Title: Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study

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Introduction

The US Army Corps of Engineers (USACE) is currently engaged in the Great Lakes and Mississippi River Interbasin Study (GLMRIS), a feasibility study of the range of options and technologies available to prevent the spread of aquatic nuisance species between the Great Lakes (GL) and Mississippi River (MR) basins via aquatic connections. In this paper, a list of aquatic alien species and those native species that occur in one basin or the other was developed along with the associated risk of their potential to disperse and become invasive. This list is the first step in establishing the current and future without project conditions for alternative plan formulation purposes. A more detailed explanation of the USACE Planning Process, as it applies to specifically this study, can be found in the GLMRIS Project Management Plan.

Intentional and accidental introductions of organisms outside their native ranges have resulted in both economic and ecological harm. Such introductions are often associated with declines in native species and general decrease in biological diversity. Many consider the negative effects posed by invasive species to be of national and global significance, whose negative consequences are presumably surpassed only by the damage of habitat, the damage of hydrogeomorphic processes that create and maintain habitats, and the physical harvesting of keystone and/or critical populations for short term economic gain (Smiley 1882, Wilson 1991, Kowarik 1995, Vitousek et. al. 1997, Ward 1998, Gido & Brown 1999, Lockwood & McKinney 2000, Blair 2000, Rahel 2000, McKinney 2001, Woodruff 2001, Mooney & Cleland 2001, Lake & Leishman 2004, Leung 2006, Lepriuer et al 2008).

In short, the biota of Earth is in a period of homogenization due to human activities that remove specialized species and opens the ecological door for pioneer/invasive species. In many instances, the addition of one aggressive alien species can displace several that share similar ecological traits. It is estimated that over 50,000 alien species may have been introduced to the United States (Pimentel 2002), which range from well intentioned instances like reed canary grass (*Phalaris aurundinacea*), to well controlled agricultural species such as the corn cultivar (*Zea maize*), to blind accidental events such as the round goby (*Neogobius melanostomus*). Of these, it is roughly estimated that only about 10% become established, with only 10% of the established becoming invasive (Groves 1991). Thus, the more alien species that are introduced to the Great Lakes or Mississippi River basins, the higher the probability that some of them will become invasive (Jeschke & Strayer 2005, Pyšek & Richardson 2006).

In general, to curtail the adverse ecological and cultural effects of invasive and other undesirable species, several actions may be under taken. The following action items were developed by the authors and not only pertain to GLMRIS, but globally as well:

1) Cease or closely control the transportation of live alien species
2) Reduce or reverse physical, chemical and biotic damages caused to natural ecosystem and associated function and structure
3) Eradicate, reduce or otherwise control already established populations of aquatic invasive and other undesirable species

USACE primarily participates in actions 2 & 3, while able to provide valuable scientific information to the first action item. As part of GLMRIS, the present document focuses attention on action item 3, by preventing further dispersal of aquatic invasive species via manmade connections.

Definitions

The scientific and technical literature on non-native species has expanded greatly, resulting in the development of many different terms useful in describing biological invasions. Although some terms are fairly standardized in their meaning or intent, the definition of certain other terms may differ widely depending on particular authors. In order to avoid confusion and to be consistent within GLMRIS, a set of terms and definitions is presented. Additionally, while these definitions are a combination of various sources, this report does not strive to reinvent definitions or to satisfy all interested parties.

"Alien" – same as non-native, although some authors consider an “alien” to be a non-native species that is of foreign origin or “exotic”

"Control" – as appropriate, eradicating, suppressing, reducing, or containing invasive species populations, preventing spread of invasive species from areas where they are present, and taking steps such as restoration of native species and habitats to reduce the effects of invasive species and to prevent further invasions.

"Ecosystem" – a term used first in 1935 by A.G. Tansley to describe a discrete unit that consists of living and non-living parts interacting to form a stable system; unit of organisms that encompass complex interactions between themselves and their environment from the genetic to the community level of organization; ecosystem is a scale dependent term and can be applied to all scales, from a small ephemeral pond, to the Great Lakes, to the whole planet

“Endemic” – a species occurrence restricted to a certain geographic area owing to factors such as geological confinement, climatic conditions, or local physical or chemical conditions, etc

“Established” – an introduced organism with one or more reproducing or breeding populations in their introduce range

“Exotic” – an organism introduced from a foreign country; a species native to an area outside of, or foreign to, the national geographic area under discussion

“Indigenous” – same as native

"Introduction" – the intentional or unintentional movement, escape, release, dissemination, or placement of a species into an ecosystem, where it was not found historically, as a result of human activity

"Invasive" – an alien or native species that can grow quickly, spread rapidly, and dominate an area to the point where native species are displaced, or have taken an area over because native species were eradicated by a previous event

"Native" – a species or taxa found naturally in a particular area or ecosystem; historically occurring in a geographic range previous to the arrival of the first European settlers; a species that is a member of the native natural biological community

“Native range” – the natural geographic area within which a native species can be found or where it historically occurred

“Non-indigenous” – same as non-native

“Non-native” – an individual, group, or population of a species that is introduced into an area or ecosystem outside its historic or native geographic range. In this report, the term includes both foreign (i.e., exotic) and transplanted organisms, and is used synonymously with “alien,” “nonnative” and “introduced.”

“Nuisance” – an invasive species as well as certain native species whose populations have grown to such an extent that they are deemed undesirable

"Species" – a group of individuals able to successfully interbreed within the group and whose members are reproductively isolated, either behaviorally or genetically, from all other groups of organisms. In general, a species is genetically and morphologically distinct from all other species

Study Area

The study area for this report includes the Great Lakes Basin and the entire Mississippi River Basin in terms of assessing the presence and dispersal threat of non-native species. Figure 1 shows the affected area for GLMRIS, which includes the Great Lakes Basin in the United States and the upper Mississippi River Basin upstream of the confluences of the Missouri and Ohio Rivers. Currently, there are several artificial or manmade pathways available or potentially available for invasive aquatic species to either disperse from the Great Lakes to the Mississippi River Basin or vice versa, which are being identified independently of this technical paper. The main conduit of concern is the Chicago Area Waterway System (CAWS), which is a permanent manmade link between Lake Michigan and the upper Illinois River (Figure 2). The natural condition of the Chicago Lake Plain area was to have intermittent connection between the Des Plaines River and the Calumet River to the south and the Chicago River to the north. This naturally sporadic (rain fall dependent) inter-basin nexus made it quite feasible to reverse the flow direction of the Chicago and Calumet Rivers. The Chicago and Calumet Rivers was then made part of the upper Illinois River via the Sanitary & Ship Canal and the Calumet Sag-Channel.

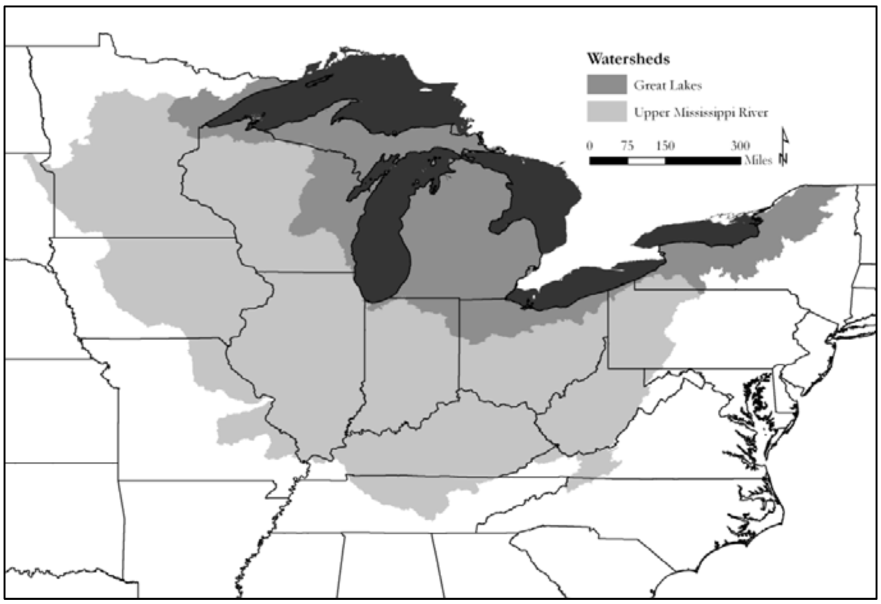

Figure 1 – Detailed Study Area depicting the Great Lakes and Upper Mississippi River basins.

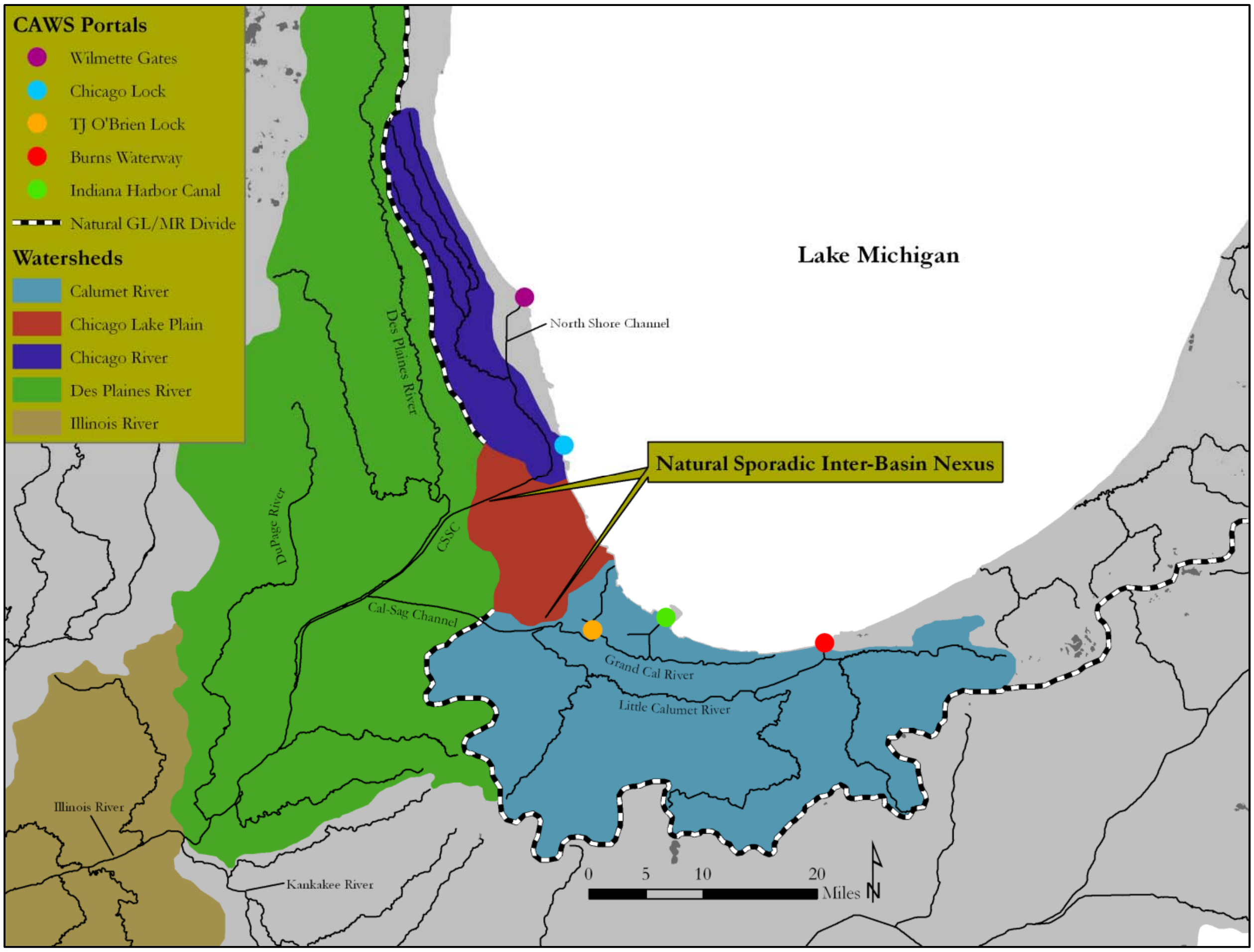

Figure 2 – Map portraying the CAWS, the primary aquatic pathways for non-native species movement and dispersal.

Methods & Results

The GLMRIS goal is to study the range of options and technologies available to prevent the spread of aquatic nuisance species through aquatic pathways. In order to structure this analysis, the authors sought to determine which species have the highest potential for dispersing and becoming invasive. In the course of the study, USACE will use these species to evaluate the efficacy of various prevention options and technologies and then determine whether the option or technology will also prevent the spread of other relevant non-native species between the basins. A sequential approach was employed. This approach consisted of three steps:

1) Identify All Potential Alien Species
2) Identify Potential Impacts & Transport Mechanisms
3) Identify High Risk Invasive Species Pertinent to GLMRIS

This approach provided a consistent and objective process to identifying alien species that are considered invasive, highly mobile, and that are within close proximity to inter-basin dispersal pathways. This approach is keystone for GLMRIS since all subsequent analyses and decisions would be based upon, or correlated to the High Risk Invasive Species. The three steps are described in detail below.

1) Identify All Potential Alien Species: An extensive literature search was initially performed to determine the number and types of aquatic alien species already present in the United States and Canada and that are most likely to be introduced into the Great Lakes and Mississippi River basins. Approximately 625 publications and reports were reviewed, in addition to other sources and personal communications (see Bibliography). A total of 254 alien aquatic species were identified to occur (e.g., there is a recorded instance) in one or both basins or with the threat of infiltrating a given basin (Appendix I). In addition to including taxa that are not native to either of the study area basins, the list also includes certain taxa known to be native to only one of the two basins, but with the potential of becoming introduced to the other. Of the 254 alien species, a total of 103 were found to already have established populations in both basins, and subsequently did not move on to the next step. A total of 87 alien species having the potential to disperse to the Mississippi River watershed were identified within the Great Lakes watershed. A total of 57 alien or native aquatic species were identified within the Mississippi River watershed as having the potential to disperse to the Great Lakes watershed. There are also 7 species that are not recorded from either basin, but are recorded from bordering watersheds poised to enter them in the near future.

2) Identify Potential Impacts & Transport Mechanisms: All the invasive species that can disperse through an aquatic pathway and have the potential to inflict adverse affects on associated ecosystems passed to the next tier. Such dispersal mechanisms, for example, are self propelled swimmers, parasitic to swimmers, floats with current, human induced (ballast water, attached to boat hull), etc.

From the initial list of 254 potential invaders, 135 species were rejected for further analysis for several reasons. There were 103 species already established in both basins that were not of concern for this study since any dispersal control mechanism is already too late. The remaining 31 species were removed from further analysis because they were not yet located in either basin, could bypass any aquatic control mechanism by terrestrial movement, or had no potential to cause adverse effects to the invaded ecosystem. The evaluation of potential to cause adverse effects to an invaded ecosystem was based on scientific literature review and informed professional judgment.

A total of 119 alien and native species were assessed for potential adverse effects to ecosystems and the methods they employ for dispersal. Appendix II details the species' native range, which basin they are established in, historical range expansions, proximity to inter-basin connections, their dispersal pathway, other introductions for situational awareness, documented or potential adverse affects/effects, and the current threat level of dispersing through any inter-basin connection. Appendix II was compiled in order to summarize information for the next step.

3) Identify High Risk Invasive Species: Based on the information gathered on the 119 aquatic invasive species in step two, a final list of High Risk Invasive Species was rendered (Appendix III). To determine High Risk Invasive Species that are pertinent for GLMRIS, informed professional judgment was employed by the Natural Resources Team. To inform the professional judgment, literature review, species

proximity to the CAWS, ecological tolerances and needs, and vagility were considered. A ranking of High/Medium/Low were given based on these reviewed parameters.

In turn, thirty nine (39) species were identified as having a high level of risk for both transferring from one basin to another, and have a high risk in that if they do disperse, the invaded ecosystem type would be moderately to severely affected by their colonization. A fact sheet was developed for each of these high risk invasive species detailing morphological characters useful for identification, including color photographs of the species, and information on their ecology, habitats and distributions, and dispersal status (Appendix III). This list of 39 species will inform USACE's initial assessment of options or technologies to prevent the spread of non-native species. USACE will then further consider whether the particular controls will prevent the spread of all relevant species.

Next Steps

The subsequent steps under the GLMRIS Feasibility Study involve two analyses (Figure 3). The first is to develop a qualitative process that characterizes the affects of a potential dispersal event of the High Risk Species defined in this White Paper. For example, if silver carp were to infiltrate the Great Lakes, adverse effects in terms of geography and ecology would be predicted. The second is to develop an analysis that determines the effectiveness of control features that would thwart or drastically reduce the dispersal of the identified High Risk Invasive species.

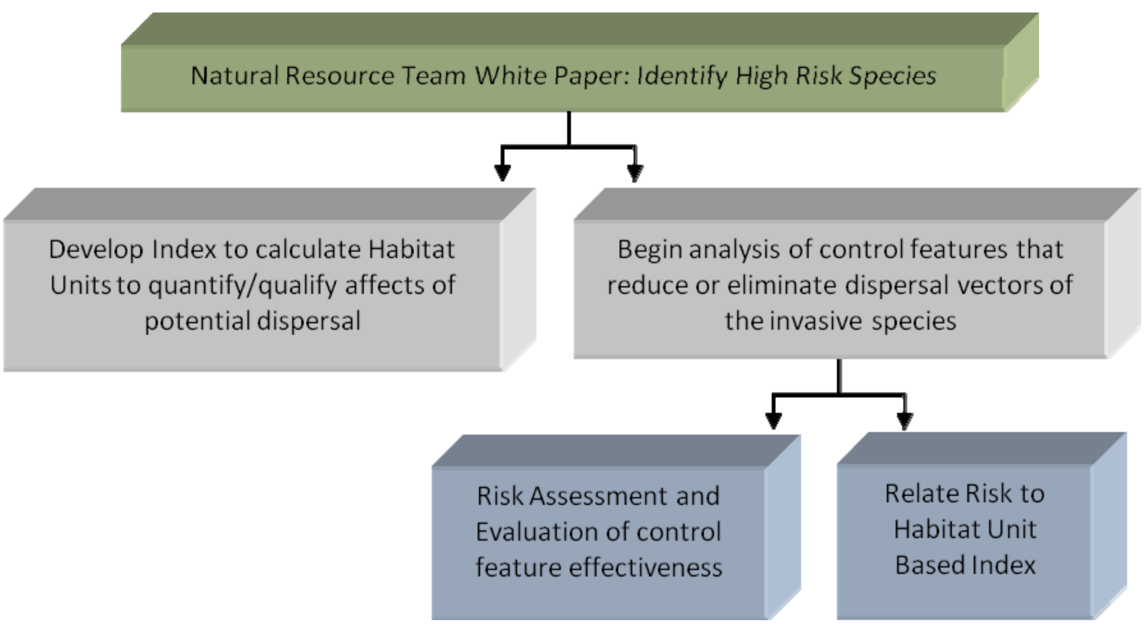

Figure 3 – Flow chart depicting process for determining effects to ecosystems and effectiveness of invasive species controls.

Appendix I - Comprehensive List of Aquatic Alien Species to the Great Lakes and Mississippi River Basins

TAXA	SPECIES NAME	COMMON NAME	NATIVE RANGE	BASIN**
algae	*Actinocyclus normanii fo. subsalsa*	diatom	Unknown	BOTH
algae	*Bangia atropurpurea*	red algae	Unknown	GL
algae	*Chroodactylon ramosum*	red algae	Unknown	GL
algae	*Cyclotella atomus*	diatom	North America, Europe & Asia	GL
algae	*Cyclotella cryptica*	diatom	Unknown	GL
algae	*Cyclotella pseudostelligera*	diatom	Unknown	GL
algae	*Cyclotella woltereki*	diatom	Unknown	GL
algae	*Diatoma ehrenbergii*	diatom	Unknown	GL
algae	*Enteromorpha flexuosa*	green algae	Unknown	GL
algae	*Enteromorpha intestinalis*	green algae	Unknown	GL
algae	*Enteromorpha prolifera*	green algae	Unknown	GL
algae	*Hymenomonas roseola*	coccolithophorid algae	Eurasia	GL
algae	*Nitellopsis obtusa*	green algae	Eurasia	GL
algae	*Skeletonema potamos*	diatom	Europe & Asia	GL
algae	*Skeletonema subsalsum*	diatom	Eurasia	GL
algae	*Sphacelaria fluviatilis*	brown algae	China	GL
algae	*Stephanodiscus binderanus*	diatom	Eurasia	GL
algae	*Stephanodiscus subtilis*	diatom	Eurasia	GL
algae	*Thalassiosira baltica*	diatom	Baltic, Arctic, & Eurasian Seas	GL
algae	*Thalassiosira lacustris*	diatom	Unknown	GL
algae	*Thalassiosira pseudonana*	diatom	Unknown	GL
algae	*Thalassiosira weissflogii*	diatom	Unknown	GL
amphibian	*Eleutherodactylus planirostris*	greenhouse frog	Caribbean	MS*
annelid	*Branchiura sowerbyi*	oligochaete	Unknown	GL
annelid	*Gianius (Phallodrilus) aquaedulcis*	oligochaete	Unknown	GL
annelid	*Potamothrix bedoti*	oligochaete	Ponto-Caspian	GL
annelid	*Potamothrix moldaviensis*	oligochaete	Ponto-Caspian	GL
annelid	*Potamothrix vejdovskyi*	oligochaete	Ponto-Caspian	GL
annelid	*Ripistes parasita*	oligochaete	Europe	GL
arthropod	*Acentropus niveus*	aquatic moth	Europe	GL
arthropod	*Tanysphyrus lemnae*	aquatic weevil	Eurasia	GL
bacteria	*Aeromonas salmonicida*	furunculosis	Unknown	BOTH
bacteria	*Cylindrospermopsis raciborskii*	cyanobacterium	Unknown	BOTH
bacteria	*Piscirickettsia cf. salmonis*	muskie pox	Unknown	GL
bacteria	*Renibacterium salmoninarum*	bacterial kidney disease	Unknown	GL
bryozoan	*Lophopodella carteri*	bryozoan	SE Asia & NE Africa	GL
coelenterate	*Cordylophora caspia*	hydroid	Ponto-Caspian & Black Seas	BOTH
coelenterate	*Craspedacusta sowerbyi*	freshwater jellyfish	Yangtze River, China	BOTH
coelenterate	*Phyllorhiza punctata*	Australian spotted jellyfish	Indo-Pacific Ocean (Australian coast)	MS

*Although in one basin, did not move on due to not utilizing an aquatic pathway

**"Basin" identifies which basin the species has been recorded from. MS = Mississippi River; GL = Great Lakes

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crustacean	*Apocorophium lacustre*	scud	Atlantic Slope	MS
crustacean	*Argulus japonicus*	parasitic copepod	Asia	BOTH
crustacean	*Bythotrephes longimanus*	spiny water flea	Eurasia	GL
crustacean	*Cercopagis pengoi*	fish-hook waterflea	Ponto-Caspian	GL
crustacean	*Corophium mucronatum*	amphipod	Black & Caspian Seas	GL
crustacean	*Daphnia galeata galeata*	waterflea	Africa, Europe & Asia	GL
crustacean	*Daphnia lumholtzi*	waterflea	Eastern Africa, Eastern Australia & India	BOTH
crustacean	*Echinogammarus ischnus*	amphipod	Black & Caspian Seas	GL
crustacean	*Eubosmina coregoni*	waterflea	Europe	GL
crustacean	*Eubosmina maritima*	waterflea	Baltic & Barents Seas	GL
crustacean	*Eurytemora affinis*	calanoid copepod	Atlantic Ocean Coasts & Asia	BOTH
crustacean	*Hemimysis anomala*	bloody red shrimp	Black & Azov Seas	GL
crustacean	*Megacyclops viridis*	cyclopoid copepod	Europe	GL
crustacean	*Neoergasilus japonicus*	copepod	Asia	GL
crustacean	*Nitokra hibernica*	harpacticoid copepod	Eurasia	GL
crustacean	*Nitokra incerta*	harpacticoid copepod	Black & Caspian Seas	GL
crustacean	*Orconectes hylas*	woodland crayfish	Missouri	MS*
crustacean	*Orconectes rusticus*	rusty crayfish	Ohio River Basin	BOTH
crustacean	*Procambarus clarkii*	red swamp crayfish	Mississippi River Basin	BOTH
crustacean	*Salmincola lotae*	copepod	Eurasia	GL
crustacean	*Schizopera borutzkyi*	harpacticoid copepod	Black Sea	GL
crustacean	*Skistodiaptomus pallidus*	calanoid copepod	Mississippi River Basin	MS
fish	*Alosa aestivalis*	blueback herring	Atlantic Slope	GL
fish	*Alosa chrysochloris*	skipjack herring	Mississippi River Basin/Gulf Slope	MS
fish	*Alosa pseudoharengus*	alewife	Atlantic Slope	GL
fish	*Ameiurus catus*	white catfish	Atlantic & Gulf Slopes	BOTH
fish	*Apeltes quadracus*	fourspine stickleback	Atlantic Slope	GL
fish	*Carassius auratus*	goldfish	Asia	BOTH
fish	*Carassius carassius*	crucian carp	Asia	MS
fish	*Channa argus*	northern snakehead	Asia	MS
fish	*Channa marulius*	great snakehead	Asia	MS
fish	*Cichlasoma nigrofasciatum*	convict cichlid	Central & South America	MS
fish	*Cichlasoma octofasciatum*	Jack Dempsey	Central America & Mexico	MS
fish	*Ctenopharyngodon idella*	grass carp	Asia	BOTH
fish	*Cyprinus carpio*	common carp	Asia	BOTH
fish	*Dorosoma petenense*	threadfin shad	Mississippi River Basin/Atlantic & Gulf Slopes	MS
fish	*Enneacanthus gloriosus*	bluespotted sunfish	Atlantic & Gulf Slopes	GL
fish	*Gambusia affinis*	western mosquitofish	Mississippi River Basin/Atlantic & Gulf Slopes	BOTH
fish	*Gasterosteus aculeatus*	threespine stickleback	Northern Pacific, Atlantic & Arctic Oceans	GL

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fish	*Gymnocephalus cernuus*	Eurasian ruffe	Eurasia	GL
fish	*Hypophthalmichthys molitrix*	silver carp	Asia	MS
fish	*Hypophthalmichthys nobilis*	bighead carp	Asia	MS
fish	*Ictalurus furcatus*	blue catfish	Mississippi River Basin / Rio Grande	MS
fish	*Lepisosteus platostomus*	shortnose gar	Mississippi River Basin	BOTH
fish	*Lepomis auritus*	redbreast sunfish	Atlantic & Gulf Slopes	MS
fish	*Lepomis microlophus*	redear sunfish	Mississippi River Basin/Atlantic & Gulf Slopes	BOTH
fish	*Menidia beryllina*	inland silverside	Miss. River Basin/Atlantic & Gulf Slopes, Mexico	MS
fish	*Misgurnus anguillicaudatus*	Oriental weatherfish	Asia	BOTH
fish	*Morone americana*	white perch	Atlantic Slope	BOTH
fish	*Morone saxatilis*	striped bass	Atlantic Slope & Gulf Slopes	BOTH
fish	*Mylopharyngodon piceus*	black carp	Asia	MS
fish	*Neogobius melanostomus*	round goby	Europe	BOTH
fish	*Notropis buchanani*	ghost shiner	Mississippi River Basin/ Gulf Slope	BOTH
fish	*Noturus insignis*	margined madtom	Atlantic Slope	GL
fish	*Oncorhynchus gorbuscha*	pink salmon	Pacific Slope, Arctic Drainage	GL
fish	*Oncorhynchus kisutch*	coho salmon	Pacific Slope, Arctic Drainage	GL
fish	*Oncorhynchus mykiss*	rainbow trout	Pacific Slope	BOTH
fish	*Oncorhynchus nerka*	kokanee (Land-locked Sockeye)	Pacific Slope, Arctic Drainage	GL
fish	*Oncorhynchus tshawytscha*	Chinook salmon	Pacific Slope, Arctic Drainage	GL
fish	*Oreochromis niloticus*	Nile tilapia	Africa	MS
fish	*Osmerus mordax*	rainbow smelt	Arctic, Atlantic, Pacific Drainages	BOTH
fish	*Petromyzon marinus*	sea lamprey	Northern Atlantic & Mediterranean Sea	GL
fish	*Phenacobius mirabilis*	suckermouth minnow	Mississippi River Basin/ Gulf Slope	BOTH
fish	*Poecilia mexicana*	shortfin molly	Mexico	MS
fish	*Poecilia sphenops*	Mexican molly	Central & South America	NR*
fish	*Proterorhinus semilunaris*	tubenose goby	Europe	GL
fish	*Pterygoplichthys disjunctivus*	vermiculated sailfin catfish	South America	MS
fish	*Pterygoplichthys pardalis*	Amazon sailfin catfish	South America	MS
fish	*Salmo salar*	Atlantic salmon	Atlantic Slope	GL
fish	*Salmo trutta*	brown trout	Europe	BOTH
fish	*Sander lucioperca*	zander	Europe	MS
fish	*Scardinius erythrophthalmus*	rudd	Europe	BOTH
fish	*Tinca tinca*	tench	Eurasia	MS
fish	*Xiphophorus hellerii*	green swordtail	Central America & Mexico	MS
fish	*Xiphophorus maculatus*	southern platyfish	Mexico & South America	MS
mammal	*Myocastor coypus*	nutria	South America	MS*
mollusk	*Bithynia tentaculata*	faucet snail	Europe	BOTH
mollusk	*Cipangopaludina chinensis malleata*	Oriental mystery snail	Asia	BOTH

*Although in one basin, did not move on due to not utilizing an aquatic pathway

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mollusk	*Cipangopaludina japonica*	Oriental mystery snail	Asia	BOTH
mollusk	*Corbicula fluminea*	Asiatic clam	Asia	BOTH
mollusk	*Dreissena polymorpha*	zebra mussel	Ponto-Caspian	BOTH
mollusk	*Dreissena rostriformis bugensis*	quagga mussel	Ponto-Caspian	BOTH
mollusk	*Gillia altilis*	snail	Atlantic Slope	GL
mollusk	*Melanoides tuberculatus*	red-rim melania	Africa & Asia	MS
mollusk	*Pisidium amnicum*	greater European pea clam	Eurasia & Africa	GL
mollusk	*Pisidium henslowanum*	Henslow peaclam	Eurasia	GL
mollusk	*Pisidium moitessierianum*	pygmy peaclam	Eurasia	GL
mollusk	*Pisidium supinum*	humpbacked peaclam	Unknown	GL
mollusk	*Pomacea insularum*	island applesnail	South America	MS
mollusk	*Potamopyrgus antipodarum*	New Zealand mud snail	New Zealand	BOTH
mollusk	*Radix auricularia*	European ear snail	Europe & Asia	GL
mollusk	*Sphaerium corneum*	fingernail clam	Eurasia	GL
mollusk	*Valvata piscinalis*	European valve snail	Europe & Asia	GL
mollusk	*Viviparus georgianus*	banded mystery snail	Mississippi River Basin	BOTH
plant	*Aeschynomene fluitans*	large sensistive plant	South Africa	MS*
plant	*Agrostis gigantea*	redtop	Eurasia	BOTH
plant	*Alnus glutinosa*	black alder	Europe, North Africa & Asia	BOTH
plant	*Alopecurus geniculatus*	water foxtail	Eastern Europe	BOTH
plant	*Alternanthera philoxeroides*	alligatorweed	South America	MS*
plant	*Alternanthera sessilis*	sessile joyweed	Asia - Tropics	MS*
plant	*Bacopa egensis*	Brazilian waterhyssop	South America	MS
plant	*Blyxa aubertii*	roundfruit blyxa	Asia	MS*
plant	*Butomus umbellatus*	flowering rush	Eurasia	BOTH
plant	*Cabomba caroliniana*	cabomba	South America	BOTH
plant	*Callitriche stagnalis*	pond waterstarwort	Mediterranean	BOTH
plant	*Carex acutiformis*	swamp sedge	Eurasia & Northern Africa	GL
plant	*Carex disticha*	sedge	Eurasia	GL
plant	*Carex flacca*	sedge	Europe	GL*
plant	*Chenopodium glaucum*	oak leaved goose foot	Eurasia	BOTH
plant	*Cirsium palustre*	marsh thistle	Europe	BOTH
plant	*Colocasia esculenta*	wild taro	Africa	MS*
plant	*Conium maculatum*	poison hemlock	Europe	BOTH
plant	*Crassula helmsii*	swamp stonecrop	Australia & New Zealand	NR
plant	*Cyperus entrerianus*	deeprooted sedge	South America	MS*
plant	*Dioscarea oppositifolia*	Chinese yam	Asia	BOTH
plant	*Dopatrium junceum*	dopatrium	Africa & Asia	MS
plant	*Echinochloa crusgalli*	barnyard grass	Asia	BOTH

*Although in one basin, did not move on due to not utilizing an aquatic pathway

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plant	*Egeria densa*	Brazilian waterweed	South America	BOTH
plant	*Eichhornia crassipes*	water-hyacinth	South America	BOTH
plant	*Epilobium hirsutum*	great hairy willow herb	Eurasia	BOTH
plant	*Epilobium parviflorum*	small flowered hairy willow herb	Great Britain	BOTH
plant	*Frangula alnus*	glossy buckthorn	Europe, North Africa, Asia	BOTH
plant	*Glyceria maxima*	reed sweetgrass	Eurasia	GL
plant	*Hydrilla verticillata*	hydrilla	Europe	MS*
plant	*Hydrocharis morsus-ranae*	European frogbit	Europe & Asia	GL*
plant	*Hygrophila polysperma*	Indian swampweed	India, Malaysia & Bhutan	NB
plant	*Impatiens glandulifera*	Indian balsam	Asia	BOTH
plant	*Ipomoea aquatica*	water spinach	China	NB
plant	*Iris pseudacorus*	yellow flag	Western Asia, North Africa & Western Europe	BOTH
plant	*Juncus compressus*	flattened rush	Eurasia	BOTH
plant	*Juncus inflexus*	rush	Eurasia	BOTH
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	unknown	MS
plant	*Limnophila indica*	Indian marshweed	Asia	NB
plant	*Limnophila sessiliflora*	Asian marshweed	Asia	MS*
plant	*Limnophila x ludoviciana*	marshweed	Mississippi River Basin	MS
plant	*Lotus corniculatus*	birdsfoot trefoil	Europe & Asia	BOTH
plant	*Ludwigia grandiflora spp. grandiflora*	Uruguay waterprimrose	South America	MS*
plant	*Lupinus polyphyllus*	lupine	Pacific Slope	BOTH
plant	*Luziola peruviana*	Peruvian watergrass	South & Central America & West Indies	MS
plant	*Lycopus europaeus*	European water horehound	Eurasia & Asia	BOTH
plant	*Lysimachia nummularia*	moneywort	Europe	BOTH
plant	*Lysimachia vulgaris*	garden loosestrife	Eurasia	BOTH
plant	*Lythrum salicaria*	purple loosestrife	Europe	BOTH
plant	*Marsilea quadrifolia*	European water clover	Europe & Asia	BOTH
plant	*Mentha aquatica*	watermint	Eurasia, Northwest Africa & Southwest Asia	BOTH
plant	*Mentha gracilis*	creeping whorled mint	Eurasia	BOTH
plant	*Mentha spicata*	spearmint	unknown	BOTH
plant	*Microstegium vimineum*	Japanese stilt grass	Asia	BOTH
plant	*Microstegium vimineum*	Japanese stilt grass	Asia	BOTH
plant	*Murdannia keisak*	marsh dewflower	Asia	MS
plant	*Myosotis scorpioides*	true forget-me-not	Europe & Asia	BOTH
plant	*Myosoton aquaticum*	giant chickweed	Eurasia	BOTH
plant	*Myriophyllum aquaticum*	parrot feather	Brazil & Argentina	MS*
plant	*Myriophyllum spicatum*	Eurasian water milfoil	Eurasia & Northern Africa	BOTH
plant	*Najas minor*	minor naiad	Asia & Africa	BOTH
plant	*Nasturtium officinale*	water cress	Europe, N Africa, W Asia	BOTH

*Although in one basin, did not move on due to not utilizing an aquatic pathway

**"Basin" identifies which basin the species has been recorded from. MS = Mississippi River; GL = Great Lakes

Appendix I - Comprehensive List of Aquatic Alien Species to the Great Lakes and Mississippi River Basins

TAXA	SPECIES NAME	COMMON NAME	NATIVE RANGE	BASIN**
plant	*Nelumbo nucifera*	sacred lotus	Eurasia	MS*
plant	*Nymphaea lotus*	white Egyptian lotus	Africa	MS
plant	*Nymphoides cristata*	crested floating heart	unknown	NB
plant	*Nymphoides peltata*	yellow floating heart	Europe & Asia	BOTH
plant	*Oryza sativa*	rice	Asia	MS*
plant	*Oxycaryum cubense*	Cuban bulrush	Mississippi River Basin	MS
plant	*Panicum repens*	torpedo grass	Eurasia & Africa	MS
plant	*Phalaris arundinaceae*	reed canary grass	Eurasia	BOTH
plant	*Phrgamites australis*	common reed	Mediterranean	BOTH
plant	*Pistia stratiotes*	water-lettuce	Africa & South America	BOTH
plant	*Poa trivialis*	rough-stalked meadow grass	Africa, Western Asia & Europe	BOTH
plant	*Polygonum caespitosum var. longisetum*	bristly lady's thumb	Eastern Asia	BOTH
plant	*Polygonum cuspidatum*	Japanese knotweed	Asia	BOTH
plant	*Polygonum perfoliatum*	mile-a-minute weed	Asia	MS*
plant	*Polygonum persicaria*	lady's thumb	Eastern Asia	BOTH
plant	*Potamogeton crispus*	curlyleaf pondweed	Eurasia & Africa	BOTH
plant	*Puccinellia distans*	weeping alkali grass	Europe, N Africa, W Asia	BOTH
plant	*Ranunculus lingua*	greater spearwort	Europe	NR
plant	*Rhamnus cathartica*	European buckthorn	Eurasia	BOTH
plant	*Rorippa sylvestris*	creeping yellow cress	Europe & Western Asia	BOTH
plant	*Rotala indica*	Indian toothcup	India & SE Asia	MS*
plant	*Rotala rotundifolia*	roundleaf toothcup	unknown	MS*
plant	*Rumex longifolius*	yard dock	Eurasia & Asia	BOTH
plant	*Rumex obtusifolius*	bitter dock	Europe	BOTH
plant	*Sagittaria guayanensis*	Guyanese arrowhead	Africa & SE Asia	MS
plant	*Sagittaria montevidensis*	giant arrowhead	Unknown	MS*
plant	*Salix alba*	white willow	Europe, Northern Africa & Central Asia	BOTH
plant	*Salix fragilis*	crack willow	Europe & Western Asia	BOTH
plant	*Salix purpurea*	purple willow	Europe, Northern Africa, Central Asia & Japan	BOTH
plant	*Salvinia minima*	water spangles	South America & Mexico	MS*
plant	*Salvinia molesta*	giant salvinia	South America	MS*
plant	*Solanum dulcamara*	bittersweet nightshade	Eurasia	BOTH
plant	*Sonchus arvensis*	field sow thistle	Eurasia	BOTH
plant	*Sonchus arvensis uliginosus*	smooth field sow thistle	Eurasia	BOTH
plant	*Sparganium glomeratum*	bur reed	Eurasia	BOTH
plant	*Trapa natans*	water chesnut	Eurasia & Africa	GL
plant	*Typha angustifolia*	narrow leaved cattail	Eurasia & Northern Africa	BOTH
plant	*Typha X*	hybrid cattails	North America	BOTH
plant	*Veronica beccabunga*	European brookline	Eurasia, Middle East & the Himalayas	BOTH

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Appendix I - Comprehensive List of Aquatic Alien Species to the Great Lakes and Mississippi River Basins

TAXA	SPECIES NAME	COMMON NAME	NATIVE RANGE	BASIN**
platyhelm	*Dactylogyrus amphibothrium*	monogenetic fluke	Unknown	GL
platyhelm	*Dactylogyrus hemiamphibothrium*	monogenetic fluke	Unknown	GL
platyhelm	*Dugesia polychroa*	flatworm	Unknown	GL
platyhelm	*Ichthyocotylurus pileatus*	digenean fluke	Unknown	GL
platyhelm	*Neascus brevicaudatus*	digenean fluke	Unknown	GL
platyhelm	*Scolex pleuronectis*	cestode	Black Sea	GL
platyhelm	*Timoniella*	digenean fluke (trematode)	Unknown	GL
protozoan	*Acineta nitocrae*	suctorian	Unknown	BOTH
protozoan	*Glugea hertwigi*	protozoan	Unknown	GL
protozoan	*Heterosporis*	Microsporidian	Unknown	BOTH
protozoan	*Myxobolus (Myxosoma) cerebralis*	salmon whirling disease	Unknown	BOTH
protozoan	*Psammonobiotus communis*	testate amoeba	Unknown	GL
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	Unknown	GL
protozoan	*Psammonobiotus linearis*	testate amoeba	Unknown	GL
protozoan	*Psammonobiotus sp.*	testate amoeba	Unknown	GL
protozoan	*Sphaeromyxa sevastopoli*	mixosporidian	Unknown	GL
protozoan	*Trypanosoma acerinae*	flagellate	Unknown	BOTH
virus	*Novirhabdovirus spp.*	VHS	unknown	BOTH
virus	*Ranavirus spp.*	largemouth bass virus	Unknown	BOTH
virus	*Rhabdovirus carpio*	SVC spring viraemia of carp	Unknown	BOTH

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**"Basin" identifies which basin the species has been recorded from. MS = Mississippi River; GL = Great Lakes

Appendix II - List of Aquatic Invasive Species with Dispersal Potential

Taxa	Species	Common Name	Native Range	Basin*	Historical Range Expansion	Proximity to Inter-Basin Connections	Transport Mechanisms	Adverse Affects/Effects	Dispersal Threat	Justification
algae	*Bangia atropurpurea*	red algae	Widespread amphi-Atlantic range, which includes the Atlantic coast of North America (Mills et al. 1993; Tittley and Neto 2005)	GL	Lake Erie in 1964 – expanded into Lake Ontario, Michigan and Huron (Kishler and Taft 1970; Lin and Blum 1976; Lin and Blum 1977)	0-75 miles	Ballast/rec. boating	Biofouling organism and also supports less diversity of macroinverts than native species (Edlund et al. 2000; Lowe et al. 1982)	High	Moderately close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid growth and establishment, range expansion compounded by anthropologic hitch hiking, high potential to cause economic and ecological damage
algae	*Chroodactylon ramosum*	red algae	This species is known by many different names and it has been recorded around the world in both marine and freshwater habitats (Guiry and Guiry 2007) . Considered native to Atlantic Coast in North America.	GL	western Lake Erie in 1964 and now also occurs in Lake Ontario, Lake Huron, Lake St. Clair (Mills et al. 1993)	>250 miles	Ballast water	Epiphyte of cladophera, adverse effects are still unknow	Medium	Distant from interbasin connection, tolerant of MS river ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, low to moderate potential to cause economic and ecological damage
algae	*Cyclotella atomus*	diatom	Widespread through marine and freshwater environments of N.A., Europe, and Asia	GL	Recorded for the first time in Lake Michigan 1964; now in Lake Ontario and Lake Erie and their drainages; Lake Huron and Lake Superior	0-75 miles	Ship ballast (Mills et al. 1993)	Low; can tolerate eutrophic, highly disturbed systems and recorded from fresh brackish, and saltwater	Low	Slow rate of growth and establishment, slow rate of range expansion, low potiential to cause economic and ecological damage
algae	*Cyclotella cryptic*	diatom	Unknown	GL	Recorded for first time in Lake Michigan in 1964 and now occurs in Lake Ontario, Lake Huron, Lake Erie, and Sandusky River (Lowe and Kline 1976; Mills et. al. 1993)	0-75 miles	Ship ballast (Mills et al. 1993)	High; ability to suppress growth responses of other species	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, range expansion compounded by anthropologic hitch hiking, high potential to cause economic and ecological damage
algae	*Cyclotella pseudostelligera*	diatom	Unknown; widespread in Europe, Russia, U.S., Africa, and S.A.	GL	Recorded for first time in the 1930s from Lake Michigan and now also occurs in Lake Ontario, Lake Erie, Lake Huron, Lake Superior, and Sandusky River	0-75 miles	Ship ballast (Mills et al. 1993)	High; associated with highly eutrophic systems; may out-compete other species during periods of high light intensit	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, range expansion compounded by anthropologic hitch hiking, high potential to cause economic and ecological damage
algae	*Cyclotella woltereki*	diatom	Unknown; Germany, Hungary, Iraq, Argentina, Poland	GL	First recorded in Lake Michigan 1964 (Stoermer and Yang 1969; Mills et al. 1993)	0-75 miles	Ship ballast (Mill et al. 1993)	Low; unknown	Low	Slow rate of range expantion, low potential to cause economic and ecological damage
algae	*Diatoma ehrenbergii*	diatom	Unknown. Reported worldwide from Antarctica to France (Kawecka and Olech 1998; Eulin and Le Cohu 1998)	GL	Lake Michigan in 1930s and Lake Huron in later years (Stoermer and Yang 1969)	0-75 miles	Ballast water	Impact unknown, populations low	Low	Slow rate of growth and establishment, slow rate of range expansion, low potiential to cause economic and ecological damage
algae	*Enteromorpha flexuosa*	green algae	Unknown. Reported worldwide.	GL	Lake Michigan drainage in Lake Muskegon and Muskegon River (Lougheed and Stevenson 2004)	75-125 miles	Ballast water/rec boating	Nutrient rich areas can cause fouling blooms and outcompete native spp. (Lougheed and Stevenson 2004)	High	Moderately close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid growth and establishment, range expansion compounded by anthropologic hitch hiking, high potential to cause economic and ecological damage
algae	*Enteromorpha intestinalis*	green algae	diverse range of habitats around the world (Cummins et al. 2004) Atlantic coast of N. America (Mills et al. 1993)	GL	1926 Wolf Creek, Lake Ontario drainage (Muenscher 1927) ; 1951 Portage River, Lake Erie drainage (Taft 1964) ; 1979 Detroit River, Lake Erie/St. Claire drainage (Catling and McKay 1980)	75-125 miles	Accidental human release, possible aquarium spill	Forms algal blooms that may lead to anoxic conditions (Vadas and Beal 1987)	Medium	Moderately close proximity to interbasin connection, tolerant of MS river ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, moderate potential to cause economic and ecological damage
algae	*Enteromorpha prolifera*	green algae	Mainly marine species known in N. America coasts and inland salt lakes in the West (Catling and McKay 1980; Mills et al. 1993)	GL	First recorded 1979 near salt production plant in Lake Ontario drainage (Catling and McKay 1980)	>250 miles	Unknown	Dense mats may form over sand flats and reduce species richness (Bolam et al. 2000)	Low	Distant from interbasin connection, intolerant of MS river ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, moderate potential to cause economic and ecological damage
algae	*Hymenomonas roseola*	coccolithophoric	Eurasia	GL	First record from Lake Huron in 1975	>250 miles	Ship ballast (Mills et al. 1993)	Low; last record in 1975; can reach high densities in eutrophic waters; found in the littoral zone of lake	Low	Distant from interbasin connection, intolerant of MS river ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, low potential to cause economic and ecological damage
algae	*Nitellopsis obtusa*	starry stonewart/green algae	Eurasia (west coast of Europe to Japan)	GL	Discovered in St. Lawrence River in 1978; reported from St. Clair River in 1983	75-125 miles	Ship ballast (Schloesser et al. 1986, Mills et al. 1993)	High; prefers deeper habitats with low light transmittance; favored by benthic fish in native range; was 9th most common plant in St. Clair Detroit River system when reported in 1983	Medium	Moderately close proximity to interbasin connection, tolerant of MS river ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, high potential to cause economic and ecological damage , only reported from a few isolated areas
algae	*Skeletonema potamos*	diatom	Widespread; known from parts of Europe and N.A. river	GL	First collected from Lake Erie in 1963; recorded from Lake Ontario, Lake Huron, and Lake Superior	75-125 miles	Ship ballast	Low; abundant in eutrophic waters and may co-occur with species of blue-green algae	Low	Moderately close proximity to interbasin connection, slow rate of growth and establishment, low potential to cause economic and ecological damage
algae	*Skeletonema subsalsum*	diatom	Eurasian water bodies including Baltic Sea, Caspian Sea, northern Germany, Sweden, Finland, and Sea of Azov	GL	First recorded from Lake Erie in 1973; subsequently recorded in Lake Ontario, Lake Michigan, and Lake Huron	0-75 miles	Ship ballast (Mills et al. 1993)	Low; brackish water species oftenassociated with eutrophic conditions; particularly known to occur during periods of elevated water temps. In the G	Low	Moderate rate of growth and establishment, partially intolerant of MS river ecological conditions, low potential to cause economic an ecological damage
algae	*Sphacelaria fluviatilis*	brown algae	Unclear; originally recorded from western Chin	GL	First recorded from Gull Lake, MI in 1975 which is part of the Lake Michigan watershed (Mills et al. 1993)	125-250 miles	Aquarium release	Low; typically unable to grow in freshwater (usually restricted to marine systems only)	Low	Reported from land locked lake in GL basin, intolerant of MS river ecological conditions, slow rate of growth and establishment, low potential to cause economic and ecological damage
algae	*Stephanodiscus binderanus*	diatom	Baltic Sea; Eurasia	GL	First recorded from Lake Michigan in 1938; recorded from Lake Erie and Ontario around 1940's to 1950's; occurs in Lake Huron and Cuyahoga River	0-75 miles	Ship ballast (Mills et al. 1993)	High; reaches high abundance in eutrophic conditions; may compete and have caused the extirpation of 4 native Cyclotella spp. in Lake Ontario; can clog short run filters and negatively impact the taste and smell of drinking wat	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, high potential to cause economic and ecological damage
algae	*Stephanodiscus subtilis*	diatom	Eurasia	GL	Recorded for first time from Lake Michigan in 1946; Lake Ontario 1972; recorded from Lake Erie and Huron (1975 and 1993 respectively)	0-75 miles	Ship ballast (Mills et al. 1993)	Low; occurs in eutrophic and chloride contaminated systems; abundance in Lake Michigan was high in the 1960's	Low	Rate of establishment and population growth is declining, low potential to cause economic and ecological damage
algae	*Thalassiosira baltica*	diatom	Baltic Sea, Arctic seas, Eurasian seas, coastal Europe	GL	First recorded from Lake Ontario in 1988; recorded in Lake Erie and Lake Superior since then	75-125 miles	Ship ballast	Medium; may have caused local extirpation of Stephanodiscus niagarae from Lake Ontario	Medium	Moderately close proximity to interbasin connection, tolerant of MS river ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, moderate potential to cause economic and ecological damage
algae	*Thalassiosira lacustris*	diatom	Unknown but widespread	GL	First recorded from Lake Erie in 1970's	75-125 miles	Ship ballast (Mills et al. 1993)	Low; unknown	Low	Moderately close proximity to interbasin connection, slow rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, low potential to cause economic and ecological damage

*identifies which basin, Mississippi (MS) or Great Lakes (GL) that the species is known to be established in

Appendix II - List of Aquatic Invasive Species with Dispersal Potential

Taxa	Species	Common Name	Native Range	Basin*	Historical Range Expansion	Proximity to Inter-Basin Connections	Transport Mechanisms	Adverse Affects/Effects	Dispersal Threat	Justification
algae	*Thalassiosira pseudonana*	diatom	Europe, Russia, N.A.	GL	Recorded for the first time from Lake Erie in 1973; later recorded from Lake Michigan, Lake Ontario, Lake Erie, and the Sandusky R	0-75 miles	Ship ballast (Mills et al. 1993)	Medium; associated with polluted regions, high nutrient concentration, high chemical oxygen demand, and red tides; non-toxi	Medium	Close proximity to interbasin connection, moderately tollerant of MS river ecological conditions, range expansion compounded by anthropologic hitch hiking, moderate potential to cause ecological and economic damage
algae	*Thalassiosira weissflogii*	diatom	Unknown, widespread (Eurasian coastal waters and inland waters of N.A., S.A., and Eurasia)	GL	First recorded in 1962 from the Detroit River (connects to Lake St. Clair and Lake Erie) ; recorded from Lake Michigan 1967, Lake Erie 1970s, Portage River 1973, and Lake Ontaric	0-75 miles	Ship ballast (Mills et al. 1993)	Low; associated with red tides, but non-toxic	Low	Moderately tollerant of MS river ecological conditions, range expansion compounded by anthropologic hitch hiking, low potential to cause ecological and economic damage
arthropod	*Acentropus niveus*	aquatic moth	Widespread; Europe (Pennak 1978; Johnson and Blossey 2002)	GL	Recorded for first time in GL basin in 1938 on the Oswego River (flows into Lake Ontario, NY) (Forbes 1938) ; also collected in Lake Erie and its drainage (Judd 1947; Judd 1950)	75-125 miles	Accidentally introduced along with European plants (Mills et al. 1993)	Low, prefers grazing on M. spicatum (Eurasian watermilfoil)	Low	Moderately close proximity to interbasin connection, slow rate of growth and establishment, low potential to cause economic and ecological damage
arthropod	*Tanysphyrus lemnae*	aquatic weevil	Eurasia	GL	First recorded from Cayuga Lake (NY) , part of the Lake Ontario drainage, in 1934; subsequently known from large area in Lake Ontario and Lake Michigan watersheds	0-75 miles	Unknown	Low; a herbivorous shredder of floating hydrophytes; often associated with duckweeds (Lemna spp.) and duckmeats (Spirodela spp.) ; in FL associated with exotic water lettuce (Pistia stratiotes)	Low	Slow rate of growth and establishment, low potential to cause economic and ecological damage
bacteria	*Piscirickettsia cf. salmonis*	Muskie pox	Unknown. The geographic range of P. salmonis could be broad. It could be native to marine environments, including parts of the Pacific and Atlantic oceans; however, some of the marine regions i which it now occurs could constitute introductions (Fryer and Hedrick 2003) .	GL	P. cf. salmonis was discovered for the first time in muskellunge in Lake St. Clair in May 2002 (Michigan DNR 2007)	Unknown	As for many diseases that naturally occur in the wild, P. salmonis infection becomes more severe in crowded aquaculture settings.	To date there are no significant negative impacts to the muskellunge fishery (Michigan DNR 2007) .	Medium	May spread through connection with host species, slow rate of range expansion, moderate potential to cause economic and ecological damage
bacteria	*Renibacterium salmoninarum*	bacterial kidney disease	Unknown. Worldwide distribution in Northern Hemisphere. First reported from Atlantic Salmon in Scotland	GL	Introduced in stocking efforts of Salmonid species for sport fishing purposes.	75-125 miles	As for many diseases that naturally occur in the wild, P. salmonis infection becomes more severe in crowded aquaculture settings.	Low, this bacteria has a short life span in freshwater and is more likely to be a significant factor in aquaculture and fish hatchery settings. Also, mainly restricted to introduced salmonids	Low	Moderately distant to interbasin connections, slow rate of spread and short lifespan in freshwater, low potential to cause ecological damage
bryozoans	*Lophopodella carteri*	bryozoans	SE Asia, Bombay and NE Africa	GL	Lake Michigan and Lake Erie.	0-75 miles	Can be transported with aquatic plants.	The ecological impact of L. carteri has not yet been thoroughly investigated. I body fluids are toxic to fish and salamanders. In some areas of the Great Lake and St. Lawrence River, L. carteri competes with zebra mussels for substrate and prevents settlement of mussel larvae. Bryozoans, in general, can easily become an economic nuisance due to their encrusting colonies. L. carteri colonies inhibit zebra mussels (Dreissena polymorpha) from settling. L. carteri also readily forms colonies on mollusk shells, against which zebra mussels appear to have no defense. There are three ways in which L. carteri could prevent recruitment of D. polmorpha: 1. There is a current produced by bryozoans lophophore cilia (used for food selection, waste rejection) that may physically prevent D. polymorpha larvae from settling. 2. The cover produced by L. carteri colonies may cause D. polymorpha larvae to seek alternate substrates. 3. The coelomic fluid of L. carteri is known to kill fish and salamanders by damaging gill tissue, and this fluid may also have a detrimenta effect on D. polymorpha larvae	High	Close proximity to interbasin connections, range expansion compounded by anthropologic hitch hiking, toxic, high potential to cause economic and ecological damage
coelenterate	*Phyllorhiza punctata*	Australian spotted jellyfish	Indo-Pacific Ocean; wide distribution along Australian coast	MS	First occurrence in U.S. from CA in 1981; collected from the Gulf Mexico in 1993 near LA; thousands have invaded coastal waters of AL, MS, and LA during summers	>250 miles	Ship-mediated transport (sessile polyp stage attached to ships or other seagoing infrastructure (e.g. towed oil or gas platforms) (Larson and Arneson 1990; Silveira and Cornelius 2000)	Low; species may be restricted to salt/brackish water and unable to survive in freshwater; in Gulf of Mexico direct economic impact on shrimp fishery (Perr et al. 2000) ; indirect effects include predation on eggs of important forage species and consumption of bivalve larvae	Low	Distant from interbasin connection, intolerant of GL basin ecological conditions, low potential to establish, low potential to cause ecological and economic damage
crustacean	*Apocorophium lacustre*	scud	Atlantic Coast of N. America	MS	Illinois River (USGS 2010) Southern Mississippi River System RM 510-515 (Payne et. Al. 1989) Ohio River (Grigorovich et. Al. 2008)	0-75 miles	Unknown, likely aquatic plant trade or ballast water	May contribute to alteration of food webs and degraded native faunal diversity (Grigorovich et. Al. 2008)	High	Close proximity to interbasin connection, tolerant of GL basin ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic high hiking, high potential to cause ecological damage to native populations
crustacean	*Bythotrephes longimanus*	spiny water flea	Northern Europe and Asia	GL	Lake Huron, Lake Ontario, Lake Erie, Lake Michigan, and Lake Superior. Long Lake of Traverse City, MI. Established in Greenwood Lake and Flour Lake, Minnesota. Allegheny Reservoir, New York	0-75 miles	Introductions common with ship ballast water; eggs can also rest in mud and be transported.	Caused major changes in the zooplankton community structure; invasion history; reproduce rapidly; competes directly with small fish and can have impact on zooplankton community. The tail spines of Bythotrephes hook on fishing lines, fouling fishing gear. Bythotrephes consume small zooplankton such as small cladocerans, copepods, and rotifers, competing directly with planktivorous larval fish for food. Bythotrephes have been implicated as a factor in the decline of alewife (Alosa pseudoharengus) in Lakes Ontario, Erie, Huron, and Michigan. Bythotrephes also compete with, and possibly pre on, Leptodora kindtii and may be a causal factor in the decline of Leptodora. Bythotrephes and Leptodora abundances are often negatively correlated . There is speculation that Bythotrephes may control the abundance of Cercopagis pengoi though competition and predation. Bythotrephes are a food source for fish including yellow perch, white perch, walleye, white bass, alewife, bloater chub, chinook salmon, emerald shiner, spottail shiner, rainbow smelt, lake herring, lake whitefish and deepwater sculpin	High	Close proximity to interbasin connection, tolerant of GL basin ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic hitch hiking, high potential to cause ecological damage to native populations
crustacean	*Cercopagis pengoi*	fish-hook water flea	Black, Caspian, Azov, and Aral seas of Europe and Asia	GL	Lake Huron, Lake Ontario, Lake Erie, Lake Michigan, and Lake Superior.	0-75 miles	Introductions common with ship ballast water and boating	Cercopagis pengoi is a consumer of other zooplankton. As such it competes with other planktivores of the Great Lakes, including the alewife (Alosa pseudoharengus) and rainbow smelt (Osmerus mordax) . Its long spine makes it less palatable to planktivorous fish. For these reasons C. pengoi could have a serious effect on the food supply of planktivores. For example, yearling alewife compete directly with C. pengoi because they are planktivorous, and cannot consume C. pengoi due to the caudal appendage. Once alewife reach their first year they are large enough to handle the caudal appendage. C. pengoi's establishment in Lake Ontario in 1998 corresponded with the lowest alewife populations in twenty years. C. pengoi also fouls fishing gear. The full impact of C. pengoi on the food web has not yet been extensively studied	High	Close proximity to interbasin connection, tolerant of GL basin ecological conditions, moderate rate of growth and establishment, range expansion compounded by anthropologic high hiking, high potential to cause ecological damage to native populations

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crustacean	*Corophium mucronatum*	amphipod	Black and Caspian Seas	GL	Lake St. Clair and littoral waters adjacent to Seaway Island, Ontario, Canada 1997	>250 miles	Unknown	Low, only recorded from Lake St. Clair in MI 199	Low	Distant from interbasin connection, tolerant of MS river ecological conditions, slow rate of growth and establishment, low potential to cause economic and ecological damage
crustacean	*Daphnia galeata galeata*	water flea	Africa, Europe, and Asia	GL	Lake Erie in 1970s or 1980s	125-250 miles	Ship ballast (Taylor and Hebert 1993)	High, able to hybridize with native D. g. mendotae which are more vigorous than parent clones	High	Moderately close proximity to interbasin connection, tolerant of MS river ecological conditions, range expansion compounded by anthropological hitch hiking, moderate potential to cause ecological damage
crustacean	*Echinogammarus ischnus*	amphipod	Black and Caspian Seas	GL	First reported in Detroit River in 1994 (Witt et al. 1997)	0-75 miles	Ship ballast (Witt et al. 1997)	High; carnivorous, has displaced native amphipod (G. fasciatus) from Lake Ontario, Lake Michigan, and Lake Erie watersheds, and expansion may be helped by Dreissena mussels	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, quick rate of range expansion compounded by anthropological hitch hiking, high potential to cause ecological damage
crustacean	*Eubosimina maritima*	water flea	Baltic and Barents seas as well as inland lakes surrounding these drainages	GL	First known occurrence in 1988 from Lake Michigan; recorded from Lake Erie and Lake Huron in early 1990's	0-75 miles	Ship ballast (De Melo and Hebert 1994; Duggan et al. 2005; Gray et al. 2005)	Medium; marine but has adapted to freshwater; most abundant and sometimes dominant species in the GL during winter; produce resting egg	Medium	Close proximity to interbasin connection, tolerant of MS river ecological conditions, moderate rate of range expansion compounded by anthropological hitch hiking, moderate potential to cause ecological damage
crustacean	*Eubosmina coregoni*	water flea	Europe	GL	First known occurrence in Lake Michigan (1966) ; established in all GL by 1980s; present in many inland lakes by 1990	0-75 miles	Ship ballast (Mills et al. 1993)	Medium; selects specific phytoplankton in the water column; tolerant of eutrophic conditions and presence of cyanobacteria than many larger Daphnia spp. ; one of the dominant zooplankton species in the GL; introduction of B. longimanus has reduced numbers	Medium	Close proximity to interbasin connection, tolerant of MS river ecological conditions, moderate rate of range expansion compounded by anthropological hitch hiking, moderate potential to cause ecological damage
crustacean	*Hemimysis anomala*	bloody red shrimp	Freshwater areas of the Black and Azov Seas; historical occurrences in the lower reaches of the Don, Danube, Dneiper, and Dneister Rivers	GL	Reported for first time in 2006 from Lake Ontario and channel connecting Muskegon Lake to Lake Michigan	75-125 miles	Ship ballast	High; could become abundant in G Lareas devoid of mysids; may reduce zooplankton biomass and diversity in GL as seen in some European reservoirs (cladocerans, rotifers, andostracods most affected) ; may reduce phytoplankton biomass as wel	High	Moderately close proximity to interbasin connection, tolerant of MS river ecological conditions, range expantion compounded by anthropological hitch hiking, rapid growth and establishment, high potential to cause economic and ecological damage
crustacean	*Megacyclops viridis*	cyclopoid copepod	Europe	GL	Recorded from Lake Superior around 1994 and Canard River drainage in Lake Erie basin	125-250 miles	Ship ballast (Hudson et al. 1996)	Medium; Preys on zooplankton and may be an effective control agent for mosquito larvae; host to many parasites in native regio	Medium	Moderately distant from interbasin connection, tolerant of MS river ecological conditions, range expansion compounded by anthropological hitch hiking, moderate potential to cause ecological damage
crustacean	*Neoergasilus japonicas*	copepod	Eastern Asia	GL	Recorded for first time in 1994 Lake Huron; has been found in Salt River drainage in CO	>250 miles	Unknown; likely fish culture (Hudson Bowen 2002)	High; ovigerous females attach to fins of fish (multiple hosts can be had) ; moved across Europe in 20 years; associated with aquacultur	High	Rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
crustacean	*Nitokra hibernica*	harpacticoid copepod	Eurasia (Black and Caspian Seas, European coasts of the Atlantic, Arctic, and Baltic Seas)	GL	Recorded on Lake Ontario in 1973; recorded from Lake Michigan, Erie, and Huron; recorded from southern Lake Michigan in 2001 but not in 2002	0-75 miles	Ship ballast (Duggan et al. 2005)	Low; associated with macrophyte beds and can be found in nearshore zones of large rivers and lakes; sometimes occurs at intakes and outflows of power stations	Low	Slow rate of expansion, low potential to cause economic or ecological damage
crustacean	*Nitokra incerta*	harpacticoid copepod	Black and Caspian Seas; Jordan River basin, southwest Asia, Italy	GL	Reported for first time in 1999 from Detroit River when it joins Lake Erie	75-125 miles	Ship ballast (Duggan et al. 2005)	Low; unknown	Low	Moderately close proximity to interbasin connection, tolerant of MS river ecological conditions, slow rate of expansion, low potential to cause economic or ecological damage
crustacean	*Salmincola lotae*	copepod	Eurasia (Sweden, Finland, northern Russia)	GL	Recorded from Apostle Islands region of Lake Superior in 1985 (Lasee et al. 1988)	75-125 miles	Unknown	Medium; burbot parasite; feeds on mucous and epithelial cells (shreds the host's epidermis)	Medium	Moderately distant from interbasin connection, tolerant of MS river ecological conditions, range expansion linked to host range, moderate potential to cause ecological and economic damage
crustacean	*Schizopera borutzkyi*	harpacticoid copepod	Black Sea basin	GL	First recorded from Lake Michigan in 1998; later discovered in Lake Erie in 2003	0-75 miles	Ship ballast	High; alters composition of nearshore communities; may be successful in competing with native species for similar resources or exploit unused resources	High	Rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
crustacean	*Skistodiaptomus pallidus*	calanoid copepod	North central, northeast, and southern U.S. in MS River basi	MS	First recorded from Lake Ontario in 1967; recorded from Lake Erie, Lake St. Clair, Lake Huron, and Saginaw River in 1970'	0-75 miles	Bait buckets, fishing equipment, recreational boaters, and hatchery stock	Low; population densities have been known to reach 10,000 individuals /m2 in Lake Erie coastal marsh; no recent records of this species (since 1970's) ; can selectively and intensely prey on some rotifer specie	Low	Already established in both GL and MS basins
fish	*Alosa aestivalis*	blueback herring	Atlantic Coast from Cape Breton, Nova Scotia, to the St. Johns River, Florida (Page and Burr 1991)	GL	Lake Ontario in 1995 (Owens et al. 1998)	>250 miles	Stocking and using man-made canals	Could impede recovery of depressed populations of indigenous fishes such as cisco and Lake trout (Owens et al. 1998)	High	Rapid rate of dispersal and range expansion with westward expansion from Lake Ontario in recent years, moderate potential to cause ecological and economic damage , considered alien to both GL and MS, tolerant of MS river ecological conditions
fish	*Alosa chrysochloris*	skipjack herring	Red River drainage (Hudson Bay Basin) and Mississippi River basin from Central Minnesota south to Gulf of Mexico, and from Southwest Pennsylvania west to eastern South Dakota, Nebraska, Kansas, Oklahoma and Texas; Gulf Slope drainages from Apalachicola River, Florida, to Colorado River, Texa	MS	Established in MS river basin and only recorded from Lake Michiga	0-75 miles	Natural range expansion	High potential to impede recovery of depressed populations of indigenous fishes	High	Close proximity to interbasin connection, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
fish	*Alosa pseudoharengus*	alewife	Atlantic Coast from Red Bay, Labrador, to South Carolina; (Page and Burr 1991)	GL	Lake Erie in 1931, Lake Huron in 1933, Lake Michigan in 1949, Lake Superior in 1954 (Miller, 1957, Phillips et al. 1982, Emery 1985)	0-75 miles	Erie Canal and Welland Canal	Perceived as reason for loss of native salmonids (Page and Laird 1993, Crowder and Binkowski 1983) , native ciscoes (Crowder 1984) and native chub species (Smith 1970)	High	Close proximity to interbasin connection, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
fish	*Apeltes quadracus*	four spine stickleback	Europe and Atlantic slope drainage of N. America from gulf of St. Lawrence to N. Carolina	GL	Natural range expansion has occurred in PA and this species has also become established where introduced in Thunder Bay, Ontario (Stephenson and Momot, 2000)	125-250 miles	Bait bucket release and shipping ballast water	May displace native stickleback populations in areas of establishmen	Medium	Moderately close to interbasin connection, tolerant of MS river ecological conditions, slow rate of population growth and expansion, moderate potential to cause ecological damage
fish	*Carassius carassius*	crucian carp	Europe and Siberia (Raicu et al. 1981)	MS	Introduced to Chicago area rivers, ponds and lakes in the early 1900s but more recent studies imply that this population has been extirpated from the area (Smith 1979)	0-75 miles	Minimal Aquaculture	Similar to goldfish and common carp. Can hybridize with either species and can cause increased turbidity and decreased aquatic vegetatio	Medium	Close to interbasin connection, tolerant of GL basin ecological conditions, slow rate of population growth and expansion, moderate potential to cause ecological damage
fish	*Channa argus*	northern snakehead	China, Russia and Korea (Courtenay and Williams 2004)	MS	Several areas of introduction have become established including the states of Virginia, Maryland, Pennsylvania and New York. Only one specimen has been confirmed from Lake Michigan with a handful of unconfirmed reports.	0-75 miles	Asian food market	Voracious predator of other fish and will compete for resources with native species	High	Close proximity to interbasin connection, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
fish	*Channa micropeltes*	giant snakehead	Tropical Asia (Roberts 1989)	MS	Species has only been reported from several areas throughout U.S. NO cases of establishment have been identifie	>250 miles	Aquarium trade	Voracious predator of other fish and will compete for resources with native species	Medium	Distant proximity to interbasin connection, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage

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Appendix II - List of Aquatic Invasive Species with Dispersal Potential

Taxa	Species	Common Name	Native Range	Basin*	Historical Range Expansion	Proximity to Inter-Basin Connections	Transport Mechanisms	Adverse Affects/Effects	Dispersal Threat	Justification
fish	*Cichlasoma nigrofasciatum*	convict cichlid	Central America, Costa Rica (Conkel 1993)	MS	Needs warm water habitat to establish, not likely that this species would survive a GL winter	>250 miles	Aquarium trade	Compete with sunfish for spawning habitat (Courtenay and Hensley 1979)	Low	Distant to interbasin connection, intolerant of GL basin ecological conditions, slow rate of population growth and expansion, moderate potential to cause ecological damage
fish	*Cichlasoma octofasciatum*	Jack Dempsey cichlid	Tropical America, Atlantic Slope	MS	Well established in southern Florida(Courtenay et al., 1974)	>250 miles	Aquarium trade	Compete with sunfish for spawning habitat	Low	Distant to interbasin connection, tolerant of GL basin ecological conditions, slow rate of population growth and expansion, moderate potential to cause ecological damage
fish	*Dorosoma petenense*	threadfin shad	Ohio River from IN to MS River basin to the Gulf; Atlantic slope drainages of FL; Gulf drainages to northern Guatemala (Page and Burr 1991)	MS	Natural expansion from its native range through streams and rivers; also moves through estuarine waters along east coast to inhabit new territory (Miller and Jorgenson 1969)	0-75 miles	Forage fish stocking programs	May compete with young centrarchids for resources and may eat planktonic larvae of native minnows and suckers (Dill and Cordone 1997)	Medium	Close proximity to interbasin connections, somewhat intolerant to GL basin ecological conditions, moderate rate of expansion, may cause ecological damage through competition for resources
fish	*Enneacanthus gloriosus*	bluespotted sunfish	Atlantic and Gulf Slope drainages below Fall Line from southern New York to lower Tombigbee River, Alabama, sout to southern Florida; above Fall Line in New York and Pennsylvania (Page and Burr 1991)	GL	Oneida Lake in 1916 (Smith 1985) , Jamesville Reservoir 1951-1966 (Werner 1972) , both in Lake Ontario Drainage	>250 miles	Accidental release and canal use	Unknown	Low	Distant to interbasin connection, tolerant of GL basin ecological conditions, slow rate of population growth and expansion, moderate potential to cause ecological damage
fish	*Gasterosteus aculeatus*	threespine stickleback	Marine and freshwater. Arctic and Atlantic drainages from Baffin Island and western side of Hudson Bay to Cape Fear Estuary, North Carolina; Pacific drainages from Alaska to Baja California. Eastern freshwater populations found far inland, including Lake Ontario. Also in Europe, Iceland, Greenland, and Pacific Coast of Asia (Page and Burr 1991) . In the Great Lakes native only below Niagara Falls (Smith 1985)	GL	Lake Huron in 1982 (Smith 1985) . Species reported as spreading rapidly through the upper Great Lakes (Smith 1985, Burr 1991)	0-75 miles	Nipissing Canal (Smith 1985) Ballast Water (Mandrak and Crossman 1992)	Will prey on eggs of native species (Page and Laird 1993)	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
fish	*Gymnocephalus cernuus*	Eurasian ruffe	Northern Europe and Asia	GL	Established in all Great Lakes	0-75 miles	Ballast water and intra lake transfer via shipping transport	The ruffe has affected fish populations in other areas where introduced. In Scotland, native perch populations declined, and in Russia whitefish numbers have declined because of egg predation by ruffe. Ruffe exhibit rapid growth and high reproductive output, and adapt to a wide range of habitat types; therefore the species may pose a threat to native North American fish. Yellow perch Perca flavescens, emerald shiners Notropis atherinoides, and trout-perch Percopsis omiscomaycus have all declined since the introduction of this fish, although the association is not clear. There is much concern that ruffe may have a detrimental effect on more desirable species in Lake Superior, such as yellow perch and walleye, by feeding on the young of these species, or by competing for food. Competition food between ruffe and yellow perch could occur between the two species but that the outcome would not always be clear Each species exhibited competitive advantages and disadvantages. Introduced ruffe inhabiting the St. Louis estuary. Their findings indicated that the species prey heavily on benthic insects thereby suggesting that ruffe compete for food with yellow perch, trout-perch, and other native benthic-feeding fishes. Similarities in dietary preferences and in feeding rates of ruffe and yellow perch suggest a strong possibility for interspecific competition. Ruffe hold an advantage over native perch in their ability to better select moving objects under relatively dim light conditions or at high turbidity. Ruffe exhibited high consumption rates of benthic invertebrates than yellow perch in darkness over bare cobble and complex substrates. Ruffe have a very sensitive lateral line system and night adapted vision, and are more adapted to foraging under poor light conditions that yellow perch. In a study of ruffe predation by native pike, bass, bullhead, walleye, and perch, ruffe comprised 71-88% of prey species biomass, all five of the selected predators ate ruffe at lower proportions, preferentially selecting native fish species	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
fish	*Hypophthalmichthys molitrix*	Silver carp	Several major Pacific drainages in eastern Asia from the Amur River of far eastern Russia south through much of eastern half of China to Pearl River, possibly including northern Vietnam	MS	First introduced to Arkansas in 1972, bighead carp now occurs in 25 states mostly occupying the Mississippi and Missouri River Basins	0-75 miles	First brought into the US in 1973. Imported and stocked for phytoplankton control in eutrophic water bodies and also a food fish. By the mid 1970s the silver carp was being raised at six state, federal, and private facilities, and by the late 1970s it had been stocked in several municipal sewage lagoons.	Impact of this species difficult to predict because of its place in the food web. In numbers, the silver carp has the potential to cause enormous damage to native species because it feeds on plankton required by larval fish and native mussels. This species would also be a potential competitor with adults of some native fishes, for instance gizzard shad, which also rely on plankton for food. Asian carp (silver and bighead carps) had dietary overlap with gizzard shad and bigmouth buffalo, but not much of one with paddlefish	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
fish	*Hypophthalmichthys nobilis*	Bighead carp	Southern and central China	MS	First introduced to Arkansas in 1972, bighead carp now occurs in 25 states mostly occupying the Mississippi and Missouri River Basins	0-75 miles	Sold in food markets; bait bucket introduction; released as part of cultural practices	The impact of this species in the United States is not adequately known. Because bighead carp are planktivorous and attain a large size, Laird and Page (1996) suggested these carp have the potential to deplete zooplankton populations. As Laird and Page pointed out, a decline in the availability of plankton can lead to reductions in populations of native species that rely on plankton for food, including all larval fishes, some adult fishes, and native mussels. Adult fishes most at risk from such competition in the Mississippi and Missouri rivers are paddlefish Polyodon spathula, bigmouth buffalo Ictiobus cyprinellus, and gizzard shad Dorosoma petenense (Burr et al. 1996; Pflieger 1997; Whitmore 1997; Tucker et al. 1998; Schrank et al. 2003) . A study by Sampson et al. (2008) found that Asian carp (silver and bighead carps) had dietary overlap with gizzard shad and bigmouth buffalo, but not much of one with paddlefish	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
fish	*Ictalurus furcatus*	blue catfish	Mississippi River basin from western Pennsylvania to southern South Dakota and Platte River, southwestern Nebraska, south to Gulf; Gulf Slope from Mobile Bay basin, Alabama, to Rio Grande drainage, Texas and New Mexico. Also Atlantic Slope of Mexico (Page and Burr 1991)	MS	Lake Pepin and Lake St. Croix, Minnesota (Phillips et al. 1982)	75-125 miles	Intentionally stocked for food and sport	Little, may hybridize with native channel catfish	Low	Exist in land locked lakes in GL basin, tolerant of GL basin ecological conditions, slow rate of range expansion, low potential to cause ecological damage

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Appendix II - List of Aquatic Invasive Species with Dispersal Potential

Taxa	Species	Common Name	Native Range	Basin*	Historical Range Expansion	Proximity to Inter-Basin Connections	Transport Mechanisms	Adverse Affects/Effects	Dispersal Threat	Justification
fish	*Lepomis auritus*	redbreast sunfish	Atlantic and Gulf Slope drainages, from New Brunswick to central Florida, and west to the Apalachicola and Choctawhatchee drainages, Georgia and Florida (Page and Burr 1991)	MS	Introduced in lower Mississippi drainages (Etnier and Starnes 1993)	>250 miles	Intentional stocking for sport fishing	May out compete native longear sunfish (Lepomis megalotis) (Etnier and Starnes 1993)	Low	Distant proximity to interbasin connection, tolerant of GL basin ecological conditions, moderate population growth and expansion, low potential to cause ecological damage
fish	*Menidia beryllina*	inland silverside	Eastern North America including Atlantic and Gulf Slopes (mostly near the coast) from Massachusetts to the Rio Grande drainage, Texas and southeastern New Mexico; north from the Mississippi River and major tributaries (mainly Arkansas and Red Rivers) to southern Illinois and eastern Oklahoma (Page and Burr 1991)	MS	1950 in Turtle Lake, Minnesota. Mississippi, Ohio and Kankakee Rivers in Illinois (Laird and Page 1996)	0-75 miles	Stocked as forage fish	May out compete native species	High	Close proximity to interbasin connection, tolerant of GL basin ecological conditions, moderate population growth and expansion, high potential to cause ecological damage by displacing native species
fish	*Mylopharyngodon piceus*	black carp	Pacific drainages of eastern Asia (China and eastern Russia) possibly Red River in Vietnam	MS	Was first introduced in MO River and has since established in the lower MS River.	>250 miles	Aquaculture, food fish, accidental transfer with Grass Carp	Adverse effects to native mussel and snail communities (Nico et. Al. 2005)	High	Tolerant of GL basin ecological conditions, high population growth and expansion, high potential to cause ecological and economic damage
fish	*Noturus insignis*	marginated madtom	Atlantic Slope from Delaware River drainage in New York to upper Altamaha River drainage in Northern Georgia	GL	Recorded from Lake Gogebick within Lake Michigan drainage, Most of invasive range is adjacent to native range indicating natural expansion (Jenkins and Burkhead, 1994)	>250 miles	Unknown	Little to none, may compete with native madtom species for resource	Low	Distant proximity to interbasin connection, tolerant of MS river ecological conditions, moderate rate of population growth, low potential to cause ecological and economic damage
fish	*Oncorhynchus gorbuscha*	pink salmon	Arctic and Pacific drainage basins from NW Territories to Sacramento River drainage, California. Also northeastern Asia	GL	Range expansion throughout GL from accidental release in Lake Superior (Eddy and Underhill 1974; Becker 1983)	0-75 miles	Aquaculture and sport stocking programs	May displace native chub and Lake Herring populations and compete with other salmonids for food resources	Low	Intolerant to MS river ecological conditions, stocking programs have failed
fish	*Oncorhynchus kisutch*	coho salmon	Arctic and Pacific drainages from Point Hope, AK to Monterey Bay, CA (Page and Burr 1991)	GL	Great Lakes stocking programs continue to supplement established populations although natural spawning does occur (Parsons 1973)	0-75 miles	Aquaculture and sport stocking programs	Compete with native Lake Trout (Page and Laird 1993)	Low	Intolerant to MS river ecological conditions, stocking programs have failed
fish	*Oncorhynchus nerka*	kokanee salmon	Arctic and Pacific drainages from Point Hope, AK to Monterey Bay, CA (Page and Burr 1991)	GL	Expansion due to intentional stocking practices which resulted in naturally reproducing populations that dwindled as stocking was suspended, only one population in GL continues to reproduce naturally in upper Lake Huron (Mills 1993)	>250 miles	Aquaculture and sport stocking programs	May compete with brown trout for spawning locations and can adversely affect rainbow trout populations	Low	Distant proximity to interbasin connection, intolerant to MS river ecological conditions, stocking programs have failed
fish	*Oncorhynchus tshawytcha*	Chinook salmon	Arctic and Pacific drainages from Point Hope, AK to Monterey Bay, CA (Page and Burr 1991)	GL	Stocking programs have helped Chinook establish in GL and continued stocking is estimated to comprise only one quarter of the GL populations (Peck 1999)	0-75 miles	Aquaculture and sport stocking programs	Heavy competition with Atlantic Salmon for spawning habitat and causes reduced survival (Scott 2003) Feeds greatly on Alewife populations putting pressure on the fishery (Schriener 1995)	Low	Intolerant to MS river ecological conditions, stocking programs have failed
fish	*Oreochromis niloticus*	Nile tilapia	Tropical and subtropical Africa, Middle East (Trewavas 1983)	MS	Established populations in Southern MS and only reported in CAW	>250 miles	Aquaculture and fish farms	Competition with native spp.	Low	Distant proximity to interbasin connection, intolerant to MS river ecological conditions, moderate potential to cause economic and ecological damage
fish	*Petromyzon marinus*	sea lamprey	Atlantic coast of N. America and landlocked in Lake Ontario (Lake Ontario population is under debate as to whether or not it is native - Smith 1985)	GL	Natural expansion into the GL was facilitated by the Erie and Welland Canals (Emery 1985)	0-75 miles	Natural range expansion when canals were constructed to facilitate navigation from St. Lawrence Sea way to GL	Preys on native fish populations of GL and has been shown to be partially responsible for the decline of many large fish species (Scott and Crossman 1973; Courtenay 1993) Populations have been reduced by 90% since management practices commenced (GLFC 1998)	High	Close proximity to interbasin connection, partially intollerant to MS river ecological conditions, rapid population growth and establishment, high potential to cause economic and ecological damage
fish	*Poecilia Mexicana*	shortfin molly	Atlantic slope from Rio San Juan, Mexico south to Guatamala (Miller 1983)	MS	Locally established in warm climates and has become the most abundant species in Ash Springs, NV (Siglar and Siglar 1987)	>250 miles	Aquarium trade and fish farm escapes	Preys on larval stages of native fish and competes for food with other natives (Scoppettone 1993)	Medium	Distant proximity to interbasin connection, intollerant to GL basin ecological conditions, slow rate of population growth, high potential to cause ecological damage
fish	*Proterorhinus semilunaris*	tubenose goby	Eurasian estuaries of Black and Caspian seas, Sea of Azov, Aegean and Aral Seas (Miller 1986)	GL	Introduced to St. Clair River and has since been reported in Lakes Huron, Erie and Superior but in small quanitiies (Jude 1993; Vanderploeg 2002) Slow rate of expansion	>250 miles	Ballast water from shipping	Compete with Rainbow darters and other natives for food (French and Jude 2001)	High	Range expansion compounded by anthropological hitch hiking, moderate rate of population growth and expansion, high potential to cause ecological damage
fish	*Pterygoplichthys disjunctivus*	vermiculated sailfin catfish	Tropical America, Amazon drainage, South America (Weber 1992)	MS	Established in Florida streams and canals with moderate expansion, little to no expansion where introduced in other states (Page 1994)	Distant, however a popular aquarium fish	Fish farm release and aquarium trade	Consumes algae, detritus and food base competing with native	Medium	Distant proximity to interbasin connection, tolerant of GL ecological conditions, high potential for aquarium release, moderate to high potential to cause ecological and economic damage
fish	*Pterygoplichthys pardalis*	Amazon sailfin catfish	Tropical America, lower lethal temp. = 46 F, South America	MS	WAKIDA-KUSUNOKI et al (2007) found Pte. Pardalis range expansion in established regions of Tobasco, Mexico.	Distant, however a popular aquarium fish	Aquarium trade, fish farms	Burrows cause shoreline erosion (Nico et Al 2009) Will also compete with natives for resources.	Medium	Distant proximity to interbasin connection, tolerant of GL ecological conditions, high potential for aquarium release, moderate to high potential to cause ecological and economic damage
fish	*Salmo salar*	Atlantic salmon	Atlantic coast drainages from northern Quebec to Connecticut; historically in Lake Ontario but now extirpated. Eastern Atlantic drainages from Arctic circle to Portugal	GL	Areas of extirpation along the east coast provide signs of decreased native range. Areas of introduction have not shown signs of reproduction	0-75 miles	Aquaculture and sport stocking programs	Can carry VHS virus and transmit to native species (Dentler 1993) Can also compete with brown trout for spawning habitat	Low	Intolerant to MS river ecological conditions, stocking programs have failed
fish	*Tinca tinca*	tench	Most of Europe, including the British Isles, and parts of western Asia (Berg 1949)	MS	Imported from Germany in 1877 (Baird 1879) ; Introduced to 36 different states by 1896 (Baughman 1947)	0-75 miles	Food and sport fish stocking programs	High, may out compete native molluscivores in both basins (Scott and Crossman 1973)	Medium	Close to interbasin connection, tolerant of GL basin ecological conditions, slow rate of population growth and expansion, moderate potential to cause ecological damage
fish	*Xiphophorus hellerii*	Green Swordtail	Middle America from Rio Nautla, Veracruz, Mexico, to northwestern Honduras	MS	Arizona, California, Colorado, Florida, Hawaii, Idaho, Louisiana, Montan, Nevada, Oklahoma, Texas, Wyoming, Puerto Rico	>250 miles	Fish farm and Aquarium release	The green swordtail has been implicated in the decline of the Utah sucker Catostomus ardens in a thermal spring in Wyoming. Green swordtails, and other introduced poeciliids, have been implicated in the decline of native damselflies on Oahu, Hawaii. Often the distributions of the damselflies and introduced fishes were found to be mutually exclusive, probably resulting from predation of the fish on the insect	Low	Distant from interbasin connection, intolerant of GL basin ecological conditions, low potential to establish, moderate potential to cause ecological and economic damage
fish	*Xiphophorus maculatus*	Southern Platyfish	Atlantic Slope of Middle America from Mexico to Belize	MS	California, Colorado, Florida, Hawaii, Nevada, Louisiana, Montana, Texas, Puerto Rico	>250 miles	Fish farm and Aquarium release	Southern platys, and other introduced poeciliids, have been implicated in the decline of native damselflies on Oahu, Hawaii. Often the distributions of the damselflies and introduced fishes were found to be mutually exclusive, probably resulting from predation of the fish on the insects	Low	Distant from interbasin connection, intolerant of GL basin ecological conditions, low potential to establish, moderate potential to cause ecological and economic damage
mollusk	*Gillia altilis*	snail	N.A. Atlantic coastal drainage	GL	First record from Oneida Lake, NY around 1915-1918; Lake Ontario in 1936; Erie Canal before 1940; may be present in Lake Erie	125-250 miles	Erie Canal system in NY (Mills et al. 1993)	Low; in some regions where native populations are declining due to anthropogenic activities	Low	Moderately distant from interbasin connection, slow rate of range expansion, low rate of population growth, low potential for ecological or economic damage
mollusk	*Melanoides tuberculatus*	red-rim melania	Northern Africa to southern Asia	MS	AZ, San Francisco Bay CA, CO, FL, HI, LA, MT, NC, NV, OR, UT, TX	>250 miles	Aquarium industry 1930s	Medium; Temperature range is 18-32^{0}C; associated with parasites then can infect humans	Medium	Distant from interbasin connection, intolerant of GL basin ecological conditions, moderate potential to cause economic and ecological damage
mollusk	*Pisidium amnicum*	greater European peaclam	Eurasia and North Africa (between Naples, Siberia, and Algiers)	GL	First recorded in GL drainage in 1897 at mouth of Genesee R. at Lake Ontario; Recorded from all the Great Lakes currently and the Hudson River in NY	0-75 miles	Solid ship ballast used in the early 1900s by ships entering the GL (Mills et al. 1993, Grigorovich et al. 2003)	High; in Europe densities have reached 1000-3300 clams/m2; capable of surviving anoxic conditions; adults can be hosts to digenean parasites (see in Eurasia) ; favors diatoms as a food source	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage

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Appendix II - List of Aquatic Invasive Species with Dispersal Potential

Taxa	Species	Common Name	Native Range	Basin*	Historical Range Expansion	Proximity to Inter-Basin Connections	Transport Mechanisms	Adverse Affects/Effects	Dispersal Threat	Justification
mollusk	*Pisidium henslowanum*	Henslow peaclam	Eurasia (Iceland, Scandinavia, France, Germany, Belgium, Russia, and UK)	GL	Appeared in GL basin between 1890-1916; established populations in Lake Ontario, Lake Michigan, and Lake Eri	0-75 miles	Solid ship ballast (Grigorovich et al. 2000, 2003)	Medium; densities in Europe have reached 330-9000 clams/m2; feeds on bacteria, diatoms, detritus, and other algae; found in large lakes and large rivers	Medium	Close proximity to interbasin connection, tolerant of MS river ecological conditions, moderate rate of dispersal and range expansion, moderate potential to cause ecological or economic damage
mollusk	*Pisidium moitessierianum*	peaclam	Eastern and western European countries, Asia (southwest-tern Siberia and northeast-tern Kazakhstan)	GL	Was observed for the first time in the GL in the Tuscarawas River (connected to the Ohio and Erie Canal) in 1890; recorded from Lake Erie, Lake Superior, and Lake St. Clair in 1997-200	75-125 miles	Solid ship ballast (Grigorovich et al. 2000, Grigorovich et al. 2003)	Medium; population densities in the GL have reached 145-178/m2; requires fairly high oxygen content and needs warm water temperatures 1-2°C	Medium	Moderately close proximity to interbasin connection, somewhat tolerant of MS river ecological conditions, moderate rate of dispersal and range expansion, low potential to cause ecological or economic damage
mollusk	*Pisidium supinum*	humpbacked peaclam	Eurasia (including Iceland)	GL	First recorded in the GL basin from Lake Ontario in 1959; also present in Lake Erie	75-125 miles	Solid ship ballast (Grigorovich et al. 2000)	Medium; sensitive to eutrophication; in N.A. more common in Ottawa R. and St. Lawrence R. than GL; in the Netherlands has reached densities of 24,000 individuals/m2; filter feeds on planktonic algae, specifically diatoms; considered endangered or rare in some regions of its native range in Europ	Medium	Moderately close proximity to interbasin connection, somewhat tolerant of MS river ecological conditions, moderate rate of dispersal and range expansion, low potential to cause ecological or economic damage
mollusk	*Pomacea insularum*	island applesnail	South America	MS	Recorded from AL, FL, GA, TX, and LA	>250 miles	Aquarium release	Low; carrier of the rat lungworm	Low	Distant from interbasin connection, slow rate of range expansion, low potential to cause ecological or economic damage
mollusk	*Potamopyrgus antipodarum*	New Zealand mudsnail	New Zealand (freshwater)	GL	First discovered in 1897 from the Snake River in ID; Populations in OR, CA, WA, CO, AZ, NY, and Canada; also in the Upper Missouri River	0-75 miles	Ship ballast or transported with live gamefish	High; abundant populations may outcompete other grazers and inhibit colonization by other macroinverts.; thrive in highly disturbed env.; expected to exert significant impacts to streams part of the GL basin; biofouler; densitie in Madison R. have reached over 300,000/m2	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
mollusk	*Radix auricularia*	European ear snail	Europe and Asia	GL	Mid-Atlantic region; first record in N.A. from Hudson River before 1869; next record from Lincoln Park, Chicago in 1901; found in Lake Erie in 1911 and Lake Ontario in 1930; also reported from Lake Huro	0-75 miles	Accidentally on plants in the late 1800s; subsequent introduction from aquarium releases	Medium; vectors for a diverse range of parasites but no known impacts to GL since its introductior	Medium	Close proximity to interbasin connection, slow rate of range expansion, moderate rate of population growth, low potential to cause economic and ecological damage
mollusk	*Sphaerium corneum*	European fingernail clam	Eurasia	GL	First recorded from GL basin from Lake Ontario in 1924; also recorded from Lake Erie, Lake Michigan, Lake Superior, Rice Lake, and Lake Huron, Lake Champlain, and Hudson River in NY	0-75 miles	Solid ship ballast (Mills et al. 1993, Grigorovich et al. 2000, 2003)	High; filter feeder but can also deposit feed (prefers diatoms but also ingests other types of phytoplankton) ; host to oligochaete, Chaetogaster limnaei limnaei, which is commensal of native snails, other native Sphaerium spp., and at least one native limpet species; host for digenean fluke	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
mollusk	*Valvata piscinalis*	European stream valvata	Europe, Caucasus, western Siberia, central Asia	GL	First recorded in Lake Ontario at the mouth of the Genesee R. in 1897; in 40 years dispersed to Lake Erie, St. Lawrence R., Hudson R., Champlain Lake, and Cayuga Lake; in 1990s recorded in Lake Superior, Lake Michigan, and Oneida Lake (Lake Ontario watershed)	0-75 miles	First introduced in packing material made of straw and marsh grasses (Mills et al. 1993) ; dispersal by ships via canals (Grigorovich et al. 2005)	High; rapid growth and high fecundity; grazes on epiphytic algae and detritus (also capable of filter feeding on suspended organic matter and algae in eutrophic environments) ; has caused decrease in native gastropod abundance (Oneida Lake) ; host for the parasitic trematode (Echinoparyphium recurvatum)	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, high potential to cause economic and ecological damage
oligochaete	*Branchiura sowerbyi*	annelid	tropical and subtropical Asia (Mills et al.1993)	GL	1st reported in the Lake Michigan drainage in 1951. Branchiura sowerbyi has also been reported in Lakes Erie, St. Clair, and Huron and the St. Clair and Detroit Rivers (Mills et al.1993, Spencer and Hudson 2003) .	0-75 miles	Aquarium trade and in soils of imported plants.	These worms burrow often and can increase sediment transfer. This may cause issues in areas with contaminated sediment. (Matisoff et al. 1999)	High	Close proximity to interbasin connection, tolerant of MS river ecological conditions, rapid rate of dispersal and range expansion, high rate of establishment and population growth, moderate potential to cause economic and ecological damage
oligochaete	*Gianius (Phallodrilus) aquaedulcis*	annelid	Western Europe in Germany's River Weser and inland caves in Spain and France (Farara and Erseus 1991) .	GL	Niagara River in Erie and Niagara Counties, New York (Mills, 1993) Southern Mississippi River System RM 510-515 (Payne et. Al. 1989) Ohio River (Grigorovich et. Al. 2008)	>250 miles	Ballast Water	May out compete native species for resources	Low	Distant from interbasin connection, slow rate of range expansion, low potential to cause ecological or economic damage
oligochaete	*Potamothrix bedoti*	tubificid worm	Ponto-Caspian region within the Black, Caspian, and Aral seas	GL	Introduced into the GL before 1959; established in all of the G	0-75 miles	Ship ballast is most likely factor (Grigorovich et al. 2003)	Low; associated with eutrophic conditions and fine substrates; favor heterotrophic aerobic bacteria as food source; may have positive impact on native oligochaetes in Europe, resulting in improved feeding by natives of numerous bacteria found in P. spp. faeces	Low	Slow rate of range expansion, little to no potential to cause ecological or economic damage
oligochaete	*Potamothrix moldaviensis*	tubificid worm	Ponto-Caspian region within the Black, Caspian, and Sea of Azov	GL	Introduced into GL before 1959; recorded from Lake Erie, Lake Michigan, Lake Ontario, Lake Superior, Lake Huron, Lake St. Clair, St. Clair River, St. Mary's River, Detroit River, Niagara River, Cayuga Lake and other waterbodies within the GL basin	0-75 miles	Unknown	Low; prefers rivers or lakes with bottom currents; generally absent from substrate with high silt and clay content; may have positive impact on native oligochaetes in Europe; in Sweden, P. moldaviensis and other P. spp. are associated with increased Oligochaete diversit	Low	Slow rate of range expansion, little to no potential to cause ecological or economic damage
oligochaete	*Potamothrix vejdovskyi*	tubificid worm	Ponto-Caspian region within the Black Sea, Caspian Sea, and Sea of Azov	GL	Introduced before 1959 in GL basin; recorded from all GL as well as Sandusky R., St. Mary's R., St. Clair R., Detroit R., Niagara R., and other inland waters of the GL basin	0-75 miles	Unknown but most likely ship ballast	Low; occurs in mesotrophic to eutrophic conditions and may be favored by the presence of some pollution; may have positive impact on native oligochaetes in Europe; however, it may compete with Tubifex tubife:	Low	Slow rate of range expansion, little to no potential to cause ecological or economic damage
oligochaete	*Ripistes parasita*	oligochaete	Europe and Lake Baikal in Asia	GL	Established populations recorded from Lake Huron, Lake Superior, St Mary's R, Lake Superior, Chemung R., Cohocton R., Chenango R., and Hudson R., and Lake Michigar	0-75 miles	Ship ballast from international shipping (Winnel and Jude 1987)	Low; unknown	Low	Slow rate of range expansion, little to no potential to cause ecological or economic damage
plant	*Bacopa egensis*	Brazilian waterhyssop	South and Central America	MS	LA (1930) , AK	>250 miles	Boats and boat trailers	Low, potential to outcompete current native and non-native aquatic plant species, may be cold intoleran	Low	Distant proximity to interbasin connection, intolerant to GL basin ecological connections, low potential to cause ecological and economic damage
plant	*Carex acutiformis*	swamp sedge	Eurasia and North Africa	GL	Ontario (1910) CT, MA, MY, MI, NY, IN	75-125 miles	Boats, boat trailers, vehicles, boots	High, displaces native plant species	High	Moderately close proximity to interbasin connection, rapid population growth and expansion, high potential to cause ecological damage
plant	*Carex disticha*	a sedge	Northern and western Europe	GL	Canada (1866) , no reports within US	>250 miles	Ballast water	Low, only established in a few populations and not seeming to sprea	Low	Distant proximity to interbasin connection, slow rate of dispersal and range expansion, low potential to cause ecological and economic damage
plant	*Dopatrium junceum*	a forb	tropical Africa and Asia	MS	LA (1969) , CA, HI	>250 miles	Sustained populations within cultivated rice fields	Low, restricted to rice fields, may be cold intolerar	Low	Distant proximity to interbasin connection, intolerant to GL basin ecological connections, low potential to cause ecological and economic damage
plant	*Glyceria maxima*	reed sweetgrass	Eurasia	GL	WI (1975) , MA (1990) , Canada (1940)	75-125 miles	Boat and boat trailers	High, displaces native plant species, poor wildlife foo	High	Moderately close to interbasin connection, tolerant of MS river ecological conditions, range expansion compounded by anthropological hitch hiking, potential to cause ecological damage
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	Asia, Africa, South America, Spain and Australia	MS	AL (1976) , AR (1974) , FL (1945) , GA (1965) , KY (1985) , LA (1961) , MS (1974) , NC (1981) , SC (1981) , TN (1986) , West Coast & AZ, KY, DE, IL, IN, MO (1934) , VI, PA	75-125 miles	Can attach to boat and boat trailers	High, shades out native plant species and found to be resistant to some herbicides	High	Moderately close to interbasin connection, tolerant of GL basin ecological conditions, range expansion compounded by anthropological hitch hiking, potential to cause ecological damage
plant	*Limnophila x ludoviciana*	marshweed	North America	MS	CA and LA (1963)	>250 miles	Can attach to boat and boat trailers	Low, potential to form large stands like other Limnophila species, may be cold intolerant	Low	Distant proximity to interbasin connection, intolerant to GL basin ecological connections, low potential to cause ecological and economic damage
plant	*Luziola peruviana*	Peruvian watergrass	South American, Central America and West Indies	MS	TX, LA (1882) , FL (1901)	>250 miles	Unknown	Low, does displace native plant species, but is not locally infrequent and may be cold intoleran	Low	Distant proximity to interbasin connection, intolerant to GL basin ecological connections, low potential to cause ecological and economic damage

*identifies which basin, Mississippi (MS) or Great Lakes (GL) that the species is known to be established in

Appendix II - List of Aquatic Invasive Species with Dispersal Potential

Taxa	Species	Common Name	Native Range	Basin*	Historical Range Expansion	Proximity to Inter-Basin Connections	Transport Mechanisms	Adverse Affects/Effects	Dispersal Threat	Justification
plant	*Murdannia keisak*	marsh dewflower	tropical and temperate Asia	MS	Southeast, TN, KY, NC, VI, DE, CT, OR, SC (1935)	>250 miles	Boats and boat trailers	High, displaces native plant species and shades out aquatic environmen	High	Popular aquatic gardening plant likely to be used in GL basin, tolerant of MS River ecological conditions, high potential to cause ecological and economic damage
plant	*Oxycaryum cubense*	Cuban bulrush	North America	MS	TX, LA, AL, FL, GA	>250 miles	Boat and boat trailers, ballast water	High, Displaces native plant species shades out aquatic environmental and ma impede navigatior	High	Popular aquatic gardening plant likely to be used in GL basin, tolerant of MS River ecological conditions, high potential to cause ecological and economic damage
plant	*Panicum repens*	torpedo grass	Europe and Australia	MS	HI, TX, LA (1971) , MS (1971) , AL (1879) , FL (1920s) , GA, SC (1987) , NC (1969) , TN (1987)	>250 miles	Boats and boat trailers	Low, found to be cold intoleran	Low	Distant proximity to interbasin connection, intolerant to GL basin ecological connections, low potential to cause ecological and economic damage
plant	*Sagittaria guayanensis*	Guayanese arrowhead	tropical Africa and southeast Asia	MS	LA (993)	>250 miles	Populations associated with rice production	Low, may be cold intolerant	Low	Distant proximity to interbasin connection, intolerant to GL basin ecological connections, low potential to cause ecological and economic damage
plant	*Trapa natans*	water chestnut	Eurasia and Africa	GL	NY (1880) and MA (1874) , VT, DE, NJ, MY (1910) , CT, VI, PA, NH, Canada	75-125 miles	Boat and boat trailers	High, displaces native plant species and shades out aquatic environmen	High	Moderately close to interbasin connection, tolerant of MS river ecological conditions, range expansion compounded by anthropological hitch hiking, potential to cause ecological damage
platyhelm	*Scolex pleuronectis*	cestode	Cos-mopolitan in distribution	GL	First collected from Lake St. Clair watershed in 199	75-125 miles	Ship ballast	Low; occurs in Black Sea watershed where it uses the round goby as its host; unlikely that it would be able to regulate N. melanostomus populatior	Low	Slow rate of range expansion, little to no potential to cause ecological or economic damage
platyhelm	*Timoniella*	digenean fluke	Unknown (Eurasia?)	GL	First recorded from Lake Superior in 1992	75-125 miles	Ship ballast with Eurasian ruffe (Gymnocephalus cernus) or round goby (Neogobius melanostomus)	Low; discovered on the introduced Eurasian ruffe; intermediate invert. hosts in GL unkown; has not been reported on native NA fishes as of ye	Low	Slow rate of range expansion, little to no potential to cause ecological or economic damage
platyhelminthes	*Dactylogyrus amphibothrium*	monogenetic fluke	Eurasian (Cone et Al 1994)	GL	In the GL, species has moved with population of Eurasian Ruff	75-125 miles	Ballast water	May be able to infect other species of hosts including the Yellow Perch (Cone et Al 1994)	Medium	Moderately close to interbasin connection, moderate potential to effect native species
platyhelminthes	*Dactylogyrus hemiamphibothrium*	monogenetic fluke	Eurasian (US Dept. of Interior 1993)	GL	In the GL, species has moved with population of Eurasian Ruff	75-125 miles	Ballast water	Species specific to Ruffe, may infect native species of the genus Gymnocephalus	Medium	Moderately close to interbasin connection, moderate potential to effect native species
platyhelminthes	*Dugesia polychroa*	flatworm	Europe, Northern Asia and Northern Africa (de Vries 1985)	GL	Established populations within Lake Ontario in 1968 but has not been detected outside this area since (Mills et Al 1993)	>250 miles	Ballast water	Competes with native Dugesia species (Boddington and Mettrick1974)	Low	Distant proximity to interbasin connection, slow rate of population growth and expansion, low potential to cause economic and ecological damage
platyhelminthes	*Ichthyocotyluruis pileatus*	digenean fluke	Ponto- and Black Caspian Seas (EPA 2008)	GL	Has been found in Round and Tubenose Gobies as well as Eurasian Ruffe, can spread with populations of these invasive species (Pronin et Al 1997)	125-250 miles	Ballast water	May effect host species ability to deal with anoxic water conditions (Pronin et Al 1997)	Low	Slow rate of population growth and expansion, low potential to cause economic and ecological damage
platyhelminthes	*Neascus brevicaudatus*	digenean fluke	Caspian, Black and Aral Seas of Eurasia (Shulman 1961)	GL	Occurs on the eyes of Gymnocephalus and will spread with this species but has only been detected in the St. Louis river, Duluth, MN	0-75 miles	Ballast water	Species specific to Ruffe, may infect native species of the genus Gymnocephalus	Low	Slow rate of population growth and expansion, low potential to cause economic and ecological damage
protozoan	*Glugea hertwigi*	mixosporidian parasite	Baltic Sea, Europe	GL	Transported to the U.S. through stocking of rainbow smelt. In Europe the species is found to move with population expantions of native rainbow smelt.	0-75 miles, may have already moved into the MS drainage	Moves with populations of rainbow smelt hosts	Parasitic to Osmerus spp. and some species of Coregonus spp. In the Great Lakes it has been recorded from Osmerus mordax	Low	Likely introduced to MS River basin already through range expansion of the host species O. mordax. Little threat to other MS River species.
protozoan	*Psammonobiotus communis*	testate amoeba	P. communis is probably native to the Ponto-Caspian region (Black Sea, Caspian Sea, and Aral Sea basins) , but it has been found in every ocean basin of the world (Nicholls and MacIsaac 2004)	GL	The most probable vector of introduction to the Great Lakes is ship ballast (Nicholls and MacIsaac 2004) . P. communis was recorded in Lake Huron in 2001 and in Lake Superior, Lake Erie and Lake Ontario in 2002 (Nicholls and MacIsaac 2004) . Given the lack of research effort devoted to testate amoebae to date, this species may have been present in the Great Lakes for many decades prior to its discovery	75-125 miles	Ballast water	Unknown	High	Range expansion compounded by anthropological hitch hiking, moderate rate of population growth and expansion, high potential to affect native species
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	Only previously been recorded from the Baltic Sea (Golemansky 1973) , but possibly originates from the Ponto-Caspian region (Black, Caspian, and Aral Sea basins) (Nicholls and MacIsaac 2004; Nicholls 2005) .	GL	The most probable vector of introduction to the Great Lakes is ship ballast (Nicholls and MacIsaac 2004) . This species was first recorded from Lake Superior, Lake Huron, Lake Erie and Lake Ontario in 2002 (as "Psammanobiotus sp."; Nicholls and MacIsaac 2004) . Given the lack of research effort devoted to testate amoebae to date, this species may have been present in the Great Lakes for many decades prior to its discovery.	75-125 miles	Ballast water	Unknown	High	Range expansion compounded by anthropological hitch hiking, moderate rate of population growth and expansion, high potential to affect native species
protozoan	*Psammonobiotus linearis*	testate amoeba	P. linearis is probably native to the Ponto-Caspian region of Eurasia (Black Sea, Caspian Sea, and Aral Sea basins) . Since it was first described from the Black Sea, it has been recorded from the Baltic Sea and the Bay of Biscay prior to being found in the Great Lakes (Nicholls and MacIsaac 2004)	GL	The most probable vector of introduction to the Great Lakes is ship ballast (Nicholls and MacIsaac 2004) . P. linearis was first recorded in 2002 from eastern Lake Ontario and from Rondeau Bay, Lake Erie (Nicholls and MacIsaac 2004)	125-250 miles	Ballast water	Unknown	High	Range expansion compounded by anthropological hitch hiking, moderate rate of population growth and expansion, high potential to affect native species
protozoan	*Sphaeromyxa sevastopoli*	mixosporidian	Black and Azov Seas (Rolbieki 2006)	GL	In the GL, species has moved with populations of Round Goby (Pronin et Al 1997)	0-75 miles	Ballast water	Little, parasite to fish species invasive to GL including the Round and Tubenose Goby (Pronin et Al 1997)	Medium	Close proximity to interbasin connection, expected to follow populations of invasive goby, low potential to affect native specie

*identifies which basin, Mississippi (MS) or Great Lakes (GL) that the species is known to be established in

Appendix III - High Risk Aquatic Invasive Species - Chicago Area Waterway System

Taxa	Species	Common Name	Basin Est.	Likely Dispersal Mechanism
algae	*Bangia atropurpurea*	red macro-algae	GL	ballast / rec. boating
algae	*Cyclotella cryptica*	cryptic algae	GL	unknown / any water
algae	*Cyclotella pseudostelligera*	cylindrical algae	GL	unknown / any water
algae	*Enteromorpha flexuosa*	grass kelp	GL	ballast / rec. boating
algae	*Stephanodiscus binderanus*	diatom	GL	ballast water
annelid	*Branchiura sowerbyi*	tubificid worm	GL	sediment transport
bryozoan	*Lophopodella carteri*	bryozoans	GL	with aquatic plants
crustacean	*Neoergasilus japonicus*	parasitic copepod	GL	parasite to fish
crustacean	*Apocorophium lacustre*	a scud	MS	ballast water
crustacean	*Bythotrephes longimanus*	spiny waterflea	GL	ballast water / sediment transport
crustacean	*Cercopagis pengoi*	fish-hook water flea	GL	ballast / rec. boating
crustacean	*Daphnia galeata galeata*	water flea	GL	ballast water
crustacean	*Echinogammarus ischnus*	a European amphipod	GL	ballast water
crustacean	*Hemimysis anomala*	bloody red shrimp	GL	ballast water
crustacean	*Schizopera borutzkyi*	harpacticoid copepod	GL	ballast water
fish	*Alosa aestivalis*	blueback herring	GL	swimmer
fish	*Alosa chrysochloris*	skipjack herring	MS	swimmer
fish	*Alosa pseudoharengus*	alewife	GL	swimmer
fish	*Channa argus*	northern snakehead	MS	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
fish	*Gymnochephalus cernuus*	ruffe	GL	swimmer
fish	*Hypophthalmichthys molitrix*	silver carp	MS	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	MS	swimmer
fish	*Menidia beryllina*	inland silverside	MS	swimmer
fish	*Mylopharyngodon piceus*	black carp	MS	swimmer
fish	*Petromyzon marinus*	sea lamprey	GL	swimmer
fish	*Proterorhinus semilunaris*	tubenose goby	GL	swimmer
mollusk	*Pisidium amnicum*	greater European pea clam	GL	ballast water
mollusk	*Sphaerium corneum*	European fingernail clam	GL	ballast water
mollusk	*Valvata piscinalis*	European stream valvata	GL	ships
plant	*Carex acutiformis*	swamp sedge	GL	recreational boating & trailers
plant	*Glyceria maxima*	reed sweetgrass	GL	recreational boating & trailers
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	MS	recreational boating & trailers
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boating & trailers
plant	*Oxycaryum cubense*	Cuban bulrush	MS	recreational boating & trailers
plant	*Trapa natans*	water chestnut	GL	recreational boating & trailers
protozoan	*Psammonobiotus communis*	testate amoeba	GL	ballast water
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	GL	ballast water
protozoan	*Psammonobiotus linearis*	testate amoeba	GL	ballast water

Appendix IV - Bibliography

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