



GLMRIS—Brandon Road

Appendix C - Risk Assessment



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**US Army Corps
of Engineers®**
Rock Island &
Chicago Districts

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Appendix C – Risk Assessment

Table of Contents

ATTACHMENT 1: PROBABILITY OF ESTABLISHMENTC-2

**ATTACHMENT 2: SENSITIVITY ANALYSIS FOR
ASIAN CARP POPULATION SIZESC-237**

Attachment 1: Probability of Establishment

Introduction

This appendix describes the process by which the probabilities of establishment ($P(\text{establishment})$) for Asian carp (both Bighead and Silver carp) and *A. lacustre* were estimated, as well as the results of that process. Each species is addressed separately, with the Bighead and Silver carp process described first, followed by the *A. lacustre* process. Each species narrative is developed as follows:

- Estimating $P(\text{establishment})$
- The Experts
- The Elicitation
- The Model
- The Composite Expert
- The Results
 - Probability of Establishment If No New Federal Action Is Taken (No New Federal Action Alternative)
 - $P(\text{establishment})$ Estimates by expert associated with each alternative Using Individual Expert Opinions
 - $P(\text{establishment})$ Estimates by alternative Using Individual Expert Opinions
- Comparison of the Technology and Nonstructural Alternative to the No New Federal Action Alternative

Bighead and Silver Carp

Estimating $P(\text{establishment})$

The GLMRIS Risk Assessment provided qualitative estimates of the $P(\text{establishment})$ of Bighead and Silver Carp. The overall $P(\text{establishment})$ was defined in that document as consisting of five probability values using conditional notation:

$$P(\text{establishment}) = P(\text{pathway}) \times P(\text{arrival} | \text{pathway}) \times P(\text{passage} | \text{arrival}) \times P(\text{colonization} | \text{passage}) \times P(\text{spread} | \text{colonization})$$

Each of the probability element values assumes that the preceeding element has occurred (e.g. passage must occur for colonization to be possible). The probability of these independent events is, hereafter, represented more simply as:

$$P(\text{establishment}) = P(\text{pathway}) \times P(\text{arrival}) \times P(\text{passage}) \times P(\text{colonization}) \times P(\text{spread}).$$

The establishment elements are generally defined as:

- P(pathway) - the probability that a complete aquatic pathway is available for interbasin transfer between the Mississippi River Basin (MRB) and Great Lakes Basin (GLB) through the Chicago Area Waterway (CAWS) aquatic pathway;
- P(arrival) - the probability of Bighead and Silver Carp arriving in the Dresden Island Pool located upstream of Dresden Dam to below BRLD;
- P(Passage) – the movement of Bighead and Silver Carp through the CAWS from below BR to Lake Michigan;
- P(colonization) - the probability of Bighead and Silver Carp colonizing in Lake Michigan, and;
- P(spread) - the probability of Bighead and Silver Carp spreading beyond Lake Michigan and into the other Great Lakes.

The values for P(arrival), passage, P(colonization), and P(spread) were obtained via expert elicitation as these values are currently unknown and there was no reasonable expectation of such data becoming available in the near-term.

Initially, it was envisioned that the independent probability values would be multiplied to give an estimation of the overall P(establishment). However, it was not possible to multiply the five probability values due to the biological complexities of Bighead and Silver Carp establishment in the GLB. For example, the number of fish that could pass from BRLD into Lake Michigan is influenced by the number of fish below BRLD. Therefore, passage must be estimated for multiple P(arrival) scenarios, each with different assumptions about the numbers of Bighead and Silver Carp that arrive below BRLD. Similarly, passage could not be defined as the probability that any one fish passes into Lake Michigan, because more than one fish is required for colonization to occur.

To account for these and other complexities, several variations of the basic P(establishment) model were considered. The ideal quantitative model, one that would include a dynamic population model capable of allowing fish to grow, reproduce, die off, find habitat and each other, was not within the time and budget constraints of the GLMRIS-BR. Therefore, a P(establishment) model that utilized quantitative values elicited from ANS experts was developed. It was necessary that the model reliably enabled the team to distinguish among the six GLMRIS-BR Alternatives. The questions the model needed to answer in a credible way were:

- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the No New Federal Action Alternative is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Nonstructural Alternative is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Technology Alternative-Electric Barrier is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Technology Alternative- Complex Noise is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Technology Alternative- Complex Noise with Electric Barrier is implemented?
- What is the probability of establishment of Bighead and Silver carp by 2021/2031/2071 if the Lock Closure Alternative is implemented?

With answers to those questions it would be possible to investigate the answers to many other questions, such as the risk reduction attributed to any plan.

The Experts

An expert elicitation was needed because there was and is no credible data for several of the model inputs. An expert elicitation was the most cost-effective and reliable way to characterize the uncertainty about the P(establishment) values for the ANS control alternatives. Six experts were identified to participate in the Bighead and Silver carp elicitation, they are:

- Duane Chapman, US Geologic Survey, Columbia Environmental Research Center
- Greg Conover, U.S. Fish and Wildlife Service, Large Rivers Fisheries Coordination Office, Midwest Region
- Kevin Irons Aquatic Nuisance Species Program Manager, Illinois Department of Natural Resources
- Jack Killgore, US Army Corps of Engineers, U.S. Army Engineer Research and Development Center, Environmental Laboratory
- Nicholas Mandrak, Department of Biological Sciences, University of Toronto Scarborough
- Greg Sass, Escanaba Lake Research Station, Wisconsin Department of Natural Resources.

The alphabetical order in which the experts are listed here does not correspond to the expert numbers that follow. The CV's of the experts are found in Addendum 1 to this appendix.

The Elicitation Process

Once the expert panel was assembled they were provided with a read ahead package of reference materials and factsheets describing:

1. The Elicitation Methodology
2. Brandon Road Lock and Dam (BRLD)
3. Existing Electric Barriers at Romeoville, IL
4. General Information on Bighead and Silver Carp
5. Current Activities
6. No New Federal Action Alternative
7. Nonstructural Alternative
8. Technology Alternative - Electric Barrier
9. Technology Alternative - Complex Noise
10. Technology Alternative - Complex Noise and Electric Barrier
11. Lock Closure
12. Pertinent Literature References.

The expert elicitation process took place at the Chicago District Offices from November 30 through December 4, 2015. The elicitation process began with a three day meeting of the experts with study team members, the elicitations were then conducted over the next few days. The purposes of the three-day meeting included:

- Site visits to BRLD for the expert panel

- Providing experts an opportunity to learn details of the alternative plans from top domain experts
- Discussion and information sharing about Bighead and Silver Carp and alternative plans among the experts
- Arriving at common assumptions, where assumptions were needed
- Training with the elicitation technique.

Highlights of the three-day pre-elicitation meeting included group discussions of the following topics:

- Operation of BRLD
- Aquatic nuisance species of concern overview
- FluEGG model
- Barge entrainment of fish at the existing electric barrier
- Influential factors for Bighead and Silver Carp arrival at BRLD including the four population arrival scenarios
- Operation and weaknesses of the electric dispersal barrier at Romeoville, IL
- 2-D hydraulic modeling of BR L&D approach channel and conditions under which fish can be carried across the barrier
- No New Federal Action Alternative
- Influential factors for Bighead and Silver Carp passage from BR L&D to Lake Michigan via the CAWS under FWOP conditions
- Nonstructural Alternative overview
- Technology Alternative-Electric Barrier overview, included the flushing lock and fish entrainment
- Technology Alternative -Complex Noise overview including laboratory and field trials
- Technology Alternative- Complex Noise and Electric Barrier overview
- Lock Closure Alternative overview
- Influential factors for Bighead and Silver Carp passage from BR L&D to Lake Michigan via the CAWS with alternatives
- Hydraulic and water-quality data collection for the investigation of Great Lakes tributaries for Bighead and Silver Carp spawning and egg-transport suitability
- Could a Bighead and Silver Carp population establish in the Great Lakes from a small introduction?
- Influential factors that impact Bighead and Silver Carp Colonization
- Influential factors that impact Bighead and Silver Carp spread
- Recap of elicitation process/alternatives
- Elicitation process and calibration exercise.

For a description of the alternatives, refer to the main report, chapter 6, Alternative Formulation. Following most of these discussions the experts identified the key factors and assumptions for each discussion. These were recorded and reviewed with the expert before and during the individual elicitations as appropriate.

The Elicitation

An elicitation provides useful information but it does not provide answers. An elicitation does not create new knowledge. It is not appropriate to treat an elicited value, range of values or distribution of values

as “a fact.” Rather, the numerical values elicited from the experts were used as inputs to the P(establishment) model described below.

When faced with uncertainty, especially in controversial or emergency situations, decision-makers seek agreement or a clear consensus from experts. However, it is not always reasonable to expect consensus on a difficult question, especially the prediction of chance events—floods, hurricane landings and paths, failure of components and infrastructure, and establishment of aquatic nuisance species (Aspinall, 2010).

Consensus is not certainty. Efforts to force experts who disagree to agree or reach consensus may dampen the value of the work of the elicitation, because the goal of an elicitation is to quantify uncertainty, not to disguise it through forced consensus. When multiple estimates exist the multiple estimates can be used individually in the analysis to help define the range of impacts that can be expected. The multiple estimates can also be pooled to define the range of uncertainty. Both individual and composite expert results are presented in this appendix.

The actual elicitations were conducted individually with each expert in the days following the three-day meeting. The elicitation team consisted of one expert panel member, one Bighead and Silver Carp domain expert, one USACE alternative plan domain expert, and one elicitation facilitator. The domain experts were available to answer any questions that arose for the expert panel member.

Before each new quantity or scenario was elicited, the panel expert was reminded of the key factors identified by the plenary panel of the experts and a summary of the features of each plan scenario was provided.

The elicitation consisted of a series of questions related to the P(establishment) elements. Responses to these questions were elicited for each of the six alternatives. Each expert provided numerical estimates for the following:

- Probability that Asian carp populations sizes (negligible, small, medium, large) would arrive at BRLD under the No New Federal Action Alternative and the Nonstructural Alternative scenarios for three time frames 2021, 2031, 2071
- An estimate of the annual number of fish that would pass from below BRLD into Lake Michigan under three carp population sizes for each of six alternative future scenarios
- An estimate of the cumulative threshold number of fish that would have to enter Lake Michigan by 2021, 2031, and 2071 that could result in colonization
- An estimate of the probability that Asian carp spread beyond Lake Michigan given that a colony is established.

The complete set of twenty-six questions are included in Annex 1 to this Appendix. The expert’s responses were recorded on an input sheet in a spreadsheet file that was visible to the expert at all times. Following each question the expert was queried about the main considerations that shaped their response. Experts were informed they could change their initial answers at any time they desired and were encouraged to do so including after the conclusion of the elicitation. After providing answers to the questions, each expert was shown how the model would use their inputs to calculate the probabilities of colonization and establishment. The experts were told they would be provided with a summary of the results obtained from their expert opinions and at that time they would have the option

of revisiting any or all of their answers to the elicitation questions. Once these probabilities were estimated each expert was given the opportunity to review the results of their model runs as reasonably representative of their views. Only one expert chose to modify his inputs as a result of the calculations.

In January 2016, new sampling data became available that indicated three Silver Carp larvae were found in the Dresden Island Pool of the Dresden Island Pool, and Asian carp eggs (either Silver or Bighead Carp) were identified in the Marseilles and Starved Rock pools of the Illinois River. These detections are within areas that Bighead and Silver Carp have historically been captures; however, the larval fish capture was approximately 90 miles upstream from prior detections. See

<http://www.asiancarp.us/news/CarpEggs.htm>. Every member of the expert panel was provided with the new data and afforded an opportunity to modify any or all parts of their elicitation. One of the six experts opted to modify his elicitation values.

The next section describes how the elicited values were used in the model to estimate the probability of establishment.

The Model

A numerical model was constructed using Microsoft Excel and Palisades @Risk software. The logic of that model is presented in the following paragraphs and figures. Twenty-eight Input quantities were estimated individually by the experts. These input values were used to generate 28 probability distributions for each expert that characterized the expert's uncertainty about each quantity. The model, described below, estimates a number of fish that could pass through the CAWS using population arrival and fish passage quantities from the experts. That number of fish is compared to a colonization threshold value. The model is iterated to obtain an estimate of $P(\text{colonization})$, which when multiplied by the $P(\text{spread})$ yields an estimate of $P(\text{establishment})$. The model was run separately for each expert.

Figure 1 introduces the initial calculations of the simulation model. The values in column C of Figure 1 are randomly generated from each expert's cumulative distribution function (CDF) that was provided in answer to the following question:

"Considering the currently existing system that is in place, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could pass from below the dam to Lake Michigan in a year?"

The expert provided a minimum and maximum quantity as well as 33rd and 67th percentile values. In a similar fashion, the annual fish quantities found in columns D and E, were derived from the expert's CDF's derived from similar questions for medium and large populations. Each iteration of the model generated a different and unique pattern of fish that could make their way through the existing pathway from below BRLD into Lake Michigan. Thus, the number of fish that make their way along that pathway depends very directly on the size of the population of Bighead and Silver Carp that arrives downstream of the lock and dam.

	A	B	C	D	E	F	G	H	I	J
1	Blue values indicate inputs, these values are derived from the input page									
2										
3	Green values indicate calculations, these values are calculated from other values in the model									
4										
5	Red values are outputs of special interest									
6										
7										
8										
9			Small Population	Medium Population	Large Population			Population Size Arrived		
10	Year	Fish/Yr	Fish/Yr	Fish/Yr				2021	2031	2071
11	2015	74	655	3299		Population size		1	2	3
12	2016	29	220	370		Population Sequence		1	2	3
13	2017	126	194	2237		Negligible		0	0	0
14	2018	51	453	2248		Small		506	539	1844
15	2019	135	799	2764		Medium		2624	1364	15905
16	2020	72	170	389		Large		14468	21757	54050
17	2021	19	133	3161		Select		506	1364	54050
18	2022	88	11	3111		Sum of fish		506	1870	55920
19	2023	85	59	79						
20	2024	7	54	2800						
21	2025	38	424	3131						
22	2026	58	21	2819						
23	2027	57	62	1809						
24	2028	88	255	360						

Figure 1: A portion of the model used to estimate the probability of establishment of Bighead and Silver Carp

Figure 2 shows an example of a CDF used to generate the values in column C. This distribution was constructed using the four values elicited from the expert. Each cell in column C has a copy of this CDF. A value is randomly selected from this distribution and displayed in the model. In a similar fashion, there is a CDF for each cell in columns D and E through the year 2071. For the GLMRIS-Brandon Road Study, USACE utilized a 50-year period of analysis. However, in order to most realistically represent ANS establishment, the probability of establishment model incorporated all years beginning in 2015 (when the elicitation was conducted) through 2071.

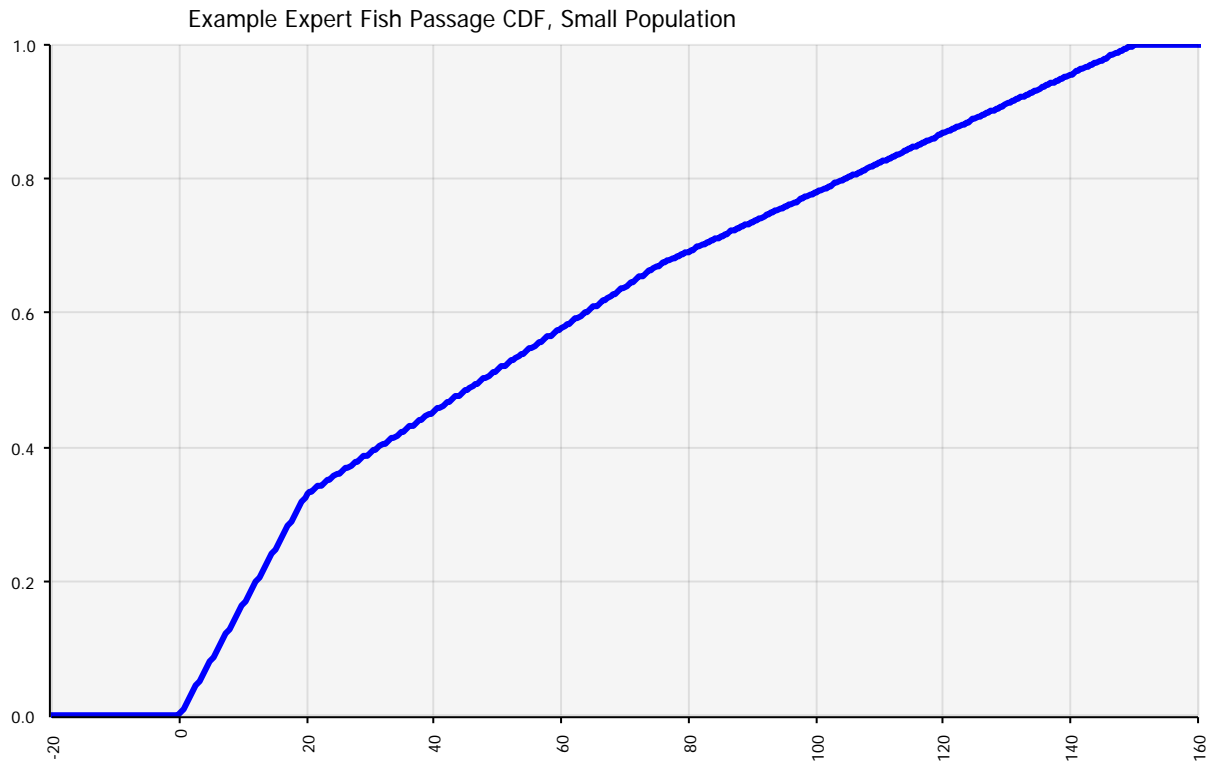
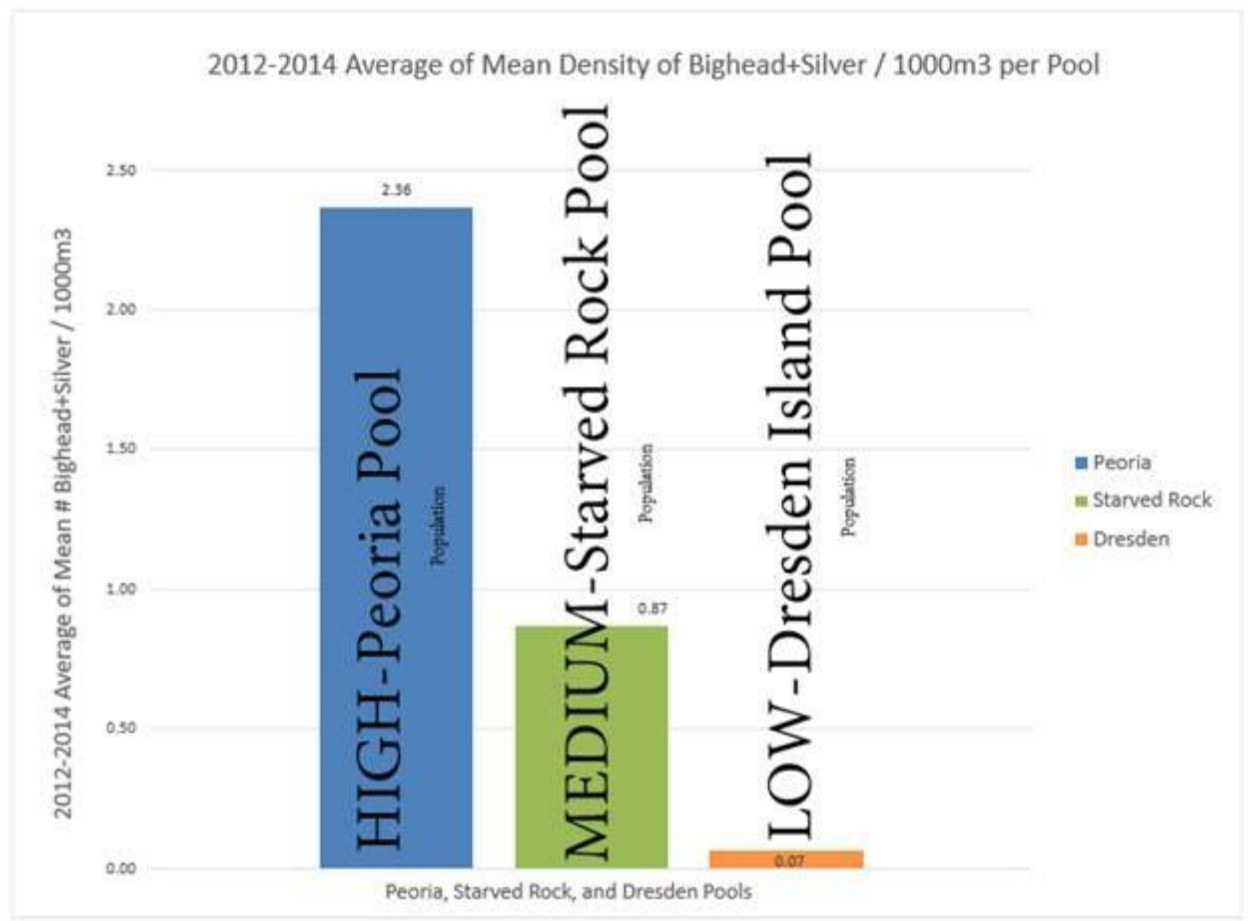


Figure 2: CDF of fish passage given a small population of Bighead and Silver Carp have arrived below Brandon Road Lock and Dam

Cells G9 through J12 in Figure 1 indicate how the model estimates the size of the population that has arrived below the lock and dam. In the iteration shown it is assumed that a small size population density (1) exists from 2015-2021, a medium population density (2) exists from 2022-2031 and a large population density (3) is present from 2032-2071. The population densities for small was equal to population density in the Dresden Island Pool; medium was equal to the population density of the Starved Rock Pool; and high was equal to the population density of the Peoria Pool. The densities were based on Asian carp monitoring data collected between 2012-2014 as displayed in Figure 2b (Coulter, 2015)¹. Row 12 assures that this sequence of population sizes never gets smaller over time. Hence, for example, a sequence of negligible (0), large (3), small (1) populations density is not possible, it would be changed to (0), (3), (3). Figure 3 shows the probability of different fish population densities arriving below BRLD during the period 2032-2071 as a discrete distribution, constructed from weights provided by the expert.

¹ Coulter, D., 2015, E-mail communication, Southern Illinois University, Dec. 2.



These probabilities of arrival differ for each of the three time periods. They were arrived at by asking the experts:

When thinking about the number of Bighead and Silver Carp that could arrive at Brandon Road by the year 2021, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):

Negligible Population _____

Small Population _____

Medium Population _____

Large Population _____

TOTAL 100 Points

Probability of Different Size Carp Populations Arriving at BRLD 2032-2071

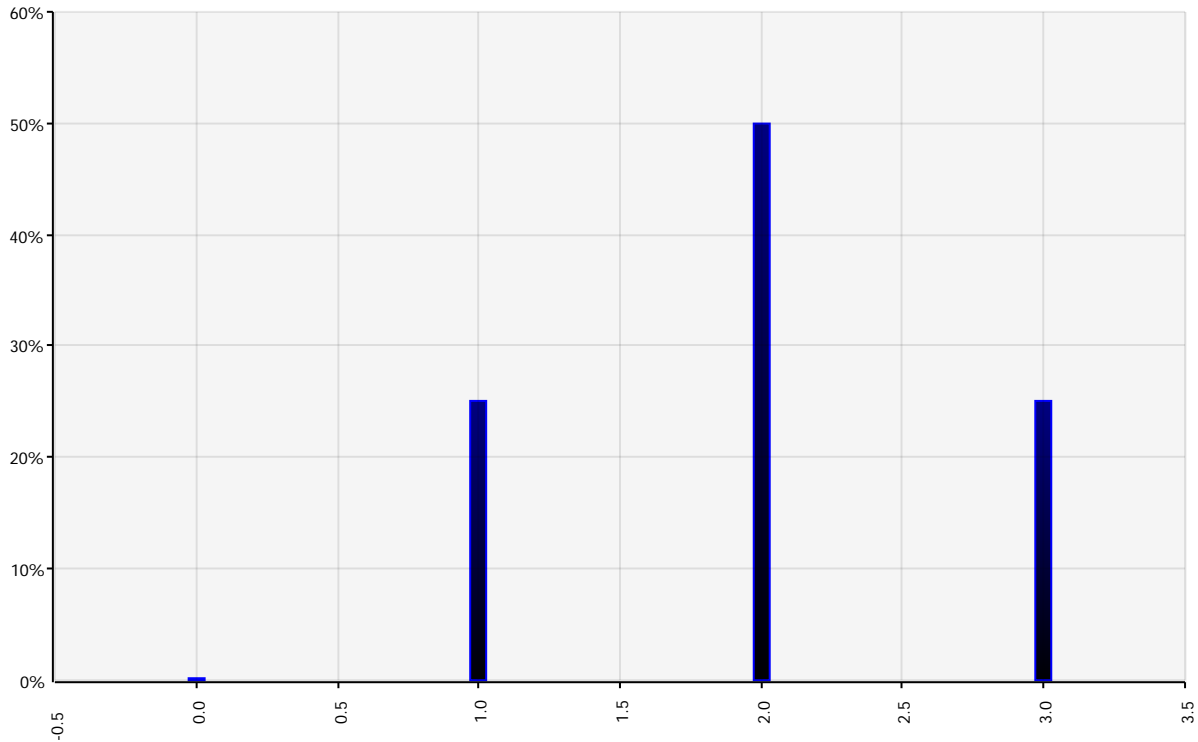


Figure 3: Expert estimation of the probability of arrival for negligible (0), small (1), medium (2), or large (3) carp populations for the period 2032-2071 below Brandon Road Lock and Dam

Model Verification and Validation

The model was carefully verified on a cell-by-cell basis by a team member not involved in the model's construction. When neither the inputs nor the outputs of a model can be validated, as was the case for this model, the best option is to try to validate the reasonableness of the process. This face validity asks experts to examine the model or its results to determine if they are reasonable.

The model was examined by a USACE model review team and found acceptable for use. Thus, the model was subjected to face validity. The elicitation experts were presented with the results of the model for their inputs and asked if they were acceptable. All experts agreed to the model outputs presented. Thus, the model results were subjected to face validity.

Cells G13 through J16 in Figure 1 simply sum the number of fish for a population of a given size and a given time frame. Thus, cells C11 through C17 sum to 506 fish. Cells H17 through J18 add up the subtotals of fish. In this iteration 506 fish get through the pathway from 2015-2021 because a small population size is present. From 2015 through 2031, 1,364 fish pass through the system. A total of 55,920 fish are estimated to pass through the system from 2015 through 2071. These would reflect fish of every size. After estimating the number of Bighead and Silver Carp that have passed into Lake Michigan, the next step is to determine whether that number is enough to result in the establishment of a sustainable colony of carp in Lake Michigan.

Bighead and Silver Carp colonization threshold values were generated from CDF's developed by the experts in response to the following question:

"What is smallest total number of fish that must make it to Lake Michigan between now and the end of 2021 to

convince you that those fish are, by themselves, numerous enough to colonize in Lake Michigan at some point in the future?"

The experts were asked to answer the same question for 2031 and 2071 as well. Figure 4 shows the threshold number of fish required to establish a sustainable colony by time period. These threshold values were randomly sampled from a CDF constructed of four points (minimum, maximum, 33rd and 67th percentiles) provided by the expert. For this iteration, if 4,781 or more fish enter Lake Michigan from 2015-2021 a colony will be established. If 14,340 fish enter between 2015-2032 there will be a colony established, as there will be if 47,389 fish enter the Lake between 2015 and 2071.

[illegible]

Figure 4: Colonization threshold values and colonization check where 0 means no colonization and 1 means colonization for the time period shown.

Only 506 fish arrived by 2021 (Figure 1), that is less than the threshold 4,781 so no (0) colonization occurred by 2021 in this instance (Figure 4). However, 55,920 fish passed into Lake Michigan by 2071 (Figure 1) and that exceeds the 47,389 fish threshold for 2071, so colonization is assumed to have occurred (Figure 4). Model logic assures that if colonization occurs in an earlier period it occurs in the later periods as well.

Fifty simulations of 1,000 iterations each were run for the steps described above. Summing the zeros and ones and dividing by 1,000 a point estimate of $P(\text{Colonization})$ can be calculated for each simulation. Fifty simulations generated a sequence of 50 point estimates of the probability of colonization. For example, in the first simulation of 1,000 iterations (not shown) colonization resulted in 427 of those iterations yielding a point estimate of $P(\text{colonization})$ of 0.427. The mean of those 50 simulations is 0.440 and the standard deviation is 0.008. These two parameters, along with the Central Limit Theorem

enable us to represent the $P(\text{colonization})$ as a normal distribution that is written into the $P(\text{col})$ Distribution row seen in Figure 7 below.

Figure 5 shows an example of a cumulative distribution function used to generate a random threshold value, in this case for time 2071. Figure 6 shows an example of a sampling distribution generated for $P(\text{Colonization})$ through the 50 simulations of 1,000 iterations each.

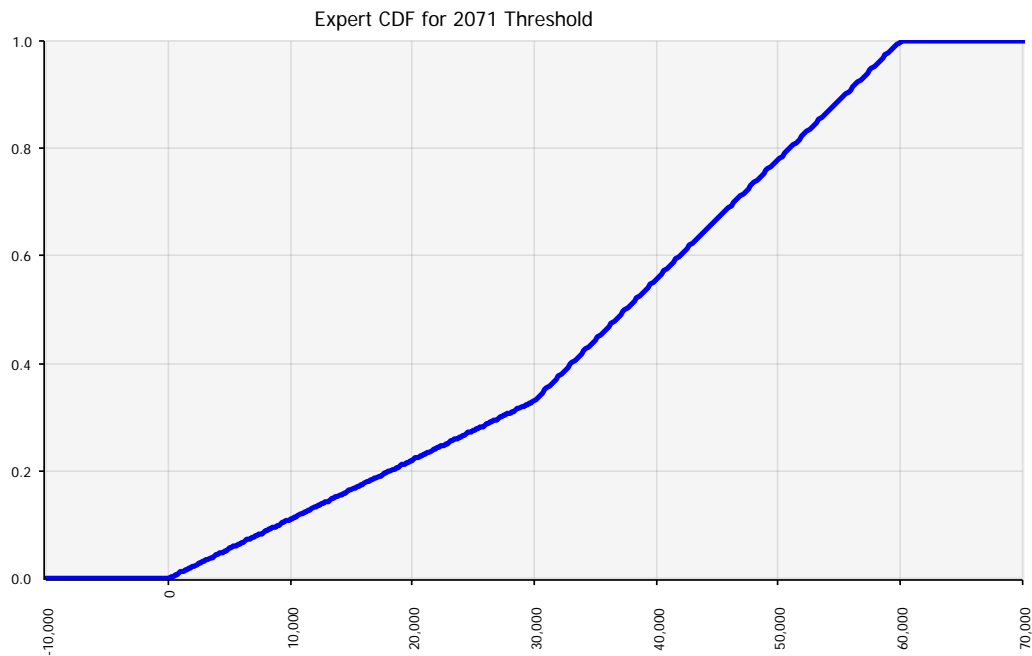


Figure 5: Expert CDF for colonization threshold for Bighead and Silver Carp entering Lake Michigan from 2015 through 2071.

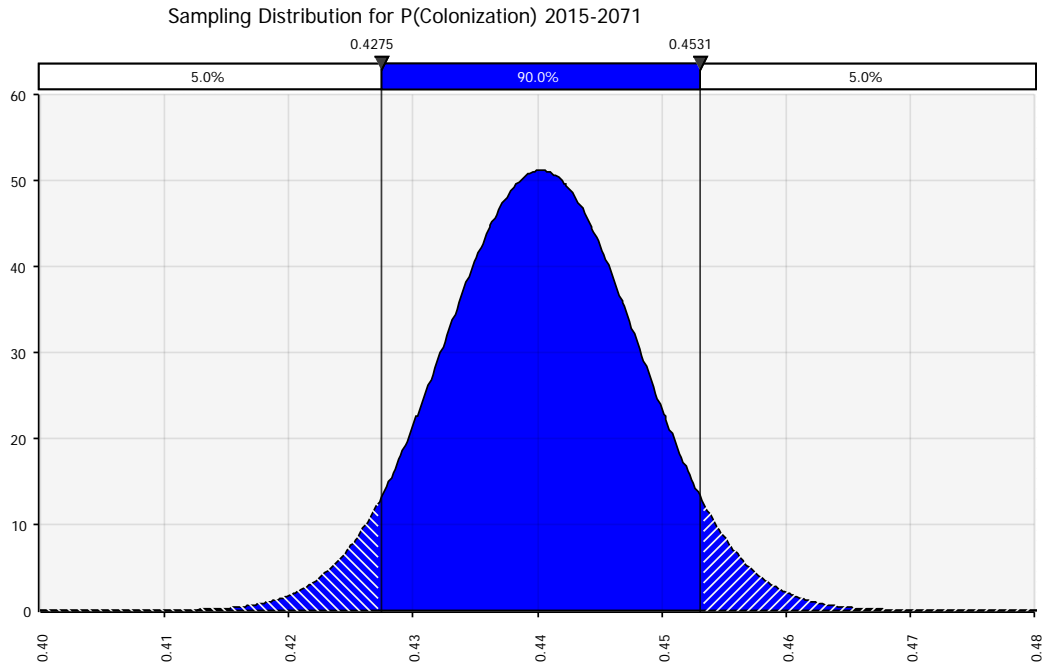


Figure 6: Sampling distribution derived for P(Colonization) for the 2015-2071 time period.

After P(colonization) was estimated, the final step was to estimate P(establishment). This was done in a second stage of the model by multiplying the P(colonization) (generated in the first stage of the model) by P(spread|colonization) to get P(establishment). Figure 7 shows a single value for P(spread|colonization) of 0.81. This spread probability was obtained by asking each expert the following:

“Assume that Asian Carp have a colony in Lake Michigan. What is the probability that Asian Carp will spread beyond Lake Michigan?”

In the model, the P(colonization) values are multiplied by the probability of spread to obtain the P(establishment) values in columns R, S, and T of Figure 7 in a simulation of 10,000 iterations.

Q	R	S	T
Probability of Spread			
0.808246077			
	2021	2031	2071
P(Est)	0.032597	0.10863533	0.352522
50 simulations of 1000 iterations were run to obtain the sampling distribution of P(Col) below.			
P(Col) Distribution	0.04033	0.13440873	0.436157

Figure 7: P(colonization) and P(establishment) calculations in the model spreadsheet.

The calculations described above were performed for each of the six Alternatives: No New Action, Nonstructural, Technology Alternative-Electric Barrier, Technology Alternative-Complex Noise, Technology Alternative-Complex Noise with Electric Barrier, and Lock Closure. The results for the No New Federal Action Alternative are shown in Figure 8. The sample output in Figure 8 is derived from numerical values provided by a single expert. Each expert had a uniquely shaped distribution that was uniquely located on the zero to one probability scale. Six different experts were elicited and each expert provided inputs for the six different Alternatives. The ANS control alternatives act on the arrival and passage components of P(establishment). For example, the alternative control measures could alter the probability of the arrived population by size or affect the numbers of fish that could pass through the system. These different values would lead to different values of P(establishment) for each ANS control alternative.

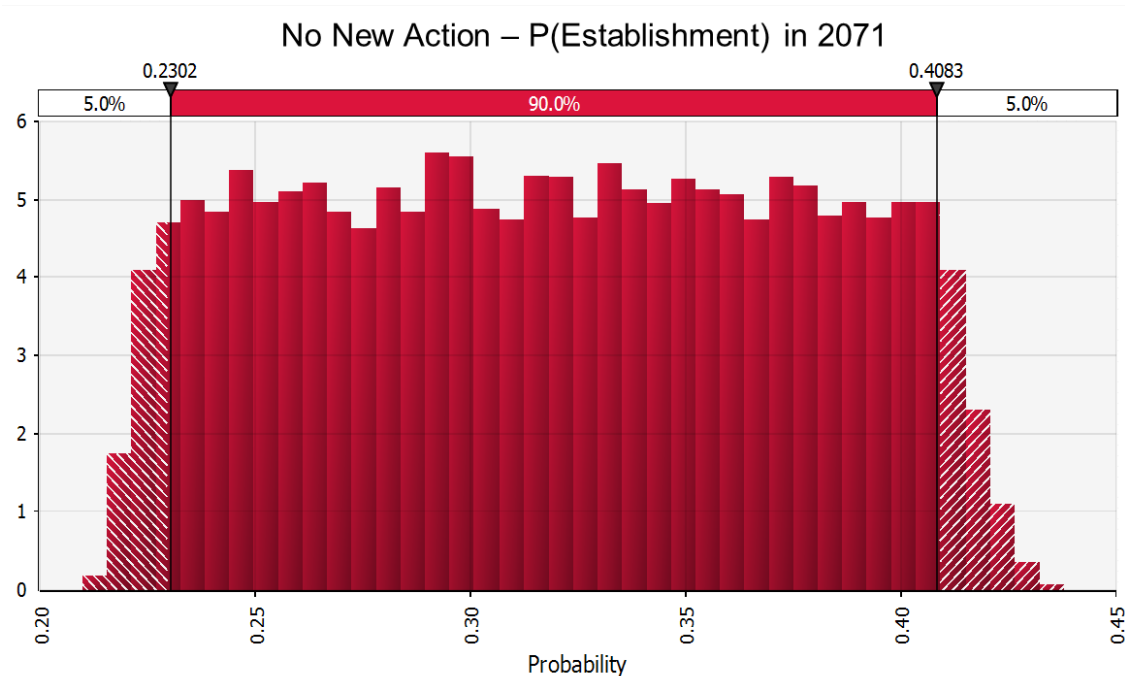


Figure 8: Sample model output showing P(establishment) in 2071 for a selected expert for the No New Federal Action Alternative condition.

The Composite Expert

When multiple estimates are available from multiple experts, it is common practice to aggregate the results of the expert elicitations. That can be done using behavioral methods, which rely on having the experts interact together to construct a single estimate. That was not an appropriate choice for GLMRIS-BR because the team was aware of and wanted to demonstrate the range of opinions (i.e. uncertainty) that exist about the likelihood of carp becoming established. Instead a mathematical aggregation of the results was used. Bolger and Rowe (2015) concluded that the costs of weighting the experts outweighs the benefits of doing so. Simple averaging of the model outputs for each expert was used because each expert was considered equal in credibility so equal weights were assigned to each. This method obtained “x” values for the minimum and maximum values and for percentiles 1, 5, 10, ..., 95, 99. The x values were averaged across percentiles to obtain a composite expert. While the use of a linear opinion pool like this is widely debated in the literature there are several references supporting the use of a simple average:

- Bolger, Fergus and Rowe, Gene. (2015). The Aggregation of Expert Judgment: Do Good Things Come to Those Who Weight? *Risk Analysis*, Vol. 35, No. 1, pp. 5-11.
- Cooke, Roger M. (1991). *Experts in Uncertainty: Opinion and Subjective Probability in Science*. New York, Oxford University Press.
- O’Hagan, Anthony, Buck, Caitlin E., Daneshkhah, Alireza, Eiser, J. Richard, Garthwaite, Paul H., Jenkinson, David J., Oakley, Jeremy E., Rakow, Tim. (2006). *Uncertain Judgements: Eliciting Experts’ Probabilities*, West Sussex, John Wiley & Sons.
- Vose, David. (2008). *“Risk Analysis A Quantitative Guide.”* 3rd ed. West Sussex: John Wiles & Sons.

The composite expert represents the average of all six experts and as such it is not representative of any one expert. However, the composite expert values are useful because they facilitate the comparison of the P(establishment) values for the six Alternatives. In this Appendix, the P(establishment) model outputs are presented for both individual experts and the composite expert.

Results

The probabilities presented in the sections that follow were not directly provided by the experts. They were directly estimated using values provided by the experts as inputs to the model described above. Thus, it is most proper to characterize these values as estimates based on the experts' opinions.

Probability of Establishment If No New Federal Action Is Taken (Federal Without Project Condition)

Figure 9 shows the P(establishment) of Bighead and Silver Carp in the GLB based on inputs from the six experts and the composite expert as a box and whisker plot. The solid box in the center captures the middle 50% of all values. The whisker to the left depicts the lowest 25% of values, the whisker to the right depicts the highest 25% of values. Dots to the left or right of the whiskers indicate outlier values, the dots should be thought of as extensions to the whiskers. The span of the box and whisker plot is indicative of the uncertainty generated with the expert's inputs, but the span also depends on the scale of the axis, which changes in some figures that follow. The model output indicated that there was less than a 10% chance that Bighead and Silver Carp will become established by 2021, the earliest date by which the nonstructural plan could be in effect. Using the composite expert to characterize this uncertain value there is less than a 4% chance of establishment.

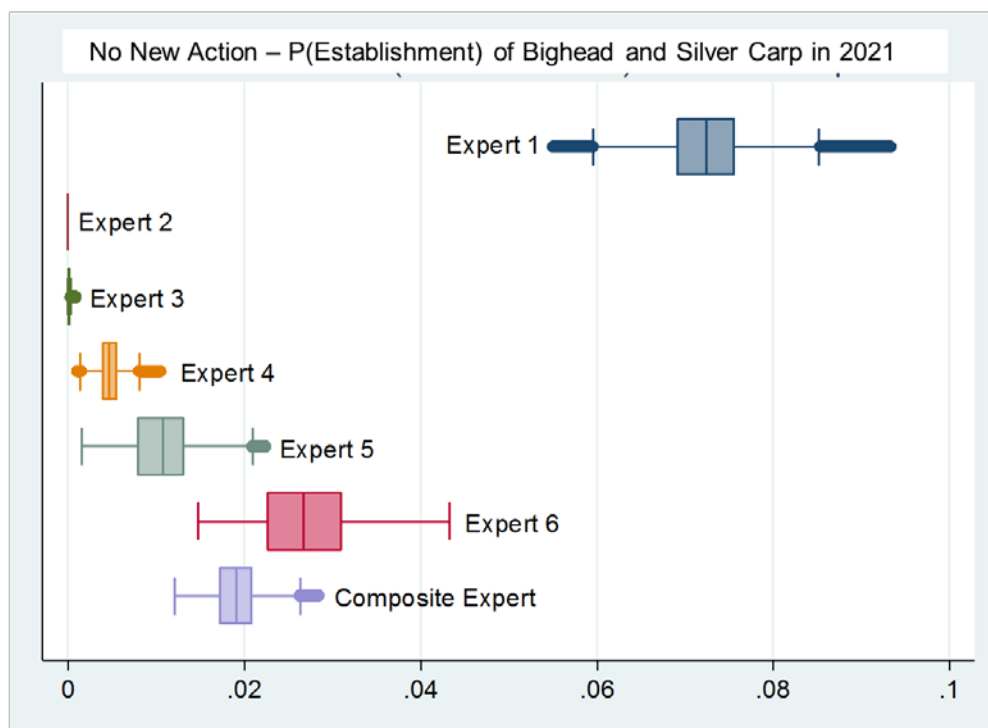


Figure 9: P(establishment) of Bighead and Silver Carp by 2021 for the No New Federal Action Alternative based on estimates provided by each expert and for the composite expert.

If the period under consideration increases to 2015 through 2031 the P(establishment) of Bighead and Silver Carp increases (Figure 10). All experts agree that P(establishment) was less than 35% at 2031. Five of the six experts have the probability at around 10% or less. The composite expert suggests the probability is about 10% or less (Figure 10).

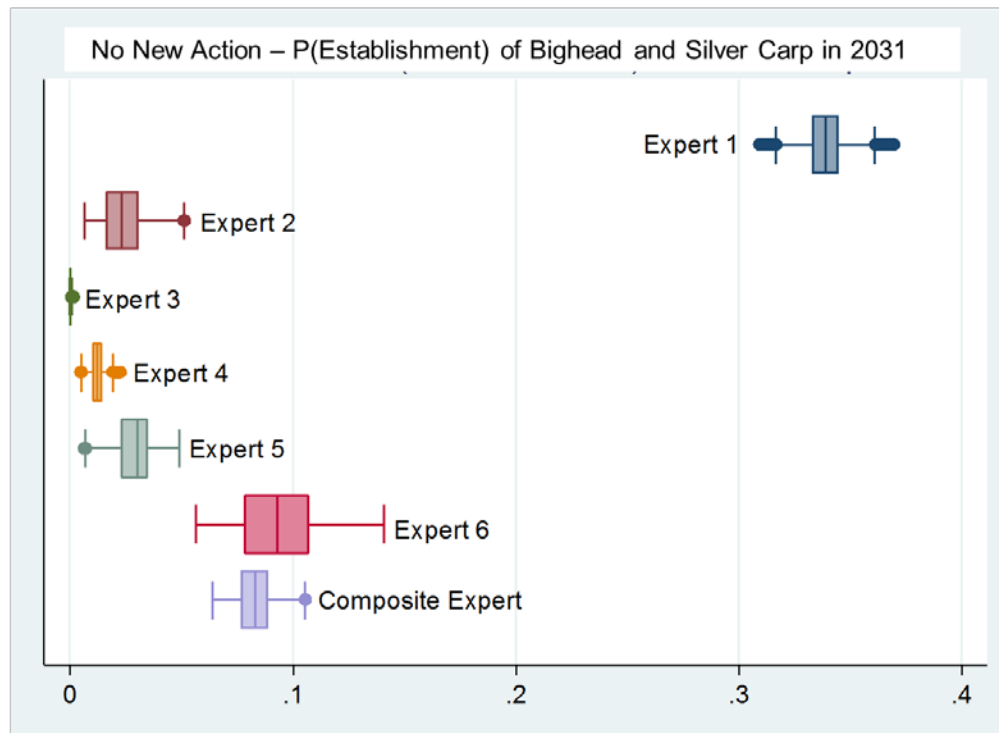


Figure 10: P(establishment) of Bighead and Silver Carp by 2031 for the No New Federal Action Alternative based on estimates provided by each expert and for the composite expert.

The P(establishment) by 2071 is subject to the greatest uncertainty (Figure 11). One expert (1) shows establishment as virtually assured while three experts suggest there is less than a 5% chance of establishment. The estimates for the other two experts are much less certain about the outcome. Using the composite expert the P(establishment) by 2071 is between 22 and 36%.

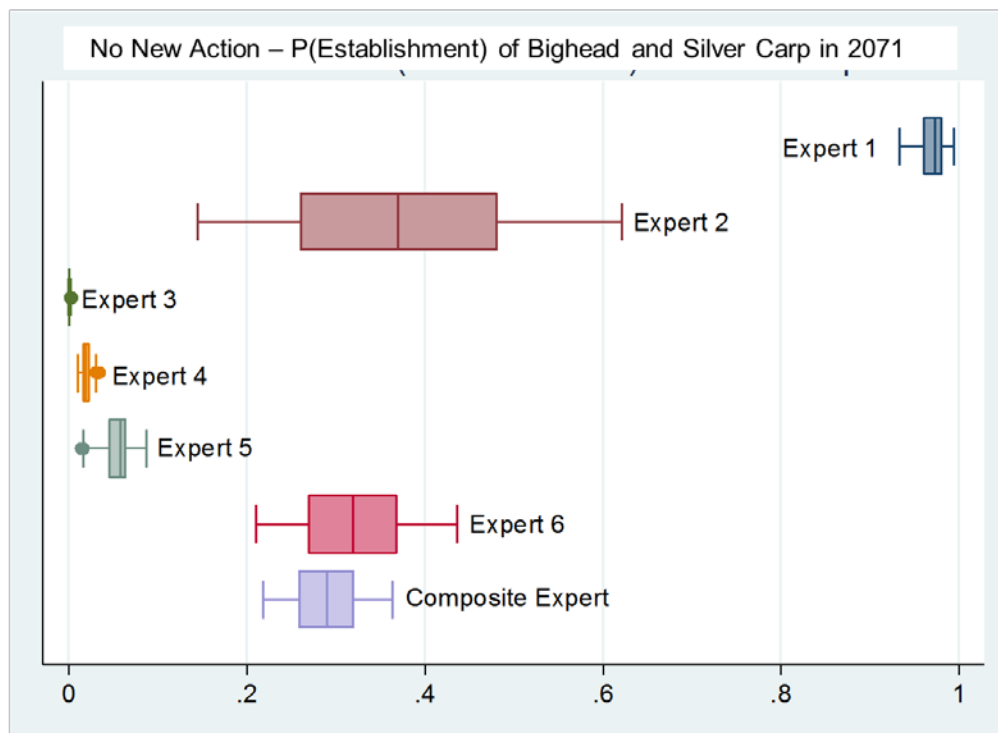


Figure 11: P(establishment) of Bighead and Silver Carp by 2071 for the No New Federal Action Alternative based on estimates provided by each expert and for the composite expert.

If we use a 50% chance of establishment as the equally likely point and the most uncertain value of all, then this analysis suggests that most expert-based probability estimates consider the establishment of Bighead and Silver Carp in the Great Lakes to be more unlikely than likely. No estimate exceeded 0.5 for the time periods 2021 and 2031. Estimates based on expert 1's opinions suggest establishment is highly likely. The upper range of estimates based on expert 2 also exceed a 0.5 chance. Most of expert 2's values and all of those of the other four experts were less than 0.5.

There are considerable differences among the estimates obtained from the expert opinions, suggesting there is a great deal of uncertainty about whether Bighead and Silver Carp will establish in the GLB. The inputs provided by Experts 3, 4, and 5 resulted in low estimates of P(establishment), with no estimate in excess of 5% and many far less than that. In contrast, the opinions of Expert 1 lead to a P(establishment) estimate between 93 and 99%. The two intermediate calculations for experts 2 and 6 tend toward the lower half of the probability spectrum. The results indicate that any preconceived belief about the likelihood of Bighead and Silver Carp establishing could be supported by the opinion of at least one of our experts.

Despite this uncertainty, a composite expert has been created by taking the average of all six experts (Figure 12)². Table 1 provides a numerical summary for the composite expert estimate of P(establishment) under the No New Federal Action scenario for three time periods.

² The CDF for each expert is displayed and x values are averaged for the minimum, 1st, 5th, 10th, 15th, ..., 95th, 99th percentiles and the maximum value to construct a composite expert CDF.

Table 1: Composite expert estimates of P(establishment) of Asian carp under the No New Federal Action scenario for three time periods. The probability that Asian Carp will become established in the Great Lakes at some point in the future because of what happens between now and 2071 is uncertain. That chance is between 22% and 36%.

	Composite Expert No New Federal Action Scenario		
	P(est) 2071	P(est) 2031	P(est) 2021
Minimum	0.22	0.06	0.01
1 st Quartile	0.26	0.08	0.02
Median	0.29	0.08	0.02
3 rd Quartile	0.32	0.09	0.02
Maximum	0.36	0.11	0.03

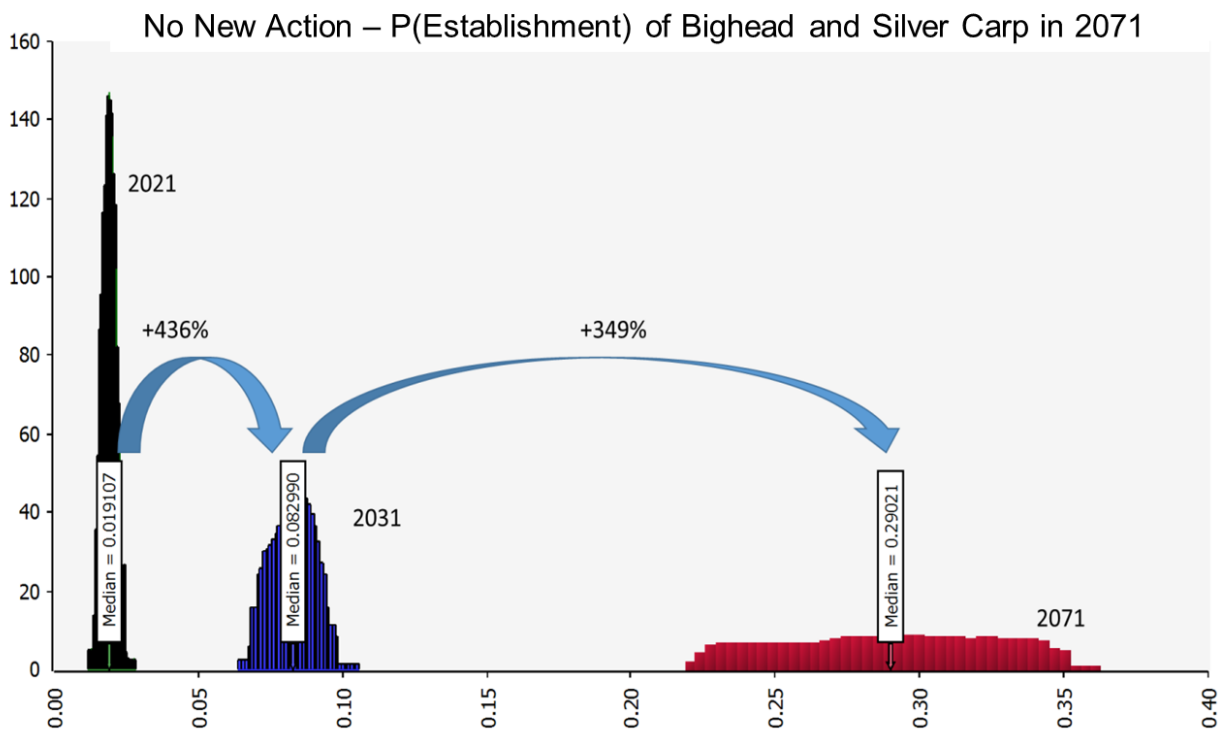


Figure 12: Composite expert P(establishment) estimates for the No New Federal Action Alternative at three time periods with median and percent change in median.

The composite expert estimate of the P(establishment) by 2021 was estimated at a maximum of 3% (Figure 12). The median probability of establishment quadruples (436% increase) from 2021 to 2031. The probability of establishment more than triples again (349% increase) from 2031 to 2071 where it ranges from 22 to 36% if No New Federal Action is taken. Note that the uncertainty around the P(establishment) estimate increases as the timeperiod gets farther into the future as indicated by the wider distribution (Figure 12).

P(establishment) Estimates Using Individual Expert Opinions

This section presents the individual results for each of the six Bighead and Silver Carp experts. It is important to pay careful attention to the scale of the horizontal axis of the figures, as it varies dramatically in some instances.

Figure 13 presents the results for Expert One using a box and whisker diagram. The box and whisker plots are distinctively separated, except for Technology Alternative-Complex Noise and Technology Alternative-Complex Noise with Electric Barrier. The separation indicates that these alternatives have distinctive effects based on the expert's inputs.

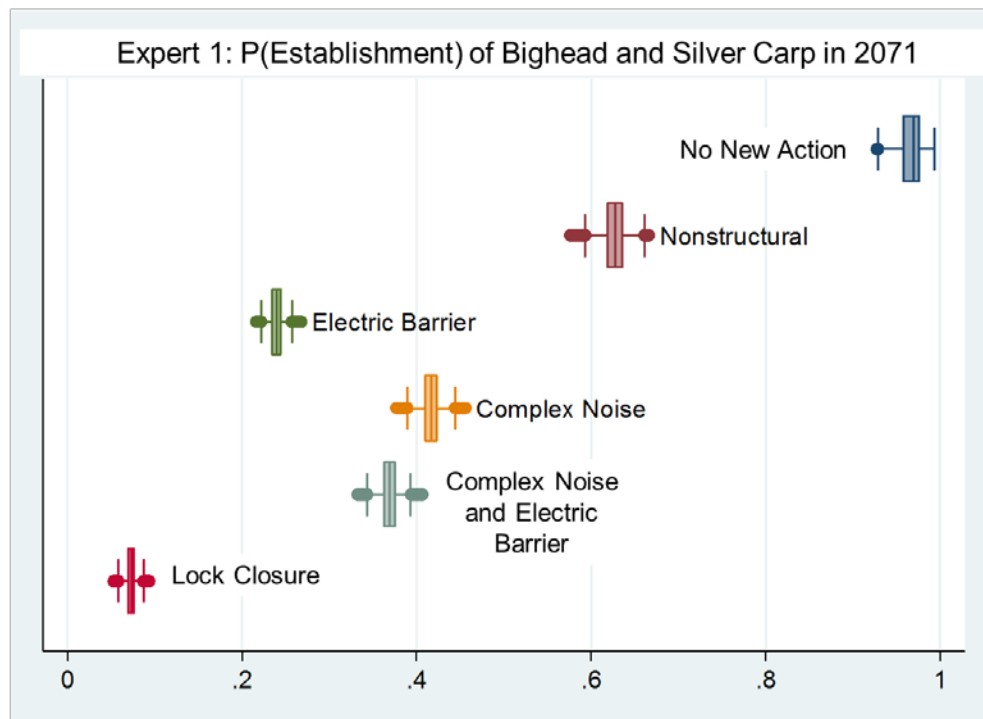


Figure 13: Bighead and Silver Carp P(establishment) values at 2071 for the No New Federal Action Alternative, Technology Alternatives, and Lock Closure Alternative estimated with input values from Expert One.

Figure 13 shows Expert One's inputs result in a high probability of establishment under the No New Federal Action Alternative. Subsequent box and whisker plots move to the left of the No New Federal Action Alternative, indicating the reductions in the P(establishment) that can be attributed to each Alternative. The P(establishment) from highest to lowest is No New Federal Action > Nonstructural Alternative > Technology Alternative-Complex Noise > Technology Alternative-Complex Noise and Electric Barrier > Technology Alternative-Electric Barrier > Lock Closure Alternative. This order of efficacy of the alternatives holds unvaryingly for all six experts, although the actual P(establishment) values vary significantly at times. Expert 1's inputs resulted in the highest P(establishment) values for all scenarios from among all the experts.

Figure 14 shows results for Expert Two. Notice the width of the box and whisker plots is greater than those for Expert One. This indicates greater uncertainty derived from Expert Two's inputs. Also note

how the scale of the horizontal axis changes from figure to figure. Expert Two's inputs led to the second highest estimate of $P(\text{establishment})$ for the the No New Federal Action Alternative and all other scenarios as well. As noted earlier, the same order of plan effectiveness prevails for all experts.

The box and whisker plots tend to overlap considerably, indicating uncertainty about the distinctive efficacy of the alternatives. If one looks at the boxes alone it is more clear that the Nonstructural and Technology Alternatives are more effective than the No New Federal Action Alternative in reducing the $P(\text{establishment})$ of Bighead and Silver Carp.

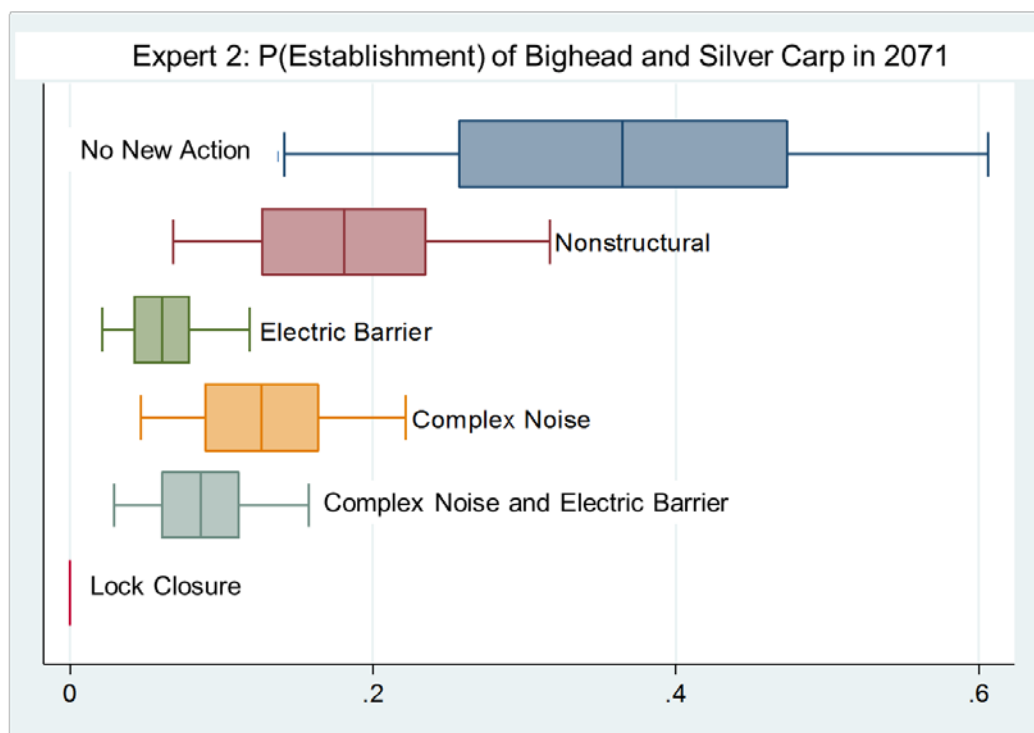


Figure 14: Bighead and Silver Carp $P(\text{establishment})$ values for the No New Federal Action Alternative, Nonstructural Alternative, Technology Alternatives, and Lock Closure Alternative estimated with input values from Expert Two.

Expert Three's inputs lead to the smallest estimates of $P(\text{establishment})$ for the No New Federal Action Alternative and all other Alternatives. Notice the horizontal scale on this figure, so the 'apparent' width of the box and whisker plots does not mislead you. There is less than a 0.4% chance of establishment based on the Expert three's inputs. This probability is so small that the plans have negligible impact in reducing the probabilities of establishment. The dots that extend beyond the rightmost whisker indicate outliers. These are values that are ≥ 1.5 times the interquartile range in distance from the median. The interquartile range is the width of the box. In this instance, the box is so narrow that outliers are common. Despite the small numbers, Expert Three's inputs provided the same order of efficacy of alternatives as every other expert.

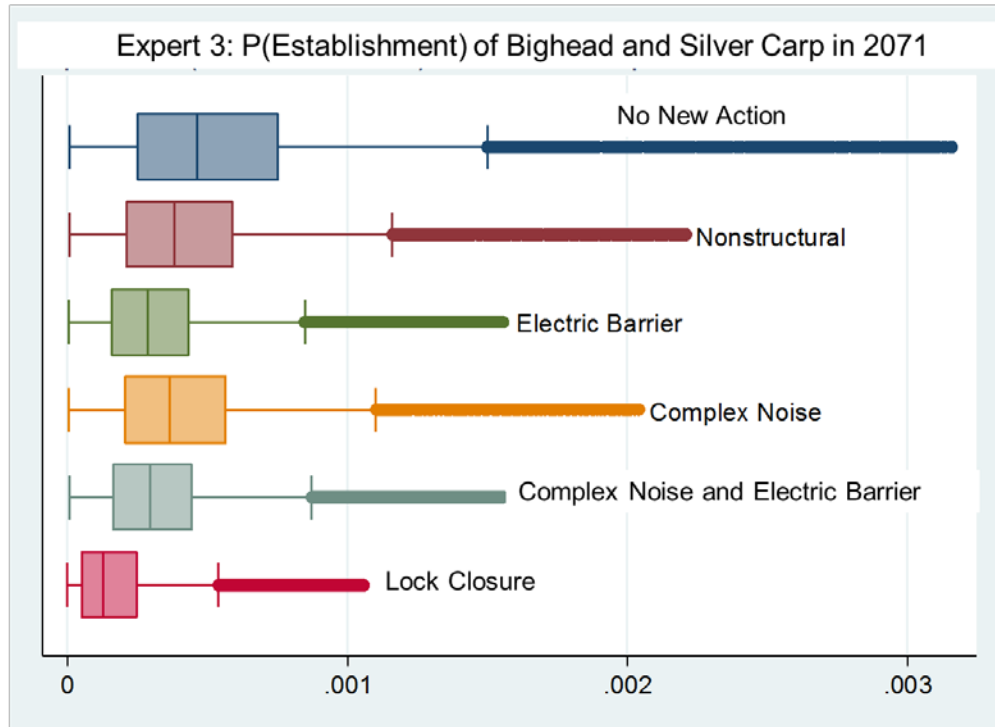


Figure 15: Bighead and Silver Carp P(establishment) values for the No New Federal Action Alternative and five other Alternatives estimated with input values from Expert Three.

Expert Four also has provided values that lead to a low P(establishment) for the No New Federal Action Alternative and all other scenarios. The P(establishment) for 2071 is less than 2%. The three technology alternatives are estimated to have effectively the same impact on reducing P(establishment), although numerically they maintain the same order of efficacy. The overlap in the boxes indicates the reduction in P(establishment) would be minimal because P(establishment) is so small to begin with.

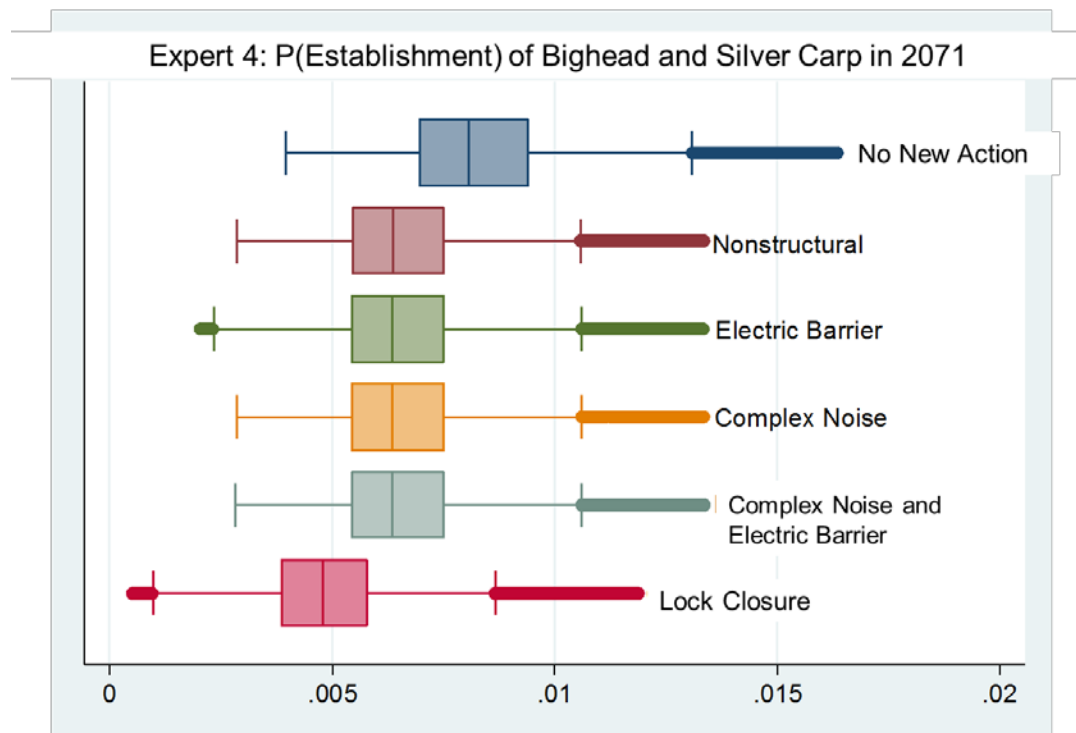


Figure 16: Bighead and Silver Carp P(establishment) values for the No New Federal Action Alternative, Technology Alternatives, and Lock Closure Alternative estimated with input values from Expert Four.

Expert Five is the third expert whose inputs provided a low P(establishment) for the No New Federal Action Alternative. It is less than 5%. Once again, because the baseline comparison probability (No New Federal Action Alternative) is so low the effects of the plans is also reduced. The order of efficacy is maintained.

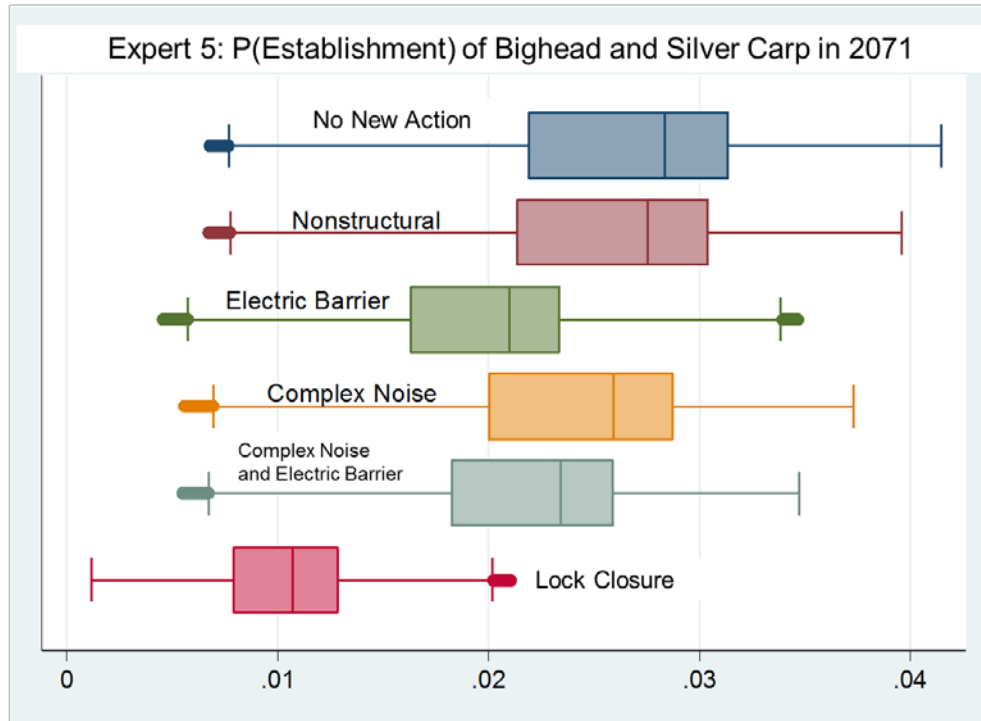


Figure 17: Bighead and Silver Carp P(establishment) values for the No New Federal Action Alternative, the Technology Alternatives, and the Lock Closure Alternative estimated with input values from Expert Five.

Expert Six results are shown in Figure 18. Expert Six's inputs lead to results that were closest to the Composite Expert results, they also exhibit the second highest extent of uncertainty based on the spread in the box and whisker plots. The Nonstructural plan is minimally effective in this expert's views, but the other plans offer distinct reductions in the P(establishment) compared to the No New Federal Action Alternative.

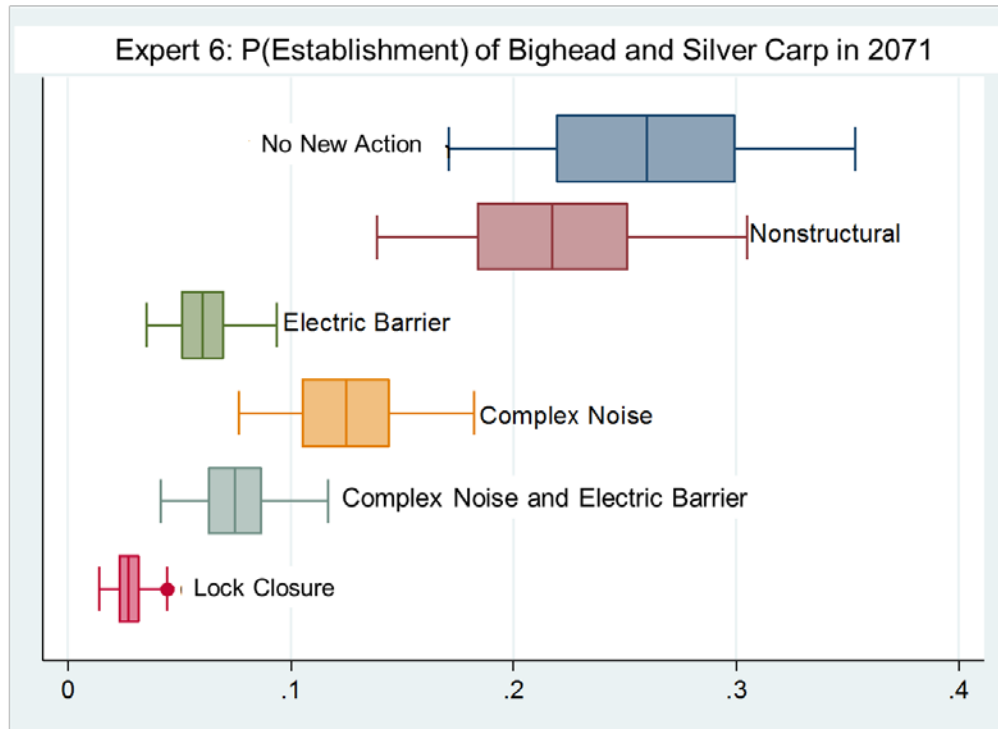


Figure 18: Bighead and Silver Carp P(establishment) values for the No New Federal Action Alternative, the Technology Alternatives, and the Lock Closure Alternative estimated with input values from Expert Six.

Three of the six expert results indicate the P(establishment) for the No New Federal Action Alternative is less than 5%. This means the probability that Bighead and Silver Carp will become established in the Great Lakes at some time in the future as a direct result of what happens between now and 2071 is less than 5%. One of the expert's results indicate the same probability is in excess of 90% (92.8 to 99.3%). The other two experts' results were the least certain and they ranged from 17.0 to 35.3% and 14.1 to 60.6%.

These results indicate that the experts are divided in their views about what will happen in the future. The uncertainty that results when considering the six experts together is so great that the resulting P(establishment) estimates range from nearly zero to nearly one. That high degree of uncertainty should not be dismissed, overlooked or ignored.

Additional Evaluations

After the describing the alternatives to the experts, the experts asked why they weren't evaluating an alternative that had the same measures as the Technology Alternative – Complex Noise with Electric Barrier but with a continuously operated electric barrier. The number of alternatives was limited to ensure the experts were not fatigued by the number of questions they were asked. At the conclusion of each elicitation, the experts were asked to rank an alternative that included the same features as the Technology Alternative – Complex Noise with Electric Barrier but with a continuously operated electric barrier rather than an intermittently operated electric barrier. They were not asked the questions that

would provide input into the model to calculate a distinctive P(establishment) value for this alternative. The expert all indicated they would rank this alternative as being similar to Technology Alternative – Electric Barrier.

Two Important Conclusions

The method used to estimate P(establishment) values results in quantitative estimates that are better interpreted as measures of the relative effectiveness of the alternatives when compared to the No New Federal Action Alternative than they are actual estimates of P(establishment). There was a great degree of spread in the P(establishment) estimates obtained from the experts' characterization of the uncertainty about the numbers of fish that would pass through the pathway under different future conditions and the numbers of fish required for colonization and subsequent spread. The range in obtained P(establishment) values spans from near zero to near one.

There are at least two very important conclusions than can be drawn from the results of the expert elicitation. First, all experts agree in the order of efficacy in the alternatives as measured by the lowest P(establishment) through 2071. From least (highest P(establishment)) to most (lowest P(establishment)) effective the alternatives are:

1. Federal No Action Plan
2. Nonstructural Alternative
3. Technology Alternative-Complex Noise
4. Technology Alternative- Complex Noise with Electric Barrier. (The electric barrier would NOT be operated when vessels are approaching the engineered channel, in the engineered channel and in the lock. Complex noise would be operated during this time.)
5. Technology Alternative- Electric Barrier (intended to be continuous operation)
6. Lock Closure

The characterizations of all six experts lead to exactly the same order. As result there is a high degree of confidence about which plans do the best job of reducing P(establishment) whatever its true value is.

Second, data from each expert show a significant reduction in the mean P(establishment) as compared to the No Action mean P(establishment) for all alternative plans. The individual reductions estimated for each expert are shown in Table 2. The percentages represent mean values for the expert and scenario pair. Thus, 97% is the mean of Expert One's estimate of P(establishment) under the No New Federal Action scenario.

This table shows the estimated size of the reduction in P(establishment) that results from each alternative using results obtained for each expert. According to Expert One the nonstructural alternative reduces the No New Federal Action P(establishment) from 97% to 69% a 29% reduction in risk. This value is obtained by calculating $(97\% - 69\%)/97\%$. This is a common way of estimating risk reduction. The mean reduction is the average of the six expert's values.

Table 2: Reduction in mean P(establishment) attributable to the alternatives using uncertainty characterizations obtained from each expert in the elicitation. Column headings are abbreviations for the alternatives: NNA=No New Federal Action, NS=Nonstructural Alternative, EB=Technology Alternative-Electric Barrier, CN= Technology Alternative-Complex Noise, BN= Technology Alternative-Complex Nose and Electric Barrier, and LC=lock closure.

Expert	NNA	NS	EB	CN	BN	LC	
1	97.00%	69.00%	42.00%	54.00%	50.00%	7.20%	
2	37.00%	19.00%	8.00%	14.00%	10.00%	0.00%	
3	0.060%	0.052%	0.037%	0.051%	0.039%	0.010%	
4	2.00%	1.60%	1.40%	1.50%	1.50%	0.48%	
5	5.40%	4.20%	1.90%	2.30%	2.30%	1.10%	
6	32.00%	27.00%	13.00%	19.00%	15.00%	2.70%	
	1	2	3	4	5	6	Mean
No New Action Mean P(Est)	97.00%	37.00%	0.06%	2.00%	5.40%	32.00%	
Nonstructural Mean P(Est)	69.00%	19.00%	0.05%	1.60%	4.20%	27.00%	
Reduction in P(Est) due NS	29%	49%	13%	20%	22%	16%	25%
	1	2	3	4	5	6	Mean
No New Action Mean P(Est)	97.00%	37.00%	0.06%	2.00%	5.40%	32.00%	
Electric Barrier Mean P(Est)	42.00%	8.00%	0.04%	1.40%	1.90%	13.00%	
Reduction in P(Est) due EB	57%	78%	38%	30%	65%	59%	55%
	1	2	3	4	5	6	Mean
No New Action Mean P(Est)	97.00%	37.00%	0.06%	2.00%	5.40%	32.00%	
Complex Noise Mean P(Est)	54.00%	14.00%	0.05%	1.50%	2.30%	19.00%	
Reduction in P(Est) due CN	44%	62%	15%	25%	57%	41%	41%
	1	2	3	4	5	6	Mean
No New Action Mean P(Est)	97.00%	37.00%	0.06%	2.00%	5.40%	32.00%	
Barrier & Noise Mean P(Est)	50.00%	10.00%	0.04%	1.50%	2.30%	15.00%	
Reduction in P(Est) due B&N	48%	73%	35%	25%	57%	53%	49%
	1	2	3	4	5	6	Mean
No New Action Mean P(Est)	97.00%	37.00%	0.06%	2.00%	5.40%	32.00%	
Lock Closure Mean P(Est)	7.20%	0.00%	0.01%	0.48%	1.10%	2.70%	
Reduction in P(Est) due LC	93%	100%	83%	76%	80%	92%	87%

There was considerable uncertainty in the estimates of P(establishment) derived from each expert's characterization of the uncertainty. Thus, it is impossible to know what the actual P(establishment) value is. Regardless of the P(establishment) estimated for the No New Federal Action future scenario, each expert's characterization of the uncertainty about the alternative plans' performances lead to significant reductions in that initial probability. Thus, all expert data show the alternatives are effective in reducing the P(establishment), whether their estimate was low, high or in between (Table 2).

For the tentatively selected plan the minimum reduction in the existing probability was 25%, the maximum reduction was 73%. The average of these six reductions (49%) suggests the TSP is likely to cut the P(establishment) in half, no matter what its true value might be. This is a strong argument in favor of the TSP's ability to reduce the risk of establishment significantly. Thus, there is a high degree of confidence that the TSP does indeed make effective reductions in P(establishment).

The actual P(establishment) is uncertain and unknown and is likely to remain so indefinitely. This analysis has produced a set of six estimates of this value based on the expert opinions of six leading Asian carp experts. No one of them can be considered right or wrong. Together they characterize the cumulative uncertainty about Asian carp becoming established in the Great Lakes via the CAWS pathway.

In an effort to aid decision makers and to facilitate an incremental cost and cost effectiveness analysis the estimates obtained from the opinions of the six experts were combined in a synthetic composite expert. This simplifies the summary of the expert elicitation by producing a set of composite values that are representative of the six experts. The values produced for this composite expert represent the average opinions of the six experts. As such they should not be interpreted as best estimates of the P(establishment). Instead they are indicators of the relative order of effectiveness of the plans and they provide a rough estimate of the relative reductions in P(establishment) provided by the alternative plans.

P(establishment) Estimates by Scenario Using Individual Expert Opinions

This section provides the reader the opportunity to compare P(establishment) 2071 estimates for each of the formulated plans by expert. The estimates of P(establishment) in order from highest to lowest is: Expert 1 > Expert 2 > Expert 6 > Expert 5 > Expert 4 > Expert 3. This pattern holds for all alternative scenarios elicited. The results for each alternative scenario are presented in Figures 19 through 23. Pay particular attention to the scale of the horizontal axis, which changes from figure to figure.

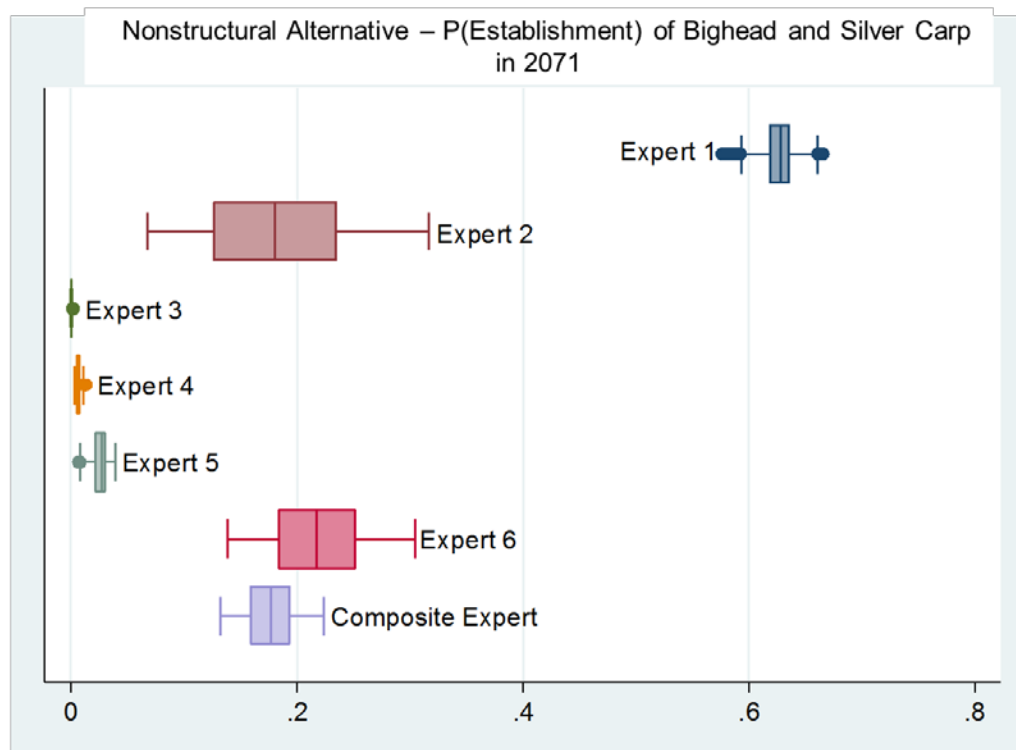


Figure 19: Bighead and Silver Carp P(establishment) 2071 values for the Nonstructural Alternative based on estimates provided by each expert and for the composite expert.

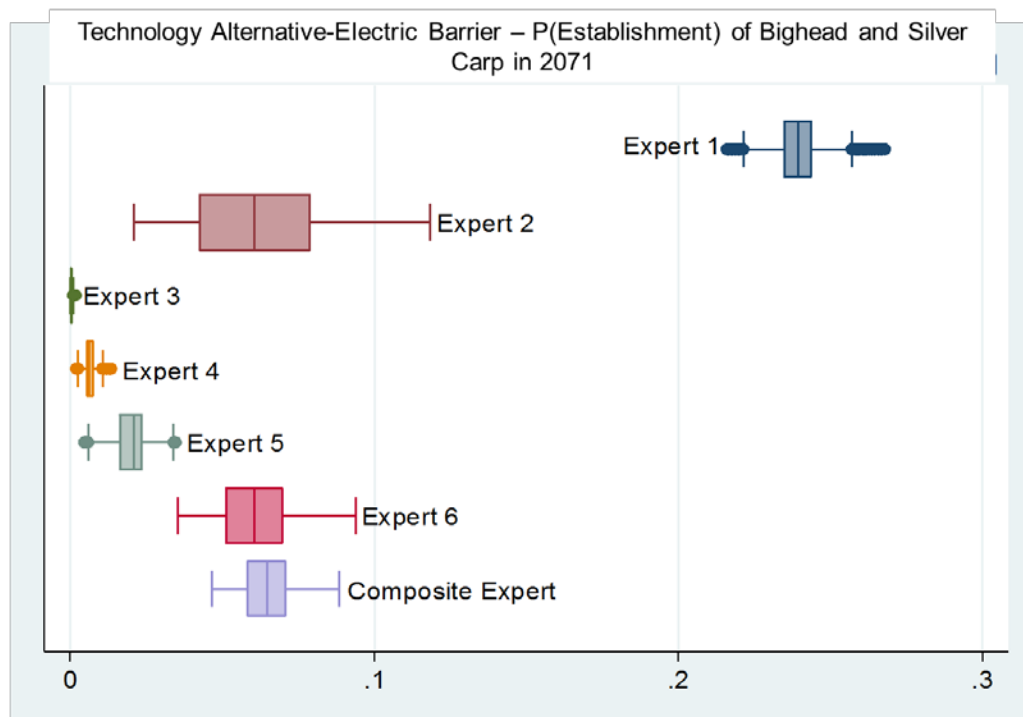


Figure 20: Bighead and Silver Carp P(establishment) 2071 values for Technology Alternative-Electric Barrier based on estimates provided by each expert and for the composite expert.

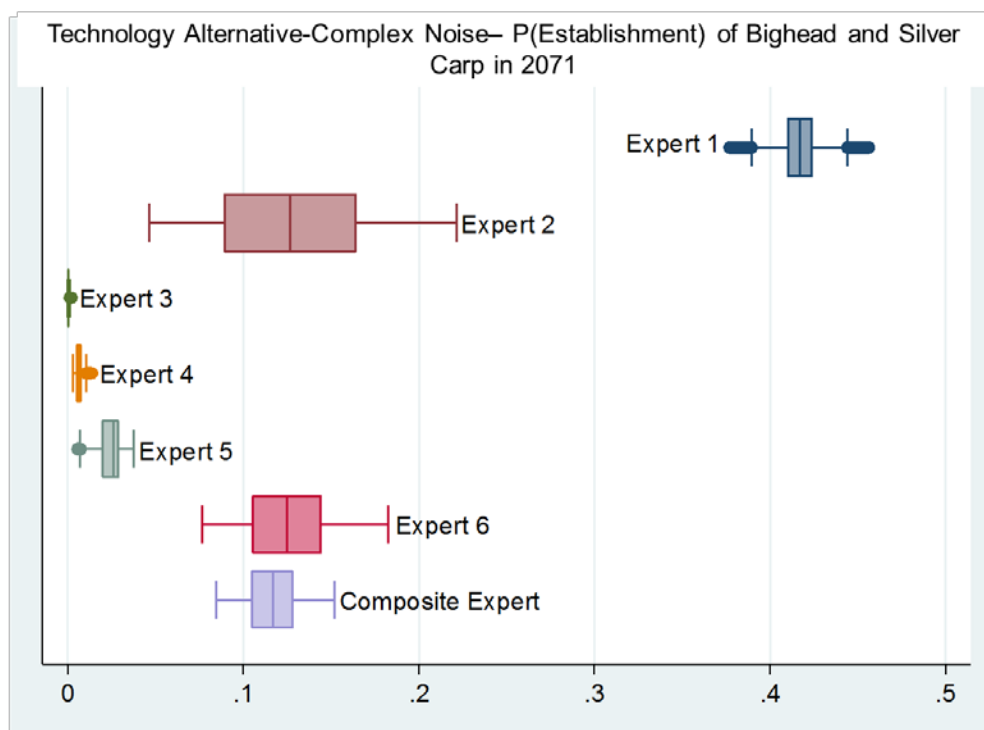


Figure 21: Bighead and Silver Carp P(establishment) 2071 values for Technology Alternative-Complex Noise based on estimates provided by each expert and for the composite expert.

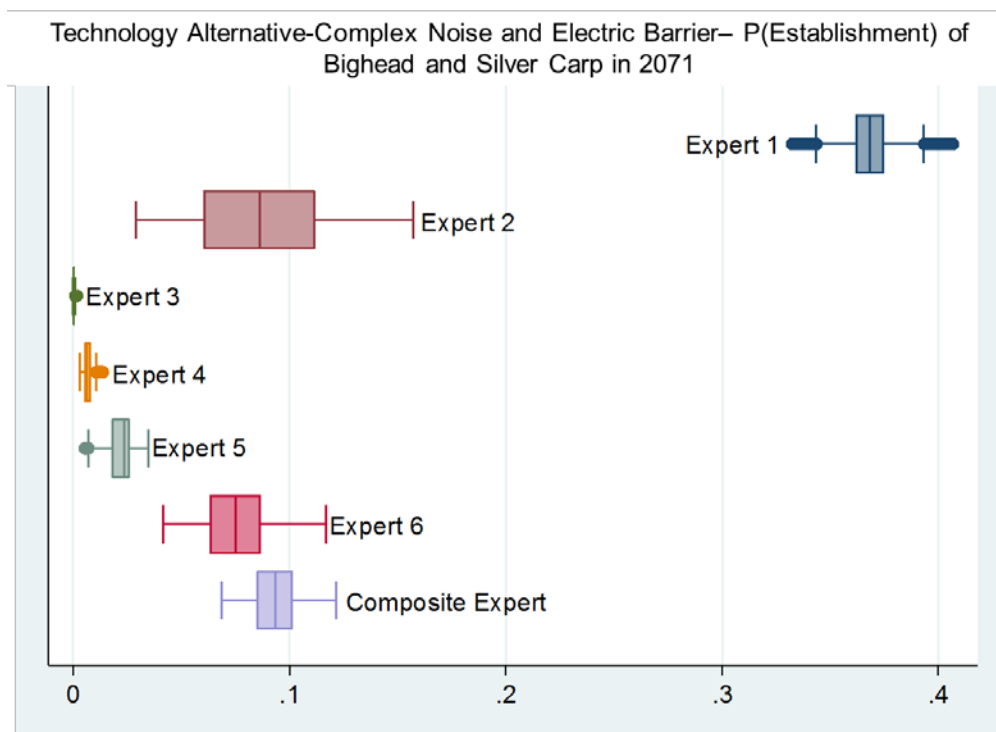


Figure 22: Bighead and Silver Carp P(establishment) 2071 values for Technology Alternative- Complex Noise with Electric Barrier based on estimates provided by each expert and for the composite expert.

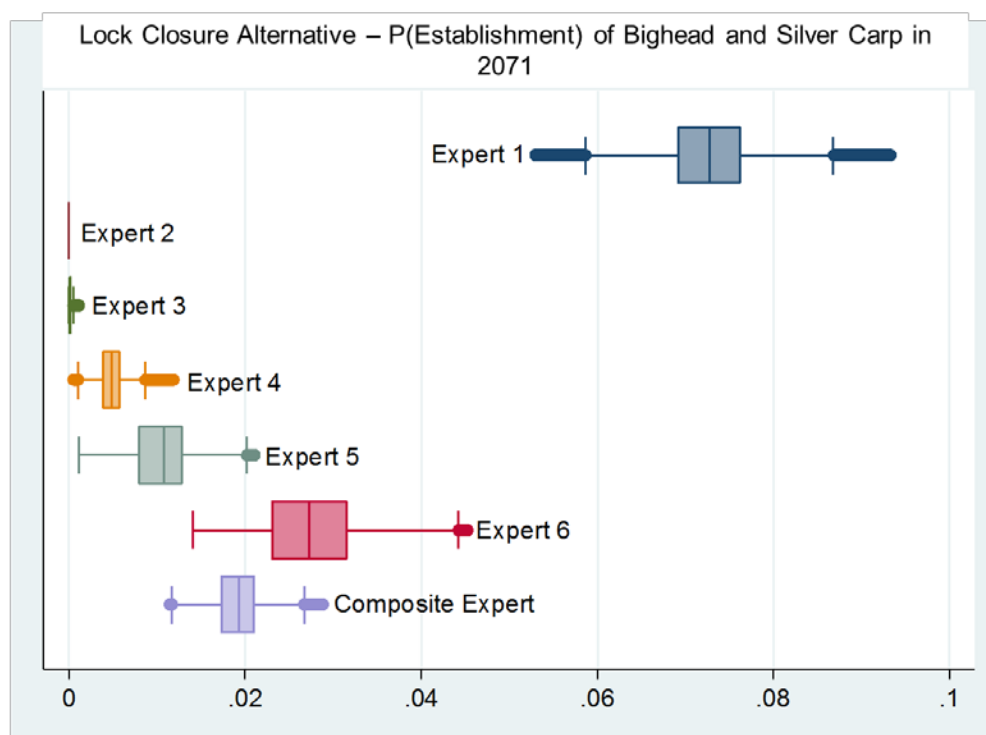


Figure 23: Bighead and Silver Carp P(establishment) 2071 values for the Lock Closure Alternative based on estimates provided by each expert and for the composite expert.

Composite Expert Residual P(establishment) for With Condition Scenarios

Table 3 presents numerical estimates of the P(establishment) for Bighead and Silver Carp by 2071. Note that these probabilities do not include any estimation of the residual risk of establishment due to non-aquatic pathways.

No future alternative implementation scenario results in a zero risk of establishment of Bighead and Silver Carp or *A. lacustre*. No matter which plan is implemented there is still some probability of establishment. That probability is the residual P(establishment). As with all P(establishment) estimates these residual estimates are uncertain.

Table 3: Five number summary estimates of Bighead and Silver Carp P(establishment) 2071 for composite expert No New Federal Action Alternative, Technology Alternatives, and Lock Closure.						
	No New Federal Action	Nonstructural	Technology Alternative-Electric Barrier	Technology Alternative-Complex Noise	Technology Alternative-Complex Noise with Electric Barrier	Lock Closure
Minimum	0.22	0.15	0.08	0.11	0.10	0.01
1st Quartile	0.26	0.18	0.10	0.14	0.12	0.02
Median	0.29	0.20	0.11	0.15	0.13	0.02
3rd Quartile	0.32	0.22	0.12	0.17	0.14	0.02
Maximum	0.36	0.26	0.14	0.19	0.17	0.03

These data are presented graphically in Figures 24 and 25. Figure 24 shows the distributions of the uncertain estimates of the P(establishment) 2071 values for the No New Federal Action Alternative, Nonstructural Alternative, Technology Alternatives, and Lock Closure. The highest Bighead and Silver Carp P(establishment) value is associated with the No New Federal Action Alternative, located to the far right in Figure 24. The spread in this distribution suggests the uncertainty of this estimate. By contrast, closing the lock shifts the distribution from a range of 22 to 36% to a range of 1 to 3%. This is the largest reduction in P(establishment) obtained by the formulated plans.

The second best reduction is 8 to 14%, which is obtained by the Technology Alternative-Electric Barrier. The barrier and noise are expected to lower the probability to 10 to 17%, while noise alone reduces the probability to 11 to 19%. The nonstructural plan reduces P(establishment) to the range of 15 to 26%.

Figure 25 adds a few features to Figure 24 to help illustrate the reduction in P(establishment) using the composite expert this time, instead of individual experts, as above. Added to the figure are markers showing the location and value of the median probabilities as well as arrows showing the reduction in median probabilities. All of these reductions are relative to the median P(establishment) of the No New Federal Action Alternative. Thus, a decrease from 0.29 to 0.02 is $[0.27]/0.29 \approx 0.93$. Note this reduction is not a probability value. It simply means that the median P(establishment) with lock closure is 93% lower than the median P(establishment) of the No New Federal Action Alternative.

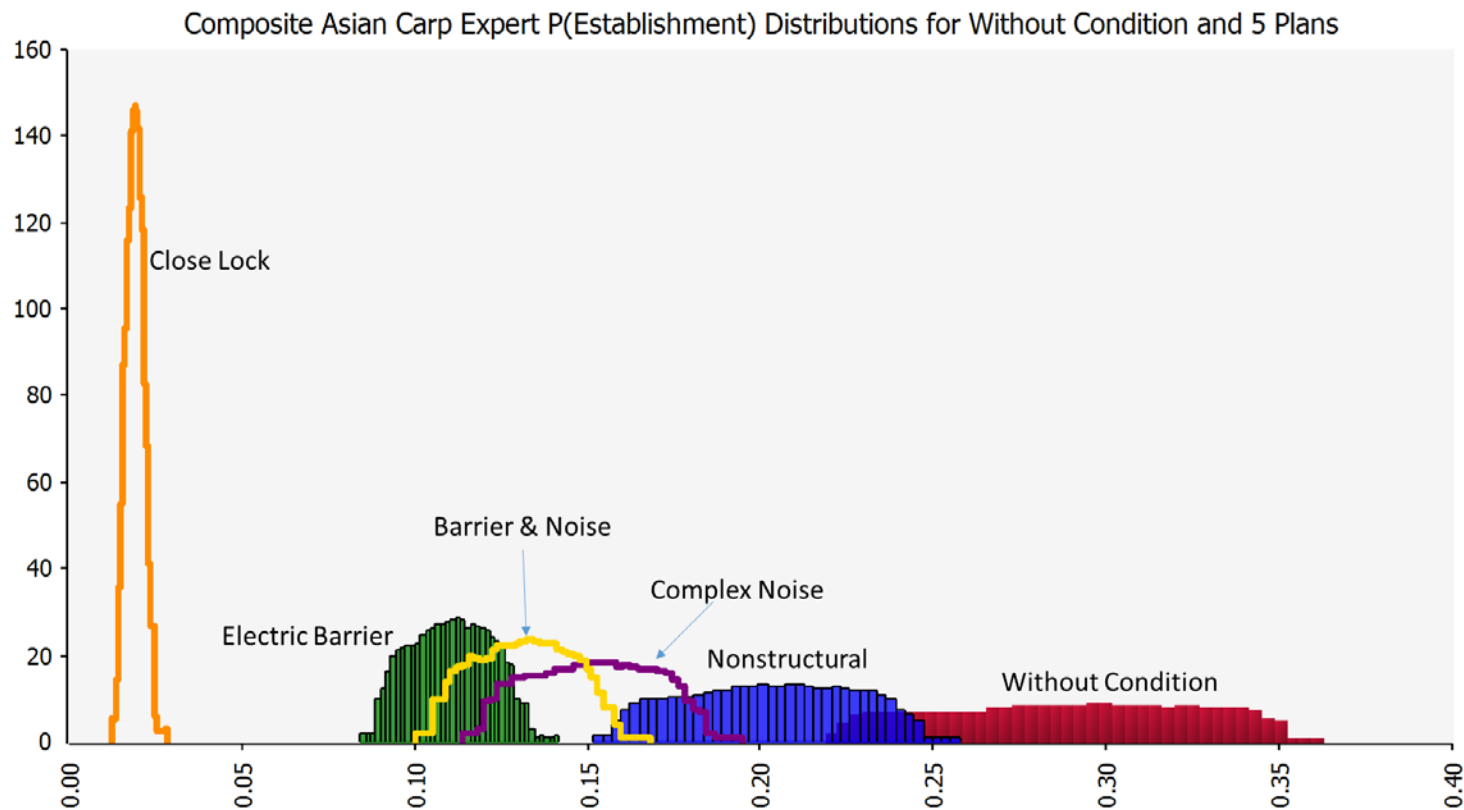


Figure 24: Estimated Bighead and Silver Carp P(establishment) 2071 distributions for composite expert No New Federal Action Alternative (Without Condition), Nonstructural Alternative (Nonstructural), Technology Alternative-Complex Noise (Complex Noise), Technology Alternative-Complex Noise with Electric Barrier (Barrier & Noise), Technology Alternative – Electric Barrier (Electric Barrier) and Lock Closure Alternative (Close Lock).

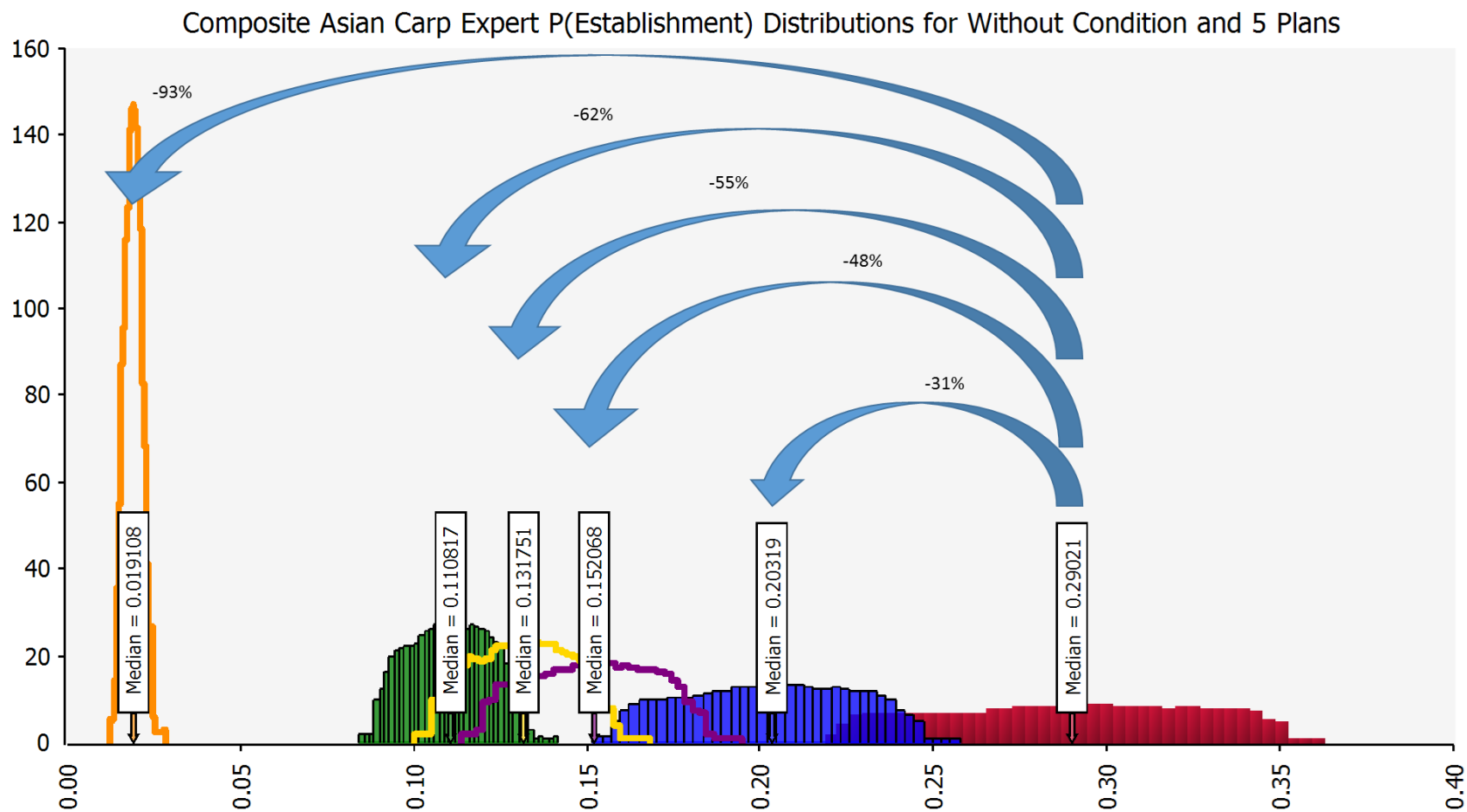


Figure 25: Estimated Reductions in composite expert Bighead and Silver Carp P(establishment) 2071 distribution No New Federal Action Alternative, Nonstructural Alternative, the three Technology Alternatives, and Lock Closure Alternative.

Figure 26 shows the same data in a different format. With the cumulative distribution functions the vertical axis of the figure has meaning. Curves further to the left, indicating lower $P(\text{establishment})$, are more desirable. Uncertainty is reflected in the footprint of the upward sloping curve.

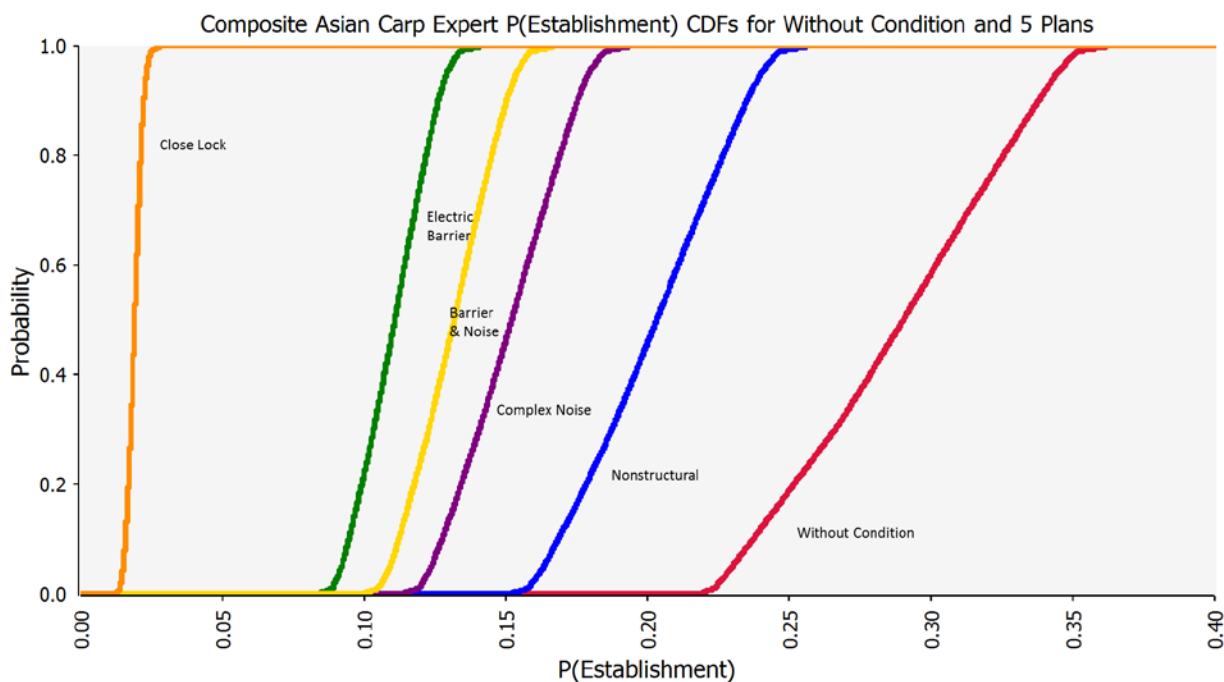


Figure 26: CDF's for composite expert Bighead and Silver Carp $P(\text{establishment})$ 2071 for the No New Federal Action Alternative (Without Condition), Nonstructural Alternative (Nonstructural), Technology Alternative-Complex Noise (Complex Noise), Technology Alternative-Complex Noise with Electric Barrier (Barrier & Noise), Technology Alternative – Electric Barrier (Electric Barrier) and Lock Closure Alternative (Close Lock).

$P(\text{establishment})$ Points of Agreement and Divergence Among Experts

The $P(\text{establishment})$ of Bighead and Silver Carp in the GLB is unknown and uncertain. However, one can characterize the uncertainty and this was achieved for the GLRMRIS-BR study by having national experts provide expert opinions in a controlled expert elicitation process. The experts' inputs did produce agreement on three major outputs from the model:

- $P(\text{establishment})$ cannot be reduced to zero
- The order of effectiveness of the plans was consistently rated. The Lock Closure Alternative resulted in the lowest $P(\text{establishment})$. The Technology Alternative-Electric Barrier, which was more effective than the Technology Alternative Complex Noise and Electric Barrier, which was more effective than Technology Alternative-Complex Noise, which was more effective than the Nonstructural Alternative, which was more effective than No New Federal Action.
- Estimates of $P(\text{establishment})$ derived from all six experts show significant relative reductions in $P(\text{establishment})$, thus, suggesting that although the precise $P(\text{establishment})$ is not known, $P(\text{establishment})$ is significantly reduced no matter what level it may be.

Experts differed on their opinions about the inputs. Figure 27 shows how the experts differed on the size of the population that would arrive at BRLD by 2021. Four of six experts thought there was some chance of a negligible sized population arriving. A small population size was designated most likely by everyone but Expert 2.

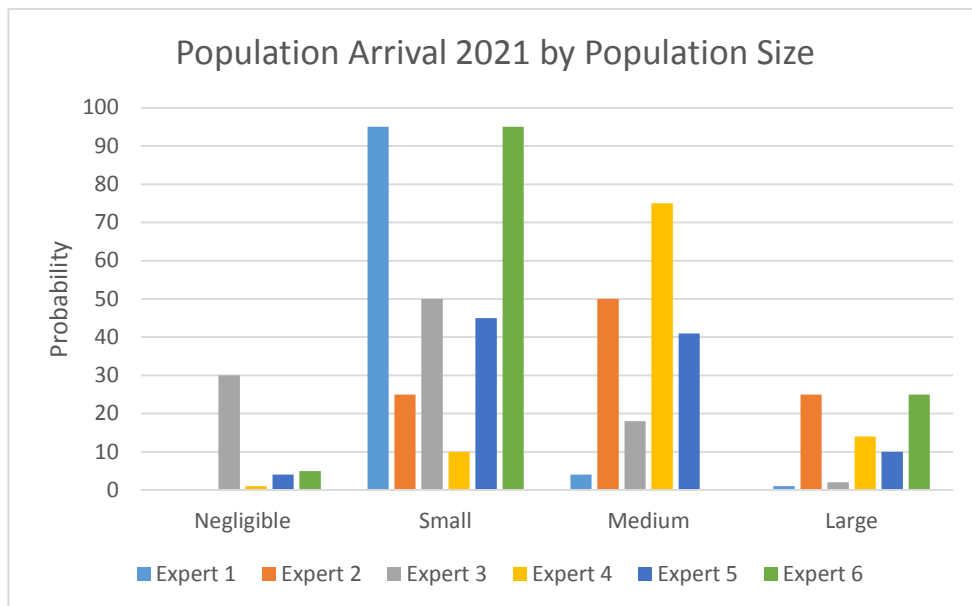


Figure 27: Population size arrival by 2021 probabilities for Bighead and Silver Carp and all experts

Figure 28 suggests considerable disagreement about the maximum number of fish that could pass from below BRLD into Lake Michigan on an annual basis. The differences become greater as the size of the population assumed to have arrived increases. Expert 6, who had the highest P(estabishment) value estimated a significantly larger number of fish would pass through the system each year. It is worth noting that the experts disagreed on the size of the fish that would pass through the system and size differences accounts for some of the differences in numbers. Experts who believed small fish were more likely to pass through the system tended to estimate larger numbers of fish.

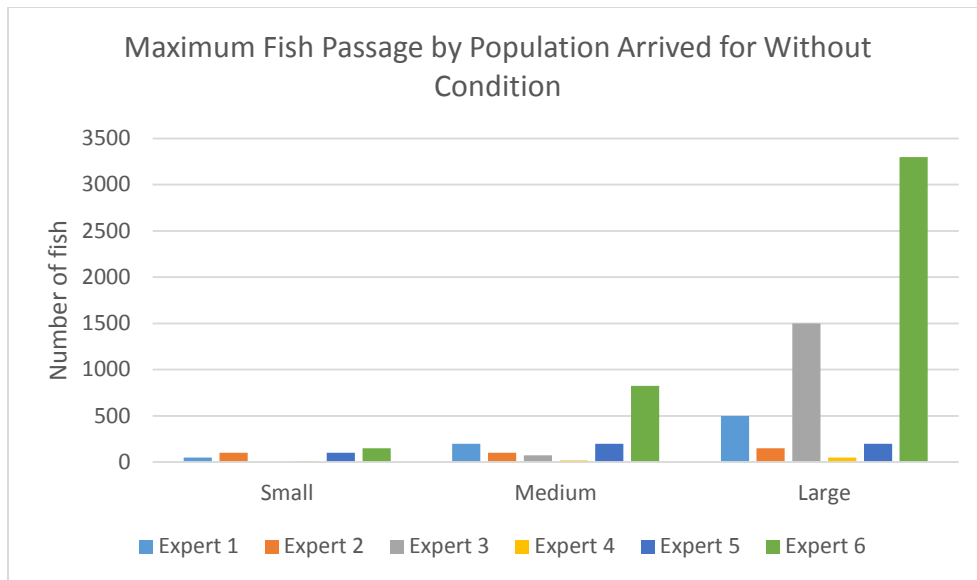


Figure 28: Maximum number of Bighead and Silver Carp passing through the existing system in a year given the size population arriving at Brandon Road Lock and Dam

Colonization thresholds were another point of significant divergence. Figure 29 shows the minimum colonization threshold by year. Contrast the difference between Expert 2 with a 1000 minimum and Expert 3 with a minimum of 2. Expert 2's high threshold values account for the corresponding low levels of P(establishment).

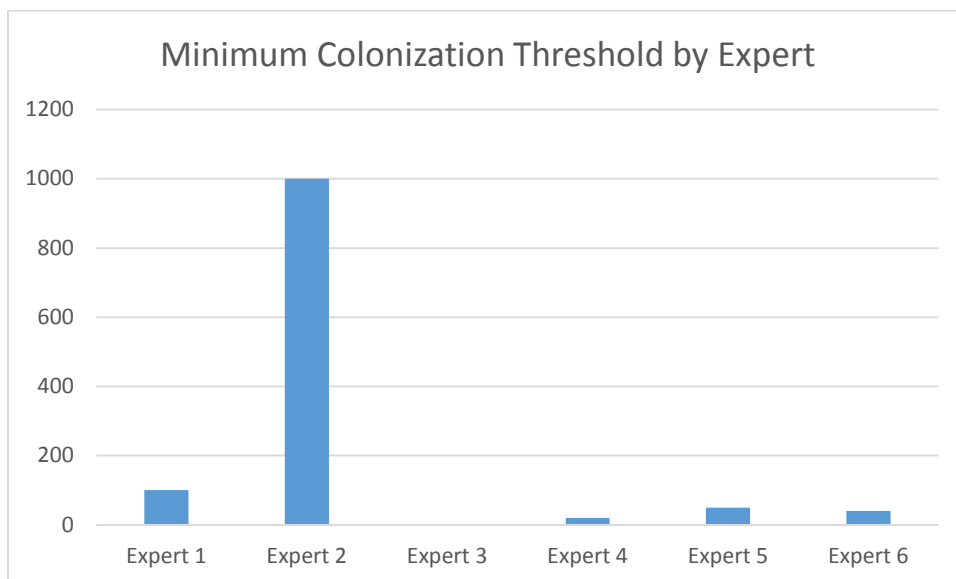


Figure 29: Minimum number of Bighead and Silver Carp required to possibly result in colonization.

Figure 30 suggests more agreement on the maximum probability of spread with relatively less agreement on the minimum probability. Expert 1 was much more certain of the spread probability than any of the other experts, for example.

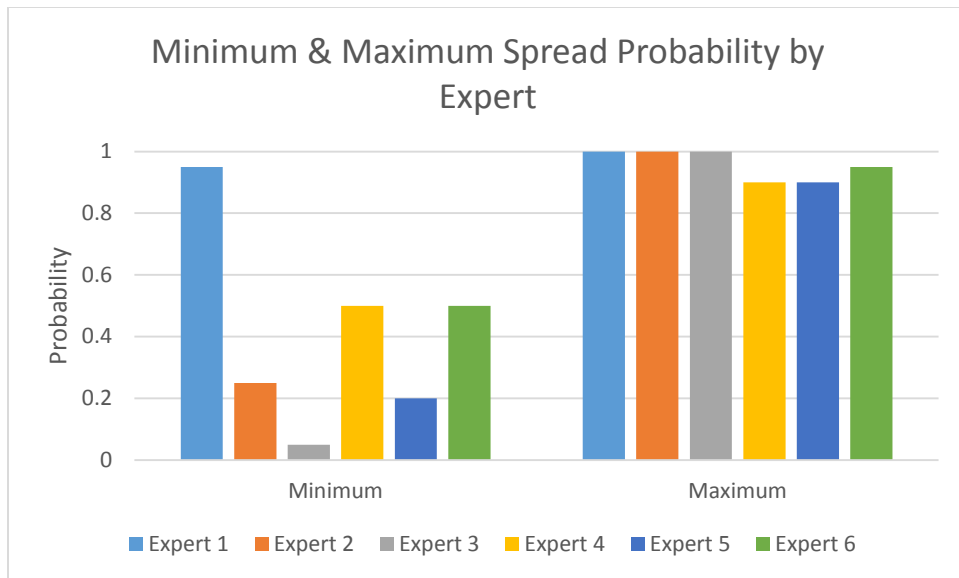


Figure 30: Minimum and maximum estimates of the probability of the spread of Bighead and Silver Carp once a colony has been established.

Figure 31 shows the amount of risk reduction, i.e. percent decline in $P(\text{establishment})$, attributed to each alternative by each expert. The numerical values are means of all expert reductions. What is significant here is that no matter how the $P(\text{establishment})$ values estimated from expert opinions differ numerically, the alternative plans on average have significant effects on the reduction of $P(\text{establishment})$. While there is less confidence in what the actual $P(\text{establishment})$ is based on the results, there is considerable confidence that that $P(\text{establishment})$ is significantly reduced by the alternatives.

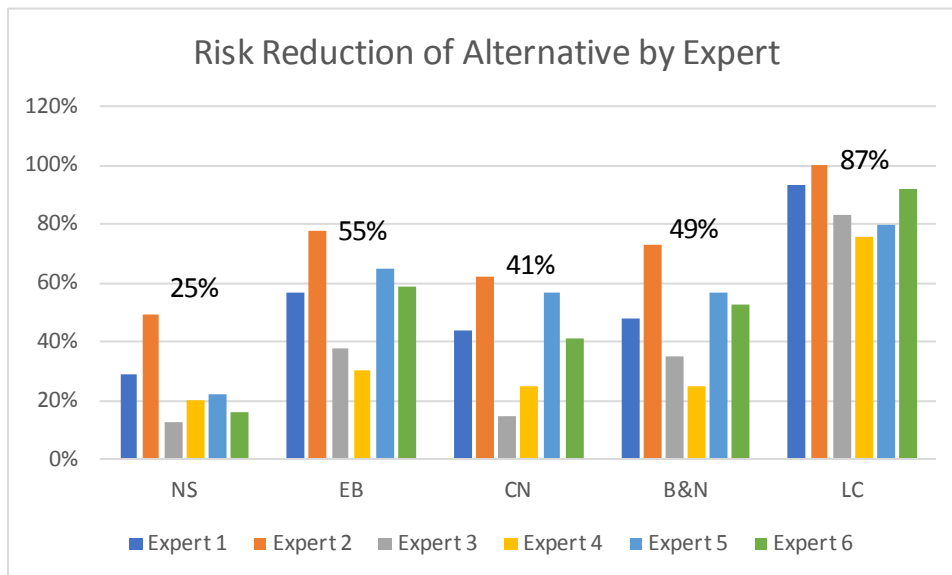


Figure 31: $P(\text{establishment})$ 2071 reductions attributed to each alternative by expert. The No New Federal Action value for that expert is noted at the top of each set of bars.

A. *Lacustre*

Estimating P(establishment)

The GLMRIS Risk Assessment provided qualitative estimates of the P(establishment) of *A. lacustre*. The P(establishment) was defined in that document as consisting of five probability values, with the overall P(establishment) defined using conditional notation as:

$$P(\text{establishment}) = P(\text{pathway}) \times P(\text{arrival} | \text{aathway}) \times P(\text{aassage} | \text{arrival}) \times P(\text{colonization} | \text{passage}) \times P(\text{spread} | \text{colonization})$$

The probability of these independent events is, hereafter, represented more simply as::

$$P(\text{establishment}) = P(\text{pathway}) \times P(\text{arrival}) \times P(\text{passage}) \times P(\text{colonization}) \times P(\text{spread}).$$

The establishment elements are generally defined as:

- P(pathway) - the probability that a complete aquatic pathway is available for interbasin transfer between the Mississippi River Basin (MRB) and Great Lakes Basin (GLB) through the Chicago Area Waterway (CAWS) aquatic pathway;
- P(arrival) - the probability of *A. lacustre* arriving in the Dresden Island Pool located upstream of Dresden Dam to below BRLD;
- P(passage) – the movement of *A. lacustre* through the CAWS from below BR to Lake Michigan;
- P(colonization) - the probability of *A. lacustre* colonizing in Lake Michigan, and;
- P(spread) - the probability of *A. lacustre* spreading beyond Lake Michigan and into the other Great Lakes.

This was the model used to estimate P(establishment) for *A. lacustre*. Members of the expert panel provided direct estimates of each of the last four probabilities on the right hand side of the equation. P(Pathway) is known to equal 1 and was not elicited. The four probabilities were multiplied together to obtain estimates of P(establishment). Once these probabilities were estimated each expert was given the opportunity to review the calculations obtained with their inputs for their reasonableness. All the experts accepted the results derived from their opinions.

Each expert provided opinions for the following values:

- An estimate of the four probabilities above at 2021, 2031, and 2071 for each of the scenarios below:
 - No New Federal Action
 - Nonstructural Alternative
 - Technology Alternative -Electric Barrier
 - Technology Alternative - Complex noise
 - Technology Alternative – Complex Noise with Electric Barrier
 - Lock Closure Alternative

These values were characterized as cumulative distribution functions defined by a minimum, 33rd and 67th percentiles, and a maximum value to characterize the uncertainty about these unknown and

unknowable values. A simulation model generated random probability values from each distribution and multiplied them to obtain an estimate of P(establishment). This calculation was repeated 10,000 times to generate a distribution of P(establishment) values. This calculation was completed for three different time periods and six different scenarios, the No New Federal Action Alternative, Nonstructural Alternative, Technology Alternatives, and Lock Closure.

The Experts

An expert elicitation was needed because there was and is no credible data for several of the model inputs. An expert elicitation was the most cost-effective and reliable way to characterize the uncertainty about the P(establishment) values for the ANS control alternatives. Five experts were identified to participate in the *A. lacustre* elicitation, they are:

1. Safra Altman, U.S. Army Corps of Engineers, U.S. Army Engineer Research and Development Center;
2. Theodore (Ted) R. Angradi, US Environmental Protection Agency;
3. Andrew M. Kramer, Odum School of Ecology, University of Georgia Athens;
4. Reuben P. Keller - Loyola University Chicago, Institute of Environmental Sustainability;
5. Linda S. Nelson, U.S. Army Corps of Engineers, U.S. Army Engineer Research & Development Center Environmental Laboratory

The Elicitation Process

Once the expert panel was assembled they were provided with a read ahead package of reference materials and factsheets describing:

1. The CAWS
2. The pools of the Illinois Waterway System
3. The distribution of *A. lacustre*
4. General biology of *A. lacustre*
5. BRLD diagram and operational information
6. Electric dispersal barrier at Romeoville, IL
7. Current activities related to *A. lacustre*
8. The GLMRIS-BR Alternatives : No New Federal Action, Nonstructural Alternative, Technology Alternative - Electric Barrier, Technology Alternative - Complex Noise, Technology Alternative - Complex Noise with Electric Barrier, and Lock Closure
9. Pertinent Literature References.

The elicitations were preceded by a two-day meeting of the experts with study team members, the elicitations were then conducted over the next two days. The meeting took place at the Chicago District Offices on December 14 and 15, 2015. The purposes of the two-day was to provide experts an opportunity to learn details of the alternative plans from top domain experts, discuss *A. lacustre* and alternative control plans, arrive at common assumptions where assumptions were needed, and provide training with the elicitation technique.

Highlights of the two-day pre-elicitation meeting included group discussions of the following topics:

- Influential Factors for *A. lacustre* Passage from BRLD to Lake Michigan via the CAWS – With Alternatives
- Influential Factors that Impact *A. lacustre* Colonization and spread
- Historic vessel movement patterns in the CAWS and Great Lakes

Following most of these discussions the experts identified the key factors and assumptions for each discussion. These were recorded and reviewed with the expert during the individual elicitations as appropriate.

The Elicitation

The elicitation team consisted of one expert panel member, one *A. lacustre* domain expert, one USACE alternative plan domain expert, and one elicitation facilitator. The domain experts were available to answer any questions that arose for the expert panel member. The elicitations were conducted via webinar.

Before each new quantity or scenario was elicited, the panel expert was reminded of the key factors identified by the plenary panel of the experts and a summary of the features of each plan scenario was provided. The elicitation consisted of the 30 questions included in Annex 2 to this Appendix. Following each question the expert was queried about the main considerations that shaped their response. Notes were taken.

The expert's responses were recorded on an input sheet in a spreadsheet file that was visible to the expert at all times. Experts were informed they could change their initial answers at any time they desired and were encouraged to do so including after the conclusion of the elicitation. The experts were told they would be provided with a summary of the results obtained from their expert opinions and at that time they would have the option of revisiting any or all of their answers to the elicitation questions. These summaries were provided about a week later and all experts accepted the results of their model runs as reasonably representative of their views.

In the next section you will learn how the model used to estimate the probability of establishment works.

The Model

The structure of the model is illustrated in Figure 32, using inputs from one expert on the P(establishment) of *A. lacustre* in 2071. Notice P(establishment) is calculated for three different time periods and for six separate alternative scenarios.

The data for this calculation was obtained directly from each expert in answer to the following questions:

1. What is the probability that a population of *A. lacustre* will arrive at Brandon Road Lock and Dam by 2021/2031/2071?
2. Considering the currently existing system that is in place, assume that a population of *A. lacustre* have arrived at Brandon Road Lock and Dam. What is the probability that some non-trivial number of *A. lacustre* will pass from below the dam to Lake Michigan by 2021/2031/2071?

3. Considering the amount of *A. lacustre* you believe will pass through the system by 2021, what is the probability those *A. lacustre* will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional *A. lacustre* enter the lake after 2021/2031/2071?
4. Assume that *A. lacustre* has a colony in Lake Michigan. What is the probability that *A. lacustre* will spread beyond Lake Michigan?

The answers to these questions were elicited from the experts as minimum, maximum, 33rd and 67th percentiles. These four values were used to construct the expert's CDF's, samples of which are shown in Figure -32. A value was randomly selected from the CDF of each of the four establishment probability elements using a Monte Carlo process with Latin Hypercube sampling. These values were multiplied together to obtain a single estimate of the P(establishment) for the given time period and scenario for each expert. A sample output distribution is shown for one expert (Figure 32).

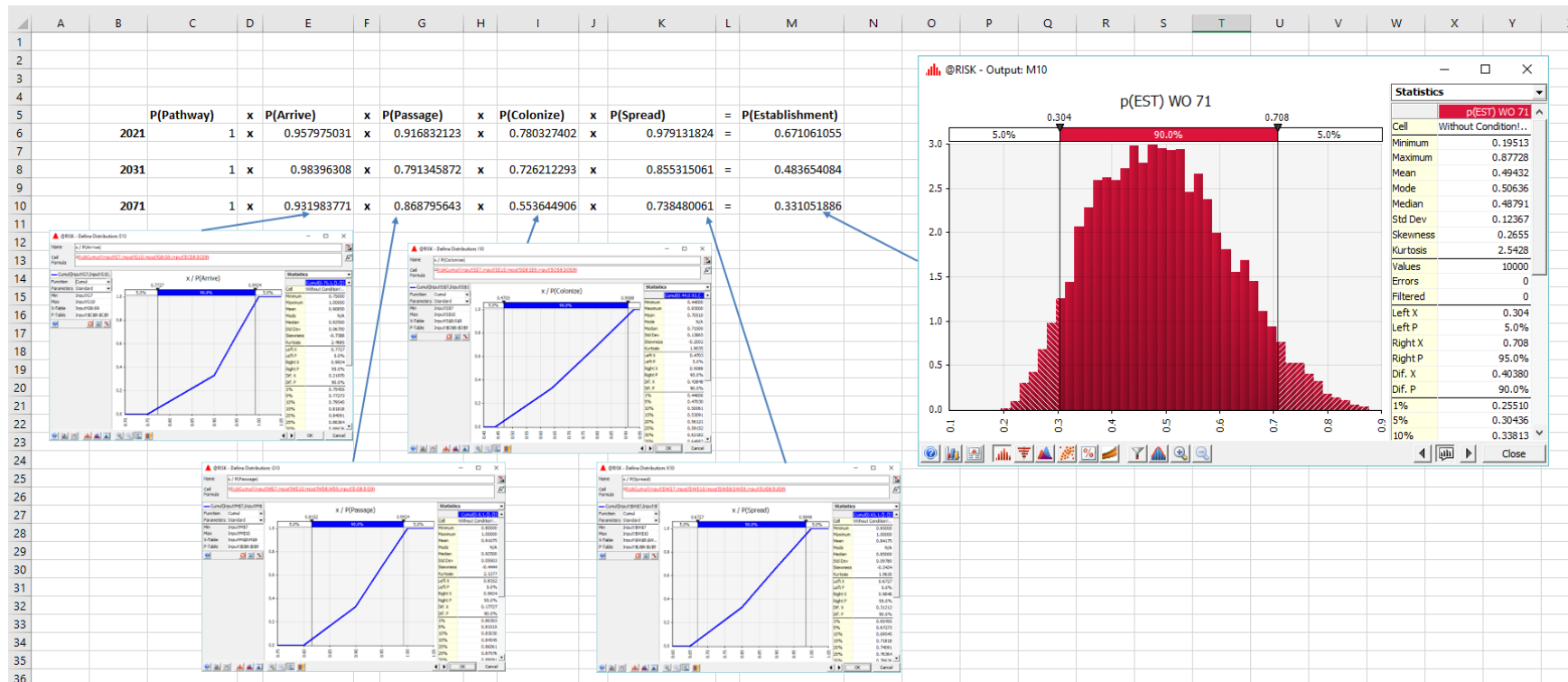


Figure 32: Illustrated example of the simulation model used to estimate P(establishment) for *A. lacustre*.

The Results

The probabilities presented in the sections that follow were not directly provided by the experts. They were directly estimated using values provided by the experts. Thus, it is most proper to characterize these values as estimates based on the experts' opinions.

Probability of Establishment If No New Federal Action Is Taken (Federal Without Project Condition)

If the Federal government takes no new action, the expert consensus is that the establishment of *A. lacustre* in the GLB is more likely than not. Figures 33, 34, and 35 show estimates of the P(establishment) of *A. lacustre* under the No New Federal Action Alternative for three time periods 2071, 2031, and 2021 for all five experts and the composite expert³. These estimates characterize the risk of establishment of *A. lacustre* if no further action is taken as a direct result of the subject study. Beginning with 2071, we see substantial overlap among the estimates of all experts. The box and whisker plots show the spread in the P(establishment) obtained from each expert's characterization of the uncertainty in the component elements of that calculation. The spread in a box plot indicates the uncertainty in that value. The relative differences in each expert's box illustrates differences in opinion among the experts. Table 4 shows the numerical values used to create the box plots for Figure 33 to 36.

³ The composite expert was generated using the same methodology used for the Asian carp elicitation. The CDF's for the five experts were averaged across percentile values from 1% to 99% with 5% increments between.

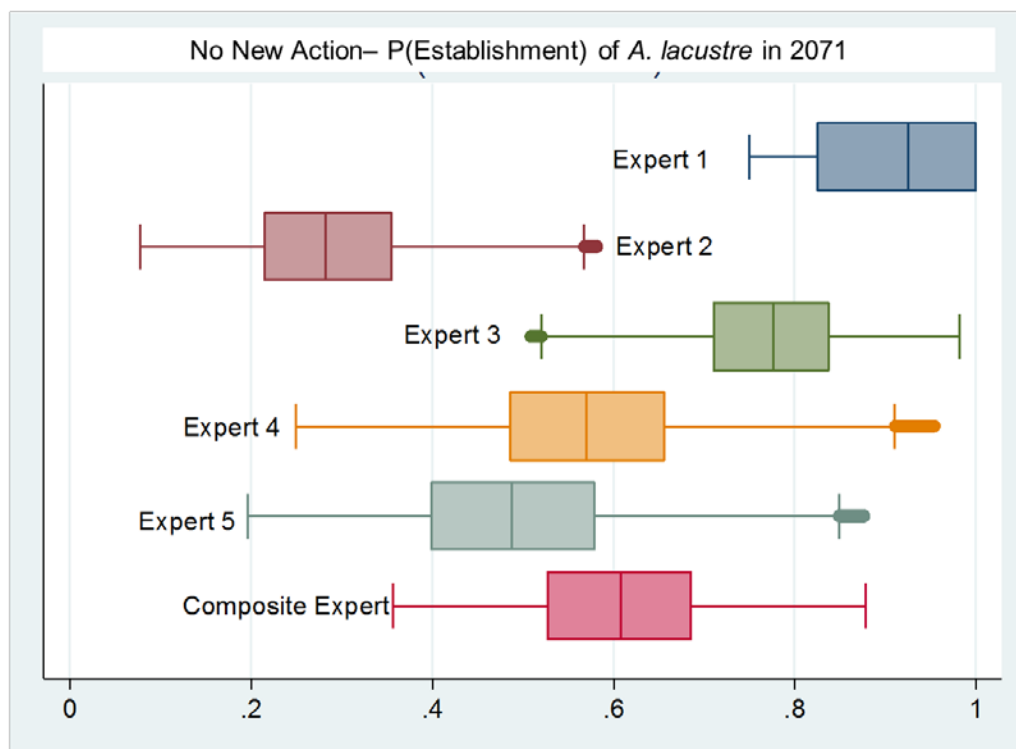


Figure 33: P(establishment) of *A. lacustre* for all experts under the No New Federal Action Alternative in 2071.

Table 4: Five number summary for P(establishment)

	Five Number Summary for P(Establishment) 2071 Federal Without Project Condition					
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Composite
Minimum	0.75	0.08	0.51	0.25	0.20	0.36
1st Quartile	0.83	0.21	0.71	0.49	0.40	0.53
Median	0.92	0.28	0.78	0.57	0.49	0.61
3rd Quartile	1.00	0.36	0.84	0.66	0.58	0.69
Maximum	1.00	0.58	0.98	0.95	0.88	0.88

Expert 1's results indicate the highest likelihood of establishment with a range from 75 to 100%. Expert 2, by contrast, has the lowest estimate of establishment ranging from 8 to 58%. It is important to consider the range of uncertainty expressed by the expert panel. To facilitate discussion of the relative effectiveness of the individual alternatives a composite expert was prepared as described in the Bighead and Silver Carp discussion, by averaging the CDF's for the five experts. The P(establishment) 2071 is between 36 and 88%. There is a 50% chance it is above 61% and a 50% chance it is below 61%.

The P(establishment) of *A. lacustre* increases over time (Figure 33 to 36). Figure 34 shows P(establishment) for 2031 ranges from 22 to 79% with a median of 45% and P(establishment) for 2021

ranges from 12 to 64% with a median of 32% as seen in Figure 35. The composite expert results were obtained by averaging the CDF's of all the experts.

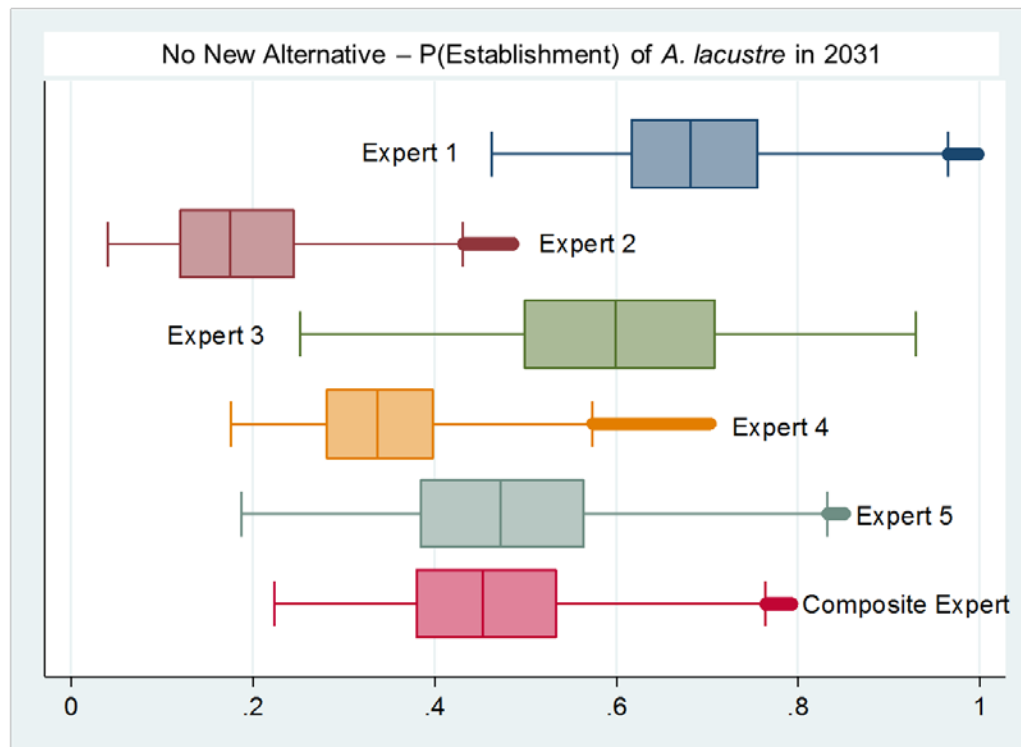


Figure 34: P(establishment) of *A. lacustre* for all experts for the No New Federal Action Alternative in 2031.

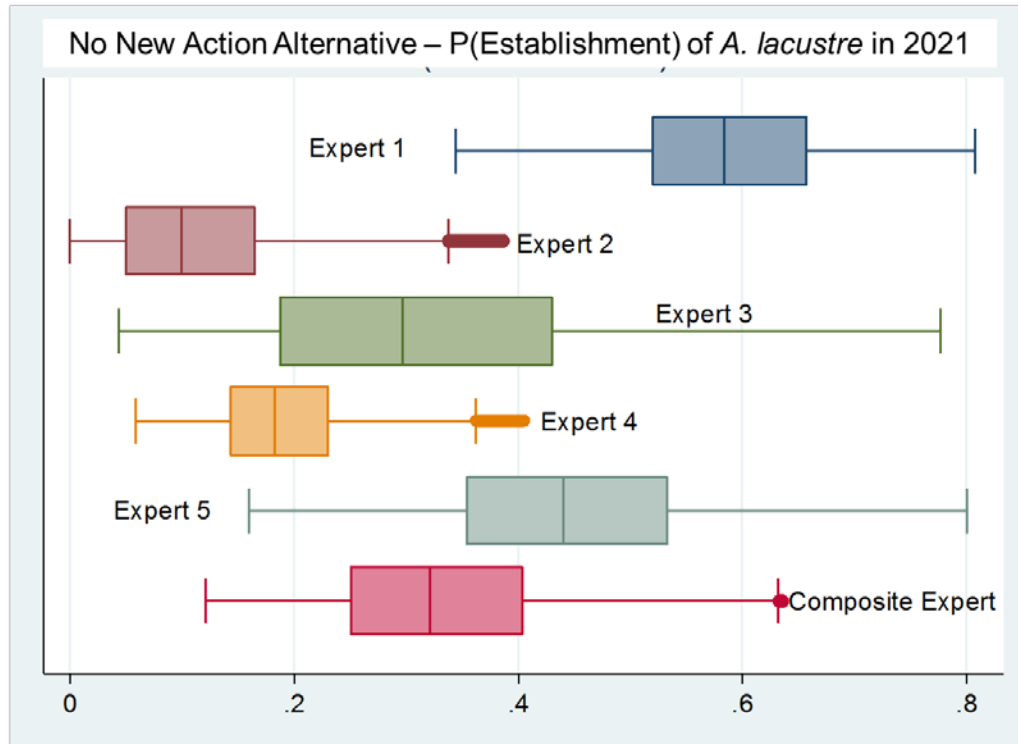


Figure 35: P(establishment) of *A. lacustre* for all experts for the No New Federal Action Alternative in 2021.

Figure 36 juxtaposes the composite expert P(establishment) distributions for the three time periods. Notice there is significant overlap among the distributions. Establishment of *A. lacustre* by 2071 is more likely than not.

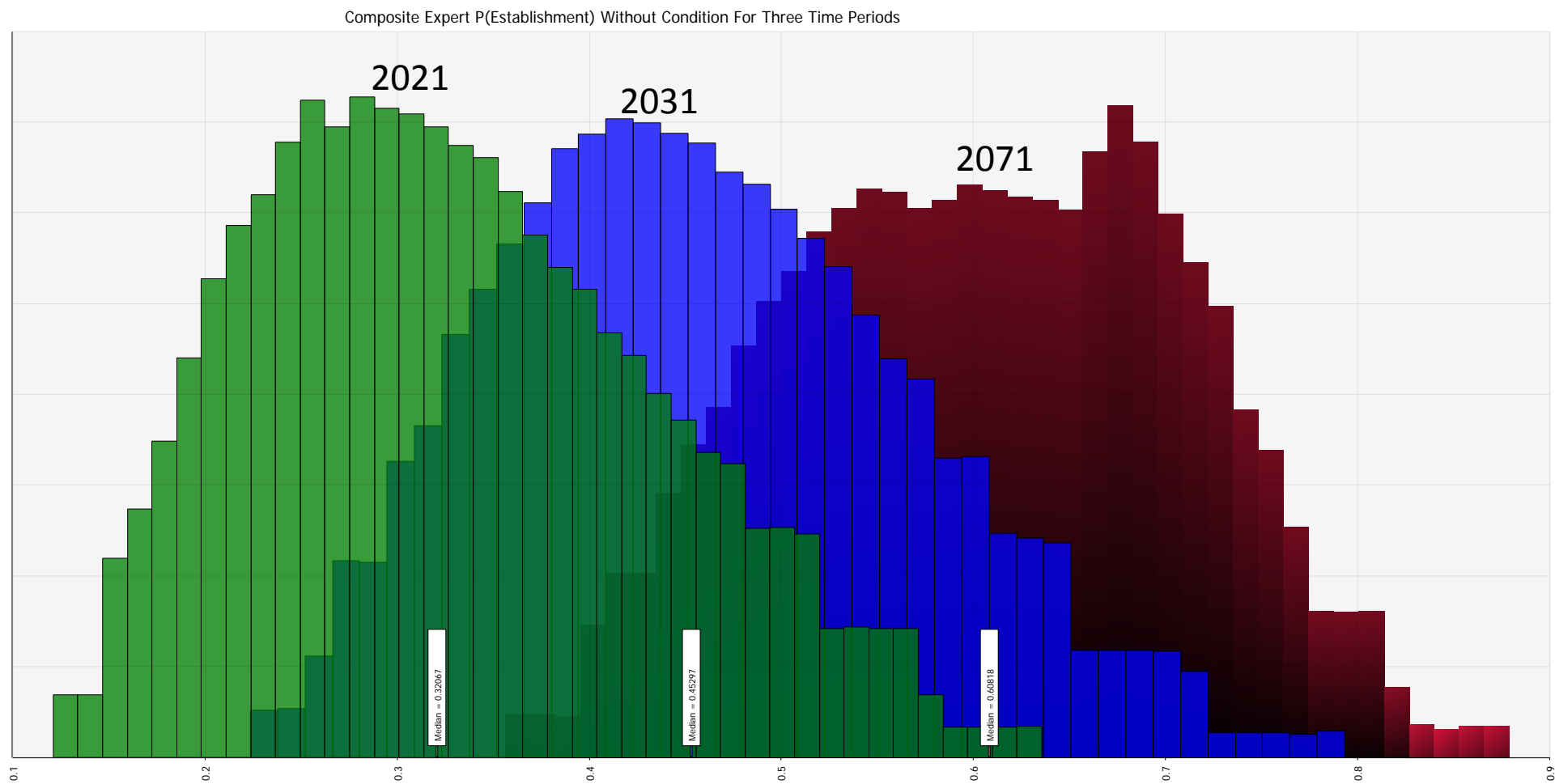


Figure 36: P(establishment) for *A. lacustre* under the No Action Alternative for three time periods.

P(establishment) Estimates Using Individual Expert Opinions

It is instructive to consider the results of each expert elicitation in considering how well the plans work to reduce the P(establishment) of *A. lacustre*. The next five figures show the estimated P(establishment) values for all experts and all Alternatives. Pay attention to changes in the horizontal axis. These differences indicate differences in opinion about how likely establishment is. Expert 1 (Figure 37), as noted, has the highest estimate of establishment and Expert 2 has the lowest estimate (Figure 38). Experts 1, 3, 4, and 5 tend to find all the plans but lock closure to be rather ineffective in reducing the P(establishment) for *A. lacustre* (Figure 37 to 41).

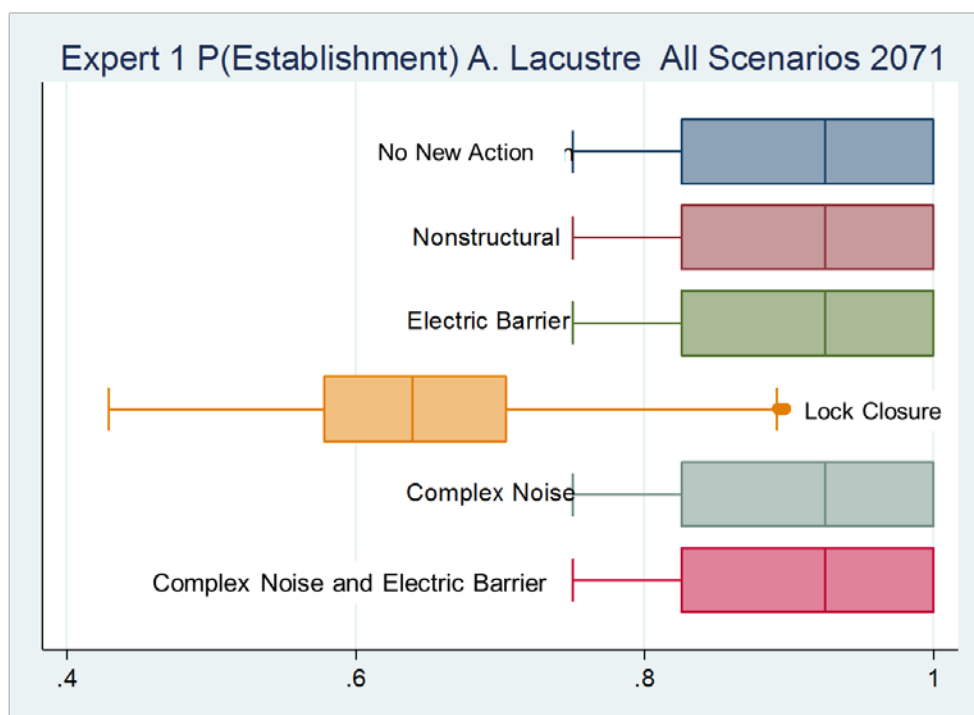


Figure 37: Expert 1 P(establishment) of *A. lacustre* in 2071 by Alternative.

Only Expert 2 found a plan other than lock closure to have some effect on P(establishment). The Electric Barrier, Complex Noise, and Complex Noise with Electric Barrier Technology Alternatives, all have an equally effective impact on reducing P(establishment) (Figure 38).

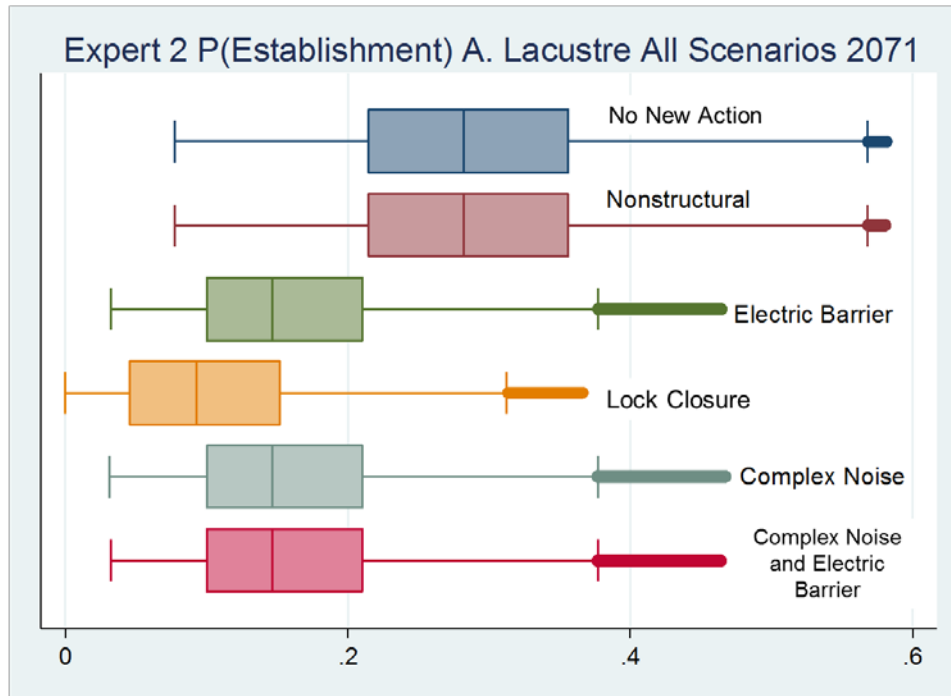


Figure 38: Expert 2 P(establishment) of *A. lacustre* in 2071 by Alternative.

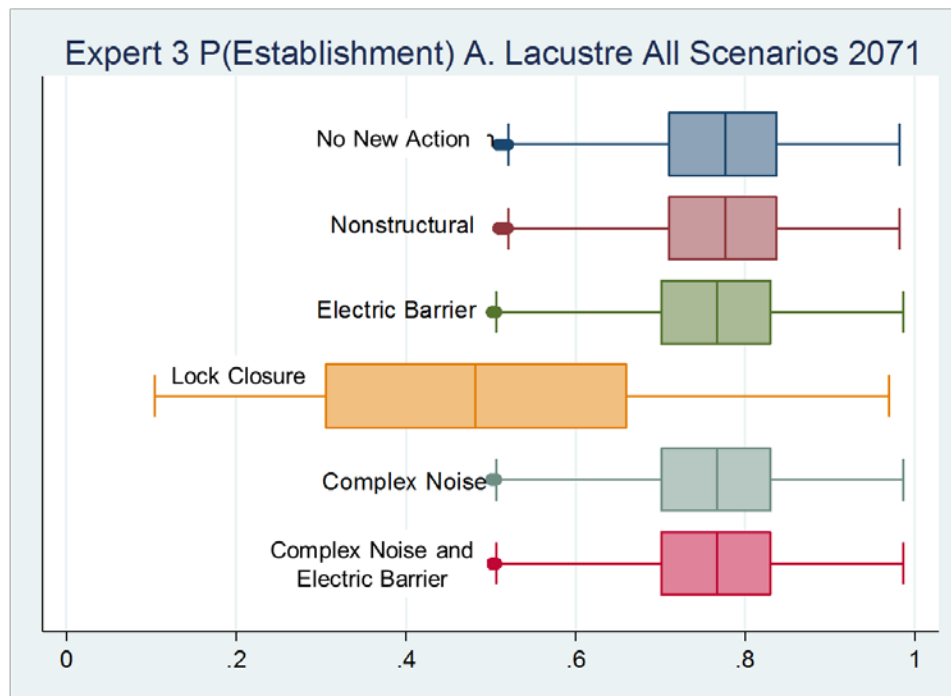


Figure 39. Expert 3 P(establishment) of *A. lacustre* in 2071 by Alternative.

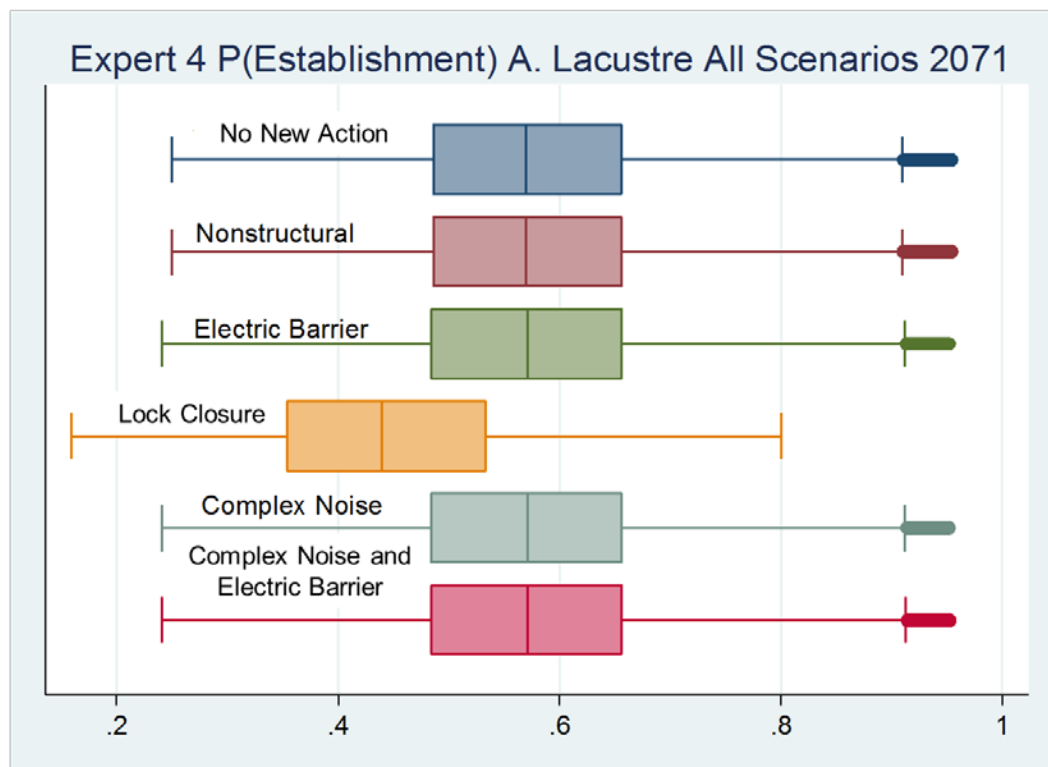


Figure 40 Expert 4 P(establishment) of *A. lacustre* in 2071 by Alternative.

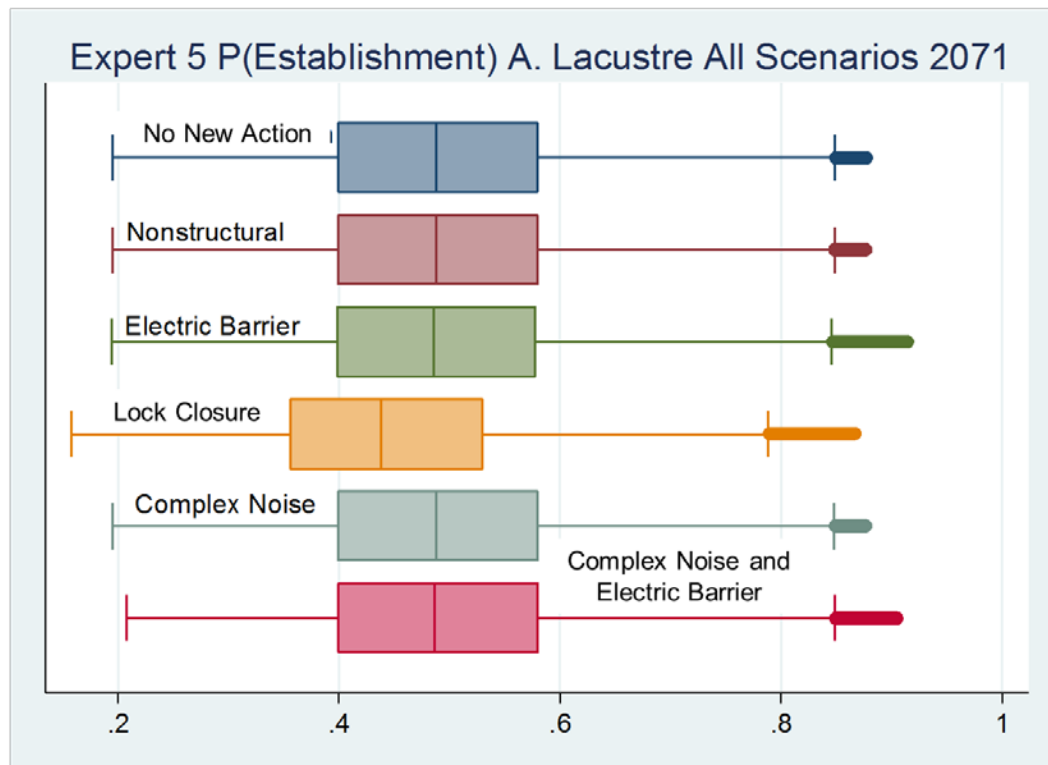


Figure 41 Expert 5 P(establishment) of *A. lacustre* in 2071 by Alternative.

There is strong agreement that the technology alternatives will be ineffective in reducing P(establishment) for *A. lacustre*. Even closing the lock has limited effectiveness.

Figure 42 shows the composite expert estimates of P(establishment) for all Alternatives. The nonstructural plan has no effect and the technology plans show a minimal reduction on P(establishment) reflecting Expert 2's judgments about the relative effectiveness of the plans. Closing the lock reduces the P(establishment) to the No New Federal Action Alternative levels for 2021. The P(establishment) shown for lock closure is the P(establishment) of *A. lacustre* between now and 2021, after which time the lock would be closed and the probability would then be reduced to zero.

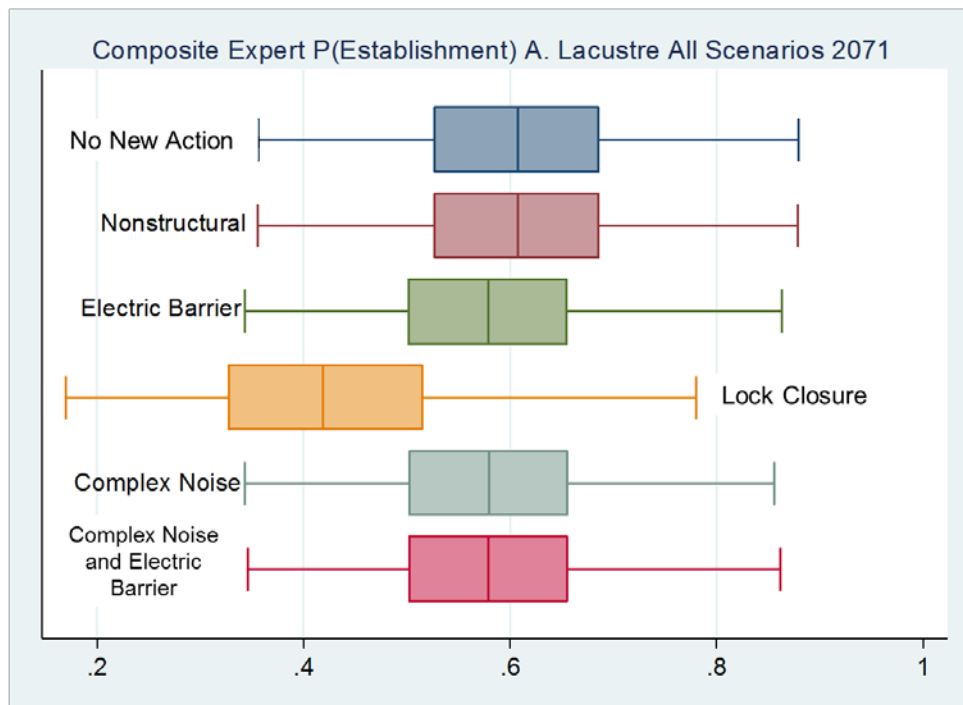


Figure 42 Composite expert P(establishment) of *A. lacustre* in 2071 by Alternative.

P(establishment) Estimates by Scenario Using Individual Expert Opinions

This section provides the opportunity to compare P(establishment) 2071 estimates for each of the formulated plans by expert. The estimates of P(establishment) in order from highest to lowest is: Expert 1 > Expert 3 > Expert 4 > Expert 5 > Expert 2. The experts were very consistent in their relative rankings, as this pattern holds for all plans elicited.

The results for each plan scenario are presented in Figures 43 through 47. Pay particular attention to the scale of the horizontal axis, which changes from figure to figure.

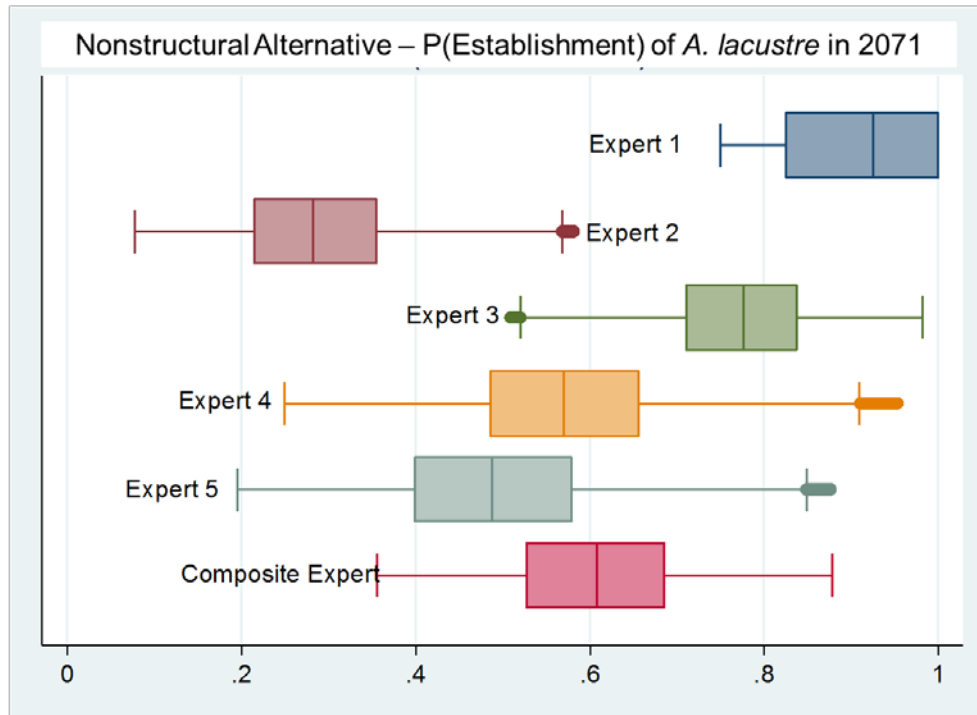


Figure 43 *A. lacustre* P(establishment) 2071 values for the Nonstructural Alternative estimated for all five experts and the composite expert.

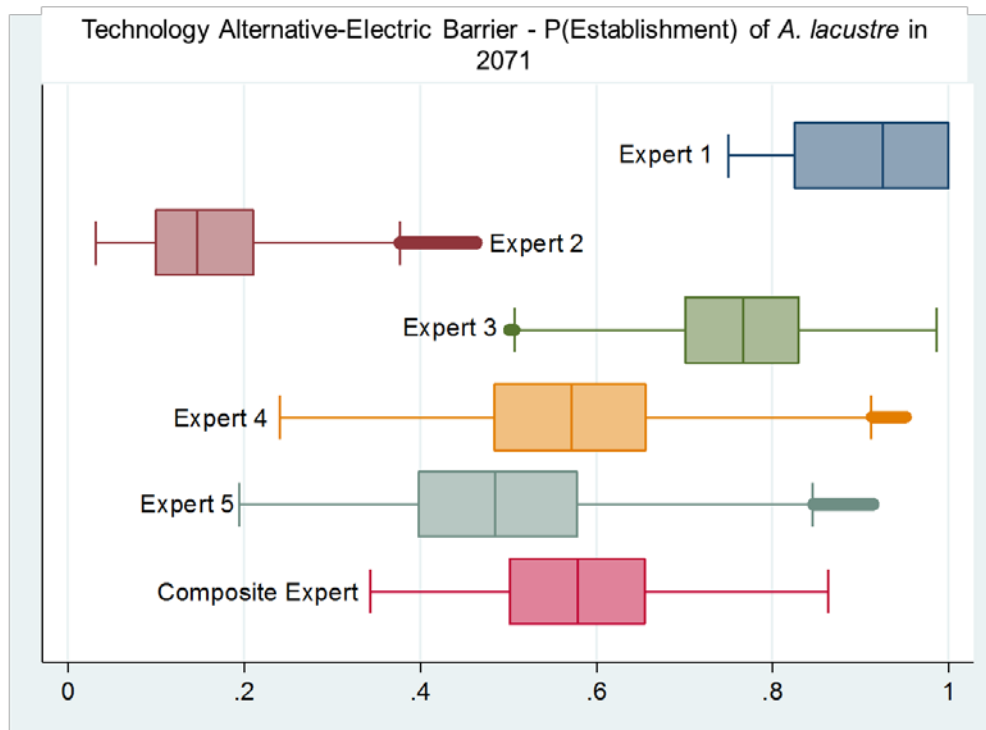


Figure 44 *A. lacustre* P(establishment) 2071 values for the Technology Alternative-Electric Barrier estimated for all five experts and the composite expert.

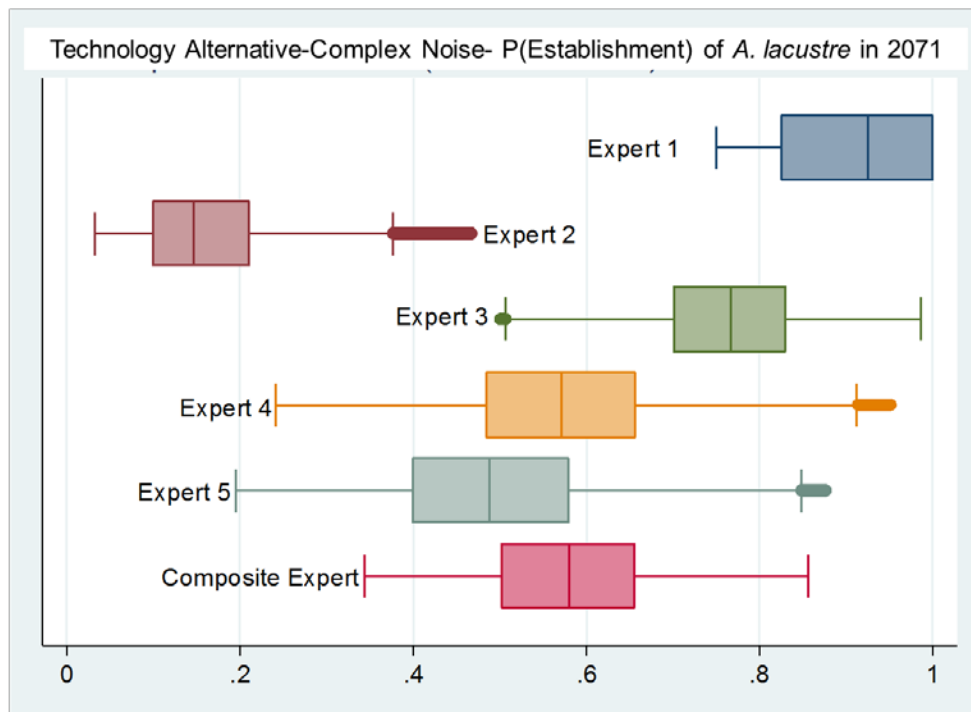


Figure 45 *A. lacustre* P(establishment) 2071 values for Technology Alternative-Complex Noise estimated for all five experts and the composite expert.

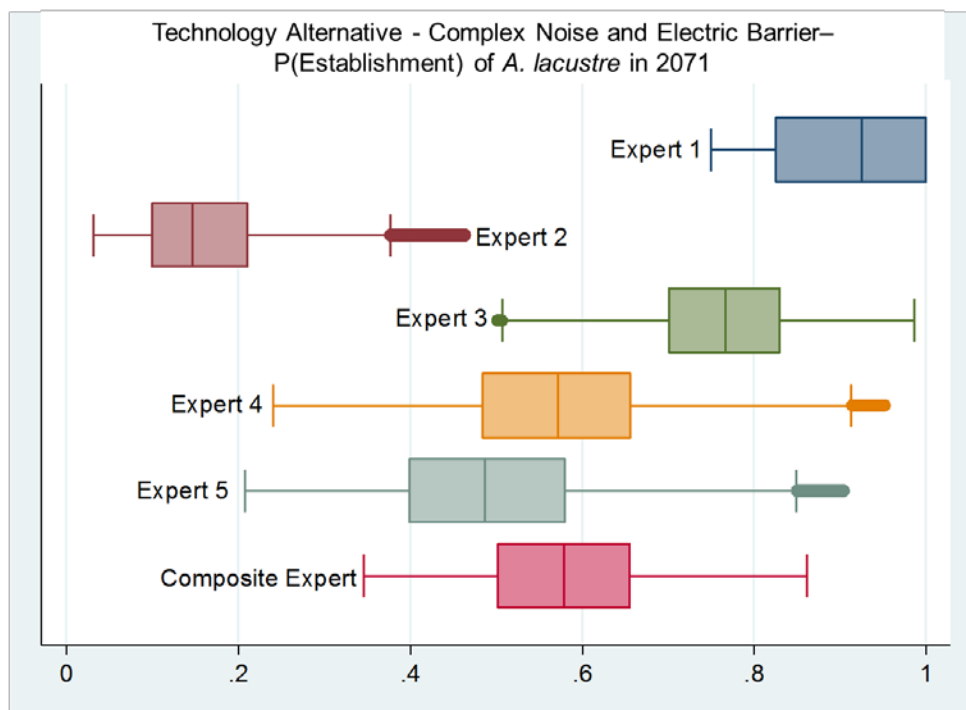


Figure 46 *A. lacustre* P(establishment) 2071 values for Technology Alternative –Complex Noise and Electric Barrier estimated for all five experts and the composite expert.

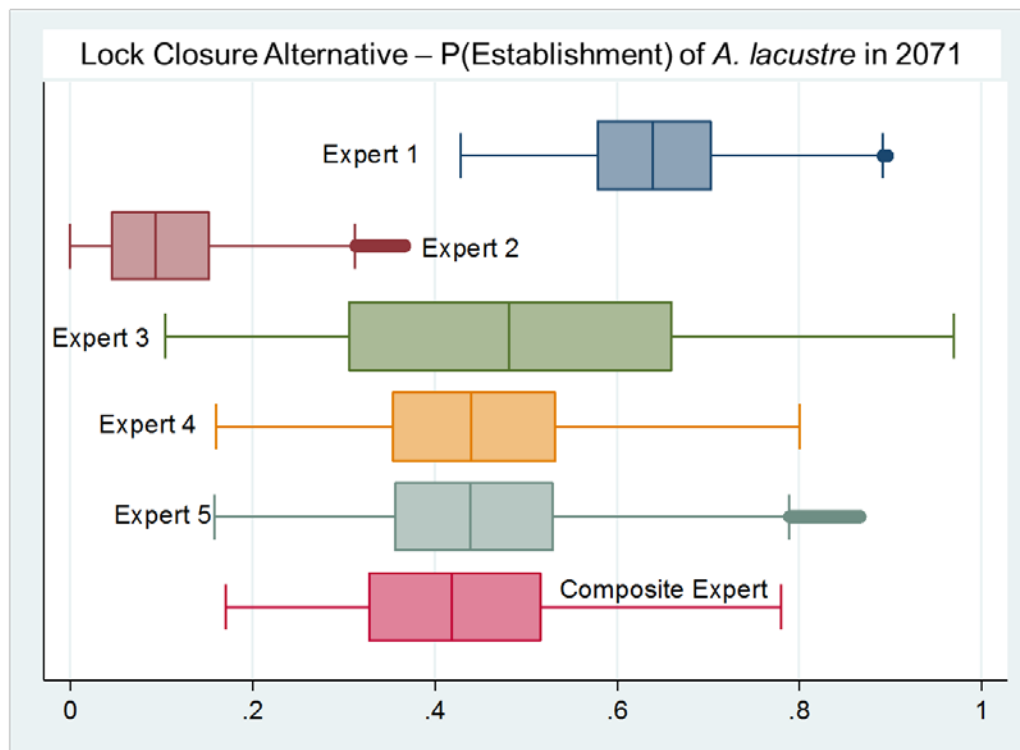


Figure 47 *A. lacustre* P(establishment) 2071 values for the Lock Closure Alternative estimated for all five experts and the composite expert.

Composite Expert Residual P(establishment) for the No New Federal Action Alternative

There is no future scenario that has zero risk of establishment of *A. lacustre*. No matter which plan is implemented there is still some probability of establishment. Closing the lock would reduce P(establishment) to 0 but there is some probability of establishment by 2021, so even that option is not guaranteed to prevent the establishment of *A. lacustre* in the GLB.

The probability of establishment that remains with a plan in place is the residual P(establishment). As with all P(establishment) estimates these residual estimates are uncertain. Table 5 presents numerical estimates of the 2071 P(establishment) for *A. lacustre*. Note that these probabilities do not include any estimation of the residual risk of establishment due to non-aquatic pathways.

Table 5. Five number summary estimates of Asian ca <i>A. lacustre</i> rp P(establishment) 2071 for composite expert No New Federal Action Alternative, Technology Alternatives, and Lock Closure.						
	No New Federal Action Alternative	Nonstructural Alternative	Technology Alternative-Electric Barrier	Technology Alternative-Complex Noise	Technology Alternative-Complex Noise with Electric Barrier	Lock Closure
Minimum	0.36	0.36	0.34	0.34	0.34	0.17
1st Quartile	0.53	0.53	0.50	0.50	0.50	0.33
Median	0.61	0.61	0.58	0.58	0.58	0.42
3rd Quartile	0.69	0.69	0.65	0.66	0.66	0.52
Maximum	0.88	0.88	0.86	0.86	0.86	0.78

P(establishment) is identical for the No New Federal Action and Nonstructural Alternatives. All technology alternatives have essentially the same negligible effect on the P(establishment) values. None of these measures are effective in reducing P(establishment) for *A. lacustre*. The composite distributions are presented graphically in Figure 48, which shows little difference among P(establishment) estimates for five of the six Alternatives. Closing the lock is the only alternative that reduces the probability estimates noticeably. Even so, considerable uncertainty remains with a range from 17-78% and a median probability of 42%.

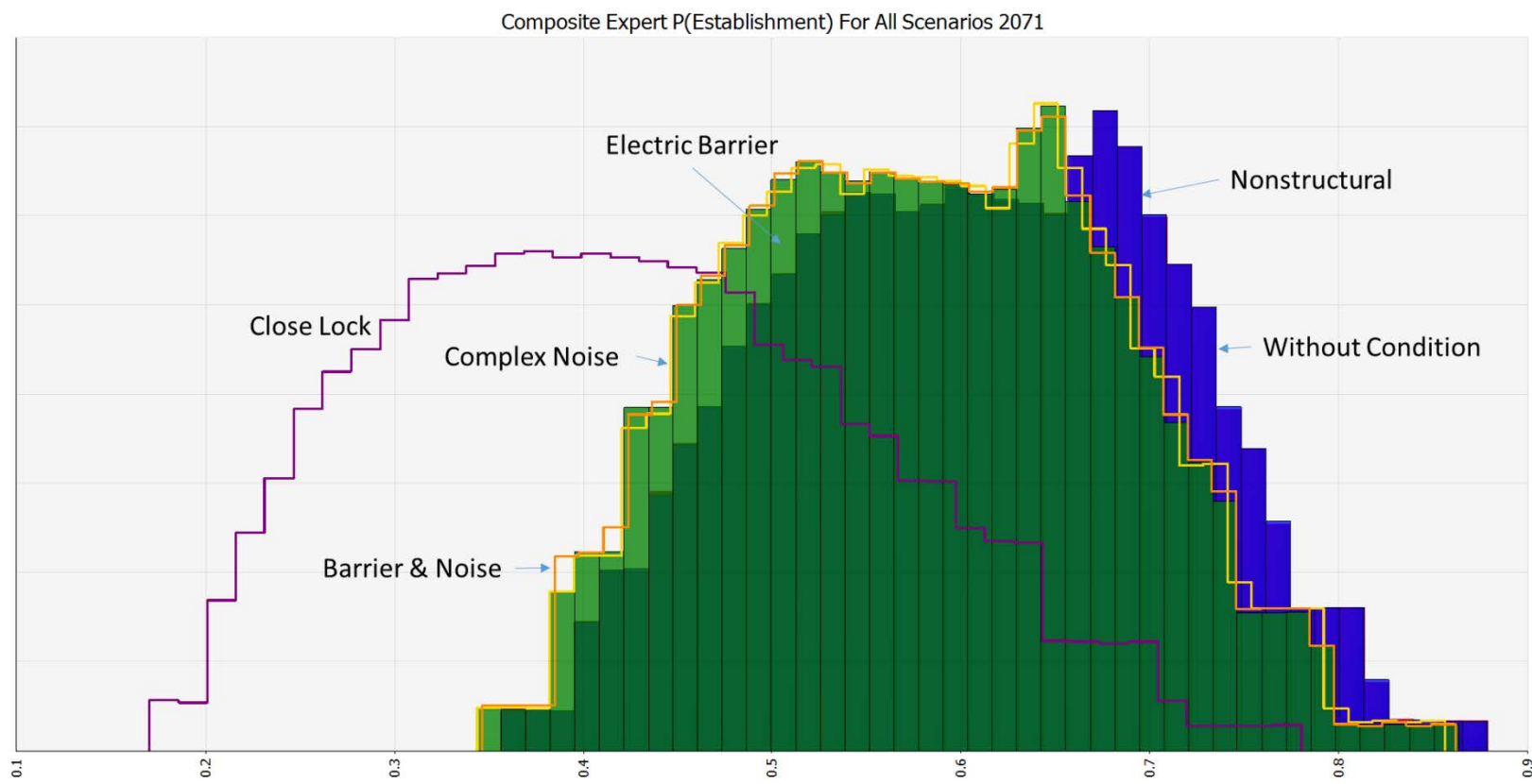


Figure 48: Estimated *A. lacustre* P(establishment) 2071 distributions for composite expert No New Federal Action Alternative, Nonstructural Alternative, Technology Alternatives, and Lock Closure Alternative.

Annex 1: Asian Carp Expert Elicitation Question Set

Without Project Condition Questions

1. When thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2021, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):

Negligible Population _____

Small Population _____

Medium Population _____

Large Population _____

TOTAL 100 Points

2. When thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2031, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):

Negligible Population _____

Small Population _____

Medium Population _____

Large Population _____

TOTAL 100 Points

3. When thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2071, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):

Negligible Population _____

Small Population _____

Medium Population _____

Large Population _____

TOTAL 100 Points

What were the main considerations in shaping your answer?

4. Considering the currently existing system that is in place, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could pass from below the dam to Lake Michigan in a year?

5. Considering the currently existing system that is in place, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could pass from below the dam to Lake Michigan in a year?

6. Considering the currently existing system that is in place, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could pass from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

7. What is smallest total number of fish that must make it to Lake Michigan between now and the end of 2021 to convince you that those fish are, by themselves, numerous enough to colonize in Lake Michigan at some point in the future?

8. What is smallest total number of fish that must make it to Lake Michigan between now and the end of 2031 to convince you that those fish are, by themselves, numerous enough to colonize in Lake Michigan at some point in the future?

9. What is smallest total number of fish that must make it to Lake Michigan between now and the end of 2071 to convince you that those fish are, by themselves, numerous enough to colonize in Lake Michigan at some point in the future?

What were the main considerations in shaping your answer?

10. Assume that Asian Carp have a colony in Lake Michigan. What is the probability that Asian Carp will spread beyond Lake Michigan?

What were the main considerations in shaping your answer?

Nonstructural Plan

11. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, when thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2021, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):

Negligible Population _____

Small Population _____

Medium Population _____

Large Population _____

TOTAL _____ 100 Points

12. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, when thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2031, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):

Negligible Population _____

Small Population _____

Medium Population _____

Large Population _____

TOTAL _____ 100 Points

13. Considering the elements of the nonstructural plan to be in place and functioning as you think well as they are capable of functioning, when thinking about the number of Asian Carp that could arrive at Brandon Road by the year 2071, please rate the following population sizes by their relative probability of arriving (larger numbers indicate a higher probability):

Negligible Population _____

Small Population _____

Medium Population _____

Large Population _____

TOTAL _____ 100 Points

What were the main considerations in shaping your answer?

14. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

15. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

15. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

Technology Alternative – Electric Barrier

15. Considering the elements of the electric barrier and barge entrainment plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

16. Considering the elements of the electric barrier and barge entrainment plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

17. Considering the elements of the electric barrier and barge entrainment plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

Lock Closure

18. Considering the elements of the lock closure plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

19. Considering the elements of the lock closure plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

20. Considering the elements of the lock closure plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

Technology Alternative – Complex Noise

15. Considering the elements of the complex noise plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

16. Considering the elements of the complex noise plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in

a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

17. Considering the elements of the complex noise plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

Technology Alternative – Complex Noise with Electric Barrier

21. Considering the elements of the electric barrier and complex noise plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a small population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

22. Considering the elements of the electric barrier and complex noise plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a medium population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

23. Considering the elements of the electric barrier and complex noise plan, which includes all the elements of the nonstructural plan, to be in place and functioning as well as you think they are capable of functioning, assume that a large population of Asian Carp have arrived at Brandon Road Lock and Dam. The number of fish that will make it all the way from downstream of the lock and dam into Lake Michigan in a year will vary from year-to-year and that number is uncertain. What do you believe is the number of fish that could survive the trip from below the dam to Lake Michigan in a year?

What were the main considerations in shaping your answer?

Annex 2: A. Iacustre Expert Elicitation Question Set

No New Federal Action (Without Condition)

1. What is the probability that a population of scud will arrive at Brandon Road Lock and Dam by 2021?
2. What is the probability that a population of scud will arrive at Brandon Road Lock and Dam by 2031?
3. What is the probability that a population of scud will arrive at Brandon Road Lock and Dam by 2071?
4. Considering the currently existing system that is in place, assume that a population of scud have arrived at Brandon Road Lock and Dam. What is the probability that some non-trivial number of scud will pass from below the dam to Lake Michigan by 2021?
5. Considering the currently existing system that is in place, assume that a population of scud have arrived at Brandon Road Lock and Dam. What is the probability that some non-trivial number of scud will pass from below the dam to Lake Michigan by 2031?
6. Considering the currently existing system that is in place, assume that a population of scud have arrived at Brandon Road Lock and Dam. What is the probability that some non-trivial number of scud will pass from below the dam to Lake Michigan by 2071?
7. Considering the amount of scud you believe will pass through the system by 2021, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2021?
8. Considering the amount of scud you believe will pass through the system by 2031, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?
9. Considering the amount of scud you believe will pass through the system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?
10. Assume that scud have a colony in Lake Michigan. What is the probability that scud will spread beyond Lake Michigan?

Nonstructural

11. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?
12. Considering the amount of scud you believe could pass through the nonstructural system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?

13. Considering the elements of the nonstructural plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?
14. Considering the amount of scud you believe could pass through the nonstructural system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?

Close Lock

15. Considering the elements of the lock closure plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?
16. Considering the amount of scud you believe could pass through the system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?
17. Considering the elements of the lock closure plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?
18. Considering the amount of scud you believe could pass through the system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?

Technology Alternative - Electric Barrier

19. Considering the elements of the electric barrier plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?
20. Considering the amount of scud you believe could pass through the electric barrier system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?
21. Considering the elements of the electric barrier plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock

and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?

22. Considering the amount of scud you believe could pass through the electric barrier system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?

Technology Alternative - Complex Noise

23. Considering the elements of the complex noise plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?
24. Considering the amount of scud you believe could pass through the complex noise system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?
25. Considering the elements of the complex noise plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?
26. Considering the amount of scud you believe could pass through the complex noise system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?

Technology Alternative - Complex Noise with Electric Barrier

27. Considering the elements of the electric barrier and complex noise plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2031?
28. Considering the amount of scud you believe could pass through the electric barrier and complex noise system by 2071, what is the probability those scud will find a suitable habitat and be sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2031?
29. Considering the elements of the electric barrier and complex noise plan to be in place and functioning as well as you think they are capable of functioning, if a population of scud manage to arrive at Brandon Road Lock and Dam, what is the probability that a significant amount of scud will pass from below the dam to Lake Michigan by 2071?
30. Considering the amount of scud you believe could pass through the electric barrier and complex noise system by 2071, what is the probability those scud will find a suitable habitat and be

sufficiently large in number to create a sustainable breeding colony in Lake Michigan at some point in the future, if no additional scud enter the lake after 2071?

Addendum 1: Experts' CV's

Safra Altman, Ph.D. 104 Dana Place Vicksburg, MS 39180 ph. 860-961-3976 email: safraaltman@gmail.com

EDUCATION

Ph.D. Behavior, Ecology, Evolution and Systematics (May 2011). University of Maryland, College Park, MD.

Dissertation title: Diversity, Invasibility, and Resource Use in Marine Fouling Communities of San Francisco Bay

Advisors: Marjorie Reaka, Anson Hines M.Sc. Oceanography (2003). University of Connecticut, Avery Point, CT.

Thesis title: Space invaders: the effect of small-scale disturbance on invasion success in marine communities Advisor: Robert Whitlatch

B.A. Biology (1997). Brown University, Providence, RI. Advisor: Jon Witman RESEARCH EXPERIENCE

2014-present Research Ecologist, U.S. Army Engineer Research and Development Center, Environmental Laboratory
Principal investigator in the Wetlands and Coastal Ecology Branch. Collaborator on various projects including landscape modeling of vegetation change on Assateague Island, MD, cost/benefit and network analysis of oyster reef connectivity, habitat suitability of invasive species, and review of the current state of microplastic as an emerging contaminant of benthic habitats. Collaboration within the U.S. Army, Army Corps of Engineers district offices, academic research groups, the International Maritime Organization (IMO), and U.S. Agency for International Development (USAID).

2013- 2014 Senior Biologist, One Stop Environmental, LLC Worked on developing landscape ecology model for Assateague Island, MD, in collaboration and use for the U.S. Army Engineer Research and Development Center – Environmental Laboratory. Projects included developing a landscape model that links landscape pattern, landscape metrics and ecological processes to identify ecological benefits including evaluation of ecosystem services and developing a relational database to serve as a U.S. Army Corps of Engineer project planning tool. Other projects focus on threatened and endangered species protection and understanding connectivity between ecosystems.

2010-2013 Postdoctoral Research Associate, The University of Georgia Odum School of Ecology & UGA Marine Institute. Advisor: James E. Byers. Lived and worked on Sapelo Island. Main project focused on the ecology of the marsh/upland ecotone by 1) testing the accuracy of current Georgia laws to define the upland salt marsh border and 2) understanding how marine invertebrates use and depend on the marsh/upland buffer or ecotone. There was a large field component to this study requiring extensive use of differential GPS and RTK GPS equipment to measure changes in coastal topography, geomorphology, shoreline position and salt marsh elevation. Extensive knowledge of experimental design, statistical analysis and taxonomic expertise (plant and invertebrate) was critical. This work was funded by GA Sea Grant. An additional study funded by NSF focused on biogeography and phylogeography of marine and estuarine species along the eastern coast of North America.

2006 –2009 Smithsonian Institution Predoctoral Fellow, Smithsonian Environmental Research Center.

2000- 2002 Graduate Research Assistant and Technician, University of Connecticut Provided research support for laboratory activities including monitoring weekly recruitment of subtidal fouling communities, assisting in a number of field projects, research diving, and data collection. Collected hard and soft substrate marine invertebrates. Processed benthic samples and identified benthic organisms. Trained and mentored 1 undergraduate intern. Additional organizational duties consisted of data entry. 1998-2000 Biological Technician, Smithsonian Environmental Research Center Participated in a number of collaborative projects involving ballast water research. Project leader for the host/parasite interaction study of *Macoma balthica* and *Perkinsus marinus*. Project leader for the North Atlantic Arrivals ballast water project and laboratory safety officer. Main responsibilities included zoo- and phytoplankton identification and enumeration, sample collection, processing, curation, data entry, and data analysis. Other responsibilities included collection and identification of fouling community invertebrates, culturing zoo- and phytoplankton, fieldwork and laboratory maintenance. 1997 Research Assistant, Brown University

Assisted Dr. Jon Witman in data collection and analysis for multiple projects involving recruitment dynamics of the blue mussel *Mytilus edulis*. Studied demography of *Asterias vulgaris* seastar populations in the Southern Gulf of Maine.

MARINE POLICY EXPERIENCE

2010 Senior Advisor for Research and Development, U.S. Committee for the Marine Transportation System, Office of the Executive Secretariat Coordinated 27 government agencies and offices in the development of a national research and development strategy for the U.S. Marine Transportation System. Planned and organized a national conference for government, industry and private stakeholders to participate in strategic planning process and identify stakeholder needs. Co-Authored research and development strategic plan.

2009-2010 Sea Grant Knauss Marine Policy Fellow, National Oceanic & Atmospheric Administration, Oceanic and Atmospheric Research Headquarters, Office of Policy, Planning, and Evaluation

Served as executive secretariat to the Committee for the Marine Transportation System's Integrated Action Team on Research & Development. Participated in the NOAA strategic planning process through internal proposals, serving as a liaison between labs and headquarters, and informing division Administrators. Served on the Joint Subcommittee for Ocean Science and Technology Ocean Partnership Interagency Working Group on Biodiversity, and on internal NOAA Biodiversity working group efforts. TEACHING, MENTORING & OUTREACH EXPERIENCE

Georgia Public Broadcasting Georgia Outdoors episode "Fiddling with Crabs", March 2012

<http://www.gpb.org/georgia-outdoors/season-19/episode/fiddling-with-crabs> Marsh Buffer Zone Ecology Friends of Sapelo Workshop, Fall 2011, May 2012 Marine Invasive Species Seminar Nerd Nite, Washington, DC, Winter 2010.

Nerd Nite is an opportunity to present interesting research to nonspecialists in a fun atmosphere. Principles of Genetics Graduate Teaching Assistant, University of Maryland. Fall 2005. Animal Diversity Graduate Teaching Assistant, University of Maryland. 3 Semesters 2004-2005, Lab Coordinator 2005. Environmental Science Graduate Teaching Assistant, University of Maryland. Fall 2003. Coastal Ecosystems Processes Graduate Teaching Assistant, University of Connecticut. 2 Semesters 2001-2002. Marine Invertebrate Zoology Graduate Teaching Assistant, University of Connecticut. Fall 2002. Introduction to Oceanography Graduate Teaching Assistant, University of Connecticut. Spring 2002. Tidepool Workshop Connecticut State Museum of Natural History, Spring 2002. Developed curriculum and co-taught workshop for teens and adults. Taste, Touch and Smell of Science Coordinator, Summer Program, University of Connecticut. 2001-2002. Directed marine education summer program for local 9-13 year olds. Developed curriculum and activities. Managed fellow graduate student instructors. Undergraduates Mentored U-GA: Sarah Weber, Mariana Rivera, Anna Laws (College of Charleston), Jamie Winokur, Megan Chase, Chris Hampton, Chelsea Sexton U-MD: Kenan Matterson (now pursuing PhD at University of Alabama) SERC: Micheal Um (now pursuing MD at Washington University), Mary-Jane Ides (Peninsula College), Autumn Turner (University of Washington). UConn: Kimberly Barber Bradley.

High School Students 5 Students, Marin County Public High Schools, Mentored 2006-2007.

Science Fair Judge South River High School, Rye Middle School, Elsie Whitlow Stokes Elementary

SELECTED PRESENTATIONS Altman, S, M Reif, and T Swannack. Process-driven ecological modeling for landscape analysis. American Geophysical Union Fall Meeting, December 2013.

Altman, S and JE Byers. Influence on tidal marshes by upland development. Georgia Research Colloquium, Georgia Coastal Research Council, October 2013, invited. Altman, S and JE Byers. Marsh crabs in the forest: ecology of the marsh/upland ecotone. 42nd Annual Benthic Ecology Meeting, March 2013.

Altman, S. The role of facilitation and inhibition by invaders in the diversity-invasibility debate. 40th Annual Benthic Ecology Meeting, March 2011.

Altman, S. Ecological Sustainability and the Challenge of Managing Risks Posed by Invasive Species. Transforming the Marine Transportation System: A Vision for Research and Development (Marine Transportation System Research & Development Conference), July 2010.

Jewett, E, KJ Larson, S Altman, T Huber and GM Ruiz. Invasive tunicates as ecosystem engineers in San Francisco Bay. Coastal and Estuarine Research Federation 20th Biennial Conference, Portland, OR, November 2009.

Altman, S. Sitting on the dock of the bay: Patterns of native and invasive diversity in San Francisco fouling communities. 6th International Marine Bioinvasions Conference, Portland, OR, August 2009.

Altman, S. Patterns of native and invasive diversity in marine fouling communities. History of Marine Animal Populations (HMAP) International Summer School, August 2009.

Altman S, GM Ruiz and AH Hines. Effects of community diversity and resource availability on invasion in marine fouling communities. Ecological Society of America Annual Meeting, San Jose, CA, August, 2007.

Altman S, GM Ruiz and AH Hines. Combined effects of diversity and resource on invasion. Benthic Ecology Meeting, Atlanta, GA, March, 2007.

Altman, S, AH Hines and GM Ruiz. Invasion success of colonial tunicates. Benthic Ecology Meeting, Virginia Institute of Marine Science, Williamsburg, VA, April, 2005. Award: Best Student Poster.

Altman, S, R. Whitlatch and J. Terwin. Space Invaders: Does disturbance facilitate or hinder invasion success in marine communities? Benthic Ecology Meeting, Mystic, Connecticut, March, 2003. Award: Best Student Talk.

PUBLICATIONS

Altman, S., M.K. Reif, and T.M. Swannack. 2014. Linking critical ecological processes to landscape pattern: Implications for USACE planning and operations. ERDC/CHL CHETN

V-23. Vicksburg, MS: U.S. Army Engineer Research and Development Center. <http://chl.erd.c.usace.army.mil/chetn>

Altman, S, J Robinson, J Pringle, JE Byers, and JP Ware. 2013. Edges and overlaps in North Atlantic phylogeography. Diversity, 5:263-275. doi:10.3390/d5020263

Altman, S and RB Whitlatch. 2007. Effects of small-scale disturbance on invasion success in marine communities. Journal of Experimental Marine Biology and Ecology, 342:15-29.

Altman, S, and JE Byers. Temporally and spatially variable use of an ecotone. In Review.

Altman, S, RT Knieb, and JE Byers. Environmental factors driving marsh delineation. In Preparation.

Jewett, E, KJ Larson, S Altman, T Huber and GM Ruiz. Invasive tunicates as ecosystem engineers in San Francisco Bay. In Preparation.

Altman S, Hines AH and GM Ruiz. Native and non-indigenous species: alpha and beta diversity in marine fouling communities of San Francisco Bay. In Preparation.

Altman S, Hines AH and GM Ruiz. The effect of diversity and resource availability on invasibility of novel non-indigenous species. In Preparation. AWARDS AND FELLOWSHIPS International Marine Bioinvasions Conference Summer 2009 Student Travel Award

Invited International Student Collaborator, Spring 2009 Global Invasions Research Coordination Network, National Science Foundation

Smithsonian Institution Predoctoral Fellow Summer 2006 – Spring 2009

Millhauser Graduate Fellow, The Park School of Baltimore 2007, 2002

Explorer's Club Grant Summer 2006

Link Foundation Graduate Fellowship Summer 2005

Smithsonian Institution Graduate Student Fellowship Summer 2004

S.Y. Feng Graduate Student Travel Award, Spring 2003, 2002 University of Connecticut

INVITED LECTURES Skidaway Institute of Oceanography, 2013. University of Wisconsin. 2011. University of Georgia Marine Institute, 2011.

University of Georgia, Odum School of Ecology. 2011. Engineer Research and Development Center, U.S. Army Corps of Engineers. 2010. US Army Corps of Engineers Navigation Strategic Planning Workshop. 2010. Northern Virginia Community College 2008. San Francisco State University, Romberg Tiburon Center for Environmental Studies, 2007. American University. 2004. George Mason University. 2003.

WORKSHOPS AND SHORT COURSES Invited Scientist, Center for Ocean Science Education Excellence Southeast Researcher Educator Exchange Forum (COSEE-SE REEF), South Carolina State Museum, July 20-22, 2011. Participant, Real Time Kinematic (RTK) Satellite Navigation Workshop, Sapelo Island National Estuarine Research Reserve, June 24-25, 2011.

Participant, History of Marine Animal Populations International Summer School, When humanities meet ecology: historic changes in Mediterranean and Black Sea marine biodiversity and ecosystems, Trieste, Italy, August 2009.

Invited Participant, West Coast Regional Research and Information Needs Planning Workshop, Oakland, CA, November 28, 2007.

Support Staff, Ocean Research Priorities Plan Workshop, Denver Colorado, April 18-20, 2006. Participant, Ecology and Taxonomy of Tunicates, Smithsonian Tropical Research Institute, Bocas del Toro, Panama, August 2006.

Participant, PRIMER-E, Multivariate Statistics for Ecologists Class, Ft. Pierce, Florida, May 2005.

SERVICE Member, Georgia Cooperative Invasive Species Management Area, 2012-2014. Proposal Reviewer: Maryland Sea Grant, National Sea Grant, Hawaii Coral Reef Initiative Research Program, Graduate Women in Science Peer Reviewer, Manuscripts from: Journal of Experimental Marine Biology and Ecology, Biological Invasions, Environmental Research Steering Committee, 2008 Benthic Ecology Meeting, Providence, RI Steering Committee, Maryland Sea Grant Aquatic Invasive Species Vectors Workshop, 2010

PROFESSIONAL MEMBERSHIPS American Geophysical Union Ecological Society of America Western Society of Naturalists Sigma Delta Epsilon, Graduate Women in Science Sigma Xi, The Scientific Research Society Diver's Alert Network

ADDITIONAL QUALIFICATIONS

Former Certified Lifeguard (ARC and ALA) AAUS Research Diver certification Enriched Air Nitrox Diver certification PADI Advanced Open Water SCUBA certification Red Cross Community CPR and First Aid Safe Boating Certificate, Connecticut and Maryland Reading and speaking proficiency in Spanish Oil Spill Response/ Hazardous Materials Training Expertise in SAS, Primer-E, R, JMP statistical packages

REFERENCES

Patricia Tuminello (Direct Supervisor) Chief, Wetlands and Coastal Ecology Branch USACE Engineer Research & Development Center – Environmental Laboratory 3909 Halls Ferry Road Vicksburg, MS 39180 Email: Patricia.T.Tuminello@usace.army.mil Phone: 601-634-4826

James Byers (Postdoctoral Advisor) Associate Professor Odum School of Ecology University of Georgia 140 E. Green St. Athens, GA 30602 Email: jebymers@uga.edu Office Phone: (706) 583-0012 Fax: (706) 542-4819

Anson H. Hines (Dissertation Co-Advisor) Director and Senior Scientist Fish & Invertebrate Ecology Smithsonian Environmental Research Center 647 Contees Wharf Rd Edgewater, MD 21037 Email: hinesa@si.edu Office Phone: (443) 482-2208 Fax: (443) 482-238

Gregory M. Ruiz (Dissertation Committee, Employer) Senior Scientist Marine Invasions Research Lab Smithsonian Environmental Research Center 647 Contees Wharf Rd Edgewater, MD 21037 Email: ruizg@si.edu Office Phone: (443) 482-2227 Fax: (443) 482-2380

CURRICULUM VITAE

Theodore (Ted) R. Angradi Education:

B.S., Wildlife Management, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1984

M.S., Wildlife and Fisheries Science, Pennsylvania State University, University Park, Pennsylvania, 1986

Ph.D., Biology, Idaho State University, Pocatello, Idaho, 1990

Employment:

Research Biologist (GS-14), US Environmental Protection Agency, Office of Research and Development, Duluth, MN, October 2010 to present.

Research Biologist (GS-13), US Environmental Protection Agency, Office of Research and Development, Duluth, MN, October 2005 to October 2010.

Research Biologist (GS-13), US Environmental Protection Agency, Office of Research and Development, Denver, CO, July 1999 to September 2005 (stationed in EPA Region 8 Office). Visiting Scientist (US Forest Service Sabbatical Appointment), Rutgers University Marine Field Station, Institute of Marine and Coastal Sciences, Tuckerton, NJ, April to December 1998.

Aquatic Ecologist (GS-13), US Forest Service, Northern Research Station, Timber and Watershed Laboratory, Parsons, WV, October 1994 to July 1999. Aquatic Ecologist (GS-12), US Forest Service, Northern Research Station, Timber and Watershed Laboratory, Parsons, WV, May to September 1994 Postdoctoral research associate (GS-11), US Forest Service, Northern Research Station, Timber and Watershed Laboratory, Parsons, WV, 1992-1994

Limnologist, Colorado River Program, Arizona Game and Fish Department, Page, AZ. March 1991-November 1992.

Postdoctoral Research Assistant, Department of Biological Sciences, Idaho State University. 1990-1991.

Research Assistant, Department of Biological Sciences, Idaho State University. 1989-1990.

2

Teaching Assistant, Department of Biological Sciences, Idaho State University. 1986-1989.

Research Assistant, School of Forest Resources, Pennsylvania State University. 1984-1986.

Professional societies:

American Fisheries Society North American Benthological Society

Honors:

EPA Bronze Metal for Commendable Service, EPA Region 8 Surface Water Team, 2003 "For outstanding accomplishments in the field of environmental monitoring and assessment in a collaborative project involving ORD, Regions, States, and Tribal nations"

EPA Superior Accomplishment Award, September 2004 "In recognition for technical leadership for GRE Field Manual and field training"

Scientific and Technological Achievement Award, Honorable Mention, 2005 "For research on river ecology in support of EPA's commitment to the protection and restoration of our Nations Great River Ecosystems." Awarded for: Angradi et al. 2004. Bank stabilization, shoreline land-use, and the distribution of large woody debris in a regulated reach of the upper Missouri River, North Dakota, USA. River Research and Applications 20:829-846.

EPA Superior Accomplishment Award, June 2005 “In recognition for reporting UMR results and development of the Great Rivers EMAP Program”

NHEERL Quality Assurance Award, October 2006 “In recognition of their extraordinary accomplishments as the Great River EMAP team and implementation of the NHEERL Quality System”

EPA Bronze Metal for Commendable Service, EMAP Great Rivers Team, 2008 “For successful planning and implementation of the Environmental Monitoring and Assessment Program for Great River Ecosystems”

Scientific and Technological Achievement Award. Level III. 2009. For advancing the Science of Large River monitoring.

Scientific and Technological Achievement Award. Level III. 2010. For advancing the Science of Large River monitoring. EPA Award for exceptional/Outstanding ORD Technical Assistance to Regions or Program Offices. 2012. In support of the development of nutrient criteria for the Nation’s Rivers and Streams.

Research Interests:

3

Fish ecology and behavior, aquatic ecology, large rivers, bioassessment, estuaries, ecological indicators, macroinvertebrates, invasive species, ecosystem services Adjunct Faculty Appointments:

Department of Biology, Marshall University, Huntington, West Virginia (Former) Division of Forestry, West Virginia University, Morgantown, West Virginia (Former)

Editorships:

Editorial board, Ecological Indicators Associate Editor, Freshwater Science

Journal articles:

1. Angradi, T.R., and W.M. Tzilkowski. 1986. Uptake and phytotoxicity of selenium in black cherry and white ash seedlings. *Forest Science* 32:806-811.
2. Angradi, T.R., and J.S. Griffith. 1990. Diel feeding chronology and diet selection of rainbow trout (*Oncorhynchus mykiss*) in the Henry's Fork of the Snake River, Idaho. *The Canadian Journal of Fisheries and Aquatic Sciences* 47:199-209.
3. Angradi, T.R. 1991. Transport of coarse particulate organic matter in an Idaho river, USA. *Hydrobiologia* 211:171-183.
4. Angradi, T.R., J.S. Spaulding, and E.D. Koch. 1991. Diel food utilization by Virgin River spinedace (*Lepidomeda mollispinis*) and speckled dace (*Rhinichthys osculus*), in Beaver Dam Wash, Utah. *The Southwestern Naturalist* 36:158-170.
5. Angradi, T.R. 1992. Effects of predation risk on foraging behavior of juvenile rainbow trout. *Canadian Journal of Zoology* 70:355-360.
6. Vinson, M.R., D.K. Vinson, and T.R. Angradi. 1992. Aquatic macrophytes and in-stream flow characteristics of a Rocky Mountain river. *Rivers* 3:260-265.
7. Angradi, T.R. 1993a. Stable carbon and nitrogen isotope analysis of seston in a regulated Rocky Mountain river. *Regulated Rivers, Research and Management* 8:251-270.

8. Angradi, T.R. 1993b. Chlorophyll content of seston in a Rocky Mountain river. *Hydrobiologia* 259:39-46.
9. Angradi, T.R., and D.M. Kubly. 1993. Effects of atmospheric exposure on chlorophyll a, biomass, and productivity of the epilithon of a tailwater river. *Regulated Rivers, Research and Management* 8:345-358.

4

10. Angradi, T.R. 1994. Trophic linkages in the lower Colorado River: multiple stable isotope evidence. *Journal of the North American Benthological Society* 13:479-495.
11. Angradi, T.R., and D.M. Kubly. 1995. Concentration and transport of particulate organic matter below Glen Canyon Dam on the Colorado River, Arizona. *Journal of the ArizonaNevada Academy of Science* 28:13-22.
12. Angradi, T.R., and M.R. Vinson. 1995. Status of and attitudes toward aquatic macroinvertebrate monitoring on National Forests and Bureau of Land Management Districts. *Bulletin of the North American Benthological Society* 12:389-397
13. Yokum, K.A., T.R. Angradi, and D.C. Tarter. 1995. Ecology of *Peltoperla arcuata* and *Tallaperla maria* (Plecoptera: Peltoperlidae) at the Fernow Experimental Forest, Tucker County, West Virginia. *Psyche* 102:151-168.
14. Angradi, T.R. 1996. Inter-habitat variation in benthic community structure, function, and organic matter storage in three Appalachian headwater streams. *Journal of the North American Benthological Society* 15:42-62
15. Adams, M.B., and T.R. Angradi. 1996. Decomposition and nutrient dynamics of hardwood leaf litter in the Fernow whole-watershed acidification experiment. *Forest Ecology and Management* 83: 61-69.
16. Yokum, K.A., B.R. Johnson, R.C. Tipton, D.C. Tarter, and T.R. Angradi. 1996. Leaf species selection by the shredding stoneflies *Peltoperla arcuata* and *Tallaperla maria* (Plecoptera: Peltoperlidae). *Journal of the West Virginia Academy of Science* 66: 34-42.
17. Angradi, T.R. 1997. Hydrologic context and macroinvertebrate community response to floods in an Appalachian headwater stream. *The American Midland Naturalist*, 139:371-386.
18. Adams, M.B., T.R. Angradi, P.J. Edwards, and J.N. Kochenderfer. 1997. Stream water and soil solution response to five years of nitrogen and sulfur additions at the Fernow Experimental Forest, West Virginia. *Forest Ecology and Management* 95:79-91.
19. Angradi, T.R., and R. Hood. 1998. An application of the plaster dissolution method for quantifying water velocity in the shallow hyporheic zone of an Appalachian headwater stream system. *Freshwater Biology* 39:301-315.
20. Angradi, T.R. 1998. Observations of *Craspedacusta sowerbyi* medusa in a West Virginia reservoir. *Brimleyana* 25:34-42.
21. Angradi, T.R. 1999. Fine sediment and macroinvertebrate assemblages in Appalachian headwater streams: a field experiment with applications for biomonitoring. *Journal of the North American Benthological Society* 18:48-65.

5

22. Angradi, T.R., R. Hood, and D.C. Tarter. 2001a. Vertical, longitudinal and temporal variation in the macrobenthos of an Appalachian headwater stream system. *The American Midland Naturalist* 146:223-242.
23. Angradi, T.R., S. Hagan, and K.W. Able. 2001b. Vegetation type and the intertidal macroinvertebrate fauna of a brackish marsh: *Phragmites* versus *Spartina*. *Wetlands* 21:75-92.
24. Angradi T.R., E.W. Schweiger, D. Bolgrien, P. Ismert, and T. Selle. 2004. Bank stabilization, shoreline land-use, and the distribution of large woody debris in a regulated reach of the upper Missouri River, North Dakota, USA. *River Research and Application* 20:829-846.
25. Schweiger, E.W., D. W. Bolgrien, T.R. Angradi, and J. R. Kelly. 2004. Environmental monitoring and assessment of a Great River ecosystem: The Upper Missouri River Pilot. *Environmental Monitoring and Assessment*: 103:5-20.
- 26.

Bolgrien, D.W., T.R. Angradi, E.W. Schweiger, and J.R. Kelly. 2004. Contemplating the Assessment of Great River Ecosystems. *Environmental Monitoring and Assessment*: 103:21-40.

27. Angradi, T.R., E.W. Schweiger, and D.W. Bolgrien. 2006. Inter-habitat variation in the benthos of the Upper Missouri River (USA): implications for biomonitoring. *Rivers Research and Application*: 22: 755-773.

28. Grigorovich, I.A., T.R. Angradi, and Carol A Stepien. 2008a. Occurrence of the quagga mussel (*Dreissena bugensis*) and the zebra mussel (*Dreissena polymorpha*) in the Upper Mississippi River System. *Journal of Freshwater Ecology* 23:429-435.

29. Grigorovich, I.A., T.R. Angradi, E.B. Emery, and M.S. Wooten. 2008b. Invasion of the Upper Mississippi River system by saltwater amphipods. *Fundamental and Applied Limnology* 173:67-77.

30. Angradi, T.R., D.W. Bolgrien, T.M. Jicha, M.S. Pearson, B.H. Hill, D.L. Taylor, E.W. Schweiger, L. Shepard, A.R. Batterman, M.F. Moffett, C.M. Elonen, and L.E. Anderson 2009a. A bioassessment approach for mid-continent great rivers: The Upper Mississippi, Missouri, and Ohio (USA). *Environmental Monitoring and Assessment* 152:425-442

31. Angradi, T.R., D.W. Bolgrien, T.M. Jicha, M.S. Pearson, D.L. Taylor, and B.H. Hill. 2009b. Multispatial-scale variation in benthic and snag-surface macroinvertebrate assemblages in mid-continent (USA) great rivers. *Journal of the North American Benthological Society* 28:122-141

6

32. Angradi, T.R., D.W. Bolgrien, T.M. Jicha, M.S. Pearson, D.L. Taylor, and B.H. Hill. Multimetric macroinvertebrate indices for mid-continent US great rivers. 2009c. *Journal of the North American Benthological Society* 28:785-804

33. Angradi, T.R., M.S. Pearson, T.M. Jicha, D.L. Taylor, D.W. Bolgrien, M.F. Moffett, K.A. Blocksom, B.H. Hill. 2009d. Using stressor gradients to determine reference expectations for great river fish assemblages. *Ecological Indicators* 9:748-764.

34. Angradi, T., Taylor, D. L., Jicha, T. M., Bolgrien, D. W., Pearson, M. S., & Hill, B. H. (2010). Littoral and shoreline wood in mid-continent great rivers (USA). *River research and applications*, 26(3), 261-278. 35. Angradi, T. R., Bolgrien, D. W., Jicha, T., & Moffett, M. F. (2010). Macroinvertebrate assemblage response to urbanization in three mid-continent USA great rivers. *Fundamental and Applied Limnology/Archiv für Hydrobiologie*, 176(3), 183-198.

36. Angradi, T. R., & Jicha, T. M. (2010). Mesohabitat-specific macroinvertebrate assemblage responses to water quality variation in mid-continent (North America) great rivers. *Ecological Indicators*, 10(5), 943-954.

37. Blocksom, K. A., Walters, D. M., Jicha, T. M., Lazorchak, J. M., Angradi, T. R., & Bolgrien, D. W. (2010). Persistent organic pollutants in fish tissue in the mid-continent great rivers of the United States. *Science of the total environment*, 408(5), 1180-1189.

38. Bolgrien, D.W., J.V. Scharold, T.R. Angradi, T.D. Corry, E. W. Schweiger, and J.R. Kelly. 2009. Trophic status of three large Missouri River reservoirs Lake and Reservoir Management 25:176-190.

39. Havel, J.E., K.A. Medly, K.D. Dickerson, T.R. Angradi, D.W. Bolgrien, P.A. Bukaveckas, and T.M. Jicha. 2009. Effects of main-stem dams on zooplankton communities of the Missouri River (USA). *Hydrobiologia* 628:121-135.

40. Reavie, E.D., T.M. Jicha, T.R. Angradi, D.W. Bolgrien, and B.H. Hill. 2010. Algal assemblages for large river monitoring: comparison among biovolume, absolute and relative abundance metrics. *Ecological Indicators* 10:167-177

41. Walters, D. M., Blocksom, K. A., Lazorchak, J. M., Jicha, T., Angradi, T. R., & Bolgrien, D. W. 2010. Mercury contamination in fish in midcontinent great rivers of the United States: Importance of species traits and environmental factors. *Environmental science & technology*, 44(8), 2947-2953.

42. Scharold, J. V., Corry, T. D., Bolgrien, D. W., & Angradi, T. R. (2010). Spatial variation in the invertebrate macrobenthos of three large Missouri River reservoirs. *Fundamental and Applied Limnology/Archiv für Hydrobiologie*, 176(2), 101-113.

7

43. Haring, H. J., Blocksom, K. A., Smith, M. E., Angradi, T., Wratschko, M. C., Armstrong, B., ... & Lazorchak, J. M. (2011). Sediment toxicity in mid-continent great rivers (USA). *Archives of environmental contamination and toxicology*, 60(1), 57-67.

44. Bolgrien, D. W., Meyer, R., Pearson, M. S., Jicha, T. M., Angradi, T. R., Taylor, D. L., ... & Hill, B. H. (2011). Spatial distributions of biophysical conditions on the Ohio River. *River Systems*, 19(2), 113-128.

45. Bukaveckas, P. A., MacDonald, A., Aufdenkampe, A., Chick, J. H., Havel, J. E., Schultz, R., ... & Taylor, D. (2011). Phytoplankton abundance and contributions to suspended particulate matter in the Ohio, Upper Mississippi and Missouri Rivers. *Aquatic sciences*, 73(3), 419-436.

46. Pearson, M. S., Angradi, T. R., Bolgrien, D. W., Jicha, T. M., Taylor, D. L., Moffett, M. F., & Hill, B. H. (2011). Multimetric fish indices for midcontinent (USA) great rivers. *Transactions of the American Fisheries Society*, 140(6), 1547-1564.

47. Angradi, T. R., Bolgrien, D. W., Jicha, T. M., Pearson, M. S., Taylor, D. L., Moffett, M. F., ... & Hill, B. H. (2011). An assessment of stressor extent and biological condition in the North American mid-continent great rivers (USA). *River Systems*, 19(2), 143-163.

48. Sgro, G. V., Reavie, E. D., Kireta, A. R., Angradi, T. R., Jicha, T. M., Bolgrien, D. W., & Hill, B. H. (2012). Comparison of diatom-based indices of water quality for mid-continent (USA) Great Rivers. *Journal of Environmental Indicators*, 5(1), 48-67.

49. Kireta, A. R., Reavie, E. D., Sgro, G. V., Angradi, T. R., Bolgrien, D. W., Hill, B. H., & Jicha, T. M. (2012). Planktonic and periphytic diatoms as indicators of stress on great rivers of the United States: Testing water quality and disturbance models. *Ecological indicators*, 13(1), 222-231.

50. Bellinger, B. J., Angradi, T. R., Bolgrien, D. W., Jicha, T. M., Hill, B. H., & Reavie, E. D. (2013). Longitudinal variation and response to anthropogenic stress in diatom assemblages of the Lower Mississippi River, USA. *River Systems*, 21(1), 29-54.

51. Hill, B. H., Bolgrien, D. W., Herlihy, A. T., Jicha, T. M., & Angradi, T. R. (2011). A synoptic survey of nitrogen and phosphorus in tributary streams and great rivers of the upper Mississippi, Missouri, and Ohio river basins. *Water, Air, & Soil Pollution*, 216(1-4), 605-619.

52. Vinson, M. R., & Angradi, T. R. (2011). Stomach emptiness in fishes: sources of variation and study design implications. *Reviews in Fisheries Science*, 19(2), 63-73.

8

53. Moore, M. J., Langrehr, H. A., & Angradi, T. R. (2012). A submersed macrophyte index of condition for the Upper Mississippi River. *Ecological Indicators*, 13(1), 196-205.

54. Angradi, T. R., Bolgrien, D. W., Starry, M. A., & Hill, B. H. (2012). Modeled Summer Background Concentration of Nutrients and Suspended Sediment in the Mid-Continent (USA) Great Rivers1. *JAWRA Journal of the American Water Resources Association*, 48(5), 1054-1070.

55. Angradi, T. R., Pearson, M. S., Bolgrien, D. W., Bellinger, B. J., Starry, M. A., & Reschke, C. (2013). Predicting submerged aquatic vegetation cover and occurrence in a Lake Superior estuary. *Journal of Great Lakes Research*, 39(4), 536-546.
56. Taylor, D. L., Bolgrien, D. W., Angradi, T. R., Pearson, M. S., & Hill, B. H. (2013). Habitat and hydrology condition indices for the upper Mississippi, Missouri, and Ohio rivers. *Ecological Indicators*, 29, 111-124.
57. Vinson, M. R., & Angradi, T. R. (2014). Muskie Lunacy: Does the lunar cycle influence angler catch of Muskellunge (*Esox masquinongy*)? *PloS one*, 9(5), e98046.
58. Bellinger, B.A., T.M. Jicha, L.P. Lehto, L.R. Seifert-Monson, D.W. Bolgrien, M.A. Starry, T.R. Angradi, M.S. Pearson, C. Elonen, and B.H. Hill. 2014. Sediment nitrification and denitrification in a Lake Superior estuary. *Journal of Great Lakes Research* 40:392-403

Proceedings (peer-reviewed):

1. Angradi, T.R., and W.M Tzilkowski. 1987. Preliminary testing of a Selenium-based deer browse repellent. Proc. 3rd Eastern Animal Damage Conference, 18-21 October 1987, Gulf Shores, Alabama.
2. Adams, M.B., J.N. Kochenderfer, T.R. Angradi, and P.J. Edwards. 1995. Nutrient budgets of two watersheds on the Fernow Experimental Forest. Pages 119-130 in K.W. Gottschalk and S.L.C. Fosbroke (eds.), *Proceedings, 10th Central Hardwoods Conference*; 1995 March 5-8; Morgantown, WV. Gen. Tech. Report. NE-197. Radnor, PA: US department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 577 p.
3. Kaller, M.D., K.J. Hartman, and T.R. Angradi. 2001. Experimental determination of benthic macroinvertebrate metric sensitivity to fine sediment in Appalachian streams. *Proceedings of the Annual Conference of the Association of Fish and Wildlife Agencies* 55:105-115.
4. Angradi T.R., Bolgrien D., Meyer R., Nawrocki T., & Starry M. 2006. GIS Model for Assessing Potential Great River Reference Reaches. *Proceedings of the American*

9

Water Resources Association 2006 Spring Specialty Conference on GIS and Water Resources IV, Houston, Texas

Other peer-reviewed reports:

1. Adams, M.B., J.N. Kochenderfer, F. Wood, T.R. Angradi, and P. Edwards. 1994. Forty years of Hydrometeorological data from the Fernow Experimental Forest, West Virginia. General Technical Report NE-184. USDA, Forest Service, Northeastern Forest Experiment Station. 24 p.
2. Angradi, T.R., and M.R. Vinson. 1995. Status of and attitudes toward aquatic macroinvertebrate monitoring on National Forests and Bureau of Land Management Districts. General Technical Report NE-200. USDA Forest Service, Northeastern Forest Experiment Station. 15 p.
3. Angradi, T.R. (editor). 2006. Environmental Monitoring and Assessment Program: Great River Ecosystems, Field Operations Manual. EPA/620/R-06/002, U.S Environmental Protection Agency, Duluth, MN. 210p. Published online at <http://www.epa.gov/emap/greatriver/fom.html>.
4. Angradi, T.R. 2011. An exploratory analysis of regional assessment data in support of nutrient criteria development for EPA Region 5,7, and 8. EPA905R-11-011
5. Angradi, T.R. 2013. An exploratory analysis of Indiana and Illinois Biotic assemblage data in support of state nutrient criteria development. EPA600R-13-009

6. Hoffman, J.C., M.E. Sierszen, T.R. Angradi, and D.W. Bolgrien. 2014. Past Successes, New Approaches and Emerging Information Needs for Remediation to Restoration to Revitalization (R2R2R) Projects: Why Great Lakes Communities Benefit from Area of Concern Delisting. Proceedings of the Joint ORD-GLNPO Workshop, Remediation to Restoration to Revitalization (R2R2R): Why Communities Benefit from AOC Delisting. US Environmental Protection Agency, Washington, DC, 36pp.

Google scholar statistics:

All citations: 1588 Since 2010:714 h-index: 20 Publications with >10 citations: 35

U.S. GEOLOGICAL SURVEY
RESEARCH SCIENTIST RECORD

1. NAME Duane Chapman
2. DATE PREPARED June 30, 2015
3. DUTY STATION Columbia Environmental Research Center
4. REGION Midwest
5. CLASSIFICATION TITLE, SERIES, AND GRADE GS-482-13
6. DATE OF ENTRANCE ON DUTY March 10, 1986
7. DATE OF LAST PROMOTION 10/23/2011
8. DATE OF LAST RESEARCH GRADE PANEL REVIEW 2011
9. EDUCATION

University of Wyoming, Zoology and Physiology, Fall 1983 - Spring 1986, Master of Science, 1986.

Iowa State University, Major: Fish and Wildlife Biology (Fisheries emphasis), Minor: English, Fall 1978 through Spring 1980. Bachelor of Science, 1980.

Graceland College, Biology major track, Fall 1975 - Spring 1978.

10. TECHNICAL TRAINING RECEIVED

- Veteran Employment Training for Hiring Managers. 1 hour instruction. Columbia, MO 2014
- Supervisory Challenge Training. 40 hours instruction, Denver, CO, September, 2012
- Leading Across Generations, 4 hours instruction, Columbia, MO, May, 2012
- USGS Radiation Safety 1 hour instruction, Columbia, MO, December 2011
- American Fisheries Society Leadership Principles Workshop, 4 hours instruction, Madison, WI, August, 2004
- Radio Telemetry for Freshwater Fish Studies, 8 hours instruction, Madison, WI, August, 2004
- Building Leadership to Further Scientific Excellence, 16 hours instruction, , Columbia MO, March, 2004

- ArcGIS training, 40 hours, ESRI, Columbia, MO, September 8-12, 2003
- Department of Interior Motorboat Operator Instructor Certification Course. Forty hours of instruction, Lake Mead, Nevada. 1995.
- Environmental Chemistry and Environmental Chemistry Lab, (5 credit hours total) Corpus Christi State University 1993.
- Hazardous Materials Training (EPA course 165.5) U.S. EPA- Region 7 Bill Keffer, trainer. Jefferson City, MO, 1995.
- Certification in Electrofishing, USFWS, Denver, Colorado, 1986
- Peace Corps Aquaculture Training (11 week intensive course in aquaculture techniques, taught at University of Oklahoma, Fall 1980)

11. PROFESSIONAL EXPERIENCE

A. PRESENT ASSIGNMENT

I am a Research Fisheries Biologist in the River Studies Branch at the Columbia Environmental Research Center (CERC). As such, I operate with little guidance in my fields of endeavor. I am Project Chief for CERC's Asian carp effort, and have spent most of my time on Asian carp projects since 2002. I am arguably the best-known international expert on Asian carps. I am responsible for identifying research needs, developing proposals for extramural funding, planning and conducting research, and interpretation of data and writing reports to client agencies and publishing the research. I hire and employ private contractors or federal term and seasonal employees to perform field data collections and analyses, and I must ensure the quality of work by these employees. I typically oversee the work of 6 – 10 technicians and scientists, including direct supervision of federal employees ranging from GS3 to GS7. In fiscal 2014, I added a GS-9 and a GS-11 to my supervisees. In 2015, my combined budget for these studies was over \$600,000, including eight projects funded with appropriated money and two with reimbursable agreements. Over the past four years, most funding has come from the Great Lakes Restoration Initiative (GLRI), USGS Asian carp appropriated funding, and USGS invasive species cyclical funds.

DATES From: May 2010 To: Present

Assessing the risk of Asian Carp Establishment in the Great Lakes (20% of my time)

Potential food resources for bigheaded carps in the Great Lakes. I first proposed this study to (GLRI and received funding in the spring of 2010. We used bioenergetics, remote sensing, and feeding studies to assess food resources, including alternative, non-planktonic foods such as dreissenid pseudofeces and veligers. This project has ended, but manuscripts are in review.

Risk Assessment of Asian Carps in the Great Lakes. I was the US science lead of the 5-person writing team for a bi-national risk assessment of bigheaded carps in the Great Lakes. In 2014, we began similar risk assessments for grass carp and black carp. Funded in part by Canada Department of Fisheries and Oceans and the Great Lakes Fishery Commission.

DATES From: January 2006 To: Present

Early life history of Asian carps (15% of my time) I am PI for these studies. We modeled the time required to reach 60 developmental stages at a range of temperatures, and the sinking rates of eggs, and used these data combined with field collections to determine spawning locations and of Asian carps and to predict the risk that rivers would support Asian carp recruitment. Currently we are working to expand those efforts to understand larval movements and to assess mortality in

eggs that settle, for use in control.

DATES From: Spring 2014 To: Present (10% of my time)

Habitat selection by young of year Asian carp, and factors affecting survival. I am PI on this project, which combines experimental-pond and field work to assess habitat selection by Asian carps and the effect of native predators and the effect of cover availability.

DATES From: January 2013 To: Present (10% of my time)

Current status and range of grass carp and black carp in North America. I am CERC's lead on this collaboration with USGS-Great Lakes Science Center, US Fish and Wildlife Service (USFWS), universities, and state agencies. Black carp captured anywhere in the USA and grass carp captured from the Great Lakes and the margins of their range are sent to CERC. We perform gonad histology, aging, and diet work on these fish, and parts are sent to others for ploidy analysis, otolith microchemistry, and genetics.

DATES From: Spring 2013 To: Present (10% of my time)

Assessment of Judas fish for the control of Asian carps. I am PI on this project. We are assessing the use of telemetered carp to locate other Asian carps in areas where they are present at low densities. Also, we are assessing methods of sterilization of Asian carps, for use as Judas fish where it is undesirable to release potentially fertile fish.

DATES From: Spring 2013 To: Present (10% of my time)

Assessment of Asian carp gear avoidance behavior. I am PI on this project. We are using DIDSON acoustic video to assess the behavior of Asian carps with the goal of modifying gears or deployments in ways that enhance capture and detection.

DATES From: 2010 To: Present (10% of my time)

eDNA technology. In 2011, I enlisted C. Richter as co-PI on this project, and hired a post-doc. We have focused on eDNA "loading" rates by bigheaded carps under different conditions, and degradation rates of eDNA, and on PCR inhibitors as confounding factors. We are currently using outdoor pond studies and acoustic measurements of fish density in rivers coupled with eDNA measurements, to assess the possibility of modelling population size or biomass of carp from eDNA concentration, and to develop a method of spawning event detection.

DATES From: September 2006 To: present (10% of my time)

Assistance to regional and national invasive species management efforts

I am the USGS representative, and Research and Risk Assessment Committee Chair for the Mississippi River Basin Panel on aquatic nuisance species (MRBP). The panel is funded by the Aquatic Nuisance Species (ANS) Task Force. I report to the panel and Task Force on issues as diverse as fee-fishing operations, navigation as a vector for invasion, and creation of rapid-response protocols. I work with the panel to establish priorities, release RFPs, and to evaluate resulting reports. I have recently been recruited by the USFWS to assist in the prioritization of the goals of the national Asian carp management plan, especially the control section and the research needs section.

Page 4 of 44

DATES From: January 2015 To: present (5% of my time)

Integrated Pest Management (IPM) book I was recently tapped to produce a chapter on early detection and monitoring methods for an American Fisheries Society (AFS) book on IPM of invasive species.

NAME AND TITLE OF SUPERVISOR, TEAM LEADER(S), OR PROJECT CHIEF(S)

Supervisor: Dr. Robert Jacobson, Branch Chief, River Studies Branch

b. PREVIOUS PROFESSIONAL POSITIONS

DATES From: January 1995 To: May 2002

Fisheries biologist in the Ecology Branch at USGS Columbia Environmental Research Center. Designed and conducted contaminant and limnology investigations on streams, wetlands, and reservoirs.

DATES From: March, 1988 To: January 1995

Assistant Leader, Corpus Christi Field Station of CERC. Conducted investigations of contaminant effects on coastal and marine ecosystems. Conducted large-scale sediment quality assessments and developed new porewater toxicity testing techniques. Also directed and conducted coral larvae research.

DATES From: September 1987 To: April, 1988

Fishery Biologist. Acting Leader at Denver Field Station of NFCRC (former name of CERC). Duties included completion and publication of striped bass research, Denver field station closure, and opening Corpus Christi field station.

DATES From: March 1986 To: September 1987

Fishery Biologist, temporary, Denver Field Station. Performed striped bass - selenium toxicity tests. Applied and validated larval fish culture techniques which were developed during graduate research.

DATES From: September, 1983 To: August 1985

Research Assistantship. University of Wyoming, US Fish and Wildlife Research Coop Unit, Laramie, WY. Performed fish culture and physiological research on larval striped bass as part of Masters degree program. Also performed work on nutrient assimilation by grass carp.

DATES From: February, 1982 To: May, 1983

Hatchery manager. Centro Agricola Cantonal (CACTU) Turrialba, Costa Rica. (Peace Corps placement). Managed tilapia aquaculture facility. Supplied fingerlings and coordinated harvests with cooperating farmers. Developed production methods for large quantities of 60-90 g tilapia for cannery.

DATES From: November, 1980 To: February, 1982

Fish Culture Extensionist. CACTU, Turrialba, Costa Rica. Designed pond construction, taught tilapia and grass carp culture, coordinated harvests, and trained a Costa Rican counterpart.

12. SIGNIFICANT RESEARCH ACCOMPLISHMENTS

a. RECENT ACCOMPLISHMENTS

I have continued to design and coordinate a multi-faceted research program involving Asian carps. This research has greatly expanded our understanding of the biology of these fishes in the United States. Throughout this work, I have strived to identify key needs and incorporate the best available technology to accomplish the mission, regardless of whether the tools and expertise exist at CERC. Thus, the research is diverse in collaborators and in methodology, including bioenergetics, aging, otolith microchemistry, ploidy measurement, aquaculture techniques, surgical sterilization of fish, remote sensing, GIS, diet studies, molecular biology, genetics, telemetry, traditional fish capture techniques, fisheries acoustics, early life history, particle-transport modelling, hydrodynamics, and other tools. The following accomplishments have been realized since my last promotion in late 2011.

Potential food resources for bigheaded carps in the Great Lakes. A published bioenergetic model evaluated availability of food for bigheaded carps in the Great Lakes. We corrected errors in that model, and improved it with parameters derived from bigheaded carps rather than unsimilar species (MS in review IP-055125, technical presentation [TP] 140,151,156). We combined that model with remotely-sensed planktonic food concentrations to assess the potential survival and growth of bigheaded carps in Lakes Erie (pub 60, TP 127,136,142) and Michigan (TP 178). We also tested the ability of bigheaded carps to survive and grow on non-planktonic foods that are abundant in the Great Lakes, such as dreissenid pseudofeces (MS in review IP-057327, TP 131,160) and modelled the ability of bigheaded carps to survive on existing dreissenid veligers (TP 159,165,172).

Risk Assessment of Asian Carps in the Great Lakes. In late 2010 I was invited to be the US science lead of the 5-person writing team for a bi-national risk assessment (BNRA) of bigheaded carps (Pub 48). In 2014, we began similar risk assessments for grass carp and black carp. The grass carp BNRA was submitted for peer review in June 2015 (IP-066352). I also provided an assessment of the risk of bigheaded carps in the Great Lakes in declarations to the US Supreme Court and District court (Pub 39, 41), and worked with USGS-GLSC to assess US tributaries of Lake Erie for their potential to be recruitment locations for Asian carps (Pub 47).

Early life history of Asian carps. I realized that an understanding of the complex early life history would provide tools for both risk assessment and control of these invasive fishes. We modeled the time required to reach 60 early life history stages of Asian carps at different temperatures (pubs 31, 45, 53, 59). We then used field collections of eggs and larvae together with those models and particle transport models to determine Asian carp spawning locations and timing, and number of eggs in the drift (pub 52). That work is now being used as a model for similar work by USGS-UMESC in the impounded reach of the Mississippi River. We used our data together with Chinese and Russian literature data in a model to assess the risk that Asian carps could use Great Lakes tributaries (pub 47) for recruitment. We also measured sinking rates of Asian carp eggs, which is important in physical models. The USGS-ILWSC used our data to model the potential for recruitment at a finer scale, predicting, for example, that Asian carps could use the Sandusky River, OH, for recruitment (TP 175,179,185,196). We shortly thereafter showed that grass carp had recruited there (pub 54, TP 170). We recently developed a development-temperature model specific to grass carp (in review, IP-060743) and it has already been incorporated in to drift models for grass carp risk assessments.

Habitat selection by young of year Asian carp, and factors affecting survival. We have completed a bit over one year of field work on this two-year project, which evaluates habitat selection in sections of the Mississippi, Illinois, and Missouri Rivers. We have completed less than a year of the

experimental pond study, which includes pit tag telemetry, a variety of predator types, and artificial habitat structures (TP 192,193,196,199). In addition, we assessed the ability of young Asian carps to withstand low dissolved oxygen conditions as a refuge from predation (MS in review IP-056596).

Current status and range of grass carp and black carp in North America. This collaboration between USGS, USFWS, universities, and state agencies began in 2013. Black carp captured in the USA and grass carp from the Great Lakes and range margins are sent to CERC. We perform gonad histology, aging, and diet work on these fish, and parts are sent to others for ploidy analysis, otolith microchemistry, and genetic work. From these data we have shown that grass carp have recruited in the Lake Erie basin (pub 54, TP 170,176) and are likely established there (TP 182,189,195), and more recently that black carp are established in the Mississippi River Basin (TP 190,197,198).

Assessment of Judas fish for the control of Asian carps. Beginning in mid-2013, telemetry data were collected that shows grouping of Judas fish captured outside the study area are grouping with other fish, including other Asian carp captured and tagged in the study area, but some fish left the study area and returned upstream through two dams to the original capture site. In June 2015 we completed a study of the effectiveness of surgical sterilization of bighead and grass carps. We also have created triploid bighead carp for evaluation as Judas fish; those fish are now one year old. Calibration of eDNA technology. This new technique for early detection of bigheaded carps was pivotal in making management decisions, especially in the Chicago Area Waterway System (CAWS), but the implications of eDNA “hits” are not well-understood. We assessed the eDNA shedding rates of bigheaded carps under different feed, temperature, and crowding conditions, and eDNA degradation rates. We also detected and proposed solutions for PCR inhibition in field samples (pub 55,57,58; TP 155,161,162,166,183). More recently, we have used those data to produce a potential model to predict carp biomass from eDNA concentrations, and we are evaluating that model in the field by coupling eDNA collections with acoustic enumeration of fish and traditional capture techniques, and hydrology. In addition, we have begun to assess eDNA as a method to detect spawning events, with great success (TP 194).

Population genetics. Collaborations with Chinese colleagues continue to bear fruit since my last promotion. Recent publications have explored the rapid genetic differentiation of introduced populations of Asian carps worldwide (pubs 46,49). This collaboration was also the recent source of Chinese black carp tissues for a marker development effort led by the US Army Corps of Engineers.

Assistance to regional and national invasive species research efforts.

I served on the Mississippi Interstate Cooperative Resource Association (MICRA) steering committee for the Review of National Triploid Grass Carp Program, including production of the RFP, working closely with the contractor, and evaluation of the product. <http://www.micrarivers.org/resource-materials/micra-documents/category/15-micra-reports.html>

As Research and Risk Assessment Committee Chair for the Mississippi River Basin Panel on aquatic nuisance species (MRBP), I worked with the EXCOM and in one case with Sea Grant and Coast Guard to issue RFPs, evaluate proposals, and evaluate and disseminate contracted reports.

I was the USGS science lead on the technical review of the Great Lakes-Mississippi River Interconnectivity Study (GLRMIS), which evaluated connections between the Great Lakes and the Mississippi River Basin as pathways for movement of aquatic nuisance species.

Gut microflora of Asian carp. I was a team member on this study to assess the gut microflora of Asian carps for potential use as enhanced eDNA markers (pub 56, TP 177,187).

b. OTHER CAREER ACCOMPLISHMENTS

Early life history of Asian carps. I recognized that an understanding of carp early life history could be the basis for risk assessments and control mechanisms for Asian carps. This work began with the Chapman 2006 (Pub 31) which set the groundwork for early life history work performed at this lab and others, including the recent hydrologic models developed by the ILWSC. A review of that document (Garvey 2007, Stages 28(1):2-3) stated "This translation will aid us in (1) identifying these fishes and (2) comparing physical characteristics of transplanted populations to those in their native waters. As such, we now have a great baseline to which future research can be compared."

Guidance to Asian carp working group. I led the team writing the Control and Mitigation sections of the "Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States"

Population genetics of Asian carps. We produced microsatellite markers for research that can be used to assess kinship, population structure, phylogeography, hybridization, and effective populations in Asian carps (pub 42). An offshoot of this work has been collaboration with Chinese scientists which has resulted in publications on the phylogeny of bighead and silver carp (Pub 35) and on genetic divergence of the carps after their introduction to novel environments and relation to source populations in Asia and Europe (Pub 40,46,49).

Development of a biological synopsis and risk assessment of bigheaded carps. We first created this review as a report in 2005, then reorganized it and added additional material, and published it as an American Fisheries Society book. "Bigheaded Carps: a biological synopsis and environmental risk assessment" is considered the definitive text on these species. (Pub 28, 34)

Eradication of tilapia in the Galapagos archipelago. In 2006, I traveled to the Galapagos and determined the extent of the tilapia invasion. I created the first draft of an eradication plan. The plan was realized by USGS and Galapagos National Park personnel, and no live tilapia have been found since (TP 106,124).

Asian Carp Symposium and Proceedings. In 2006, using a grant from the Mississippi River Basin Panel on Aquatic Nuisance Species (MRBP) and contributions from other sponsors, I organized an independent symposium on invasive Asian carps. The symposium showcased the current knowledge and research on Asian carps at a time when Asian carp research was just beginning in the USA. As part of the symposium, I taught a half-day session on Asian carp biology. I edited the book "Invasive Asian Carps in North America" (2011) which is in part the proceedings of this symposium, although it contains other work (Pub 43).

Asian carp habitat selection and movements in the Missouri River. Using telemetry, I catalogued the movements and habitat selection of adult Asian carps. Results from this study were reported in Kolar et al 2007 (pub 34).

Reproduction of bigheaded carps in the Missouri River. We used gonadosomatic index data and histological analysis to show that bigheaded carps are incremental spawners and reproductively active over a greater portion of the year than was previously believed. We also identified evidence of intersex, possibly resulting from contaminant exposure. (Pub 30)

Piscicides and bigheaded carps. I led this study, which was used to inform the million-dollar rotenone application at the Chicago Ship and Sanitary Canal barrier. (Pub 27)

Contaminants and nutritional content of bigheaded carps, and development of “carp cakes” animal food. In these studies, related to harvest of bigheaded carps as control method, I worked with chemists, nutritionists, and a meat scientist. (Pub 32, 42)

Development of the National Asian Carp Management and Control Plan. I led the drafting team on two (Control and Mitigation) of the seven sections of the plan. I then participated in the extensive review and revision of the entire plan. I was the USGS lead for this effort. Although the section leads are not listed as “editors”, it occupied a substantial portion of my time from 2003 to 2007. http://www.asiancarp.us/documents/Carps_Management_Plan.pdf

Lisbon Bottom Project. This was an innovative, interdisciplinary project to evaluate ecological dynamics of large-river floodplains. I am first author of three of six chapters of “Ecological Dynamics of Lisbon Bottom, Missouri” and I was responsible for the Executive summary. (Pub 23, 24, 25) <http://infolink.cr.usgs.gov/Science/Lisbon/index.htm>

Water quality assessment of Los Alamos National Lab I led the toxicology portion of this 2000-2001 study of streams at LANL. In situ and lab-based toxicity tests were performed. The study was used by the USFWS in litigation, thus required a very high degree of documentation and adherence to protocols (Pub 21).

Development, evaluation, and validation of the porewater toxicity test approach. Dr. Scott Carr and I began work on marine and estuarine sediment porewaters in 1988. I designed, built, and tested the porewater extractor that made this research possible. We performed sediment quality assessments of 12 major estuaries. (Pub 6,7,8,10,11,12,14,15) Our methods have been used in at least 11 countries, and were included in the Canadian dredged material program. After 1995, I developed and used porewater toxicity tests in fresh waters. (Pub 16,17, 21, 22). These techniques were incorporated into the Biomonitoring of Status and Trends program. In 2000, the Society of Environmental Toxicology and Chemistry invited me to assist in writing a book describing the state of the science. (Pub 22)

Reservoir limnology research. I led research on eutrophication and mercury in Elephant Butte and Caballo Reservoirs in New Mexico and of Fort Cobb Reservoir in Oklahoma. (Pub26)

Assessing impacts of oil and gas production activities on marine and estuarine ecosystems

Our research is largely responsible for regulations banning the discharge of oilfield produced water into estuaries of Texas and Louisiana. (Pub 7, 8, 12, 15)

Coral larvae early life history and toxicological studies. In 1993, I developed a method to grow coral larvae from eggs (Pub 9). The March 1998 issue of National Geographic briefly discussed Sea Grant’s use of these methods to start new coral colonies.

Research on larval striped bass initial gas bladder inflation. This research provided solutions to the problem of gas bladder inflation failure in culture (Pub 1,3,4,5). In 1989, Patrick Keys, hatchery manager, Ohio DNR, said this research saved his hatchery ten to twenty thousand dollars per year. Other researchers modified these techniques for walleye and barramundi.

13. SCIENTIFIC LEADERSHIP

I have served as the USGS representative to the Mississippi River Basin Panel on Aquatic Nuisance Species (MRBP) since its inception in May, 2003. In January 2006 I was voted Chair of the Research and Risk Assessment Committee and I remain in that position, which is an EXCOM position for the panel. In that time, under my leadership, the committee has funded or produced: A decision support system for aquatic nuisance species, a symposium on the use of genetics to control exotics (and subsequent symposium publication), several conference symposia, a study of the potential for tug and barge traffic to transport Asian carp larvae in the bilge (I drafted the RFP and worked with the Coast Guard and Sea Grant to obtain a grant from GLRI and to evaluate proposals and the product by the contractor), maintained an aquatic nuisance species (ANS) experts database, a preliminary evaluation of fee-fishing operations as ANS vectors, an independent symposium and proceedings on Asian carps, a rapid risk assessment screening tool, an evaluation of the sensitivity of Asian carps to rotenone and antimycin, eDNA marker development for black carp, provided many guidance and direction letters and suggestions for the Aquatic Nuisance Species Task Force (ANSTF), and searched for and provided speakers on diverse topics for the education of MRBP members, ranging from hydrofracking as a vector for ANS to big river commercial navigation as an ANS vector.

Served on the steering committee for the study “The use of grass carp (*Ctenopharyngodon idella*) in the United States: Production, triploid certification, shipping, regulation, and stocking recommendations for reducing spread throughout the United States.” Report published February 2015. <http://www.micrarivers.org/resource-materials/micra-documents/category/15-micra-reports.html>

Selected to and served on the invasive species team on “Great Lakes Futures”. This team was put together to provide direction for Great Lakes Restoration Initiative funding.

I was US science lead for the Asian carp Binational Risk Assessment, which investigated the risk posed by bigheaded carps to the Laurentian Great Lakes. Project was funded by the Canadian Department of Fisheries and Oceans and the USEPA. Late 2010 to early 2012.

I led the team writing the “Control” and “Minimizing Adverse Impacts” sections of the “Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States”. This diverse team contained members of state agencies, the aquaculture industry, and NGOs. http://www.asiancarp.us/documents/Carps_Management_Plan.pdf
In 2006, I acquired funding for, and chaired, the independent symposium “The Invasive Asian Carps in North America. I was entirely responsible for arranging the program, and acquisition of funding from the seven different funding sources. I also found funding for, and edited, the proceedings of the symposium which was published as a book by the American Fisheries Society.

Under the “US-Russian Agreement on Cooperation in the Field of Environmental Protection”, I led Project 02.02-15, Assessment of Complex Anthropogenic Impacts on Ecosystems Reservoirs and Rivers, which has a strong invasive species element. I led this project for two years.

14. SCIENTIFIC AND PUBLIC SERVICE

a. CURRENT MEMBERSHIPS IN PROFESSIONAL SOCIETIES.

I have been a member of the American Fisheries Society (AFS) since 1979. I am a member of the Early Life History Section, and I am a very active member of the Introduced Fish Section. I was elected President of the Introduced Fish Section of the AFS in 2006, an AFS Governing Board position. I served in this capacity for 3 years, and in the IFS EXCOM as “immediate past president” for an additional three years. I also have served on section committees charged with symposia development for several AFS meetings, and I continue to moderate the section’s list serve. I served as president of the Missouri Chapter of the AFS from 2005 to 2006. In this position I also served on the governing board of the North Central Division of the AFS 2005-2006. As president (2005-2006) I presided over a substantial revision of the bylaws of that organization, to bring the bylaws up-to-date with current activities and with the parent society constitution. I also served as Chair of the Legislative and Environmental Issues committee of the Missouri Chapter of the AFS from 1998 until 2004.

b. TECHNICAL PRESENTATIONS

200. Whitley, G.W., Chapman D.C., Jenkins, J.A., Bailey, J., and Nicks, D., 2015, Evidence of black carp recruitment in the Mississippi River: Presentation at 145th Annual Meeting of the American Fisheries Society, Portland, Oregon, 16-20 August, 2015 BAO approval 3/7/15 IP-063953
199. Larson, J., J. Amberg, D.C. Chapman, A.E. George, C.-A. Hayer, B. Knights, G. McCalla, E. Monroe, C. Rees, W. Richardson, M. Tuttle-Lau and J. Vallazza. 2015. Preliminary Findings: 2013 and 2014 Asian Carp egg/larval sampling on the Mississippi River. Webex provided to USFWS, state, and university partners performing research on carp in the Mississippi River. June 2015. PRESENTED (I presented the CERC half of the webex). No published abstract requiring FSP process.
198. Whitley, G.W., D.C. Chapman, J.A. Jenkins, J. Bailey, J., and D. Nicks. 2015. Evidence of black carp establishment in the middle Mississippi River: Presentation at Midwest Fish and Wildlife Conference, Indianapolis, Indiana, 08-11 February 2015 BAO approval 10/24/14 IP-060468
197. Chapman, D.C., G.W. Whitley, J.A. Jenkins, J. Bailey, J., and D. Nicks. 2015. Evidence of black carp establishment in the middle Mississippi River: Presentation at Missouri Natural Resource Conference, Osage Beach, MO, 08-11 February 2015 PRESENTED BAO approval 11/6/14 IP-060965
196. Chapman, D.C., C.E. Byrd, T. Garcia, C.-A. Hayer, B. Knights, and E. Murphy. 2014. It’s in their nature: Using the early life history characteristics of Asian carps in development of controls: Presentation at Midwest Fish and Wildlife Conference, Indianapolis, Indiana, 08-11 February 2015. BAO approval 10/30/14 IP-060638
195. Whitley, G.W., Chapman, D.C., and King, T.E., 2014, Distinguishing stocked and naturally reproduced grass carp in the Great Lakes using otolith oxygen and carbon isotope ratios: Presentation at Midwest Fish and Wildlife Conference, Indianapolis, Indiana, 08-11 February

2015 BAO approval 10/21/14 IP-060467

194. Hayer, C-A., D.C. Chapman, C.A. Richter, and A. George. 2014. Correlation of eDNA and other molecular signals with the presence of Asian carp eggs and larvae: an early detection tool: Presentation at Midwest Fish and Wildlife Conference, Indianapolis, Indiana, 08-11 February 2015. BAO approval 10/30/14 IP-060759
193. Hayer, C-A, D.C. Chapman, and C. Byrd. 2014. Assessing Natural Recruitment Constraints on Asian Carp in River Reaches of Varying Abundance Gradients: Guidelines for Control: Presentation at Midwest Fish and Wildlife Conference, Indianapolis, Indiana, 08-11 February 2015, BAO approval 10/29/14 IP-060654
192. Hayer, C-A, D.C. Chapman, and C. Byrd. 2014. Assessing Natural Recruitment Constraints on Asian Carp in River Reaches of Varying Abundance Gradients: Guidelines for Control: Presentation at Missouri Natural Resources Conference, Osage Beach, Missouri, 04-06 February 2015, BAO approval 10/30/14 IP-060787
191. Chapman, D.C. 2014. Asian Carps in North America: History, Effects and Control Efforts. KEYNOTE presentation at Montana Weed Control Association January 14, 2015 INVITED, PRESENTED (No published abstract requiring FSP review)
190. Chapman, D.C. 2014. Current status and research on black carp captures in the United States. Binational Risk Assessment of Black Carp Scoping Meeting. December 2014. Ann Arbor, MI. INVITED, PRESENTED BAO approval 4/8/15 IP-064834
189. Chapman, D.C. 2014. Current Status and Research on Grass Carp captured in the Laurentian Great Lakes. Binational Risk Assessment of Grass Carp Progress Meeting. December 2014, Ann Arbor, MI. INVITED, PRESENTED. No published abstract requiring FSP process.
188. Jacobson, R., D. Chapman, and A. Delonay. 2014. Emerging technologies for fisheries research in large rivers. Webinar, part of emerging technologies web symposium. (No published materials requiring FSP process.)
187. Lin Ye, Jon Amberg, Duane Chapman, Mark Gaikowski, Camila Carlos Wen-Tso Liu. 2014. Bacterial community of invasive Asian carp and indigenous American fish reflects host physiology. International Symposium on Microbial Ecology. Seoul, South Korea. August 24-19 2014. BAO approval 4/14/14 IP-045121
186. Cameron R. Turner, Christopher L. Jerde, Matthew A. Barnes, W. Lindsay Chadderton, Andrew R. Mahon, Duane C. Chapman, Karen L. Uy, Robert C. Everhart, Mark A. Renshaw, Joel Corush, Scott W. Campbell, Frank deNoyelles, Brett Olds, Michael Pfrender, David M. Lodge. 2014. Believing without seeing: Ecometagenetic analysis of aquatic ecosystems using macrobial (not microbial) environmental DNA. Ecological Society of America (ESA), Sacramento, CA, USA, August 10-15 BAO approval 2/28/14 IP-055111
185. Murphy, E., T. Garcia, P.R. Jackson, D.C. Chapman, and M.H. Garcia. 2014. Using the Fluvial Egg Drift Simulator (FluEgg) in an Integrated Pest Management Approach to Asian Carp Control. American Fisheries Society 144th Annual Meeting, Quebec. BAO approval 7/21/14 IP-

055451

184. George, A. and D.C. Chapman. 2014. Larval swimming behavior in Grass Carp *Ctenopharyngodon idella* and bigheaded carps *Hypophthalmichthys* spp. American Fisheries Society 144th Annual Meeting, Quebec. BAO approval 2/12/2014 IP-054726
183. Klymus, K, C.A. Richter, D.C. Chapman, and C. Paukert. 2014. Quantification of eDNA shedding rates from invasive bighead carp *Hypophthalmichthys nobilis* and silver carp *Hypophthalmichthys molitrix*. American Fisheries Society 144th Annual Meeting, Quebec INVITED. BAO approval 3/10/14 IP-055390
182. Bailey, J., E. Monroe, N. Grueneis, J.A. Jenkins, A. Benson, D. Chapman, J. Deters, G.W. Whitledge, G. Conover, and S. Finney. 2014. Ploidy determination of Grass Carp and Black Carp captured from the Great Lakes Basin (USA and Canada) and other watersheds. American Fisheries Society 144th Annual Meeting, Quebec. BAO approval 3/20/14. IP-055614.
181. Chapman, D.C. Asian Carp Biology and Effects and Current Efforts. Nebraska Invasive Species Council. Webex. 2/14/14 INVITED, PRESENTED, Powerpoint distributed BAO approval 3/20/14 IP-055701
180. Chapman, D.C. 2014. Use of Life History Science for Control Strategies. USGS Asian Carp and Partners Meeting, (affiliated meeting with Midwest Fish and Wildlife Conference, Kansas City, Missouri, January 2014) PRESENTED (no published abstract, FSP not required)
179. Garcia, T., E.A. Murphy, D.C. Chapman, P.R. Jackson, and M. Garcia. 2014. Tributary assessment tool: Is your river at risk of recruitment? Fluvial Egg Drift Simulator (FluEgg). USGS Asian Carp and Partners Meeting, (affiliated meeting with Midwest Fish and Wildlife Conference, Kansas City, Missouri, January 2014 – no published abstract requiring FSP approval)
178. Anderson, K.R., D.C. Chapman, T.T. Wynne, C.P. Paukert, and R. Stumpf. 2014. Planktonic food resource availability for bigheaded carps in Lake Michigan derived from remote sensing and bioenergetics. Midwest Fish and Wildlife Conference, Kansas City, Missouri, January 2014. BAO approval 10/17/14 IP-051861
177. Liu, W.-T., J.J. Amberg, M.P. Gaikowski, and D.C. Chapman. 2014. Microbial source tracking and its potential to assist eDNA assay for Asian carp monitoring. Midwest Fish and Wildlife Conference, Kansas City, Missouri, January 2014. INVITED.
176. Chapman, D.C., J.J. Davis, T. King, J.A. Jenkins, P.M. Kocovsky, J.G. Miner, J. Farver, and P.R. Jackson. 2014. Recruitment of grass carp in the Great Lakes Basin. Midwest Fish and Wildlife Conference, Kansas City, Missouri, January 2014. PRESENTED BAO approval 9/30/2013 IP-051907
175. Murphy, E.A., T. Garcia, D.C. Chapman, P.R. Jackson, and M. Garcia. 2014. Assessment of Great Lakes tributaries for Asian carp spawning and recruitment suitability. Midwest Fish and Wildlife Conference, Kansas City, Missouri, January 2014. INVITED. BAO approval 11/6/13 IP-052157

174. Pitts, P., B. McKeage, D. Thornhill, and D. Chapman. 2014. Treatment of Australian Water Clover (*Marsilea mutica*) and Yellow Floating-Heart (*Nymphoides peltata*) in Missouri. Midwest Fish and Wildlife Conference, Kansas City, Missouri, January 2014. INVITED. BAO approval 10/29/13 IP-052291
173. Chapman, D.C. 2013. The Biology and Management of Asian Carp: Lessons for Minnesota. Freshwater Society – College of Biological Sciences Lecture series. University of Minnesota. October 2013. INVITED, PRESENTED No published abstract requiring FSP process.
172. Strakosh, T. R., K. R. Anderson, S. R. Hensler, and D. C. Chapman. 2013. Dreissenid veligers as a food source for silver and bighead carp in Lakes Erie and Michigan: a bioenergetics model. Lake Michigan: State of the Lake Conference, Sheboygan, Wisconsin. BAO approval 1/25/13 IP-043538
171. Chapman, D.C. Invasive Fishes in the Large Rivers of the United States. American Fisheries Society annual meeting, Little Rock, AR, September 8-12, 2013. INVITED, PRESENTED BAO approval 3/14/13 IP-044638
170. Davis, J.E., D.C. Chapman, J.A. Jenkins, P.M. Kocovsky, J.G. Miner, J.R. Farver and P.Ryan Jackson. First Evidence Of Grass Carp Recruitment In The Great Lakes Basin. American Fisheries Society annual meeting, Little Rock, AR, September 8-12, 2013 BAO approval 6/5/2013 IP-046145
169. Zhu, C., X. Yu, D.C. Chapman, and J. Tong. Molecular population genetic studies on introgressive hybridization between silver carp and bighead carp in the Mississippi and the Yangtze Rivers. Am. Fish. Soc. annual meeting, Little Rock, AR, September 8-12, 2013. BAO approval 3/15/13 IP-044613
168. Phelps, Q, J.J. Hoover, K. Baerwaldt, and D.C. Chapman. Paddlefish, Sturgeon, and Bigheaded Carps – Status, Biology, and Management in the Mississippi River. American Fisheries Society annual meeting, Little Rock, AR, September 8-12, 2013. INVITED. BAO approval 4/1/13 IP-044925
167. Liu, W-T., L. Ye, J.J. Amberg, M.P. Gaikowski, and D.C. Chapman. Microbial source tracking and its potential to assist eDNA assay for Asian carp monitoring. American Fisheries Society annual meeting, Little Rock, AR, September 8-12, 2013
166. Klymus, K., C. Richter, D.C. Chapman, and C.P. Paukert. DNA shedding rates of Asian carps, for use in understanding field collections of eDNA. American Fisheries Society annual meeting, Little Rock, AR, September 8-12, 2013 BAO approval 10/25/12 IP-041784
165. Strakosh, T. R., K. R. Anderson, S. R. Hensler, and D. C. Chapman. Dreissenid veligers as a food source for silver and bighead carp in Lakes Erie and Michigan: a bioenergetics model. American Fisheries Society annual meeting, Little Rock, AR, September 8-12, 2013 BAO approval 1/25/13 IP-043538
164. Chapman, Duane C. 2013. Current status of Asian carps in the Missouri River. Webinar presented to Missouri River Recovery Implementation Committee (MRRIC) July 30 2013 (No published abstract requiring FSP process)

163. Chapman, D.C. 2013. Habitat and Life Cycle Needs, and Recruitment as Relates to Harvest. (Lead-off paper for Asian carp commercial harvest workshop) Presented at Joint meeting of the Mississippi River Basin Panel on aquatic nuisance species and the Mississippi Interstate Cooperative Resource Association, Columbus, OH, July 24, 2013 (No published abstract requiring FSP process)
162. Klymus, K., C. Richter, D.C. Chapman, and C. Paukert. DNA shedding rates of Asian carps, for use in understanding field collections of eDNA. International Conference on Conservation Biology, Baltimore, Maryland, July 21-25, 2013.
161. Klymus, K., D.C. Chapman, C. Richter, and C. Paukert. 2013. DNA shedding rates of Asian carps, for use in understanding field collections of eDNA. Presentation at 56th Annual Conference on Great Lakes Research, West Lafayette, Indiana, June 2-6. 2013. http://iaglr.org/conference/downloads/2013_abstracts.pdf
160. Chapman, D.C., K.R. Anderson, E. Brothers, and M. Lucey, 2013. Nonplanktonic alternative food sources for bighead and silver carps in the Great Lakes. Presentation at 56th Annual Conference on Great Lakes Research, West Lafayette, Indiana, June 2-6. 2013
http://iaglr.org/conference/downloads/2013_abstracts.pdf
159. Strakosh, T.R., K.R. Anderson, S.R. Hensler, and D.C. Chapman, 2013, Dreissenid veligers as a food source for Silver and Bighead Carp in lakes Erie and Michigan: a bioenergetics model: Presentation at 56th Annual Conference on Great Lakes Research, West Lafayette, Indiana, June 2-6. 2013
http://iaglr.org/conference/downloads/2013_abstracts.pdf BAO approval 1/25/13 IP-043538
158. Ireland, S., D. Chapman, and E. Roseman. 2013. Comparative taxonomy and description of larval bighead and silver carp with native Great Lakes fishes. 56th Annual International Association of Great Lakes Research Conference, June 2-6, 2013 http://iaglr.org/conference/downloads/2013_abstracts.pdf
157. Lance, R.F., J. Amberg, M. Bartron, D.C. Chapman, C. Richter, H.L. Farrington, C.E. Edwards, M.R. Carr, X. Guan, E. Perkins, L. Hatch, and K. Baerwaldt. Asian Carp eDNA: Evolution and Calibration. National Conference on Ecosystem Restoration, Schaumburg, IL. July 2013.
156. Chapman, D.C, K. Anderson, E. Brothers, M. Lucey, and K. Masagounder. Assessment of non-planktonic food sources for bigheaded carps in the Laurentian Great Lakes. International Conference on Aquatic Invasive Species, Niagara Falls, ON, April 2013. INVITED, PRESENTED
155. Klymus, K., C. Richter, D. Chapman, and C. Paukert. DNA shedding rates of Asian carps, for use in understanding field collections of environmental DNA. International Conference on Aquatic Invasive Species, Niagara Falls, ON, April 2013 IP-041784
154. Chapman, D.C. Warmwater Paylakes in the Eastern USA: Business models and ANS implications. Webex presentation to Southeast Aquatic Research Partnership. March 2013 INVITED, PRESENTED

153. Chapman, D.C. History and effects of Asian carps in North America and Missouri. Missouri Audobon Society, Jefferson City, MO March 2013 INVITED, PRESENTED
152. Chapman, D.C. A pragmatic discussion of the Asian carp invasion. Joint meeting of the OH and WV AFS Chapters, Huntington, WV February 2013 KEYNOTE, INVITED, PRESENTED
151. Anderson, K.R., D.C. Chapman, K. Masagounder, E. Brothers, and L. Lucey. Assessment of non-planktonic food sources for bigheaded carps in the Laurentian Great Lakes. Midwest Fish and Wildlife Conference, Wichita, KS, December 2012
150. Anderson, K.R., D.C. Chapman, and T.T. Wynne. Assessing risks of Great Lakes invasion by understanding Asian carp and blue-green algae dynamics. Midwest Fish and Wildlife Conference, Wichita, KS, December 2012
149. Chapman, D.C., A.E. George, J. Deters, B. McElroy, and K. Massagounder. Combining biological and physical sciences to understand bigheaded carp spawning and early life history. Upper Midwest Invasive Species Conference, La Crosse, WI. October 30, 2012 (Poster – no author could attend conference, so provided poster was posted by another CERC colleague)
148. Chapman, D.C. Managing undesired and invading species. (Seven 30 minute modules, 1: Intro and reasons to manage 2: Effects 3: Risk assessment 4: Prevention 5: Regulation as a tool 6: Control 7: Emerging control methodologies). Recorded lecture for Kentucky State University on-line Advanced Fisheries Management class. Recorded November 29 and 30 2012. This is designed to be offered in all semesters. INVITED, PRESENTED
147. Chapman, D.C., J. Deters, T. Garcia, P. M. Kocovsky, N.E. Mandrak, B. McElroy, and E. Murphy. Assessment of non-planktonic food sources for bigheaded carps in the Laurentian Great Lakes. American Fisheries Society Meeting, St. Paul, MN, August 2012. PRESENTED
146. Chapman, D.C. Use of drift models to understand Asian carp spawning and early life history. American Fisheries Society Meeting, St. Paul, MN, August 2012. INVITED, PRESENTED
145. Baerwaldt, K, R. Lance, D. Chapman, J Amberg, E. Perkins, M. Bartron, E. Russo, and L.K. Hatch. Calibrating eDNA methodology: An Asian carp genetic surveillance tool in the Chicago Area Waterway System. American Fisheries Society Meeting, St. Paul, MN August 2012.
144. Goszewski, T, D.C. Chapman, and D. Nolte. Spawning abrasion patches in female bighead and silver carps as indicators of spawning activity. American Fisheries Society Meeting, St. Paul, MN, August 2012
143. Chapman, D.C. Asian carp: History, Effects, and what do we do now? Missouri River Relief Speaker series presentation, Kansas City, MO, July 2012. INVITED, PRESENTED
142. Kocovsky, P.M., D.C. Chapman, and J.E. McKenna. A coarse-scale assessment of thermal and hydrologic suitability of the Maumee River for spawning of bigheaded carp (*Hypophthalmichthys* spp.) Annual Meeting of the Great Lake Fishery Commission. March 23, 2012.

141. Chapman, D.C. Challenges and pitfalls in the development of markets for invasive bighead and silver carps. Food Science Department of the University of Missouri Lecture Series. April 11, 2012, INVITED, PRESENTED
140. Masagounder, K., D.C. Chapman, and C. Paukert. Validation of bioenergetics models for bighead and silver carps. Presented at Asian carp symposium of the Midwest Fish and Wildlife Conference, December 6, 2011. INVITED
139. Chapman, D.C., J. Deters, A. George, K. Masagounder, and B. McElroy. Aspects of the early life history of bighead and silver carps pertaining to spawning river requirements. Presented at Asian carp symposium of the Midwest Fish and Wildlife Conference, December 6, 2011. INVITED, PRESENTED.
138. Chapman, D.C., J. Deters, A. George, K. Masagounder, and B. McElroy. Aspects of the early life history of bighead and silver carps pertaining to spawning river requirements. Presented at the Annual Meeting of the American Fisheries Society, September 7, 2011. PRESENTED.
137. Chapman, D.C. Uncertainties regarding the establishment and effects of bighead and silver carps in the Great Lakes. Presented at the Coastal Zone Conference, Chicago, IL July 19, 2010, INVITED, PRESENTED
136. Kocovsky, P.M. and D.C. Chapman. 2011. Suitability of the Maumee River for spawning of Asian carp (*Hypophthalmichthys* spp.). Presented at Annual meeting of the International Association of Great Lakes Research. May 20, 2011.
135. Chapman, D.C. and K. Masagounder. Investigations in bioenergetics of Asian carp. Asian Carp Binational Risk Assessment meeting, Chicago, IL, May 11, 2011. INVITED, PRESENTED
134. Chapman, D.C. Asian carp and reservoirs: How to assess the risk? Aquatic Nuisance Species Task Force meeting, Little Rock, AR, May 5, 2011. INVITED, PRESENTED
133. Chapman, D.C. Status of research on transport of Asian Carps in bilge and ballast of commercial barges and tows. Mississippi River Basin Panel on Aquatic Nuisance Species, Little Rock, AR, May 4, 2011. INVITED, PRESENTED
132. Chapman, D.C. Asian carp: History, effects, and whadda-we-do-now? Missouri River Relief Lecture Series, April 12, 2011. INVITED, PRESENTED
131. Masagounder, K. and D.C. Chapman. Asian carp bioenergetics and alternative foods. USGS/Great Lakes Restoration Initiative meeting, April 23, 2011
130. Phelps, Q.E., D.R. Ernat, D.C. Chapman, and G.W. Whitledge. Identifying recruitment sources of Asian carps threatening to invade the Great Lakes: Presentation at 71st Midwest Fish and Wildlife Conference, Minneapolis, Minnesota, December 12-15, 2010
129. Chapman, D.C. Review of bighead and silver carp effects on water quality. Midwest Fish

and Wildlife Conference. December 13, 2010. INVITED, PRESENTED

128. Chapman, D.C. Management and control of Asian carps in the Missouri River Basin. Missouri River Confab, Jefferson City, MO December 9, 2010. INVITED, PRESENTED

127. Chapman, D.C., M.P. Gaikowski, J.A. Gross, T.D. Hubert, P.R. Jackson, P.M. Kocovsky, C.S. Kolar, E.E. Little, K. Masagounder, and E.A. Murphy. USGS research towards understanding and controlling bighead and silver carps in the USA. Third Borok Conference on Invasive Species in the Holarctic. October 2010, Mishkin, Russia. INVITED, PRESENTED

126. Li, S.F, J.W. Xu, Q.L. Yang, C.H. Wang, D.C. Chapman, and G. Lu. Genetic change and ancestry of introduced populations of silver carp as revealed by mitochondrial DNA, American Fisheries Society Annual Meeting, September 2010. PRESENTED

125. Chapman, D.C. and P.M. Kocovsky. Suitability of Lake Erie for spawning and maturation of silver and grass carp. American Fisheries Society Annual Meeting, September 2010. PRESENTED

124. Nico L.G., Howard L. Jelks, Duane Chapman, William F. Loftus. Islands and invasions: Eradication of Nile tilapia in the Galapagos Archipelago, Ecuador. American Fisheries Society Annual Meeting, Pittsburgh, PA, September, 2010.

123. Chapman, D.C. Asian carps in the Great Lakes: Understanding the complexities and uncertainties. International Conference on Aquatic Invasive Species, San Diego, CA, August 2010. INVITED, PRESENTED

122. Chapman, D.C., J.E. Deters, and A. George. Investigations of eggs and larvae of Asian carps in the lower Missouri River and its tributaries to determine spawning locations and drift duration. American Fisheries Society Larval Fish Conference, May 2010, Santa Fe, NM.

121. Chapman, D.C. Asian Carp in Missouri, the MRB, and the Great Lakes. Given to students University of Missouri Fish Ecology course, Rob Hayward, professor. April 2010, Columbia, MO.

120. Chapman, D.C. Asian carp in the Great Lakes: Understanding the complexities and uncertainties. Presented at a public symposium titled "Asian Carp Invasion: Potential Economic and Ecological Impacts in the Great Lakes" at the Shedd Aquarium in Chicago. Co-sponsored by the Program on the Global Environment and the Chicago Council on Science and Technology. One of five speakers. March, 2010, Chicago, IL. INVITED, PRESENTED.

119. Chapman, D.C. Carpe Diem (Day of the Carp). Ohio Wildlife Diversity Conference, March 2010, Columbus, OH. INVITED, PRESENTED.

118. Chapman, D.C. Asian carp in the Great Lakes: Understanding the complexities and uncertainties. Ohio Charter Captains Conference. March, 2010. INVITED, PRESENTED

117. Chapman, D.C., K.S. Irons, M.A. McClelland, T.M. O'Hara, G.G. Sass, J. Thomas, and M.S. Pearson. Condition factor changes in bighead and silver carp in Midwestern rivers:

what do they tell us? Missouri Natural Resources Conference, Osage Beach, MO, February, 2010.

116. Chapman, D.C. and J.E. Deters. Duration of drift by Asian carp eggs and larvae in the Missouri River. Missouri Natural Resources Conference, Osage Beach, MO, February, 2010.

115. Chapman, D.C. Can Asian carp establish in the Great Lakes? American Fisheries Society Annual Meeting, Nashville, TN, August 2009. INVITED, PRESENTED.

114. Chapman, D.C., 2009, Shared lessons and shared needs: a comparison of Asian polyculture carps and common carp in North America: Presentation at 139th American Fisheries Society Annual Meeting, Nashville, Tennessee, August 30 - September 3, 2009 INVITED, PRESENTED

113. Chapman, D.C. Overview of the effects of invasive species on inland fisheries. American Fisheries Society Annual Meeting, Nashville, TN, September 2009. INVITED, PRESENTED.

112. Irons K.S., D.C. Chapman, M.A. McClelland, T.M. O'Hara, G.G. Sass, J.A. Thomas, T.R. Cook, and M.S. Pearson. Asian carps: Big rivers, big fish, big problems? American Fisheries Society Annual Meeting, Nashville, TN, September 2009. INVITED.

111. Deters, J.E. and D.C. Chapman. Location and Timing of Asian Carp Spawning in the Lower Missouri River. American Fisheries Society Annual Meeting, Nashville, TN, September 2009.

110. Irons K.S., D.C. Chapman, M.A. McClelland, T.M. O'Hara, G.G. Sass, J.A. Thomas, and M.S. Pearson. Asian carps in the mid-continent great rivers. North American Benthological Society, Grand Rapids, MI. May 2009.

109. Chapman, D.C. Invasion biology of Asian carps: When conventional wisdom lets you down. University of Nebraska Departmental Seminar. Lincoln, NB. February 2009.

108. Chapman, D.C. and R. Jacobson. Shallow Water Habitat Construction: Effects on Asian Carp Recruitment. USGS- Columbia Environmental Research Center Intralab Conference. Columbia, MO, January 2009. INVITED, PRESENTED

107. Chapman, D.C. Invasion Biology of Bighead and Silver Carps. USGS- Columbia Environmental Research Center Intralab Conference. Columbia, MO, January 2009. INVITED, PRESENTED

106. Nico, L.G., H.L. Jelks, W.F. Loftus, and D. Chapman "Eradication of Non-native Tilapia from Laguna El Junco, a Natural Crater Lake in the Galapagos Archipelago, Ecuador." U.S. Geological Survey – Florida Integrated Science Center – Science Meeting, Orlando, Florida October 2008. INVITED

105. Chapman, D.C. Management and Control of Invasive Bighead and Silver carps. Graduate Seminar, South Dakota State University. October 2008. INVITED, PRESENTED

104. Chapman, D.C. What's going on with Asian carp? 100th Meridian meeting, Lincoln, NB, October, 2010. INVITED, PRESENTED.
103. Chapman D.C., A. Braddy, A. Clarke, E. Dierenfeld, R. Kolli. Specialty animal foods - new product made from invasive silver carp. American Fisheries Society Annual Meeting, Invasive Species Symposium, August 2008. Ottawa, Canada. INVITED, PRESENTED
102. Chapman, D.C, and J.E. Deters. Comparison of aging methods and structures for bighead and silver carp. American Fisheries Society Annual Meeting,, Ottawa, Canada. August 2008. PRESENTED
101. Moy, P. and D.C. Chapman. Potential environmental effects of Asian carps on the Great Lakes. Presented at the Great Lakes Regional Research Information Network workshop, Chicago, IL, June, 2008. INVITED
100. Chapman, D.C. Effects of bighead and silver carps on invaded environments. International Association for Great Lakes Research Annual Meeting, St. Petersburg, Canada, May 2008. INVITED, PRESENTED
99. Chapman, D.C. Current research activities on Asian carps. 100th Meridian biannual meeting, Council Bluffs, Iowa, March 2008. INVITED, PRESENTED
98. Chapman, D.C. History and Ecology of the Chinese Major Carps in the United States. Presentation given seven times in China, at venues including Chinese Academy of Science, (Beijing), University of Beijing (Beijing), Chinese Academy of Fisheries Science (Yichang), Chinese Academy of Fisheries Science (Jianli) Institute of Hydrobiology (Wuhan), and Shanghai Fisheries University (Shanghai), May, 2007. INVITED, PRESENTED
97. Chapman, D.C. Invasive Aquatic Species in the Large Rivers of the Midwest: What Can Be Done? University of Missouri Fish and Wildlife Seminar series, February 22, 2007. INVITED, PRESENTED
96. Chapman, D.C., C. Orazio, T. May, J. Meadows, K. Echols, and M. Walther. Chemical Contaminants in Tissues of Invasive Bighead and Silver Carps of the Missouri River near Easley, Missouri. Missouri Natural Resources Conference, Feb. 2006, INVITED, PRESENTED.
95. Chapman, D.C., C. Orazio, T. May, E. Dierenfeld, J. Meadows, K. Echols, and M. Walther. Chemical Contaminants and Nutritional Quality of Invasive Bighead and Silver Carps of the Missouri River near Easley, Missouri. American Fisheries Society Annual Meeting, Lake Placid, NY, Sept. 2006, PRESENTED.
94. Chapman, D.C. Invasive Aquatic Species in the Large Rivers of the Midwest: What Can Be Done? American Fisheries Society Annual Meeting, Lake Placid, NY, Sept. 2006, INVITED, PRESENTED.
93. Chapman, D.C. Why ARE carps so invasive? Presented at the Controlling Common Carp Symposium, October 6, 2006. INVITED, PRESENTED

92. Chapman, D.C. and J. E. Deters. Wing dike morphology and use by bighead and silver carps. Presented at the symposium: The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem, August 22, 2006, Peoria, IL. PRESENTED
91. Chapman, D.C. and J. Deters. Morphometrics for the determination of sex and hybridization in *Hypophthalmichthys* spp. Presented at the symposium: The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem, August 22, 2006, Peoria, IL. PRESENTED
90. Davis, B.M., P.L. Hudson, and D.C. Chapman. Zooplankton diet of bighead and silver carps in the Missouri River and one of its tributaries. Presented at the symposium: The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem, August 22, 2006, Peoria, IL. INVITED
89. Papoulias, D.M., D.C. Chapman, and D.E. Tillitt. Reproductive condition and occurrence of intersex in bighead and silver carp in the Missouri River. Presented at the symposium: The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem, August 22, 2006, Peoria, IL. INVITED
88. Gu, B., and D.C. Chapman. Use of Isotopes to Compare the Trophic Status of Bighead, Silver Carp and Filter-feeding Fishes Native to the United States. Presented at the symposium: The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem, August 22, 2006, Peoria, IL. INVITED
87. Chapman, D.C., B. Cudmore, and N.E. Mandrak. Ecological Plasticity of Invasive Aquatic Species: A Confounding Factor for Risk Assessments. International Conference on Aquatic Invasive Species. Key Biscayne, FL. May, 2006 INVITED, PRESENTED.
86. Jacobson, R.B., Chapman, D.C., Delonay, A.J., and Johnson, H.E. 2005. Flow, form, and fish responses in an intensively engineered river system: The Lower Missouri River. USGS Eastern Region Ecological Flows Conference, February, 2005. INVITED.
85. Chapman, D.C. Morphometrics for the determination of sex and hybridization in *Hypophthalmichthys* species. Midwest Fish and Wildlife Conference, Grand Rapids, MI. January, 2005. PRESENTED
84. Chapman, D.C. and Conover, G. Controlling existing populations of feral Asian carps in the United States: tools, options, and knowledge gaps. Midwest Fish and Wildlife Conference, Grand Rapids, MI, January, 2005. PRESENTED
83. Chapman, D.C. Bighead and silver carps: invaders of America's large rivers. Invasion of Species in the Holarctic Conference, Borok, Russia. September, 2005. INVITED
82. Chapman, D.C. and Jacobson, R.B. Pairing telemetry with hydrodynamic modeling and habitat classification for bighead and silver carp in the Missouri River. . Invasive Species in Large Rivers Symposium at the American Fisheries Society annual meeting, Anchorage, AK. September, 2005. INVITED, PRESENTED
81. Chapman, D.C. Bighead and silver carp in the Great Rivers of the Midwestern United States.

Restoration Management Workshop, Overton Bottoms, MO. July, 2005. INVITED, PRESENTED

80. Jacobson, R.B., Chapman, D.C, Delonay, A.J., Johnson, Harold E., III. Flow, form, and fish responses in intensively engineered river systems. Presentation at USGS workshop "Linking hydrological change and ecological response in streams and rivers of the eastern United States.", Herndon, VA, February, 2005

79. Chapman, D.C. Morphometrics for the determination of sex and hybridization in *Hypophthalmichthys* species. Asian carp symposium at the Southern Division of the American Fisheries Society annual meeting. Virginia Beach, VA. February, 2005. PRESENTED

78. Chapman, D.C. Telemetry and habitat characterization of bighead and silver carps in the lower Missouri River. Asian carp symposium at the Southern Division AFS annual meeting. Virginia Beach, VA, February, 2005 INVITED, PRESENTED

77. Chapman, D.C. Asian carp research in the Missouri River. Missouri River Briefings, Columbia, MO, October 2004. PRESENTED

76. Little, E.E. and Chapman, D.C. Use of pheromones in the management of Asian carps. Missouri River Briefings, Columbia, MO, October, 2004.

75. Chapman, D.C. Current USGS research on Asian carps. MICRA executive board meeting. September 2004. INVITED, PRESENTED

74. Chapman, D.C., Carollo B., Deters, J.E., and Witte, C.C.. Movements and habitat selection of bighead and silver carp in the lower Missouri River. Asian carp symposium at the annual meeting of the America Fisheries, Society, Madison, WI, August 2004. INVITED, PRESENTED

73. Davis, B.M., Hudson, P.L., and Chapman, D.C. Zooplankton diet of bighead and silver carp in the lower Missouri River and one of its tributaries. Asian carp symposium at the annual meeting of the America Fisheries, Society, Madison, WI, August 2004. INVITED

72. Chapman, D.C., Hudson, P.L. and Benson, A.J. Biology of bighead (*Hypophthalmichthys nobilis*) and silver carp (*H. molitrix*) in the USA. Beijing International Symposium on Biological Invasions, Beijing, People's Republic of China, June, 2004. PRESENTED

71. Chapman, D.C. Bighead and Silver Carp in the Missouri River and its Tributaries. Aquatic Nuisance Species Task Force, Columbia, Missouri, May 2004. INVITED, PRESENTED

70. Chapman, D.C., Witte, C.C., Deters, J.E., and Carollo, B. Movements and habitat selection of bighead and silver carp in the lower Missouri River. Missouri River Natural Resources Conference, Columbia, MO, May 2004. PRESENTED

69. Chapman, D.C. Bighead and silver carp, Missouri River invaders. Association of Partners for Public Lands Conference. St Louis, MO. March, 2004. INVITED, PRESENTED

68. Chapman, D.C. Bighead and silver carp in the Missouri River. Upper Mississippi River Fish Barrier Feasibility Study Project Coordination Meeting. January 2004. INVITED, PRESENTED.
67. Chapman, D.C., Deters, J.E., Carollo, B and Witte, C.C. Update on Asian carp research at CERC. Meeting of the Mississippi River Basin Panel on Aquatic Nuisance Species. January 2004. INVITED, PRESENTED
66. Elliott, C.M., Jacobson, R.B., Johnson, H.E. III, Delonay, A.J., Stancil, W., Chapman, D.C., Lastrup, M., Allert, A.J., and Wanner, G. An integrated interdisciplinary approach for quantifying habitat use on the Missouri River. North Central Geological Society of America, Kansas City, MO, March 2003.
65. Chapman, D.C., Witte, C.C, Elliott, C.M. and Jacobson, R.B. Winter habitat of bighead and silver carp in the Missouri River and its tributaries. Missouri River Natural Resources Conference, Atchison, KS, June 2003. PRESENTED.
64. Chapman, D.C., Deters, J.E., and Witte, C.C. Bighead and Silver Carp in the Missouri River and its tributaries. Meeting of the Mississippi River Basin Panel on Aquatic Nuisance Species. St.Paul, MN, May, 2003. INVITED, PRESENTED
63. Chapman, D.C. and Witte, C.C. Bighead and silver carp research on the Missouri River. Missouri Chapter of the American Fisheries Society, Rivers and Streams Technical Committee meeting, Bennett Springs, Missouri, July, 2003. INVITED, PRESENTED
62. Chapman, D.C., Brumbaugh, W.G., Echols, K.R., Canavan, C.M., and Jones, S.B. Limnology and mercury studies in New Mexico Reservoirs. Western Reservoirs Progress Meeting, March 2002, Denver, CO. INVITED, PRESENTED
61. Chapman, D.C., Brumbaugh, W.G. and Canavan, C. M. Mercury in fish and sediment of Elephant Butte Reservoir, NM. Rio Grande/Rio Bravo Symposium, Texas Academy of Science, Laredo, TX, March 2002. INVITED, PRESENTED
60. Chapman D. C., Echols, K.R., and Canavan, C. M. Nutrients, phytoplankton, and hydrogen sulfide in Elephant Butte Reservoir, New Mexico. Rio Grande/Rio Bravo Symposium, Texas Academy of Science, Laredo, TX, March 2002. INVITED, PRESENTED
59. Echols, K.R., J.F Fairchild., D.C. Chapman, K.P Feltz, C.E Orazio, and S.B Jones. Seasonal trends of microcystin toxins in algal blooms of a Midwestern reservoir. U.S. Geological Survey, National Program Review, Contaminants Program, Stevenson, WA, March 2002.
58. Wildhaber, M.L., A.L. Allert, D. Mulhern, V.M. Tabor, C.J. Schmitt, D. Edds, A. Bulger, J.L. Albers, J.S. Tiemann, D.P. Gillette, C. Wilkinson, D. Chapman, E. Callahan, J.E. Whitaker, P. J. Lamberson, and K.L. Powell. March 2002. Multiple factors limit populations of the federally-listed threatened Neosho madtom (*Noturus placidus*). U.S. Geological Survey, National Program Review, Contaminants Program, Stevenson, WA, March 2002.
57. Chapman, D.C, A. L. Allert, J.F. Fairchild, T.W. May, C.J. Schmitt, E.V. Callahan. Toxicity and metal concentrations of groundwater, pore waters, and surface waters of the Missouri

- River near a metals refining site, with a discussion of toxic units. USGS National Program Review, Contaminants program, Stevenson, WA, March 2002.
56. Lusk, J., R. MacRae, D.C. Chapman, and A.L. Allert. A water quality survey of three intermittent streams in Los Alamos County, New Mexico. Arizona-New Mexico Chapter of the American Fisheries Society Annual Meeting, Safford, AZ, February 2002.
55. Chapman, D.C. B.A. Poulton, E. Ehrhardt, J.F. Fairchild, and R. Jacobson. An integrated study of bottomland wetlands within a bend of the Missouri River. Missouri Natural Resources Conference, Osage Beach, MO, February 2002. PRESENTED.
54. Echols, K.R., J.F. Fairchild., D.C. Chapman., K.P. Feltz., C.E. Orazio, and S.B. Jones. Seasonal trends of microcystin toxins in algal blooms of a Midwestern reservoir. Annual meeting of the Society of Environmental Contamination and Toxicology, Baltimore, MD, Nov. 2001.
53. Chapman, D.C., B.A. Poulton, and E. Ehrhardt. Integrated biota and limnology study of Lisbon Bottom Wetlands. Lisbon Bottom Symposium, Columbia, MO, July 2001. INVITED, PRESENTED
52. Ehrhardt, E., J. Fairchild, B. Poulton, D. Chapman, and R. Jacobson. Evaluation of a GIS representation of shallow habitat on the Missouri River Floodplain. Missouri State GIS Conference, Jefferson City, MO, March 2001.
51. Echols, K.R., Fairchild, J.F., Chapman, D.C., Feltz, K.P., Orazio, C.E., Jones, S.B. Seasonal Trends of Microcystin Toxins in Algal Blooms of a Midwestern Reservoir. Society of Environmental Toxicology and Chemistry Annual Meeting, Baltimore, MD November 2001.
50. Chapman, D.C. Invasive aquatic species in the Missouri River. Presentation to CELT team, Columbia MO, March, 2001
49. Chapman, D.C. In vivo chlorophyll: Measurement and interpretation. USGS WRD Water Quality Technical Conference, New Orleans LA, January 2001. INVITED, PRESENTED
48. Chapman, D.C., G.F. Denny, and J.F. Fairchild. Preliminary assessment of a broadband acoustic fish identification system for use in the Missouri River. Annual Meeting of the American Fisheries Society, St. Louis, MO, August 2000. PRESENTED.
47. Chapman, D.C. Limnological Investigations at Elephant Butte Reservoir. Second Annual Reservoir Ecology Workshop. March 2000, Las Vegas, NV. INVITED, PRESENTED
46. Chapman, D. C., A. L. Allert, J. Fairchild, T. W. May, C. J. Schmitt, J. A. DeLashmit, and E. V. Callahan. Investigation of toxicity associated with a lead refinery on the Missouri river, Omaha, Nebraska. Ozark-Prairie Society of Environmental Toxicology and Chemistry meeting, Kansas City, MO, August 2000. PRESENTED.
45. Fairchild, J.F, D.C. Chapman D.C., K.R. Echols, T. Johnson, S.B. Jones, B. Lakish. An integrated assessment of the water quality of Fort Cobb Reservoir, Oklahoma. Western Reservoirs Progress Meeting, Columbia, MO, September 2000.

44. Chapman, D.C., W. G. Brumbaugh, T.W. May, K.R. Echols, L. Johnson, B. Lakish and S.B. Jones Limnological Investigations at Elephant Butte and Caballo Reservoirs, New Mexico. Western Reservoirs Progress Meeting, September 2000, Columbia, MO. PRESENTED.
43. Ehrhardt, E., J.F. Fairchild, and D.C. Chapman. 2000. A GIS model of waterbird distribution within a wetland complex. 4th Annual Missouri River Natural Resources Conference, May 2000, Bismarck, ND. PRESENTED.
42. Chapman, D.C., A. L. Allert, J.F. Fairchild, T.W. May, C.J. Schmitt, E.V. Callahan, and J.A. Delaschmit. 2000. Bioavailability and toxicity of metals in groundwater, sediment, and surface waters of the Missouri River near a lead refinery. 4th Annual Missouri River Natural Resources Conference: Missouri River Management: It's Everybody's Business, May 2000, Bismarck, ND. PRESENTED.
41. Chapman, D.C., and J.F. Fairchild. 2000. Limnology of floodplain wetlands at Lisbon Bottom, MO. 4th Annual Missouri River Natural Resources Conference: Missouri River Management: It's Everybody's Business, Bismarck, ND, May 2000. PRESENTED.
40. Chapman, D.C., and J.F. Fairchild. 2000. Fish use of flood plain wetlands at Lisbon Bottom, MO. 4th Annual Missouri River Natural Resources Conference: Missouri River Management: It's Everybody's Business, Bismarck, ND, May 2000. PRESENTED
39. Poulton, B.C., J.F. Fairchild, D.C. Chapman and E. Ehrhardt. Influence of wetland chronology/hydrology on aquatic invertebrate communities of the Lower Missouri River Flood Plain. 4th Annual Missouri River Natural Resources Conference: Missouri River Management: It's Everybody's Business, Bismarck, ND, May 2000.
38. Chapman, D. and J.F. Fairchild. 2000. Productivity and fish species assemblages of permanent and temporary wetlands on a floodplain within a bend of the Lower Missouri River. Missouri Natural Resources Conference, Osage Beach, MO, February 2000. PRESENTED.
37. Chapman D.C. Sources of sulfide at Elephant Butte Reservoir, Western Reservoir Program Progress meeting, Grand Coulee Dam, WA. November 1999. INVITED, PRESENTED
36. Allert, A., D. Chapman, J. Fairchild, T. May, C. Schmitt, E. Callahan, and J. Delashmit. Toxicology and elemental contaminant concentrations of groundwater, sediment pore water, and surface waters of the Missouri River associated with a metals refining site in Omaha, Nebraska. Society of Environmental Toxicology and Chemistry annual meeting, Philadelphia, PA, November 1999.
35. Wildhaber, M.L., A.L. Allert, D. Mulhern, V.M. Tabor, C.J. Schmitt, D. Edds, A. Bulger, C. Wilkinson, D. Chapman, E. Callahan, J.E. Whitaker, P.T. Lamberson, and K.L. Powell. A multifaceted approach to determining the factors limiting populations of a federally-listed threatened fish species: The Neosho madtom (*Noturus placidus*). Fisheries and Aquatic Resources National Program Review, USGS Biological Resources Division, Madison, WI, August, 1998
34. Jacobson R., D. Chapman, and B. Poulton. ECRC research on the Missouri River. Natural

Resource Conservation Service's Missouri River Post-flood Task Force Meeting. 1998.

33. Chapman, D.C. ECRC Research at Lisbon Bottoms. Natural Resource Conservation Service's Missouri River Post-flood Task Force Meeting. 1998. INVITED, PRESENTED

32. Chapman, D.C., D. M. Papoulias, J. N. Huckins, C. G. Ingersoll, B. T. Johnson, S. B. Jones, J. D. Petty, D. E. Tillitt, and D. R. Buckler. Bioindicators of Contaminant Exposure in the Rio Grande River. Fifteenth annual meeting of the Society of Environmental Toxicology and Chemistry, San Francisco, CA. 1997. PRESENTED

31. Allert, A., M. Wildhaber, C. M. Schmitt, E. Callahan and D. C. Chapman. Natural and Human Factors Explaining the Distribution and Site Densities of the Neosho Madtom (*Noturus placidus*). Society of Environmental Toxicology and Chemistry, San Francisco, CA. 1997.

30. Allert, A., M. Wildhaber, C. M. Schmitt, E. Callahan and D. C. Chapman. Natural and Human Factors Explaining the Distribution and Site Densities of the Neosho Madtom (*Noturus placidus*). Ozark-Prairie Chapter of the Society of Environmental Toxicology and Chemistry, San Francisco, CA. 1997.

29. Chapman, D.C. Midwest Science Center Research in Texas. USGS WRD-BRD Texas research coordination meeting in Austin, TX. 1997.

28. Chapman, D.C., D. M. Papoulias, J. N. Huckins, C. G. Ingersoll, B. T. Johnson, S. B. Jones, J. D. Petty, D. E. Tillitt, and D. R. Buckler. Bioindicators of Contaminant Exposure in the Rio Grande River. Presented at the 8th U.S./Mexico Border States Conference on Recreation, Parks and Wildlife, Hermosillo, Sonora, Mexico 1997. PRESENTED

27. Chapman, D.C., D. M. Papoulias, J. N. Huckins, C. G. Ingersoll, B. T. Johnson, S. B. Jones, J. D. Petty, D. E. Tillitt, and D. R. Buckler. Linking Contaminant Impacts to the Status of Biological Resources of the Lower Rio Grande. First Lower Rio Grande Issue Team Meeting, Corpus Christi, TX. 1995. PRESENTED

26. Carr, R.S., D.C. Chapman, W. Roach, and C.L. Howard. Sediment quality triad assessment of an estuarine produced water discharge site. International Seminar on Produced Water, Trondheim, Norway, September, 1995. INVITED

25. Carr, R.S., D.C. Chapman, J.M. Biedenbach, E.R. Long, G. Thursby, and D.D. MacDonald. Sediment quality assessment studies in Boston Harbor, Massachusetts. Second SOCIETY OF ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY World Congress, Vancouver, British Columbia, Canada. 1995. INVITED

24. Carr, R.S., D.C. Chapman, W. Roach, and C. Howard. Sediment quality triad assessment of an estuarine produced water discharge site. International Symposium on Produced Water, Trondheim, Norway. 1995. INVITED

23. Carr, R.S., D.C. Chapman, J.M. Biedenbach, and L. Robertson. Marine and estuarine porewater toxicity testing - species and endpoint comparisons. Fifteenth annual meeting of the Society of Environmental Toxicology and Chemistry, Denver, CO. 1994. PRESENTED

22. Carr, R.S., D.C. Chapman, and J.M. Biedenbach. Sediment porewater toxicity assessment studies in the vicinity of offshore oil and gas exploration and production platforms. MMS Information Transfer Meeting, New Orleans, LA, 1994.
21. Chapman, D.C. and R. Hooten. Coral larvae toxicity testing and early life history; recommendations for future research. Flower Gardens National Marine Sanctuary Research Workshop, Houston, TX, 1994. PRESENTED, INVITED
20. Chapman, D.C., R.S. Carr, and J.M. Biedenbach. Sediment quality assessment surveys in Gulf of Mexico estuaries. Gulf of Mexico Workshop on Contaminated Sediments. New Orleans, LA. 1994. PRESENTED, INVITED
19. Hooten, R. and D.C. Chapman. Flower Gardens coral larvae toxicity testing and early life history. Presented at the Texas Academy of Science annual meeting, Houston, TX. 1993.
18. Hooten, R. and D.C. Chapman. Flower Gardens coral larvae toxicity testing and early life history. Presented at the Texas Bays and Estuaries annual meeting, Port Aransas, TX. 1993.
17. Carr, R.S., D.C. Chapman, E.R. Long, and D.D. MacDonald. Sediment quality assessment studies in Tampa Bay, Florida. 81st Statutory Meeting of the International Council for the Exploration of the Sea, Dublin, Ireland. 1993. INVITED
16. Chapman, D.C. and R.S. Carr. Toxicity of sediment pore water associated with offshore oil and gas platforms in the Gulf of Mexico. Society of Environmental Toxicology and Chemistry 14th Annual Meeting, Houston, TX. 1993. PRESENTED
15. D'Unger C.V., D.C. Chapman, and R.S. Carr. An economically viable alternative to coastal discharge of produced water. Society of Environmental Toxicology and Chemistry 14th Annual Meeting, Houston, TX. 1993.
14. Carr, R.S., D.C. Chapman, J.M. Biedenbach, and L. Robertson. Recent advances in marine and estuarine porewater toxicity testing. Society of Environmental Toxicology and Chemistry 14th Annual Meeting, Houston, TX. 1993. PRESENTED
13. Carr, R.S. and D.C. Chapman. Effect of extraction method, storage conditions and manipulations on the toxicity of estuarine sediment pore water. First Society of Environmental Toxicology and Chemistry World Congress, Lisbon, Portugal. 1993. INVITED
12. Carr, R.S., D.C. Chapman and C.L. Howard. Survey of Galveston Bay bottom sediments and benthic communities. 2nd annual Galveston Bay-State of the Bay Symposium, Galveston, TX. 1993. INVITED
11. Carr, R.S., D.C. Chapman, J.M. Biedenbach and C.L. Howard. Sediment quality triad assessment survey in the Galveston Bay complex. Society of Environmental Toxicology and Chemistry 13th Annual Meeting, Cincinnati, OH. 1992.

10. Carr, R.S., D.C. Chapman, J.M. Biedenbach, and L. Robertson. Evaluation of the porewater approach for assessing the quality of marine and estuarine sediments. Gordon Research Conference in Environmental Sciences, New Hampton, NH. 1992.
 9. Carr, R.S., D.C. Chapman, and W. Roach. Impact of produced water discharges on Texas estuaries. Society of Environmental Toxicology and Chemistry 12th Annual Meeting. 1991.
 8. Chapman D.C. and R.S. Carr. Impact of oilfield brines on sediment and sediment pore water in two Texas estuaries. South Central Society of Environmental Toxicology and Chemistry Annual Meeting, Denton, TX. 1991. PRESENTED
 7. Chapman D.C. Brine discharges in Nueces Bay. Texas Bend Bays and Estuaries Meeting, Port Aransas, TX. 1991. PRESENTED
 6. Carr, R.S. and D.C. Chapman. Comparison of solid-phase and pore-water approaches for assessing the quality of marine and estuarine sediments. First International Ocean Pollution Symposium. Parguera, PR. 1991 INVITED
 5. Carr, R.S. and D.C. Chapman. Solid-phase versus pore-water approaches for assessing the quality of marine and estuarine sediments. Society Of Environmental Toxicology And Chemistry 11th Annual Meeting. Crystal City, VA. 1990.
 4. Carr, R.S. and D.C. Chapman. Sediment quality assessment studies in Corpus Christi Bay and Nueces Bay, TX. Coastal Bend Bays and Estuaries Meeting, Port Aransas, TX. 1990.
 3. Carr, R.S. and D.C. Chapman. Continuing evaluation of the pore water approach for assessing the quality of marine and estuarine sediments. Society of Environmental Toxicology And Chemistry 10th Annual Meeting. Toronto, Canada. 1989.
 2. Chapman, D.C., W.A. Hubert, and U.T. Jackson. A method for separating larval striped bass with uninflated gas bladders from normal larvae. Colorado- Wyoming chapter of the American Fisheries Society. Laramie, WY. 1987. PRESENTED
 1. Chapman, D.C. Gas bladder inflation in larval striped bass. Great Plains Fishery Workers Association Annual Meeting. Fort Collins, CO. 1987. PRESENTED
- c. RENDERING SCIENTIFIC JUDGMENT

I often provide reviews as requested by scientific journals. In the past four years, I have reviewed manuscripts for: Transactions of the American Fisheries Society (5), Biological Invasions (4), Journal of Great Lakes Research (2), Aquatic Invasions (3), Plos One, Fisheries (2), Journal of Fish and Wildlife Management, Fisheries, Ecological Engineering, Evolutionary Applications, Freshwater Biology, Journal of Fish Biology, Reviews in Fish Biology and Fisheries, Chemosphere, Ecology of Freshwater Fish, Conservation Biology, Aquaculture Nutrition, North American Journal of Fisheries Management, Fisheries Management and Ecology, North American Journal of Aquaculture, Asian Fisheries Science Journal, Aquatic Invasion Records, Journal of Applied Ichthyology, and Hydrobiologia.

I have provided formal reviews of proposals, as requested by Sea Grant (2) and MRBP (2), USAID, and of state agency and GLFC reports and white papers, as well as FSP reviews of many USGS documents and abstracts. Represented USGS at Corps of Engineers charrette on Chicago Area Waterway System as a pathway for invasive species transfer between the Great Lakes and the Mississippi River Basin, to provide judgment related to risk of Asian carp passage through the waterway. November 14-16, 2012

Provided briefing on Asian carp to Congresswoman Judy Biggert (IL-13) and her staffers at her request, August 6, 2012. Also, on several occasions I have been called upon to review USGS congressional briefings that pertain to Asian carps.

In 2010, I was asked by the Department of Justice (DOJ) and the Department of Interior liaison to DOJ to provide an extensive declaration on the biology of Asian carps and their risk to the Laurentian Great Lakes to provide to the Supreme Court of the United States for use in evaluation of a suit between several Great Lakes states and the state of Illinois. Later, I was again asked to provide declarations on this subject for use in a later case that went to court. I was then briefly detailed to DOJ in September 2010 to testify in that court case (See Special Assignments below).

In April 2006, at the request of USAID, I reviewed a proposal on the eradication of invasive tilapia from the Galapagos. I was asked to participate in the review because I had recently worked with rotenone (Pub 26), I have worked extensively in the culture of tilapia in Central America, and I am fluent in Spanish, the language of the proposal. After receiving my review, the Ecuador National Park Service and USAID requested that Dr. Leo Nico and I come to the Galapagos to determine the extent of the invasion and plan an eradication. (See Special Assignments below)

Served as USGS science representative on the multi-year Great Lakes-Mississippi River Interconnectivity Study (GLMRIS) team, Focus Area 2. July 2010 to May 2013. The team generated a report on locations, both natural and man-made, where aquatic nuisance species could pass between the Great Lakes and the Mississippi River Basin, and ranked them in order of importance. <http://glmris.anl.gov/documents/docs/interim/SummaryReport.pdf>

I served on the review panel for the Canadian Asian Carp Risk Assessment in October 2004.

Associate editor, Progressive Fish Culturist, 1993 - 1996 editorial boards.

Subpoenaed as expert witness in court case on produced water discharge in Nueces Bay. My data on sediment, sediment porewater, produced water effluent toxicity and on the chemistry of effluents and sediments in Nueces Bay was critical to City of Corpus Christi's case. As a result of this litigation, produced water discharge permits to this bay were canceled.

Subpoenaed as an expert witness in court case on produced water discharges in Galveston Bay. My data on the toxicity of produced waters and of sediments influenced by produced water in the Galveston Bay area, including the large discharge in question, was critical to the Sierra Club's case. As a result of this litigation, the discharge permit was canceled.

d. LECTURESHIPS AND OTHER ACADEMIC SERVICE

Lectureship

Presented Lecture “The Biology and Management of Asian Carp: Lessons for Minnesota.” Freshwater Society – College of Biological Sciences Lecture series. University of Minnesota. October 2013.

Recorded seven-module lecture (each module approximately 30 minutes) on management of nuisance species for repeated use in Kansas State University’s on-line course in Fisheries Management. November, 2012

I have often served as a guest speaker in university courses, both at the University of Missouri and at Texas A&M Corpus Christi, on topics including aquaculture effluents, environmental toxicology, and invasive species.

Seminars:

Chapman, D.C. History, Biology, and Control of Asian Carps in North America. Presentation to the University of Missouri Student Chapters of the Wildlife Society and of the American Fisheries Society. October 2013.

Chapman, D.C. Invasion Biology of Asian carps. Graduate seminar, University of Minnesota, October 2013.

Chapman, D.C. Assessing the risk of Asian carps to the Great Lakes. Guest Lecture, Advanced Fisheries Management Class, University of Missouri. November 29, 2011.

Chapman, D.C. Invasion biology of Asian carps: When conventional wisdom lets you down. Graduate seminar at University of Nebraska, Omaha. February 2009.

Management and control of invasive bighead and silver carps. Duane Chapman. South Dakota State University Fish and Wildlife Seminar, October 8, 2008. Brookings, SD.

Invasive Aquatic Species in the Large Rivers of the Midwest: What Can Be Done? Duane Chapman. UMC Fish and Wildlife Seminar, February 23, 2007, University of Missouri, Columbia MO.

Biology of Asian Carps: What we know and what we'd like to know. Duane Chapman. One-hour presentation leading off the symposium: The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem, August 22, 2006, Peoria, IL

USGS research on bighead and silver carp in the Missouri River. Duane Chapman. UMC Fish and Wildlife Seminar, October 29, 2004, University of Missouri, Columbia MO.

Current research on the invasive bighead (*Hypophthalmichthys nobilis*) and silver carps (*H. molitrix*) and their status in the USA. Duane C. Chapman, Patrick L. Hudson and Amy J. Benson. June 17, Peking University, Beijing, People's Republic of China.

Current research on the invasive bighead (*Hypophthalmichthys nobilis*) and silver carps (*H.*

molitrix) and their status in the USA. Duane C. Chapman, Patrick L. Hudson and Amy J. Benson. June 20, Research Center for Eco-environmental Sciences, Wuhan, People's Republic of China.

Other academic services:

I co-chaired the graduate committee of Russell Hooten, master's degree candidate, Texas A&M University-Corpus Christi (TAMU-CC). His research was in use of algal spores in toxicity testing, including porewater toxicity testing. Defense and graduation in May 1996.

I served as an advisor and committee member for Claude D'Unger, Master's degree candidate in Environmental Science, TAMU-CC. Thesis title: "An economic evaluation of oil-field produced water disposal alternatives in Nueces Bay". I also prepared the resulting journal publication, which meshed my toxicology work with his economic study. Defense and graduation May 1995.

d. TECHNICAL TRAINING PROVIDED

In Corpus Christi, 1993-1994, provided several training sessions to persons and agencies interested in the porewater extraction procedure. These included private contracting agencies, state agencies, universities, and Fish and Wildlife Service employees.

I developed a Semi Permeable Membrane Device (SPMD) deployment/retrieval training video that has been distributed by CERC's inventors of this technology.

I performed yearly training on fish dissection for the Biomonitoring of Status and Trends team, 1996 through 2000

I have been a Department of Interior certified Motorboat Operator Instructor since 1996. I continue to provide training to one or two classes per year.

In January 2001, I twice gave a presentation entitled "In vivo chlorophyll: Measurement and interpretation" at the USGS WRD Water Quality Technical Conference in New Orleans LA. This invited presentation was provided because of concerns that this new technology had a high potential for misuse and misinterpretation.

f. SPECIAL ASSIGNMENTS

In November and early December 2007, I was on assignment to USAID to assist in an assessment of the status of invasive tilapia in the Galapagos, and to develop an eradication plan. Dr. Leo Nico and I traveled to the Galapagos and worked with the Ecuador National Park Service on this effort. We established that tilapia were only present in one body of water, Laguna Junco. This volcanic caldera is said to be the only permanent natural lentic body of water in the archipelago, and is home to endemic invertebrates found nowhere else. The populations of these invertebrates were heavily impacted by the tilapia, to the point that we found none of them during our stay. I drafted (in Spanish) the rotenone application plan for eliminate the tilapia. The plan was implemented less than a year later by Dr. Nico and collaborators (I was unable to make a return trip to the Galapagos

because of Asian carp duties). The operation appears to have been successful. No live tilapia have been collected or observed there since the eradication.

In September of 2010, I was briefly assigned to the Justice Department to provide declarations and court testimony when Great Lakes States sued the Corps of Engineers regarding closure of Chicago locks as a defense against Asian carp invasion to the Great Lakes. This followed an earlier request by the Justice Department to provide a declaration to the US Supreme Court regarding Asian carp biology and history in the United States, as it relates to the invasion of the Great Lakes.

g. OTHER TECHNICAL ACTIVITIES

By invitation, I was a member of the “Asian Carp Rapid Response Team” from 2006 to 2010. This team, led by Dr. Phil Moy of Sea Grant-University of Wisconsin, was in charge of activities associated with all aspects of potential movement of invasive species, particularly Asian carps, between the Great Lakes and the Mississippi River basin via the Chicago Ship and Sanitary Canal. I provided technical assistance to this team in relation to Asian carp biology. I developed a powerpoint presentation that describes the difference between grass carp and black carp. These two species are similar in morphology and there was concern by state biologists in Missouri and Illinois that cases of mistaken identity between black and grass carp might occur (dark grass carp and light black carp occur naturally). The presentation was provided electronically to collaborators, and is available on the web at:

http://www.cerc.usgs.gov/pubs/center/pdfDocs/carp_compare.pdf

I prepared the briefing paper “Invasive aquatic species in the Missouri River” for the Missouri River Basin Interstate Roundtable in November 2002.

Panelist, Water Quality Techniques, panel discussion at the USGS WRD Water Quality Technical Conference January 2001, New Orleans, LA.

Chapman, D.C. Virtual Fish: SPMD Basics. This is the home page for the national Semi-Permeable Membrane Device website. Updated most recently in February 2006. <http://wwwaux.cerc.cr.usgs.gov/SPMD/index.htm>

15. OUTREACH AND INFORMATION TRANSFER

Asian carp have created a stir in the media, and I respond to an average of more than one media contact weekly. These have resulted in hundreds of newspaper articles, including a front page piece in the Wall Street Journal, and many citations in Dan Egan’s well-known series on the Asian carp invasion in the Milwaukee Journal-Sentinel. Many interviews were either directly taken by international news services or picked up from other outlets by these news services, therefore the total number of articles is very high but cannot be determined. I have also been featured in articles in the National Journal and in several popular magazines, including Discover Magazine. I have had many radio interviews as well, including pieces on both NPR and Canadian Public Radio, and on nationally broadcast hunting and fishing radio shows. My work on Asian carps has also been featured in three television pieces on the National Geographic Channel, one on the Discovery Channel, in the Canadian Broadcasting Company’s “The Nature of Things” and in many national news pieces on

Asian carps on NBC, CBS, ABC, FOX, and ESPN.

Provided lecture “The Biology and Management of Asian Carp: Lessons for Minnesota” to approximately 300 people in St. Paul, MN, at the request of the Freshwater Society (October 2013).

Provided requested webex to the Missouri River Recovery Implementation Committee (MRRIC) “Asian carp in the Missouri River”, July 30, 2013.

Provided lecture “Asian carp: History, effects, and what do we do now?” to two Chapters of Missouri River Relief, in Kansas City (July 2012) and Saint Louis (November 2012)

At the request of the Mississippi River Basin Panel on aquatic nuisance species, I starred in a training video on Asian carp fileting and bone removal in 2009. The video was distributed widely on DVD by Sea Grant and is available in three parts on Youtube, where the first part alone has had over 45,000 views.

<http://www.youtube.com/watch?v=T1NVUV8yhmU>

Science Magazine Published the Article "Expanding Trade with China Creates Ecological Backlash" in the Nov. 5 2005 edition of News Focus, which featured my research program on invasive Asian carps. This was largely a result of my presentation at the BISOBI conference in Beijing, China.

At the request of the Missouri Department of Conservation, I wrote the following article for publication in the Department’s public outreach magazine: “Carp Lemonade: Making the Best of Some Bigheaded Invaders”, Missouri Conservationist, July 2004, pp. 8-13. This is an article on bighead and silver carp effects on native fishes with information on how to capture and prepare the fish for human consumption. Available on the web at:

<http://mdc.mo.gov/documents/conmag/20040701.pdf>

I penned a sidebar on avoiding injury from jumping Asian carp for The Complete Paddler: A Guidebook for Paddling the Missouri River from the Headwaters to St. Louis, Missouri, by David L. Miller, published in 2005.

I have provided photographs of Asian carps for many individuals and agencies performing research and/or outreach on Asian carps. These include Science Magazine, Michigan Environmental Educators, Missouri Department of Conservation, Missouri Stream Teams, Minnesota DNR, FishPro Environmental Consultants, Environmental Journalism, TCI Inc. (for a high school biology text), Buffalo (OH) News, Native Fish Conservancy, Illinois Natural History Survey, Illinois-Indiana Sea Grant, Louisiana Sea Grant, US Fish and Wildlife Service, MICRA, and others. I contributed formatted datasets and prepared figures and maps of water quality, productivity, fish assemblages, and zooplankton assemblages to the Arcview Lisbon Bottom Decision Support System (DSS) generated by the Center. The objective of this DSS was to be both an aid to the USFWS in management of Lisbon Bottom, and as a demonstration of the use of DSS in conservation lands management. The resulting application was the first decision support tool for the Big Muddy Refuge and the first tool available through the NBII-2 network being established through the Missouri River InfoLINK for sharing Missouri River information from multiple sources.

Chapman, D.C. SPMD Basics. Though penned many years ago, this document remains the home page for the national SPMD website. <http://www.waux.cerc.cr.usgs.gov/SPMD/>

16. INVENTIONS, PATENTS HELD

I invented a sediment pore water extractor which has now been used by many researchers in several countries. It has become a standard for extracting pore waters for sediment quality assessment surveys, because it works well with almost any sediment type. (Pub 10)

I made substantial modifications to a sediment coring device originally invented by Dr. Christopher Onuf. (Pub 13)

17. HONORS, AWARDS, RECOGNITION, ELECTED MEMBERSHIPS

- Special Achievement Award, December 1986. For conducting striped bass toxicity tests.
- Special Achievement Award, January 1989. For research and publications on striped bass and grass carp.
- Special Achievement Award, September 1991. For design, and testing of porewater extraction device.
- Special Achievement Award, August 1992. For high level of performance in sediment research.
- On-the-Spot Award, September 1992. For completion of several amphipod sediment toxicity tests. Each of these tests included more than 45 simultaneous treatments, five replicates each, a probable world record.
- Special Commendation, National Park Service, for efforts in restoring native live oaks to Padre Island National Park. January 1992
- On-the-Spot Award, June 1993. For successful completion of sediment extractions of hundreds of samples from several bay systems around the US. All extractions completed within ten days of field collection, a logistical feat.
- Quality Performance Award, August 1993. For high level of performance in conducting sediment quality assessment surveys in several bay systems.
- Special Achievement Award, August 1994. For high level of performance in continued sediment quality assessment surveys, and managing field station during leader's absence abroad for nearly half the year.
- Star Award, for excellence in motorboat operator training. September 1996
- Star Award, for compilation, summary and presentation of Lisbon Bottoms Symposium. October 2001
- Letter of Recognition from the Missouri Chapter of the American Fisheries Society, for efforts involved with the Missouri Natural Resources Conference. January 2003
- Star Award, August 2003, for outreach efforts related to Asian carp.
- Elected and served in Vice President – President – Immediate Past-President series of the Missouri Chapter of the American Fisheries Society beginning January 2004.
- Letter of Recognition and plaque from USFWS for efforts in developing the Asian Carp Management and Control Plan. August, 2005.
- Elected Chair of the Research and Risk Assessment Committee of the Mississippi River Basin Panel on Aquatic Nuisance Species, January, 2006. I still occupy this Excom position.
- John L. Funk Award of Excellence, from the Missouri Chapter of the American Fisheries Society, in recognition of long-term contributions to aquatic resource conservation in Missouri. February, 2007.
- Professional Conservationist of the Year, from the Conservation Federation of Missouri. The Conservation Federation of Missouri [<http://www.confedmo.org/>] is a federation of 70 non-

governmental organizations such as sportsmen's groups (Missouri Trout Unlimited, Missouri Wild Turkey Federation), environmental organizations (Ozark Wilderness Waterways, Forest Releaf of Missouri) and conservation professional groups (Missouri Conservation Agents Association, Missouri Chapter Soil & Water Conservation Society). March 2007.

- Elected President of Introduced Fishes Section of the American Fisheries Society (three year term beginning 2007, plus two years as past president)

- Star award, February 2007, for being chosen as the recipient of the MOAFS Funk Award and the CFM Professional Conservationist of the year.

- On-the-Spot Award, for media work associated with Asian carp and the Chicago Ship and Sanitary Canal, December 2009

- Star Award, for demonstrated leadership in Asian carp research, May 2010

- Star Award, for outstanding work pursuing and publishing fundamental science on Asian carp biology. September 2012.

- Department of the Interior Honor Award for superior service in Asian carp research. October 3, 2013

- USGS Excellence in Leadership Award. Group award for the Asian Carp Science Team.

18. BIBLIOGRAPHY

a. PUBLISHED REPORTS

- 1) Chapman, D.C. 1985. Observations on failure of initial gas bladder inflation in striped bass. Masters Thesis, Department of Zoology and Physiology, University of Wyoming, Laramie, Wyoming.
- 2) Chapman, D.C., W.A. Hubert, and U.T. Jackson. 1987. Phosphorus retention by grass carp (*Ctenopharyngodon idella*) fed sago pondweed (*Potamogeton pectinatus*). *Aquaculture* 65:221-225.
- 3) Chapman, D.C., W.A. Hubert, and U.T. Jackson. 1988. Influence of access to air and of salinity on gas bladder inflation in striped bass. *The Progressive Fish Culturist* 50:23-27.
- 4) Chapman, D.C. and U.T. Jackson. 1988. Method for separating normal striped bass larvae from those with uninflated gas bladders. *The Progressive Fish Culturist* 50:166-169.
- 5) Chapman, D.C. 1992. Failure of gas bladder inflation in striped bass: effect on selenium toxicity. *Archives of Environmental Contamination and Toxicology* 22:296-299.
- 6) Carr, R.S. and D.C. Chapman. 1992. Comparison of solid-phase and pore-water approaches for assessing the quality of marine and estuarine sediments. *Chemistry and Ecology* 7:19-30.
- 7) D'Unger, C., C.J. Prouty, W. Tunnell, G. Jeffress, D. Chapman, and R.S. Carr. 1993. Environmentally sound alternatives to tidal brine discharges in Nueces Bay. *New Waves: Texas Water Resources Institute* 6:2976.
- 8) Carr, R.S., D.C. Chapman, and C. Howard. 1993. Survey of Galveston Bay sediments and benthic communities. in *Proceedings, The Second State of the Bay Symposium, Galveston Bay National Estuary Program Publication 23*, Webster, TX, pp. 83-94.

- 9) Chapman, D.C. and R. Hooten. 1994. Flower Gardens coral larvae toxicity testing and early life history. Flower Gardens Technical Series Report 94-02 pp. 13-15.
- 10) Carr, R.S., and D.C. Chapman. 1995. Comparison of methods for conducting marine and estuarine sediment porewater toxicity tests - extraction, storage, and handling techniques. *Archives of Environmental Contamination and Toxicology* 28:69-77
- 11) Carr, R.S., E.R. Long, H.L. Windom, D.C. Chapman, G. Thursby, and G.M. Sloane. 1996. Sediment quality assessment studies of Tampa Bay, Florida. *Environmental Toxicology and Chemistry* 15:1218-1231.
- 12) D'Unger, C., D.C. Chapman, and R.S. Carr. 1996. Discharge of oilfield-produced water in Nueces Bay, TX: a case study. *Environmental Management* 20:143-150.
- 13) Onuf, C.P., D.C. Chapman, and W.M. Rizzo. 1996. Inexpensive, easy to construct suction coring devices usable from small boats. *Journal of Sedimentary Research*. 66:1031-1032.
- 14) Carr, R.S., D.C. Chapman, C.L. Howard, J.M. Biedenbach. 1996. Sediment quality triad assessment survey of the Galveston Bay, Texas system. *Ecotoxicology*. 5:341-364.
- 15) Carr, R.S., D.C. Chapman, B.J. Presley, J.M. Biedenbach, L. Robertson, P. Boothe, R. Kilada, T. Wade and P. Montagna. 1997. Sediment porewater toxicity assessment studies in the vicinity of offshore oil and gas production platforms in the Gulf of Mexico. *Canadian Journal of Fisheries and Aquatic Science* 53:2618-2628.
- 16) Chapman, D.C. and A.L. Allert. 1997. Los Alamos National Laboratory Use Assessment Phase II: Toxicity Testing of Surface Waters and Sediment Pore Waters at Los Alamos National Laboratory. Report to the USFWS New Mexico Ecological Service Field Office. 65pp plus appendices.
- 17) Allert, A.L., M.L. Wildhaber, C.J. Schmitt, D.C. Chapman, and E.V. Callahan. 1997. Toxicity of sediments and pore-waters and their potential impact on Neosho madtom, *Noturus placidus*, in the spring river system affected by historic zinc-lead mining and related activities in Jasper and Newton Counties, Missouri and Cherokee County, Kansas. Final Report to US Fish and Wildlife Service. 100 pp.
- 18) Grady, J, J. Milligan, D. Chapman, E. Ehrhardt, D. Dieterman, D. Galat, J. Hooker, J. Kubisiak, A. Delonay, E. Little, J. Robinson, and J. Tibbs. 1999. Fishes of the Missouri River, chute, and floodplain habitats. pp 39-54 in Initial Biotic Survey of Lisbon Bottom, Big Muddy National Fish and Wildlife Refuge. USGS/BRD/BSR – 2000-0001 <http://www.cerc.usgs.gov/pubs/center/pdfDocs/Lisbon.pdf>
- 19) Chapman, D.C., D.M. Papoulias, and C.P. Onuf. 1998. Environmental Change in South Texas. pp 43-46 in M.J. Mac, P.A. Opler, and P.D. Doran, eds. Status and Trends of the Nation's Living Resources. U.S. Department of the Interior, USGS Biological Resources Division. Washington, D.C. 964 pp.
- 20) Chapman, D.C., A.L. Allert, J.F. Fairchild, T.W. May, C.J. Schmitt, and E.V. Callahan. 1999.

Toxicity and elemental contaminant concentrations of groundwater, sediment pore waters, and surface waters of the Missouri River associated with a metals refining site in Omaha, NB. USGS Biological Resources Division Technical Report to the USEPA under IAG DW14952122-01-1, Columbia Environmental Research Laboratory, Columbia, MO. 43. pp plus appendices.

Grady, J., Milligan, J., Chapman, D., Ehrhardt, E., Dieterman, D., Galant, D., Hooker, J., Kubisiak, J., Delonay, A., Little, E., Robinson, J., and Tibbs, J., 1999, Fishes of Missouri River, chute and flood plain habitats: chap. 4 of Humburg, D.D. and Burke, V.J., eds., Initial Biotic Survey of Lisbon Bottom, Big Muddy National Fish and Wildlife Refuge: U.S. Geological Survey Biological Science Report 2000-2001, p. 39-53. <http://pubs.er.usgs.gov/usgspubs/bsr/bsr000001>

21) Chapman, D.C., A.L. Allert, J.F. Fairchild, T.W. May, C.J. Schmitt, and E.V. Callahan. 2001. Toxicity and bioavailability of metals in the Missouri River adjacent to a lead refinery. U.S. Geological Survey Biological Science Report USGS/BRD/BSR – 2001-0004. 27pp. Available on the web at <http://www.cerc.usgs.gov/pubs/center/pdfDocs/BSR2001-0004.pdf>

21) Lusk, J.D., R.K. MacRae, D.C. Chapman, and A.L. Allert. 2002. A water quality assessment of four intermittent streams in Los Alamos County, NM. Report to the US Department of Energy, New Mexico Environment Department, and Los Alamos National Lab. 234 pp. plus appendices.

22) Nipper, M., G.A. Burton Jr., D.C. Chapman, K.G. Doe, M. Hamer, and K.T. Ho. 2002. Issues and recommendations for porewater toxicity testing: methodological uncertainties, confounding factors and toxicity identification evaluation procedures. pp. 143 - 162 in: Carr, R.S. and M. Nipper (eds), Porewater Toxicity Testing: Biological, Chemical, and Ecological Considerations: Methods, Applications and Recommendations for Future Areas of Research, Society of Environmental Toxicology and Chemistry Press. 315 pp.

23) Chapman, D.C., J.F. Fairchild, and E.A. Ehrhardt. 2002. Limnology of Lisbon Bottom Wetlands. pp. 37-63 in Chapman, D.C, E.A.Ehrhardt, J.F. Fairchild, R. Jacobson, B.A Poulton, L.C. Sappington, B.P. Kelly, and W.R. Mabee. 2002. Ecological dynamics of wetlands at Lisbon Bottom, Big Muddy Fish and Wildlife Refuge, Missouri. report to the Big Muddy Fish and Wildlife Refuge, USFWS, Columbia, MO. 160 pp. USGS Open-File Report 2004-1036. available on-line at: <http://infolink.cr.usgs.gov/Science/Lisbon/index.htm>

24) Chapman, D.C., B.C. Poulton, and W.R. Mabee. 2002. Zooplankton of Lisbon Bottom Wetlands. pp. 65-81 in Chapman, D.C, E.A.Ehrhardt, J.F. Fairchild, R. Jacobson, B.A Poulton, L.C. Sappington, B.P. Kelly, and W.R. Mabee. 2002. Ecological dynamics of wetlands at Lisbon Bottom, Big Muddy Fish and Wildlife Refuge, Missouri. Report to the Big Muddy Fish and Wildlife Refuge, USFWS, Columbia, MO. 160 pp. USGS Open-File Report 2004-1036. available on-line at: <http://infolink.cr.usgs.gov/Science/Lisbon/index.htm>

25) Chapman, D.C. 2002. Fishes of Lisbon Bottom Wetlands. pp. 115-139 in Chapman, D.C, E.A.Ehrhardt, J.F. Fairchild, R. Jacobson, B.A Poulton, L.C. Sappington, B.P. Kelly, and W.R. Mabee. 2002. Ecological dynamics of wetlands at Lisbon Bottom, Big Muddy Fish and

- 36) Chapman, D.C. and J.E. Deters. 2009. Effect of water hardness and dissolved-solid concentration on hatching success and egg size in bighead carp. *Transactions of the American Fisheries Society*, 138(6): 1226-1231 IP-010726 BAO approval 1/12/09
- 37) Chapman, D.C. 2009. Flying Fish Great Dish. DVD produced by Louisiana State University Ag Center. Also available in three parts on youtube: <http://www.youtube.com/watch?v=T1NVUV8yhmU>
- 39) Chapman, D.C. 2010 (potential for) Establishment of Asian carp in the Great Lakes. Declaration to the US Supreme Court, in the case of the states of Wisconsin, Michigan, New York v. state of Illinois and Metropolitan Sanitary District of Grater Chicago. NRS-#631673-DOJ
- 40) Li, S.F., Q.L. Yang, J.W. Xu, C.H. Wang, D.C. Chapman, and G.Q. Lu, GQ. 2010. Genetic Diversity and Variation of Mitochondrial DNA in Native and Introduced Bighead Carp. *Transactions of the American Fisheries Society*, 139 (4): 937-946 IP-015835 BAO approval 8/25/09
- 41) Chapman, D.C. 2010. Declaration to the US District Court, in the case of the states of Wisconsin, Michigan, New York v. US Army Corps of Engineers and Metropolitan Sanitary District of Grater Chicago. NRS-#674645-DOJ
- 42) King, T.L., M.S. Eackles, and D.C. Chapman. 2011. Tools for assessing kinship, population structure, phylogeography, and interspecific hybridization in Asian carps invasive to the Mississippi River, USA: isolation and characterization of novel tetranucleotide microsatellite DNA loci in silver carp *Hypophthalmichthys molitrix*. *Conservation Genetic Resources*. 3(3):397-401. <http://www.springerlink.com/content/72466g6803424169/>
- 43) Chapman, D.C. and M. Hoff, editors. 2011. Invasive Asian Carps in North America. American Fisheries Society Symposium 74, Bethesda, Maryland, USA. 266 pp. IP-006962
- 44) Orazio, C.E., D.C. Chapman, T.W. May, J.C. Meadows, M.J. Walther, K.R. Echols, J.E. Deters, and E.S. Dierenfeld. 2011. Evaluation of environmental contaminants and elements in bigheaded carps of the Missouri River at Easley, Missouri, USA. Pages 199-214 in D.C. Chapman and M.H. Hoff, (eds.) Invasive Asian Carps in North America. American Fisheries Society, Symposium 74, Bethesda, MD. IP-013770
- 45) Chapman, D.C., and A.E. George. 2011. Developmental rate and behavior of early life stages of bighead and silver carp: U.S. Geological Survey Scientific Investigations Report 2011-5076. 10 pp + appendices IP-028186
- 46) Li, S.F., J.W. Xu, Q.L. Yang, C.H. Wang, D.C. Chapman, and G. Lu. 2011. Significant genetic differentiation between native and introduced silver carp (*Hypophthalmichthys molitrix*) inferred from mtDNA analysis. *Environmental Biology of Fish* 92:503-511. BAO approval 12/7/10 IP-021466
- 47) Kocovsky, P.M., D.C. Chapman, and J.E. McKenna. 2012. Thermal and hydrologic suitability of Lake Erie and its major tributaries for spawning of Asian carps. *Journal of*

Great Lakes Research 38(1):159-166 BAO approval 12/8/11 IP-033299

48) Cudmore, B., N.E. Mandrak, J.M. Dettmers, D.C. Chapman, and C.S. Kolar. 2012. Binational ecological risk assessment of bigheaded carps, DFO Canadian Science Advisory Secretariat, Research Document 2011/114. 57p., http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2011/2011_071-eng.pdf

49) Chen, Q., Wang, C., Lu, G., Zhao, J., Chapman, D.C., Zsigmond, J., Li, S. 2012. "Microsatellite genetic diversity and differentiation of native and introduced grass carp populations in three continents." *Genetica* 140: 115-123. BAO approval 3/19/13 IP-023856

50) Fleming, B., R. Lance, R. Perkins, E. Russo, J. Killgore, M. Schultz, D. Smith, K. Baerwaldt, E. Drott, R. Hankcock, D. Chapman, J. Amberg, M. Bartron, and K. Schilling. 2012. Environmental DNA Calibration Study Interim Technical Review Report <http://www.asiancarp.us/documents/ECALSFirstInterimReportFINAL.pdf> BAO approval 3/19/13 IP-035574

51) Chapman, D.C. 2010. Facts about invasive bighead and silver carps. USGS Fact Sheet 3033, 2pp. BAO approval 7/29/10 BAO approval 6/24/10 IP-020258

52) Deters, J.E., D.C. Chapman, and B. McElroy. 2013. Location and timing of Asian carp spawning in the Lower Missouri River. *Environmental Biology of Fishes* 96:617-629. BAO approval 8/16/13 IP-026008

53) George, A.E, and D.C. Chapman. 2013. Aspects of embryonic and larval development in bighead carp *Hypophthalmichthys nobilis* and silver carp *Hypophthalmichthys molitrix*. *Plos One* 8(8):e73829 BAO approval 7/25/13 IP-038088

54) Chapman, D.C., J.J. Davis, J.A. Jenkins, P.M. Kocovsky, J.G. Miner, J. Farver, and P.R. Jackson. 2013. First evidence of grass carp recruitment in the Great Lakes Basin. *Journal of Great Lakes Research*. 39:547-554. BAO approval 8/16/2013 IP-046079

55) Klymus, K, C. Richter, D. Chapman, and C. Paukert. 2013. ECALS: Loading Studies Interim Report October 2013. Understanding how diet affects the eDNA shedding rate of bigheaded carps. BAO approval 12/9/13 IP-052631

56) Ye, L., J. Amberg, D.C. Chapman, M. Gaikowski, and W. Liu. 2013. Fish gut microbiota analysis differentiates physiology and behavior of invasive Asian carp and indigenous American fish. *ISME Journal* 8:541-555. BAO approval 7/30/13 IP-045121

57) Baerwaldt, K., M. Bartron, K. Schilling, D. Lee, E. Russo, T. Estes, R. Fischer, B. Fleming, M. Guilfoyle, J. Kilgore, R. Lance, E. Perkins, M. Schultz, D. Smith, J. Amberg, D. Chapman, M. Gaikowski, K. Klymus, and C. Richter. 2014 Environmental DNA Calibration Study Interim Technical Review Report. 234 pp. http://www.asiancarp.us/documents/IP-057663_ECALS_Interim_Report_FINAL.pdf

BAO approval 11/20/2014 IP-057663

- 58) Klymus, K.E., C.A. Richter, D.C. Chapman, and C. Paukert. 2015. Quantification of eDNA shedding rates from invasive bighead carp *Hypophthalmichthys nobilis* and silver carp *Hypophthalmichthys molitrix*. Biological Conservation. BAO approval 5/21/2014 IP-053423
- 59) George, A.E, and D.C. Chapman. 2015. Embryonic and larval development and early behavior in grass carp, *Ctenopharyngodon idella*: implications for recruitment in rivers. Plos One 10(3): e0119023. BAO approval 10/28/14 IP-056158
- 60) Anderson, K.R., D.C. Chapman, T.T. Wynne, K. Masagounder, and C.P. Paukert. 2015. Suitability of Lake Erie for bigheaded carps based on bioenergetic models and remote sensing. Journal of Great Lakes Research. 41:358-366. BAO approval 2/6/15 IP-056785
- 61) George, A.E., D.C. Chapman, J.E. Deters, S.O. Erwin, and C.-A. Hayer. 2015. Effects of sediment burial on grass carp, *Ctenopharyngodon idella* (Valenciennes, 1844), eggs. Journal of Applied Ichthyology. Doi: 10.1111 (published on-line) ISSN 0175-8659. IP-060743 BAO approval 7-17-15
- 62) Klymus, K.E., C.A. Richter, D.C. Chapman, and C. Paukert. 2015. A reply to Iversen et al.'s comment "Monitoring of animal abundance by environmental DNA — An increasingly obscure perspective". Biological Conservation. BAO approval 8-28-15 IP-068606
- 63) Cudmore et al. binational risk assessment of grass carp. BAO approval 12-17-15 IP-066352
- b. REPORTS ACCEPTED FOR PUBLICATION
- Larson et al. 2016 Asian carp eggs cannot be distinguished from other cyprinid species on the basis of morphology alone
19. PUBLICATIONS
- 1) Chapman, D.C., J.J. Davis, J.A. Jenkins, P.M. Kocovsky, J.G. Miner, J.Farver, and P.R. Jackson. 2013. First evidence of grass carp recruitment in the Great Lakes Basin. Journal of Great Lakes Research. 39:547-554 IP-046079

This article reports on the first evidence of recruitment by any Asian carp in the Great Lakes Basin. In this study, we combined otolith microchemistry, water quality, fish aging techniques, river hydrographic data, and ploidy analysis to provide multiple lines of evidence that grass carp captured in the Sandusky River were the result of natural recruitment in that river. I acquired the fish, organized the team with the skills required to address the multiple lines of evidence, and led the development of the manuscript. I have long identified the potential for grass carp establishment in the Great Lakes to be both a potential (and nearly overlooked) problem and an opportunity, because grass carp have reproductive requirements that are very similar to bigheaded carps, in that they are

broadcast spawners with drifting eggs that are thought to remain in the drift until hatching. The required drift time and turbulences required are roughly similar. Publication of this document has spurred a flurry of research on both of these fronts, including the Binational Risk Assessment of Grass Carp, adaptation of egg drift models for grass carp (in part for comparison to bigheaded carps), a further assessment of grass carp origin via otoliths and ploidy, and other research on grass carp status in the Great Lakes including larval collections and telemetry of adults by USGS and states bordering Lake Erie.

2) Chapman, D.C. and M.H. Hoff, editors. 2011. Invasive Asian Carps in North America. American Fisheries Society Symposium 74, Bethesda, Maryland, USA. 266 pp. IP-006962.

This book is partly the proceedings of a symposium which I chaired in Peoria, IL, but it also contains other research developed after the symposium. I acquired funding for the symposium, planned the program, invited the speakers, and acquired funding for the proceedings. I enlisted Mike Hoff as co-editor to provide for peer review for the introduction and the chapter I authored, invited additional authors to fulfill gaps in information on black carp, history of the Asian carp invasion, and history and use of the electric barrier that were not covered in symposium. I acted as editor for the remainder of the chapters, including providing for multi-reviewer peer review and including rejection of some chapters that were deemed inadequate through peer review. There are seventeen chapters, plus the introduction. Topics covered range from black carp status in the Mississippi River basin, to a history and an evaluation of the electric barrier in the Chicago Ship and Sanitary Canal, to stock-recruit and dispersal models, to contaminants in carp, to control methods. The topics in the symposium and the book are the topics of highest interest to agencies represented in the Mississippi River Basin Panel on aquatic nuisance species. For example, Dr. Papoulias' chapter on accuracy of ploidy measurement was important to the recent evaluation of the triploid grass carp certification program. The information in Dr. Orazio's chapter on contaminants in bigheaded carps (of which I am second author) has already been extensively used by entrepreneurs in development of markets for bigheaded carps.

3) Kolar, C.S., D.C. Chapman, W.R. Courtenay, C.M Housel, J.D. Williams, and D.P. Jennings. 2007. Bigheaded Carps: A Biological Synopsis and Environmental Risk Assessment. American Fisheries Society Special Publication 33. 208 pp.

This book is the most comprehensive source of information on bighead, silver, and large-scale silver carps in any language, and is considered the definitive text on these species. In addition to being a thorough review of the Asian carp literature and a comprehensive risk assessment for bigheaded carps in North America, it also contains substantial results from my research and field observations of Asian carps. I was the only one of the authors with substantial experience working directly with these fishes, I contributed strongly to the drafting and editing of all the chapters, but I drafted nearly all the original text for chapters 3,5, 9, and 11, with Chapter 5 (Biology and Natural History of Bighead Carp) and Chapter 6 (Biology and Natural History of Silver Carp) being the largest and most centrally important chapters to the biosynopsis. I did not provide the first draft of Chapter 6, but it was patterned after my Chapter 5, used much of the same information, and I assisted strongly with editing that chapter. In addition, because of other demands on the first author at that time, I took charge of answering the reviews and editing the book after the book was sent out for peer review.

20. REFERENCES FOR DUANE CHAPMAN

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EDUCATION

M.Sc. Zoology (1996). Southern Illinois University, Carbondale, IL.

B.A. Zoology (1992). Southern Illinois University, Carbondale, IL.

EXPERIENCE

Fish and Wildlife Biologist, U.S. Fish and Wildlife Service, Large Rivers Fisheries Coordination Office, Midwest Region

Coordinator, Mississippi Interstate Cooperative Resource Association

Assistant Project Leader, U.S. Fish and Wildlife Service, Carterville Fish and Wildlife Coordination Office, Midwest Region

Chair, Asian Carp Working Group, Aquatic Nuisance Species Task Force

Fishery Biologist, U.S. Fish and Wildlife Service, Carterville Fish and Wildlife Coordination Office, Midwest Region

INVITED PRESENTATIONS

Conover, G.A. Management and control of Asian Carps. Joint meeting of the Great Lakes and Mississippi River Basin Panels on Aquatic Nuisance Species, Milwaukee, Wisconsin, June 17-19, 2008.

Conover, G.A. Management and control of Asian carps in the United States. 2007 Governors Conference on the Management of the Illinois River System, Peoria, Illinois, October 2-4, 2007.

Conover, G.A. Management and control of Asian carps in the United States. Middle Mississippi River Partnership 2007 Summer Meeting, Cape Girardeau, Missouri, July 11, 2007.

Conover, G.A. Management and control of Asian carps in the United States. 2007 Great Lakes Biennial Meeting and Conference, Chicago, Illinois, June 6-8, 2007.

Conover, G.A. Asian carp management and control plan. Biology and Management of the Common Carp, Bloomington, Minnesota, October 6, 2006.

Conover, G.A. A national strategy for the management and control of Asian carps in the United States. The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem, Peoria, Illinois, August 22-23, 2006.

Conover, G.A. A national strategy for the management of grass carp in the United States. 66th Annual Midwest Fish & Wildlife Conference, Grand Rapids, Michigan. December 11-14, 2005.

Conover, G.A. Development of a national Asian carp management plan. 2005 Southern Division American Fisheries Society Spring Meeting, Virginia Beach, Virginia. February 10-13, 2005.

Conover, G.A. Development of a national management and control plan for Asian carp. Aquaculture America, World Aquaculture Society, New Orleans, Louisiana, January 17-20, 2005.

Conover, G.A. Development of a Management and Control Plan for Asian Carp. Aquatic Nuisance Species Task Force, Arlington, Virginia, November 4-5, 2003.

Conover, G.A. The U.S. Fish & Wildlife Service Triploid Grass Carp Inspection and Certification Program. Managing Fish in Wetlands, Minneapolis, Minnesota, February 27, 2001.

Conover, G.A., J.M. Grady, and C.J. Surprenant. MICRA national cooperative paddlefish research in the Ohio River. 60th Midwest Fish and Wildlife Conference, Cincinnati, Ohio, December 6-9, 1998.

SELECTED PRESENTATIONS

Conover, G.A. Draft management and control plan for Asian carps in the United States. 67th Annual Midwest Fish & Wildlife Conference, Omaha, Nebraska. December 3-6, 2006.

Conover, G.A. Management and Control Plan for Asian Carps in the United States. 66th Annual Midwest Fish & Wildlife Conference, Grand Rapids, Michigan. December 11-14, 2005.

Conover, G.A. Development of a national management and control plan for Asian carp. 134th Annual Meeting of the American Fisheries Society, Madison, Wisconsin, August 22-26, 2004.

Conover, G.A. and N.M. Caswell. Evaluations of the fisheries response to dredge material placement in the Upper Mississippi and Illinois Rivers. 41st Annual Meeting of the Illinois Chapter of the American Fisheries Society, Ina, Illinois, March 4-6, 2003.

Conover, G.A. and J.M. Grady. Movements of Coded-Wire Tagged Paddlefish in the Mississippi River Basin. 61st Midwest Fish & Wildlife Conference, Chicago, Illinois, December 5-8, 1999.

Conover, G.A., N.P. Brennan, J.M. Grady, and P.W. Bettoli. Establishment and management of a multi-agency, coded-wire tag paddlefish database for the Mississippi River Basin. 128th Annual Meeting of the American Fisheries Society, Hartford, Connecticut, August 23-27, 1998.

Conover, G.A. and R.J. Sheehan. Fin-clip, freeze-brand, or oxytetracycline marks: Which is the best choice? 34th Annual Meeting of the Illinois Chapter of the American Fisheries Society, Chicago, Illinois, March 5-7, 1996. *Lewis L. Osborne Best Student Paper Award*.

Conover, G.A. and R.J. Sheehan. Fin-clip, freeze-brand, or oxytetracycline marks: Which is the best choice? 57th Midwest Fish and Wildlife Conference, Detroit, Michigan, December 3-5, 1995.

SELECTED PUBLICATIONS AND REPORTS

Conover, G.A. and R. J. Sheehan. 1999. Survival, growth, and mark retention in juvenile black crappies marked with fin clips, freeze brands, or oxytetracycline. *North American Journal of Fisheries Management* 19:824-827.

Conover, G.A. and R.J. Sheehan. 1996. Evaluation of oxytetracycline marks on sagittal otoliths of black crappie. *North American Journal of Fisheries Management* 16:686-688.

Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass, and silver carps in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force, Washington, DC.

Caswell, N., C. Wrasse, and **G. Conover**. 2004. Evaluation of fisheries response to dredged material placement at Senate Island (IWW RM 130.0 - 133.1 L) and Hogback Island/Long Island (UMR RM 331.7 - 333.5 L) - Year 3. United States Fish and Wildlife Service, Carterville Fishery Resources Office, 9053 Route 148, Marion, IL 62959. 158pp +appendices.

Caswell, N., **G. Conover**, C. Wrasse, and C. Hilliard. 2003. 2002 Annual Report: Evaluation of fisheries response to dredged material placement at Senate Island (IWW RM 130.0 - 133.1 L) and Hogback Island/Long Island (UMR RM 331.7 - 333.5 L) - Year 2. United States Fish and Wildlife Service, Carterville Fishery Resources Office, 9053 Route 148, Marion, IL 62959. 224pp +appendices.

Conover G.A., L.J. Pitcher, M. Thomas, C. Hilliard, A. Plauk, and C. Wrasse. 2002. Evaluation of fisheries community response to dredged material placement at Senate Island (IWW River Mile 130.0 - 133.1 L) and Hogback Island/Long Island (UMR River Mile 331.7 - 333.5 L) - Year 1. United States Fish and Wildlife Service, Carterville Fishery Resources Office, 9053 Route 148, Marion, IL 62959. 105pp +appendices.

Conover, G.A. and J.M. Grady. 2000. Mississippi River Basin paddlefish research coded-wire tagging project 1998 annual report. Mississippi Interstate Cooperative Research Association, P.O. Box 774, Bettendorf, IA 52722. 33pp.

Stinson, C.W., **G.A. Conover**, and M.L. Thomas. 2000. Biological assessment of the fish and mussel fauna of the Kankakee River Basin. United States Fish and Wildlife Service, Carterville Fishery Resources Office, 9053 Route 148, Marion, IL 62959. 34pp.

Sheehan, R.J., R.C. Heidinger, P.S. Wills, M.A. Schmidt, **G.A. Conover**, K.L. Hurley. 1999. Guide to the Pallid Sturgeon Shovelnose Sturgeon Character Index (CI) and Morphometric Character Index (mCI). SIUC Fisheries Bulletin No. 14. Fisheries Research Laboratory, Southern Illinois University, Carbondale, Illinois 62901-6511. 16pp

Grady, J.M. and **G.A. Conover**. 1998. Mississippi River Basin paddlefish research coded-wire tagging project 1997 annual report. Mississippi Interstate Cooperative Resource Association, P.O. Box 774, Bettendorf, IA 52722.

Shasteen, S.P., C.J. Surprenant, and **G.A. Conover**. 1996. Age, growth, and catch analysis of paddlefish in Swan Lake of the Illinois River. United States Fish and Wildlife Service, Carterville Fishery Resources Office, 9053 Route 148, Marion, IL 62959. 21pp.

PROFESSIONAL MEMBERSHIPS

Illinois Chapter, American Fisheries Society

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EDUCATION

B.A. Biology (1987). Northland College, Duluth, MN.

EXPERIENCE

October Aquatic Nuisance Species Program Manager at Illinois Department of Natural Resources (IDNR) 2010-present

1991- Large River Ecologist, Illinois Natural History Survey/University of Illinois October 2010

As the Program Manager for Aquatic Nuisance Species (ANS) and Aquaculture Kevin has a wide a variable course of duties. As the lead for Asian carp work in Illinois, he oversee the Illinois contributions to the Asian Carp Regional Coordinating Committee (ACRCC) where multiple federal and state agencies collaborate to bring the best solutions to control and management of Asian carp with the overall directive to keep reproducing populations of Asian carp from Lake Michigan, and thus the Great Lakes Basin. Additionally, he serves as co-chair of the AIS Task force for Council of Great Lakes Governors (and Premiers), representative of the Midwest Governors Association, Illinois representative on the Mississippi, and Great Lakes panels on ANS. In addition to carp work, Kevin strives to support relevant management and policy in regards to other ANS. Aquaculture duties revolve around permits and policy to maintain healthy Illinois aquatic life. Prior to coming to the IDNR, his responsibilities were as a large river ecologist at the Illinois Natural History Survey's Illinois River Biological Station as well as a fisheries specialist for the Long-Term Resource Monitoring Program. He has worked at the Survey's Illinois River Biological Station, in Havana, Illinois, from 1991 until 2010. Over these years Kevin's research has focused on the strengths of the LTRMP to answer research questions as well topics of invasive species in the Illinois River. These invasives include: white perch *Morone americana*, round goby *Neogobius melanostomus*, and Asian carp species (bighead carp *Hypophthalmichthys nobilis*, silver carp *Hypophthalmichthys molitrix*, and grass carp *Ctenopharyngodon idella*). In addition to the day to day monitoring on large rivers, my research has focused on largemouth bass population dynamics, winter habitat preference, and age and growth of several riverine species. He also provides much of the GIS support for the field station; which includes development of a decision-support system

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ACADEMIC POSITIONS:

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EDUCATION:

University of Notre Dame, Department of Biological Sciences, Notre Dame, IN, USA
Dissertation: *Ecological and Bioeconomic Risk Assessment for Invasive Species* (Ph.D. October 2006)
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Monash University, Melbourne, Australia
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Honors thesis: *An Experimental Study of the Ecological Effects of the Introduced Freshwater Fish Oriental Weatherloach* (*Misgurnus anguillicaudatus*).
Advisor Prof. P.S. (Sam) Lake.

EDITED VOLUMES:

Keller RP, M Cadotte & G Sandiford. 2015. *Invasive Species in a Globalized World: Ecological, Social, and Legal Perspectives on Policy*. University of Chicago Press.

Keller RP, DM Lodge, M Lewis & J Shogren. 2009. *Bioeconomics of Invasive Species: Integrating Ecology, Economics, Policy and Management*. Oxford University Press.

PEER REVIEWED PUBLICATIONS (* = student):

Howeth JG, CA Gantz, PL Angermeier, EA Frimpong, MH Hoff, **RP Keller**, NE Mandrak, MP Marchetti, JD Olden, CM Romagosa & DM Lodge. *In Press*. Predicting invasiveness of species in trade: climate match, trophic guild, and fecundity influence invasive success of nonnative freshwater fish. *Diversity and Distributions*.

Springborn MR, **RP Keller**, S Elwood, CR Romagosa, C Zambrana-Torrel, & P Daszak. 2015. Integrating risk assessment for invasion and disease risk in live animal trade. *Diversity and Distributions*. DOI: 10.1111/ddi.12281

- Gantz CA, DR Gordon, CL Jerde, **RP Keller**, WL Chadderton, PD Champion, & DM Lodge. 2015. Managing the introduction and spread of non-native aquatic plants in the Great Lakes: a regional risk assessment approach. *Management of Biological Invasions* 6:45-55.
- Keller RP**, MW Cadotte, & G Sandiford. 2015. Working across disciplines to understand and manage invasive species. Peer reviewed book chapter in Keller et al. volume *Invasive Species in a Globalized World*.
- Sandiford G, **RP Keller**, & MW Cadotte. 2015. Final Thoughts: Nature and Human Nature. Peer reviewed book chapter in Keller et al. volume *Invasive Species in a Globalized World*.
- Wittman ME, CL Jerde, JG Howeth, SP Maher, AM Deines, JA Jenkins, GW Whitedge, SR Burbank, WL Chadderton, AR Mahon, JT Tyson, CA Gantz, **RP Keller**, JM Drake, & DM Lodge. 2014. Grass carp in the Great Lakes region: Expert perception of ecological risk, potential for establishment, and re-evaluation of experimental evidence on ecological impact. *Canadian Journal of Fisheries and Aquatic Sciences* 71:992-999.
- Xu J, TL Wickramaratne, NV Chawla, EK Grey, K Steinhäuser, **RP Keller**, JM Drake & DM Lodge. 2014. Improving management of aquatic invasions by integrating shipping network, ecological, and environmental data: data mining for social good. *KDD Data Mining Proceedings*. DOI: 10.1145/2623330.2623364.
- Keller RP** and M Springborn. 2014. Closing the screen door to new invasions. *Conservation Letters* 7:285-292. DOI: 10.1111/conl.12071
- Nghiem, L.T.P., T. Soliman, D.C.J. Yeo, H.T.W. Tan, T.A. Evans, J.D. Mumford, **R.P. Keller**, R.H.A. Baker, R.T. Corlett, and L.R. Carrasco. 2013. Economic and environmental impacts of harmful non-indigenous species in Southeast Asia. *Public Library of Science ONE* 8(8):e71255. doi:10.1371/journal.pone.0071255
- Gordon GR, CA Gantz, CL Jerde, WL Chadderton, **RP Keller**, PD Champion. 2012. Weed risk assessment for aquatic plants: modification of a New Zealand system for the United States. *Public Library of Science ONE* 7(7): e40031. doi:10.1371/journal.pone.0040031
- Keller RP** & C Perrings. 2011. International policy options for reducing the environmental impacts of invasive species. *BioScience* 61:1005-1012.
- Springborn M, CM Romagosa & **RP Keller**. 2011. The value of nonindigenous species risk assessment in international trade. *Ecological Economics*. 70:2145-2153.
- Keller RP**, J Geist, JM Jeschke & I Kühn. 2011. Invasive species in Europe: ecology, status and policy. *Environmental Sciences Europe* 23:23.
- Keller RP**, D Kocev* & S Džeroski. 2011. Trait-based risk assessment for invasive species: high performance across diverse taxonomic groups, geographic ranges and machine learning/statistical tools. *Diversity and Distributions*. 17:451-461.
- Keller RP**, JM Drake, M Drew & DM Lodge. 2011. Linking Environmental Conditions and Ship Movements to Estimate Invasive Species Transport Across the Global Shipping Network. *Diversity and Distributions* 17:93-102.
- Keller RP** & DM Lodge. 2010. Prevention: designing and implementing national policy and management programs to reduce the risks from invasive species. *In* Perrings C, M Williamson & M Lonsdale (editors). *Bioinvasions and Globalization*. Oxford University Press.
- Keller RP**, PSE zu Ermgassen* & D Aldridge. 2009. Vectors and timing of nonindigenous freshwater species establishment in Great Britain. *Conservation Biology* 23:1526-1534.
- Keller RP** & JM Drake. 2009. Trait based risk assessment for invasive species. *In* Keller RP, DM Lodge, MA Lewis & JF Shogren (editors). *Bioeconomics of Invasive Species: Integrating Ecology, Economics, Policy and Management*. Oxford University Press.
- Keller RP**, DM Lodge, M Lewis, J Shogren & M Krkosek*. 2009. Putting bioeconomic research into practice. *In* Keller RP, DM Lodge, MA Lewis & JF Shogren (editors) *Bioeconomics of Invasive Species: Integrating Ecology, Economics, Policy and Management*. Oxford University Press.

- Lodge DM, M Lewis, J Shogren & **RP Keller**. 2009. Introduction to biological invasions: biological, economic and social perspectives. *In* Keller RP, DM Lodge, MA Lewis & JF Shogren (editors) *Bioeconomics of Invasive Species: Integrating Ecology, Economics, Policy and Management*. Oxford University Press.
- Bampfylde C, A Bobeldyk*, JA Murray*, K Drury, **RP Keller**, C McIntosh. 2009. Interactions between theoreticians and empiricists: rusty crayfish as a case-study. *In* Keller RP, DM Lodge, MA Lewis & JF Shogren (editors). *Bioeconomics of Invasive Species: Integrating Ecology, Economics, Policy and Management*. Oxford University Press.
- Keller RP** & DM Lodge. 2009. Invasive Species. *In* GE Likens (editor). *Encyclopedia of Freshwaters*. Elsevier, Oxford, UK.
- Keller RP**, K Frang* & DM Lodge. 2008. Preventing the spread of invasive species: intervention guided by ecological predictions leads to economic benefits. *Conservation Biology* 22:80-88.
- Keller RP**, DM Lodge & DC Finnoff. 2007. Risk assessment for invasive species produces net bioeconomic benefits. *Proceedings of the National Academy of Sciences USA* 104:203-207.
- Keller RP** & DM Lodge. 2007. Species invasions from commerce in live aquatic organisms – problems and possible solutions. *BioScience* 57:428-436.
- Keller RP**, JM Drake & DM Lodge. 2007. Fecundity as a basis for risk assessment of nonindigenous molluscs. *Conservation Biology* 21:191-200. **Keller RP** & PS Lake. 2007. Potential impacts of a recent and rapidly spreading colonizer of Australian freshwaters: Oriental weatherloach (*Misgurnus anguillicaudatus*). *Ecology of Freshwater Fish* 16:124-132.
- Keller RP**, C VanLoon, AN Cox, DM Lodge, L-M Herborg & J Rothlisberger. 2007. From bait shops to the forest floor: earthworm use, transport and disposal by anglers. *American Midland Naturalist* 158:321-328.
- Loo SE, **RP Keller** & B Leung. 2007. Freshwater invasions: using historical data to analyze spread. *Diversity and Distributions* 13:23-32.
- Bossenbroek JM, J McNulty & **RP Keller**. 2005. Can ecologists heat up the discussion on invasive species risk? *Risk Analysis* 25:1595-1597.

PUBLICATIONS IN REVIEW:

- Keller RP** & A Masoodi. Saving Kashmir's Wular Lake from invasive aquatic plants. In review at *BioScience*.

PUBLICATIONS IN PREPARATION:

- Keller RP**, J Deines* & DM Lodge. High accuracy of rapid risk assessment for fish introductions to the United States. For submission to *Biological Invasions*.
- Keller RP** & R Thomas*. Differential impacts of invasive species on human welfare in developed and developing countries. For submission to *Conservation Biology*.
- Grey EK, **RP Keller**, C. Gantz & D.M. Lodge. Predicting the establishment and impact risk of non-native crayfish. For submission to *Fisheries*.
- Jacobs A* & **RP Keller**. History and future of aquatic invasions in Illinois. For submission to *Biological Invasions*.
- Jacobs A* & **RP Keller**. Correlates of invasive aquatic species spread in Illinois. For submission to *Journal of the Illinois Academy of Science*.
- Scheiwiller K* & **RP Keller**. Historical patterns of zebra mussel spread across inland waterways in the Great Lakes Basin. For submission to *Diversity and Distributions*.

OTHER PUBLICATIONS (SELECTED):

- Keller RP** & M Springborn. 2011. Long-term correlations in European socioeconomic conditions create a bias to conclusion that an invasion debt occurs. *Proceedings of the National Academy of Sciences* 108:E220 (letter to editor).
- Keller RP**. Chicago River is due for a change. *Commentary* article in Chicago Tribune, 1 September 2010, p. 40.
- Keller RP** & C Perrings. 2010. International policy options to reduce the harmful impacts of invasive alien species. *Commissioned report for United Nations Environment Program*.
- Keller RP**. 2007. Trade in live aquatic organisms. *Lakeline* Fall 2007:30-31 (review article in lake management publication).
- Harris J, L Bowling, **RP Keller**, RJ Keller, J Kress, PS Lake & DC McPhail. 2006. The Tooma River project – interdisciplinary probes into ill-defined and unpredictable contamination. Technical Report. CRC for Freshwater Ecology, Canberra (Australia).
- Keller RP** & DM Lodge. 2005. Probability of nonindigenous seafood species becoming established. *Conservation Biology* 19:287-288 (letter to editor).
- Drake JM & **RP Keller**. 2004. Environmental justice alert: do developing nations bear the burden of risk for invasive species? *BioScience* 54:718-719 (op-ed).

INVITED ORAL PRESENTATIONS (SELECTED):

- Keller, RP**. January 30, 2015. Preventing the Arrival of Invasive Species: From Models to Policy. Invited department seminar at the University of Adelaide's Environment Institute (Adelaide, Australia).
- Keller RP**. October 3, 2014. Risk Assessment for Invasive Species in the Great Lakes. 20 minute presentation via Webinar as part of a session co-organized by the Environmental Law Institute and the National Invasive Species Council. 235 people from across the US and Canada registered for the Webinar.
- Keller RP**. September 24, 2014. Differential Impacts of Invasive Species in Developing and Developed Countries, *and* Economic Outcomes From Applying Risk Assessment for Invasive Species. One hour presentation via Skype to the EU funded COST Workshop on the Socio-Economic Impacts of Invasive Species, held in Cyprus. I was invited as an international participant but was not able to attend. I was then asked to present my results from these two projects to the group, which I was able to do.
- Keller RP**. September 19, 2014. Preventing Invasions from Trade in Live Aquatic Organisms. One hour presentation to invasive species managers and policy makers from across the Great Lakes Basin. Shedd Aquarium, Chicago.
- Keller RP**. June 3, 2014. Preventing invasions from trade in live aquatic organisms. Invited presentation at BIOTIC conference on trade and invasive species in the Great Lakes. University of Wisconsin, Milwaukee.
- Keller RP**. October 15, 2013. Invasive species in the Great Lakes, and what we can do to prevent them. Invited Keynote presentation at the *Second Annual Sheinboks Lecture and Scholars Awards*. Chicago State University.
- Keller RP**. July 2012. Reducing the economic and ecological risks from invasive species. Invited Keynote presentation to the Invasive Species Working Group of the Pacific Northwest Economic Region Annual Meeting. Saskatoon, Canada.
- Keller RP**, D Kocov & S Džeroski. August 2011. Trait-based risk assessment for invasive species: high performance across diverse taxonomic groups, geographic ranges and machine learning/statistical tools. Ecological Society of America. Austin, Texas, USA.
- Keller RP**. October 6, 2010. Community ecology in a globalized world: invasive species, economics and the future of the Great Lakes. Departmental Seminar, Department of Biology, Loyola University.
- Keller RP**. June 2010. Bioeconomics of invasive species. 16th Annual German-American Frontiers of Science Symposium (organized and funded by the National Academies of Science). Potsdam, Germany.

- Keller RP**, April 2009. Global shipping networks drive changing risks of invasion. Odum Conference, Understanding and Managing Biological Invasions as Dynamic Processes. Rensselaerville Institute, New York, USA.
- Keller RP**, JM Drake, M Drew & D Lodge. April 2009. Predicting future Great Lakes invaders: global datasets of shipping traffic and environmental conditions identify high-risk shipping routes. International Conference on Aquatic Invasive Species. Montreal, Canada.
- Keller RP**, K Frang & DM Lodge. December 2008. Risks and bio-economic impacts associated with movement of live bait. Midwest Fish and Wildlife Conference. Columbus, Ohio, USA.
- Keller RP**, J Rothlisberger, WL Chadderton & DM Lodge. October 2008. Prevention strategies for limiting the spread of aquatic invasive species by recreational boaters. Natural Areas Association annual meeting. Nashville, Tennessee, USA.
- Keller RP**, PSE zu Ermgassen & D Aldridge. 2007. The history and future of freshwater invasions in Great Britain. London Freshwater Group Spring 2007 meeting. Linnean Society, London, UK.
- Keller RP**, DM Lodge, K Frang & DC Finnoff. 2007. Ecological and economic theory in analyzing risk in biological invasions. Symposium presentation at Ecological Society of America annual meeting, San Jose, CA, USA.

OTHER RECENT PRESENTATIONS (SELECTED):

- Keller RP**, E Cole* and K Garbach. May 18, 2015. Outreach to Prevent Spread of Invasive Species: Tracing Messages to Action. Oral presentation at Society of Freshwater Science annual meeting in Milwaukee, WI.
- Cole E*, K Garbach & **RP Keller**. August 11, 2015. Assessing outreach efforts to recreational boaters as a means to reduce spread of aquatic invasive species. Oral presentation at Ecological Society of America annual meeting. Baltimore, USA.
- Keller RP** & C Gantz. August 15, 2014. Cost and Consistency of Different Approaches to Risk Assessment for Invasive Species. Presentation at Ecological Society of America Annual Meeting, Sacramento, California.

TEACHING

Professor, Loyola University Chicago

Fall 2011-present

- Developed and taught: *Environmental Sustainability* (Fall 2011 & Spring 2012)
- Developed and taught: *Honors, Science and Society* (Fall 2011, 2012, 2013, 2014, Spring 2012, 2013)
 - Each of these sections satisfied the LUC requirement for students to take an ‘engaged learning’ course. This required me to work with students to develop large projects, outside of class. A number of these are detailed in the following section (*Student Engagement*).
- Developed and taught: *The Scientific Basis of Environmental Issues* (Fall 2012 – Fall 2015)
- Developed and taught capstone class for Environmental Science majors (Fall 2015)

Lecturer, University of Chicago

Fall 2009-present

- Developed and taught: *Human Impacts on the Global Environment* (Fall 2009 and 2010)
- Developed and taught: *Freshwater ecosystems of the Calumet region* (Spring 2010 & 2011)

Teaching Fellow, University of Notre Dame

Fall 2007

- Taught upper level *General Ecology* with Prof. Jennifer Tank.

Laboratory course coordinator, University of Notre Dame

Spring 2006

- Wrote labs for upper level *Biostatistics* lab course and coordinated 10 teaching assistants.

- Taught upper level *Biostatistics* lab course section

STUDENT ENGAGEMENT

- During my time at Loyola University I have had both formal and informal opportunities to encourage student projects that engage with the community. Many of these have been through the *Engaged Learning* sections that I have taught. Three representative projects (out of >20 completed or underway) are:
 - *Student Operation for Avian Relief (SOAR)*: I worked with students in Spring 2012 to investigate the problems of migratory bird deaths resulting from window collisions on campus. The project has continued to the present, and involves students searching campus before dawn every morning to locate dead and injured birds. Injured birds are transported to a sanctuary for rehabilitation. Dead birds are identified and transferred to the Field Museum where they become part of their collection. Working with external bird experts and LUC facilities we have made two of the most dangerous buildings on campus safe by having blinds closed. We are continuing to work to make other buildings more safe. Students have been leaders in this project throughout, from collecting birds, liaising with the Field Museum and other science partners, to developing multilingual outreach posters to thank and inform LUC housekeeping staff about the project and why they are asked to close blinds. Students working on this project were awarded the 2014 *Community Engagement Award for Innovation in Sustainability* by the Loyola University Research Opportunities Program. Additionally, I was awarded Chicago Audubon Society's 2015 *Protector of the Environment* award for the work done to reduce bird deaths.
 - *Invasive Species and Environmental Justice*: This continuing project with undergraduate students has investigated the impacts of invasive species on human welfare and environmental justice. Four undergraduates have now worked on this project, and we have an active collaboration with an academic in Kashmir, India, where we are investigating some recent invasions and their impacts on fisheries, water availability, and poverty. Undergraduate Reana Thomas was awarded a fellowship by the *Pulitzer Center on Crisis Reporting*. This funded her to travel to Kashmir to investigate and write about these issues. Her work is published at: <http://pulitzercenter.org/people/reana-thomas>
 - My students worked with an after school program affiliated with Gale Elementary School to develop curriculum for growing vegetables in the school's greenhouse. The greenhouse was otherwise underused, and the curriculum developed enabled the program to easily leverage the resources available. The class lessons were given in both paper form and in videos created by the students, and included a visit to Loyola's urban gardens by Gale Elementary students.

MENTORING

- Three undergraduate students (Trent Henry, Abby Jahn, Gabrielle Habeeb) are conducting research in my lab during academic year 2015-16. Henry & Jahn have LUROP Mulcahy Fellowships
Aug 2015 - present
- Undergraduates Trent Henry, Gabrielle Habeeb, and Jon Brenner worked with me over summer 2015 sampling aquatic invertebrates from the Chicago River and Lake Michigan. Henry had a LUROP Provost Fellowship.
May 2015 - present
- Masters student Ellen Cole. Cole has presented at regional and national meetings Aug 2013 - present
- Masters student Abigail Jacobs. Jacobs has presented at local, national and international meetings, and defended in October 2014. We are working on two publications. Aug 2012 – October 2014
- Undergraduate Kevin Scheiwiller looked at the history of spread of zebra mussel across the Great Lakes region. He was supported by a LUROP Mulcahy Fellowship. We are currently working to finalize a manuscript.
Aug 2013 – present

- Mentored several undergraduate students looking at the international environmental justice issues presented by invasive species, Loyola University Chicago. One of these students was Reana Thomas who worked with the project for five semesters. She and I successfully applied for a fellowship from the *Pulitzer Center on Crisis Reporting*. This funded Reana to visit Kashmir, India, during summer 2014 to interview scientists, policy-makers, and water users, about the effects of invasive plants in Wular Lake. Her journalism is published at: <http://pulitzercenter.org/people/reana-thomas>

Jan 2012 – Dec 2014

- Mentored undergraduate project titled *Impacts of Invasive Plants in the United States, and Adequacy of the Federal Response*, University of Chicago
Aug. 2010 - present
- Mentored NSF Research Experience for Teachers fellow Summer 2005 (co-author Frang on Keller et al. 2008)
- Mentored NSF Research Experience for Undergraduates student Summer 2004
- Undergraduate research students (>5) during graduate and post-doc career 2001-2009

GRANT WRITING:

- **RP Keller.** Assessing Current Invasion Risks to the Southern Basin of Lake Michigan and Developing Early Detection and Rapid Response Guidelines to Address Future Risks. May 2015. Submitted to combined US-EPA/USFWS Great Lakes Restoration Initiative RFP in conjunction with IL DNR. Total request of \$111,925. Fully funded.
- **RP Keller.** Integrating Climate Change Predictions and Aquatic Invasive Species Risk Assessment for the Great Lakes. May 2015. Submitted to combined US-EPA/USFWS Great Lakes Restoration Initiative RFP in conjunction with IL DNR. Total request of \$98,843. Fully funded.
- **RP Keller** (lead PI) & J Bossenbroek (Co PI, University of Toledo). May 2015. Determining the Potential of Recreational Boats to Vector Invasive Species Throughout the Great Lakes. Submitted to combined US-EPA/USFWS Great Lakes Restoration Initiative RFP in conjunction with IL DNR. Total request of \$215,143 (\$96,235 of this to U Toledo as a sub-contract). Not funded.
- **RP Keller.** April 2014. Distribution of Native and Invasive Crayfish in the Chicago Area Waterways System and Near Shore Lake Michigan. Submitted to IL Department of Natural Resources. Total request of \$15,689.97. Fully funded.
- **RP Keller.** April 2015. Assessing the Distribution of *Apocorophium lacustre* in the Chicago Area Waterway System. Submitted to IL Department of Natural Resources. Total request of \$23,532.07. Fully funded.
- **RP Keller.** January 2015. Monitoring And Control Strategies To Respond To Growing Threats From Invasive Species In The Southern Basin Of Lake Michigan. Submitted to IL-IN SeaGrant with a total budget of \$121,781. Not funded.
- **RP Keller.** October 24, 2014. Mapping location, spread, and impacts of invasive species in the Chicago Region. Submission to Illinois Department of Natural Resources 2014 State Wildlife Grant Pre-Proposal. Total budget request \$91,376. Not funded.
- Sabo, A & **RP Keller.** November 3, 2014. Assisted tree migration risks, feasibility and implementation guidance: an evaluation of species ecology, landscape structure, and partners. Proposal submitted to SESYNC for Autumn Sabo to be a resident post-doc at SESYNC, with RP Keller acting as mentor. Total budget to Loyola, if funded, would be two months of summer salary for Keller, and travel funds. Not funded.
- **Keller RP & K Garbach** (co-PIs) (July 2013). *Outreach to Address AIS in Illinois: Tracing Outreach Messages*. Submission to Illinois Department of Natural Resources, as a sub-contract through Illinois Natural History Survey. Total budget request: \$101,789. Duration: August 31, 2013 – December 31, 2015. Status: fully funded.

- **Keller RP** (sole PI). 2012-2014. Invasive Aquatic Species in Illinois: Inventory Species and Update State Management Plan. Proposal to Illinois Department of Natural Resources. Fully funded for \$82,000.
- **Keller RP (PI), T Hoellein, J Kelly, C Peterson, T Hoang, C Putonti, D Treering (March 2012).** The Effects of Spatial and Temporal Variation of Measured Abiotic and Biotic Attributes on Ecosystem Health in the Chicago Area Waterways System: Building the Foundation for Scientific Inquiry. Submission to Loyola University Chicago internal grant program “Stimulating Multidisciplinary Research at Loyola’s Lakeside Campuses”. Funded at \$20,000.
- CL Jerde (lead PI) & **RP Keller**, DM Lodge, A Mahon, C Knapp (co-PIs). 2012. Invasive Species Surveillance of the Bait Trade. Proposal to US EPA. Status: Fully funded for \$273,309.
- K Bertrand (lead PI), **RP Keller** and 13 others (co-PIs). Cross-cultural analysis of the biological and social consequences of hybridization: lessons from Asian carp. Pre-proposal submitted to NSF with a total estimated budget of \$4.4million. Not successful.
- Lead author of *Preventing Invasions from Trade in Live Aquatic Organisms*, submitted to EPA in January 2010. Proposal successful and fully funded at \$997,364.
- Lead author of *Risk Assessment Framework for Invasive Freshwater Animals*, submitted to USGS in August 2009. Proposal successful and fully funded at \$50,000.
- Successful application to Program on the Global Environment (University of Chicago) competition for funds to support undergraduate research. \$2,500 for academic year 2010-11.
- Co-author of funding proposals to National Science Foundation (3), US Environmental Protection Agency, National Oceanic and Atmospheric Administration (3), National Center for Ecological Analysis and Synthesis (2), Great Lakes Commission.

ACADEMIC SERVICE:

- **Proposed and organized** session at the biennial *Chicago Wilderness Congress* (organized by Chicago Wilderness, November 15th, 2012) titled “Reimagining the Chicago and Calumet Rivers for the 21st Century and Beyond”. The session included four presentations; myself, Debra Shore (elected Commissioner for the Metropolitan Water Reclamation District of Greater Chicago), David St. Pierre (Executive Director of the MWRD), and Josh Ellis (Program Director at the Metropolitan Planning Council). The session was a great success with >200 attendees.
- **Proposed and organized** session at the June 2013 International Association of Great Lakes Research conference, held at Purdue University.
- **Organized** *Invasive Species in a Globalized World* Conference, May 2011. This brought researchers together from a range of disciplines, and from across the globe.
- **Associate editor** for journal *Diversity and Distributions*. July 2010 – December 2015.
- **Reviewer** for *PNAS*, *Conservation Biology*, *Frontiers in Ecology and the Environment*, *BioScience*, *Diversity and Distributions*, *Ecological Applications*, *Methods in Ecology and Evolution*, *Oikos*, *Limnology and Oceanography*, *Journal of Environmental Management*, *Ecological Economics*, *Biological Invasions*, *American Malacological Bulletin*, *International Journal of Biodiversity Science and Management*, *Limnologica*, and many other journals. *Book proposals Oxford University and Springer Presses*.
- **Co-organizer** of Midwest Ecology and Evolution Conference, 2004.

OUTREACH:

Keller RP. October 3, 2014. Risk Assessment for Invasive Species in the Great Lakes. 20 minute presentation via Webinar as part of a session co-organized by the Environmental Law Institute and the National Invasive Species Council. 235 people from across the US and Canada registered for the Webinar.

Keller RP. 20 June, 2012. Economic and Environmental Benefits from Risk Assessment for Invasive Species. Presentation given as part of a Congressional Briefing held in the House Office Building, Washington DC.

Keller RP. 1 November, 2011. Economic and Environmental Benefits of Risk Assessment for Invasive Species. Presentation given as part of a Congressional Briefing, sponsored by Great Lakes United and the Northeast Midwest Institute, in the Senate Building, Washington DC.

Lessons from the Gulf Oil Spill

November 3, 2010

- Organized public event at Shedd Aquarium, Chicago, with three expert speakers.

Asian carp invasion: potential economic and ecological impacts in the Great Lakes

April 6, 2010

- Organized public event at Shedd Aquarium, Chicago, with five expert speakers.

Developing aquatic species risk assessment tools for U.S. National Invasive Species Council

- Working with Risk Assessment Working Group to update tools

September 2009 – March 2011

Advisor to City of Chicago program on invasive species

2006-present

- Advised City as to which species should be banned from sale (many of these species identified through research reported in Keller & Lodge 2007).
- Presented expert testimony at City Council meeting in support of new invasive species ordinance (ordinance passed).

Member of Indiana Department of Natural Resources working group on risk assessment for aquatic invasive plants

2007-present

- Developed risk assessment tool for predicting which aquatic plant species proposed for trade are likely to cause harm. Tool is now being used for state policy.

WORKING GROUP AND POLICY REVIEW GROUP MEMBERSHIP:

Invited participant in Commonwealth Scientific and Industrial Research Organization (CSIRO, Australia) expert elicitation on Invasion Risk from Global Shipping and biofouling. Consisted of me working through and ranking risk for different shipping scenarios, and two hours of followup phone calls with the full expert group. Five experts were chosen from North America. March – May, 2015.

Member expert peer review panel for Canada's proposed National Biological Risk Assessment Guidelines, June 2008.

Invited participant at *Ecological and Economic Science and Management of Invasive Species*. Workshop to develop recommendations for COP9 of Convention on Biological Diversity, October 2007.

Member *Machine Learning Tools for Ecology* working group. Funded by National Center for Ecological Analysis and Synthesis, 2006-2008.

UNIVERSITY SERVICE:

- Member of University's Academic Council, 2014-16.
- Member of Institute of Environmental Sustainability Masters Degree committee, and IES Academic Council.
- Developed new B.S. in Environmental Science concentration in *Concentration and Restoration*. This included developing several new courses.
- Prepared and presented University Seminar *Living on the Roof of the World: Relationships between Humans and the Environment in Tibet* as part of Loyola University Chicago celebration of the Dalai Lama's campus visit.
- Department of Environmental Science representative on the Loyola University Academic Council, August 2011 – present
- Member of four LUC faculty search committees during 2011-14

AWARDS:

- Awarded inaugural *Kolvenbach Award* for Engaged Teaching by Loyola University Chicago. One LUC faculty is selected for this award annually.
- Awarded the *Protector of the Environment* award by Chicago Audubon Society, 2015. This award is in recognition of the work I've done with students to reduce bird deaths at Loyola's campus.
- Designated a *Master Researcher* by the Sujack Awards Committee, Loyola University Chicago, 2013. Three faculty from across Loyola received this award in 2013.
- *Outstanding teaching in the Biological Sciences*. University of Notre Dame. 2006.
- *Outstanding Graduate Student Teacher Award for Excellence in Teaching*. Kaneb Center for Teaching and Learning, University of Notre Dame. 2006.
- *Striving for Excellence in Teaching certificate*. Kaneb Center for Teaching and Learning, University of Notre Dame. 2006.
- *Fisher Fellowship* (one semester of stipend) awarded by Department of Biological Sciences in Fall, 2003, in recognition of contributions made to non-academic department life (in particular, establishing and serving as founding president of the Biology Graduate Student Organization).

PRESS COVERAGE

(SELECTED):

Interviewed for:

- Online Magazine Hakai by Geogg Giller, for an article about potential marine invasions of the Arctic region. 11/24/15.
- U.S. Catholic Magazine, for a profile of me in the December 2015 issue.
- Nature Magazine article, interviewed by Boer Deng, and quoted by her, for article about artificial intelligence applications to modeling the spread of diseases. <http://www.nature.com/news/artificial-intelligence-joins-hunt-for-human-animal-diseases-1.17568>
- Article about SOAR bird program for article in DNAinfo. <http://www.dnainfo.com/chicago/20141119/rogers-park/loyolas-buildings-are-beautiful-but-deadly-for-migrating-birds-researchers>
- Radio WILL (NPR station in Champaign, IL) *Focus* program, May 25, 2011. Audio online at <http://will.illinois.edu/focus/interview/focus110525b/>
- WBEZ's (Chicago Public Radio) *Worldview*, June 1st, 2010. Audio online at http://www.chicagopublicradio.org/Program_wv.aspx?episode=42333.
- Public Radio International's *The World*, May 5th, 2010. Audio online at <http://www.worldscience.org/podcast/elephant-bees-oil-spill-gulf-coast-climate-asian-carp-bald-eagle/>

Research cited by articles in: New York Times, Nature Conservancy Magazine, Environmental Science & Technology, newswise.com, suburbanchicagonews.com, Wyoming Public Radio, South Bend Tribune.

Research described in press releases from: Union of Concerned Scientists, The Nature Conservancy, Illinois-Indiana SeaGrant, University of Notre Dame, University of Wyoming, the Australian Weeds Co-operative Research Center.

Jack Killgore

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EDUCATION

Ph.D. Aquatic Ecology (1995). University of Mississippi, Oxford, MS.

M.Sc. Fisheries (1979). Sam Houston State University, Huntsville, TX.

B.A. Zoology (1976). University of Arkansas, Fayetteville, AR.

EXPERIENCE

Team Leader, Environmental Laboratory, U.S. Army Engineer Research and Development Center (ERDC). Dr. Killgore directs an interdisciplinary team conducting research on environmental biology of fishes, threatened (sturgeon) and invasive (Asian carp) fish species, ecosystem restoration in rivers and floodplains, and environmental impact assessment of U. S. Army Corps of Engineers flood control and navigation projects.

SELECTED PRESENTATIONS AND PUBLICATIONS

2015

Tripp, S., K. J. Killgore, and J. E. Garvey (2015) "Fish movements and passage through a water control structure: River stage and floodplain connectivity." *River Research and Applications*. Published online in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/rra.2901.

Holliman, F. H., K. J. Killgore, and C. Shea (2015) "Development of Operational Protocols for Electric Barrier Systems on the Chicago Sanitary and Ship Canal: Induction of Passage-Preventing Behaviors in Small Sizes of Silver Carp." ERDC/TN ANSRP 15-1, Vicksburg, MS.

2014

Harrison, A. B., W. T. Slack, and K. J. Killgore (2014) "Feeding Habitats of Young-of-year River Sturgeon *Scaphirhynchus* spp. in the Lower Mississippi River." *The American Midland Naturalist*, 171(1):54-67. 2014.

Hoover, J.J., C.E. Murphy, and K.J. Killgore (2014) "Ecological Impacts of Suckermouth Catfishes (Loricariidae) in North America: A Conceptual Model." ERDC Technical Bulletin ANSRP 14-1, Vicksburg, MS.

Killgore, K. J., P. Hartfield, T. Slack, R. Fischer, D. Biedenharn, B. Kleiss, J. Hoover, and A. Harrison (2014) "Conservation Plan for the Interior Least Tern, Pallid Sturgeon, and Fat Pocketbook Mussel in the Lower Mississippi River (Endangered Species Act, Section 7(a)(1))." MRG&P Report No. 4, Vicksburg, MS: U.S. Army Engineer Research and Development Center.

2013

Miranda, L.E., K.J. Killgore, and J.J. Hoover (2013) "Fish assemblages in borrow-pit lakes of the lower Mississippi River.," *Trans. Am. Fish. Soc.* 142: 596-605.

Hoover, J.J., S.G. George, and K.J. Killgore (2013) "A paddlefish entrained by the 2011 Mississippi River flood: rescue, recapture, and inferred swim speed,," *Southeastern Nat.* 2(4): N26-N30.

Divers, S.J., S.S. Boone, A. Berliner, E.A. Kurimo, K.A. Boysen, D.R. Johnson, K.J. Killgore, S.G. George, and J.J. Hoover (2013) "Nonlethal acquisition of large liver samples from free-ranging river sturgeon (*Scaphirhynchus*) using single-entry endoscopic biopsy forceps,," *J. Wildl. Diseases* 49(2): 321-331.

2012

Miranda, L. E., J. N. Aycock, and K. J. Killgore (2012) "A direct-gradient multivariate index of biotic condition,," *Transactions of the American Fisheries Society* 141: 1637-1648.

2011

Hoover, J.J., J.A. Collins, K.A. Boysen, A.W. Katzenmeyer, and K.J. Killgore. (2011) "Critical swim speeds of adult shovelnose sturgeon in rectilinear and boundary layer flow,," *Journal of Applied Ichthyology* 27: 226-230.

Miranda, L.E. and K. J. Killgore (2011) "Catfish spatial distribution in the free-flowing Mississippi River. Conservation, ecology, and management of catfish: the second international symposium. ,"

American Fisheries Society American Fisheries Society Symposium 77, Bethesda, Maryland
Hoover, J.J., J.A. Collins, K.A. Boysen, A.W. Katzenmeyer, and K.J. Killgore (2011) "Critical swim speeds of adult shovelnose sturgeon in rectilinear and boundary layer flow." *Journal of Applied Ichthyology* 27: 226-230.

Killgore, K.J., L.E. Miranda, C.E. Murphy, D. M. Wolff, J. J. Hoover, T. M. Keevin, S. T. Maynard, and M. A. Cornish (2011) "Fish entrainment rate through towboat propellers in the upper Mississippi and Illinois Rivers." *Transactions of the American Fisheries Society* 140:570-581.

2010

Kirk, J. P., K. J. Killgore, W. T. Slack, and S. G. George (2010) "A preliminary evaluation of trawling for young-of-year Gulf sturgeon," *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies* 64:162-165.

Hoover, J. J., A. Turnage, and K. J. Killgore. (2010) "Swimming performance of juvenile paddlefish: quantifying risk of entrainment. , " *American Fisheries Society, Paddlefish Management, Propagation, and Conservation in the 21st Century American Fisheries Symposium* 66, Bethesda, Maryland

AWARDS AND FELLOWSHIPS

Herbert D. Vogel award for Scientist of the Year, Summer 2009

Engineer Research and Development Center

USFWS Southeast Region, Regional Director's Spring 2011

Conservation Award

ERDC Research and Development Awards 2011, 20013, 2015

PROFESSIONAL MEMBERSHIPS

American Fisheries Society

Southeastern Fishes Council

Odum School of Ecology
University of Georgia
Athens, GA 30602 (706)
583-5538

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website: <http://kramera3.myweb.uga.edu/>

Andrew M. Kramer

EDUCATION

Ph.D., Fisheries and Wildlife / Ecology, Evolutionary Biology and Behavior (dual degree), 2007,
Michigan State University
Advisor: Orlando Sarnelle
Dissertation title: Copepodology in alpine lakes: limitations to recovery of
Hesperodiaptomus shosone after exotic fish eradication

Bachelor of Science, 2000, Saint Louis University
Honors degree, Biology (*summa cum laude*)

GRANTS AND AWARDS

Research Grants

National Science Foundation, Macrosystems Biology, “Multi-scale dynamics of white-nose syndrome in North America”, 2015-2017. **PI: Kramer, A.**, co-PI: Drake, J.M. (\$291,000)
Edward and Phyllis Reed Endowment, “Pheromone specificity between closely and distantly related species in the genus *Hesperodiaptomus*”. 2010. (**Kramer co-PI**, collaborative with Jeannette Yen, Georgia Institute of Technology, \$5900).
Valentine/Eastern Sierra Reserve Graduate Student Grant, University of California Reserve System, 2006 (\$1500)
Sigma Xi Grant-in-Aid of Research, 2006 (\$580)
National Science Foundation Graduate Research Fellowship, 2001-2005 (~\$100,000)
Michigan State University Graduate School Research Enhancement Award, 2005 (\$1000)
Research Experience for Undergraduates Supplement to NSF award "Recovery of ecosystem structure and function following exotic species eradication" (co-authored with PIs Orlando Sarnelle and Roland Knapp), 2002 (\$6000)

Scholarships, Honors and Awards

Ecological Dissertations in the Aquatic Sciences participant (Eco-DAS VIII, formerly DIALOG) (2008)
Michigan State University Dissertation Completion Fellowship, 2007
Michigan State University Ecology, Evolutionary Biology and Behavior Fellowship, 2006
Michigan State University Distinguished Fellowship, 2000 and 2004
Fisheries and Wildlife Department Graduate Student Organization travel grant, 2005 and 2007
Ecology, Evolutionary Biology and Behavior program travel grant, 2005 and 2007
Saint Louis University, Outstanding Senior in Department of Biology, 2000

PEER-REVIEWED PUBLICATIONS *indicates undergraduate author

Drury, K.L.S., J.D. Suter*, J.B. Rendall*, **A.M. Kramer** and J.M. Drake. 2015. Immigration can destabilize tri-trophic interactions: implications for conservation of top predators. *Theoretical Ecology*. 8:285-296. doi: 10.1007/s12080-014-0249-1
Drake, J.M., R.B. Kaul, L. Alexander, S. O'Regan, **A.M. Kramer**, et al. 2015. Ebola cases and health system demand in Liberia. *PLOS Biology*, Jan 13: 10.1371/journal.pbio.1002056

- Kramer, A.M.** and J.M. Drake. 2014. Time to competitive exclusion. *Ecosphere*, 5:52.
<http://dx.doi.org/10.1890/ES14-00054.1>
- Lasley-Rasher, R.S., **A.M. Kramer**, V. Burdett-Coutts, J. Yen. 2014. Prevalence of fertilization limitation in the coastal marine copepods *Temora longicornis* and *Eurytemora herdmanni*. *PLoS ONE* 9(11):e112920. doi: 10.1371/journal.pone.0112920
- Kramer, A.M.**, M.M. Lyons, F.C. Dobbs, J.M. Drake. 2013. A stochastic model of bacterial colonization and extinction on marine aggregates. *Ecology and Evolution*, 3: 4300-4309. doi: 10.1002/ece3.789
- Maher, S.P., **A.M. Kramer**, et al. 2012. Non-diffusive spread of White-nose Syndrome regulated by spatial heterogeneity and climate. *Nature Communications* 3, 1306
doi:10.1038/ncomms2301
- Drake, J.M. and **A.M. Kramer**. 2012. Mechanistic analogy: how microcosms explain nature. *Theoretical Ecology* 5:433-444 doi: 10.1007/s12080-011-0134-0
- Kramer, A. M.**, O. Sarnelle and J. Yen. 2011. The effect of mating behavior and temperature variation on the critical population density of a freshwater copepod. *Limnology and Oceanography* 56:707-715.
- Drake, J.M. and **A.M. Kramer**. 2011. Allee effects. *Nature Education Knowledge* 2(9):2.
- Yen, J., J. Sehn*, K. Catton, **A. M. Kramer** and O. Sarnelle. 2011. Trail following in 3D by the freshwater copepod *Hesperodiptomus shoshone*. *Journal of Plankton Research*. 33:907-916.
- Vercken, E., **A.M. Kramer**, P.C. Tobin, J.M. Drake. 2011. Critical patch size generated by Allee effect in gypsy moth, *Lymantria dispar* (L.). *Ecology Letters*. 14:179-186.
- Kramer, A. M.** and J. M. Drake. 2010. Experimental demonstration of population extinction due to a predator-driven Allee effect. *Journal of Animal Ecology* 79: 633–639.
- Featured as an In Focus article with commentary: S.D. Gregory and F. Courchamp. 2010. Safety in numbers: extinction arising from predator-driven Allee effects. Journal of Animal Ecology* 79:511-514.
- Griffen, B., D. Spooner, **A. M. Kramer**, A. Santoro, A. Spivak, and N. Kelly. 2010. Moving species redundancy toward a more predictive framework. p. 30-46. In: P.F. Kemp [ed.], *Eco-DAS VIII Symposium Proceedings*. ASLO. doi:10.4319/ecodas.2010.978-0-9845591-1-4.30
- Kramer, A. M.**, B. Dennis, A.M. Liebhold, and J. M. Drake. 2009. The evidence for Allee effects. *Population Ecology* 51: 341-354.
- Kramer, A. M.**, O. Sarnelle and R. A. Knapp. 2008. Allee effect limits colonization success of sexually reproducing zooplankton. *Ecology* 89: 2760–2769.
- Kramer, A. M.** and O. Sarnelle. 2008. Limits to genetic bottlenecks and founder events imposed by the Allee effect. *Oecologia* 157:561-569.
- Kramer, A. M.** and L. Francis. 2004. Predation resistance and nematocyst scaling for *Metridium senile* and *M. farcimen*. *Biological Bulletin* 207 (2): 130-140.

Papers in review

- Kramer, A.M.**, G. Annis, M.E. Wittman, W.L. Chadderton, E.S. Rutherford, D.M. Lodge, L. Mason, D. Beletsky, C. Riseng, and J.M. Drake. Suitability of Great Lakes for invasive species based on global species distribution models and local aquatic habitat. In review. **Kramer, A.M.**, J.E. Ward, F.C. Dobbs, M. Pierce, and J.M. Drake. The contribution of marine aggregate-associated bacteria to the accumulation of pathogenic bacteria in oysters: an agent-based model. In review.
- Kramer, A.M.**, J.T. Pulliam, L.W. Alexander, A.W. Park, P. Rohani and J.M. Drake. Spatial spread of the West Africa Ebola epidemic. In review.
- Kaul, R.B., **A.M. Kramer**, F.C. Dobbs, J.M. Drake. Experimental demonstration of an Allee effect in microbial populations. In review.
- Wittman, M.E., G. Annis, **A.M. Kramer**, L. Mason, C. Riseng, E. Rutherford, W.L. Chadderton,

D. Beletsky, J.M. Drake and D.M. Lodge. Refining species distribution model outputs using landscape-scale habitat data: Forecasting Grass Carp and Hydrilla establishment in the Great Lakes region. In revision. Journal of Great Lakes Research

RESEARCH POSITIONS

Assistant Research Scientist, Odum School of Ecology, University of Georgia, Aug 2013 – present.

Postdoctoral researcher, Odum School of Ecology, University of Georgia, Sept. 2009 – April 2013. Microscopic islands: theory of island biogeography for aquatic pathogens. Mentor: Dr. John Drake

Postdoctoral researcher, Odum School of Ecology, University of Georgia, Oct. 2007-March 2009. Dynamics of low density populations, including the impact of Allee effects on colonization success in freshwater zooplankton. Mentor: Dr. John Drake

Ph.D. candidate, Michigan State University, Department of Fisheries and Wildlife, Aug. 2000-Aug. 2007. Copepodology in alpine lakes: limitations to recovery of *Hesperodiaptomus shoshone* after exotic fish eradication, advisor Dr. Orlando Sarnelle

TEACHING POSITIONS (Year/# of students)

Co-Instructor, ECOL 4500 Evolutionary Ecology, University of Georgia (Spring 2015 / 13).

Instructor, BIOL 1101 Biology: the Human Experience, Gainesville State College, Gainesville, GA. (Summer 2009, 2 sections of lecture and laboratory, 20 students each)

Co-Instructor, ECOL 4000/6000 Population and Community Ecology, University of Georgia (Fall 2008 / 20).

Instructor, ECOL 3500 Ecology, University of Georgia (Summer 2008 / 28).

Guest Lecture, ECOL 4000/6000 Population and Community Ecology, University of Georgia (2015/35), predator-prey interactions.

Guest Lecture, FYOS 1001: The Structure of Scientific Revolutions, University of Georgia (2013/10), led discussion about what scientists do for this freshman odyssey course.

Guest Lecture, ECOL 8310 Population Ecology, University of Georgia (2011 / 25), one lecture, one discussion.

Guest Lecture, ECOL 8310 Population Ecology, University of Georgia (2009 / 16), one lecture, two discussions, lab exercise.

Guest Lecture, ECOL 8310 Population Ecology, University of Georgia (2008 / 12)

Guest Lecture, FW 443 Restoration Ecology, Michigan State University (2006 / 25)

Guest Lecture, FW 109 Conservation of Freshwater Ecosystems, Michigan State University (2002 / 40)

Teaching Assistant, ISP 217L Water and the Environment Laboratory, Michigan State University (2007, 2006, 2005 / 80 each semester)

Teaching Assistant, MMG 426 Biogeochemistry, Kellogg Biological Station, Michigan State University (2006 / 12)

MENTORING EXPERIENCE

Advisor for NSF Research Experience for Undergraduates students

Summer 2015: Annakate Schatz

Project: Model accuracy in forecasting pathogen spread using climatic data

Summer 2002: Blair Wilson

Project: Detecting mating pheromones in *Hesperodiaptomus shoshone*

Mentoring undergraduate research:

Spring 2014: Navdeep Patel: Predicting spatial spread of non-stationary wildlife disease

Summer 2013 – Summer 2014: Deeran Patel: Predicting spatial spread of non-stationary disease using species distribution models

Spring 2010-Spring 2012: Tierney O’Sullivan and Theresa Stratmann, experimental and theoretical research on Daphnia population dynamics.

Advisor for undergraduates assisting with my Ph.D. research and the High Sierra Experimental Lakes Project

Summer 2004: Chris Brownfield

Summer 2003: Greg Goldsmith

Project: *Dispersal of limnetic zooplankton via streams in Humphreys Basin, Sierra Nevada*

Active in providing statistical and modeling consultation and/or tutoring for several

graduate students: Mike Buchalski, Western Michigan University; Trip Armstrong, UC

Davis; Tad Dallas, UGA; Reni Kaul, UGA; Jason Lang, UGA; Keri Goodman, UGA; Sarah

Heisel, UGA; Rachel Lasley, Georgia Tech, Larisa Pender-Healey, Georgia Tech and others

in a more limited role.

PRESENTATIONS AND WORKSHOPS

Invited:

Organizer, Oral Session for the 100th meeting of the Ecological Society of America in Baltimore, MD. Allee effects: theory and applications. Co-organized with Ludek Berec and John Drake.

Cary Institute of Ecosystem Studies, Millbrook, New York. November 2014.

Leibniz Institute for Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany. April 2014.

Kennesaw State University, Ecology and Evolution seminar series, September 2013.

Leadership without Limits! Presentation on species interactions and species conservation in aquatic systems. Program is for high school students that are children of migrant farm workers, will be developing community projects on water issues. June 2013.

Computational Ecology and Epidemiology Study Group, University of Georgia, tutorial on using R to produce high quality figures and graphics. February 2012

Mammoth Lakes Academy (high school), research and career seminar, August 2011

University of South Carolina, Biological Sciences seminar, March 2011

Ohio State University, School of Environment and Natural Resources, February 2011

Oceans and Human Health, Gordon Research Seminar, June 2010

Eco-DAS symposium, University of Hawaii-Manoa, October 2008

Auburn University, Fisheries and Allied Aquaculture seminar, September 2008

Michigan State University, Fisheries and Wildlife Graduate Student Organization seminar April 2006

Contributed:

A.M. Kramer, M.E. Wittman, G. Annis, L. Mason, C. Riseng, E. Rutherford, W.L. Chadderton, D. Beletsky, J.M. Drake and D.M. Lodge. Predicting habitat suitability for invasive species in the Great Lakes: Combining species distribution models and high resolution aquatic variables. (poster). Ecological Society of America, Aug 2015, Baltimore.

Maher, S.P., A.M. Kramer, J.T. Pulliam, K.E. Langwig, A.M. Kilpatrick, W.F. Frick and J.M. Drake. Visiting an old friend: using recent data to revise expectations of white-nose syndrome spread. American Society of Mammologists, June 2015, Jacksonville.

Kramer, A.M., D. Patel*, J.M. Drake. Predicting future spread during an outbreak using species distribution models. Ecological Society of America, Aug 2014, Sacramento.

Kaul, R.B., A.M. Kramer, F.C. Dobbs, J.M. Drake. Allee effects: scaling down to the microbial level. Ecological Society of America, Aug 2014, Sacramento.

Kramer, A.M., G. Annis, M. E. Wittmann, W. L. Chadderton, E. Rutherford, L. Mason, J. M. Drake. Predicting potential distribution of invasive species using range bagging: golden

mussel and killer shrimp in the Great Lakes. Joint Aquatic Sciences Meeting, May 2014, Portland, OR.

Kramer, A.M., F. Dobbs, M. Maille Lyons, J.M. Drake. Tiny islands: Colonization and extinction of microbial species on marine aggregates. Ecological Society of America, Aug. 2013, Minneapolis.

Kramer, A.M., J. E. Ward, M. Pierce, F. Dobbs, J.M. Drake. Understanding the contribution of marine aggregate-associated bacteria to pathogen load in oysters using an agent-based model. Association for the Sciences of Limnology and Oceanography, Feb. 2013, New Orleans.

Kramer, A.M., J. E. Ward, M. Pierce, F. Dobbs, J.M. Drake. The contribution of marine aggregate-associated bacteria to pathogen load in oysters: an agent-based model. NSF Ecology and Evolution of Infectious Disease PI meeting, 2013, Athens GA (poster)

Kramer, A.M., J.T. Pulliam, S.P. Maher, and J.M. Drake. Simplifying networks: spread of White-nose syndrome in North America. Ecological Society of America 2012, Portland, OR.

Maher, S.P., A.M. Kramer, et al. Non-diffusive spread of White-nose Syndrome regulated by spatial heterogeneity and climate. American Society of Mammologists June 2012, Reno, NV.

Kaul, R.B., A.M. Kramer, F.C. Dobbs, J.M. Drake. Allee effects in experimental microbial systems. American Society for Microbiology 2012, San Francisco, CA. (poster).

Kramer, A.M. and J.M. Drake. Population variance and extinction of two competitors consuming a common resource. Ecological Society of America 2011, Austin TX.

Theresa Stratmann*, Tierney O'Sullivan*, Amara Channell*, Andrew Kramer, Marcus Zokan, Andrea Silletti and John Drake. Two paths to extinction: effect of deteriorating environments on extinction time and distribution. Ecological Society of America 2011, Austin TX. (poster)

Kramer, A.M. and J.M. Drake. Mechanistic model of bacterial persistence on marine aggregates. NSF Ecology and Evolution of Infectious Disease PI meeting, 2011, Madison WI (poster)

Kramer, A.M., E. Vercken, P. Tobin, J.M. Drake. Allee effects induce critical area for establishment in gypsy moth invasion. Ecological Society of America 2010, Pittsburgh, PA.

M. Maille Lyons and A. M. Kramer. Microscopic islands: Modeling the theory of island biogeography for aquatic pathogens colonizing marine aggregates. NSF Ecology and Evolution of Infectious Disease PI meeting, 2010, Atlantic City NJ (poster)

Kramer, A.M. and J.M. Drake. Allee effect due to predator functional response: effects on population growth rate and extinction in an experimental zooplankton system. Ecological Society of America 2008, Milwaukee, WI. (poster)

Kramer, A.M. and O. Sarnelle. The Allee effect limits the loss of genetic variability during population bottlenecks. Ecological Society of America 2007, San Jose, CA.

Kramer, A.M. and O. Sarnelle. Allee effect on population growth rate in sexually reproducing zooplankton. American Society of Limnology and Oceanography 2007 Aquatic Sciences meeting, Santa Fe, NM

Kramer, A.M., Sarnelle, O., and Knapp, R.A. Allee effect limits re-establishment of an alpine copepod: multi-lake stocking experiment. American Society of Limnology and Oceanography 2005 Summer meeting, Santiago de Compostela, Spain

* indicates undergraduate author

Workshops:

Marine Biosecurity Workshop: Research frontiers from integrative marine biosecurity analyses. Environment Institute, University of Adelaide, Australia. (Invited).

NIMBioS Investigative Workshop: Individual-based Ecology of Microbes. National Institute for Mathematical and Biological Synthesis, University of Tennessee, June 2011.

PROFESSIONAL AND LEADERSHIP ACTIVITIES

Journal reviews: Ecology (3), Ecology Letters (3), Oikos (4), American Naturalist (1), Limnology and Oceanography (1), Ecological Applications (2), Evolution (1), Journal of Animal Ecology (3), Biology Letters (1), Ecosphere (1), Oecologia (1), Genetics (2), Conservation Biology (1), Bulletin of Mathematical Biology (1), Biological Invasions (1), Diversity and Distributions (1), Methods in Ecology and Evolution (1), Ecography (1), Ecological Modelling (1), Journal of Applied Ecology (1), Behavioral Ecology (1), Ecological Entomology (1), Behaviour (1), Behavioral Ecology and Sociobiology (1), Restoration Ecology (1), PLoS ONE (2), Population Ecology (2), American Midland Naturalist (1), Transactions American Fisheries Society (1), Journal of Mammology (1).

Proposal reviews: NSF (4), Oregon Sea Grant.

Curriculum reviews: SEPUP/Science Education for Public Understanding Program, Lawrence Hall of Science, UC Berkeley

Presentation judge, Odum School of Ecology Graduate Student Symposium, 2010, 2011, 2013, 2014, 2015. Georgia Science and Engineering Fair: 2015.

Professional Societies: Ecological Society of America, American Society of Limnology and Oceanography

Graduate representative, Fisheries and Wildlife Department Graduate Committee, Fall 2004- Spring 2006

Responsible Conduct of Research:

- 6 part seminar series on research ethics, completed in 2005 (Michigan State University)
- CITI online research ethics module, 2010, 2015 (University of Georgia)

NICHOLAS EDWARD MANDRAK

A. BIOGRAPHICAL INFORMATION

1. PERSONAL

Nicholas Edward Mandrak (DOB: April 12, 1963)
Department of Biological Sciences 2069 Waterbridge Drive
University of Toronto Scarborough Burlington, ON
1265 Military Trail L7M 3W2
Toronto, ON M1C 1A4 (905)331-4400
(416)208-2248 mandrak4@cogeco.ca
nicholas.mandrak@utoronto.ca

2. DEGREES

Ph.D.; University of Toronto, November 1994.

Thesis Title: Biogeographic patterns of freshwater fishes in relation to historical and environmental processes in Ontario lakes and streams.

Graduate Supervisor: Dr. Edwin J. Crossman.

Minors: Geographic Information Systems; Multivariate Statistics.

M.Sc.; University of Toronto, March 1990.

Thesis Title: The zoogeography of Ontario freshwater fishes.

Graduate Supervisor: Dr. Edwin J. Crossman.

Minor: Environmental Factors.

B.Sc.; University of Toronto, June 1986.

Biogeography Specialist, Anthropology Minor.

3. EMPLOYMENT

2013 - Associate Professor, Department of Biological Sciences, University of Toronto present Scarborough. Toronto, ON.

2006 - Executive Director, DFO National Centre of Expertise for Aquatic Risk 2013 Assessment (CEARA), Great Lakes Laboratory for Fisheries and Aquatic

Sciences, Department of Fisheries and Oceans, Burlington, ON.

2005 - Section Head, Biodiversity Science Section, Great Lakes Laboratory for Fisheries

2013 and Aquatic Sciences, Department of Fisheries and Oceans, Burlington, ON.

2001 - Research Scientist, Great Lakes Laboratory for Fisheries and Aquatic

2013 Sciences, Department of Fisheries and Oceans, Burlington, ON.

1999 - Assistant Professor, Department of Biological Sciences, Youngstown

2001 State University, Youngstown, OH.

1997 - Assistant Professor, Department of Biology, Trent University,

1999 Peterborough, ON.

Curriculum Vitae – Nicholas Edward Mandrak

1994 - Assistant Professor and Associate Curator of Fishes, Department of

1997 Biological Sciences, Fort Hays State University, Hays, KS.

1986 - Teaching Assistant, Department of Zoology, University of Toronto.

1993

4. HONOURS

2010. Personal letter from DFO Minister Shea commending good work being done on AIS file.

2010. DFO Immediate Award for participation in Asian Carp Control in Chicago Sanitary Canal project.

2007. Faculty of 1000 Recommended Paper. Leung, B. and N.E. Mandrak. 2007. The risk of establishment of aquatic invasive species: joining invasibility and propagule pressure. *Proceedings of the Royal Society of London Series B* 274: 2603-2609.

2005. DFO Prix d'Excellence Award. Risk Assessment of Asian Carps.

2004. DFO Distinctive Merit Award. Risk Assessment of Asian Carps.

2001-2002. Research Professorship, Youngstown State University.

1997. Outstanding Scholarship Award, College of Health and Life Sciences, Fort Hays State University.

1997. Outstanding Mediated Classroom Teacher Award, College of Health and Life Sciences, Fort Hays State University.

5. PROFESSIONAL AFFILIATIONS AND ACTIVITIES

Adjunct Professor: Trent University, Queen's University, University of Guelph, University of Windsor.

Research Associate: Ichthyology, Royal Ontario Museum; South Africa Institute for Aquatic Biodiversity.

Grant reviewer: Great Lakes Fishery Commission, Hudson River Foundation, National Oceanic and Atmospheric Agency (NOAA), Natural Sciences and Engineering Research Council of Canada (NSERC), North Carolina Sea Grant, Ontario Living Legacy Trust, South African National Research Foundation.

Journal reviewer: *Aquatic Invasions*, *American Fisheries Society*, *Biological Invasions*, *Bioscience*, *Canadian Field-Naturalist*, *Canadian Journal of Fisheries and Aquatic Sciences*, *Climatic Change*, *Conservation Letters*, *Copeia*, *Diversity and Distributions*, *Environmental Biology of Fishes*, *Fisheries*, *Global Ecology and Biogeography*, Illinois Natural History Survey, *Journal of Aquatic Ecosystem Health and Management*, *Journal of Great Lakes Research*, Milwaukee Public Museum, *North American Journal of Fisheries Management*, *Science*, *PLoS One*, *Transactions of the American Fisheries Society*.

Program reviewer: Lake Tahoe AIS Management Program, United States Fish and Wildlife Service, United States Geological Survey, United States National Parks Service. June 2015

Chair. Canadian Science Advisory Secretariat Meeting on Information in support of a Recovery Potential Assessment of American Eel (*Anguilla rostrata*) in Canada. Ottawa, ON. June 2013.

Participant, CSAS National Science Peer Review of national risk assessment of Ship-mediated introductions of AIS in Canada. CSAS Meeting, Burlington, ON, March 2013, June 2013.

Guest Editor. 2012-2013. *Journal of Great Lakes Research*.

Testified before the Parliamentary Standing Committee on Fisheries and Oceans. May 2012, October 2012.

Member. 2012-2013. Deputy Ministers' National Research Scientist Promotion Committee.

Chair, Canadian Science Advisory Secretariat Meeting National Science Peer Review of risk assessment of Ship-mediated introductions of AIS in the Atlantic and Pacific regions of Canada. CSAS Meeting, Burlington, ON, March 2012.

Chair. Canadian Science Advisory Secretariat Meeting on Information in support of a Recovery Potential Assessment of Northern Madtom (*Noturus stigmosus*) in Canada. Burlington, ON. March 2012.

Member, Board of Directors, 2012-present. Canadian Conference for Fisheries Research.

Guest Editor. 2011. *Northeastern Naturalist*.

Chair, Canadian Science Advisory Secretariat National Science Peer Review of risk assessment of Ship-mediated introductions of AIS in the Great Lakes and Arctic regions of Canada. CSAS Meeting, Burlington, ON, March 2011.

Curriculum Vitae – Nicholas Edward Mandrak

Official Canadian Delegate. 2011. Convention on Biological Diversity ad hoc technical expert group meeting on alien species as pets, aquarium and terrarium species, and as live bait and live food. Geneva, Switzerland.

Member, Canadian Aquatic Invasive Species Team, Great Lakes Water Quality Agreement, 2010-2012.

Member, Canadian Species and Habitat Team, Great Lakes Water Quality Agreement, 2010-2012.

Co-chair. Canadian Science Advisory Secretariat Meeting on Information in support of a Recovery Potential Assessment of Spotted Gar (*Lepisosteus oculatus*) in Canada. Burlington, ON. June 23, 2010.

Chair. 2010. Binational Asian Carp Risk Assessment Scientist Meeting. Chicago, IL. November 15-16, 2010.

Member, Research Committee, Great Lakes Commission. 2010-present.

Member, Scientific Committee. 2010-2012. Canadian Aquatic Invasive Species Network II.

President. 2009-2010. Canadian Conference for Fisheries Research.

Member, Steering Committee, ICAIS, 2008-2009.

Member, Steering Committee, NSERC Network Workshop on Conservation in Canada. April 2009.

Associate Editor, Biological Invasions, 2009 to present.

Advisory Committee Member. 2008. Building a Framework to Advance Aquatic Nuisance Species Management of Organisms in Trade in the Great Lakes Region, Great Lakes Commission.

Chair, Canadian Science Advisory Secretariat Regional Science Peer Review of the reidside dace (*Clinostomus elongatus*) recovery potential assessment. CSAS Meeting, Burlington, ON. December 2007.

Chair, Canadian Science Advisory Secretariat Regional Science Peer Review of the Atlantic salmon (*Salmo salar*) recovery potential assessment. CSAS Meeting, Burlington, ON. March 2007.

Chair, CSAS Regional Science Peer Review of the silver lamprey (*Ichthyomyzon unicuspis*) prior to assessment by COSEWIC. CSAS Meeting, Burlington, ON. March 2007.

Member, Ontario Biodiversity Strategy Science Forum. 2007-2012.

Chair, CSAS National Science Peer Review of the Canadian tunicate risk assessment. CSAS Meeting, Charlottetown, Prince Edward Island. November 2006.

Chair, CSAS National Science Peer Review of the Quantitative Biological Risk Assessment Tool (QBRAT). CSAS Meeting, Ottawa, ON. November 2006.

Program Chair, Canadian Conference for Fisheries Research, 2007.

Session Chair, "Aquatic Invasive Species", Canadian Conference for Fisheries Research, January 2005, 2006.

Member, DFO Tunicate Working Group, 2006-2007.

Member, DFO National RPA Working Group, 2006-2013.

Member, Organizing Committee, State of Lake Huron Conference, 2006.

Member, Planning Committee, Lake Erie Millenium Project Habitat Classification and Binational Map Project, 2005-6.

Member, Advisory Committee, Huron-Erie Corridor Committee, 2006-2013.

Project Team Member, Barcoding Life: Canadian Freshwater Fishes, 2005-2009.

Writing Team Member, Development of harmonized guidelines and a decision support tool for cage culture site applications in Ontario. DFO-FHM-OMNR Species at Risk Act Discussion Paper. 2005.

Chair, CSAS Zonal Science Peer Review of the American eel (*Anguilla rostrata*) prior to assessment by COSEWIC. CSAS Meeting, Quebec City, PQ. October 2005.

Chair, CSAS Regional Science Peer Review of the Allowable Harm Process for freshwater species in Central and Arctic region. CSAS Meeting, Burlington, ON. October 2005, February 2006.

Member, Planning Committee, State of Lake Huron Symposium, 2005-6.

Session Organizer and Chair, "Aquatic Species at Risk in the Great Lakes Basin". International Association for Great Lakes Research Annual Meeting, May 2005.

Committee Member. Lake Erie Millenium Project Habitat Classification and Binational Map Project, 2005.

Member, Goby Working Group, Ontario Ministry of Natural Resources, 2004-2013.

Member, Joint American Fisheries Society- American Society of Ichthyologists and Herpetologists, Names Committee, 2004-present.

Member, American Society of Ichthyologists and Herpetologists, Endangered Species Committee, 2004-present.

Curriculum Vitae – Nicholas Edward Mandrak

Member, Centre for Environmental Cooperation Aquatic Invasive Species Risk Assessment Working Group, 2004-2010.
Co-editor, *Freshwater Fishes, Fisheries and Habitat of the World* series, *Journal of Aquatic Ecosystem Health and Management*, 2004-present.

Editorial Board Member, *Journal of Aquatic Ecosystem Health and Management*, 2004-present.

Member, Freshwater Ecoregions of the World Project, World Wildlife Fund, 2004-2008.

Special Session Organizer and Chair, "Celebrating the 30th Anniversary of the *Freshwater Fishes of Canada*", Canadian Conference for Fisheries Research, January 2003.

Invited Member of Organizing Committee, Chair of Aquatic Biodiversity and Invasive Species Session. DFO National Science Workshop, November 2003.

Scientific Advisor, WWF Nature Audit, 2003.

Scientific Advisor, Canadian Eel Science Working Group. 2003-2007.

Member, Freshwater Fishes Specialists' Subcommittee, COSEWIC, April 2002-present.

Founding Member, Canada-Ontario Introductions and Transfers Committee. September 2001-present.

Member, The Nature Conservancy of Canada Aquatic Blueprint Advisory Board, September 2001-2006.

Member, Great Lakes Fishery Commission Board of Technical Experts. September 1999-2012.

Special Session Organizer and Chair "A Symposium Honouring Dr. E.J. Crossman". American Society of Ichthyologists and Herpetologists Annual Meeting. June 1998.

Abstract Editor and Coordinator of Biology Sessions, Kansas Academy of Sciences Annual Meeting. May 1997.

Member, American Fisheries Society Publication Awards Committee, 1996-1997.

Chair, American Fisheries Society, Southern Ontario Chapter, Student Affairs Committee, 1989-1991.

Thesis Defence Examiner: Fort Hays State University (10); Trent University (2); Youngstown State University (4).

B. ACADEMIC HISTORY

6. A. RESEARCH ENDEAVOURS

Biogeography, Biodiversity, and Conservation of Freshwater Fishes

B. **RESEARCH AWARDS** (grants, contracts, fellowships) during preceding 5 years

Canada Foundation for Innovation. 2015-2019. Biodiversity and conservation of freshwater fishes laboratory. \$80,000.

Ontario Ministry of Research and Innovation, 2015-2019. Biodiversity and conservation of freshwater fishes laboratory. \$80,000.

Fisheries and Oceans Canada. 2014-2016. Fish species at risk and aquatic invasive species in Ontario. Academic Research Contribution Program. \$225,000.

Fisheries and Oceans Canada. 2014-2015. Risk assessment of recreational boating activity in the Great Lakes basin as a pathway for introduction and spread of aquatic invasive species. Co-PI: Andrew Drake. \$25,000.

Transport Canada. 2014-2015. Benefits analysis for ballast water discharge standards in Canada. Co-PI: Andrew Drake. \$25,000.

Ontario Ministry of Natural Resources and Forestry. 2014-2015. Ecological risks of the baitfish pathway. Co-PI: Andrew Drake. \$25,000.

Species at Risk Research Fund for Ontario. 2015-2017. Science in support of protocol development for detection and monitoring of wetland fishes at risk. \$37,500.

NSERC Discovery Grant. 2014-2018. Biodiversity, biogeography, and conservation of Canadian freshwater fishes. \$135,000.

Ontario Invasive Species Centre Partnership Fund. 2014-2015. Predicting the inland spread of Round Goby: How many gobies does it take to establish a new population? Co-PI: Andrew Drake. \$30,000.

Aquatic Invasive Species Programme, DFO. 2013-2014. Centre of Expertise for Aquatic Risk Assessment (CEARA). \$240,000.

Curriculum Vitae – Nicholas Edward Mandrak

Asian Carp Programme, DFO. 2013-2014. Tracking fish movement through the Welland Canal and St. Marys River. \$150,000.

Species at Risk Programme, DFO. 2013-2014. Evaluation of habitat use by, and effects of drain maintenance on Pugnose Minnow and Blackstripe Topminnow in agricultural drains. \$85,000.

Species at Risk Programme, DFO. 2013-2014. Spatial extent of Bridle Shiner in eastern Ontario. \$37,500.

Species at Risk Programme, DFO. 2013-2014. Targeted surveys to determine current distribution Channel Darter in Detroit River, Lake St. Clair and St. Clair River. \$37,500.

Species at Risk Programme, DFO. 2013-2014. Evaluation of habitat use by, and effects of drain maintenance on Grass Pickerel in agricultural drains. \$37,500.

Species at Risk Programme, DFO. 2013-2014. Targeted survey to determine the spatial extent of Lake Chubsucker within Long Point Bay. \$85,000.

Species at Risk Programme, DFO. 2013-2014. Genetic spatial structure of Northern Madtom in Canadian populations. \$37,500.

Species at Risk Programme, DFO. 2013-2014. Spatially explicit population viability analysis of Pugnose Shiner in the Bay of Quinte and St. Lawrence River. \$85,000.

Species at Risk Programme, DFO. 2013-2014. Identifying YOY and juvenile Spotted Gar habitat in Rondeau Bay. \$37,500.

Species at Risk Programme, DFO. 2013-2014. Development of eDNA methods for detection of Eastern Sand Darter extent in southwestern Ontario drainages. \$37,500.

Species at Risk Programme, DFO. 2013-2014. Development of eDNA methods for detection of Northern Madtom in historic, current, and adjacent habitats. \$37,500.

Species at Risk Programme, DFO. 2013-2014. Distribution of Pugnose Shiner in the Teeswater River, Ontario. \$25,000.

Species at Risk Programme, DFO. 2013-2014. Critical habitat of Spotted Gar: spatial extent in Rondeau Bay drains using traditional gears. \$37,500.

Aquatic Invasive Species Programme, DFO. 2012-2013. Tracking fish movement through the Welland Canal. \$39,000.

Aquatic Invasive Species Programme, DFO. 2012-2013. Centre of Expertise for Aquatic Risk Assessment (CEARA). \$240,000.

Asian Carp Programme, DFO. 2012-2013. Tracking fish movement through the Welland Canal and St. Marys River. \$50,000.

Species at Risk Programme, DFO. 2012-2013. Critical habitat of Channel Darter: instream flow needs in the Trent River. \$50,000.

Species at Risk Programme, DFO. 2012-2013. Critical habitat of Lake Chubsucker: spatial extent in the Lake Huron drainage and upper Niagara watershed. \$75,000.

Species at Risk Programme, DFO. 2012-2013. Critical habitat of Northern Madtom: spatial extent in Lake St. Clair and the Sydenham River. \$100,000.

Species at Risk Programme, DFO. 2012-2013. Critical habitat of Pugnose Shiner: spatial extent in St. Lawrence River and Trent River. \$50,000.

Species at Risk Programme, DFO. 2012-2013. Critical habitat of Spotted Gar: spatial extent in Long Point Bay. \$50,000.

Species at Risk Programme, DFO. 2012-2013. Development of eDNA methods to detect Spotted Gar in historic, current, and adjacent sites. \$50,000.

Species at Risk Programme, DFO. 2012-2013. Spatially explicit population viability analysis of Pugnose Shiner in the St. Lawrence River. \$50,000.

Species at Risk Programme, DFO. 2012-2013. Evaluation of habitat use by, and effects of drain maintenance on, Grass Pickerel in agricultural drains. \$50,000.

Great Lakes Fishery Commission Fishery Research Program. 2012-2014. Predicting the secondary spread of aquatic invasive species through ballast water and recreational boating in the Great Lakes basin. Co-PIs: S. Bailey and A. Drake. \$70,000.

Aquatic Invasive Species Programme, DFO. 2011-2012. Determining the magnitude of impact of round goby on benthic fish species at risk in riverine systems. Co-PI: S. Reid. \$8,000.

Aquatic Invasive Species Programme, DFO. 2011-2012. Centre of Expertise for Aquatic Risk Assessment (CEARA). \$240,000.

Great Lakes Fishery Trust. 2011-2012. Human dimensions of the baitfish industry. \$18,000.

Curriculum Vitae – Nicholas Edward Mandrak

Ontario Invasive Species Centre Partnership Fund. 2011-2012. Tracking fish movement through the Welland Canal and St. Marys River. \$100,000.

Ontario Invasive Species Centre Partnership Fund. 2011-2012. Determining the magnitude of impact of round goby on benthic fish species at risk in riverine systems. Co-PI: S. Reid. \$25,000

Species at Risk Programme, DFO. 2011-2012. Identifying the critical habitat, limiting factors and threats of Spotted Gar. \$118,000.

Species at Risk Programme, DFO. 2011-2012. Critical habitat of Channel Darter populations in Ontario: understanding population structure and fragmentation effects using genetics and implications for population re-establishment. \$38,000.

Species at Risk Programme, DFO. 2011-2012. Critical habitat of Pugnose Shiner in Canada: population structure, detectability, habitat preferences, and the effects of turbidity and oxygen depletion. \$100,000.

Species at Risk Programme, DFO. 2011-2012. Evaluation of habitat use by, and effects of drain maintenance on, Grass Pickerel in agricultural drains. \$25,000.

Committee on the Status of Endangered Wildlife in Canada. 2010-2012. COSEWIC Status Reports. \$18,000.

Aquatic Invasive Species Programme, DFO. 2010-2011. Centre of Expertise for Aquatic Risk Assessment (CEARA)

\$270,000. Aquatic Invasive Species Programme, DFO. 2010-2011. Determining the magnitude of impact of round goby on benthic fish species at risk in riverine systems. Co-PIs: M. Koops, S. Reid, M. Poos, S. Tiegs, and A. Drake. \$19,500.

Species at Risk Programme, DFO. 2010-2011. Identifying the critical habitat, limiting factors and threats of Spotted Gar. \$18,000.

Species at Risk Programme, DFO. 2010-2011. Critical habitat of Channel Darter populations in Ontario: understanding population structure and fragmentation effects using genetics and implications for population re-establishment. \$54,800.

Species at Risk Programme, DFO. 2010-2011. Critical habitat of Pugnose Shiner and Spotted Gar: the effect of turbidity on physiology and behaviour. \$60,000.

Species at Risk Programme, DFO. 2010-2011. Critical habitat of Pugnose Shiner, Northern Madtom, and Lake Chubsucker: distribution, abundance, and habitat preferences. \$130,000.

Species at Risk Programme, DFO. 2010-2011. Evaluation of habitat use by, and effects of drain maintenance on, Grass Pickerel in agricultural drains. \$25,000.

Species at Risk Programme, DFO. 2010-2011. Pugnose Minnow, Bridle Shiner and Blackstripe Topminnow in Canada: determining population size, distribution, abundance, and habitat preferences. \$78,000.

C. **PATENTS** awarded during past 5 years.

C. **SCHOLARLY AND PROFESSIONAL WORK***

7. Refereed publications

A. Articles

Bailey, S., J.A. Hoyle, N.E. Mandrak, and O. Johannsson. A chronicle of nonindigenous species in the Bay of Quinte, Lake Ontario. J. Aquat. Eco. Health Mgt. (in press)

Mandrak, N.E. Fish species at risk in the Bay of Quinte and vicinity. J. Aquat. Eco. Health Mgt. (in press)

Mandrak, N.E., and B.C. Cudmore. Risk assessment: cornerstone of an aquatic invasive species program. J. Aquat. Eco. Health Mgt. (in press)

MacIsaac, H.J., B. Beric, S.A. Bailey, N.E. Mandrak, and A. Ricciardi. Are the Great Lakes at risk of new fish invasions from trans-Atlantic shipping? J. Great Lakes Res. (early online: DOI 10.1016/j.jglr.2015.07.004)

Ginson, R., R.P. Walter, N.E. Mandrak, C.L. Beneteau, and D.D. Heath. 2015. Hierarchical analysis of genetic structure in the habitat-specialist Eastern Sand Darter (*Ammocrypta pellucida*). Ecology and Evolution 5: 695-708.

Glass, W.R., R.P. Walter, D.D. Heath, N.E. Mandrak, and L.D. Corkum. 2015. Genetic structure and diversity of spotted gar (*Lepisosteus oculatus*) at its northern range edge: implications for conservation. Conserv. Genet. DOI 10.1007/s10592-015-0708-2

Curriculum Vitae – Nicholas Edward Mandrak

- Chu, C., C.K. Minns, N.P. Lester, and N.E. Mandrak. 2015. An updated assessment of human activities, the environment, and freshwater fish diversity in Canada. *Can. J. Fish. Aquat. Sci.* 72: 1-14. 10.1139/cjfas-2013-0609 (early online; Editor's Choice).
- Drake, D.A.R., R. Burngart, T. Dobson, and N.E. Mandrak. 2015. Can we predict risky human behaviour involving invasive species? A case study of the release of fishes to the wild. *Biological Invasions* 17: 309-326.
- Dextrase, A.J., N.E. Mandrak, and J.A. Schaefer. 2014. Modelling occupancy of an imperilled stream fish at multiple scales while accounting for imperfect detection: implications for conservation. *Freshwater Biology* 59: 1799-1815.
- Drake, D.A.R., and N.E. Mandrak. 2014. Bycatch, bait, anglers, and roads: quantifying vector activity and propagule introduction risk across lake ecosystems. *Ecological Applications* 24: 877-894.
- Drake, D.A.R., and N.E. Mandrak. 2014. Ecological risk associated with live bait fisheries: a new angle on selective fishing. *Fisheries* 39: 201-211.
- Granados, M., N.E. Mandrak, and D. Jackson. 2014. Synthesizing reference conditions for highly degraded areas through best professional judgement. *J. Great Lakes Res.* 40 (Suppl. 2): 37-42.
- McCusker, M., N.E. Mandrak, N. Lovejoy. 2014. Population structure and conservation genetic assessment of the Endangered Pugnose Shiner, *Notropis anogenus*. *Conservation Genetics* 15:343-353.
- McCusker, M., N.E. Mandrak, S. Doka, J. van Wieren; J.E McKenna; D.M. Carlson, N. Lovejoy. 2014. Estimating the distribution of the Endangered Pugnose Shiner (*Notropis anogenus*) in the St. Lawrence River using a habitat model. *J. Great Lakes Res.* 40: 980-988
- Roseman, E.F., P.A. Thompson, J.M Farrell, N.E. Mandrak, and C.A. Stepien. 2014. Conservation and management of fisheries and aquatic communities in Great Lakes connecting channels. *J. Great Lakes Res.* 40 (Suppl. 2): 1-6.
- Bunt, C.M., T. Heiman, and N.E. Mandrak. 2013. Ontogeny of larval and juvenile Black Redhorse (*Moxostoma duquesnei*). *Copeia* 2013 (1):121-126.
- Blanchet, S., Y. Reyjol, J. April, N.E. Mandrak, M.A. Rodríguez, L. Bernatchez, and P. Magnan. 2013. Phenotypic and phylogenetic correlates of geographic range size in Canadian freshwater fishes. *Global Ecology and Biogeography* 22(9):1083-1094.
- Bunt, C.M., N.E. Mandrak, D.C. Eddy, S.A. Choo-Wing, T.G. Heiman, and E. Taylor. 2013. Habitat utilization, movement and use of groundwater seepages by larval and juvenile Black Redhorse, *Moxostoma duquesnei* *Environ. Biol. Fish.* 96:1281-1287
- Drake, D.A.R., and N.E. Mandrak. 2013. Evaluating the potential for freshwater bycatch using likelihood methods and fishery-independent data. *Reviews in Fish and Fisheries.* 20(8):2286-2299.
- Page, L.M., H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, N.E. Mandrak, and R.L. Mayden. 2013. New seventh edition of Common and Scientific Names of Fishes. *Fisheries* 38(4):188-189.
- Schwalb, A.N., T.J. Morris, N.E. Mandrak, and K. Cottenie. 2013. Distribution of freshwater unionid mussels depends the distribution of host fishes at a regional scale. *Diversity and Distributions* 19: 446-454.
- Beneteau, C.L., R.P. Walter, N.E. Mandrak, and D.D. Heath. 2012. Range expansion by invasion: genetic characterization of invasion of the greenside darter (*Etheostoma blennioides*) at the northern edge of its distribution. *Biological Invasions* 14(1):191-201.
- Glass, W., L.D. Corkum, and N.E. Mandrak. 2012. Evaluating home range and habitat utilization of the Threatened Spotted Gar (*Lepisosteus oculatus*) in Rondeau Bay using radiotelemetry. *North Am. J. Fish. Mgt.* 141:1026-1035
- Gray, S.M., L.J. Chapman, and N.E. Mandrak. 2012. Turbidity reduces hatching success in Threatened Spotted Gar (*Lepisosteus oculatus*). *Environmental Biology of Fishes* 94:689-694.
- Harford, W.J., A.M. Muir, C. Harpur, S.S. Crawford, S. Parker, and N.E. Mandrak. 2012. Seasonal distribution of bloater (*Coregonus hoyi*) in the waters of Lake Huron surrounding the Bruce Peninsula. *J. Great Lakes Res.* 38(2):381-389.
- Docker, M.F., N.E. Mandrak, and D.D. Heath. 2012. Contemporary gene flow between "paired" silver (*Ichthyomyzon unicuspis*) and northern brook (*I. flossor*) lampreys: Implications for conservation. *Conservation Genetics* 13(3):823-835.
- Nett, J.H.G., T.B. Campbell, N.E. Mandrak, and S.D. Tiegs. 2012. Detecting invasive Round Goby in wadeable streams: a comparison of gear types. *North American Journal of Fisheries Management* 32(2):360-364.

Curriculum Vitae – Nicholas Edward Mandrak

- Poos, M., D. Lawrie, C.Tu, D.A. Jackson, and N.E. Mandrak. 2012. Estimating local and regional population sizes for an endangered minnow, redbreasted dace (*Clinostomus elongatus*), in Canada. *Aquatic Conservation: Marine and Freshwater Ecosystems* 22(1):47-57.
- Glass, W.R., L.D. Corkum, and N.E. Mandrak. 2011. Pectoral fin ray aging: an evaluation of a non-lethal method for aging gars and its application to a population of the threatened Spotted Gar. *Environmental Biology of Fishes* 90(3):235-242.
- Trumpickas, J., N.E. Mandrak, and A. Ricciardi. 2011. Nearshore fish assemblages associated with introduced predators in lakes. *Aquatic Conservation: Marine and Freshwater Ecosystems* 21:338-347.
- Drake, D. A. R., and N. E. Mandrak. 2010. Least-cost transportation networks predict spatial interaction of invasion vectors. *Ecological Applications* 20(8):2286-2299.
- Hedges, K.J., M.A. Koops, N.E. Mandrak and O.E. Johannsson. 2010. Use of aquatic protected areas in the management of large lakes. *J. Aquat. Eco. Health Manag.* 13(2):135-142.
- Lapointe, N.W.R., L.D. Corkum, and N.E. Mandrak. 2010. Macrohabitat associations of fishes in shallow waters of the Detroit River. *Journal of Fish Biology* 76:446–466.
- Mandrak, N. E. and Cudmore, B. 2010. The fall of native fishes and the rise of non-native fishes in the Great Lakes Basin. *Aquatic Ecosystem Health & Management* 13(3):255-268.
- Beneteau, C.L., N.E. Mandrak, and D.D. Heath. 2009. The effects of river barriers and range expansion of the population genetic structure and stability in Greenside Darter (*Etheostoma blennioides*) populations. *Conserv. Genetics* 10(2):477-487.
- Munawar, M., N.E. Mandrak, I.F. Munawar, and M. Fitzpatrick. 2009. How are the North American Great Lakes coping with multiple stressors? Comparison of lakes Ontario and Superior. *Verh. Internat. Verein. Limnol.* 30 (7):1013–1019.
- Pitcher, T.E., Beneteau C.L., Walter, R.P., Wilson, C.C., Mandrak, N.E., Heath, D.D. 2009. Isolation and characterization of microsatellite loci in redbreasted dace (*Clinostomus elongatus*). *Conservation Genetics Resources* 1:381-383.
- Reid S.M., and N.E. Mandrak. 2009. Effect of diel period and season on seining effort required to detect changes in Lake Erie beach fish assemblages. *Environ. Monit. Assess.* 153:73-82
- Abell, R. et al. (including N.E. Mandrak). 2008. Freshwater ecoregions of the world: biogeographic units for freshwater biodiversity conservation. *Bioscience* 58(5):403-414.
- Carswell, J. D., K. Gardiner, M. Bertolotto, A. Rizzini and N. Mandrak. 2008. A web-based and mobile environmental management system. *Journal of Environmental Informatics* 12(1):9-20.
- Chu, C., N.E. Jones, N.E. Mandrak, A.R. Piggott and C.K. Minns. 2008. The influence of air temperature, groundwater discharge and climate change on the thermal diversity of stream fishes in southern Ontario watersheds. *Can. J. Fish. Aquat. Sci.* 65:297-308.
- Dopazo, S.N., L.D. Corkum and N.E. Mandrak. 2008. Fish assemblages and environmental variables associated with gobiids in the Huron-Erie corridor of the lower Great Lakes. *J. Great Lakes Res.* 34(3):450-460.
- Drake, D.A.R., M. Power, M.A. Koops, S.E. Doka and N.E. Mandrak. 2008. Environmental factors affecting growth of Eastern Sand Darter. *Can. J. Zool.* 86(7):714-722.
- Gerson, H., B. Cudmore, N.E. Mandrak, L.D. Coote, K.Farr and G. Baillargeon. 2008. Monitoring international wildlife trade with coded species data. *Cons. Biol.* 22:4-7.
- Gerson, H., B. Cudmore, N.E. Mandrak, L.D. Coote, K.Farr and G. Baillargeon. 2008. Use of the Taxonomic Serial Number (TSN) as a required data element in international wildlife trade: Response to Fragoso and Ferriss. *Conserv. Biol.* 22:1651-1654.
- Hubert, N., R. Hanner, E. Holm, N.E. Mandrak, E. Taylor, et al. 2008. Identifying Canadian freshwater fishes through DNA barcodes. *PLoS ONE* 3(6):e2490.
- Jelks, H.L., S.J. Walsh, N.M. Burkhead, S. Contreras-Balderas, E. Díaz-Pardo, D.A. Hendrickson, J. Lyons, N.E. Mandrak, F. McCormick, J.S. Nelson, S.P. Platania, B.A. Porter, C.B. Renaud, J. J. Schmitter-Soto, E.B. Taylor, and M.L. Warren, Jr. 2008. Conservation status of imperiled North American freshwater and diadromous fishes. *Fisheries* 33(8):372-407.
- Minns, C.K., J.E. Moore, B.J. Shuter and N.E. Mandrak. 2008. A preliminary national analysis of some key characteristics of Canadian lakes. *Can. J. Fish. Aquat. Sci.* 65: 1763–1778.
- Poos, M.S., N.E. Mandrak and R.L. McLaughlin. 2008. A practical framework for selecting between single species, multi-species, and ecosystem-based recovery plans for imperilled species. *Can. J. Fish. Aquat. Sci.* 65:2656-2666.

Curriculum Vitae – Nicholas Edward Mandrak

- Reid S.M. and N.E. Mandrak. 2008. Historical changes in the distribution of Threatened channel darter (*Percina copelandi*) in Lake Erie with general observations on the beach fish assemblage. J. Great Lakes Res. 34(2):324-333.
- Reid, S.M., C.C. Wilson, N.E. Mandrak, and L.M. Carl. 2008. Population structure and genetic diversity of black redbhorse (*Moxostoma duquesnei*) in a highly fragmented watershed. Conserv. Genet. 9:531–546.
- Reid S.M., and N.E. Mandrak. 2008. Lake Erie beaches: diel variation in fish assemblage structure and implications for monitoring. Hydrobiologia 618:139–148.
- Reid S.M., N.E. Mandrak, L.M. Carl and C.C. Wilson. 2008. Influence of dams and habitat condition on the distribution of redbhorse (*Moxostoma*) species in the Grand River watershed, Ontario. Environ. Biol. Fish. 81:111–125.
- Sheldon, T.A., N.E. Mandrak, and N.R. Lovejoy. 2008. Biogeography of the deepwater sculpin (*Myoxoxcephalus thompsonii*), a Nearctic glacial relict. Can. J. Zool. 86(2):108-115.
- Stammler, K.L., R.L. McLaughlin and N.E. Mandrak. 2008. Streams modified for drainage provide fish habitat in agricultural areas. Can. J. Fish. Aquat. Sci. 65: 509-522.
- Herborg, L.-M., N.E. Mandrak, B. Cudmore, and H.J. MacIsaac. 2007. Comparative distribution and invasion risk of snakehead and Asian carp species in North America. Can. J. Fish. Aquat. Sci. 64:1723-1735.
- Neave, F. B., N. E. Mandrak, M. F. Docker and D. L. Noakes. 2007. Differentiating sympatric *Ichthyomyzon* ammocoetes using meristic, morphological, pigmentation and gonad analyses. Can J. Zool. 85:549-560.
- Lapointe, N.W.R., L.D. Corkum, and N.E. Mandrak. 2007. Seasonal and ontogenic shifts in microhabitat selection by fishes in the shallow waters of the Detroit River, a large connecting channel. Trans. Am. Fish. Soc. 136:155-166.
- Leung, B., and N.E. Mandrak. 2007. The risk of establishment of aquatic invasive species: joining invasibility and propagule pressure. Proceedings of the Royal Society of London Series 274:2603-2609.
- Poos, M.S., N. E. Mandrak and R. L. McLaughlin. 2007. Effectiveness of two common sampling methods for assessing imperiled freshwater fishes. Journal of Fish Biology 70:691–708.
- Beneteau, C.L., N.E. Mandrak and D.D. Heath. 2006. Characterization of eight polymorphic microsatellite DNA markers for the greenside darter, *Etheostoma blennioides* (Percidae). Molecular Ecology Notes 7:641-643.
- Dextrase, A. and N.E. Mandrak. 2006. Impacts of invasive alien species on freshwater fauna at risk in Canada. Biological Invasions 8:13–24.
- Lapointe, N.W.R., L.D. Corkum, and N.E. Mandrak. 2006. A comparison of methods for sampling fish diversity in shallow offshore waters of large rivers. N. Amer. J. Fish. Manage. 26: 503-513.
- Lapointe, N.W.R., L.D. Corkum and N.E. Mandrak. 2006. Point sampling by boat electrofishing- a test of the effort required to assess fish communities. N. Amer. J. Fish. Manage. 26:793-799.
- Minns, C.K., N.E. Mandrak and M. Munawar. 2006. Preface. Journal of Aquatic Ecosystem Health and Management, 9(4):387–389.
- Neave, F.B., N.E. Mandrak, M.F. Docker and D.L. Noakes. 2006. Effects of preservation on pigmentation and length measurements in larval lampreys. J. Fish Biol. 68(4):991-1001.
- Nelson, J.S., H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, N.E. Mandrak and J.D. Williams. 2006. Comment on the proposed reinstatement of the specific name *Sphyraena acus*. Bull. Zool. Nomen. 63(Part 1).
- Nelson, J.S., H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, N.E. Mandrak and J.D. Williams. 2006. Corrections to, “Common and Scientific Names of Fishes from the United States, Canada and Mexico, 6th ed.”. Copeia 2006: 559-562.
- Nelson, J.S., H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, N.E. Mandrak and J.D. Williams. 2006. Corrections to, “Common and Scientific Names of Fishes from the United States, Canada and Mexico, 6th ed.”. Fisheries 31(3): 138-140.
- Chu, C., N.E. Mandrak and C.K. Minns. 2005. Potential impacts of climate change on the distribution of common and rare freshwater fishes in Canada. Distribution and Diversity 11 (4):299-310.
- Munawar, M., I.F. Munawar, N.E. Mandrak, M. Fitzpatrick, R. Dermott and J. Leach. 2005. An overview of the impact of non-indigenous species on the food web integrity of North American Great Lakes: Lake Erie example. J. Aquat. Ecosyst. Health Manag. 8:1-21.

Curriculum Vitae – Nicholas Edward Mandrak

- Fraser, B., N.E. Mandrak and R.L. McLaughlin. 2005. Lack of morphological differentiation of two species of Blacknose Dace (*Rhinichthys atratulus* and *R. obtusus*) in Canada. *Canadian Journal of Zoology* 83:1502–1509.
- Carswell, J.D., K. Gardiner, M. Bertolotto and N.E. Mandrak. 2004. Applications of mobile computing for fish species at risk management. *Environmental Informatics Archives* 2:413-421.
- Vander Zanden, M.J., J.D. Olden, N.E. Mandrak and J.H. Thorne. 2004. Predicting the occurrence and impact of bass introductions on lake trout in central Ontario lakes. *Ecological Applications* 14(1):132–148.
- Chu, C., C.K. Minns, and N.E. Mandrak. 2003. Comparative regional assessment of factors impacting freshwater fish resources in Canada. *Can. J. Fish. Aquat. Sci.* 60: 624-634.
- Eberle, M.E., E.G. Hargett, T.L. Wenke, and N.E. Mandrak. 2002. Changes in fish assemblages, Solomon River basin, Kansas: habitat alterations, extirpations, and introductions. *Trans. Kan. Acad. Sci.* 105: 178-192.
- Hoofer, S.R., J.R. Choate, and N.E. Mandrak. 1999. Mensural discrimination between *Reithrodontomys megalotis* and *R. montanus*. *J. Mammology* 80(1): 91-101.
- Mandrak, N.E. and W.R. Ramshaw. 1998. The status of the Eastern Silvery Minnow, *Hybognathus regius*, in Canada. *Can. Field-Nat.* 112:141-146.
- Holm, E. and N.E. Mandrak. 1996. The status of the Eastern Sand Darter, *Ammocrypta pellucida*, in Canada. *Can. Field-Nat.* 110:462-469.
- Mandrak, N.E. and E.J. Crossman. 1996. The status of the Lake Chubsucker, *Erimyzon sucetta*, in Canada. *Can. Field-Nat.* 110: 478-482.
- Mandrak, N.E. 1995. Biogeographic patterns of fish species richness in Ontario lakes in relation to historical and environmental factors. *Can. J. Fish. Aquat. Sci.* 52: 1462-1474.
- Murphy, R.W., V. Kovac, O. Hadrath, G. Allen, A. Fishbein and N.E. Mandrak. 1995. mtDNA gene sequence, allozyme, and morphological stability among red diamond rattlesnakes, *Crotalus ruber* and *Crotalus exsul*. *Can. J. Zool.* 73:270-281.
- Litvak, M.K. and N.E. Mandrak. 1993. The ecology of the freshwater baitfish industry in Canada and the United States. *Fisheries* 18(12):6-13.
- Mandrak, N.E. and E.J. Crossman. 1992. Postglacial dispersal of freshwater fishes into Ontario. *Can. J. Zool.* 70:2247-2259.
- Mandrak, N.E. 1991. Review of Dynamic Biogeography. *Can. Field-Nat.* 106:620-621.
- Mandrak, N.E. 1989. Potential invasion of the Great Lakes by fish species associated with climatic warming. *J. Great Lakes Res.* 15:306-316.
- B. Books and/or Chapters**
- Drake, D.A.R., and N.E. Mandrak. 2014. How will invasive species impact the future of fisheries? Book Chapter in W.W. Taylor, A.J. Lynch, and N.J. Leonard (eds.), *Future of Fisheries: Perspectives for Emerging Professionals*. American Fisheries Society Publication, Bethesda, MD.
- Page, L., H. Espinosa, L.T. Findley, C.R. Gilbert, R.N. Lea, N.E. Mandrak, R.L. Mayden, and J.S. Nelson. 2013. *Common and scientific names of fishes from the United States, Canada and Mexico*. 7th Edition. American Fisheries Society Special Publication 24. Bethesda, MD, USA.
- Mandrak, N.E. and B.C. Cudmore. 2012. Fish species at risk and non-native fishes in the Great Lakes Basin: Past, Present and Future In: *Great Lakes Policy and Management*, Second Edition. Great Lakes Fishery Commission, Ann Arbor, MI.
- Roth, B.M., N.E. Mandrak, T. Hrabik, G.G. Sass, and J. Peters. 2012. Fishes and decapod crustaceans of the Great Lakes basin. In: *Great Lakes Policy and Management*. Great Lakes Fishery Commission, Ann Arbor, MI.
- Cudmore, B. and N.E. Mandrak. 2011. Assessing the risk of Asian carps in Canada. pp.15-30 In D. Chapman and M. Hoff (eds.), *Asian Carp International Symposium*. American Fisheries Society Special Publication 76, Bethesda MD.
- Holm, E., N.E. Mandrak and M. Burridge. 2009. *The field guide to freshwater fishes of Ontario*. Royal Ontario Museum, Toronto, ON. 464 pp.

Curriculum Vitae – Nicholas Edward Mandrak

Renaud, C.B., M. F. Docker and N.E. Mandrak. 2009. Taxonomy, distribution and conservation of lampreys in Canada. In Biology and Conservation of lampreys in North America. American Fisheries Society Special Publication. Bethesda, MD. American Fisheries Society Symposium 72:293–309.

Mandrak, N.E. and K.E. Brodribb. 2006. How well do parks protect fish species at risk in Ontario? pp. 205-220 In: G. Nelson et al. (eds). Protected areas and species and ecosystems at risk: research and planning challenges. Proceedings of the Parks Research Forum of Ontario Annual Meeting 2005. Parks Research Forum of Ontario, University of Waterloo, Waterloo, ON.

Staton, S.K. and N.E. Mandrak. 2006. Focusing conservation efforts for freshwater biodiversity. Pp. 197-204 In: G. Nelson et al. (eds). Protected areas and species and ecosystems at risk: research and planning challenges. Proceedings of the Parks Research Forum of Ontario Annual Meeting 2005. Parks Research Forum of Ontario, University of Waterloo, Waterloo, ON.

Mandrak, N.E., and E.J. Crossman. 2003. Fishes of Algonquin Park. Friends of Algonquin Park, Whitney, ON.

Wilson, C.C. and N.E. Mandrak. 2003. History and evolution of lake trout in shield lakes: past and future challenges. pp. 21- 35 In: J.M. Gunn, R.J. Steedman and R.A. Ryder (eds.). Boreal shield watersheds: lake trout ecosystems in a changing environment. Lewis Publishers, Boca Raton, FL.

Jackson, D.A. and N.E. Mandrak. 2002. Changing fish biodiversity: predicting the loss of cyprinid biodiversity due to global climate change. pp. 89-98 In: McGinn, N.A. (ed.). Fisheries in a changing climate. American Fisheries Society, Symposium 32, Bethesda, MD.

Litvak, M.K., and N.E. Mandrak. 1999. Baitfish trade as a vector of aquatic introductions. In: R. Claudi and J. Leach (eds.). Non-indigenous freshwater organisms: vectors, biology, and impacts. Lewis Publishers, Boca Raton, FL.

Mandrak, N.E. and E.J. Crossman. 1992. A checklist of Ontario freshwater fishes annotated with distribution maps. Roy. Ont. Mus. Life Sci. Publ., Toronto, ON. 184 pp.

C. Books edited

8. Non-Refereed Publications

Watkinson, D., T. Pratt, and N.E. Mandrak. 2015. COSEWIC update status report for River Darter (*Percina shumardi*). Submitted to COSEWIC. xxiii + 28 pp.

Dextrase, A.J., Mandrak, N.E., Barnucz, J., Bouvier, L.D., Gaspard, R., Reid, S.M. 2014. Sampling effort required to detect fishes at risk in Ontario. Can. Manuscr. Rep. Fish. Aquat. Sci. 3024: v + 50 p.

Colm, J. and N.E. Mandrak. 2014. COSEWIC Status appraisal summary for Grass Pickerel (*Esox americanus vermiculatus*). Submitted to COSEWIC. 15 pp.

Glass, W. and N.E. Mandrak. 2014. COSEWIC Status appraisal summary for Spotted Gar (*Lepisosteus oculatus*). Submitted to COSEWIC. 15 pp.

Glass, W. and N.E. Mandrak. 2014. COSEWIC update status report for Spotted Gar (*Lepisosteus oculatus*). Submitted to COSEWIC. X + 38 pp.

Glass, W.R. and Mandrak, N.E. 2014. Distribution of Spotted Gar (*Lepisosteus oculatus*) adults and juveniles in the Rondeau Bay, Long Point Bay, and Hamilton Harbour watersheds. Can. Manuscr. Rep. Fish. Aquat. Sci. 3048: iii + 21 p.

Glass, W.R., Mandrak, N.E. and M.A. Koops. 2014. Application of the Ecologically Significant Species Criteria to the aquatic community of the Bay of Quinte, Lake Ontario. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/043. v + 32 p.

Mandrak, N.E. and L. Bouvier. 2014. COSEWIC Status appraisal summary for Spotted Sucker (*Minytrema melanops*). Submitted to COSEWIC. 15 pp.

Mandrak, N.E., Boyko, A.L., and S.S. Staton. 2014. Assessment of information required for the identification of critical habitat for Northern Madtom (*Noturus stigmosus*), Spotted Gar (*Lepisosteus oculatus*), Lake Chubsucker (*Erimyzon sucetta*) and Pugnose Shiner (*Notropis anogenus*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/059. v + 44 p.

Gantz, C., Mandrak, N.E., and Keller, R.P. 2013. Application of an aquatic plant risk assessment to non-indigenous freshwater plants in trade in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/nnn. v + 24 p.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E., Boyko, A.L., Staton, S.S. 2013. Assessment of information required for the identification of critical habitat for Northern Madtom (*Noturus stigmosus*), Spotted Gar (*Lepisosteus oculatus*), Lake Chubsucker (*Erimyzon sucetta*) and Pugnose Shiner (*Notropis anogenus*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/nnn. v + 55 p.
- Mandrak, N.E., Gantz, C., Jones, L.A., Marson, D., and Cudmore, B. 2013. Evaluation of five freshwater fish risk assessment protocols and application to non-indigenous organisms in trade in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/nnn. v + 127 p.
- Schroeder, B., Mandrak, N.E., and Cudmore, B.C. 2013. Application of a freshwater mollusc risk assessment to non-indigenous organisms in trade in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/nnn. vi + 27p.
- Bouvier, L.D., and N.E. Mandrak. 2013. Information in support of a Recovery Potential Assessment of Pugnose Minnow (*Opsopoeodus emiliae*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/135. v + 26 p.
- Bouvier, L.D., B.S. Schroeder, and N.E. Mandrak. 2013. Information in support of a Recovery Potential Assessment of Silver Shiner (*Notropis photogenis*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/130. iv + 33 p.
- DFO. 2013. Proceedings of the regional Science Advisory Process on the Recovery Potential Assessment of Pugnose Minnow (*Opsopoeodus emiliae*), 1 November 2012. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2012/048.
- DFO. 2013. Proceedings of the regional Recovery Potential Assessment of Silver Chub (*Macrhybopsis storeriana*); March 5, 2013. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2013/008..
- DFO. 2013. Proceedings of the Recovery Potential Assessment of Silver Shiner (*Notropis photogenis*) in Canada; 24-25 September 2012. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2012/047.
- Mandrak, N.E., L.D. Bouvier, E. Holm, and M. Burrige. 2013. COSEWIC assessment and update status report on the Cutlip Minnow (*Exoglossum maxillingua*) in Canada. Submitted to COSEWIC.
- McCulloch, B.R., L.D. Bouvier, and N.E. Mandrak. 2013. Information in support of a Recovery Potential Assessment of Silver Chub (*Macrhybopsis storeriana*) in Ontario. DFO Can. Sci. Advis. Sec. Res. Doc. 2013/020. v + 36 p.
- Snyder E., Mandrak, N.E., Niblock, H., Cudmore, B. 2013. Developing a screening-level risk assessment prioritization protocol for aquatic non-indigenous species in Canada: review of existing protocols. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/097. vii + 75 p.
- Cudmore, B., N.E. Mandrak, J. Dettmers, D.C. Chapman, and C.S. Kolar 2012. Binational ecological risk assessment of bigheaded carps (*Hypophthalmichthys* spp.) for the Great Lakes basin. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/114. vi + 57 p.
- DFO. 2012. Proceedings of a Workshop on the Canadian Aquatic Invasive Species Rapid Response Framework; June 9-10, 2009. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2012/016.
- DFO. 2012. Proceedings of the regional Science Advisory Process on the Recovery Potential Assessment of Northern Madtom; March 19, 2012. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2012/027.
- DFO. 2012. Recovery potential assessment of Northern Madtom (*Noturus stigmosus*) in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/051.
- Mandrak, N.E., Cudmore, B and Chapman, P.M. 2012. National detailed-level risk assessment guidelines: assessing the biological risk of aquatic invasive species in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/092. vi + 17 p.
- McCulloch, B.R. and N.E. Mandrak. 2012. Information in support of a Recovery Potential Assessment of Northern Madtom (*Noturus stigmosus*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/076. iv + 21 p.
- Bouvier, L.D. and N.E. Mandrak. 2011. Information in support of a Recovery Potential Assessment of Lake Chubsucker (*Erimyzon sucetta*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/048. vi + 23 p.
- Cudmore, B.C., and Mandrak, N.E. 2011. Biological synopsis of Tench (*Tinca tinca*). Can. Manuscr. Rep. Fish. Aquat. Sci. 2904: v + 20 p.
- Locke, A., Mandrak, N.E., and Therriault, T.W. 2011. A Canadian rapid response framework for aquatic invasive species. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/114. vi + 30 p.
- DFO. 2011. Proceedings of the Regional Science Advisory Process on the Recovery Potential Assessment of Lake Chubsucker (*Erimyzon sucetta*); 9 March 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/007.

Curriculum Vitae – Nicholas Edward Mandrak

- Birt, T., N.E. Mandrak, and E. Holm. 2011. COSEWIC assessment and update status report on the Blackstripe Topminnow (*Fundulus notatus*) in Canada. Submitted to COSEWIC.
- Gibson, S.F., N.E. Mandrak, E. Holm, B. Cudmore, and M. Burrige. 2011. COSEWIC assessment and update status report on the Pugnose Minnow (*Opsopoeodus emiliae*) in Canada. Submitted to COSEWIC.
- Mandrak, N.E., D. Watkinson, E. Holm, and M. Burrige. 2011. COSEWIC assessment and update status report on the Silver Chub (*Macrhybopsis storeriana*) in Canada. Submitted to COSEWIC.
- Mandrak, N.E., E. Holm, and M. Burrige. 2011. COSEWIC assessment and update status report on the Pugnose Shiner (*Notropis anogenus*) in Canada. Submitted to COSEWIC.
- Mandrak, N.E., S.F. Gibson, E. Holm, M. Burrige, and P. Dumont. 2011. COSEWIC assessment and update status report on the Bridle Shiner (*Notropis bifrenatus*) in Canada. Submitted to COSEWIC.
- McCulloch, B., N.E. Mandrak, and E. Holm. 2011. COSEWIC assessment and update status report on the Northern Madtom (*Noturus stigmosus*) in Canada. Submitted to COSEWIC.
- Bouvier, L.D., A.L. Boyko and N.E. Mandrak. 2010. Information in support of a Recovery Potential Assessment of Pugnose Shiner (*Notropis anogenus*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/009. vi + 23p.
- Bouvier, L.D. and N.E. Mandrak. 2010. Information in support of a Recovery Potential Assessment of Channel Darter (*Percina copelandi*) in Ontario. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/029. vi + 39 p.
- Bouvier, L.D. and N.E. Mandrak. 2010. Information in support of a Recovery Potential Assessment of Spotted Gar (*Lepisosteus oculatus*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/079. vi + 22 p.
- Clark, D.S., Cooper, T., Doherty, A., Ford, J.K.B., Koops, M.A., Mandrak, N.E., Morris T.J., Smedbol, R.K., 2010. Terms and Concepts Used in the Species at Risk Program. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/082. vi + 33 p.
- Coker, G.A., Ming, D.L., and Mandrak, N.E. 2010. Mitigation guide for the protection of fishes and fish habitat to accompany the Species at Risk Recovery Potential Assessments conducted by Fisheries and Oceans Canada (DFO) in Central and Arctic Region. Vers. 1.0. Can. Manuscr. Rep. Fish. Aquat. Sci. 2904: vi + 40 p.
- DFO. 2010. Proceedings of the Central and Arctic Regional Science Advisory Process on the Recovery Potential Assessment of Pugnose Shiner; 6 October 2009. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2010/012.
- DFO. 2010. Proceedings of the Zonal Science Advisory Process on the Recovery Potential Assessment of Eastern Sand Darter; 2-3 December 2009. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2010/015.
- DFO. 2010. Proceedings of the Zonal Science Advisory Process on the Recovery Potential Assessment of Channel Darter; 30 November – 1 December 2009. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2010/016.
- DFO. 2010. Proceedings of the CSAS Peer-review of the risk assessment for New Zealand mud snail in Canadian waters; 24-25 March 2010. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2010/023.
- DFO. 2010. Proceedings of the Central and Arctic Regional Science Advisory Process on the Recovery Potential Assessment of Spotted Gar in Canada; 23 June 2010. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2010/033.
- DFO. 2010. Proceedings of the National Workshop on Six Invasive Fishes Risk Assessment in British Columbia; 4-6 March 2008. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2009/040.
- DFO. 2010. Proceedings of the National Peer Review of the Risk Assessments of two solitary and three colonial Invasive Tunicates in both Atlantic and Pacific Canadian Waters; March 13-14, 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2009/045.
- Dimond, P.E., Mandrak, N.E., and Brownson, B. 2010. Summary of the rapid response to Round Goby (*Neogobius melanostomus*) in Pefferlaw Brook with an evaluation of the national rapid response framework based on the Pefferlaw Brook experience. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/036. vi + 33 p.
- Mandrak, N.E., J. Barnucz, and D. Marson. 2010. Targeted sampling of fish species at risk in the Grand River watershed, 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2922: v + 29 p.
- Marson, D., J. Barnucz, and N.E. Mandrak. 2010. Fish community sampling in National Wildlife Areas in southwestern Ontario, 2002-2005. Can. Manuscr. Rep. Fish. Aquat. Sci. 2918: v + 47 p.

Curriculum Vitae – Nicholas Edward Mandrak

- DFO. 2009. Proceedings of the Central and Arctic Regional Science Advisory Process on the Assessment of Information Required for the Identification of Critical Habitat for Freshwater Fishes; 29 May 2008. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2009/042. (Chair: N.E. Mandrak; Editor: K. Martin).
- DFO. 2009. Proceedings of the Central and Arctic Regional Science Advisory Process on the Recovery Potential Assessment of Redside Dace, 14 December 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2009/003. (Chair: N.E. Mandrak; Editor: K. Martin).
- DFO. 2009. Zonal Science Peer Review of the American eel (*Anguilla rostrata*) prior to assessment by COSEWIC; 11-12 October, 2005. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2009/028. (Chair: N.E. Mandrak).
- Boyko, A., J. Barnucz, and N. E. Mandrak. 2009. Boat electrofishing survey of the fish assemblages in the Detroit River, Ontario. Canadian Manuscript Report of Fisheries and Aquatic Sciences.
- Boyko, A., and N.E. Mandrak. 2009. Boat electrofishing survey of the St. Lawrence River and Lake St. Francis, 2004. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2831.
- Cudmore, B.C. and N.E. Mandrak. 2009. Snakehead (*Channidae*) trinational risk assessment. pp. 17-24 In: Mendoza, R. et al. 2009. Trinational risk assessment guidelines for aquatic alien invasive species. Commission for Environmental Cooperation, Montreal, QC. 100 pp.
- Dextrase, A.J., E. Holm, N.E. Mandrak, and P. Dumont. 2009. COSEWIC assessment and update status report on the Eastern Sand Darter (*Ammocrypta pellucida*) in Canada. Submitted to COSEWIC.
- Marson, D., B. Cudmore, D.A.R. Drake, and N.E. Mandrak. 2009. Summary of a survey of aquarium owners in Canada. Can. Manuscr. Rep. Fish. Aquat. Sci. 2905: iv + 20 p.
- Marson, D., B. Cudmore, D.A.R. Drake, and N.E. Mandrak. 2009. Summary of a survey of water garden owners in Canada. Can. Manuscr. Rep. Fish. Aquat. Sci. 2906: v + 23 p.
- Marson, D. and N.E. Mandrak. 2009. Sampling of the fish communities in the Saugeen River watershed, 2005-2006. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2828.
- Marson, D., N. E. Mandrak, and J. Barnucz. 2009. Sampling of the fish communities on the First Nations lands on the Thames River, 2005. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2829.
- Marson, D. and N.E. Mandrak. 2009. Survey of the fish assemblages in the nonwadeable waters of the Sydenham River in 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2916: v + 21 p.
- Marson, D., N.E. Mandrak, and D.A.R. Drake. 2009. Targeted sampling of fish species at risk in Lyons and Tea Creeks, 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2910: iv + 18 p.
- McLaughlin, R.L., M.L. Jones, N.E. Mandrak, and D. Stacey. 2009. FishMaP On-Line: a web application supporting science-based decisions concerning fish movement and passage. Great Lakes Fishery Commission 2009 Project Completion Report. 19 pp.
- Mendoza, R. and 19 co-authors (including N.E. Mandrak). 2009. Trinational risk assessment guidelines for aquatic alien invasive species. Commission for Environmental Cooperation, Montreal, QC. 100 pp.
- Doolittle, A., N.E. Mandrak, P. Brunette, D. Ming and C. Bakelaar. 2007. Development of a web mapping tool and distribution maps for Ontario fishes with emphasis on species at risk. Canadian Technical Report of Fisheries and Aquatic Sciences 2699. 45 pp.
- Neave, F.B., G.A. Bravener and N. E. Mandrak. 2007. Conservation status report for silver lamprey (*Ichthyomyzon unicuspis*) in Canada. Canadian Science Advisory Secretariat Research Document 2007/043. 54 pp.
- Neave, F.B., G.A. Bravener and N. E. Mandrak. 2007. COSEWIC Status Report on Silver Lamprey (*Ichthyomyzon unicuspis*). Submitted to COSEWIC.
- Pratt, T.C. and N.E. Mandrak. 2007. Abundance, distribution and identification of the shortjaw cisco (*Coregonus zenithicus*) in the proposed Lake Superior marine protected area. Canadian Technical Report of Fisheries and Aquatic Sciences 2697. 26 pp.
- Sawatzky, C.D., D. Michalak, J.D. Reist, T.J. Carmichael, N.E. Mandrak, and L.G. Heuring. 2007. Distributions of freshwater and anadromous fishes from the Mainland Northwest Territories, Canada. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2793. 239 pp.
- Cudmore, B., A. Wagner, M.A. Koops and N.E. Mandrak (chairperson). 2007. National Case Studies Workshop Evaluating the Quantitative Biological Risk Assessment Tool (QBRAT). November 29-30, 2006. Ottawa ON. Canadian Science Advisory Secretariat Proceedings Series 2007/014. 14 pp.
- Chapman, P.M., B. Cudmore and N.E. Mandrak. 2007. Proceedings of the National Risk Assessment Methods Workshop. Canadian Science Advisory Secretariat Proceedings Series 2006/049. 35 pp.
- Cudmore, B. N.E. Mandrak, T.J. Morris and A. Edwards. 2006. Allowable harm analysis workshops for

Curriculum Vitae – Nicholas Edward Mandrak

freshwater species at risk in Central and Arctic Region, October 18-19, 2005, February, 8-9, 2006, February 13-14, 2006, Burlington, ON. Canadian Science Advisory Secretariat Proceedings Series 2006/026. 14 pp.

Edwards, A., J. Barnucz, and N. E. Mandrak. 2006. Boat electrofishing survey of the fish assemblages in the St. Clair River, Ontario. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2742. 56 pp.

Edwards, A., J. Barnucz, and N. E. Mandrak. 2006. Fish assemblage surveys of Rondeau Bay, Ontario: 2004 – 2005. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2773. 48 pp.

Edwards, A. and N.E. Mandrak. 2006. Fish assemblage surveys of the Lower Thames River, Ontario, using multiple gear types: 2003-2004. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2772: vi + 91 pp.

Mandrak, N.E., J. Barnucz and D. Marson. 2006. Survey of the fish assemblages of St. Lawrence Islands National Park in 2005. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2777.

Mandrak, N.E., J. Barnucz and D. Marson. 2006. Targeted sampling of fish species at risk in the Grand River watershed, 2003. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2778.

Mandrak, N.E., J. Barnucz, D. Marson and G. J. Velema. 2006. Targeted, wadeable sampling of fish species at risk in the Lake St. Clair watershed of southwestern Ontario, 2003. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2779.

Mandrak, N.E., J. Barnucz, G. J. Velema and D. Marson. 2006. Survey of the status of black redbreast (*Moxostoma duquesnei*), and spotted gar (*Lepisosteus oculatus*), in Canada, 2002. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2776.

Mandrak, N.E. and A.J. Dextrase. 2006. Eastern sand darter habitat modeling and reintroduction. Interim Report to Endangered Species Recovery Fund World Wildlife Fund Canada/Environment Canada.

Mandrak, N.E., A. Edwards, B.C. Cudmore and T.J. Morris. 2006. Proceedings of Allowable Harm Analysis Workshops for Freshwater Species at Risk in Central and Arctic Region; October 18-19, 2005; February 8-9, 2006; and February 13-14, 2006. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2006/026.

Marson, D., J. Barnucz and N. E. Mandrak. 2006. Fish community sampling in National Wildlife Areas in southwestern Ontario, 2002-2005. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2780.

Mellow, R., N.E. Mandrak and B.C. Cudmore. 2006. Update COSEWIC Status report on the Blackfin Cisco *Coregonus nigripinnis*. Submitted to COSEWIC.

Reid, S.M. and N.E. Mandrak. 2006. Evaluation of potential impact of Springbank Dam restoration on black redbreast (*Moxostoma duquesnei*) and other sucker species in the Thames River, Ontario. Can. Tech. Rpt. Fish. Aquat. Sci. 2670: 31 pp.

Cudmore, B. and N.E. Mandrak. 2005. Risk assessment for Northern Snakehead (*Channa argus*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2005/075.

Cudmore, B., T. J. Morris and N. E. Mandrak. 2005. Determining a recovery approach for freshwater Species at Risk in Ontario. DFO Can. Sci. Advis. Sec. Res. Doc. 2005/076.

Dick, T. N.E. Mandrak, B. Cudmore, and J. Reist. 2005. COSEWIC status report on the Lake Sturgeon, *Acipenser fulvescens*, in Canada. Submitted to COSEWIC.

Jones, N.E., N.E. Mandrak and N. Kim. 2005. Methods for sampling fishes and their habitats in Ontario's flowing waters: Proceedings of the Flowing Waters Working Group Workshop. Ontario Ministry of Natural Resources. Peterborough, ON. 15 pp.

Mandrak, N.E. and B. Cudmore. 2005. Update COSEWIC status report on Bigmouth Buffalo, *Ictiobus cyprinellus*. Submitted to COSEWIC.

Mandrak, N.E. and B. Cudmore. 2005. Update COSEWIC status report on Black Buffalo, *Ictiobus niger*. Submitted to COSEWIC.

Mandrak, N.E. and B. Cudmore. 2005. Update COSEWIC status report on Flathead Catfish, *Pylodictis olivaris*. Submitted to COSEWIC.

Mandrak, N.E., B. Cudmore, and E.J. Crossman. 2005. Update COSEWIC status report on Lake Chubsucker, *Erimyzon sucetta*. Submitted to COSEWIC.

Mandrak, N.E., B. Cudmore and D. Noltie. 2005. Update COSEWIC status report on Orangespotted Sunfish, *Lepomis humilis*. Submitted to COSEWIC.

Neave, F., N.E. Mandrak and D. Cuddy. 2005. Updated status of the Northern Brook Lamprey, *Ichthyomyzon fossor*, in Canada. Submitted to COSEWIC.

Reid, S.M., N.E. Mandrak, and J. Barnucz. 2005. Inventory and habitat characterization for the north-

Curriculum Vitae – Nicholas Edward Mandrak

shore Lake Erie populations of the channel darter. Annual Report to COA.

Sheldon, T.A., N.E. Mandrak, J.M. Casselman, C.C. Wilson, and N.R. Lovejoy. 2005. Update COSEWIC status report on Deepwater Sculpin, *Myoxocephalus thompsonii*. Submitted to COSEWIC.

Tremblay, V., D.K. Cairns, F. Caron, J.M. Casselman and N.E. Mandrak. 2005. COSEWIC status report on the American eel, *Anguilla rostrata*. Submitted to COSEWIC.

Cudmore, B. and N.E. Mandrak. 2004. Biological synopsis of grass carp (*Ctenopharyngodon idella*). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2705.

Mandrak, N.E. 2004. Update status of the Kiyi, *Coregonus kiyi*, in Canada. Submitted to COSEWIC.

Mandrak, N.E. 2004. Update status of the Shortnose Cisco, *Coregonus reighardi*, in Canada. Submitted to COSEWIC.

Mandrak, N.E. and B. Cudmore. 2004. Risk assessment for Asian carps in Canada. Canadian Stock Assessment Secretariat Research Document 2004/103.

Mandrak, N.E. and B. Cudmore. 2004. Update status of the Spotted Gar, *Lepisosteus oculatus*, in Canada. Submitted to COSEWIC.

Mandrak, N.E. and B. Cudmore. 2004. Update status of the Warmouth, *Lepomis gulosus*, in Canada. Submitted to COSEWIC. Mandrak, N.E. and S. Reid. 2004. Update status of the Black Redhorse, *Moxostoma duquesnei*, in Canada. Submitted to COSEWIC.

Reid, S. and N.E. Mandrak. 2004. Update status of the River Redhorse, *Moxostoma carinatum*, in Canada. Submitted to COSEWIC.

Reid, S. and N.E. Mandrak. 2004. Update status of the Spotted Sucker, *Minytrema melanops*, in Canada. Submitted to COSEWIC.

Holm, E. and N.E. Mandrak. 2003. Updated status of the Silver Chub, *Macrhybopsis storeriana*, in Canada. Submitted to COSEWIC.

Mandrak, N.E. and E. Holm. 2003. Updated status of the Blackstripe Topminnow, *Fundulus notatus* in Canada. Submitted to COSEWIC.

Stirling, C.H., E.M.P. Chadwick, D. Duplisea, N.E. Mandrak and E. D. Richards. 2003. Report of the National Science Workshop 2003, Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, St. John's, NL / Atelier national des sciences 2003, Peches et Oceans Canada, Centre des peches de l'Atlantique nord-ouest, St. John's, T.-N. Canadian Technical Report of Fisheries and Aquatic Sciences 2530.

Holm, E. and N.E. Mandrak. 2002. Update COSEWIC status report on the Pugnose Shiner *Notropis anogenus* in Canada. Submitted to COSEWIC.

Holm, E. and N.E. Mandrak. 2002. Updated status of the Silver Chub, *Macrhybopsis storeriana*, in Canada. Submitted to COSEWIC.

Mandrak, N.E. 2001. The status of introduced fish species in Algonquin Provincial Park. Final Report to the Ontario Ministry of Natural Resources.

Mandrak, N.E. 2000. The development of a national fish distribution database. Final Report to the Canada Department of Fisheries and Oceans.

Mandrak, N.E. 1999. An aquatic ecoregion classification for Ontario. Final Report to the Ontario Ministry of Natural Resources.

Mandrak, N.E. 1998. An assessment of the suitability of using a terrestrial ecoregion classification to protect aquatic biodiversity in Ontario. Final Report to the Ontario Ministry of Natural Resources.

Eberle, M.E., T.L. Wenke, and N.E. Mandrak. 1998. Assessment of the Solomon River, North Fork Solomon River, and South Fork Solomon River in northwestern Kansas. Final Report to Kansas Department of Wildlife and Parks and the U.S. Bureau of Reclamation.

Eberle, M.E., S. Hoofer, N. Mandrak and T.L. Wenke. 1997. Assessment of fish communities in western Kansas streams during 1994-1996. Final Report to U.S. Fish and Wildlife Service.

Mandrak, N.E., M.E. Eberle and T.L. Wenke. 1997. Assessment of the Republican River, White Rock Creek and Prairie Dog Creek in Kansas. Final Report to Kansas Department of Wildlife and Parks and the U.S. Bureau of Reclamation.

Crossman, E.J. and N.E. Mandrak. 1992. Fish communities of Algonquin Park. Final Report to the Ontario Ministry of Natural Resources.

9. Manuscripts/publications, etc. in preparation and submitted to publishers but not yet accepted.

- Drake, D.A.R., and N.E. Mandrak. 2014. Canada's other freshwater commercial fishery: science and management of baitfishes in response to shifting ecological and socioeconomic baselines. In: S. Cooke (ed.). *Freshwater fisheries in Canada: historical and contemporary perspectives on the resources and their management*. American Fisheries Society, Bethesda, MD. (submitted)
- Glass, W.R., R.P. Walter, D.D. Heath, N.E. Mandrak, and L.D. Corkum. DNA analysis reveals presence of Threatened Spotted Gar (*Lepisosteus oculatus*) in Canadian commercial fish market. *Ecol. and Evol.* (submitted)
- Howeth, J.G., C.A. Gantz, P.L. Angermeier, E.A. Frimprong, M.H. Hoff, R.P. Keller, N.E. Mandrak, M.P. Marchetti, J.D. Olden, C.M. Romagosa, and D.M. Lodge. Predicting invasiveness of species in trade: climate match, trophic guild, and fecundity influence invasion success of nonnative freshwater fishes. *Diversity and Distributions* (submitted)
- Jelks, H.L., Burkhead, N.M., N.E. Mandrak, J.J. Schmitter-Soto, J. Staiger, S.J. Walsh. Conservation of North American inland fishes: what is being done to preserve ichthyodiversity? In M. Warren and S.J. Walsh (eds.). *Freshwater Fishes of North America*, Volume 2. Johns Hopkins Press, Baltimore, MD. (submitted)
- Taylor, E.B., N.E. Mandrak, J.R. Post, and J.D. Reynolds. Conservation of Canadian freshwater fishes: current status, challenges, and research needs. In: S.J. Cooke (ed.). *Freshwater fisheries in Canada: historical and contemporary perspectives on the resources and their management*. American Fisheries Society, Bethesda, MD. (submitted)
- MacIsaac, H., and N.E. Mandrak. Introduced freshwater fishes in Canada. In Cooke, S. (ed). *Freshwater fishes and fisheries in Canada*. American Fisheries Society, Baltimore, MD. (in prep)
- Mandrak, N.E., A. Curry, P. Dumont, E. Holm, J. Reist, E. Taylor, and D. Watkinson. *Atlas of the freshwater fishes of Canada*. Royal Ontario Museum, Toronto, ON. (in prep)
- Mandrak, N.E., J.R. Post, J. Reynolds, and E. Taylor. Conservation of freshwater fishes in Canada. In S. Cooke (ed). *Freshwater fishes and fisheries in Canada*. American Fisheries Society, Baltimore, MD. (in prep)
- Mandrak, N.E., A. Curry, P. Dumont, J. Reist, E. Taylor, and D. Watkinson. Zoogeography of freshwater fishes in Canada. In Cooke, S. (ed). *Freshwater fishes and fisheries in Canada*. American Fisheries Society, Baltimore, MD. (in prep)
- Nico, L., N.E. Mandrak, and S. Contreras-Balderas. Introduced freshwater fishes in North America. In M. Warren and S.J. Walsh (eds.). *Freshwater Fishes of North America*, Volume 2. Johns Hopkins Press, Baltimore, MD. (in prep)
- Woodford, D.J., H.J. MacIsaac, D.M. Richardson, N.E. Mandrak, B.W. van Wilgen, J. Wilson, and O.L.F. Weyl. Confronting the wicked problem of managing invasive species. *Frontiers in Ecology and the Environment*. (in prep)
10. Papers presented at meetings and symposia (2002-present)
- Balasingham, K.B.*, Mandrak, N.E., Walter, R.P., and Heath, D.D. 2015. eDNA-based detection of rare and invasive species in southern Ontario: the Little River experiment. Canadian Aquatic Invasive Species Network (CAISN), Halifax, NS. April 2015.
- Campbell, S.E.*, and N.E. Mandrak. 2015. Changes in functional diversity of fish species in the Great Lakes, 1870-2010. Annual General Meeting of the American Fisheries Society- Ontario Chapter. Orillia, ON. February 26th-28th.
- Castañeda, R.A.*, O.L.F. Weyl, and N.E. Mandrak. 2015. Developing a novel detection technique for rare freshwater fishes. Annual General Meeting of the Canadian Aquatic Invasive Species Network. Halifax, NS. April 27, 2015.
- Colm, J.E.*, N.E. Mandrak, and B.L. Tufts. 2015. Fish Community Change in Jones Creek- highlights for Grass Pickerel (*Esox americanus vermiculatus*). 68th Annual Canadian Conference for Fisheries Research. Ottawa, ON. January 9, 2015.

Curriculum Vitae – Nicholas Edward Mandrak

- Finigan, P.A.*, N.E. Mandrak, and B.L. Tufts. 2015. Littoral Fish Community Change in Southeastern Ontario. Canadian Conference for Fisheries Research. Ottawa, ON. January 8, 2015.
- Finigan, P.A.*, N.E. Mandrak, and B.L. Tufts. 2015. Littoral Fish Community Change in Southeastern Ontario. Annual General Meeting of the American Fisheries Society: Ontario Chapter. Orillia, ON. February 26, 2015.
- Gaspard, R.*, Barnucz, J., Bouvier, L., Glass, W.R., and Mandrak, N.E. 2015. Habitat use of Silver Shiner (*Notropis photogenis*), a Threatened species, in its known range in the Great Lakes basin. Canadian Conference for Fisheries Research. Ottawa, ON. January 9, 2015.
- Gaspard, R.*, Barnucz, J., Bouvier, L., Glass, W.R., and Mandrak, N.E. 2015. Silver Shiner: habitat descriptions and distribution in Ontario. General Meeting of the American Fisheries Society Ontario Chapter. Orillia, ON. February 28, 2015.
- Kindree, M.M.*, and N.E. Mandrak. 2015. Effect of sampling gear and effort on the Index of Biotic Integrity in the Huron-Erie Corridor. Annual General Meeting of the American Fisheries Society- Ontario Chapter. Orillia, ON. February 26-28, 2015.
- Kim, J.-W.* and Mandrak, N.E. 2015. Evaluation of non-permanent barrier technologies to prevent fish movements: a mesocosm study. Midwest Fish and Wildlife Conference, Indianapolis, IN, February 2015.
- Kim, J.-W.* and Mandrak, N.E. 2015. A mesocosm study: evaluation of non-permanent barrier technologies to prevent fish movements. Canadian Conference for Fisheries Research (CCFFR), Ottawa, ON. January 2015.
- Kim, J.-W.* and Mandrak, N.E. 2015. Understanding freshwater fish movement through Welland Canal using acoustic telemetry. American Fisheries Society Annual Meeting, Portland, OR. August 2015.
- Kim, J.-W.* Mandrak, N.E., and Gross, J. 2015. The effectiveness of non-physical barriers for fish movement: water gun, boomers, bubble, sound, and alarm cue. American Fisheries Society Annual Meeting, Portland, OR. August 2015.
- Kramski, N.A.*, N.E. Mandrak, and R.L. McLaughlin. 2015. Conservation of fishes in altered ecosystems: the movement ecology of grass Pickerel in an agricultural drain. 68th Annual Canadian Conference for Fisheries Research. Ottawa, ON. January 11, 2015.
- Mandrak, N. 2015. Predicting fish invaders using trait-based models: lessons from the Laurentian Great Lakes. American Fisheries Society Annual Meeting, Portland, OR. August 2015.
- Raab, D.*, N.E. Mandrak, and A. Ricciardi. 2015. Round Goby impact on native fishes in a flow-modified tributary. 2015 Annual General Meeting of the Canadian Aquatic Invasive Species Network II. Halifax, NS. April 27, 2015.
- Raab, D.*, N.E. Mandrak, and A. Ricciardi. 2015. Round Goby impact on native fishes in a flow-modified tributary. 2015 Annual Meeting of the Association for the Study of Limnology and Oceanography. Granada, Spain. February 23, 2015.
- Rook, N.A.*, N.E. Mandrak, and S.M. Reid. 2015. Recolonization trends in fish communities following the restoration of a Great Lakes coastal wetland. American Fisheries Society Ontario Chapter Annual Meeting. Orillia, ON. February 26-28, 2015.
- Bouvier, L.D.*, N.E. Mandrak, and T.J. Morris. 2014. Implementing the Canadian Species at Risk Act: the role of science advice for freshwater taxa. American Fisheries Society Annual Conference, Quebec City, QC. August 2014.
- Balasingham, K.B.* Mandrak, N.E., Walter, R.P., Barnucz, J., and Heath, D.D. 2014. eDNA-based detection of invasive species threats to rare stream fishes in southern Ontario. Canadian Aquatic Invasive Species Network (CAISN), Gatineau, QC. April 2014.
- Glass, W.*, and N.E. Mandrak. 2014. Detection probability of Spotted Gar in Canada, based on gear type. American Fisheries Society Annual Conference, Quebec City, QC. August 2014.
- Kim, J.-W., Mandrak, N.E., Marson, D., Cudmore B. 2014. Evaluating fish movement through the Welland Canal: an update. Great Lakes Acoustic Telemetry Observation System Coordination Meeting (GLATOS), Ann Arbor, MI. March 2014.
- Kim, J.W.*, N.E. Mandrak, D. Marson, and B. Cudmore. 2014. Quantifying the direct movement of fishes through the Welland Canal using acoustic telemetry. American Fisheries Society Annual Conference, Quebec City, QC. August 2014.
- Malcolm, G.*, N.E. Mandrak, D.A. Jackson, and C.K. Minns. 2014. Optimizing the COSEWIC criterion of location: freshwater fishes as a case study. American Fisheries Society Annual Conference, Quebec City, QC. August 2014.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E. 2014. The Great Lakes have changed, but not homogenized. American Society of Ichthyologists and Herpetologists Annual Conference, Chattanooga, TN. July 2014.
- McCusker, M.R.*, N.E. Mandrak, and N.R. Lovejoy. 2014. Population Viability analysis of an endangered minnow using a metapopulation model. 1st Joint Conference Canadian Society for Ecology and Evolution, Canadian Society of Zoology, and the Society of Canadian Limnologists: Genomes to Biomes Conference. Montreal QC. May 25-29, 2014.
- McCusker, M.R., N.E. Mandrak, and N.R. Lovejoy. 2014. Population Viability Analysis for the Pugnose Shiner, *Notropis anogenus*, in the St. Lawrence River. Joint Ontario Species at Risk Planning-Science Meeting, Fisheries and Oceans Canada, Burlington, ON. October 23, 2014.
- Raab, D.*, N.E. Mandrak, and A. Ricciardi. 2014. Competition among invasive Round Goby and a native benthic fishes across an environmental gradient. 2014 Annual Student Retreat of the McGill Conservation Ecology and Evolutionary Biology Group. Mont St. Hilaire, QC. April 4, 2014.
- Raab, D.*, N.E. Mandrak, and A. Ricciardi. 2014. Going against the flow? Round Goby abundance varies along physical gradients in a dammed Great Lakes tributary. 144th Annual Meeting of the American Fisheries Society. Quebec City, QC. August 18, 2014.
- Raab, D.*, N.E. Mandrak, and A. Ricciardi. 2014. Round Goby invasion of a dammed Great Lakes tributary: factors affecting abundance. 2014 Annual General Meeting of the Canadian Aquatic Invasive Species Network II. Gatineau, QC. April 28, 2014.
- Wellband, K.*, R.P. Walter, N.E. Mandrak, A.T. Fisk, and D.D. Heath. 2014. Stomach content DNA from predatory fishes: environmental sampling of trophic relationships. American Fisheries Society Annual Conference, Quebec City, QC. August 2014.
- Balasingham, KB*, Mandrak, NE., Walter, RP., Barnucz, J., and Heath, DD. 2013. eDNA and Next-generation sequencing to detect species at risk in southern Ontario. Poster presented at the State of Strait (SOS) conference at GLIER and Lake Erie Millennium Network (LEMN) conference, University of Windsor, ON, CA.
- Brinsmead, J.K.*, B. Koenig, D.A.R. Drake, N.E. Mandrak, D. Copplesstone, and D. Mitchell. 2013. One of these things is not like the others: prevalence of non-target species in commercial baitfish in Ontario. 18th International Conference on Aquatic Invasive Species. Niagara Falls, ON. April 22, 2013.
- Glass, W.R.*, Walter, R., Heath, D., Mandrak, N.E., and Corkum, L.D. 2013. Conservation implications of genetic structure among core and northern edge populations of Spotted Gar (*Lepisosteus oculatus*), based on microsatellite analyses. General Meeting of the American Fisheries Society Ontario Chapter. Orillia, ON. February 28, 2013.
- Glass, W.R.*, Corkum, L.D., and Mandrak, N.E. 2013. Conservation of fish species at risk in Canada: populations at the edge of their range. 143rd annual Meeting of the American Fisheries Society. Little Rock, AK. September 12, 2013.
- Kim, J.-W.*, Mandrak, N.E., Marson, D. and Cudmore, B. 2013. Evaluation of various non-permanent barrier technologies to prevent fish movements: a mesocosm study. American Fisheries Society (AFS), Little Rock, AR. August 2013.
- Kim, J.-W.* and Mandrak, N.E. 2013. Evaluating the risk of direct movement of fishes through the Welland Canal. International Conference on Aquatic Invasive Species (ICAIS), Niagara Falls, ON. May 2013.
- Kramski, N.A.*, N.E. Mandrak, and R.L. McLaughlin. 2013. Movements of Listed Grass Pickerel *Esox americanus vermiculatus* in an Agricultural Drain and the Implications for Drain Maintenance. 66th Annual Canadian Conference for Fisheries Research. Windsor, ON. January 5, 2013.
- Kramski, N.A.*, N.E. Mandrak, and R.L. McLaughlin. 2013. Movements of listed Grass Pickerel in an agricultural drain and the implications for drain maintenance. Canadian Society of Zoologists Meeting. Guelph, ON. May 14, 2013.
- Kramski, N.A.*, N.E. Mandrak, and R.L. McLaughlin. 2013. Movements of listed Grass Pickerel *Esox americanus vermiculatus* in an agricultural drain and the implications for drain maintenance. 56th Annual Conference of the International Association for Great Lakes Research. West Lafayette, IN. June 5, 2013.
- Marson, D.*, Kim, J.-W., Cudmore, B. and Mandrak, N.E. 2013. Evaluating fish movement through the Welland Canal using acoustic telemetry. Annual Meeting of Ontario Chapter of the American Fisheries Society (AFS-ON). Orillia, ON. March 2013.

Curriculum Vitae – Nicholas Edward Mandrak

- Kim, J.-W., Mandrak, N.E., Marson, D. and Cudmore, B. 2013. Evaluating the direct movement of fishes through the Welland Canal using acoustic telemetry. American Fisheries Society (AFS), Little Rock, AR. August 2013.
- Kim, J.-W., Mandrak, N.E., Marson, D., Cudmore B. 2013. Evaluating fish movement through the Welland Canal using Acoustic telemetry. Great Lakes Acoustic Telemetry Observation System Coordination Meeting (GLATOS), Ann Arbor, MI. March 2013.
- McCusker, M.R.*, N.E. Mandrak, and N.R. Lovejoy. 2013. Modeling extinction risk of an endangered minnow in the upper St. Lawrence River. International Biogeography Society Conference: The Geography of Species Associations. Montreal, QC. November 15-17, 2013.
- Glass, W.R., Walter, R., Heath, D., Mandrak, N.E., and Corkum, L.D. 2012. Novel molecular phylogeny of the Lepisosteidae and identification of specimens of unknown origin. General Meeting of the American Fisheries Society Ontario Chapter. Woodview, ON. March 3, 2012.
- Glass, W.R., Walter, R., Heath, D., Mandrak, N.E., and Corkum, L.D. 2012. Novel molecular phylogeny of the Lepisosteidae and identification of specimens of unknown origin. Ecological and Evolutionary Ethology of Fishes. Windsor, ON. June 20, 2012.
- McCusker, M.R., N.E. Mandrak, and N.R. Lovejoy. 2012. Population fragmentation and decline in the endangered Pugnose Shiner. Evolution Conference, 1st Joint Congress on Evolutionary Biology including the American Society of Naturalists (ASN), the Canadian Society for Ecology and Evolution (CSEE) the European Society for Evolutionary Biology (ESEB), the Society for the Study of Evolution (SSE), and the Society of Systematic Biologists (SSB). Ottawa, ON. July 6-10, 2012
- Glass, W.R., Corkum, L.D., and Mandrak, N.E. 2011. Molecular phylogeny of the family Lepisosteidae. Canadian Conference for Fisheries Research. Toronto, ON. January 7, 2011.
- Drake*, D.A.R., N.E. Mandrak, and H.H. Harvey. 2010. From incidental harvest to release: quantifying the likelihood of introducing aquatic invasive species through the baitfish industry in Ontario. 53rd Annual International Association of Great Lakes Research Conference. Toronto, Ontario. 17-21 May 2010.
- Drake*, D.A.R., N.E. Mandrak, and H.H. Harvey. 2010. Evaluating concern for freshwater bycatch within a Canadian bait fishery. 140th Annual Meeting of the American Fisheries Society. Pittsburgh, Pennsylvania, 12-16 September, 2010.
- Glass, W.R.*, L.D. Corkum and N.E. Mandrak Evaluating habitat utilization of the Threatened Spotted Gar (*Lepisosteus oculatus*) in Rondeau Bay with the aid of radiotelemetry. 53rd Conference on Great Lakes Research. Toronto, Ontario, Canada. May 17-21, 2010.
- Granados, M, N.E. Mandrak, and D.A. Jackson. Detecting changes in fish communities in response to habitat rehabilitation: a comparison of multimetric and multivariate approaches. 53rd Conference on Great Lakes Research. Toronto, Ontario, Canada. May 17-21, 2010.
- Granados, M, Mandrak, N.E. and D.A. Jackson. Constructing reference conditions through best professional judgment. 5th Annual Meeting of the Canadian Society for Ecology and Evolution. Quebec City, Quebec, Canada. May 9-12, 2010.
- Gray*, S., L. Chapman, and N.E. Mandrak. Turbidity affects behaviour of the Endangered Pugnose Shiner, *Notropis anogenus*. International Conference for Conservation Biology, Edmonton, AB. July 2010.
- Hedges*, K.J., N.E. Mandrak, M.A. Koops and O.E. Johannsson. If you build it, will they come (or stay)? Summary and assessment of Great Lakes Aquatic Protected Areas Canadian Conference for Fisheries Research, Winnipeg, MB. January 2010.
- Mandrak*, N.E., J. Barnucz, and K. Hedges. Evaluating the effects of agricultural drain maintenance on grass pickerel, a species of special concern. Conference for Fisheries Research, Winnipeg, MB. January 2010.
- McCusker*, M.R., N.E. Mandrak and N.R. Lovejoy, Genetic variation in an endangered minnow throughout its native range. Canadian Conference for Fisheries Research, Winnipeg, MB. January 2010.
- McLaughlin*, R., M. Jones, N.E. Mandrak, D. Stacey, D., and J. Cote. FishMaP: a web application supporting science-based decisions concerning fish movement and passage. 53rd Conference on Great Lakes Research. Toronto, Ontario, Canada. May 17-21, 2010.
- Stammler*, K.L., Bailey R.C., Yates, A.G. and N.E. Mandrak. Extent and characteristics of enclosed watercourses and their effects on downstream aquatic ecosystems. 42nd Drainage Engineers Conference. Guelph, ON. October 22, 2010.

Curriculum Vitae – Nicholas Edward Mandrak

- Stammler*, K.L., R.C. Bailey, and N.E. Mandrak. Responses of downstream aquatic ecosystems across a gradient of headwater enclosure in agricultural streams. Headwater stream symposium at the American Fisheries Society 140th Annual Meeting. Pittsburgh, PA. September 12-17, 2010.
- Stammler*, K.L., B. Ward-Campbell, R.L. McLaughlin, R.C. Bailey, and N.E. Mandrak. Biological fisheries implications of agricultural drainage practices. Stressors, Habitat, and Biology in Agricultural Streams: A 1-Day Workshop. Utopia, ON. February 17, 2010.
- Drake, D.A.R.*, H.H. Harvey, and N.E. Mandrak. 2009. Investigating patterns of risk activity within an invasion pathway. 16th International Conference on Aquatic Invasive Species, Montreal, Quebec. May 2009.
- Drake, D.A.R.*, H.H. Harvey, and N.E. Mandrak. 2009. Quantifying the likelihood of introducing aquatic invasive species through the baitfish industry in Ontario. Annual General Meeting of the Canadian Aquatic Invasive Species Network, Halifax, Nova Scotia. April 2009.
- Drake, D.A.R.*, H.H. Harvey, and N.E. Mandrak. 2009. Quantifying the likelihood of introducing aquatic invasive species through the baitfish industry in Ontario. 52nd Annual International Association of Great Lakes Research Conference, Toledo, Ohio. May 2009.
- Drake, D.A.R.*, N.E. Mandrak, and H.H. Harvey. 2009. Investigating patterns of risk activity within an invasion pathway. 16th International Conference for Aquatic Invasive Species. Montreal, QC. April 21, 2009.
- Drake, D.A.R.*, N.E. Mandrak, and H.H. Harvey. 2009. Quantifying the dispersal potential of aquatic invasive species using vector-based risk models. 62nd Annual Canadian Conference for Fisheries Research. Ottawa, ON. January 10, 2009.
- Glass, W.R.*, L.D. Corkum and N.E. Mandrak. 2009. Home range and critical habitat of the Threatened Spotted Gar (*Lepisosteus oculatus*) in Rondeau Bay, Southwestern Ontario, Canada. Annual Meeting of the Southern Division of the American Fisheries Society. New Orleans, LA. January 17, 2009.
- Granados, M.*, N.E. Mandrak, and D.A. Jackson. 2009. Measuring changes in the fish assemblages of the Huron-Erie Corridor Areas of Concern. 52nd Conference on Great Lakes Research. Toledo, Ohio, USA. May 18-22, 2009.
- Granados, M.*, N.E. Mandrak, and D.A. Jackson. 2009. Measuring fish community change in the Detroit River. 2009 State of the Strait Conference. Windsor, Ontario, Canada. April 28, 2009.
- Granados, M.*, N.E. Mandrak, and D.A. Jackson. 2009. Assessing the Application of the Index of Biotic Integrity in Areas of Concern. 62nd Canadian Conference for Fisheries Research. Ottawa, Ontario, Canada. January 9-11, 2009.
- Harpur, C.*, N.E. Mandrak and H.H. Harvey. 2009. Examining natural variation in the inland lake fish communities in Bruce Peninsula National Park, Ontario. 62nd Canadian Conference For Fisheries Research. Ottawa, ON. January, 11, 2009.
- Mandrak, N.E. 2009. GlobalFish: an environmental matching tool for freshwater organisms. 16th International Conference for Aquatic Invasive Species. Montreal, QC. April 21, 2009.
- Stammler, K.L.*, R.C. Bailey, and N.E. Mandrak. 2009. Downstream effects of headwater enclosures on fishes and their habitat. Headwater stream symposium at the American Fisheries Society 139th Annual Meeting. Nashville, Tennessee. August 30-September 3, 2009.
- Stammler, K.L.*, R.C. Bailey, and N.E. Mandrak. 2009. Effects of enclosing headwaters on downstream agro-ecosystems: Hierarchical variability in biota and their environment. Impacts of agriculture on stream ecosystems symposium at the North American Benthological Society, 57th Annual Meeting. Grand Rapids, MI. May 17-22, 2009.
- April, J.*, and 11 others (including N.E. Mandrak). 2009. Identifying Canadian freshwater fishes through DNA barcodes. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.
- Chu, C.*, N. Jones, N.E. Mandrak, A. Piggott, and C.K. Minns. 2008. Air temperature, groundwater discharge and climate change influences on the thermal diversity of stream fishes in southern Ontario. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.
- Corkum, L.D.*, N.E. Mandrak, and S.N. Dopazo. 2008. Fish assemblages and environmental factors Associated with gobiids in the Huron-Erie Corridor. 51st Annual Conference on Great Lakes Research, Peterborough, ON. May 2008.
- Dextrase, A.J.*, and N.E. Mandrak. 2008. Modeling habitat of the imperiled Eastern Sand Darter at multiple scales to help guide recovery and repatriation efforts. American Fisheries Society Annual Meeting. Ottawa, ON. August 18, 2008.

Curriculum Vitae – Nicholas Edward Mandrak

- Dextrase, A.J.*, and N.E. Mandrak. 2008. Eastern Sand Darter habitat modeling and reintroduction. E. J. Crossman Symposium, Ontario Chapter of the American Fisheries Society. Burlington, ON. October 17, 2008.
- Drake, A.*, N.E. Mandrak and H.H. Harvey. 2008. Forecasting invasion pathways: using gravity models to predict angler movement. 1st Annual American Fisheries Society - Ontario Chapter Student Colloquium. Kingston, ON. March 1, 2008.
- Drake, A.*, N.E. Mandrak and H.H. Harvey. 2008. Quantifying the spread of aquatic invasive species, genes and pathogens: the baitfish industry in Ontario as a model system. 51st Annual International Association of Great Lakes Research Conference. Peterborough, ON. May 21, 2008.
- Drake, A.*, N.E. Mandrak and H.H. Harvey. 2008. Forecasting invasion pathways: using gravity models to predict angler movement. 138th Annual Meeting of the American Fisheries Society. Ottawa, ON. August 19, 2008.
- Edwards, A.*, N.E. Mandrak, and S. Staton. 2008. Approaches to identifying critical habitat for Northern Madtom (*Noturus stigmosus*) in Canada. 138th Annual Meeting of the American Fisheries Society. Ottawa, ON. August 2008.
- Glass, W.R.*, L.D. Corkum, and N.E. Mandrak. 2008. Age and growth of the Threatened Spotted Gar in Rondeau Bay, Southwestern Ontario. American Fisheries Society Annual Conference. Ottawa, ON. August 20, 2008.
- Glass, W.R.*, L.D. Corkum, and N.E. Mandrak. 2008. Age and growth of the Threatened Spotted Gar in Rondeau Bay, Southwestern Ontario, Canada. II Reunion Internacional Sobre la Investigacion y Manejo De Los Lepisosteidos. Heredia, Costa Rica. September 26, 2008.
- Glass, W.R.*, L.D. Corkum, and N.E. Mandrak. 2008. Age and growth of the Threatened Spotted Gar in Rondeau Bay, southwestern Ontario. E.J. Crossman Award Symposium. Burlington, ON. October 17, 2008.
- Granados, M.*, N.E. Mandrak, and D.A. Jackson. 2008. Assessing the Index of Biotic Integrity as a measure of Remedial Action Plan status in Areas of Concern. 138th American Fisheries Society Annual Meeting. Ottawa, ON. August 17-21, 2008.
- Hedges, K.*, N., Mandrak, M. Koops, and O. Johannsson. 2008. Parking on the water: evaluating the management and conservation of Great Lakes fishes through Aquatic Protected Areas. American Fisheries Society Annual Meeting. Ottawa, ON. August 21, 2008.
- Hedges, K.*, N., Mandrak, M. Koops, and O. Johannsson. 2008. Aquatic protected areas in the Great Lakes: inventory, evaluation and GAP analysis. International Association of Great Lakes Research. Peterborough, ON. May 20, 2008.
- Hedges, K.*, N., Mandrak, M. Koops, and O. Johannsson. 2008. Aquatic Protected Areas in the Great Lakes: Inventory, Evaluation and GAP Analysis. Great Lakes Fishery Commission Council of Lake Committees. Windsor, ON. April 22, 2008.
- Hedges, K.*, N., Mandrak, M. Koops, and O. Johannsson. 2008. Use of Aquatic Protected Areas for management and conservation of Great Lakes fishes. Great Lakes Fisheries Commission Lake Committee Meetings. Niagara Falls, ON. March 19, 2008.
- Nelson, J.S.*, H. Espinosa-Perez, L. Findley, C. Gilbert, R. Lea, N.E. Mandrak, R. Mayden and L. Page. 2008. Changes in the taxonomy of Canadian fishes since 1973 and the "Common and scientific names of fishes from the United States, Canada, and Mexico. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.
- Pratt, T.* and N.E. Mandrak. 2008. The continuing loss of cisco diversity in the Laurentian Great Lakes. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.
- Reid, S.M.*, Sager, E., and N.E. Mandrak. 2008. Impacts of the non-native macrophyte, *Cabomba caroliniana*, on littoral biota and food web dynamics in a central Ontario lake. North American Lake Management Society Symposium 2008. Lake Louise, Alberta. November 2008.
- Renaud, C.*, M. Docker, and N.E. Mandrak. 2008. Lampreys in Canada: changes since 1973. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.
- Reyjol, Y.*, M.A. Rodriguez, P. Magnan, and N.E. Mandrak. 2008. Comparison of taxonomic and functional richness across Canadian freshwater ecoregions: a freshwater fish perspective. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.
- Stammler, K.L., R.C. Bailey and N.E. Mandrak. 2008. Examining the cumulative effects of headwater enclosures on downstream fish assemblages and water chemistry in stream agro-ecosystems. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.

Curriculum Vitae – Nicholas Edward Mandrak

- Staton, S.*, N.E. Mandrak, and K. Killins. 2008. Challenges and successes in recovering freshwater ecosystems in southern Ontario. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.
- Ward-Campbell, B.M.S.*, R.L. McLaughlin, and N.E. Mandrak. 2008. Short-term effects of drain maintenance on fish assemblages inhabiting agricultural drains in southwestern Ontario. American Fisheries Society Annual Meeting. Ottawa, ON. August 2008.
- Beneteau, C., N.E. Mandrak and D.D. Heath. 2007. Population structure in Canadian greenside darters: conservation one site at a time. Canadian Conference for Fisheries Research, Montreal, PQ. January 2007.
- Dopazo, S., L.D. Corkum, and N.E. Mandrak. 2007. Fish assemblages and environmental factors associated with gobiids in the Huron-Erie corridor. Ontario Biology Day, Hamilton, ON. March 2007.
- Drake, A., M. Power, M. Koops, S. Doka, and N. Mandrak. 2007. Environmental factors affecting growth of eastern sand darter *Ammocrypta pellucida*. Canadian Conference for Fisheries Research, Montreal, PQ. January 2007.
- Drake, A., N. Mandrak, and H. Harvey. 2007. Determining the risk of introducing and spreading aquatic invasive species through the baitfish industry in Ontario. Annual General Meeting of the Canadian Aquatic Invasive Species Network, Ottawa, ON. April 2007.
- Pratt, T.C. and N.E. Mandrak. 2007. Abundance, distribution and identification of deepwater ciscoes in Lake Superior. American Fish Society Annual Meeting. San Francisco, CA. September 2007.
- Ward-Campbell, B.M.S., R.L. McLaughlin and N.E. Mandrak. 2007. Impacts of drain maintenance on fish and benthic invertebrate assemblages in agricultural drains. Canadian Conference for Fisheries Research, Montreal, PQ. January 2007.
- Ward-Campbell, B.M.S., R.L. McLaughlin and N.E. Mandrak. 2007. Impacts of drain maintenance on fish and benthic invertebrate assemblages. North American Benthological Society Annual Meeting, Columbia, South Carolina. June 2007.
- Bouvier, L.D., S.E. Doka, N.E. Mandrak and K.S. McCann. 2006. Effects of fish habitat and fish assemblage composition of differing levels of connectivity between coastal wetlands and pen water environments. 49th Annual Conference on Great Lakes Research, Windsor, ON. May 2006.
- Chu, C., N.E. Jones, N.E. Mandrak, and A. Piggott. 2006. Temperature and fish biodiversity in Ontario streams. Canadian Conference for Fisheries Research, Calgary, AB. January 2006.
- Cudmore, B. and N.E. Mandrak. 2006. Live food fish industry in Canada: vector and pathways for invasive freshwater fishes. 14th International Conference for Aquatic Invasive Species, Key Biscayne, FL. May 2006.
- Drake, A., M. Power, M. Koops, S. Doka, and N. E. Mandrak. 2006. Environmental factors affecting growth of eastern sand darter (*Ammocrypta pellucida*). 67th Midwest Fish and Wildlife Conference, Omaha, NE. December 2006.
- Drake, A., M. Power, M. Koops, S. Doka, and N. Mandrak. 2006. Environmental factors affecting growth of eastern sand darter *Ammocrypta pellucida* in the lower Thames River, Ontario. Ontario Ecology and Ethology Colloquium, St. Catharines, ON. May 2006.
- Herborg, L.M., Cudmore, B., N.E. Mandrak, D.M. Lodge and H.J. MacIsaac. 2006. The use of ecological niche modeling in identifying high risk areas for species invasions. 49th Annual Conference on Great Lakes Research, Windsor, ON. May 2006.
- Lapointe, N.W.R., L.D. Corkum and N.E. Mandrak. 2006. Fish-macrohabitat associations in shallow Canadian waters of the Detroit River. 49th Annual Conference on Great Lakes Research, Windsor, ON. May 2006.
- Mandrak, N.E. and B. Cudmore. 2006. Risk assessment of snakeheads (*Channidae*) in Canada. 14th International Conference for Aquatic Invasive Species, Key Biscayne, FL. May 2006.
- Mandrak, N.E., J. Barnucz, M.S. Poos and H. Surette. 2006. How much sampling effort is required to detect freshwater fish species at risk? 67th Midwest Fish and Wildlife Conference, Omaha, NE. December 2006.
- Mandrak, N.E., N.E. Jones and H. Ball. 2006. Monitoring stream fishes in Ontario: past, present and future. 67th Midwest Fish and Wildlife Conference, Omaha, NE. December 2006.
- Master, L.L., A. Olivero and N.E. Mandrak. 2006. An analysis of some alternative approaches for setting priorities for the conservation of North American freshwater fishes. American Fish Society Annual Meeting, Lake Placid, NY. September 2006.

Curriculum Vitae – Nicholas Edward Mandrak

- Munawar, M.I.F. Munawar, N.E. Mandrak, H. Niblock and M. Fitzpatrick. 2006. Exploring the pelagic food web in the world's largest lakes: Laurentian Great Lakes example. European Large Lakes Symposium 2006, Tartu, Estonia.
- Pratt, T.C., and N.E. Mandrak. 2006. Abundance, distribution and identification of shortjaw cisco (*Coregonus zenithicus*) in the proposed Lake Superior marine protected area. Canadian Conference for Fisheries Research, Calgary, AB. January 2006.
- Pratt, T.C., N.E. Mandrak, B. Harford and S. Parker. 2006. Evaluating the current status of deepwater ciscoes (*Coregonus* spp.) in lakes Superior and Huron. Great Lakes Fishery Commission Native Species Restoration Workshop, Ann Arbor, MI. November 2006.
- Reid, S.M., J. Barnucz and N.E. Mandrak. 2006. Round goby and Lake Erie beach fish communities. Canadian Conference for Fisheries Research, Calgary, AB. January 2006.
- Sheldon, T., N.E. Mandrak, C.C. Wilson and N. Lovejoy. 2006. Conservation genetics of deepwater sculpin. Great Lakes Fishery Commission Native Species Restoration Workshop, Ann Arbor, MI. November 2006.
- Stammler, K.L., R.L. McLaughlin, and N.E. Mandrak. 2006. Agricultural drains as fish habitat in southwestern Ontario. Canadian Conference for Fisheries Research, Calgary, AB. January 2006.
- Stammler, K.L., R.L. McLaughlin, and N.E. Mandrak. 2006. Agricultural drains as fish habitat in southwestern Ontario. GLSF Symposium: Agricultural Non-point Source Pollution Reduction, Burlington, ON. February 2006.
- Stammler, K.L., R.L. McLaughlin, and N.E. Mandrak. 2006. Agricultural drains as fish habitat in southwestern Ontario. American Fisheries Society, Ontario Chapter General Meeting, Orillia, ON. March 2006.
- Stammler, K.L., R.L. McLaughlin, and N.E. Mandrak. 2006. Streams modified for drainage provide fish habitat in agricultural areas. Environmental Research Western Earth Day Colloquium, London, ON. April 2006.
- Stammler, K.L., R.L. McLaughlin, and N.E. Mandrak. 2006. Streams modified for drainage provide fish habitat in agricultural areas. American Fisheries Society, 136th Annual Meeting, Lake Placid, NY. September 2006.
- Stammler, K.L., R.L. McLaughlin, N.E. Mandrak, R.C. Bailey, B. Ward-Campbell, and L. Wren. What's happening in drains? A review of current research. A.D. Latonell Conservation Symposium, Orillia, ON. November 2006.
- Barnucz, J., A.L. Edwards, N.E. Mandrak, M. Parslow and E. Torenvliet. 2005. Changes in fish assemblages of three areas of concern in the lower Great Lakes. Ontario Chapter of the American Fisheries Society Annual Meeting, Orillia, ON. February 2005.
- Bouvier, L.D., S.E. Doka, N.E. Mandrak and K.S. McCann. 2005. Diking as a means of maintaining fish habitat in coastal wetlands in the face of climate change. Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Bouvier, L.D., S.E. Doka, N.E. Mandrak and K.S. McCann. 2005. Diking as a means of maintaining fish habitat in coastal wetlands in the face of climate change. Ontario Chapter of the American Fisheries Society Annual Meeting, Orillia, ON. February 2005.
- Bouvier, L.D., S.E. Doka, K.S. McCann, S. Crawford and N.E. Mandrak. 2005. Wetland accessibility and fish assemblages. American Fisheries Society Annual Meeting. Anchorage, AK. September 2005.
- Burkhead, N.M., H.L. Jelks, S.J. Walsh, S. Contreras-Balderas, E. Díaz-Pardo, D.A. Hendrickson, J. Lyons, N.E. Mandrak, F. McCormick, J.S. Nelson, S.P. Platania, B.A. Porter, C.B. Renaud, J.J. Schmitter-Soto, E.B. Taylor, M.L. Warren Jr. 2005. Revision of the American Fisheries Society list of imperiled freshwater and diadromous fishes of North America. American Society of Ichthyologists and Herpetologists Annual Meeting, Tampa, FL. July 2005.
- Burkhead, N.M., H.L. Jelks, S.J. Walsh, S. Contreras-Balderas, E. Díaz-Pardo, D.A. Hendrickson, J. Lyons, N.E. Mandrak, F. McCormick, J.S. Nelson, S.P. Platania, B.A. Porter, C.B. Renaud, J.J. Schmitter-Soto, E.B. Taylor, M.L. Warren Jr. 2005. Revision of the American Fisheries Society list of imperiled freshwater and diadromous fishes of North America. American Fisheries Society Annual Meeting. Anchorage, AK. September 2005.
- Chu, C., C.K. Minns and N.E. Mandrak. 2005. Potential distribution changes in lake trout, walleye and smallmouth bass with climate change. Canadian Conference for Fisheries Research. Windsor, ON. January 2005.

Curriculum Vitae – Nicholas Edward Mandrak

- Cudmore, B. and N.E. Mandrak. 2005. Risk assessment of Asian carps in Canada. Ontario Chapter of the American Fisheries Society Annual Meeting, Orillia, ON. February 2005.
- Cudmore, B., T.J. Morris and N.E. Mandrak. 2005. Going against the flow: implementing an ecosystem approach to recovery planning. New Currents in Conserving Freshwater Systems Symposium, New York NY. April 2005.
- Cudmore, B., T.J. Morris and N.E. Mandrak. 2005. Science needs under the Canadian Species at Risk Act for recovering aquatic species at risk. International Association for Great Lakes Research Annual Meeting. Ann Arbor, MI. May 2005.
- Doka, S.E., L.D. Bouvier, N.E. Mandrak, and C.K. Minns. 2005. Vulnerability of freshwater coastal wetland fish assemblages to climate change and an assessment of cultural adaptation strategies. Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Doka, S.E., M.A. Koops, N.E. Mandrak, and J. Barnucz. 2005. Non-destructive estimation of population characteristics in fish species at risk. Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Koops, M.A., S.E. Doka, N.E. Mandrak and J. Barnucz. 2005. Non-destructive estimation of population characteristics in fish species at risk. International Association for Great Lakes Research Annual Meeting. Ann Arbor, MI. May 2005.
- Koops, M.A., N.E. Mandrak and C. K. Minns. 2005. Potential impact of climate change facilitated invasion by North American fishes on the great lakes fish community. Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Lapointe, N. W. R., L. D. Corkum, and N. E. Mandrak. 2005. Fish-habitat associations in shallow Canadian waters of the Detroit River. American Fisheries Society Annual Meeting. Anchorage, AK. September 2005.
- Lapointe, N. W. R., L. D. Corkum, and N. E. Mandrak. 2005. Fish-habitat associations in shallow Canadian waters of the Detroit River. International Association for Great Lakes Research Annual Meeting. Ann Arbor, MI. May 2005.
- Lapointe, N. W. R., L. D. Corkum, and N. E. Mandrak. 2005. Fish-habitat associations in shallow Canadian waters of the Detroit River. Ontario Chapter of the American Fisheries Society Annual Meeting, Orillia, ON. February 2005.
- Lapointe, N. W. R., L. D. Corkum, and N. E. Mandrak. 2005. Fish-habitat associations in shallow Canadian waters of the Detroit River. Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Mandrak, N.E. and B. Cudmore. 2005. Risk assessment of Asian carps in Canada. Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Mandrak, N.E. and K.E. Brodribb. 2005. How well do parks protect fish species at risk in Ontario? Parks Research Forum of Ontario Annual Meeting, Guelph, ON. May 2005.
- Mandrak, N.E. and S. Staton. 2005. Identifying conservation hot spots for protecting freshwater species at risk in Canada. American Society of Ichthyologists and Herpetologists Annual Meeting, Tampa, FL. July 2005.
- Mandrak, N.E. and S. Staton. 2005. Identifying conservation hot spots for protecting freshwater species at risk in Canada. International Association for Great Lakes Research Annual Meeting. Ann Arbor, MI. May 2005.
- Mandrak, N.E., C. Bakelaar, A. Doolittle, P. Brunette, D. Ming and K. Gray. 2005. Web mapping tool for species at risk in Ontario. Ontario Chapter of the American Fisheries Society Annual Meeting, Orillia, ON. February 2005.
- Mandrak, N.E., J. Barnucz, M. Poos, and H. Surette. 2005. How much sampling is required to detect fish species at risk in the Great Lakes basin? Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Mandrak, N.E., J. Barnucz, M. Poos, and H. Surette. 2005. How much sampling is required to detect fish species at risk in the Great Lakes basin? Ontario Chapter of the American Fisheries Society Annual Meeting, Orillia, ON. February 2005.
- Mandrak, N.E., J. Barnucz, M. Poos, and H. Surette. 2005. How much sampling is required to detect fish species at risk in the Great Lakes basin. International Association for Great Lakes Research Annual Meeting. Ann Arbor, MI. May 2005.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E., M. Munawar, and C.K. Minns. 2005. An update on the proposed book, "Freshwater Fishes, Their Biodiversity, Fisheries, and Habitats: A Global Assessment of Their Health and Prospects" European Union Fish Habitat Conference, Hull, UK. July 2005.
- Rae, C., C. Bakelaar, N.E. Mandrak, and B. Cudmore. 2005. Application of GIS to a risk assessment of the introduction and establishment of non-native fish species in the Great Lakes basin. Ontario Chapter of the American Fisheries Society Annual Meeting, Orillia, ON. February 2005.
- Sheldon, T., N.E. Mandrak, C. Wilson, and N.R. Lovejoy. 2005. Determining the current distribution of deepwater sculpin (*Myoxocephalus thompsoni*) in Canada. Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Stammler, K.L., N.E. Mandrak, and R.L. McLaughlin. 2005. Do agricultural drains provide fish habitat? Canadian Conference for Fisheries Research. Windsor, ON. January 2005.
- Stammler, K.L., N.E. Mandrak, and R.L. McLaughlin. 2005. Do agricultural drains provide fish habitat? Ontario Chapter of the American Fisheries Society Annual Meeting, Orillia, ON. February 2005.
- Staton, S. and N.E. Mandrak. 2005. Identifying conservation hot spots for protecting freshwater species at risk in Canada. New Currents in Conserving Freshwater Systems Symposium, New York NY. April 2005.
- Staton, S. and N.E. Mandrak. 2005. Identifying conservation hot spots for protecting freshwater species at risk in Canada. American Fisheries Society Annual Meeting. Anchorage, AK. September 2005.
- Staton, S. and N.E. Mandrak. 2005. Focusing conservation efforts for freshwater biodiversity. Proceedings of the Parks Research Forum of Ontario Annual Meeting 2005.
- Bouvier, L.D., S.E. Doka, and N.E. Mandrak. 2004. Comparison of hoopnetting and boat electrofishing as sampling techniques of fish assemblages in coastal wetlands in southern Ontario. International Association for Great Lakes Research, Waterloo, ON. May 2004.
- Doka, S.E., L.D. Bouvier, N.E. Mandrak and C.K. Minns. 2004. The impact of climate change and adaptation strategies on freshwater coastal wetland fish assemblages. 4th World Fisheries Congress Conference. Vancouver, British Columbia. May 2004.
- Koops, M., N.E. Mandrak and C.K. Minns. 2004. Ecological risk to the Great Lakes from climate change facilitated invasion by North American Fishes. International Association for Great lakes Research, Waterloo, ON. May 2004.
- Mandrak, N.E. 2004. Fish faunal classification for the Great Lakes basin. International Association for Great Lakes Research, Waterloo, ON. May 2004.
- Mandrak, N.E., J. Barnucz, M. Poos, and H. Surette. Developing sampling protocols for fish species at risk in the Great Lakes basin. Canadian Conference for Fisheries Research, St. John's, NF. January 2004.
- Mandrak, N.E., J. Barnucz, M. Poos, and H. Surette. Developing sampling protocols for fish species at risk in the Great Lakes basin. Boreal Research Symposium, Laurentian University, Sudbury, ON. February 2004.
- Mandrak, N.E., J. Barnucz, M. Poos, and H. Surette. Developing sampling protocols for fish species at risk in the Great Lakes basin. Species at Risk 2004 Conference. Victoria, BC. March 2004.
- Mandrak, N.E., J. Barnucz, M. Poos, and H. Surette. 2004. Developing sampling protocols for fish species at risk in the Great Lakes basin. Southern Ontario Chapter of the American Fisheries Society Annual Meeting, Dorset, ON. March 2004.
- Mandrak, N.E., J. Barnucz, M. Poos, and H. Surette. 2004. Developing sampling protocols for fish species at risk in the Great Lakes basin. International Association for Great Lakes Research, Waterloo, ON. May 2004.
- Mandrak, N.E., C.K. Minns, and C. Chu. 2004. Potential impacts of climate change on the distributions of freshwater fish species at risk in Canada. Species at Risk 2004 Conference. Victoria, BC. March 2004.
- Mandrak, N.E. and R.L. McLaughlin. Great Lakes FishMAP: an ecological database and mapping website. International Association for Great Lakes Research, Waterloo, ON. May 2004.
- Poos, M.S., N.E. Mandrak, and R.L. McLaughlin. 2004. Fish Species at Risk Assessment and Protection on the Sydenham River. Canadian Conference for Fisheries Research, St. John's, NF. January 2004.
- Poos, M.S., N.E. Mandrak, and R.L. McLaughlin. 2004. Can single factor remediation recover fish species at risk in a complex system? Canadian Conference for Fisheries Research, Southern Ontario Chapter of the American Fisheries Society Annual Meeting, Dorset, ON. March 2004.

Curriculum Vitae – Nicholas Edward Mandrak

- Poos, M.S., N.E. Mandrak, and R.L. McLaughlin. 2004. Identifying the relation of biotic interactions, water chemistry and geomorphologic characteristics for limiting fish species at risk in the Sydenham River. International Association for Great Lakes Research, Waterloo, ON. May 2004.
- Poos, M.S., N.E. Mandrak, and R.L. McLaughlin. 2004. Fish species at risk in the Sydenham River: the trade-offs involved in protection and recovery. American Fisheries Society Annual Meeting, Madison, WI. August 2004.
- Staton, S.K., N. E. Mandrak, C.K. Minns, and C. Chu. 2004. Southwestern Ontario: the crossroads of freshwater biodiversity, invaders and species at risk in Canada. International Association for Great Lakes Research, Waterloo, ON. May 2004.
- Surette, H., N.E. Mandrak and T.D. Nudds. 2004. Ecological integrity in uncharted waters: historical changes in the fish assemblages of Point Pelee National Park. Canadian Conference for Fisheries Research, St. John's, NF. January 2004.
- Surette, H., N.E. Mandrak and T.D. Nudds. 2004. Ecological integrity in uncharted waters: historical changes in the fish assemblages of Point Pelee National Park. Canadian Conference for Fisheries Research, Southern Ontario Chapter of the American Fisheries Society Annual Meeting, Dorset, ON. March 2004.
- Surette, H., N.E. Mandrak and T.D. Nudds. 2004. Ecological integrity in uncharted waters: historical changes in the fish assemblages of Point Pelee National Park. International Association for Great Lakes Research, Waterloo, ON. May 2004.
- Surette, H., N.E. Mandrak and T.D. Nudds. 2004. Ecological integrity in uncharted waters: historical changes in the fish assemblages of Point Pelee National Park of Canada. Canadian Conference for Fisheries Research, St. John's, ON. January 2004.
- Koops, M., N.E. Mandrak and C.K. Minns. 2003. Ecological risk to the Great Lakes from climate change facilitated invasion by North American Fishes. DFO National Science Workshop, St. John's, NF. November 2003.
- Staton, S.K. and N. E. Mandrak. 2003. Southwestern Ontario: the crossroads of freshwater biodiversity, invaders and species at risk in Canada. DFO National Science Workshop, St. John's, NF. November 2003.
- Mandrak, N.E., C. Bakelaar, A. Doolittle, D. Ming. K. Gray, and P. Brunette. 2003. Web mapping tool for fish species at risk in Ontario. DFO National Science Workshop, St. John's, NF. November 2003.
- Surette, H., N.E. Mandrak and T.D. Nudds. 2003. Ecological integrity in uncharted waters: historical changes in the fish assemblages of Point Pelee National Park. University of Guelph, Guelph, ON. November 2003.
- Surette, H., N.E. Mandrak and T.D. Nudds. 2003. Ecological integrity in uncharted waters: historical changes in the fish assemblages of Point Pelee National Park of Canada. Point Pelee National Park of Canada, Leamington, ON. October 2003.
- Dextrase, A.J. and N.E. Mandrak. 2003. Impact of invasive alien species on aquatic species at risk in Canada. 12th International Conference on Aquatic Invasive Species, Windsor, ON. June 2003.
- Poos, M.S., N.E. Mandrak, and R.L. McLaughlin. 2003. Identifying the relation of biotic interactions, water chemistry and geomorphologic characteristics for limiting fish species at risk in the Sydenham River. Canadian Society of Zoologists, Waterloo, ON, May 2003.
- Poos, M.S., N.E. Mandrak, and R.L. McLaughlin. Identifying limiting factors for fish species at risk (sar) in the Sydenham River. Ontario Ecology & Ethology Colloquium, Hamilton, ON, May 2003.
- Gibson, S.F., E. Holm, and N.E. Mandrak. 2003. Identification of Ontario fishes and the need for quality assurance: Are we at a crossroads? OMNR Research and Assessment Meeting, Peterborough, ON. April 2003.
- Mandrak, N.E., J. Clark, F. Neave, M. Poos, H. Surette, R.L. McLaughlin, D.L.G. Noakes and M. Docker. 2003. Fish species at risk research in the Great Lakes basin. Southern Ontario Chapter of the American Fisheries Society Annual Meeting, Dorset, ON. March 2003.
- Mandrak, N.E. 2003. Current and proposed fish species at risk projects in the Lake Erie and Lake St. Clair basins. Lake Erie LaMP Habitat Committee Meeting, February 2003.
- Poos, M.S., N.E. Mandrak, and R.L. McLaughlin, R.L. 2003. Species at Risk on the Sydenham River: their destined hour. Southern Ontario Chapter of the American Fisheries Society, Dorset, ON, February 2003.

Curriculum Vitae – Nicholas Edward Mandrak

- Minns, C.K., C.Chu, and N.E. Mandrak. 2003. Comparative regional assessment of factors impacting freshwater fish resources in Canada. Canadian Conference for Fisheries Research, Ottawa, ON. January 2003.
- Mandrak, N.E. 2003. Freshwater fish species at risk in Canada: current status, protection and causes of decline. Canadian Conference for Fisheries Research, Ottawa, ON. January 2003.
- Wilson, C., N.E. Mandrak, J. Casselman, and N.R. Lovejoy. 2003. Mitochondrial phylogeography among Great Lakes populations of the deepwater sculpin, *Myoxocephalus thompsoni*. Canadian Conference for Fisheries Research, Ottawa, ON. January 2003.
- Mandrak, N.E. 2003. Freshwater fish species at risk in Canada: current status, protection and causes of decline. Canadian Conference for Fisheries Research, Ottawa, ON. January 2003.
- Wilson, C., N.E. Mandrak, J. Casselman, and N.R. Lovejoy. 2003. Mitochondrial phylogeography among Great Lakes populations of the deepwater sculpin, *Myoxocephalus thompsoni*. Canadian Conference for Fisheries Research, Ottawa, ON. January 2003.
- Mandrak, N.E. 2002 Current fish species-at-risk research in the Great Lakes region. DFO National Science Workshop, Burlington, ON. November 2002.
- Mandrak, N.E. 2002. Patterns of freshwater fish diversity in Canada. DFO National Science Workshop, Burlington, ON. November 2003.
- Minns, C.K., N.E. Mandrak, and C. Chu. 2002. omparative regional assessment of factors impacting freshwater fish resources in Canada. DFO National Science Workshop, Burlington, ON. November 2002.
- Neave, F.B., Mandrak, N.E. and M.F. Docker. 2002. Developing a key for indigenous larval lampreys of the Great Lakes using genetics, digital imaging and moorphometrics. DFO National Science Workshop, Burlington, ON. November 2002.
- Surette, H., N.E. Mandrak and T.D. Nudds. 2002. Historical changes in the fish assemblages of Point Pelee National Park. Loaves and Fishes Seminar Series, University of Guelph, Guelph, ON. November 2002.
- Mandrak, N.E. 2002. Freshwater fish species at risk in Canada: current status, protection and causes for decline. American Society of Ichthyologists and Herpetologists Annual Meeting, Kansas City, MI. July 2002.
- Noble, J. and N.E. Mandrak. 2002. Ecological characteristics of fish species-at-risk in the Great Lakes basin. American Society of Ichthyologists and Herpetologists Annual Meeting, Kansas City, MI. July 2002.
- Mandrak, N.E. and G.R. Smith. 2002. Development of a fish distribution database for the Great Lakes and its tributaries. International Association for Great Lakes Research, Winnipeg, MB. June 2002.
- Noble, J. and N.E. Mandrak. 2002. The development of a fish rare and endangered species database for the Great Lakes. Ohio Fish and Wildlife Conference, Columbus, OH. February 2002.
- Mandrak, N.E. 2001. The development of a national freshwater fish distribution database. American Society of Ichthyologists and Herpetologists Annual Meeting, State College, PA. July 2001.
- Noble, J. and N.E. Mandrak. 2001. The development of a fish rare and endangered species database for the Great Lakes. American Society of Ichthyologists and Herpetologists Annual Meeting, State College, PA. July 2001.
- Klingensmith, S. and N.E. Mandrak. 2001. Age and growth of silver chub (*Macrhybopsis storeriana*) in Lake Erie. Ohio Academy of Sciences Annual Meeting, Mt. Union, OH. March 2001.
- Noble, J. and N.E. Mandrak. 2001. The development of a fish rare and endangered species database for the Great Lakes. Ohio Academy of Sciences Annual Meeting, Mt. Union, OH. March 2001.
- Testa, E., N.E. Mandrak and L. Schroeder. 2001. Changes in fish health and communities in the Mahoning River. Ohio Academy of Sciences Annual Meeting, Mt. Union, OH. March 2001.
- Kelly, E. and N.E. Mandrak. 2001. Anthropogenic influences on fish communities of the Gull River drainage, Ontario. Canadian Conference for Fisheries Research, Toronto, ON. January 2001.
- Mandrak, N.E. 2001. Predicting the spread and impact of introduced fishes in Algonquin Park, Ontario. Canadian Conference for Fisheries Research, Toronto, ON. January 2001.
- Mandrak, N.E. 2001. The development of a national freshwater fish distribution database: an update. Canadian Conference for Fisheries Research, Toronto, ON. January 2001.
- Minns, C.K., N.E. Mandrak, and J.R.M. Kelso. 2000. Regional distributions of freshwater fishes and their multiple stresses in Canada: the challenges of large-scale conservation. Freshwater Fish Conservation: Options for the Future, Albufiera, Portugal. October 2000.

Curriculum Vitae – Nicholas Edward Mandrak

- Carl, L., C. C. Wilson and N.E. Mandrak. 2000. Effects of dams and locks on fragmentation, stability, and metapopulation dynamics of riverine fish species and communities. Canadian Conference for Fisheries Research, St. John, NB. January 2000.
- Gibson, S.F., N.E. Mandrak, and C.C. Wilson. 2000. Historical changes in Ontario stream fish assemblages, 1970's to 1998: what have we done? Canadian Conference for Fisheries Research, St. John, NB. January 2000.
- Mandrak, N.E. 2000. Development of a national fish distribution database. Canadian Conference for Fisheries Research, St. John, NB. January 2000.
- Carl, L., C. C. Wilson and N.E. Mandrak. 1999. Effects of dams and locks on fragmentation, stability, and metapopulation dynamics of riverine fish species and communities in a river system. Midwest Fish and Wildlife Conference, Chicago, IL. December 1999.
- Mandrak, N.E. 1998. The impact of introduced smallmouth bass (*Micropterus dolomieu*) on native fish communities in Algonquin Park, Ontario. Canadian Conference for Fisheries Research, Kingston, ON. January 1998.
- Bradley, D.L. and N.E. Mandrak. 1997. Historical changes in the distribution of fishes in northwestern Kansas. Kansas Academy of Sciences, Hays, KS. April 1997.
- Bohnen, L.A., J.R. Thomasson, G.K. Hulett and N.E. Mandrak. 1997. Designing a sampling method for determining lant biodiversity around Wilson Reservoir. Kansas Academy of Sciences, Hays, KS. April 1997.
- Eberle, M.E., T.L. Wenke, N.E. Mandrak and S.R. Hooper. 1997. Surveys of fishes in western Kansas streams: 1994-1996. Kansas Academy of Sciences, Hays, KS. April 1997.
- Foutz, H.P. and N.E. Mandrak. 1997. Spatiotemporal patterns in fish assemblages in relation to environmental factors in the Republican River, Kansas. Kansas Academy of Sciences, Hays, KS. April 1997.
- Malloy, T. and N.E. Mandrak. 1997. The effects of streamflow alteration on fish assemblages within the Republican River. Kansas Academy of Sciences, Hays, KS. April 1997.
- Hargett, E.G., M. Eberle and N.E. Mandrak. 1997. The effects of varying salinity on fish assemblages in western Kansas. Kansas Academy of Sciences, Hays, KS. April 1997.
- Carr, C.B., J.R. Choate and N.E. Mandrak. 1997. A preliminary assessment of systematic relationships among populations of *Peromyscus leucopus* in western Kansas. Association of Southwestern Naturalists' Annual Meeting, Fayetteville, AR. April 1997.
- Mandrak, N.E. 1996. Ichthyofaunal regions of Ontario in relation to environmental and historical factors. American Society of Ichthyologists and Herpetologists Annual Conference, New Orleans, LA. June 1996.
- Hooper, S.J., J.R. Choate and N.E. Mandrak. 1996. Can cranial measurements be used to discriminate between *Reithrodontomys megalotis* and *R. montanus*? American Society of Mammalogists Annual Meeting, Grand Forks, ND. June 1996.
- Bradley, D.L. and N.E. Mandrak. 1996. Historical changes in the distribution of fishes in northwestern Kansas. Association of Southwestern Naturalists' Annual Meeting, Edinburgh, TX. April 1996.
- Hooper, S.J. and N.E. Mandrak. Mensural discrimination between *Reithrodontomys megalotis* and *R. montanus*. Association of Southwestern Naturalists' Annual Meeting, Edinburgh, TX. April 1996.
- Hooper, S.J., J.R. Choate and N.E. Mandrak. 1995. Mensural discrimination between *Reithrodontomys megalotis* and *R. montanus*. American Society of Mammalogists Annual Meeting, Burlington, VT. June 1995.
- Mandrak, N.E. 1993. Patterns and processes of fish species richness in Ontario. American Society of Ichthyologists and Herpetologists Annual Conference, Austin, TX. June 1993.
- Mandrak, N.E. Patterns of fish species richness in Ontario. Canadian Conference for Fisheries Research, Peterborough, ON. January 1993.
- DeGroot, P., J. Carnio, F.X. Faigal and N.E. Mandrak. 1992. Conservation of the Liberian mongoose: does *Liberitiscus khuni* occur in the Cote d'Ivoire and what can we learn from GIS analysis? American Association of Zoological Parks and Aquaria, Toronto, ON. September 1992.
- Mandrak, N.E. 1992. Scale and pattern in Ontario fish species richness. American Society of Ichthyologists and Herpetologists Annual Conference, Champaign, IL. June 1992.
- Mandrak, N.E. 1992. Scale and pattern in Ontario fish species richness. Ontario Ecology and Ethology Symposium, Peterborough, ON. April 1992.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E. 1992. Postglacial dispersal of freshwater fishes into Ontario. Southern Ontario Chapter of the American Fisheries Society Annual Meeting, Barrie, ON. January 1992.
- Mandrak, N.E. 1992. Potential invasion of the Great Lakes by fish species associated with climatic warming. Southern Ontario Chapter of the American Fisheries Society Annual Meeting, Barrie, ON. January 1992.
- Mandrak, N.E. and E.J. Crossman. A review of introduced fishes in the Canadian Great Lakes. International Association of Great Lakes Research Annual Meeting, Buffalo, NY. June 1991.
- Mandrak, N.E. and E.J. Crossman. An ichthyofaunal survey of Algonquin Park. Royal Ontario Museum Twelfth Annual Research Colloquium, Toronto, ON. November 1990.
- Mandrak, N.E. and E.J. Crossman. Patterns of postglacial dispersal of freshwater fishes into Ontario. American Society of Ichthyologists and Herpetologists Annual Conference, Charleston, SC. June 1990.
- Mandrak, N.E. 1990. Postglacial dispersal of freshwater fishes into Ontario. Canadian Conference for Fisheries Research, Ottawa, ON. January 1990.
- Mandrak, N.E. Mapping the distributions of Ontario freshwater fishes. Royal Ontario Museum Eleventh Annual Research Colloquium, Toronto, ON. November 1989.
- Mandrak, N.E. 1989. Postglacial dispersal of freshwater fishes into Ontario. American Society of Ichthyologists and Herpetologists Annual Conference, San Francisco, CA. June 1989.
- Mandrak, N.E. 1988. A statistical model of postglacial dispersal of freshwater fishes into Ontario. Royal Ontario Museum Tenth Annual Research Colloquium, Toronto, ON. November 1988.

11. Invited Lectures

- Mandrak, N.E. 2015. Fish species at risk in the Great Lakes: transboundary conservation challenges. Biodiversity without Boundaries NatureServe International Conference. Traverse City, MI. April 2015.
- Mandrak, N.E. 2015. Trans-Atlantic freshwater fishes: risk assessment of species and pathways. CAISN Workshop: Transatlantic aquatic invasions: Perspectives from North America and Europe. Granada, Spain. February 2015.
- Mandrak, N.E. 2015. Predicting fish invaders using trait-based models: lessons from the Laurentian Great Lakes. Frontiers in Invasion Ecology Research: Theoretical Frameworks, Methods and Applications Session. American Society of Limnology and Oceanography. Granada, Spain. February 2015.
- Mandrak, N.E.* and J. Kim. 2015. Canadian research in support of Asian carp management. Ontario Federation of Anglers and Hunters Asian Carp Information Session. Toronto, ON. February 2015.
- Mandrak, N.E. 2015. Asian carps in North America. Scientific Services, Kruger National Park, South Africa. January 2015.
- Mandrak, N.E. 2015. Monitoring using the Index of Biotic Integrity. Scientific Services, Kruger National Park, South Africa. January 2015.
- Mandrak, N.E.*, D. Heath, R. Walter, C. Wilson, and S. Reid. 2015. Evaluating the use of eDNA to Detect species at risk and aquatic invasive species. Scientific Services, Kruger National Park, South Africa. January 2015.
- Drake, D.A.R.*, and N.E. Mandrak. 2014. How will invasive species impact the future of fisheries? Symposium: Future of Fisheries: Perspectives for Emerging Professionals. American Fisheries Society Annual General Meeting. Quebec City, QC. Aug 18, 2014.
- Drake, D.A.R.*, and N.E. Mandrak. 2014. Canada's other freshwater commercial fishery: science and management of baitfishes in response to shifting ecological and socioeconomic baselines. Symposium: Freshwater Fisheries in Canada: Historical and Contemporary Perspectives on the Resources and their Management. American Fisheries Society Annual General Meeting. Quebec City, QC. Aug 18, 2014.
- Mandrak, N.E.* and J. Kim. 2014. Canadian research in support of Asian carp management. Ontario Invasive Species Centre. Asian Carp Webinar Series. Toronto, ON. December 2014.
- <http://www.asiancarp.ca/SitePages/Resources/WebinarSeries.aspx>
- Mandrak, N.E.*, A. Curry, P. Dumont, J. Reist, E. Taylor, and D. Watkinson. 2014. The zoogeography of Canadian freshwater fishes. Symposium: Freshwater Fisheries in Canada: Historical and Contemporary Perspectives on the Resources and their Management. American Fisheries Society Annual General Meeting. Quebec City, QC. Aug 18, 2014.
- Mandrak, N.E.*, J.R. Post, J. Reynolds, E. Taylor. 2014. Freshwater fish species at risk in Canada. Symposium: Freshwater Fisheries in Canada: Historical and Contemporary Perspectives on the Resources and their Management. American Fisheries Society Annual General Meeting. Quebec City, QC. Aug 18, 2014.
- Bouvier, L.*, S. Nadeau, and N.E. Mandrak. 2013. Threats assessments in Recovery Potential Analyses. National DFO SARA Threats and Ecological Indicators Workshop. Ottawa, ON. May 2013.
- Kim, J., N.E. Mandrak*, and D. Marson. 2013. Evaluating the risk of direct movement of fishes and invertebrates through the Welland Canal. Great Lakes Acoustic Telemetry Observatory Workshop, Great Lakes Fishery Commission, Ann Arbor, MI. March 2013.
- Mandrak, N.E. 2013. Asian Carps in North America: a wicked problem? Wicked Problems Workshop. South Africa Annual Invasive Species Conference, Stellenbosch University. November 2013.
- Mandrak, N.E.*, D. Heath, R. Walter, C. Wilson, and S. Reid. 2013. Evaluating the use of eDNA to Detect species at risk and aquatic invasive species. South Africa Institute for Aquatic Biodiversity, Grahamstown, South Africa. November 2013.
- Mandrak, N.E. 2013. Canada's National Centre of Expertise for Aquatic Risk Assessment: delivering key science advice in support of aquatic invasive species research, policy, and management. Canadian Aquatic Invasive Species Network Annual General Meeting. Kananaskis, AB. May 2013.
- Mandrak, N.E. 2013. Fishes of Algonquin Provincial Park. Public Lecture Series, Grand Lake Campground, Algonquin Park, ON. August 2013.
- Mandrak, N.E. 2013. Invasive fishes: what's next? A Canadian perspective. Other Fishes Session Keynote Lecture. International Conference for Aquatic Invasive Species, Niagara Falls, ON. April 2013.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E. 2013. Preliminary assessment of the suitability of Canadian Great Lakes tributaries for Asian carp spawning. Asian Carp Session. International Conference for Aquatic Invasive Species, Niagara Falls, ON. April 2013.
- Mandrak, N.E. 2013. Conservation of freshwater fishes in Canada: challenges at the science-policy interface. Biology Department Seminar, University of Toronto Scarborough Campus. March 1, 2013.
- Mandrak, N.E. 2013. Pugnose Shiner (*Notropis anogenus*) and critical habitat in eastern Ontario. DFO SARA Outreach Workshop, Kingston, ON. March 6, 2013.
- Mandrak, N.E. 2013. The role of DFO in protecting aquatic species at risk. Fisheries Class, Queen's University, Kingston, ON. March 7, 2013.
- Mandrak, N.E.* and R. Keller. 2013. Identifying climate match hot spots to facilitate risk screening of freshwater fishes in trade. AIS Risk Assessment Symposium. American Society for Limnology and Oceanography Annual Meeting. New Orleans, LA. February 2013.
- Mandrak, N.E.*, B. Cudmore, J. Dettmers, D. Chapman, and C. Kolar. 2013. Binational ecological risk assessment of bigheaded carps in the Great Lakes. Ontario Commercial Fishers' Association Annual Meeting, London, ON. January 2013.
- Mandrak, N.E.*, D. Heath, R. Walter, C. Wilson, and S. Reid. 2013. Evaluating the use of eDNA to detect species at risk and aquatic invasive species. South Africa Institute for Aquatic Biodiversity Seminar. Grahamstown, South Africa. November 2013.
- Mandrak, N.E. 2012. What is reasonable to expect from Science? National DFO SARA Permitting Workshop. Toronto, ON. December 2012.
- Mandrak, N.E. 2012. Aquatic invasive species in the Great Lakes: bigheaded carps as a case study. Introduction to Environmental Science Class. University of Toronto, Toronto, ON. November 29, 2012.
- Mandrak, N.E. 2012. Aquatic habitat fragmentation: barrier to native species conservation or invasive species? Aquatic Habitat Connectivity: Science and Management Community Special Session. American Fisheries Society Annual Meeting. St. Paul, MN. August 2012.
- Mandrak, N.E. 2012. Evaluating the effects of agricultural drain maintenance on Grass Pickerel, a species of Special Concern. Niagara College, St. Catharines, ON. April 2012.
- Mandrak, N.E. 2012. Evaluating the effects of agricultural drain maintenance on Grass Pickerel, a species of Special Concern. Bert Miller Naturalist Club, Fort Erie, ON. March 2012.
- Mandrak, N.E. 2012. Progress report on 2012 SAR projects. Regional SARCEP Meeting, Burlington, ON. November 2012.
- Mandrak, N.E.*, M. Koops, T. Pratt, J. Stackhouse, and J. Barnucz. 2012. Evaluating the risk of direct movement of fishes and invertebrates through the Welland Canal and St. Marys River. Great Lakes Acoustic Telemetry Observatory Workshop, Great Lakes Fishery Commission, Rogers City, MI. February 2012.
- Mandrak, N.E.*, T. Pratt, and S.C. Reid. 2012. Evaluating the current status of deepwater ciscoes (*Coregonus* spp.) in the Canadian waters of Lake Huron, 2002-2006. DFO Pre-COSEWIC assessment of Shortjaw Cisco CSAS RAP Meeting, Burlington, ON. November 2012.
- Cudmore, B.C., Mandrak, N.E.*, and J. Dettmers. 2011. Evaluating the threat of Asian carps to the Great Lakes: a binational risk assessment. Great Lakes Fishery Commission Lake Committee, Windsor, ON. Windsor, ON. March 23, 2011.
- Mandrak, N.E. 2011. Algonquin fishes: past, present, and future. Algonquin Fisheries Symposium, Huntsville, ON. March 2, 2011.
- Mandrak, N.E. 2011. Binational risk assessment of Asian Carp in the Great Lakes: science update. Asian Carp Binational Risk Assessment US Managers and Scientists Meetings, Detroit, MI. June 2011.
- Mandrak, N.E. 2011. Binational risk assessment of Asian Carp in the Great Lakes: science update. Asian Carp Binational Risk Assessment Canadian Managers Meeting, Toronto, ON. June 2011.
- Mandrak, N.E. 2011. Binational risk assessment of Asian Carp in the Great Lakes: science update. Asian Carp Binational Risk Assessment US Managers and Scientists Meetings, Detroit, MI. September 2011.
- Mandrak, N.E. 2011. Binational risk assessment of Asian Carp in the Great Lakes: probability of spread. Asian Carp Binational Risk Assessment CSAS Peer Review Meeting, Cleveland, OH. November 2011.
- Mandrak, N.E.*, E. Snyder, H., and B.C. Cudmore. 2011. Developing a screening-level risk assessment prioritization protocol for aquatic non-indigenous species in Canada. Part 1: review of existing protocols. CSAS Peer Review Meeting, Montreal QC. November 2011.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E. 2011. Incorporating eDNA into natural resource management. OMNR eDNA Workshop, Peterborough, ON. December 2011.
- Mandrak, N.E. 2011. DFO Huron-Erie Corridor (HEC) sampling, 2010. HEC Committee Meeting. Ann Arbor, MI. March 16, 2011.
- Mandrak, N.E. 2011. Fishes. Grade 1 Class, Sacred Heart of Jesus Elementary School, Burlington, ON. May 2011.
- Mandrak, N.E. 2011. Non-native fishes in the Great Lakes basin: past, present and future. Introduction to Environmental Science Class. University of Toronto, Toronto, ON. November 15, 2011.
- Mandrak, N.E. 2011. Progress report on 2011 SAR projects. Regional SARCEP Meeting, Burlington, ON. November 2011.
- Mandrak, N.E. 2010. Binational risk assessment of Asian Carp in the Great Lakes: science needs. Asian Carp Binational Risk Assessment Managers and Scientists Meetings, Detroit, MI. November 2010.
- Mandrak, N.E. 2010. The science (and art) of the risk assessment of aquatic invasive species. Assistant Deputy Minister Science Lecture Series. DFO, Ottawa, ON. March 26, 2010.
- Mandrak, N.E. 2010. Fisheries and Oceans Canada's National AIS Program: A Progress Report. Ontario Federation of Anglers and Hunters Board of Directors Meeting. Peterborough, ON. April 15, 2010.
- Mandrak, N.E. 2010. Progress report on 2010 SAR projects. Regional SARCEP meeting, Winnipeg, MB. November 2010.
- Mandrak, N.E. 2010. Fishes. Grade 1 Class, Sacred Heart of Jesus Elementary School, Burlington, ON. May 2010.
- Mandrak, N.E.* and B. Cudmore. 2010. Canadian approach to risk assessment of aquatic invasive species. Northeast Aquatic Nuisance Species Panel Annual Meeting, Portland, ME. May 3, 2010.
- Mandrak, N.E.* and B. Cudmore. 2010. Canadian approach to risk assessment of aquatic invasive species. National Aquatic Nuisance Species Panel Semi-Annual Meeting, Portland, ME. May 4, 2010.
- Mandrak, N.E.* and B. Cudmore. 2010. Canadian approach to risk assessment of aquatic invasive species. DFO AIS Regulatory Framework Meeting, Halifax, NS. June 10, 2010.
- Mandrak, N.E.* and B. Cudmore. 2010. Non-native fishes in the Great Lakes basin: past, present and future. Great Lakes Fishery Commission Law Enforcement Committee, Windsor, ON. Windsor, ON. March 23, 2010.
- Locke, A., N. E. Mandrak*, and T.W. Therriault. 2009. A Canadian Rapid Response Framework for Aquatic Invasive Species. Asian Carp Rapid Response Workshop, Peterborough, ON. September 25, 2010
- Mandrak, N.E. 2010. Aquatic species at risk research in Long Point Bay. Long Point Research and Conservation Networking Group. Port Rowan, ON. November 30, 2010.
- Mandrak, N.E. 2010. Current status, trends, threats and future of the Great Lakes Ecozone. Society for Conservation Biology Annual Conference. Edmonton, AB. July 5-8, 2010.
- Mandrak, N.E. 2010. Non-native Fishes in the Great Lakes Basin: Past, Present and Future. Introduction to Environmental Science Class. University of Toronto, Toronto, ON. November 25, 2010.
- Drake, D.A.R.*, N.E. Mandrak, and H.H. Harvey. 2009. Quantifying the likelihood of introducing aquatic invasive species through the baitfish industry in Ontario. 52nd Annual Meeting of the International Association of Great Lakes Research. Toledo, OH. May 18, 2009.
- Drake, D.A.R.*, N.E. Mandrak, and H.H. Harvey. 2009. Quantifying the likelihood of introducing aquatic invasive species through the baitfish industry in Ontario. 3rd Annual General Meeting of the Canadian Aquatic Invasive Species Network. Halifax, NS. May 4, 2009.
- Hedges, K.*, Mandrak, N.E., M. Koops, and O. Johansson. 2009. Aquatic protected areas in the Great Lakes basin: inventory, evaluation and gap analysis. CPAWS Wildlands League Aquatic Protected Areas Workshop. June 2009.
- Locke, A., N. E. Mandrak*, and T.W. Therriault. 2009. A Canadian Rapid Response Framework for Aquatic Invasive Species. National Aquatic Invasive Species Committee, Halifax, NS. October 2009.
- Mandrak, N.E. 2009. Changes in the freshwater fish fauna of Canada since 1973. Canadian Conference for Fisheries Research, Ottawa, ON. January 2009.
- Mandrak, N.E. 2009. The importance of historical museum records in understanding biodiversity changes: examples from the Great Lakes. Canadian Conference for Fisheries Research, Ottawa, ON. January 2009.
- Mandrak, N.E. 2009. CEARA. Extended National Science Directors Committee meeting, Montreal, QC. February 27-28, 2009.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E. 2009. The role of DFO Science in protecting fish species at risk in Canada. Department of Biology, University of Toronto, Scarborough, ON. March 2009.
- Mandrak, N.E. 2009. How many freshwater fish species are really at risk in Canada? Redpath Museum, McGill University, Montreal, QC. March 2009.
- Mandrak, N.E. 2009. Fishes. Grade 1 Class, Sacred Heart of Jesus Elementary School, Burlington, ON. May 2009.
- Mandrak, N.E. 2009. Adaptation. Grade 6 Class, Sacred Heart of Jesus Elementary School, Burlington, ON. May 2009.
- Mandrak, N.E. 2009. Can cross-boundary protected areas be used to conserve Great Lakes fishes? CPAWS Wildlands League Aquatic Protected Areas Workshop. June 2009.
- Mandrak, N.E. 2009. How well do parks protect fish species at risk in Ontario? CPAWS Wildlands League Aquatic Protected Areas Workshop. June 2009.
- Mandrak, N.E.*, J. Barnucz, and A. Drake. 2009. Identifying Great Lakes fishes with emphasis on baitfishes. Great Lakes Fishery Commission Law Enforcement Committee, Chautauqua, NY. September 2009.
- Mandrak, N.E. 2009. Fish Species at Risk in agricultural drains. 41st Drainage Engineers Conference, Guelph, ON. October 2009.
- Mandrak, N.E. 2009. Progress report on 2009 SAR projects. Regional SARCEP meeting, Burlington, ON. November 2009.
- Stammler, K.L.*, R.C. Bailey, and N.E. Mandrak. 2009. What happens when headwater drains are buried? Land Improvement Contractors of Ontario Conference. London, ON. Jan 20-22, 2009.
- Stammler, K.L.*, B. Ward-Campbell, R.L. McLaughlin, R.C. Bailey, and N.E. Mandrak. 2009. Biological fisheries implications of agricultural drainage practices. Stressors, Habitat, and Biology in Agricultural Streams: a 1-Day Workshop. Utopia, ON. February 17, 2010
- Drake, A., N.E. Mandrak*, and H. Harvey. 2008. Quantifying the spread of aquatic invasive species, genes and pathogens: the baitfish industry in Ontario as a model system. Great Lakes Law Enforcement Committee.
- Stammler, K.L.*, R.C. Bailey, and N.E. Mandrak. 2009. What happens when headwater drains are buried? Land Improvement Contractors of Ontario Conference. London, ON. Jan 20-22, 2009
- Drake, A.*, N.E. Mandrak, and H. Harvey. 2008. Quantifying the spread of aquatic invasive species, genes and pathogens: the baitfish industry in Ontario as a model system. Great Lakes Fish Health Committee Annual General Meeting, 138th Annual Meeting of the American Fisheries Society. Ottawa, ON. August 20, 2008.
- Mandrak, N.E.* (and 6 Baitfish Pathway Team members). 2008. The live bait pathway. Exploring the Organisms in Trade Vector Workshop. Great Lakes Commission. Detroit, MI. June 2008.
- Mandrak, N.E. 2008. Fishes. Grade 1 Class, Sacred Heart of Jesus Elementary School, Burlington, ON. May 2008.
- Mandrak, N.E.* and J. Barnucz. 2008. The role of SARA in protecting fish species at risk. Royal Ontario Museum Fish Species at Risk Identification Course. Toronto, ON. May 2008.
- Corkum, L.D.*, N.E. Mandrak, S.N. Dopazo and S.M. Reid. 2008. Fish assemblages in nearshore Canadian waters in the Huron-Erie Corridor and Lake Erie beaches. Lake Erie Millenium Network Workshop, Windsor, ON. April 2008.
- Stammler, K.L.*, Ward-Campbell, B., McLaughlin, R.L., R.C. Bailey and N.E. Mandrak. 2008. What's happening in drain research? Ontario Great Lakes Area Learning and Development Session. Barrie, ON. December 4, 2008
- Stammler, K.L.*, Ward-Campbell, B., McLaughlin, R.L., R.C. Bailey and N.E. Mandrak. 2008. Addressing uncertainties related to fish habitat in drains – overview of current research. 40th Drainage Engineers Conference. Guelph, ON. October 24, 2008
- Stammler, K.L.*, R.C. Bailey and N.E. Mandrak. 2008. Fish assemblage and water chemistry responses across a gradient of headwater stream enclosures. Biodiversity and agricultural sustainability in North America Symposium. Joint Meeting of Ichthyologists and Herpetologists. Montreal, QC. July 2008.
- Cudmore, B. and N.E. Mandrak*. 2007. Canadian live trade risk assessment. Aquatic Nuisance Species Task Force - Great Lakes Panel Meeting. Detroit, MI. November 2007.
- Dextrase, A.J.*, and N. E., Mandrak. 2007. Eastern sand darter habitat modelling and repatriation. Great Lakes Laboratory for Fisheries and Aquatic Sciences Seminar Series, December 2007.

Curriculum Vitae – Nicholas Edward Mandrak

- Drake, A. *, M. Power, M. Koops, S. Doka, and N.E. Mandrak. 2007. Biological characteristics of eastern sand darter (*Ammocrypta pellucida*): implications for habitat management. Fisheries and Oceans Canada Fish Habitat Partnership Workshop. Alliston, ON. January 2007.
- Drake, A. *, M. Power, M. Koops, S. Doka, and N.E. Mandrak. 2007. Biological characteristics of eastern sand darter (*Ammocrypta pellucida*). Fisheries and Oceans Canada Eastern Sand Darter Experts Workshop. Ottawa, ON. February 2007.
- Drake, A. *, N.E. Mandrak, and H. Harvey. 2007. Determining the risk of introducing aquatic invasive species through the commercial baitfish industry in Ontario. Michigan District of Natural Resources Annual Fisheries Research Meeting: Assessing and Managing Aquatic Invasive Species, Alpena, MI. October 2007.
- Mandrak, N.E. 2007. The SARA process as it relates to Atlantic salmon. Ontario Ministry of Natural Resources Atlantic Salmon Restoration Research Meeting. Cobourg, ON. January 2007.
- Mandrak, N.E. 2007. Protecting fish species at risk in Canada as it relates to commercial fishing. Ontario Commercial Fishing Association Annual Meeting. London, ON. January 2007.
- Mandrak, N.E. 2007. The role of SARA in protecting fish species at risk. Royal Ontario Museum Fish Species at Risk Identification Course. Lindsay, ON. February 2007.
- Mandrak, N.E. 2007. Overview of the Centre of Expertise for Aquatic Risk Assessment. DFO Science Renewal Workshop. Montebello, QC. February 2007.
- Mandrak, N.E. 2007. Overview of the Centre of Expertise for Aquatic Risk Assessment. DFO Deputy Minister Science Advisory Council Meeting. Ottawa, ON. April 2007.
- Mandrak, N.E. 2007. RC41670: Que CEARA SARA. Great Lakes Laboratory for Fisheries and Aquatic Sciences Retreat. Parry Sound, ON. April 2007.
- Mandrak, N.E. 2007. Recovery potential analysis (RPA) for freshwater species at risk in Central and Arctic Region. DFO National RPA Meeting. Ottawa, ON. August 2007.
- Mandrak, N.E. 2007. Designation of critical habitat for freshwater species at risk in Central and Arctic Region. DFO National Critical Habitat Meeting. Ottawa, ON. August 2007.
- Mandrak, N.E. 2007. Redside dace (*Clinostomus elongatus*) recovery potential assessment. CSAS Meeting, Burlington, ON. December 2007.
- Mandrak, N.E. 2007. Black redbreast (*Moxostoma duquesnei*) recovery potential assessment. CSAS Meeting, Burlington, ON. December 2007.
- Mandrak, N.E. and B. Cudmore. 2007. Canadian guidelines for assessing risk of aquatic invasive species. DFO National Introductions and Transfers Committee Risk Assessment Workshop. Toronto, ON. February 2007.
- Mandrak, N.E., and B. * Cudmore. 2007. Biodiversity of fishes in the Kawarthas. Nature Ontario Annual General Meeting, Peterborough, ON. May 2007.
- Mandrak, N.E. *, and B. Cudmore. 2007. Canadian guidelines for assessing risk of aquatic invasive species. USFWS Risk Assessment Workshop. Kansas City, MO. August 2007.
- Mandrak, N.E. *, and B. Cudmore. 2007. Canadian Centre of Expertise for Aquatic Risk Assessment. Aquatic Nuisance Species Task Force - Great Lakes Panel Meeting. Detroit, MI. November 2007.
- Mandrak, N.E. *, C.B. Renaud, and M. F. Docker. 2007. Taxonomy, distribution and conservation of lampreys in Canada. American Fish Society Annual Meeting. San Francisco, CA. September 2007.
- Stammler, K.L. *, N.E. Mandrak, R. McLaughlin, R. Bailey, and B. Ward-Campbell. 2007. Do agricultural drains provide fish habitat? Annual Meeting of the Land Improvement Contractors of Ontario. London, ON. January 2007.
- Cudmore, B. and N.E. Mandrak*. 2006. Asian carps and the Canadian live food fish trade. The Invasive Asian Carps in North America: A Forum to Understand the Biology and Manage the Problem. Peoria, IL. August 2006.
- Cudmore, B.* and N.E. Mandrak. 2006. Risk assessment of snakeheads (Channidae) in Canada. Centre for Environmental Cooperation Aquatic Invasive Species Risk Assessment Working Group. Merida, Mexico. January 2006.
- Cudmore, B.* and N.E. Mandrak. 2006. Update: Canadian risk assessment of the aquarium trade. Centre for Environmental Cooperation Trilateral Risk Assessment Meeting. Orlando, FL. October 2006.
- Mandrak, N.E. 2006. Recovery potential analysis (RPA) for freshwater species at risk in Central and Arctic region. Quebec Regional RPA Workshop, Montreal, PQ. December 2006.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E. 2006. Can cross-boundary protected areas be used to conserve Great Lakes fishes? Parks Research Forum of Ontario, Niagara Falls, ON. June 2006.
- Mandrak, N.E. 2006. Fishes. Grade 1 Class, Sacred Heart of Jesus Elementary School, Burlington, ON. April 2006.
- Mandrak, N.E. 2006. Monitoring invasive fish species in Ontario. Central and Arctic AIS Monitoring Zonal Workshop, Burlington, ON. October 2006.
- Mandrak, N.E. 2006. Overview of pathways of effects approach to AHA in C&A for freshwater species. DFO Fish Habitat Management National Allowable Harm Workshop, Ottawa, ON. February 2006.
- Mandrak, N.E. 2006. Proposed method for allowable harm analysis (AHA) for freshwater species at risk in Central and Arctic region. Lake Sturgeon AHA Workshop, Winnipeg, MB. March 2006.
- Mandrak, N.E. 2006. Que CEARA SARA. DFO Regional Science Managers' Committee Meeting. Burlington, ON. September 2006.
- Mandrak, N.E. 2006. The biodiversity of Algonquin Park fishes. Department of Biology, University of Western Ontario, London, ON. August 2006.
- Mandrak, N.E. 2006. The role of DFO in protecting species at risk. Department of Biology, University of Western Ontario, London, ON. March 2006.
- Mandrak, N.E. 2006. The role of DFO in protecting species at risk. Nawash Tribal Council, Cape Croker, ON. February 2006.
- Mandrak, N.E.* and M. Munawar. 2006. The rise of introduced fishes and the fall of fish species at risk in Lake Huron: a review. State of Lake Huron Conference, Honey Harbour, ON. October 2006.
- Mandrak, N.E. and M. Munawar*. 2006. The rise of introduced fishes and the fall of fish species at risk in Lake Ontario: a review. 49th Conference on Great Lakes Research, Windsor, ON. May 2006.
- Mandrak, N.E., A. Drake* and H.H. Harvey. 2006. Determining the risk of spreading AIS through the baitfish industry in Ontario. American Fish Society Annual Meeting, Lake Placid, NY. September 2006.
- Mandrak, N.E.*, T.J. Morris and A. Rose. 2006. Applying the proposed method for allowable harm analysis for freshwater species at risk in Central and Arctic region: a hypothetical case study in the Grand River of southwestern Ontario. DFO Fish Habitat Management National Allowable Harm Workshop, Ottawa, ON. February 2006.
- Munawar, M.*, N.E. Mandrak, I.F. Munawar, M. Fitzpatrick, R. Dermott, H. Niblock. 2006. Implications of the impact of exotic species on the food web dynamics in the North American Great Lakes. Great Lakes of the World (GLOW) IV, Bagamoyo, Tanzania. February 2006.
- Munawar, M.*, N.E. Mandrak, I.F. Munawar, M. Fitzpatrick, H. Niblock. 2006. Global threats and impacts of aquatic non-indigenous species to biosecurity: Lessons learnt from the North American Great Lakes. International conference on the Majestic River Ganga: health, integrity and management. Patma University, Patma, India. November 2006.
- Mandrak, N.E. 2005. The role of DFO in protecting species at risk. Great Lakes Institute for Environmental Research, University of Windsor, Windsor, ON. November 2005.
- Mandrak, N.E. 2005. Ongoing DFO activities in the Huron-Erie corridor. Lake St. Clair Biennial Conference, Wallaceburg, ON. September 2005.
- Mandrak, N.E. 2005. Science, FHM and SARA. DFO-FHM OGLA Learning and Development Session, Collingwood, ON. September 2005.
- Mandrak, N.E. 2005. Biodiversity of fishes in the Georgian Bay basin. Georgian Bay Association Annual Meeting, Toronto, ON. April 2005.
- Mandrak, N.E. 2005. The COSEWIC process as it relates to the American eel. Canadian Eel Science Working Group Meeting, Quebec City, PQ. January 2005.
- Mandrak, N.E. 2005. The role of DFO in protecting species at risk. DFO-FHM Aquatic Species at Risk Information Session, Burlington, ON. April 2005.
- Mandrak, N.E. 2005. Fish species at risk in the Great Lakes basin: policy, protection and prospects. Canadian Society of Zoologists Annual Meeting, Plenary Session. Kingston, ON. May 2005.
- Bogutskaya, N.*, A. Naseka and N. E. Mandrak. 2004. Threats to the fishes of Khanka Lake, a large, shallow Asian lake. International Association for Great Lakes Research, Waterloo, ON. May 2004.
- Mandrak, N.E. 2004. Biodiversity of fishes on the boreal shield in Ontario. Boreal Research Symposium, Laurentian University, Sudbury, ON. February 2004.
- Mandrak, N.E. 2004. The role of DFO in protecting species at risk. Loaves and Fishes Seminar Series, University of Guelph, February 2004.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E. 2004. The role of DFO in protecting species at risk with emphasis on Carolinian Canada. Carolinian Canada Conference, Port Franks, ON. October 2004.
- Mandrak, N.E.* and S. Casselman. 2004. Black redhorse critical habitat case study. SARCEP Critical Habitat Workshop, Halifax, NS. December 2004.
- Munawar, M.*, N.E. Mandrak, I.F. Munawar, R. Dermott, H. MacIsaac, and M. Fitzpatrick. 2004. Impacts of exotic species invasions on ecosystem health and food web dynamics: the Great Lakes experience. Second International Conference on Environmental Concerns: Innovative Technologies and Management Options, Xiamen, China. October 2004.
- Munawar, M.*, N.E. Mandrak, I.F. Munawar, R. Dermott, and M. Fitzpatrick. 2004. Changes and threats to ecosystem health and sustainable development: lessons from the North American Great Lakes. Seventh Asian Fisheries Forum, Penang, Malaysia. November 2004.
- Staton, S.K., N. E. Mandrak*, C.K. Minns, and C. Chu. 2004. Carolinian Canada: the crossroads of freshwater biodiversity, invaders and species at risk. Carolinian Canada Conference, Port Franks, ON. October 2004.
- Mandrak, N.E. 2003. Web mapping tool for fish species at risk in Ontario. DFO Technology Transfer Workshop. Ottawa, ON. December 2003.
- Mandrak, N.E. 2003. Current fish species-at-risk research in the Great Lakes region. DFO-FHM OGLA Learning and Development Session, Orillia, ON. September 2003.
- Mandrak, N.E. 2003. Current fish species-at-risk research in the Great Lakes region. OMNR Species-at-Risk Workshop, Dorset, ON. March 2003.
- Mandrak, N.E. 2003. Changes in the fish fauna of the Canadian Great Lakes basin: 1973-present. Canadian Conference for Fisheries Research, Ottawa, ON. January 2003.
- Olden, J.D.* and N.E. Mandrak. 2003. A hierarchical understanding and prediction of fish species distributions in Ontario. Canadian Conference for Fisheries Research, Ottawa, ON. January 2003.
- Reist, J.D.* and N.E. Mandrak. 2003. Changes in the freshwater fish fauna of Arctic Canada: 1973 to Present. Canadian Conference for Fisheries Research, Ottawa, ON. January 2003.
- Mandrak, N.E. 2002. Proposed national freshwater ecological areas classification for COSEWIC. COSEWIC National Meeting. Ottawa, ON. November 2002.
- Mandrak, N.E. 2002. Ghosts of fish introductions past, present and future: predicting the impact of smallmouth bass introductions. Department of Geography Seminar Series, Syracuse University. November 2002.
- Mandrak, N.E. 2002. Proposed national freshwater ecological areas classification for COSEWIC. Freshwater Fish Species Specialist Group, COSEWIC. Vancouver, BC. September 2002.
- Mandrak, N.E.* and C.C. Wilson. 2002. Deepwater sculpin in Canada: population trends, genetic diversity and conservation status reassessed. Native Fishes Restoration Workshop, Great Lakes Fishery Commission, Ann Arbor, MI. June 2002.
- Mandrak, N.E. Proposed national freshwater ecological areas classification for COSEWIC. COSEWIC national meeting. Ottawa, ON. November 2002.
- Mandrak, N.E. Ghosts of fish introductions past, present and future: predicting the impact of smallmouth bass introductions. Department of Geography Seminar Series, Syracuse University. November 2002.
- Mandrak, N.E. Proposed national freshwater ecological areas classification for COSEWIC. Freshwater Fish Species Specialist Group, COSEWIC. Vancouver, BC. September 2002.
- Mandrak, N.E.* and C.C. Wilson. Deepwater sculpin in Canada: population trends, genetic diversity and conservation status reassessed. Native Fishes Restoration Workshop, Great Lakes Fishery Commission, Ann Arbor, MI. June 2002.
- Mandrak, N.E. Ghosts of fish introductions past, present and future: predicting the impact of smallmouth bass introductions. Loaves and Fishes Seminar Series, University of Guelph, December 2001.
- Mandrak, N.E. Biodiversity of Algonquin Park fishes. Algonquin Park Fisheries Research Symposium, Algonquin Park. December 2001.
- Mandrak, N.E. Predicting the spread and impact of introduced fishes in Algonquin Park. Algonquin Park Fisheries Research Symposium, Algonquin Park. December 2001.
- Mandrak, N.E. Predicting the Wisconsinian distributions of the deepwater sculpins, *Cottus ricei* and *Myoxocephalus thompsoni*. International Association of Great Lakes Research Annual Conference, Green Bay, WI. June 2001.
- Mandrak, N.E. Biodiversity and conservation of freshwater fishes. Pymatuning Laboratory Summer Seminar Series. June 2000.

Curriculum Vitae – Nicholas Edward Mandrak

- Mandrak, N.E.* and C.C. Wilson. Protecting aquatic biodiversity in Ontario. Science and Management of Protected Areas Association Conference, University of Waterloo, Waterloo, ON. May 2000.
- Mandrak, N.E. Biogeography, biodiversity and conservation biology of freshwater fishes. Department of Biological Sciences, Youngstown State University, Youngstown, OH. April 1999.
- Mandrak, N.E. Biogeography, biodiversity and conservation biology of freshwater fishes. Department of Fisheries and Oceans, Winnipeg, MB. March 1999.
- Mandrak, N.E. Biogeography of Ontario fishes in relation to historical and environmental factors. Department of Zoology, University of Toronto, Toronto, ON. December 1998.
- Mandrak, N.E. Biodiversity and conservation of fishes in Algonquin Park. Department of Zoology, University of Toronto, Toronto, ON. October 1998.
- Mandrak, N.E. Threats to the fish diversity of Khanka Lake, Russia. American Society of Ichthyologists and Herpetologists Annual Conference, Guelph, ON. July 1998.
- Mandrak, N.E. An assessment of the suitability of using a terrestrial ecoregion classification to protect aquatic biodiversity in Ontario. Aquatic Classification Workshop, Ontario Ministry of Natural Resources, Toronto, ON. March 1998.
- Mandrak, N.E. Biogeographic patterns of freshwater fishes in relation to historical and environmental factors. Division of Biology, Kansas State University, Manhattan, KS. December 1997.
- Mandrak, N.E. Threats to the biological diversity of freshwater fishes. Division of Biology, Kansas State University, Manhattan, KS. December 1997.
- Mandrak, N.E. Biogeographic patterns of Ontario fishes in relation to historical and environmental factors. Department of Biology, Trent University, Peterborough, ON. September 1997.
- Mandrak, N.E. Threats to the biological diversity of freshwater fishes. Department of Biology, Trent University, Peterborough, ON. June 1997.
- Mandrak, N.E. Threats to the biological diversity of Khanka Lake, Russia. International Ecological Congress, Voronezh, Russia. September 1996.
- Mandrak, N.E. Russian waters: an ichthyological expedition in Russia's Far East. Department of Systematics and Ecology, University of Kansas, Lawrence, KS. March 1996.
- Mandrak, N.E. Fish species richness in Ontario lakes: the effect of spatial autocorrelation in ecology. Department of Systematics and Ecology, University of Kansas, Lawrence, KS. March 1996.
- Mandrak, N.E.* and E.J. Crossman. Biogeographic patterns of fish species richness in Ontario lakes in relation to historical and environmental factors. Society of Canadian Limnologists, Biodiversity Session, Ottawa, ON. January 1995.
- Mandrak, N.E. Threats to the fish diversity of Khanka Lake, Russia. Department of Biological Sciences and Allied Health, Fort Hays State University, Hays, KS. December 1994.
- Mandrak, N.E. Relationships between fish species richness and historical and environmental factors in Ontario lakes. Department of Biological Sciences and Allied Health, Fort Hays State University, Hays, KS. May 1994.
- Mandrak, N.E. and M.K. Litvak*. The ecology of the commercial baitfish industry in North America. Institute of Ichthyology, University of Guelph, Guelph, ON. March 1994.
- Mandrak, N.E.* and E.J. Crossman. Biodiversity of fish communities in Algonquin Park. The Role of Provincial Parks in Conserving Biodiversity Symposium, Dorset, ON. September 1993.
- Mandrak, N.E.* and E.J. Crossman. A review of introduced freshwater fishes in Ontario. American Fisheries Society, Southern Ontario Chapter Annual Workshop, Barrie, ON. January 1991.
- Mandrak, N.E. Potential range extensions of fish species in eastern North America associated with climatic warming. American Fisheries Society, New York Chapter Annual Meeting, Owego, NY. January 1990.

Curriculum Vitae – Nicholas Edward Mandrak

D. LIST OF COURSES (in preceding 5 years)

12. Indicate in each case whether you had major responsibility for design of course.

A. Undergraduate courses taught

2014/15

BIOD54H - Applied Conservation Biology (new course designed by NEM)

BIOD98H - Directed Research Course in Biology

B. Graduate courses taught

2014/15

EES1100Y - Advanced Seminar in Environmental Science (modified by NEM)

EES3000H - Applied Conservation Biology (new course designed by NEM)

EES3003H - Topics in Applied Biodiversity (new course designed by NEM)

C. Theses supervised

Masters Students

Brett Allen. 2015-present. Spatio-temporal effects of multiple stressors on the fish assemblages of the Credit river watershed. University of Toronto.

Paul Bzonek. 2015-present. Evaluating the effectiveness of light and sound control measures to inhibit fish movement. University of Toronto.

Yiminxue Zheng. 2015-present. Effects of multiple stressors on Brook Trout (*Salvelinus fontinalis*) in Greater Toronto Area streams. University of Toronto.

Meagan Kindree. 2014-present. The effects of gear selection on the calculation of the Index of Biotic Integrity based on fish communities. University of Toronto.

Natalie Rook, 2014-present. The effects of wetland creation on fish communities. University of Toronto. Co-supervisor: S. Reid.

Julia Colm, 2013-present. The Grass Pickerel in Canada: distribution, abundance, and conservation status. Queen's University. Co-supervisor: B. Tufts.

Paul Finigan, 2013-present. Littoral fish community changes in southeastern Ontario. Queen's University. Co-supervisor: B. Tufts.

Gabrielle Malcolm. 2013-2015. Use of location in COSEWIC assessments of freshwater fishes. University of Toronto. Co-supervisor: D. Jackson.

Natacha Kramski, 2011-2015. The effects of agricultural drain maintenance on the Grass Pickerel, a species of special concern. University of Guelph. Co-supervisor: R.L. McLaughlin.

Jun Cheng. 2011-2013. The effect of Area of Occupancy scale on assessing conservation status of aquatic species. University of Toronto. Co-supervised by D. Jackson.

Monica Granados. 2008-2010. Is the IBI an appropriate measure of fish habitat rehabilitation in areas of concern? University of Toronto. Co-supervised by D. Jackson.

Cavan Harpur. 2007-2010. Changes in the fish communities of Bruce Peninsula lakes: 1970s to present. University of Toronto. Co-supervised by H. Harvey.

Courtney Beneteau, 2004-2007. Conservation genetics of darters. University of Windsor. Co-supervised by D. Heath.

Heather Surette. 2002-2006. Fish species at risk at Point Pelee National Park: current assessment, historic changes and threats. University of Guelph. Co-supervised by T. Nudds.

Katie Stammler, 2004-2005. Do agricultural drains act as natural watercourses? University of Guelph. Co-supervised by R.L. McLaughlin.

Nick Lapointe, 2003-2005. Habitat associations of fish communities in the Detroit River. University of Windsor. Co-supervised by L.D. Corkum.

Joshua Clark, 2002-2004. Resource partitioning in redhorses (*Moxostoma* spp.). University of Guelph. Co-supervised by D.L.Noakes.

Curriculum Vitae – Nicholas Edward Mandrak

Fraser Neave. 2002-2004. Development of genetic markers and a morphological key for native lamprey ammocoetes in the Great Lakes basin. University of Guelph. Co-supervised by D.L.Noakes.

Mark Poos. 2002-2004. Fish species at risk in the Sydenham River: current assessment, historic changes and threats. University of Guelph. Co-supervised by R.L. McLaughlin.

Joshua Noble. 2000-2002. Hot spot analysis of rare and endangered fishes in the Great Lakes basin. Youngstown State University.

Douglas Bradley. 1995-1998. Historical changes in fish distributions in northwestern Kansas. Fort Hays State University.

Paul Foutz. 1995-1998. Spatiotemporal changes in the fish communities of the Republican River, Kansas. Fort Hays State University.

Terence Malloy. 1995-1997. The distribution of fish communities in relation to environmental factors in the Republican River of the Great Plains. Fort Hays State University.

Doctoral Students

Sunci Aviljas, 2014-present. The role of context-dependence in the establishment and impact of a global invader. McGill University. Co-supervisor: T. Ricciardi.

Sara Campbell. 2014-present. Spatial and temporal changes in the functional diversity of Great Lakes fish communities. University of Toronto.

Rowshyra Casteneda, 2014-present. Detection probability of rare species: a comparison of traditional and novel methods. University of Toronto.

Fielding Montgomery, 2014-present. The effects of agricultural drain maintenance on fish species at risk. University of Toronto. Co-supervisor: S. Reid.

Dustin Raab, 2013-present. Interaction of invasive species and habitat modification in tributaries. McGill University. Co-supervisor: T. Ricciardi.

Belinda Ward-Campbell, 2005-2015. Evaluating Best Management Practises for designing and maintaining agricultural drains to maintain fish habitat. University of Guelph. Co-supervisor: R.L. McLaughlin.

Alan Dextrase, 2006-2013. Identifying critical habitat and reintroduction of the Endangered Eastern Sand Darter. Trent University.

William Glass. 2007-2012. Critical habitat of spotted gar in Canada elucidated by Radio-telemetry. University of Windsor. Co-supervised by L. Corkum.

Andrew Drake. 2006-2010. Quantitative risk assessment of the baitfish industry in Ontario. University of Toronto. Co-supervised by H. Harvey.

Postdoctoral Fellows

Nathan Lujan, 2015-present. Predicting historical fish movement using gene flow. Co-supervisor: N. Lovejoy.

Pasan Samarasin-Dissanayake, 2015-present. Detection probability of endangered wetland fish species.

Dominic Halas, 2014. Genetics of Goldfish in North America. Co-supervisor: N. Lovejoy.

William Glass, 2013-present. Identifying the critical habitat of the Threatened Spotted Gar.

Lisa Jones, 2013-present. Risk of grass Carp in the Great Lakes.

Ryan Walter, 2013-present. Detecting fish species at risk using eDNA. Co-supervisor: D. Heath, Windsor.

Jaewoo Kim, 2012-present. Quantifying and controlling the movement of invasive fishes.

Megan McCusker, 2011-2014. Conservation genetics of the Pugnose Shiner. Co-supervisor: N. Lovejoy.

Andrew Drake, 2010-present. Modelling AIS movement through bait, boating, and shipping pathways.

Shidan Murphy, 2011-2013. Potential effect of climate change on fishes in the Great Lakes.

Suzanne Gray, 2010-2012. The effects of turbidity on Pugnose Shiner behaviour and physiology. Co- Supervisor: L. Chapman, McGill.

Kevin Hedges, 2007-2010. Aquatic protected areas in the Great Lakes basin: inventory, evaluation and gap analysis.

Scott Reid, 2007-2008. Taxonomy, biology and critical habitat of shortjaw cisco in White Partridge Lake, Algonquin Park.

Curriculum Vitae – Nicholas Edward Mandrak

D. Other teaching and lectures given (in preceding 5 years)

E. ADMINISTRATIVE POSITIONS

13. A. Positions held and service on committees and organizations within the University.

Chair, PhD Examination Committee. Maude Therberge, School of Public Health, University of Toronto. June 2015.

Member, Aquatic Ecology Search Committee, Department of Ecology and Evolutionary Biology, University of Toronto, 2014, 2015.

Member, Conservation Biology Lecturer Search Committee, Department of Biological Sciences, University of Toronto Scarborough, 2015.

Member, PhD Examination Committee. Aaron Hall, Department of Ecology and Evolutionary Biology, University of Toronto. January 2015.

Member, PhD Examination Committee. Pasan Samarasin-Dissanayake, Department of Ecology and Evolutionary Biology, University of Toronto. August 2015.

Co-organizer of Biological Sciences Departmental Seminar Series, 2014-2016.

Director, Master's of Environmental and Physical Sciences Conservation and Biodiversity Stream, University of Toronto Scarborough. 2014-present.

Member, Conservation Biology Search Committee, Department of Biological Sciences, University of Toronto Scarborough, 2014.

Member, MSc Committee. Simone Yasui, Department of Ecology and Evolutionary Biology, University of Toronto, 2014-present.

Member, MSc Committee. Lindsay Ogston, Department of Ecology and Evolutionary Biology, University of Toronto, 2013-2015.

B. Positions held and service on committees and organizations outside the University of scholarly and academic significance.

Associate Editor, *Biological Invasions*, 2009 to present.

Member, Board of Directors, Canadian Conference for Fisheries Research, 2013-present.

Member, Research Committee, Great Lakes Commission. 2010-present.

Co-editor, *Freshwater Fishes, Fisheries and Habitat of the World* series, *Journal of Aquatic Ecosystem Health and Management*, 2004-present.

Editorial Board Member, *Journal of Aquatic Ecosystem Health and Management*, 2004-present.

Member, Joint American Fisheries Society- American Society of Ichthyologists and Herpetologists, Names Committee, 2004-present.

Member, American Society of Ichthyologists and Herpetologists, Endangered Species Committee, 2004-present.

Member, Freshwater Fishes Specialists' Subcommittee, COSEWIC, April 2002-present.

CURRICULUM VITAE

Linda S. Nelson, Ph.D.

U.S. Army Engineer Research & Development Center

Environmental Laboratory, EM-W

3909 Halls Ferry Road

Vicksburg, MS 39180-6199

Phone: 601-634-2656

E-mail: Linda.S.Nelson@usace.army.mil

Education

1982 - B.S., Biology. University of South Dakota, Vermillion, SD

1985 - M.S., Crop Production and Physiology. Iowa State University, Ames, IA

Thesis: Isolating potential allelochemicals from soybean-soil residues

2001 - Ph.D., Botany/Weed Science. Purdue University, West Lafayette, IN

Thesis: Phytoremediation of TNT-contaminated water by the submersed aquatic macrophyte *Potamogeton pectinatus*

Employment History and Professional Experience

2010-present: *Assistant Technical Director*, Civil Works, Environmental Engineering and Sciences and *Program Manager*, Aquatic Nuisance Species Research Program and the Aquatic Plant Control Research Program, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS.

1988-2010: *Plant Physiologist*, Chemical Control Technology Team and *Program Manager* (since 2009), Aquatic Nuisance Species Research Program, U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS.

2005-present: *Adjunct Professor*. Department of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS.

1985-1988: *Research Associate*. Iowa State University - U.S. Army Corps of Engineers Waterways Experiment Station, Intergovernmental Personal Agreement (IPA), Vicksburg, MS.

Current Job Responsibilities

Provide technical and program support to the Technical Director and Environmental Laboratory Director on all issues related to environmental engineering and sciences within the Corps of Engineers Civil Works Business Area. Assist in planning, programming, and budget execution of major multidisciplinary environmental quality research. Serve as Program Manager for the Aquatic Plant Control Research Program (\$3.375M budget in 2015) and the Aquatic Nuisance Species Research Program (\$670K budget in 2015) and other invasive species R&D initiatives within the Corps of Engineers. Program management responsibilities include: reviewing and developing the direction of current and future research; managing, distributing and monitoring funding execution; maintaining program websites; reviewing report and program documentation; interfacing with program Technical Monitors at Corps Headquarters level; and providing technical guidance to requesting Corps Districts/Divisions and the Invasive Species Leadership Team on issues related to aquatic nuisance species. Serve as the Army representative on the Technical Advisory Committee for the Resource Conservation and Climate Change Program Area of the Strategic Environmental Research and Development Program (SERDP).

Peer-Reviewed Publications

- Theel, H., L. **Nelson**, and C. Mudge. 2012. Effects of plant growth regulation on hydrilla and habitat complexity. *J. Aquat. Plant Manage.* 50:129-135.
- Nelson**, L.S. 2009. Chapter 13.4 Giant and common salvinia, pp. 105-111. In: *Biology and Control of Aquatic Plants: A Best Management Practices Handbook*. (Gettys, L.A., W.T. Haller, and M. Bellaud, eds.). Aquatic Ecosystem Restoration Foundation, Marietta, GA. 210 pp.
- Nelson**, L.S. and J.F. Shearer. 2008. Evaluation of triclopyr and *Mycoleptodiscus terrestris* for control of Eurasian watermilfoil (*Myriophyllum spicatum*). *Invasive Plant Sci. and Manage.* 1:337-342.
- Madsen, J.D., R.M. Wersal, K.D. Getsinger and L.S. **Nelson**. 2008. Sensitivity of wild rice (*Zizania palustris* L.) to the aquatic herbicide triclopyr. *J. Aquat. Plant Manage.* 46:150-154.
- Nelson**, L.S., L.M. Glomski, and D.N. Gladwin. 2007. Effect of glyphosate rate and spray volume on control of giant salvinia. *J. of Aquat. Plant Manage.* 45:58-61.
- Nelson**, L.S. and J.F. Shearer. 2005. 2,4-D and *Mycoleptodiscus terrestris* for control of Eurasian watermilfoil. *J. Aquat. Plant Manage.* 43:29-34.
- Glomski, L.M., L.S. **Nelson**, and J.G. Skogerboe. 2003. Clearigate treatments for control of giant salvinia. *J. Aquat. Plant Manage.* 41:127-129.
- Nelson**, L.S., A.B. Stewart, and K.D. Getsinger. 2002. Fluridone effects on fanwort and water marigold. *J. Aquat. Plant Manage.* 40:58-63.

Shearer, J.F. and L.S. **Nelson**. 2002. Integrated use of endothall and a fungal pathogen for management of the submersed macrophyte *Hydrilla verticillata* (L.f.) Royle. *Weed Tech.* 16:224-230.

Nelson, L.S., J.G. Skogerboe, K.D. Getsinger. 2001. Herbicide evaluation against giant salvinia. *J. Aquat. Plant Manage.* 39:48-53.

Nelson, L.S. and K.D. Getsinger. 2000. Herbicide evaluation for control of wild taro. *J. Aquat. Plant Manage.* 38:70-72.

Nelson, L.S., J.F. Shearer, and M.D. Netherland. 1998. Mesocosm evaluation of integrated fluridone-fungal pathogen treatment on four submersed plants. *J. Aquat. Plant Manage.* 36:73-77.

Nelson, L.S. 1997. Response of hydrilla and American pondweed to flurprimidol. *J. Aquat. Plant Manage.* 35:50-54.

Nelson, L.S., K.D. Getsinger, J.E. Freedman. 1996. Efficacy of triclopyr on purple loosestrife and associated wetland vegetation. *J. Aquat. Plant Manage.* 34:72-74.

Nelson, L.S. 1996. Growth regulation of Eurasian watermilfoil with flurprimidol. *J. Plant Growth Regulation.* 15:33-38.

Getsinger, K.D., G.O. Dick, R.M. Couch, and L.S. **Nelson**. 1994. Mesocosm evaluations of bensulfuron methyl activity on Eurasian watermilfoil, vallisneria, and American pondweed. *J. Aquat. Plant Manage.* 32:1-6.

Nelson, L.S., M.D. Netherland, and K.D. Getsinger. 1993. Bensulfuron methyl activity on Eurasian watermilfoil. *J. Aquat. Plant Manage.* 31:179-185.

Nelson, L.S., K.D. Getsinger, and K.T. Luu. 1993. Effect of chemical treatments on bahiagrass (*Paspalum notatum*) suppression. *Weed Tech.* 7:127-133.

Einhellig, F.A., and L.S. **Nelson**. 1982. Effects of ferulic and p-coumaric acid addition to soil on grain sorghum. *Proc. South Dakota Acad. Sci.* 61:127-129.

Government Reports, Miscellaneous Publications

GLMRIS Technology Team (J. Potthoff, M. Cornish, L. **Nelson** and J. Crossland). 2012. Inventory of Available Controls for Aquatic Nuisance Species of Concern – Chicago Area Waterways System. http://glmr.is.anl.gov/documents/docs/ANS_Control_Paper.pdf

Mudge, C.R., R.M. Wersal, and L.S. **Nelson**. 2011. Evaluation of commercially available herbicide mixes for control of rosette stage yellow starthistle (*Centaurea solstitialis* L.). ERDC/EL TN-11-3. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 8 pp.

Nelson, L.S. and J.F. Shearer. 2009. Integrated weed management strategies for control of hydrilla. APCRP Technical Notes Collection, ERDC/TN APCRP-CC-09. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 6 pp.

- Shearer, J.F. and L.S. **Nelson**. 2009. Combining ALS-inhibiting herbicides with the fungal pathogen, *Mycoleptodiscus terrestris* for control of hydrilla. ERDC/TN-APCRP-CC-11. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 9 pp.
- Glomski, L.M., M.D. Netherland, and L.S. **Nelson**. Potential impact of submersed 2,4-D and triclopyr applications on native emergent plants. ERDC/TN APCRP-CC-10. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 8 pp.
- Shearer, J.F. and L.S. **Nelson**. 2009. Combining ALS-inhibiting herbicides with the fungal pathogen *Mycoleptodiscus terrestris* for control of hydrilla. APCRP Technical Notes Collection, ERDC/TN APCRP-CC-11. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 9 pp.
- Glomski, L.M. and L.S. **Nelson**. 2008. Evaluation of 2,4-D ester and triclopyr against waterlily and spatterdock. APCRP Technical Notes Collection, ERDC/TN APCRP-CC-07. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 6 pp.
- McFarland, D.W., L.S. **Nelson**, M. Grodowitz, R.M. Smart, and C.S. Owens. 2004. *Salvinia molesta* D.S. Mitchell (giant salvinia) in the United States: a review of species ecology and approaches to management. ERDC/EL SR-04-2. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 40 pp.
- A. Cofrancesco, J.F. Shearer, L.S. **Nelson**, J. Kilgore, A. Miller, and B. Payne. 2003. Early detection rapid response plan for invasive species in the Devils Lake Watershed, ND. Report to the St. Paul District.
- Nelson**, L.S., C.S. Owens, and K.D. Getsinger. 2003. Response of wild rice to selected aquatic herbicides. ERDC/EL TR-03-14. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 18 pp.
- Nelson**, L.S. and J.F. Shearer. 2002. Response of Eurasian watermilfoil to integrated fluridone-fungal pathogen treatment. APCRP Technical Note, TN APCRP-IC-03. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 7 pp.
- Nelson**, L.S. 1999. Survey of threatened and endangered wetland and aquatic plants at four Corps of Engineers Districts. Technical Report A-99-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 55 pp.
- Shearer, J.F. and L.S. **Nelson**. 1999. Managing hydrilla: field trials using biological and chemical control technologies alone and in combination. APCRP Technical Notes Collection, TN APCRP-IC-02. U.S. Army Engineer Research and Development Center, Vicksburg, MS. 9 pp.
- Nelson**, L.S., J.F. Shearer, and M.D. Netherland. 1998. Integrated fluridone-fungal pathogen treatment for four submersed plants. Aquatic Plant Control Technical Note IC-01, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 9 pp.
- Nelson**, L.S., K.D. Getsinger, and J.E. Freedman. 1995. Selective control of purple loosestrife with triclopyr. Technical Report WRP-SM-4. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 31 pp.

Nelson, L.S., and K.D. Getsinger. 1994. Battling purple loosestrife brings some success. Wetlands Research Program Bulletin. 4(1):5-7.

Nelson, L.S. and M.D. Netherland. 1993. Efficacy of bensulfuron methyl on Eurasian watermilfoil. Technical Report A-93-2. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 25 pp.

Nelson, L.S., K.D. Getsinger, and K.T. Luu. 1992. Evaluation of plant growth regulators for use in grounds maintenance at military installations. Technical Report EL-92-24. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 161 pp.

Nelson, L.S. and T.K. Van. 1991. Growth regulation of Eurasian watermilfoil and hydrilla using bensulfuron methyl. Information Exchange Bulletin A-91-1, Aquatic Plant Control Research Program. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 7 pp.

Nelson, L.S. T.K. Van, C.A. Lembi, and T. Chand. 1991. Plant growth regulators for aquatic plant management. Proceedings, 25th Annual Meeting, Aquatic Plant Control Research Program, Miscellaneous Paper A-91-3. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 10 pp.

Nelson, L.S. 1990. Plant growth regulators for aquatic plant management. Proceedings, 24th Annual Meeting, Aquatic Plant Control Research Program, Miscellaneous Paper A-90-3. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 4 pp.

Vadhwa, O.P., F.B. Matta, and L.S. **Nelson**. 1990. Effects of uniconazole and mefluidide on root growth of bermudagrass as determined with a rhizotron. Research Report, Mississippi Agricultural and Forestry Experiment Station. 15:1-4.

Westerdahl, H.E., L.S. **Nelson**, K.D. Getsinger, and K.T. Luu. 1990. Plant growth regulator evaluation for five Corp of Engineers projects and one military installation. Technical Report R-90-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 83 pp.

Invited Presentations (2003-present)

Aquatic Plant Management Training Seminars for the municipalities of Arecibo, Mayaguez, Guayama, and Toa Baja in Puerto Rico. Training seminars sponsored by Jacksonville District Corps of Engineers and the Puerto Rico Department of Environment and Natural Resources. April-May 2010. "Chemical control of aquatic plants"

Invasive Species Control Summit, Scottsbluff, NE, May 2008. "Integrating herbicides and burning to restore a phragmites-dominated wetland"

186th Meeting, Armed Forces Pest Management Board, Natural Resources Committee,

February 2008. “Biology and Management of Cogongrass (*Imperata cylindrica*) and giant reed (*Arundo donax*)”

Puerto Rico Department of Natural Resources, August 2007. “Managing aquatic weeds with herbicides”

Mississippi Exotic Pest Plants Council Meeting, Jackson, MS, November, 2006.

“Chemical Control Research at the Engineer Research & Development Center”

27th Annual Meeting, South Carolina Aquatic Plant Management Society, Springmaid

Beach, SC, August 2005. “Impact of herbicides and burning on restoration of a

Phragmites-dominated wetland”

34th Annual Conference of the Louisiana Pesticide Applicators Association, Marksville,

LA, November 2004. “Chemical control of aquatic plants – research update”

Mississippi Exotic Pest Plants Council Meeting, Vicksburg, MS, December 2004.

“Chemical control of aquatic plants”

Salvinia molesta – Lake Wilson Meeting sponsored by Hawaii Department of Land

Management, Hawaii Department of Agriculture, Corps of Engineers Honolulu

District and Pacific Ocean Division, Honolulu, HI, February 2003. “Chemical

management of giant salvinia”

Federal Energy Regulatory Commission Noxious Plant Workshop, Green Bay, WI, May

2003. “Managing purple loosestrife and Eurasian watermilfoil with herbicides”

Professional Presentations (2003-present)

51st Annual Meeting, Aquatic Plant Management Society, Baltimore, MD, July 2011.

“Presidential Address: Balancing emerging threats with strategic goals”

29th Annual Meeting, Mid-South Aquatic Plant Management Society, October 2010.

“Corps of Engineers Invasive Species Initiatives and Research Programs”

16th International Conference on Aquatic Invasive Species, April, 2009.

“Integrating herbicides with *Mycoleptodiscus terrestris* to control hydrilla”

27th Annual Meeting, Mid-South Aquatic Plant Management Society, October 2008.

“Integrating herbicides with *Mycrocyptodiscus terrestris* to control hydrilla”

2nd Annual Meeting, U.S. Army Sustainable Range Program (SRP) Workshop. July 2008.

“Invasive plant research at USAERDC-Environmental Lab: past, present, future”

Florida DEP-IFAS Research Review, Ocala, FL, March 2007.

“Integrated weed management strategies for control of hydrilla”

47th Annual Meeting, Aquatic Plant Management Society, Nashville, TN, July 2007.

“Mesocosm evaluation of fluridone and *Mycrocyptodiscus terrestris* for control of hydrilla”

25th Annual Meeting, Mid-South Aquatic Plant Management Society, October 2006.

“Activity of flumioxazin on giant salvinia”

46th Annual Meeting, Aquatic Plant Management Society, Portland, OR, July 2006.

“Effect of glyphosate rate, spray volume, and adjuvant addition for control of giant salvinia”

“Interactive effects of diquat and *Mycrocyptodiscus terrestris* on hydrilla”

45th Annual Meeting, Aquatic Plant Management Society, San Antonio, TX, July 2005.

“Impact of herbicides and burning for management of *Phragmites*”

“Integrated weed management strategies for improved hydrilla control”

49th Annual Meeting, Weed Science Society of America, Honolulu, HI, February 2005.

“Integrating 2,4-D and triclopyr with a fungal pathogen *Mycrocyptodiscus terrestris* for control of Eurasian watermilfoil”

44th Annual Meeting, Aquatic Plant Management Society, Tampa, FL, July 2004.

“Evaluating herbicide strategies to control *Hydrilla verticillata* and minimize injury to the native plant, *Sagittaria kurziana*”

“Integrating triclopyr and a fungal pathogen (*Mycrocyptodiscus terrestris*) for control of Eurasian watermilfoil (*Myriophyllum spicatum*)”

43rd Annual Meeting, Aquatic Plant Management Society, Portland, ME, July 2003.

“Herbicides and prescribed burning for control of *Phragmites* at St. John’s Marsh, Michigan”

“Pathogen Research on Aquatic Plants”

Professional Activities/Service

2011-2012: Immediate Past President, Aquatic Plant Management Society
2010-2011: President, Aquatic Plant Management Society
2009-2010: President-Elect Aquatic Plant Management Society
2008-2009: Vice President, Aquatic Plant Management Society
2008-2010: Board of Directors, Mid-South Aquatic Plant Management Society
2007-2010: Board of Directors, Weed Science Society of America
2004-2011: Pesticide Committee and Natural Resources Committee, Armed Forces
Pest Management Board
2001-2007: Secretary and Newsletter Editor, Aquatic Plant Management Society
1999-2001: Chair, Student Affairs Committee, Aquatic Plant Management Society

Professional Development Activities

May 2011: Eckerd College Leadership Development Program
November 2003: Corps of Engineers Leadership Education and Development Program
August 1996: U.S. Army Engineer Waterways Experiment Station Long-term Training
Program
1988-present: Certified Pesticide Applicator, Mississippi Department of Agriculture
and Commerce, Bureau of Plant Industry.

Honors and Awards

July 2015 – President’s Award, Aquatic Plant Management Society
May 2014 – Superior Civilian Service Award, U.S. Department of the Army
July 2011 – Outstanding Service as President (2010-2011), Aquatic Plant Management
Society
May 2008 – Federal Laboratory Consortium Award for Excellence in Technology
Transfer
May 2007 – ERDC Research and Development Achievement Award
May 2007 – Achievement Medal for Civilian Service, U.S. Department of the Army
July 2007 – T. Wayne Miller Distinguished Service Award, Aquatic Plant
Management Society
July 2005 – Best Technical Poster Award, Aquatic Plant Management Society
May 2004 – Commander’s Award for Civilian Service, U.S. Department of the Army
July 2004 – Best Technical Poster Award, Aquatic Plant Management Society

Professional Affiliations

Aquatic Plant Management Society, 1991-present

Weed Science Society of America, 1996-present

South Carolina Aquatic Plant Management Society, 2005

Mid-South Aquatic Plant Management Society, 2000-present

Gamma Sigma Delta, 1985-present

Phi Sigma, 1982-present

CURRICULUM VITAE

12/03/15

Gregory G. Sass

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Escanaba Lake Research Station

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Boulder Junction, Wisconsin 54512

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Professional Employment

-Adjunct Professor, Department of Biology, University of Minnesota-Duluth,
2015-present

-Northern Unit Fisheries Research Team Leader, Wisconsin Department of Natural Resources, 2014-present

-University Associate, University of Wisconsin-Stevens Point, 2012-present

-Honorary Fellow, Center for Limnology, University of Wisconsin-Madison,
2011-present

-Northern Lakes Fisheries Research Scientist, Wisconsin Department of Natural
Resources, 2011 - 2014

-Research Affiliate, Illinois Natural History Survey, Prairie Research Institute, University
of Illinois at Urbana-Champaign, 2011 - present

-Interim Director, Forbes Biological Station, Illinois Natural History Survey, 2011

-Adjunct Associate Professor, Department of Natural Resources and Environmental
Sciences, University of Illinois at Urbana-Champaign, 2010 - present

-Assistant Research Professor, Illinois Natural History Survey, Prairie Research Institute, University of Illinois at
Urbana-Champaign, 2010-2011

-Adjunct Professor, Department of Biological Sciences, Eastern Illinois University,
2009-present

- Academic Professional, Illinois Natural History Survey, Prairie Research Institute, University of Illinois at
Urbana-Champaign, 2008-2011

- Affiliate, Program for Ecology, Evolution, and Conservation Biology, University of
Illinois at Urbana-Champaign, 2008-present

- Adjunct Assistant Professor, Department of Natural Resources and Environmental
Sciences, University of Illinois at Urbana-Champaign, 2008-2010

- Adjunct Professor, Department of Biological Sciences, Western Illinois University,
2007 – present

- Assistant Professional Scientist, Division of Ecology and Conservation Sciences,
Illinois Natural History Survey, 2006-2008

- Director, Illinois River Biological Station, Illinois Natural History Survey, 2006 – 2011
- Research Associate with Stephen R. Carpenter and James F. Kitchell, Center for Limnology, University of Wisconsin – Madison, 2004 – 2006
- Research Assistant, Center for Limnology, University of Wisconsin – Madison, 1999-2004
- Teaching Assistant, University of Wisconsin – Madison, Spring 2002 and 2003
- National Science Foundation IGERT Trainee, University of Wisconsin – Madison, 1999-2003
- Project Assistant, University of Wisconsin – Madison, Summer 1999

Academic Degrees:

- Doctor of Philosophy in Zoology, University of Wisconsin-Madison, 2004
Advisor: James F. Kitchell. Dissertation: Fish community and food web responses to a whole-lake removal of coarse woody habitat.
- Master of Science in Zoology, University of Wisconsin-Madison, 2001
Advisor: James F. Kitchell. Thesis: An analysis of walleye, *Stizostedion vitreum vitreum*, growth in the ceded territory of northern Wisconsin, 1977-2000.
- Bachelor of Science with honors in biology, Magna Cum Laude, University of South Florida, 1999. Advisor: Philip J. Motta. Thesis: The effects of satiation on prey capture kinematics in the largemouth bass, *Micropterus salmoides*.

Teaching Experience:

- Ecology of Fishes Lecture and Laboratory (ZOO 510, 511) Teaching Assistant, spring 2002 and spring 2003

Professional Memberships:

- Wisconsin Chapter of the American Fisheries Society, 2016-2017 (President)
- Wisconsin Chapter of the American Fisheries Society, 2015-2016 (President-elect)
- Wisconsin Chapter of the American Fisheries Society, 2011 - present
- Mississippi River Research Consortium, 2006 – present (Vice-president 2008-2009, President 2009-2010)
- Illinois Chapter of the American Fisheries Society, 2006 - 2011
- Organization of Biological Field Stations, 2006 - present
- Ecological Society of America, 1999 - present
- American Fisheries Society, 1999 - present
- Phi Kappa Phi National Honor Society, 1998 - present
- Golden Key National Honor Society, 1997 – present

Certifications:

- Mega-surgery, Research Animal Resources Center, University of Wisconsin-Madison
- PADI open water, advanced open water, ice, night, deep, rescue SCUBA diver

Peer-reviewed Publications:

1. VanMiddlesworth, T.D., N.N. McClelland, **G.G. Sass**, A.F. Casper, T.W. Spier, and M.J. Lemke. Biotic interactions and fish community succession during a large- scale Floodplain restoration of The Nature Conservancy's Emiquon Preserve, Illinois, USA, 2007-2014. *Hydrobiologia* (Provisionally accepted).
2. VanMiddlesworth, T.D., **G.G. Sass**, B.A. Ray, T.W. Spier, J. Lyons, N.N. McClelland, and A.F. Casper. Food habits and relative abundances of bowfin, spotted gar, and largemouth bass: implications for controlling common carp. *Hydrobiologia* (In press).
3. Bailey, C.T., B.A. Ray, and **G.G. Sass**. Growth of black crappies in two west Tennessee impoundments with implications for a reduced minimum length limit. *Journal of the Tennessee Academy of Sciences* (In press).
4. Tsehaye, I., B.M. Roth, and **G.G. Sass**. Exploring optimal walleye exploitation rates for northern Wisconsin Ceded Territory lakes using a hierarchical Bayesian age-structured model. *Canadian Journal of Fisheries and Aquatic Sciences* (Provisionally accepted).
5. Gilbert, S.J. and **G.G. Sass**. Trends in a northern Wisconsin muskellunge fishery: results from a county-wide angling contest, 1964-2010. *Fisheries Management and Ecology* (In press).
6. Levengood, J.M., D.J. Soucek, **G.G. Sass**, and J.M. Epifanio. 2015. Inter-specific and spatial comparisons of perfluorinated compounds in bighead and silver carp. *Bulletin of Environmental Contamination and Toxicology* 95:561-566. DOI:10.1007/s00128-015-1646-x.
7. Lamer, J.T., B. Ruebush, Z. Arbieva, M. McClelland, J. Epifanio, and **G.G. Sass**. Diagnostic SNPs reveal widespread introgressive hybridization between introduced bighead and silver carp in the Mississippi River Basin. *Molecular Ecology* 24:3931-3943. DOI:10.1111/mec.13285.
8. Rypel, A.L., D. Goto, **G.G. Sass**, and M.J. Vander Zanden. Production rates of walleye and their relationship to exploitation in Escanaba Lake, Wisconsin, 1965- 2009. *Canadian Journal of Fisheries and Aquatic Sciences* (in print).
9. **Sass, G.G.**, C. Hinz, A.C. Erickson, N.N. Michaels, M.A. McClelland, and J.M. Epifanio. 2014. Invasive bighead and silver carp effects on zooplankton communities in the Illinois River, Illinois, USA. *Journal of Great Lakes Research* 40:911-921. <http://dx.doi.org/10.1016/j.jglr.2014.08.010>.
10. **Sass, G.G.** and M.S. Allen. 2014. Q&A: Book editors, *Foundations of Fisheries Science*, Greg G. Sass and Micheal S. Allen. *Fisheries* 39(7):316-317.
11. Gaeta, J.W., T.R. Hrabik, **G.G. Sass**, B.M. Roth, S.J. Gilbert, and M.J. VandeZanden. A whole lake experiment to control invasive rainbow smelt via overfishing and food web manipulation. *Hydrobiologia* 746:433-444. DOI:10.1007/s10750-014-1916-3.
12. Liss, S.A., **G.G. Sass**, and C.D. Suski. Influence of local-scale abiotic and biotic factors on stress and nutrition in invasive silver carp. *Hydrobiologia* 736:1-15. DOI:10.1007/s10750-014-1880-y.

13. Hansen, J.F., **G.G. Sass**, J.W. Gaeta, G.A. Hansen, D.A. Isermann, J. Lyons, and M.J. Vander Zanden. 2014. Largemouth bass management in Wisconsin: intra- and inter-specific implications of abundance increases. Pages 193-206 *in* M.D. Tringali, J.M. Long, T.W. Birdsong, and M.S. Allen, editors. Black bass Diversity: multidisciplinary science for conservation. American Fisheries Society, Symposium 82, Bethesda, Maryland.
14. Myers, R.A., M.W. Smith, J.M. Hoenig, N. Kmiecik, M. Luehring, M.T. Drake, P.J. Schmalz, and **G.G. Sass**. 2014. Determining size- and sex-specific capture and harvest selectivity for walleyes from tagging studies. *Transactions of the American Fisheries Society* 143:438-450. DOI:10.1080/00028487.2013.862177.
15. Gaeta, J.W., **G.G. Sass**, and S.R. Carpenter. 2014. Drought-driven lake level loss: effects on coarse woody habitat and fish. *Canadian Journal of Fisheries and Aquatic Sciences* 71:1-11. DOI:dx.doi.org/10.1139/cjfas-2013-0451 (Editor's Choice Article for 2014, Most Read Article for the Canadian Journal of Fisheries and Aquatic Sciences in 2014).
16. Levengood, J., D.J. Soucek, **G.G. Sass**, A. Dickinson, and J.M. Epifanio. 2014. Elements of concern in fillets of bighead and silver carp from the Illinois River, Illinois. *Chemosphere* 104:63-68. DOI:10.1016/j.chemosphere.2013.10.058.
17. Lamer, J.T., **G.G. Sass**, J.Q. Boone, Z.H. Arbieva, S.J. Green, and J.M. Epifanio. 2013. Restriction site-associated DNA sequencing generates high quality single nucleotide polymorphisms for assessing hybridization between bighead and silver carp in the United States and China. *Molecular Ecology Resources* DOI: 10.1111/1755-0998.12152.
18. Levengood, J., D. Soucek, A. Dickinson, **G.G. Sass**, J. Epifanio. 2013. Spatial and interspecific patterns in persistent contaminant loads in bighead and silver carp from the Illinois River. *Ecotoxicology* 22(7):1174-1182. DOI 10.1007/s10646-013-1105-6.
19. Liss, S.A., **G.G. Sass**, and C.D. Suski. 2013. Spatial and temporal influences on the physiological condition of invasive silver carp. *Conservation Physiology* 1:doi:10.1093/conphys/cot017.
20. Tsehaye, I., M. Catalano, D. Glover, **G.G. Sass**, and B.M. Roth. 2013. Prospects for fishery-induced collapse of invasive Asian carp in the Illinois River. *Fisheries* 38(10):445-454. (Top three most popular articles published in *Fisheries* in 2013).
21. McClelland, M.A., K.S. Irons, **G.G. Sass**, T.M. O'Hara, and T.R. Cook. 2013. A comparison of two electrofishing programmes used to monitor fish on the Illinois River, Illinois, USA. *River Research and Applications* 29:125-133. DOI:10.1002/rra.1590
22. McClelland, M.A. and **G.G. Sass**. 2012. Assessing fish collections from random and fixed site sampling methods on the Illinois River. *Journal of Freshwater Ecology* 27: 325-333. DOI:10.1080/02705060.2012.658213.
23. McClelland, M.A., **G.G. Sass**, T.R. Cook, K.S. Irons, N.N. Michaels, T.M. O'Hara, and C.S. Smith. 2012. The long-term Illinois fish population monitoring program. *Fisheries* 37(8):340-350.
24. **Sass, G.G.**, S.R. Carpenter, J.W. Gaeta, J.F. Kitchell, and T.D. Ahrenstorff. 2012. Whole-lake addition of coarse woody habitat: response of fish populations. *Aquatic Sciences-Research Across Boundaries* 74:255-266.

DOI:10.1007/s00027-011-0219-2.

25. Ruebush, B.C., **G.G. Sass**, J.H. Chick, and J.D. Stafford. 2012. *In situ* tests of sound-bubble-strobe light barrier technologies to prevent range expansions of Asian carp. *Aquatic Invasions* 7:37-48. DOI:10.3391/ai.2012.7.01
26. Weis, J.J. and **G.G. Sass**. 2011. Largemouth bass nest site selection in small, north temperate lakes varying in littoral coarse woody habitat abundances. *North American Journal of Fisheries Management* 31:943-951. DOI:10.1080/02755947.2011.633688
27. Ahrenstorff, T.D., T.R. Hrabik, J.D. Stockwell, D.L. Yule, and **G.G. Sass**. 2011. Seasonally dynamic diel vertical migrations of *Mysis diluviana*, coregonine fishes, and siscowet lake trout in the pelagia of western Lake Superior. *Transactions of the American Fisheries Society* 140:1504-1520. DOI: 10.1080/00028487.2011.637004
28. Gaeta, J.W., M.J. Guarascio, **G.G. Sass**, and S.R. Carpenter. 2011. Lakeshore residential development and growth of largemouth bass (*Micropterus salmoides*): a cross-lakes comparison. *Ecology of Freshwater Fish* 20:92-101. DOI: 10.1111/j.1600-0633.2010.00464.x.
29. Rach, J.J., **G.G. Sass**, J.A. Luoma, and M.P. Graikowski. 2010. Effects of water hardness on size and hatching success of silver carp eggs. *North American Journal of Fisheries Management* 30:230-237.
30. **Sass, G.G.**, T.R. Cook, K.S. Irons, M.A. McClelland, N.N. Michaels, T.M. O'Hara, and M.R. Stroub. 2010. A mark-recapture population estimate for invasive silver carp (*Hypophthalmichthys molitrix*) in the La Grange Reach, Illinois River. *Biological Invasions* 12:433-436. DOI:10.1007/s10530-009-9462-z.
31. Ahrenstorff, T.D., **G.G. Sass**, and M.R. Helmus. 2009. The influence of littoral zone coarse woody habitat on home range size, spatial distribution, and feeding ecology of largemouth bass (*Micropterus salmoides*). *Hydrobiologia* 623:223-233.
32. Helmus, M.R. and **G.G. Sass**. 2008. The rapid effects of a whole-lake reduction of coarse woody debris on fish and benthic macroinvertebrates. *Freshwater Biology* 53:1423-1433.
33. Irons, K.S., **G.G. Sass**, M.A. McClelland, and J.D. Stafford. 2007. Reduced condition factor of two native fish species coincident with invasion of non-native Asian carps in the Illinois River, U.S.A. Is this evidence for competition and reduced fitness? *Journal of Fish Biology* 71:258-273.
34. Mercado-Silva, N., **G.G. Sass**, B.M. Roth, S.J. Gilbert, and M.J. Vander Zanden. 2007. Walleye recruitment decline as a consequence of rainbow smelt invasions in Wisconsin lakes. *Canadian Journal of Fisheries and Aquatic Sciences* 64:1543-1550.
35. Roth, B.M., I.C. Kaplan, **G.G. Sass**, P.T. Johnson, A.E. Marburg, A.C. Yannarell, T.V. Willis, M.G. Turner, and S.R. Carpenter. 2007. Linking terrestrial and aquatic ecosystems: the role of woody habitat in lake food webs. *Ecological Modelling* 203:439-452.
36. **Sass, G.G.**, J.F. Kitchell, S.R. Carpenter, T.R. Hrabik, A.E. Marburg, and M.G. Turner. 2006. Fish community and food web responses to a whole-lake removal of coarse woody habitat. *Fisheries* 31(7):321-330.

37. **Sass, G.G.**, C.M. Gille, J.T. Hinke, and J.F. Kitchell. 2006. Whole-lake influences of littoral structural complexity and prey body morphology on fish predator-prey interactions. *Ecology of Freshwater Fish* 15:301-308.
38. **Sass, G.G.** and J.F. Kitchell. 2005. Can growth be used as a surrogate measure of walleye (*Sander vitreus*) abundance change? *Canadian Journal of Fisheries and Aquatic Sciences* 62:2159-2168.
39. **Sass, G.G.**, S.W. Hewett, T.D. Beard, Jr., A.H. Fayram, and J.F. Kitchell. 2004. The role of density-dependence in growth patterns of ceded territory walleye populations of northern Wisconsin: effects of changing management regimes. *North American Journal of Fisheries Management* 24:1262-1278.
40. Flaherty, C.M., **G.G. Sass**, and K.E. Stiles. 2003. Human mercury toxicity and ice angler fish consumption: are people eating enough to cause health problems? *Risk Analysis* 23:497-504.
41. **Sass, G.G.** and P. J. Motta. 2002. The effects of satiation on strike mode and prey capture kinematics in the largemouth bass, *Micropterus salmoides*. *Environmental Biology of Fishes* 65:441-454.

Theses:

- Sass, G.G.** 2004. Fish community and food web responses to a whole-lake removal of coarse woody habitat. Ph.D. dissertation, University of Wisconsin – Madison.
- Sass, G.G.** 2001. An analysis of walleye, *Stizostedion vitreum vitreum*, growth in the ceded territory of northern Wisconsin, 1977-2000. Master's thesis, University of Wisconsin – Madison.
- Sass, G.G.** 1999. The effects of satiation on strike mode and prey capture kinematics in the largemouth bass, *Micropterus salmoides*. Honor's thesis, University of South Florida.

Books:

- Sass, G.G.** and M.S. Allen. 2014. Foundations of fisheries science. American Fisheries Society Press, Bethesda, Maryland.

Book Chapters:

- Roth, B.M., N.E. Mandrak, J. Peters, T.R. Hrabik, and **G.G. Sass**. 2012. Fishes and decapod crustaceans of the Great Lakes basin. In: *Great Lakes Policy and Management*, 2nd Edition. W.W. Taylor and A. Lynch (eds). Michigan State University Press, East Lansing, Michigan.
- Irons, K.S., **G.G. Sass**, M.A. McClelland, and T.M. O'Hara. 2011. The long-term resource monitoring program: insights into the Asian carp invasion of the Illinois River, Illinois, USA. In: *Invasive Asian Carps in North America*. D.C. Chapman and M.H. Hoff (eds.). American Fisheries Society Symposium 74. Bethesda, Maryland. pp. 31-50.
- Sass, G.G.** 2009. Coarse woody debris in lakes and streams. In: *Encyclopedia of Inland Waters*. Volume 1. G.E. Likens (ed.). Oxford: Elsevier. pp. 60-69.

Sass, G.G. 2008. The black sheep. In: Biologists in the field; stories, tales, and anecdotes from 150 years of field biology. M.R. Jeffords, S.L. Post, and C. Warwick (eds.). Illinois Natural History Survey Educational Material 02.

Kitchell, J.F. and **G.G. Sass**. 2008. Great Lakes ecosystems: invasions, food web dynamics, and the challenge of ecological restoration. In: The Vanishing Present: Wisconsin's Changing Lands, Waters, and Wildlife. D.M. Waller and T.P. Rooney (eds.). The University of Chicago Press, Chicago, Illinois. pgs. 157-170.

Reports:

Tyszko, S.M., N.N. Michaels, B.J. Lubinski, T.W. Edison, J.E. Epifanio, J.H. Chick, and **G.G. Sass**. 2012. The long-term Illinois, Mississippi, Ohio, and Wabash rivers fish population monitoring program: project F-101-R-23. Illinois Natural History Survey Technical Report 2012.

Sass, G.G., D. Dreikosen, G. Kubenik, M. Lorenzoni, M. Snyder, B. Roth, M. Catalano, and I. Tsehaye. 2012. The effects of exploitation on northern walleye populations. Annual Report, Project F-95-P SSDI, Statewide Fisheries and Habitat Research. Wisconsin Department of Natural Resources.

Sass, G.G., J. Lyons, J. Hansen, J. Gaeta, G. Hansen, D. Isermann, S. Carpenter, and J. Vander Zanden. 2012. Modeling bass-walleye interactions in northern Wisconsin lakes. Annual Report, Project SSBW. Wisconsin Department of Natural Resources.

Sass, G.G., D. Dreikosen, G. Kubenik, M. Lorenzoni, and M. Snyder. 2012. Northern Highland Fishery Research Area population and harvest monitoring. Annual Report, Project F-95-P SSDK, Statewide Fisheries and Habitat Research. Wisconsin Department of Natural Resources

Sass, G.G., J.H. Chick, and B.S. Ickes. 2012. Setting quantitative fish management targets for the Upper Mississippi River System. LTRMP technical report (in press).

Sass, G.G., T.R. Cook, K.S. Irons, M.A. McClelland, N.N. Michaels, and T.M. O'Hara 2012.. Experimental and comparative approaches to determine factors supporting or limiting submersed aquatic vegetation in the Illinois River and its backwaters. LTRMP technical report (in press).

Garvey, J.E., **G.G. Sass**, J. Trushenski, D. Glover, P.M. Charlebois, J. Leavengood, B.M. Roth, G. Whitley, B.C. Small, S.J. Tripp, and S. Secchi. 2012. Fishing down the bighead and silver carps: reducing the risk of invasion to the Great Lakes. Final report to the Illinois Department of Natural Resources.

Van Middlesworth, T.D., N.N. Michaels, and **G.G. Sass**. Fish and aquatic vegetation monitoring of The Nature Conservancy's Emiquon Preserve. Illinois Natural History Survey Technical Report 2012 (01).

Van Middlesworth, T.D., N.N. Michaels, and **G.G. Sass**. Fish and aquatic vegetation monitoring of The Nature Conservancy's Emiquon Preserve. Illinois Natural History Survey Technical Report 2011 (06).

Michaels, N.N., Tyszko, S., McClelland, M.A., and G.G. Sass. 2011. The long-term Illinois, Mississippi, Ohio, and Wabash river fish population monitoring program.

- Project F-101-R-22 Annual Report to the Illinois Department of Natural Resources. Prairie Research Institute Technical Report 23. Illinois Natural History Survey, Champaign. 110 pp.
- Michaels, N.N. and **G.G. Sass**. 2010. Fish and aquatic vegetation monitoring of The Nature Conservancy's Emiquon Preserve. Illinois Natural History Survey Technical Report 2010 (14).
- Sass, G.G.**, M.A. McClelland, T.R. Cook, K.S. Irons, T.M. O'Hara, and N.N. Michaels. 2009. Factors supporting or limiting submersed aquatic vegetation establishment and growth in the Starved Rock reach of the Illinois River. U.S. Army Corps of Engineers Technical Report, Rock Island District.
- McClelland, M.A. and **G.G. Sass**. 2009. The long-term Illinois River fish Population monitoring program: project F-101-R-16-20 final report (2004-2008) with program amendment, 2009. Illinois Natural History Survey Technical Report 2009 (21).
- McClelland, M.A. and **G.G. Sass**. 2009. The long-term Illinois River fish population monitoring program: project F-101-R-20. Illinois Natural History Survey Technical Report 2009 (7).
- Michaels, N.N. and **G.G. Sass**. 2009. Fish and aquatic vegetation monitoring of The Nature Conservancy's Emiquon Preserve. Illinois Natural History Survey Technical Report 2009 (10).
- McClelland, M.A. and **G.G. Sass**. 2008. The long-term Illinois River fish population monitoring program: project F-101-R-19. Illinois Natural History Survey Technical Report 2008 (10).
- Michaels, N.N. and **G.G. Sass**. 2008. Fish and aquatic vegetation monitoring of The Nature Conservancy's Emiquon Preserve. Illinois Natural History Survey Technical Report 2008 (56).
- O'Hara, T.M., M.A. McClelland, K.S. Irons, T.R. Cook, and **G.G. Sass**. 2008. The effect of a recently completed Habitat Rehabilitation and Enhancement Project (HREP) on fish abundances in the La Grange Reach of the Illinois River using Long Term Resource Monitoring Program (LTRMP) data. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. LTRMP Technical Report 2008-T001. 16 pp. (Reference 2006APE17b.)
- McClelland, M.A. and **G.G. Sass**. 2007. The long-term Illinois River fish population monitoring program: project F-101-R-18. Illinois Natural History Survey Technical Report 2007 (24).
- Manuscripts, Book Chapters, and Reports in Review:**
- Chick, J.H., C.R. Dolan, **G.G. Sass**, and B.S. Ickes. Does variation in day electrofishing catch per unit effort data reflect variation in the abundance of fishes? USGS Report.
- Sass, G.G.**, C.D. Suski, M.S. Allen, and J.W. Gaeta. Effects of catch-and-release angling on a largemouth bass (*Micropterus salmoides*) population in a north temperate lake, 2001-2005. Proceedings of the Black Bass Diversity: Multidisciplinary Science for Conservation Symposium.
- Liss, S.A., J.T. Lamer, **G.G. Sass**, and C.D. Suski. Physiological consequences of

hybridization: backcrossing decreases nutritional performance in invasive Asian carp. Canadian Journal of Fisheries and Aquatic Sciences.

Moody-Carpenter, C.J., **G.G. Sass**, L.D. Frankland, E.K. Bollinger, and R.E. Colombo. Demographics and sampling efficiency of flathead catfish, *Pylodictis olivaris*, in the Wabash River, Illinois/Indiana, USA. Journal of Fish and

Wildlife Management.

Spacapan, M.R., J.F. Besek, and **G.G. Sass**. Perceived influence and response of river users to invasive bighead and silver carp in the Illinois River. Society and Natural Resources.

Manuscripts in Draft Form:

Extramural Funding:

2007

1. Environmental Monitoring and Assessment Program – Great Rivers Ecosystems (EPA) - \$67,047
2. Long-term Illinois River fish population monitoring program (USFWS, Federal Aid in Sportfish Restoration) - \$58,500
3. Fish and aquatic vegetation monitoring of The Nature Conservancy's Emiquon Preserve (TNC) - \$49,084
4. National Great Rivers Research and Education Center Undergraduate Internship (NGRREC) - \$6,000
5. Long-term Resource Monitoring Program on the La Grange reach of the Illinois River (USACE) - \$297,047
6. Biotic assessment of the Ten Mile Creek watershed (USACE, IDNR) - \$35,000

2007 totals = \$512,678

2008

1. Factors supporting or limiting submersed aquatic vegetation in the Starved Rock reach of the Illinois River (USACE) - \$40,874
2. Setting quantitative fish management objectives for the Upper Mississippi River System (USACE) - \$45,588
3. Long-term Illinois River fish population monitoring program (USFWS, Federal Aid in Sportfish Restoration) - \$60,000
4. Long-term Resource Monitoring Program on the La Grange reach of the Illinois River (USACE) - \$314,923
5. Factors supporting or limiting submersed aquatic vegetation in the Illinois River (USACE) - \$105,772
6. Purchase of the Illinois River Biological Station through the Federal Aid in Sportfish Restoration Program (USFWS, IDNR) - \$277,708
7. National Great Rivers Research and Education Center Undergraduate Internship

(NGRREC) - \$6,000

8. Biotic assessment of the Crow Creek West watershed (USACE, IDNR) - \$20,000

2008 totals = \$870,865

2009

1. Long-term Illinois River fish population monitoring program (USFWS, Federal Aid in Sportfish Restoration) - \$87,150

2. Long-term Resource Monitoring Program on the La Grange reach of the Illinois River (USACE) - \$361,233

3. Ecosystem-scale testing of sound-bubble barriers to prevent range expansions of Asian carp (NOAA Sea Grant) - \$200,000

4. National Great Rivers Research and Education Center Undergraduate Internship (NGRREC) - \$6,000

5. Supplemental work: effectiveness of the existing electric barriers in the Chicago Sanitary and shipping canal (U.S. EPA) - \$10,000

6. Long-term Illinois and Mississippi River fish population monitoring program (USFWS, Federal Aid in Sportfish Restoration) - \$148,760

7. Long-term Illinois and Mississippi River fish population monitoring program – Supplemental Funding for Segment 21 (USFWS, Federal Aid in Sportfish Restoration) - \$238,950

2009 totals = \$1,052,093

2010

1. Long-term Resource Monitoring Program on the La Grange reach of the Illinois River (USACE) - \$385,993

2. National Great Rivers Research and Education Center Undergraduate Internship (NGRREC) - \$6,000

3. Floodplain Restoration Monitoring of the Aquatic Vegetation and Fish Communities of the Nature Conservancy's Emiquon Preserve, 2010-2013 (TNC) - \$67,367

4. The Long-term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program – Segment 22 (USFWS, Federal Aid in Sportfish Restoration) \$571,333

5. Monitoring Population Responses and Ecosystem Change Following Asian Carp Removal in the Illinois River System (Illinois Department of Natural Resources) – \$214,776

6. The Long-term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program – Amendment to Segment 22 (USFWS, Federal Aid in Sportfish Restoration) \$18,000

2010 totals = \$1,263,469

2011

1. Long-term Resource Monitoring Program on the La Grange reach of the Illinois River (USACE) - \$396,227
2. National Great Rivers Research and Education Center Undergraduate Internship (NGRREC) - \$6,000
3. An Analysis of RiverWatch Data (National Great Rivers Research and Education Center) - \$8,000
4. Feeding Habits of Bowfin, Gar, and Largemouth Bass: A Comparative Study Between The Nature Conservancy's Emiquon Preserve, Illinois and Reelfoot Lake, Tennessee (TNC) - \$1,905
5. The Long-term Illinois, Mississippi, Ohio, and Wabash River Fish Population Monitoring Program – Segment 23 (USFWS, Federal Aid in Sportfish Restoration) - \$569,393
6. Entrainment and Survival of Asian Carp in Barge Ballast Tanks (SAIC) - \$28,273

2011 totals = \$1,009,798

2007 – 2011 totals = \$4,708,903

Graduate Students, Post-docs, and Graduate Committees:

1. Daisuke Goto, Ph.D., Post-Doctoral Research Associate, Center for Limnology, University of Wisconsin-Madison (co-advised with Dr. Andrew Rypel and Dr. M. Jake Vander Zanden)
2. Jim Lamer, Ph.D. 2015, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (co-advised with Dr. John Epifanio)
-Janice Lee Fenske Memorial Award finalist, 2009
3. Kirsten Nelson, M.S. 2014, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (co-advised with Dr. Dave Wahl)
4. Todd Van Middlesworth, M.S. 2014, Department of Biological Sciences, Western Illinois University (co-advised with Dr. Tim Spier)
5. Ed Culver, M.S. 2014, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (graduate committee)
6. Mike Wilson, M.S. 2014, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (graduate committee)
7. Maureen Ferry, M.S. 2013, College of Natural Resources, University of Wisconsin-Stevens Point (graduate committee)
8. Cassi Moody, M.S. 2013, Department of Biological Sciences, Eastern Illinois University (co-advised with Dr. Robert Colombo)
9. Stephanie Liss, M.S. 2013, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (co-advised with Dr. Cory Suski)

-University of Illinois NRES Excellence in Research Award – 2012 (\$1,250)
-Janice Lee Fenske Memorial Award Finalist, 2012
-University of Illinois College of ACES 2013 Graduate Student Research Award

10. Joshua Mulhollem, M.S. 2013, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (graduate committee)

11. Zach Zuckerman, M.S. 2012, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (graduate committee)

12. Corey DeBoom, M.S. 2012, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (graduate committee)

13. Blake Ruebush, M.S. 2011, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign

-Janice Lee Fenske Memorial Award finalist, 2008, 2009, 2010

14. Nerissa Michaels, M.S. 2011, Department of Biological Sciences, Western Illinois University (co-advised with Dr. Tim Spier)

-Janice Lee Fenske Memorial Award finalist, 2009

15. Steven Butler, M.S. 2007, Department of Natural Resources and Environmental Sciences, University of Illinois at Urbana-Champaign (graduate committee)

Undergraduate Interns:

1. Molly Spacapan, University of Illinois at Urbana-Champaign, Illinois American Fisheries Society, Larimore Student Research Scholar and National Great Rivers Research and Education Center Internship, 2011. Title of Project: Illinois River use in the context of the invasion of exotic Asian carp; A human dimensions study

2. Molly Spacapan, University of Illinois at Urbana-Champaign, National Great Rivers Research and Education Center Internship, 2010. Title of Project: A human-dimension evaluation of river usage in the La Grange Reach of the Illinois River following the invasion of Asian carp.

3. Anthony Erickson, Bradley University, National Great Rivers Research and Education Center Internship, 2009. Title of Project: Zooplankton community composition along a longitudinal gradient of invasive Asian Carp densities in the Illinois River.

4. Thad Cook, Western Illinois University, National Great Rivers Research and Education Center Internship, 2008. Title of Project: A comparative approach to determine factors supporting or limiting submersed aquatic vegetation in the Illinois River.

5. Matt Stroub, Western Illinois University, National Great Rivers Research and Education Center Internship, 2007. Title of Project: Fish population dynamics of an annually-flooded seasonally-isolated backwater lake of the Illinois River.

Invited Presentations:

1. University of Minnesota-Duluth, Biology Departmental Seminar

Duluth, Minnesota, October 9, 2015

Title of Talk: Current knowledge of the relationships between fish and coarse woody in Wisconsin lakes

2. UWSP Student Subunit of the American Fisheries Society

Stevens Point, Wisconsin, September 16, 2015

Title of Talk: Current knowledge of the relationships between fish and coarse woody in Wisconsin lakes

3. Vilas County Lakes & Rivers Association – Celebrating Lakes and Rivers Day

Conserve School, Land O' Lakes, Wisconsin, June 12, 2015

Title of Talk: Current knowledge of the relationships between fish and coarse woody in Wisconsin lakes

4. University of Wisconsin – Stout

Menomonie, Wisconsin, May 7, 2015

Title of Talk: The Escanaba Lake Research Station: the past, present, and future of Wisconsin's experimental fisheries research lakes

5. North Lakeland Discovery Center, Nibbles and Knowledge Program

Manitowish Waters, Wisconsin, June 19, 2014

Title of Talk: Managing Fish Habitat: What Can we Learn from Wildlife Ecology?

6. International Conference on Engineering and Ecohydrology for Fish Passage

Madison, Wisconsin, June 9-11, 2014

Title of Talk: The Effects of Visual and Acoustic Deterrents to Prevent the Upstream Movement of Asian Carps

7. 143rd Meeting of the American Fisheries Society

Little Rock, Arkansas, September 8-12, 2013

Title of Talk: Largemouth Bass Management in Wisconsin: Intra- and Inter-specific Implications of Abundance Increases

8. Southern Division of the American Fisheries Society Annual Meeting

Black Bass Diversity: Multidisciplinary Science for Conservation Symposium

Nashville, Tennessee, February 8-10, 2013

Title of Talk: Largemouth Bass Management in a Multi-species Sport Fishery:

Implications for Intra-specific Growth and Walleye Populations in Northern Wisconsin

9. North American Lakes Management Society Annual Meeting

Madison, Wisconsin, November 7, 2012

Title of Talk: Fish Population Dynamics in a Northern Wisconsin Lake Following a Whole-lake Addition of Coarse Woody Habitat

10. South Dakota State University Fisheries and Wildlife Departmental Seminar Series

Brookings, South Dakota

Title of Talk: Is there a native recipe for controlling invasive common carp?

11. University of Wisconsin-Stevens Point American Fisheries Society Student Subunit

Stevens Point, Wisconsin

Title of Talk: The Escanaba Lake Research Station: the past, present, and future of Wisconsin's experimental fisheries research lakes

12. Wisconsin Lakes Partnership Convention

Green Bay, Wisconsin

Title of Talk: The Escanaba Lake Research Station: the past, present, and future of

Wisconsin's experimental fisheries research lakes

13. UW-Madison, Center for Limnology, Brownbag Seminar

Madison, Wisconsin

Title of Talk: The Escanaba Lake Research Station: the past, present, and future of Wisconsin's experimental fisheries research lakes

14. Illinois Department of Natural Resources Brownbag Seminar

Springfield, Illinois

Title of Talk: The Nature Conservancy's Emiquon Preserve: fish and waterfowl responses to the restoration of two former Illinois River floodplain lakes

15. University of Tennessee at Martin, 2011

Martin, Tennessee

Title of Talk: The Nature Conservancy's Emiquon Preserve: fish and waterfowl responses to the restoration of two former Illinois River floodplain lakes

16. 71st Midwest Fish and Wildlife Conference, 2010*

Minneapolis, Minnesota

Title of Talk: Zooplankton community composition across a gradient of Asian carp densities and pre- and post-invasion within the Illinois River, USA

*Talk given by Duane Chapman due to weather related cancellation for GGS

17. Asian Carp Marketing Summit, September 20-21, 2010

Alton, Illinois

Title of Talk: Status of Asian carp in the Midwestern United States

18. 17th International Conference on Aquatic Invasive Species, 2010

San Diego, California

Title of Talk: Capture Efficiency of Asian Carp in the La Grange Pool of the Illinois River Using Traditional Gear

19. 17th International Conference on Aquatic Invasive Species, 2010

San Diego, California

Title of Talk: The Effects of Visual and Acoustic Deterrents to Prevent the Upstream Movement of Asian Carps

20. University of Illinois at Urbana-Champaign, 2010 – NRES Departmental Seminar
Champaign, Illinois

Title of Talk: Characterizing the Illinois River in the Context of the Upper Mississippi River System: Fish and Submersed Aquatic Vegetation Communities

21. Western Illinois University, 2010 – Plenary Speaker for Graduate Student Symposium

Macomb, Illinois

Title of Talk: Environmental and Economic Impacts of Asian Carps on the Illinois River

22. University of Florida, 2010

Gainesville, Florida

Title of Talk: Fish community and food web responses to a whole-lake removal and addition of coarse woody habitat

23. Kent State University, 2009

Kent, Ohio

Title of Talk: Fish community and food web responses to a whole-lake removal and addition of coarse woody habitat

24. Irons, K.S., D.C. Chapman, M.A. McClelland, T.M. O'Hara, **G.G. Sass**, J.A. Thomas, and M.S. Pearson
The 57th Annual Meeting of the North American Benthological Society, 2009
Grand Rapids, Michigan
Title of Talk: Asian carps in the mid-continent great rivers
25. Illinois Lake Management Association Annual Meeting
2009
Peoria, Illinois
Title of Talk: Environmental and Economic Impacts of Asian Carps on the Illinois River
26. Upper Mississippi River Conservation Committee, Fall Fish Technical Meeting, 2008
Wyalusing State Park, Wisconsin
Title of Talk: Setting Management Objectives for UMRS Fisheries
27. Program in Ecology, Evolution, and Conservation Biology Seminar; University of Illinois at Urbana-Champaign
2008
Urbana, Illinois
Title of Talk: Fish Community Responses to Reciprocal Whole-lake Manipulations of Coarse Woody Habitat in Two Northern Wisconsin Lakes
28. 11th Biennial Governor's Conference on the Management of the Illinois River System, 2007
Peoria, Illinois
Title of Talk: Environmental and Economic Impacts of Asian Carps on the Illinois River
29. International Joint Commission on the Great Lakes Biennial Meeting, 2007
Chicago, Illinois
Title of Talk: Environmental and Economic Impacts of Asian Carps on the Illinois River
30. Wisconsin Lakes Convention, 2006
Green Bay, Wisconsin
Title of Talk: Lessons Learned from Two Whole-lake Manipulations of Coarse Woody Habitat: Implications for Fisheries Management
31. North American Lake Management Society 25th International Symposium, 2005
Madison, Wisconsin
Title of Talk: Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
32. Wisconsin Lakes Convention, 2005
Green Bay, Wisconsin
Title of Talk: Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
33. Virginia Polytechnic Institute and State University (Virginia Tech), 2005
Blacksburg, Virginia
Title of Talk: Fish community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat
34. Wisconsin Department of Natural Resources Lake Leaders Conference, 2004

Minocqua, Wisconsin

Title of Talk: Biomanipulation as a Tool to Mitigate Negative Effects of Exotic Rainbow Smelt Introductions; Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat

35. Annual Meeting of the Esocid Technical Committee of the American Fisheries Society, 2003

Minocqua, Wisconsin

Title of Talk: Fish Community Responses to a Whole-lake Manipulation of Littoral Zone Coarse Woody Habitat: Implications for Esocid Management

36. American Society of Limnology and Oceanography Annual Meeting, 2003

Salt Lake City, Utah

Title of Talk: Fish Community Responses to a Whole-lake Manipulation of Littoral Zone Coarse Woody Debris in a Northern Wisconsin Lake

37. Annual Meeting of the Wisconsin Chapter of the American Fisheries Society, 2003*

Madison, Wisconsin

Title of Talk: Fish Community Responses to a Whole-lake Manipulation of Littoral Zone Coarse Woody Debris

*Best Student Paper Award

Contributed Presentations:

Parks, T. et al.

44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society

Eau Claire, Wisconsin, February 24-26, 2015

Title of Talk: The status of ciscoes in Wisconsin's inland lakes

Isermann, D.A., et al.

44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society

Eau Claire, Wisconsin, February 24-26, 2015

Title of Talk: Cisco population characteristics in Wisconsin lakes

Noring, A., et al.

44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society

Eau Claire, Wisconsin, February 24-26, 2015

Title of Talk: Relationships between growth trajectories of walleye and cisco in northern Wisconsin lakes

Sass, G.G., et al.

44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society

Eau Claire, Wisconsin, February 24-26, 2015

Title of Talk: Fish production and ecotone responses to long-term additions of coarse woody habitat

Johnson, G., et al.

44th Annual Meeting of the Wisconsin Chapter of the American Fisheries Society

Eau Claire, Wisconsin, February 24-26, 2015

Title of Poster: Biotic and abiotic factors influencing walleye recruitment in Escanaba Lake, Wisconsin from 1958-2013

Levengood, J.M., D.J. Soucek, **G.G. Sass**, and J.M. Epifanio

75th Midwest Fish and Wildlife Conference

Indianapolis, Indiana, February 8-11, 2015

Title of Talk: Spatial and Inter-specific patterns of contaminant burdens in bighead and silver carp from the Illinois River

Nelson, K., D.H. Wahl, and **G.G. Sass**

144th Annual Meeting of the American Fisheries Society

Quebec City, Canada, August 17-21, 2014

Title of Talk: Competitive interactions between common carp and bighead carp

Goto, D., A. Rypel, **G.G. Sass**, J. Gaeta, G. Hansen, and M.J. Vander Zanden

144th Annual Meeting of the American Fisheries Society

Quebec City, Canada, August 17-21, 2014

Title of Talk: Selective harvest effects on body size and productivity of exploited walleye stocks in north temperate lakes

Isermann, D.A., N. Nate, G. Hansen, and **G.G. Sass**

144th Annual Meeting of the American Fisheries Society

Quebec City, Canada, August 17-21, 2014

Title of Talk: Evaluation of biological performance indicators for monitoring exploitation of walleye populations in northern Wisconsin

Van Middleworth, T.D., **G.G. Sass**, T.W. Spier, B.A. Ray, and A.F. Casper

144th Annual Meeting of the American Fisheries Society

Quebec City, Canada, August 17-21, 2014

Title of Talk: The feeding habits and relative abundances of bowfin, spotted gar, and largemouth bass: can native piscivores control invasive common carp?

VanMiddleworth, T.D., **G.G. Sass**, T.W. Spier, and B.A. Ray

52nd Annual Meeting of the Illinois Chapter of the American Fisheries Society

Bloomington, Illinois, March 4-6, 2014

Title of Talk: The feeding habits of native piscivorous fishes: Can they control common carp?

Sass, G.G., S.P. Newman, B.M. Roth, and I. Tsehay

Wisconsin Chapter of the American Fisheries Society Annual Meeting

Green Bay, Wisconsin

Title of Talk: Abundance and growth responses of walleye (*Sander vitreus*) to 35% annual exploitation on Big Crooked Lake, Wisconsin, 1998-2008

Nelson, K., D.H. Wahl, and **G.G. Sass**

Midwest Fish and Wildlife Conference

Kansas City, Missouri

Title of Talk: Competitive interactions between bighead carp and bluegill

VanMiddleworth, T.D., **G.G. Sass**, T.W. Spier, and B.A. Ray

5th Society For Ecological Restoration World Conference on Ecological Restoration

Madison, Wisconsin, October 6-11

Title of Poster: Relative abundance and feeding habits of native piscivorous fishes at The Nature Conservancy's Emiquon Preserve and Reelfoot Lake: Can native fish control common carp?

Moody, C.J., L.D. Franklin, **G.G. Sass**, and R.E. Colombo

143rd Annual Meeting of the American Fisheries Society

Little Rock, Arkansas, September 8-12

Title of Talk: Flathead catfish gear assessments and demographics in the Wabash

River

Smith, M., R. Myers, J. Hoenig, N. Kmiecik, M. Luehring, M. Drake, P. Schmalz, and **G.G. Sass**

143rd Annual Meeting of the American Fisheries Society

Little Rock, Arkansas, September 8-12

Title of Talk: Determining size- and sex-specific capture and harvest selectivity for walleye

Lamer, J.T., **G.G. Sass**, J.M. Epifanio, M.A. McClelland, and B.C. Ruebush

143rd Annual Meeting of the American Fisheries Society

Little Rock, Arkansas, September 8-12

Title of Talk: Asian carp hybridization: prevalence, distribution, and post-zygotic success in the Mississippi River Basin

Van Middlesworth, T.D., N.N. Michaels, **G.G. Sass**, B.A. Ray, and T.W. Spier

143rd Annual Meeting of the American Fisheries Society

Little Rock, Arkansas, September 8-12

Title of Talk: Is there a native recipe for controlling common carp?

Nelson, K., D.H. Wahl, and **G.G. Sass**

143rd Annual Meeting of the American Fisheries Society

Little Rock, Arkansas, September 8-12

Title of Talk: Competitive interactions between bighead carp and bluegill

Liss, S.A., **G.G. Sass**, and C.D. Suski

Annual Meeting of the Mississippi River Research Consortium

LaCrosse, Wisconsin, April 24-26, 2013

Title of Talk: Spatial and temporal influences on the physiological condition of invasive silver carp

Lamer, J.T., **G.G. Sass**, J.M. Epifanio, M.A. McClelland, and B.C. Ruebush

Annual Meeting of the Mississippi River Research Consortium

LaCrosse, Wisconsin, April 24-26, 2013

Title of Talk: Asian carp hybridization: prevalence, distribution, and post-zygotic success in the Mississippi River basin

VanMiddlesworth, T.D., **G.G. Sass**, T.W. Spier, and B.A. Ray

2013 Emiquon Science Symposium

Lewistown, Illinois

Title of Poster: Relative abundance and feeding habits of bowfin, spotted gar, and largemouth bass at The Nature Conservancy's Emiquon Preserve and Reelfoot Lake: can native fish control common carp?

Ferry, M., T. Ginnett, **G.G. Sass**, and K. Gauthier

Wisconsin Chapter of the American Fisheries Society Annual Meeting

Rothschild, Wisconsin, February 5-7, 2013

Title of Talk: Zebra Mussel Habitat Preference, Growth, and Mortality Within and Among Lakes in Northeast Wisconsin and Upper Michigan

Eslinger, L. and **G.G. Sass**

Wisconsin Chapter of the American Fisheries Society Annual Meeting

Rothschild, Wisconsin, February 5-7, 2013

Title of Talk: Dietary Habits and Overlap Between Walleye and Smallmouth Bass in The Turtle-Flambeau Flowage, Wisconsin

Gilbert, S. and **G.G. Sass**

Wisconsin Chapter of the American Fisheries Society Annual Meeting

Rothschild, Wisconsin, February 5-7, 2013

Title of Talk: Trends in Wisconsin's Muskellunge Fishery Based on 47 Years of Angler Entries from a Single Countywide Contest

Ferry, M., T. Ginnett, **G.G. Sass**, and K. Gauthier

Upper Midwest Invasive Species Conference, October 29-31, 2012

LaCrosse, Wisconsin

Title of Talk: Examining zebra mussel habitat preference and population dynamics in northeast Wisconsin and Upper Michigan

Van Middlesworth, T.D., **G.G. Sass**, T.W. Spier, and B.A. Ray

Prairie Lightning Mini-Symposium, 2012

Urbana, Illinois

Title of Poster: Relative abundance and feeding habits of bowfin, spotted gar, and largemouth bass at the Emiquon Preserve and Reelfoot Lake: can native fish species control invasive common carp?

Van Middlesworth, T.D., **G.G. Sass**, T.W. Spier, and B.A. Ray

142nd Annual Meeting of the American Fisheries Society, 2012

St. Paul, Minnesota

Title of Poster: Relative abundance and feeding habits of bowfin, spotted gar, and largemouth bass at the Emiquon Preserve and Reelfoot Lake: can native fish species control invasive common carp?

Lamer, J.T., **G.G. Sass**, J. Epifanio, B.C. Ruebush, T.L. Tobias, and M.A.

McClelland

142nd Annual Meeting of the American Fisheries Society, 2012

St. Paul, Minnesota

Title of talk: Asian carp hybridization: prevalence, distribution, and fitness in the Mississippi River Basin.

Stuck, J.G., L. Frankland, **G.G. Sass**, D.H. Wahl, and R.E. Colombo

142nd Annual Meeting of the American Fisheries Society, 2012

St. Paul, Minnesota

Title of Talk: Demographic differences of silver carp, *Hypophthalmichthys molitrix*, populations between impacted and unimpacted Midwestern river ecosystems

Catalano, M.J., I. Tsehaye, B.M. Roth, and **G.G. Sass**

142nd Annual Meeting of the American Fisheries Society, 2012

St. Paul, Minnesota

Title of Talk: Forecasting the responses of bighead and silver carp populations to commercial harvest in the Illinois River

Gaeta, J.W., Z.J. Lawson, **G.G. Sass**, and S.R. Carpenter

142nd Annual Meeting of the American Fisheries Society, 2012

St. Paul, Minnesota

Title of Talk: Effects of climate-driven water level loss on fish habitat availability, predator-prey interactions, population dynamics, and behavior in two north temperate lake basins

Moody, C.J., L. Frankland, **G.G. Sass**, and R.E. Colombo

142nd Annual Meeting of the American Fisheries Society, 2012

St. Paul, Minnesota

Title of Talk: A tale of the Wabash River flathead catfish: sampling inefficiencies and demographics

Chick, J.H., C. Dolan, and **G.G. Sass**

142nd Annual Meeting of the American Fisheries Society, 2012

St. Paul, Minnesota

Title of Talk: An assessment of the relationship between electrofishing catch-per-unit-effort data and fish abundance

Van Middlesworth, T.D., **G.G. Sass**, B.A. Ray, and T.W. Spier

44th Annual Meeting of the Mississippi River Research Consortium

LaCrosse, Wisconsin

Title of Talk: Relative abundances and feeding habits of bowfin, gar, and largemouth bass at the Emiquon Preserve and Reelfoot Lake: Can particular native fish species assemblages control invasive common carp?

Liss, S.A., **G.G. Sass**, and C.D. Suski

44th Annual Meeting of the Mississippi River Research Consortium

LaCrosse, Wisconsin

Title of Poster: Nutrition and condition of invasive silver carp across large Illinois rivers: Can stress and nutrition influence establishment?

Van Middlesworth, T.D., N.N. Michaels, and **G.G. Sass**

5th Annual Emiquon Science Symposium

Lewistown, Illinois

Title of Talk: The Nature Conservancy's Emiquon Preserve: fish community Monitoring, 2007-2011

Liss, S., **G.G. Sass**, and C.D. Suski

50th Annual Meeting of the Illinois Chapter of the American Fisheries Society

Utica, Illinois

Title of Poster: Nutrition and condition of invasive silver carp across large Illinois rivers: can stress and nutrition influence establishment?

Tyszko, S.M., M.A. McClelland, N.N. Michaels, and **G.G. Sass**

50th Annual Meeting of the Illinois Chapter of the American Fisheries Society

Utica, Illinois

Title of Poster: Fish community indices of biotic integrity applied to the large rivers of Illinois

McClelland, M.A., **G.G. Sass**, T.R. Cook, N.N. Michaels, K.S. Irons, and T.M. O'Hara

American Fisheries Society 141st Annual Meeting

Seattle, Washington

Title of Talk: The long-term Illinois River fish population monitoring program, 1957-2010

Roth, B.M., N.E. Mandrak, **G.G. Sass**, T.R. Hrabik, and J. Peters

American Fisheries Society 141st Annual Meeting

Seattle, Washington

Title of Talk: Ichthyofauna of the Great Lakes Basin

Lamer, J.T., **G.G. Sass**, J.M. Epifanio, M.A. McClelland, A. Hernandez, and J. Thimmapuram

American Fisheries Society 141st Annual Meeting
 Seattle, Washington
 Title of Poster: Nuclear and mitochondrial SNP development for molecular
 Discrimination of bighead carp, silver carp, and their hybrids
 Irons, K.S., **G.G. Sass**, M.A. McClelland, and T.M. O'Hara
 American Fisheries Society 141st Annual Meeting
 Seattle, Washington
 Title of Talk: Bigheaded carp invasion of the La Grange Reach of the Illinois River:
 Insights from the Long-term Resource Monitoring Program
 Moody, C.J., **G.G. Sass**, L.D. Frankland, and R.E. Colombo
 American Fisheries Society 141st Annual Meeting
 Seattle, Washington
 Title of Poster: Demographics of a commercially exploited population of flathead
 catfish in the Wabash River
 Stuck, J.G., L.D. Frankland, **G.G. Sass**, and R.E. Colombo
 American Fisheries Society 141st Annual Meeting
 Seattle, Washington
 Title of Poster: Monitoring the population demographics of invasive silver carp in the
 Illinois River
 Tyszko, S.M., M.A. McClelland, N.N. Michaels, and **G.G. Sass**
 American Fisheries Society 141st Annual Meeting
 Seattle, Washington
 Title of Poster: Fish community indices of biotic integrity applied to the large rivers
 of Illinois
 Michaels, N.N., **G.G. Sass**, T.W. Spier
 American Fisheries Society 141st Annual Meeting
 Seattle, Washington
 Title of Poster: Biomanipulation of the largemouth bass population to control
 invasive species and eutrophication at The Nature Conservancy's Emiquon Preserve
 Ruebush, B.C., **G.G. Sass**, and J.H. Chick
 American Fisheries Society 141st Annual Meeting
 Seattle, Washington
 Title of Poster: *In-situ* tests of sound-bubble-strobe light barrier technologies to
 prevent range expansions of Asian carp
 Ruebush, B.C., **G.G. Sass**, and J.H. Chick
 43rd Annual Mississippi River Research Consortium
 La Crosse, Wisconsin
 Title of Poster: *In-situ* evaluation of sound-bubble-strobe light barrier technologies to
 prevent the range expansions of Asian carp
 Michaels, N.N., **G.G. Sass**, and T.W. Spier
 43rd Annual Mississippi River Research Consortium
 La Crosse, Wisconsin
 Title of Poster: The Nature Conservancy's Emiquon Preserve: largemouth bass diet
 response to restoration
 Van Middlesworth, T.D., **G.G. Sass**, T.W. Spier, B.C. Ruebush, L. Solomon, M.A.
 McClelland, N.N. Michaels, S.M. Tyszko, and T.R. Cook

43rd Annual Mississippi River Research Consortium

La Crosse, Wisconsin

Title of Poster: Aquatic vegetation and fish community monitoring at the Nature Conservancy's Emiquon Preserve: testing for regime shifts in ecosystem state

Bushman, B., **G.G. Sass**, and M.A. McClelland

43rd Annual Mississippi River Research Consortium

La Crosse, Wisconsin

Title of Poster: Common carp in the Illinois River

Van Middlesworth, T.D., **G.G. Sass**, T.W. Spier, M.A. McClelland, N.N. Michaels, S.M. Tyszkowski, and T.R. Cook

3rd Midwest-Great Lakes Society for Ecological Restoration Chapter Meeting
Springfield, Illinois

Title of Talk: Aquatic vegetation and fish community monitoring at the Nature Conservancy's Emiquon Preserve: testing for regime shifts in ecosystem state

Michaels, N.N., **G.G. Sass**, and T.W. Spier

3rd Midwest-Great Lakes Society for Ecological Restoration Chapter Meeting
Springfield, Illinois

Title of Talk: The Nature Conservancy's Emiquon Preserve: largemouth bass diet response to restoration

Michaels, N.N., **G.G. Sass**, and T.W. Spier*

Illinois Lake Management Association and Illinois Chapter American Fisheries Society Joint Annual Conference

Peoria, Illinois

Title of Talk: The Nature Conservancy's Emiquon Preserve – Largemouth bass *Micropterus salmoides* diet response to restoration

*IL AFS Best Student Paper Award

Spacapan, M.R., B.C. Ruebush, S. Lischka, and **G.G. Sass**

Illinois Lake Management Association and Illinois Chapter American Fisheries Society Joint Annual Conference

Peoria, Illinois

Title of Talk: A human-dimensions evaluation of river usage in the La Grange reach of the Illinois River following the invasion of Asian carp

Ruebush, B.C., **G.G. Sass**, J.H. Chick, and C.D. Suski

Illinois Lake Management Association and Illinois Chapter American Fisheries Society Joint Annual Conference

Peoria, Illinois

Title of Talk: *In-situ* evaluation of sound-bubble-strobe light barrier technologies to prevent the range expansions of Asian carp

Sass, G.G., A.C. Erickson, and M.A. McClelland

140th Annual Meeting of the American Fisheries Society

Pittsburgh, Pennsylvania

Title of Talk: Zooplankton community composition across a gradient of Asian carp densities and pre- and post- invasion within the Illinois River, USA

Ruebush, B.C., **G.G. Sass**, and J.H. Chick

140th Annual Meeting of the American Fisheries Society

Pittsburgh, Pennsylvania

Title of Talk: Ecosystem-scale evaluation of sound bubble barrier technologies to prevent range expansions of Asian carps

Michaels, N.N., **G.G. Sass**, and T.W. Spier

140th Annual Meeting of the American Fisheries Society

Pittsburgh, Pennsylvania

Title of Talk: The Nature Conservancy's Emiquon Preserve: The emerging food web in a newly restored floodplain lake

Irons, K.S., T.M. O'Hara, M.A. McClelland, T.R. Cook, N.N. Michaels, and **G.G. Sass**

140th Annual Meeting of the American Fisheries Society

Pittsburgh, Pennsylvania

Title of Poster: Catfishes in the Upper Mississippi River System: distribution and trends as noted by the long term resource monitoring program

McClelland, M.A., T.R. Cook, K.S. Irons, T.M. O'Hara, **G.G. Sass**, N.N. Michaels, and C.S. Smith

140th Annual Meeting of the American Fisheries Society

Pittsburgh, Pennsylvania

Title of Poster: Fifty years of the long term Illinois fish population monitoring program

O'Hara, T.M., K.S. Irons, M.A. McClelland, and **G.G. Sass**

Conservation, Ecology, and Management of Catfish, The Second International Symposium

St. Louis, Missouri

Title of Talk: Assessment of channel catfish (*Ictalurus punctatus*) populations in the Upper Mississippi River system

Irons, K.S., T.M. O'Hara, M.A. McClelland, T.R. Cook, N.N. Michaels, and **G.G. Sass**

Conservation, Ecology, and Management of Catfish, The Second International Symposium

St. Louis, Missouri

Title of Poster: Catfishes in the Upper Mississippi River system: Distribution and trends as noted by the Long Term Resource Monitoring Program

Michaels, N.N., **G.G. Sass**, and T.W. Spier

42nd Annual Mississippi River Research Consortium

La Crosse, Wisconsin

Title of Talk: The Nature Conservancy's Emiquon Preserve: the emerging food web in a newly restored floodplain lake

Ruebush, B.C., **G.G. Sass**, and J.H. Chick

42nd Annual Mississippi River Research Consortium

La Crosse, Wisconsin

Title to Talk: Ecosystem-scale evaluation of sound bubble barrier technologies to prevent range expansions of Asian carps

Irons, K.S., T.M. O'Hara, M.A. McClelland, T.R. Cook, N.N. Michaels, and **G.G. Sass**

42nd Annual Mississippi River Research Consortium

La Crosse, Wisconsin

Title of Talk: Catfishes in the Upper Mississippi River System. Distribution and trends as noted by the Long Term Resource Monitoring Program

Sass, G.G., A.C. Erickson, and M.A. McClelland

48th Meeting of the Illinois Chapter of the American Fisheries Society

Whittington, Illinois

Title of Talk: Zooplankton community composition across a gradient of Asian carp

Densities and pre- and post-invasion within the Illinois River, USA

Irons, K.S., D.C. Chapman, M.A. McClelland, T.M. O'Hara, **G.G. Sass**, J.A.

Thomas, T.R. Cook, and M.S. Pearson

48th Meeting of the Illinois Chapter of the American Fisheries Society

Whittington, Illinois

Title of Poster: Asian carps in the mid-continent great rivers

Michaels, N.N., **G.G. Sass**, T. Spier, T.M. O'Hara, K.S. Irons, M.A. McClelland, and T.R. Cook

48th Meeting of the Illinois Chapter of the American Fisheries Society

Whittington, Illinois

Title of Poster: The Nature Conservancy's Emiquon Preserve: resetting and restoring the Thompson Lake fish community

O'Hara, T.M., K.S. Irons, M.A. McClelland, T.R. Cook, N.N. Michaels, and

G.G. Sass

48th Meeting of the Illinois Chapter of the American Fisheries Society

Whittington, Illinois

Title of Poster: Status and trends of channel catfish in the UMRS: explaining variability in year class strength and relative abundances

Michaels, N.N., **G.G. Sass**, T.M. O'Hara, M.A. McClelland, K.S. Irons, and T.R.

Cook

70th Annual Midwest Fish and Wildlife Conference

Springfield, Illinois

Title of Talk: The Nature Conservancy's Emiquon Preserve: fish and aquatic vegetation monitoring, 2007-2009

Cook, T.R., K.S. Irons, M.A. McClelland, **G.G. Sass**, T.M. O'Hara, N.N. Michaels, and M.R. Stroub

70th Annual Midwest Fish and Wildlife Conference

Springfield, Illinois

Title of Poster: Long-term trends in Illinois River water quality: reflective of global changes?

Ruebush, B., **G.G. Sass**, and J.H. Chick

70th Annual Midwest Fish and Wildlife Conference

Springfield, Illinois

Title of Poster: Ecosystem-scale evaluation of sound bubble barrier technologies to prevent range expansions of Asian carps

Irons, K.S., D. Chapman, M.A. McClelland, T.M. O'Hara, and **G.G. Sass**

70th Annual Midwest Fish and Wildlife Conference

Springfield, Illinois

Title of Poster: Asian carps in the mid-continent great rivers

O'Hara, T.M., M.A. McClelland, K.S. Irons, T.R. Cook, and **G.G. Sass**

70th Annual Midwest Fish and Wildlife Conference

Springfield, Illinois

Title of Poster: Status and trends of channel catfish in the UMRS: identifying mechanisms determining year class strength and relative abundances

Sass, G.G., S.R. Carpenter, J.F. Kitchell, and J. Gaeta

139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Talk: Fish population dynamics in a northern Wisconsin lake following a whole-lake addition of coarse woody habitat

Irons, K.S., D.C. Chapman, M.A. McClelland, T.M. O'Hara, **G.G. Sass**, J.A. Thomas, T.R. Cook, and M.S. Pearson

139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Talk: Asian carps: big rivers, big fish, big problems?

Lamer, J., C. Dolan, J. Petersen, J. Chick, J. Epifanio, and **G.G. Sass**

139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Talk: Hybridization between silver and bighead carp in the Mississippi and Illinois rivers

Michaels, N.N., **G.G. Sass**, T. Spier, T. Cook, T.M. O'Hara, K. Irons, and M.A. McClelland

139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Poster: The Nature Conservancy's Emiquon Preserve: resetting and restoring the Thompson Lake fish community

Baerwaldt, K., **G.G. Sass**, and J.E. Garvey

139th Annual Meeting of the American Fisheries Society

Nashville, Tennessee

Title of Poster: Growth rates of silver carp in different regions of the world: higher growth in non-native habitats

Michaels, N.N., **G.G. Sass**, T.W. Spier, T.R. Cook, T.M. O'Hara, K.S. Irons, and M.A. McClelland

Mississippi River Research Consortium 41st Annual Meeting

La Crosse, Wisconsin

Title of Talk: The Nature Conservancy's Emiquon Preserve: resetting and restoring the Thompson Lake fish community

Irons, K.S., D.C. Chapman, M.A. McClelland, T.M. O'Hara, **G.G. Sass**, J. Thomas, and M.S. Pearson

Mississippi River Research Consortium 41st Annual Meeting

La Crosse, Wisconsin

Title of Poster: Asian carps in the mid-continent great rivers

Sass, G.G., S.R. Carpenter, J.F. Kitchell, and J. Gaeta

Midwest Fish and Wildlife Conference, 2008

Columbus, Ohio

Title of Talk: Fish population dynamics in a northern Wisconsin lake following a whole-lake addition of coarse woody habitat

Gaeta, J.W., M.J. Guarascio, **G.G. Sass**, and S.R. Carpenter
 93rd Ecological Society of America Annual Meeting
 Milwaukee, Wisconsin
 Title of Talk: Coarse woody habitat density and largemouth bass (*Micropterus salmoides*) growth rates
Sass, G.G., T.R. Cook, K.S. Irons, M.A. McClelland, N.N. Michaels, T.M. O'Hara, and M.R. Stroub
 Mississippi River Research Consortium, 2008
 Dubuque, Iowa
 Title of Talk: Environmental and economic impacts of Asian carps in the Illinois River
 O'Hara, T.M., K.S. Irons, **G.G. Sass**, T.R. Cook, M.A. McClelland, N.N. Michaels, and M.R. Stroub
 Mississippi River Research Consortium, 2008
 Dubuque, Iowa
 Title of Talk: Identification of habitat conditions influencing non-native Asian carps reproduction in the Upper Mississippi River system
 McClelland, M.A., **G.G. Sass**, T.R. Cook, K.S. Irons, T.M. O'Hara, C.S. Smith, N.N. Michaels, and M.R. Stroub
 Mississippi River Research Consortium, 2008
 Dubuque, Iowa
 Title of Talk: Fifty years of the long-term Illinois River fish population monitoring program
 Cook, T.R., K.S. Irons, M.A. McClelland, **G.G. Sass**, T.M. O'Hara, N.N. Michaels, and M.R. Stroub
 Mississippi River Research Consortium, 2008
 Dubuque, Iowa
 Title of Poster: Long-term trends in Illinois River water quality: reflective of global changes?
 Michaels, N.N., **G.G. Sass**, T.W. Spier, T.R. Cook, T.M. O'Hara, K.S. Irons, M.A. McClelland, and M.R. Stroub
 Mississippi River Research Consortium, 2008
 Dubuque, Iowa
 Title of Poster: The Nature Conservancy's Emiquon Preserve: resetting and restoring the Thompson Lake fish community
 Stroub, M.R. and **G.G. Sass**
 Mississippi River Research Consortium, 2008
 Dubuque, Iowa
 Title of Poster: Fish population dynamics of an annually-flooded seasonally-isolated backwater lake of the Illinois River
 Irons, K.S., **G.G. Sass**, T.R. Cook, T.M. O'Hara, M.A. McClelland, N.N. Michaels, and M.R. Stroub
 Mississippi River Research Consortium, 2008
 Dubuque, Iowa
 Title of Poster: Asian carps!
Sass, G.G., S.R. Carpenter, J.F. Kitchell, and J. Gaeta

Illinois Chapter of the American Fisheries Society 46th Annual Meeting
 Rockford, Illinois
 Title of Talk: Fish population dynamics in a northern Wisconsin lake following a whole-lake addition of coarse woody habitat
 Irons, K.S., **G.G. Sass**, T.R. Cook, T.M. O'Hara, M.A. McClelland, N.N. Michaels, and M.R. Stroub
 Illinois Chapter of the American Fisheries Society 46th Annual Meeting
 Rockford, Illinois
 Title of Talk and Poster: An overview of the Illinois River Biological Station's Asian carps research
 O'Hara, T.M., K.S. Irons, **G.G. Sass**, T.R. Cook, M.A. McClelland, N.N. Michaels, and M.R. Stroub
 Illinois Chapter of the American Fisheries Society 46th Annual Meeting
 Rockford, Illinois
 Title of Talk: Identification of habitat conditions influencing non-native Asian carps reproduction in the upper Mississippi River system
 McClelland, M.A., **G.G. Sass**, T.R. Cook, K.S. Irons, T.M. O'Hara, C.S. Smith, N.N. Michaels, and M.R. Stroub
 Illinois Chapter of the American Fisheries Society 46th Annual Meeting
 Rockford, Illinois
 Title of Talk: Fifty years of the long-term Illinois River fish population monitoring program, 1957-2007
Sass, G.G., T.R. Cook, K.S. Irons, M.A. McClelland, N.N. Michaels, T.M. O'Hara, M.R. Stroub, and G. Conover
 Midwest Fish and Wildlife Conference, 2007
 Madison, Wisconsin
 Title of Talk: Environmental and economic impacts of Asian carps in the Illinois River
 Irons, K.S., **G.G. Sass**, M.A. McClelland, and J.D. Stafford.
 Fisheries Society of the British Isles Annual Symposium, 2007
 Exeter, England
 Title of Talk: Reduced condition factor of two native fish species coincident with invasion of non-native Asian carps in the Illinois River, USA: evidence for competition and reduced fitness?
Sass, G.G., K.S. Irons, T.M. O'Hara, T.R. Cook, M.A. McClelland, N.N. Michaels, M.L. Smith, and M.R. Stroub
 Mississippi River Research Consortium, 2007
 LaCrosse, Wisconsin
 Title of Talk: Active versus passive management of common and grass carp for backwater lake native fish restoration: a case study from the Nature Conservancy's Emiquon Preserve
 O'Hara, T.M., M.A. McClelland, K.S. Irons, T.R. Cook, and **G.G. Sass**
 Mississippi River Research Consortium, 2007
 LaCrosse, Wisconsin
 Title of Talk: The effect of a recently completed habitat rehabilitation and Enhancement project (HREP) on fish abundances in the La Grange Reach of the

Illinois River using Long Term Resource Monitoring Program (LTRMP) data
Irons, K.S., **G.G. Sass**, M.A. McClelland, and J.D. Stafford
Mississippi River Research Consortium, 2007

LaCrosse, Wisconsin

Title of Talk: Reduced condition factor of two native fish species coincident with invasion of non-native Asian carp in the Illinois River: evidence for competition and reduced fitness?

McClelland, M.A. and **G.G. Sass**

Mississippi River Research Consortium, 2007

LaCrosse, Wisconsin

Title of Talk: Trends in largemouth bass and bluegill populations among the upper and lower Illinois River, 1957-2006

Michaels, N.N., **G.G. Sass**, and K.S. Irons

Mississippi River Research Consortium, 2007

LaCrosse, Wisconsin

Title of Poster: Sportfish trends in the La Grange reach of the Illinois River, 1994-2006

Stroub, M.R., **G.G. Sass**, and K.S. Irons

Mississippi River Research Consortium, 2007

LaCrosse, Wisconsin

Title of Poster: Fish population dynamics of an annually-flooded seasonally-isolated backwater lake of the Illinois River

Sass, G.G., K.S. Irons, T.M. O'Hara, T.R. Cook, M.A. McClelland, N.N. Michaels, M.L. Smith, and M.R. Stroub

Annual Meeting of the Illinois Chapter of the American Fisheries Society, 2007

Findlay, Illinois

Title of Talk: Active versus passive management of common and grass carp for backwater lake native fish restoration: a case study from the Nature Conservancy's

Emiquon Preserve

O'Hara, T.M., M.A. McClelland, K.S. Irons, T.R. Cook, and **G.G. Sass**

Annual Meeting of the Illinois Chapter of the American Fisheries Society, 2007

Findlay, Illinois

Title of Talk: The effect of a recently completed habitat rehabilitation and Enhancement project (HREP) on fish abundances in the La Grange Reach of the Illinois River using Long Term Resource Monitoring Program (LTRMP) data

Irons, K.S., **G.G. Sass**, M.A. McClelland, and J.D. Stafford

Annual Meeting of the Illinois Chapter of the American Fisheries Society, 2007

Findlay, Illinois

Title of Talk: Reduced condition factor of two native fish species coincident with invasion of non-native Asian carp in the Illinois River: evidence for competition and reduced fitness?

McClelland, M.A. and **G.G. Sass**

Annual Meeting of the Illinois Chapter of the American Fisheries Society, 2007

Findlay, Illinois

Title of Talk: Trends in largemouth bass and bluegill populations among the upper and lower Illinois River, 1957-2006

Michaels, N.N., **G.G. Sass**, and K.S. Irons
 Annual Meeting of the Illinois Chapter of the American Fisheries Society, 2007
 Findlay, Illinois
 Title of Poster: Sportfish trends in the La Grange reach of the Illinois River,
 1994-2006
 Stroub, M.R., **G.G. Sass**, and K.S. Irons
 Annual Meeting of the Illinois Chapter of the American Fisheries Society, 2007
 Findlay, Illinois
 Title of Poster: Fish population dynamics of an annually-flooded seasonally-isolated
 backwater lake of the Illinois River
 49th Annual Conference of the International Association for Great Lakes Research
 2006
 Windsor, Ontario, Canada
 Title of Talk: Priority Management Recommendations for Exotic Sea Lamprey
 (*Petromyzon marinus*) Control in Distinct Thermal Regions of Lake Superior
 135th Meeting of the American Fisheries Society, 2005
 Anchorage, Alaska
 Title of Talk: Fish Community and Food Web Responses to a Whole-lake Removal
 of Coarse Woody Habitat
 National Science Foundation Biocomplexity in the Environment Awardees Meeting,
 2005
 Arlington, Virginia
 Title of Poster: Biocomplexity. Divergent Dynamics: Complex Interactions of
 Riparian Land, People, and Lakes
 134th Meeting of the American Fisheries Society, 2004
 Madison, Wisconsin
 Title of Talk: Bioindicators of Walleye Population Collapse
 89th Meeting of the Ecological Society of America, 2004
 Portland, Oregon
 Title of Talk: Yellow Perch Population Collapse: Effects of a Whole-lake Removal
 of Coarse Woody Habitat
 PERCIS III: The Third International Percid Fish Symposium, 2003
 Madison, Wisconsin
 Title of Talk: Yellow Perch Population Collapse: Distribution and Abundance
 Responses Associated with a Whole-lake Removal of Littoral Zone Coarse Woody
 Habitat
 87th Meeting of the Ecological Society of America, 2002
 Tucson, Arizona
 Title of Talk: Bioenergetic Explanations for Sexually Dimorphic Walleye Growth:
 the Influences of Sex-specific Reproductive and Activity Costs
 131st Meeting of the American Fisheries Society, 2001
 Phoenix, Arizona
 Title of Talk: Predicting Adult Walleye, *Stizostedion vitreum*, Densities Across
 Northern Wisconsin Lakes: Can Within-Lake Population Dynamics be Expanded to
 Regional Scale Management?
 86th Meeting of the Ecological Society of America, 2001

Madison, Wisconsin

Title of Talk: Whole-lake Patterns of Predation Mortality: The Influence of Littoral Zone Structural Complexity and Depth on Fish Predator-prey Interactions

62nd Midwest Fish and Wildlife Conference, 2000

Minneapolis, Minnesota

Title of Talk: Growth Dynamics of Walleye in Ceded Territory Lakes of Northern Wisconsin, 1990-1999

American Society of Ichthyologists and Herpetologists 79th Annual Meeting, 1999

The Pennsylvania State University

Title of Poster: The Effects of Satiation on Prey Capture Kinematics in the Largemouth Bass, *Micropterus salmoides*

Invited Guest Lectures:

1. University of Wisconsin – Stevens Point

Course: Fish Management

February 13, 2015

Title: Aquatic Invasive Species Management: Case Studies and Lessons

2. University of Wisconsin – Stevens Point

Course: Fish Management

February 17, 2014

Title: Aquatic Invasive Species: Characteristics, Management, and Prevention of Spread

3. University of Wisconsin – Stevens Point

Course: Fish Management

February 20, 2013

Title: Aquatic Invasive Species: Characteristics, Management, and Prevention of Spread

4. University of Wisconsin – Stevens Point

Course: Fish Management

April 18, 2012

Title: Environmental and Economic Impacts of Asian Carps in the Illinois River

5. University of Illinois at Urbana-Champaign

Course: Fisheries Ecology and Management

October 28, 2009

Title: Environmental and Economic Impacts of Asian Carps in the Illinois River

6. University of Minnesota – Duluth

Course: Fisheries Ecology

October 5, 2005

Title: Fish Community and Food Web Responses to a Whole-lake Removal of Coarse Woody Habitat

7. University of Wisconsin – Madison

Course: General Ecology

November 15, 2004

Title of Lecture: Physiological Ecology: Fundamental and Applied Uses of Bioenergetics Models

8. University of Wisconsin – Madison

Course: Ecology of Fishes

March 4, 2003

Title of Lecture: Human Effects on Fish Predator-prey Interactions and Population Dynamics

9. University of Minnesota – Duluth

Course: Fisheries Ecology

September 26, 2002

Title of Lecture: Human Effects on Fish Predator-prey Interactions and Population Dynamics

10. University of Wisconsin - Madison

Course: Ecology of Fishes

March 21, 2002

Title of Lecture: Applicability of Fish Ecology to Fisheries Management

11. University of Minnesota - Duluth

Course: Fisheries Ecology

September 14, 2001

Title of Lecture: Linear and Non-linear Techniques for Estimating Fish Growth Parameters

Workshops and Symposia:

1. The Nature Conservancy's Emiquon Preserve: Ecological Lessons Learned from a Large-scale Floodplain Restoration Effort Symposium (Co-organizer)

70th Annual Midwest Fish and Wildlife Conference

Springfield, Illinois

2. Integrated Management of the Illinois and Mississippi River Backwaters Workshop (Co-Organizer)

Forbes Biological Station, Havana, IL, June 18-19, 2007.

Representatives from: Illinois Natural History Survey, The Nature Conservancy, Illinois Department of Natural Resources, United States Fish and Wildlife Service

3. Littoral Zone Structural Complexity Workshop (Organizer)

Center for Limnology, Trout Lake Station, Boulder Junction, WI, September 21-23, 2003. Representatives from: University of Washington, Minnesota Department of

Natural Resources, Department of Fisheries and Oceans – Canada, Ontario Ministry of Natural Resources, Wisconsin Department of Natural Resources, University of Wisconsin – Stevens Point, University of Wisconsin - Madison

Manuscript, Book Chapter, and Report Reviews:

A Handbook of Global Freshwater Invasive Species (book chapter review)

Canadian Journal of Fisheries and Aquatic Sciences

Current Zoology

Ecology

Ecology of Freshwater Fish

Ecology Letters

Ecology and Society
Fisheries
Fisheries Management and Ecology
Freshwater Biology
Hydrobiologia
Journal of Fish Biology
Journal of Great Lakes Research
Landscape Ecology
Marine Ecology Progress Series
North American Journal of Fisheries Management
Northeastern Naturalist (Guest Editor)
Oikos
Restoration Ecology
The American Midland Naturalist
Transactions of the American Fisheries Society
United States Geological Survey

Proposal Reviews:

Minnesota Sea Grant
National Science Foundation
National Sea Grant

Awards and Honors:

- U.S. Geological Survey, Customer Service Excellence Award, LTRMP, 2008
- U.S. Department of the Interior, Cooperative Conservation Award, LTRMP, 2007
- Who's Who of Emerging Leaders, 1st Edition, 2007 - present
- Who's Who in America, 60th Edition, 2006 – present
- DIALOG VII Symposium Awardee, Dauphin Island, AL, December 3-10, 2005

University of Wisconsin - Madison

- 2003 WI Chapter of the American Fisheries Society Annual Meeting – Best Student Paper
- National Science Foundation Integrated Graduate Education and Research Traineeship (IGERT), Human Dimensions of Social and Aquatic System Interactions, 1999 – 2003
- John Jefferson Davis Travel Award – 2001, 2002, 2003
- Anna Grant Birge Memorial Award – 2001, 2002, 2003

University of South Florida

- College of Arts and Sciences, Non-Resident Tuition Waiver Scholarship, 1997 - 1999
- Biology Honors Program, 1996 - 1999
- College of Arts and Sciences, Deans List of Scholars, 1996 - 1999

- Honors Convocation, 1995 - 1999
- College of Arts and Sciences Deans List, 1995 - 1996
- Presidential Fee Waiver Scholarship, 1995 - 1997

Service Activities:

- Invited contributor, U.S. Army Corps of Engineers Expert Elicitation Panel on the Great Lakes Mississippi River Interbasin Study to prevent range expansion of Asian carp, Chicago, Illinois, 2015
- President-Elect, Wisconsin Chapter of the American Fisheries Society, 2015-2016
- Chair, INHS Forbes Biological Station Directorship search, 2011
- Chair, INHS Field Station Committee, 2010-2011
- Asian Carp Monitoring and Rapid Response Workgroup, 2010-2011
- INHS Human Resources Committee, 2009-2011
- President, Mississippi River Research Consortium, 2009-2010
- Vice-President, Mississippi River Research Consortium, 2008-2009
- Illinois Chapter of the American Fisheries Society Executive Committee Member at Large, 2007-2008
- INHS Division of Ecology and Conservation Science Stream Ecologist Search Committee, 2007
- INHS Division of Ecology and Conservation Science Recorder, 2007
- North American Journal of Fisheries Management Subcommittee of the American Fisheries Society Publication Awards Committee, 2005-2006
- Mentor, Alternative Breaks Program, University of Wisconsin - Madison
- Chair, Graduate Student Activities Committee, Madison Ecology Group, University of Wisconsin – Madison
- Program mentor for an undergraduate minority student (SEEDS), Ecological Society of America
- College for Kids Program, University of Wisconsin - Madison
- Saturday Enrichment Program, University of Wisconsin - Madison

Grades:

- University of South Florida, 1995 - 1999:
- GPA in Major - 3.913/4.0
- Overall GPA - 3.851
- University of Wisconsin-Madison, 1999-2004
- GPA in Major – 4.0/4.0
- Overall GPA – 3.966

Research Interests:

My research interests within the field of aquatic ecology have primary emphasis

on fish ecology, ichthyology, and fisheries biology. Specific interests involve predator-prey interactions, bioenergetics, population dynamics, and ecosystem-based fisheries management. Ongoing research focuses on long-term resource monitoring of the large rivers of Illinois, invasive species ecology and management, and floodplain lake restoration ecology. In addition, I study the response of fish communities and food webs to whole-lake manipulations of coarse woody habitat in several northern Wisconsin lakes, the ecosystem effects of a whole-lake removal of an exotic fish and crayfish, and exotic sea lamprey and lake trout interactions and food web dynamics in Lake Superior. Current research is aimed at better understanding walleye exploitation in northern Wisconsin lakes and the influences of invasive species and environmental variability on aquatic ecosystems in Wisconsin.

References:

Dr. Jennifer Hauxwell – Former Supervisor
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Dr. John Chick – Colleague
National Great Rivers Research and Education Center
Illinois Natural History Survey
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Attachment 2: Sensitivity Analysis for Asian Carp Population Sizes

Context

Currently, the population of Bighead and Silver Carp (hereafter referred to as Asian carp) below Brandon Road Lock and Dam (BRLD) is negligible. Asian carp management activities to reduce the Asian carp population downstream of BRLD are subject to the availability of future appropriations and allocation decisions. Therefore it is possible that future funding for current activities could be reduced or discontinued. Consequently, it is appropriate to examine how the efficacy of the GLMRIS-BR Alternatives would be affected by changes in the population size of Asian carp in Dresden Island Pool located directly below BRLD.

For the GLMRIS-Brandon Road Study, USACE utilized a 50-year period of analysis. However, in order to most realistically represent ANS establishment, the probability of establishment model incorporated all years beginning in 2015 (when the elicitation was conducted) through 2071. This sensitivity analysis explores the impacts of two hypothetical, extreme scenarios on the estimates of P(establishment) of Asian Carp in the Great Lakes Basin (GLB). One scenario assumes the Asian Carp population in Dresden Island Pool is always large for the entire period of analysis through 2071. The second scenario assumes the population of Asian Carp below BRLD is small during the entire 50-year period of analysis. Small is defined as the Asian carp population density found in the Dresden Island Pool (Figure 1). Medium is defined as the Asian carp population density in the Starved Rock pool, and large is defined as the Asian carp population density in the Peoria Pool. The population densities were based on monitoring data collected between 2012 and 2014. The baseline population scenarios are based on the actual estimates of Asian carp population density below Dresden Island Pool that were provided by the experts during the elicitation (Figure 1). These estimates included population sizes of Asian carp for the period of analysis that vary based on the opinion of the individual experts. Thus, the baseline represents the P(establishment) values used to evaluate the Alternatives.

To simplify the comparison of sensitivity analysis results only composite expert results are presented. The composite expert was obtained by averaging the cumulative distribution function for each of the six experts for the No New Action Alternative, the Nonstructural Alternatives, and for each Technology Alternatives that were the subject of an expert elicitation. A similar process was followed for the sensitivity scenarios.

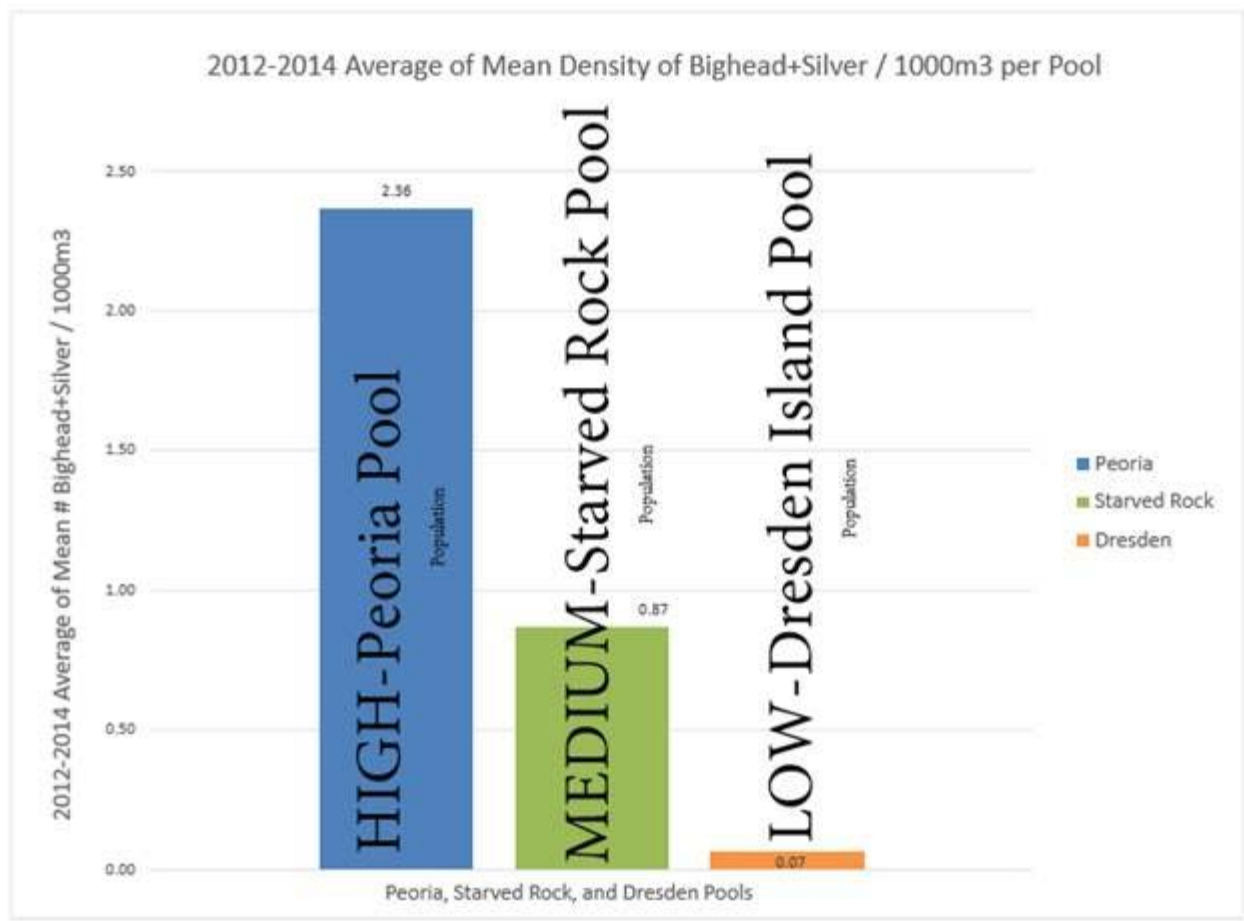


Figure 1. Average of 2012-2014 Mean Density of Bighead and Silver Carp/1000m³ Per Pool in the Dresden Island Pool. (Coulter, D., 2015, E-mail communication with J. Potthoff, Southern Illinois University, Dec. 2.)

All Large Populations

The first sensitivity scenario assumes the population of Asian carp downstream of Brandon Road Lock and Dam is large from the present through 2071. This assumption provides an upper limit bound on P(Establishment) estimates. The analysis addresses the following questions:

- 1) What happens to P(establishment) under the No New Action Alternative if the population of Asian carp downstream of Brandon Road Lock and Dam is always large?
- 2) What happens to the efficacy of the alternative plans, i.e., P(establishment), if the population of Asian carp downstream of Brandon Road Lock and Dam is always large?

Answers

- 1) What happens to P(establishment) under the No New Action Alternative if the population of Asian carp downstream of Brandon Road Lock and Dam is always large?

No New Action Alternative

Compared to the baseline scenario, the P(establishment) by 2071 for the No New Action Alternative increases if the Asian carp population in Dresden Island Pool is always large. A numerical summary of the changes is shown in Table 1.

Table 1 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous large population scenarios with the No New Action Alternative

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.22	0.26	0.29	0.32	0.36
Large Population	0.29	0.35	0.40	0.45	0.50

Figure 2 shows the results graphically. The red (left) distribution is the baseline estimate of P(establishment) and the blue (right) distribution assumes a continuous large population. The center of mass for the P(establishment) distributions increases about 10 percentage points under the large population scenario

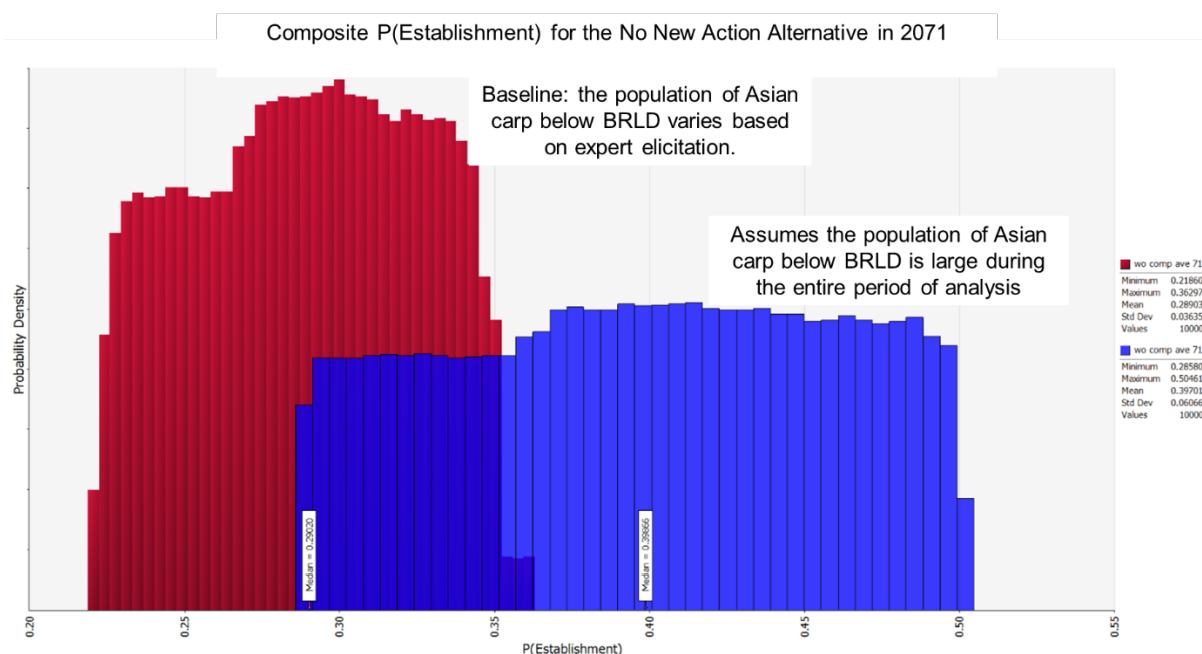


Figure 2 Composite expert Asian carp establishment probability distributions for the No New Action Alternative. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

This comparison shows that the probability of establishment of Asian carp in the GLB will rise if circumstances arise that result in a large population of Asian carp downstream of BRLD for the entire period of analysis. P(establishment) increases by about one third from 22-36% to 29-50%.

- 2) What happens to the efficacy of the alternative plans, i.e., P(Establishment) if the population of Asian carp downstream of Brandon Road Lock and Dam is always large?

Nonstructural Alternative

The Nonstructural Alternative performs significantly differently if a continuous large population is present, as seen in Table 2. The P(Establishment) roughly doubles in the sensitivity scenario shown in Figure 3.

Table 2 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous large population scenarios with the Nonstructural Alternative

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.15	0.18	0.20	0.22	0.26
Large Population	0.29	0.35	0.40	0.45	0.50

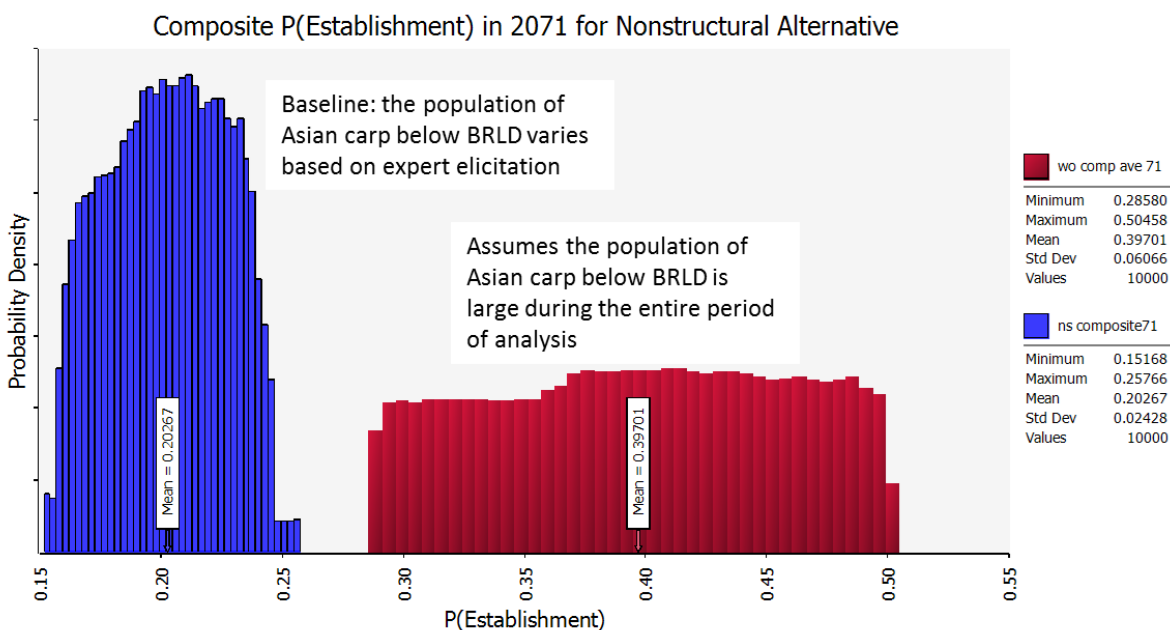


Figure 3 Composite expert Asian carp establishment probability distributions for the Nonstructural Alternative. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

Technology Alternative - Electric Barrier

The sensitivity analysis indicates that the efficacy of the Technology Alternative - Electric Barrier would be greatly compromised by the continued presence of a large population of Asian carp in Dresden Island Pool during the 50-year period of analysis. Compared to the baseline, the P(establishment) roughly triples for the large Asian carp population scenario (Table 3). Figure 4 shows a blue (right) probability distribution for P(establishment) with the electric barrier alternative in place with continuously large populations of Asian carp.

Table 3 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous large population scenarios with the Technology alternative - Electric Barrier P(establishment).

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.08	0.10	0.11	0.12	0.14
Large Population	0.26	0.30	0.34	0.37	0.41

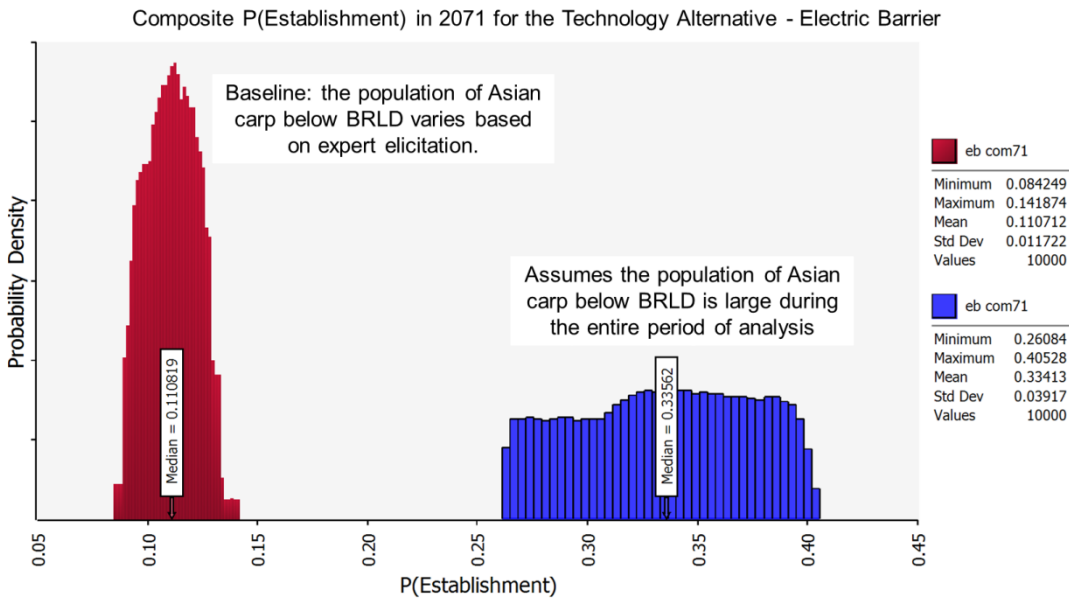


Figure 4 Composite expert Asian carp establishment probability distribution for the Technology Alternative-Electric Barrier. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

Technology Alternative-Complex Noise

Compared to the baseline, the P(establishment) value for the Technology Alternative - Complex Noise increases by a factor of about 2.2 if a continuous large population of Asian carp is assumed to be present in Dresden Island Pool (Table 4 and Figure 5).

Table 4 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous large population scenarios with the Technology Alternative -Complex Noise P(establishment).

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.11	0.14	0.15	0.17	0.19
Large Population	0.28	0.33	0.38	0.42	0.47

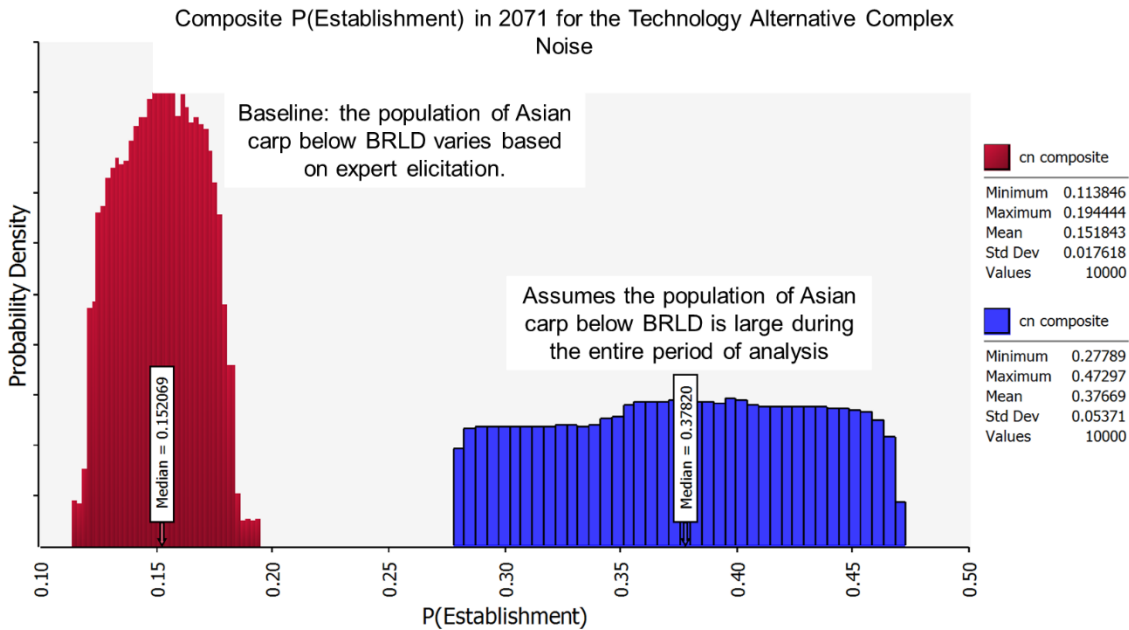


Figure 5 Composite expert Asian carp establishment probability distributions for the Technology Alternative-Complex Noise. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

Technology Alternative-Complex Noise with Electric Barrier

Compared to the baseline, the P(establishment) value for the Technology Alternative - Complex Noise with Electric Barrier Alternative increases by a factor of about 2.5 if a large population of Asian carp is assumed to be present in Dresden Island Pool for the entire 50-year period of analysis (Table 5 and Figure 6).

Table 5 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous large population scenarios with the Technology Alternative- Complex Noise with Electric Barrier .

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.10	0.12	0.13	0.14	0.17
Large Population	0.26	0.31	0.34	0.38	0.42

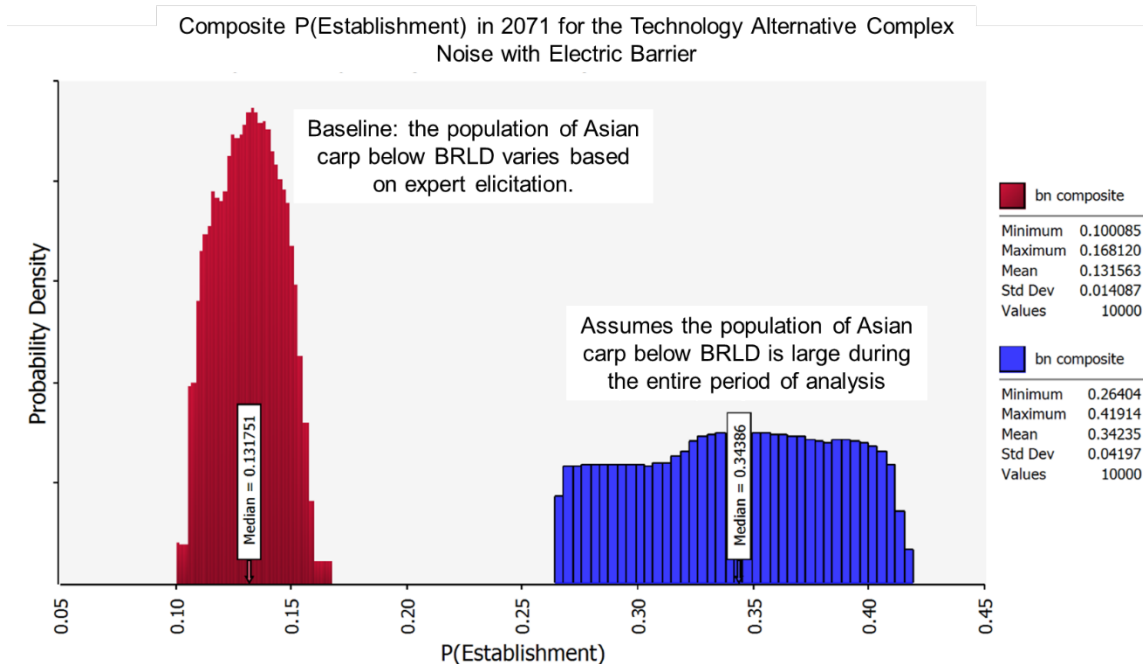


Figure 6 Composite expert Asian carp establishment probability distributions for the Technology Alternative - Complex Noise with Electric Barrier. The red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

The Technology Alternative - Complex Noise with Electric Barrier Alternative was presented to the experts as having operating conditions that included having the electric barrier turned off when a vessel was immediately downstream of the approach channel, in the approach channel and in the lock. At the close of the elicitation, the panel was asked how a Technology Alternative - Complex Noise with Electric Barrier alternative would compare in effectiveness if the electric barrier was assumed to operate continuously. The experts assumed the effectiveness would be identical to the Technology Alternative – Electric Barrier. Values for its performance were not separately elicited for this reason. Therefore, the P(establishment) of this alternative with these operating conditions is identical to that presented above for the Technology Alternative - Electric Barrier. Refer to the Table 3 and Figure 3 for how the alternative would be impacted by an all large population.

Lock Closure Alternative

Compared to the baseline, P(establishment) for the Lock Closure Alternative increases over ten-fold if a large Asian carp population is assumed to be present in Dresden Island Pool during the entire 50-year period of analysis (Table 6 and Figure7). The P(establishment) was higher because the greater population of carp increased the passage rate and, subsequently, P(establishment) before the lock could be closed.

Table 6 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous large population scenarios with the Lock Closure Alternative.

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.01	0.02	0.02	0.02	0.03
Large Population	0.24	0.26	0.29	0.31	0.33

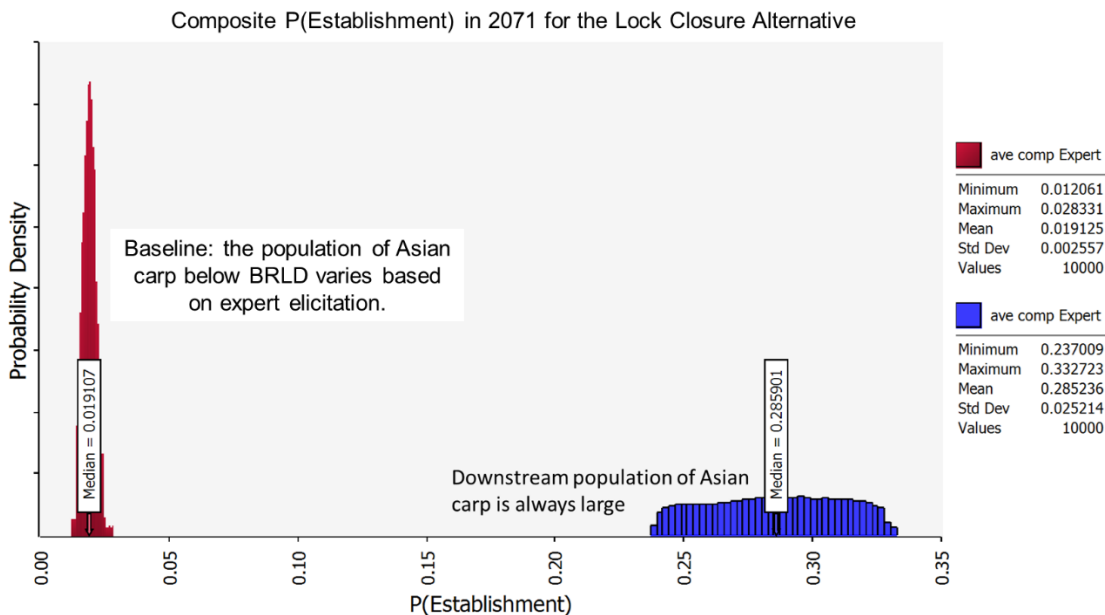


Figure 7 Composite expert Asian carp establishment probability distributions for the Lock Closure Alternative; the red distribution is the baseline scenario and the blue distribution is the continuous large population scenario.

Continuous Large Population Sensitivity Conclusion

The presence of a large population downstream of BRLD seriously reduces the efficacy of the nonstructural and all of the technology alternatives in preventing the establishment of Asian carp in the GLB. The P(establishment) for lock closure depends on whether enough Asian carp move into the GLB to establish before the lock is closed, because, once the lock is closed, passage into Lake Michigan falls to zero. The P(establishment) increases over ten-fold for the Lock Closure Alternative if a large Asian carp population is assumed to be present in Dresden Island Pool prior to closure. Overall, the results of the sensitivity analysis indicate the importance of including efforts to prevent an increase in the current Asian carp population size in Dresden Island Pool as part of any alternative plan.

Continuous Small Population

Context

The second sensitivity scenario assumes a small population of Asian carp could be maintained in Dresden Island Pool located below BRLD through 2071. This assumption provides a lower limit bound on P(establishment) estimates. The analysis addresses the following questions:

- 3) What happens to P(establishment) under the No New Action Alternative if the population of Asian carp downstream of Brandon Road Lock and Dam is always small?

- 4) What happens to the efficacy of the alternative plans, i.e., $P(\text{Establishment})$ if the population of Asian carp downstream of Brandon Road Lock and Dam is always small?

Answers

- 3) What happens to $P(\text{establishment})$ under the No New Action Alternative if the population of Asian carp downstream of Brandon Road Lock and Dam is always small?

Compared to the baseline, $P(\text{establishment})$ for the No New Action Alternative decreases to about a third of the baseline if a small Asian carp population is assumed to be present in Dresden Island Pool for the entire 50-year period of analysis (Table 7).

Table 7 Composite expert summary for $P(\text{establishment})$ of Asian carp by 2071 for baseline and continuous small population scenarios with the No New Action Alternative.

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.22	0.26	0.29	0.32	0.36
Small Population	0.08	0.09	0.10	0.11	0.13

Figure 8 shows the results graphically. The red (right) distribution is the baseline estimate of $P(\text{establishment})$ and blue (left) shows $P(\text{establishment})$ for the continuous small population scenario. The center of mass for the distributions has decreased almost 20 percentage points from 29 to 10%. Overall the $P(\text{establishment})$ distribution decreases about two-thirds if a small population of Asian carp is assumed in Dresden Island Pool for the entire period of analysis.

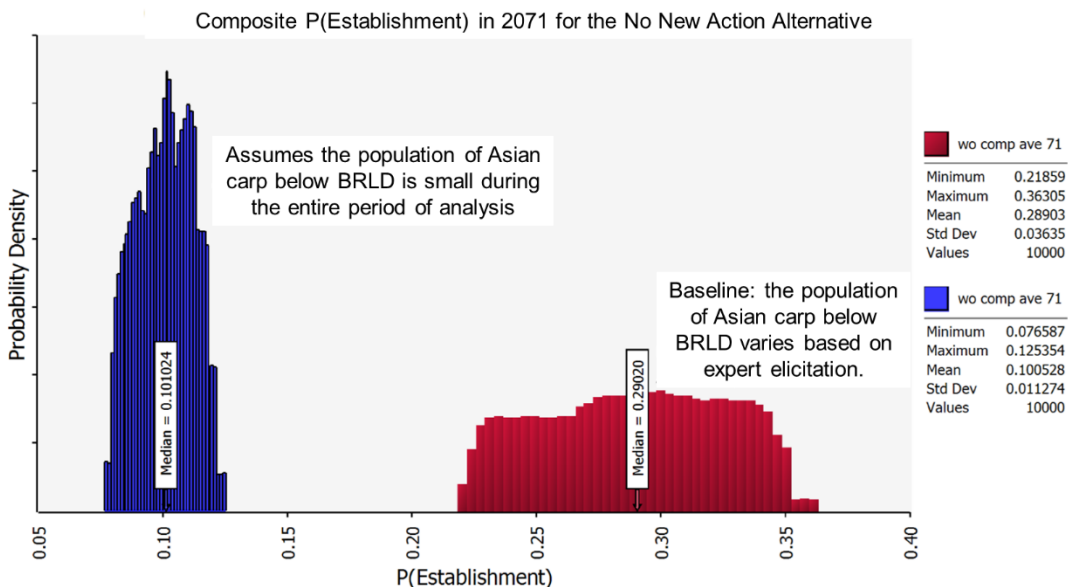


Figure 8 Composite expert Asian carp establishment probability distributions for the No New Action Alternative. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.

- 4) What happens to the efficacy of the alternative plans, i.e., $P(\text{Establishment})$ if the population of Asian carp downstream of Brandon Road Lock and Dam is always small?

Nonstructural Alternative

The nonstructural plan's effectiveness increases, if the downstream Asian carp population size can be held to a small size (Table 8). The baseline estimate of P(establishment) is the red (right) distribution shown in Figure 9. The small population sensitivity scenario shifts this distribution to the left, representing a significant improvement in effectiveness.

Table 8 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous small population scenarios with the Nonstructural Alternative.

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.15	0.18	0.20	0.22	0.26
Small Population	0.08	0.09	0.10	0.11	0.13

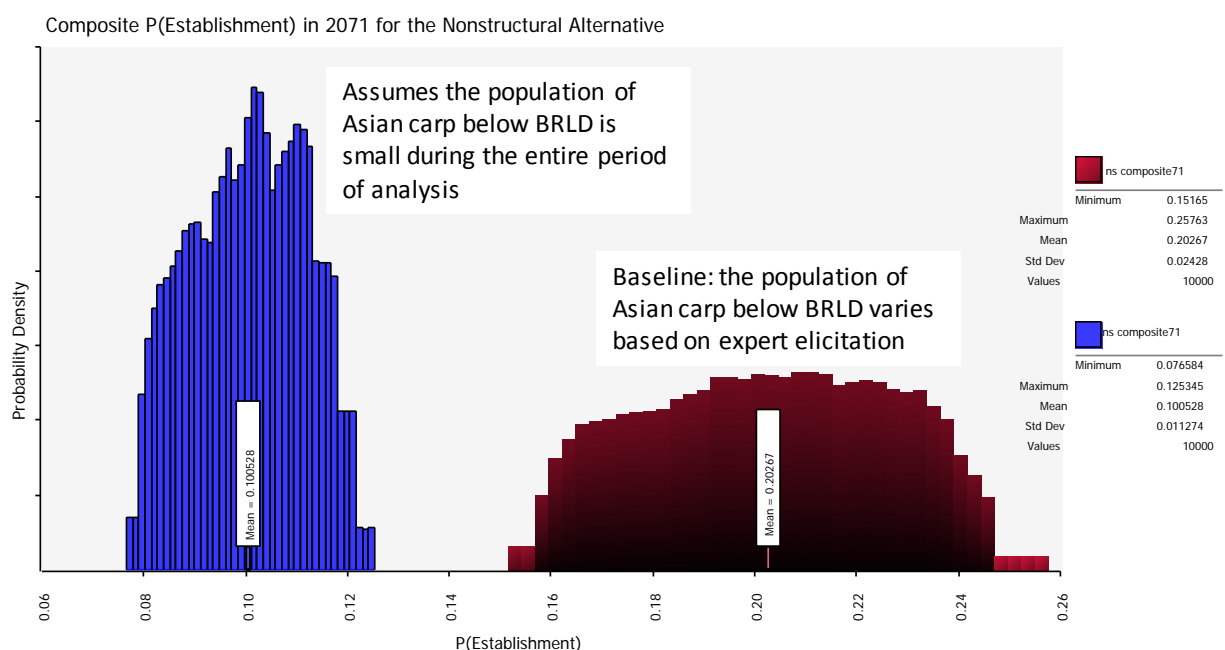


Figure 9 Composite expert Asian carp establishment probability distributions for the Nonstructural Alternative. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.

Technology Alternative- Electric Barrier

The efficacy of the electric barrier alternative improves if a small population of Asian carp can be maintained in Dresden Island Pool. The P(establishment) is roughly one-third of the baseline P(establishment) that used the population sizes based on the actual inputs from the expert elicitation (Table 9 and Figure 10). Note this alternative was presented as having operating conditions that included having the electric barrier turned off when a vessel was immediately downstream of the approach channel, in the approach channel and in the lock.

Table 9 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous small population scenarios with the Technology Alternative-Electric Barrier.

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.08	0.10	0.11	0.12	0.14
Small Population	0.03	0.04	0.04	0.04	0.05

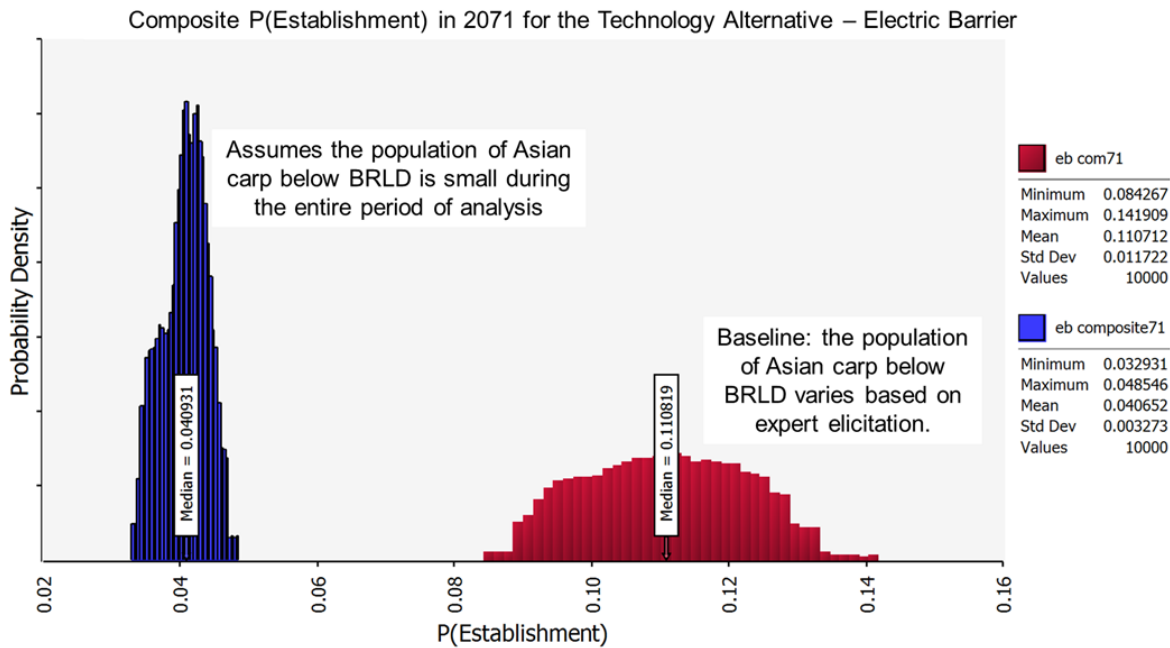


Figure 10 Composite expert Asian carp establishment probability distributions for the Technology Alternative- Electric Barrier. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.

Technology Alternative - Complex Noise

Compared to the baseline, the P(establishment) value for the complex noise alternative decreases by about two-thirds if a continuous small population of Asian carp is assumed to be present in Dresden Island Pool for the period of analysis (Table 10 and Figure 11).

Table 10 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous small population scenarios with the Technology Alternative-Complex Noise.

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.11	0.14	0.15	0.17	0.19
Small Population	0.04	0.05	0.06	0.06	0.07

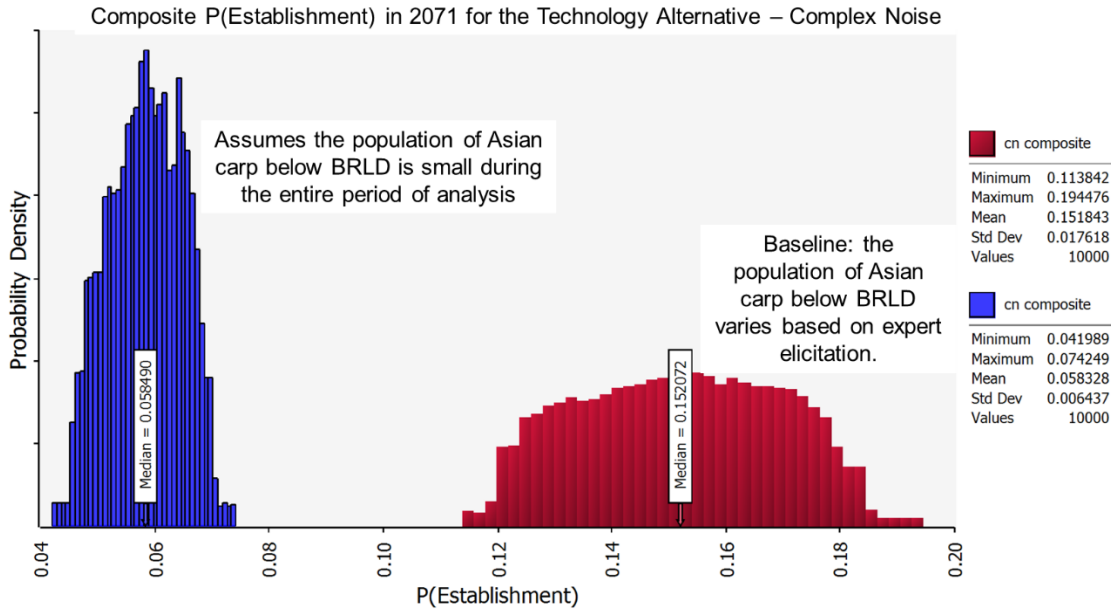


Figure 11 Composite expert Asian carp establishment probability distributions for the Technology Alternative-Complex Noise. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.

Technology Alternative - Complex Noise with Electric Barrier

Compared to the baseline, the P(establishment) value for the Technology Alternative – Complex Noise with Electric Barrier Alternative decreases by a factor of about two-thirds if a continuous small population of Asian carp is assumed to be present in Dresden Island Pool for the period of analysis (Table 11 and Figure 12).

Table 11 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous small population scenarios with the Technology Alternative-Complex Noise with Electric Barrier.

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.10	0.12	0.13	0.14	0.17
Small Population	0.04	0.05	0.05	0.05	0.06

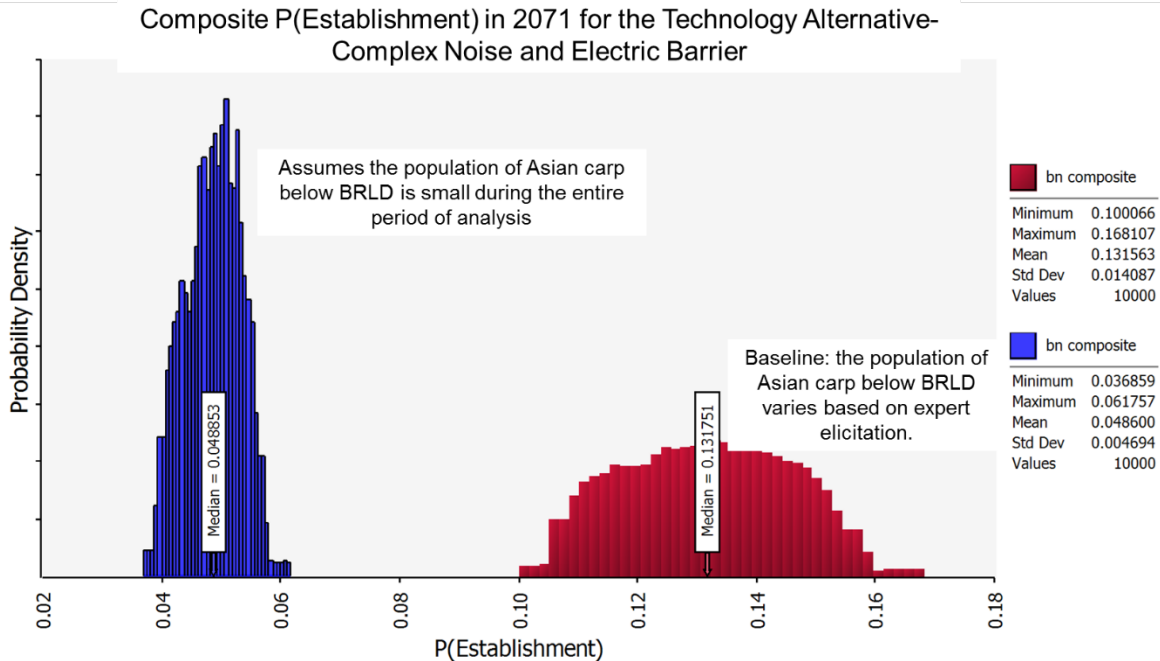


Figure 12 Composite expert Asian carp establishment probability distributions for the Technology Alternative-Complex Noise with Electric Barrier. The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.

Lock Closure

The probability of establishment for the Lock Closure Alternative depends on whether enough Asian carp could enter the GLB to establish before the lock could be closed. This value is small in the baseline estimate and falls about one-third if a small population of Asian carp is assumed to be present in Dresden Island Pool from now until the lock can be closed (Table 12 and Figure 13). This scenario is more realistic than assuming a large Asian carp population in Dresden Island Pool for the time period from now lock closure, simply because the current population is small.

Table 12 Composite expert summary for P(establishment) of Asian carp by 2071 for baseline and continuous small population scenarios with the Lock Closure Alternative

	Minimum	1 st Quartile	Median	3 rd Quartile	Maximum
Baseline	0.01	0.02	0.02	0.02	0.03
Large Population	0.01	0.01	0.01	0.01	0.02

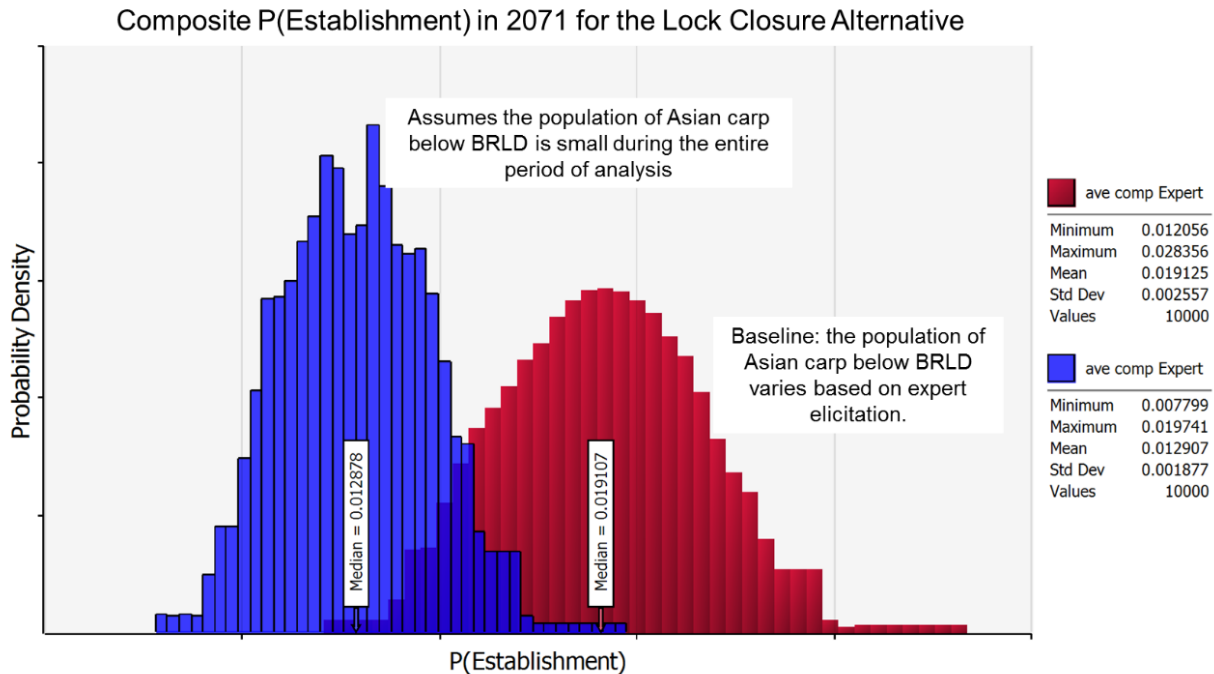


Figure 13 Composite expert Asian carp establishment probability distributions for the Lock Closure Alternative The red distribution is the baseline scenario and the blue distribution is the continuous small population scenario.

Additional Analysis

The Technology Alternative – Complex Noise with Electric Barrier was presented with operating conditions that included having the electric barrier turned off when a vessel was immediately downstream of the approach channel, in the approach channel and in the lock. As noted in the large population discussion, at the close of the elicitation, the panel was asked how a Technology Alternative - Complex Noise with Electric Barrier alternative would compare in effectiveness if the electric barrier was assumed to operate continuously. The values for estimating $p(\text{establishment})$ using the model were not elicited from the experts. The expert panel members rated the efficacy of the Technology Alternative – Complex Noise with Electric Barrier assuming the electric barrier ran continuously to be similar to the Technology Alternative - Electric Barrier. The Technology Alternative- Electric Barrier values are presented in Table 9 and Figure 10.

Continuous Small Population Sensitivity Conclusion

The results of the sensitivity analysis indicate that the efficacy of all of the GLMRIS-BR Alternatives can be significantly enhanced if a small population of Asian carp can be maintained downstream of BRLD. Considered in concert with the results of the large population scenario, these results highlight the importance of a continuous and successful effort to control the population of carp downstream of BRLD.

Conclusions

The probability of establishment of Asian carp in the GLB grows larger over time. Figure 14, reproduced from the P(Establishment) Appendix, shows that the longer the period of time considered the greater the P(Establishment).

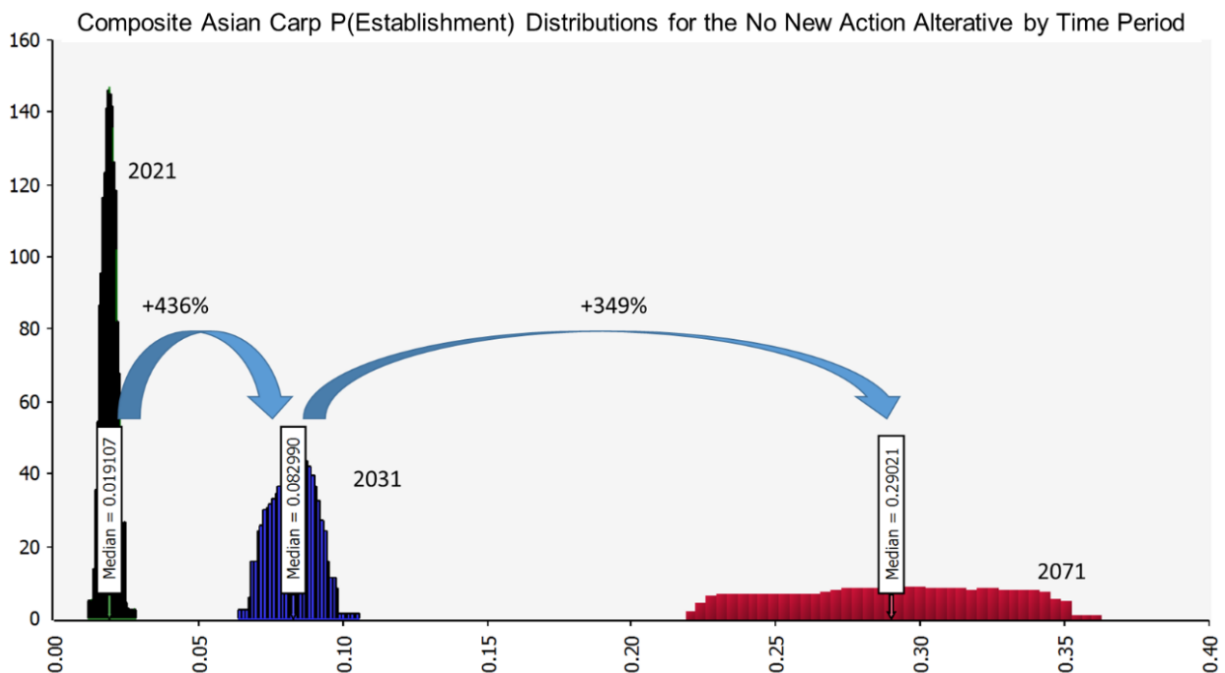


Figure 14 Composite expert Non New Action Alternative P(Establishment) estimates for Asian carp for three time periods with median and percent change in median.

As summarized in Table 13, these sensitivity analyses reveal useful insights into the range of expected performance of the various alternatives in comparison to the No Action Alternative. The P(Establishment) used for plan evaluation is based on each expert's characterization of the uncertainty associated with the population density of Asian carp (small, medium or large) developing in Dresden Island Pool. The results of the large population scenario analysis indicate that the P(establishment) value rises to 26-41% if the Technology Alternative-Electric Barrier is implemented, but the Asian carp population in Dresden Island Pool is large throughout 2071 (Table 13). That is higher than the experts' estimated P(establishment) for the baseline best estimate No New Action Alternative of 22-36%. Furthermore, the small population sensitivity analysis indicates that if the nonstructural measures included in the alternatives are effective in keeping population density small through 2071, the efficacy of all of the technology alternatives would be significantly enhanced. For example, the Technology Alternative- Electronic Barrier has a range of 3-5% for the small population scenario compared to 8-14% in the baseline scenario (Table 14). Thus, if the Asian Carp population density remains small in Dresden Island Pool, the P(establishment) for the Technology Alternative – Complex Noise with Electric Barrier would be even lower than the baseline composite expert estimate. These comparisons highlight the importance of a sustained and successful nonstructural plan.

The Nonstructural Alternative differs from the No New Action Alternative only based on the way in which it affects the probability of arrival of different sized Asian carp populations. Because the small and

large population scenarios eliminate those variations the two scenarios are equivalent if a continuous population in Dresden Island Pool is assumed. When populations sizes are uncertain and varied these two scenarios have different values.

The P(Establishment) values for the Lock Closure Alternative reflect the probabilities of establishment only in the years leading up to lock closure. Once the lock is actually closed these probabilities drop to zero. As with the Nonstructural and Technology Alternatives, P(establishment) is highest for the large population scenario (Table 14).

For Table 13 and 14, the No New Action is the No New Federal Action. The Nonstructural is the Nonstructural Alternative. Electric Barrier is the Technology Alternative – Electric Barrier. Complex Noise is Technology Alternative – Complex Noise. Complex Noise & Electric Barrier is Technology Alternative – Complex Noise with Electric Barrier, and Lock Closure is the Lock Closure Alternative.

Table 13 Comparison of five number summaries for future without condition and with plan conditions 2071 for three scenarios-small population, best estimate, large population.						
Small Population of Asian Carp Always Present						
	No New Action	Nonstructural	Electric Barrier	Complex Noise	Complex Noise & Electric Barrier	Lock Closure
Minimum	0.08	0.08	0.03	0.04	0.04	0.01
1st Quartile	0.09	0.09	0.04	0.05	0.05	0.01
Median	0.1	0.1	0.04	0.06	0.05	0.01
3rd Quartile	0.11	0.11	0.04	0.06	0.05	0.01
Maximum	0.13	0.13	0.05	0.07	0.06	0.02

Best Estimate (Baseline) - With Variation in Arrival Population Size Based on Expert Inputs						
	No New Action	Nonstructural	Electric Barrier	Complex Noise	Complex Noise & Electric Barrier	Lock Closure
Minimum	0.22	0.15	0.08	0.11	0.1	0.01
1st Quartile	0.26	0.18	0.1	0.14	0.12	0.02
Median	0.29	0.2	0.11	0.15	0.13	0.02
3rd Quartile	0.32	0.22	0.12	0.17	0.14	0.02
Maximum	0.36	0.26	0.14	0.19	0.17	0.03

Large Population of Asian Carp Always Present

	No New Action	Nonstructural	Electric Barrier	Complex Noise	Complex Noise & Electric Barrier	Lock Closure
Minimum	0.29	0.29	0.26	0.28	0.26	0.24
1st Quartile	0.35	0.35	0.3	0.33	0.31	0.31
Median	0.4	0.4	0.34	0.38	0.34	0.34
3rd Quartile	0.45	0.45	0.37	0.42	0.38	0.38
Maximum	0.5	0.5	0.41	0.47	0.42	0.42

Table 14 Summary comparison showing minimum and maximum values of composite expert P(Establishment) 2071 estimates for three scenarios- small population, best estimate, large population.

	Small Population Scenario	Best Estimate	Large Population Scenario
No New Action Alternative	8-13%	22-36%	29-50%
Nonstructural Alternative	8-13%	15-26%	29-50%
Technology Alternative-Electric Barrier	3-5%	8-14%	26-41%
Technology Alternative-Complex Noise	4-7%	11-19%	28-47%
Technology Alternative-Complex Noise and Electric Barrier	4-6%	10-17%	26-42%
Lock Closure Alternative	1-2%	1-3%	24-42%

Figure 15 provides an explanation for the importance of population size in Dresden Island Pool on P(establishment). Note the vertical scale is logarithmic, thus each horizontal gridline is another order of magnitude. The numbers on the horizontal axis correspond to one of the six experts elicited. With a small population in place, an average of 69 fish could pass through the CAWS annually. If the population is large, the mean is 14 times larger at 950 fish annually. It is these larger numbers of fish passing that account for the increases in P(Establishment).

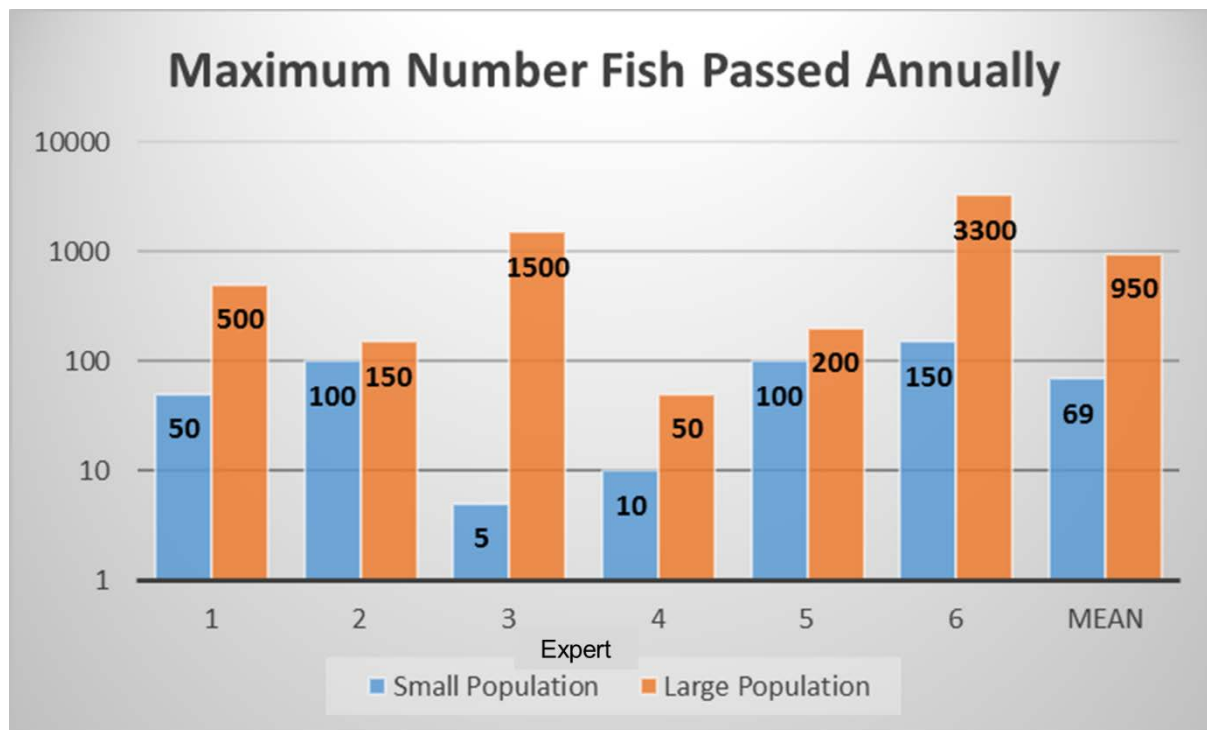


Figure 15 Comparison of the maximum number of fish that could pass annually from below Brandon Road Lock and Dam into Lake Michigan under the No New Action Alternative. .