APPENDIX B. NONINDIGENOUS SPECIES THAT MAY SPREAD TO THE GREAT LAKES

Table B-1. Summary of Literature Review for potentially invasive species. The 58 species shown as shaded represent those with the greatest risk.

Type of Organism Common Name (Scientific Name)	In GL?[a]	Invasion History[b]	Spread Potential in GL[c]	Ecol. Impact in GL[d]	Species Origin[e]	Possible Source[f]	Concern, Consequence, Invasion[g]	Lit. Source[h]
cnidarian Hydroid *(Cordylophora caspia)*	**Yes**	**Yes**	**High**	**Med**	Ponto-Caspian Sea	aquarium; ballast water	established in L. Erie, Baltic Sea basin; invasion history	13, 19, 52
crustacean Amphipod *(Pontogammarus crassus)*	No	**Yes**	**NEK**	**NEK**	Caspian Sea	ballast water	established in Baltic Sea; not established yet, may be introduced	13, 19, 30
crustacean Amphipod *(Corophium curvispinum)*	No	**Yes**	**High**	**Med**	Caspian Sea	ballast water	found in L. St. Clair; invasion history; displaced filter-feeding caddisflies widely distributed in Europe; high densities in Baltic ports; established itself in British Isles	14, 19, 23, 29, 30
crustacean Amphipod *(Dikerogammarus villosus)*	No	**Yes**	**High**	**High**	Ponto-Caspian Sea	ballast water; canals (Europe)	not established yet; established in Baltic Sea basin; eat and replace native amphipods; invading and decreasing natives in Europe; have rapid impact on macroinvertebrate survival, leading to population declines; invading most of Western Europe's hydrosystems	6, 7, 8, 13, 19, 30
crustacean Amphipod *(Pontogammarus robustoides)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water; canals (Europe)	not established yet; established in Baltic Sea basin	13, 19, 30
crustacean Amphipod *(Echinogammarus ischnus)*	**Yes**	**Yes**	**High**	**Med**	Ponto-Caspian Sea	ballast water	established in L. Erie, Huron, Ontario; invasion history; limited dispersal capability; displaced native amphipod *Gmelinoides fasciatus*	4, 9, 13, 19, 25, 26, 29, 32, 52, 53
crustacean Amphipod *(Dikerogammarus haemobaphes)*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	ballast water; canals (Europe)	not established yet; established in Baltic Sea basin	13, 19, 30
crustacean Amphipod *(Corophium sowinskyi)*	No	**Yes**	**Med**	**Med**	Ponto-Caspian Sea	canals	spreading across Europe; not established yet; could alter littoral communities and food webs	30
crustacean Amphipod *(Echinogammarus warpachowskyi)*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	ballast water	not established yet; established in Baltic Sea basin	13, 19
crustacean Amphipod *(Pontogammarus aralensis)*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	ballast water	not established yet; established in Baltic Sea basin	13

crustacean Amphipod *(Echinogammarus berilloni)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Amphipod *(Echinogammarus trichiatus)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Amphipod *(Gammarus tigrinus)*	No	NEK	**NEK**	**NEK**	North America	ballast water	not established yet, may be introduced	13
crustacean Amphipod *(Gmelinoides fasciatus)*	No	NEK	**NEK**	**NEK**	Asia	ballast water	not established yet, may be introduced	13
crustacean Amphipod *(Iphigenella shablensis)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Amphipod *(Pontogammarus maeoticus)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Amphipod *(Pontogammarus obesus)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13, 30
crustacean Amphipod *(Pontogammarus subnudas)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Isopod *(Jaera istri)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Isopod *(Jaera sarsi)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Isopod *(Proasellus coxalis)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Isopod *(Proasellus meridianus)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13

crustacean Mysid shrimp *(Hemimysis anomala)*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	ballast water	not established yet; established in Baltic Sea basin; reduction of zooplankton; biomagnification of contaminants at higher trophic levels; adaption to shallow, warm waters	13, 19, 30
crustacean Mysid shrimp *(Paramysis ullskyi)*	No	**Yes**	**Med**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet; established in Baltic Sea basin; reduction of zooplankton; biomagnification of contaminants at higher trophic levels; adaption to shallow, warm waters	30
crustacean Mysid shrimp *(Limnomysis benedeni)*	No	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet; established in Baltic Sea basin; reduction of zooplankton; biomagnification of contaminants at higher trophic levels; adaption to shallow, warm waters	13, 19, 30
crustacean Mysid shrimp *(Paramysis intermedia)*	No	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet; established in Baltic Sea basin; reduction of zooplankton; biomagnification of contaminants at higher trophic levels; adaption to shallow, warm waters	13, 30
crustacean Mysid shrimp *(Paramysis lacustris)*	No	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet; established in Baltic Sea basin; reduction of zooplankton; biomagnification of contaminants at higher trophic levels; adaption to shallow, warm waters	13, 19, 30
crustacean Pseudocumid *(Pseudocuma cercaroides)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Pseudocumid *(Pterocuma pectinata)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	not established yet, may be introduced	13
crustacean Rusty crayfish *(Orconectes rusticus)*	No	**Yes**	**High**	**High**	Southeast United States	bait	found in inland waters of Michigan (not Great Lakes); invasion history; spreading north into Ontario, northern Midwest; reduction of vegetation important to native fish for food and cover; habitat destruction; affects native crayfish industry (Ontario)	4, 17, 46, 48, 49, 56
fish Alewife *(Alosa pseudoharengus)*	**Yes**	**Yes**	**Present**	**High**	Atlantic coast of North America	bait fish; canals	found in L. Ontario, Erie, Michigan, Superior; restructure a lake's food web, leaving less food for native fish; contributed to extinction of some native species	5, 9, 11, 29, 30, 35, 44, 49, 52, 55, 56
fish Arowana *(Osteoglossum bicirrhosum)*	No	NEK	**NEK**	**NEK**	South America	ornamental	potential there but have slow growth rate; inability to survive temperatures below 58 degrees Fahrenheit	11, 31

fish Bighead carp *(Hypophthalmichthys nobilis / Aristichthys nobilis)*	**Yes**	**Yes**	**High**	**Med**	China	aquaculture; fish market; canals	few isolated cases in L. Erie; tolerate low temp; established in Mississippi River basin; invasion history; vast mobility; voracious consumption habits; clog fishing nets and scare away commercial fish; competes with native fish	11, 12, 14, 17, 31, 34, 39, 43, 44, 46, 49, 56
fish Black carp *(Mylopharyngodon piceus)*	No	No	**NEK**	**NEK**	China	aquaculture	not established yet; reports found in conclave of Ohio, Missouri, and Mississippi Rivers; vast mobility; voracious consumption habits; clog fishing nets and scare away commercial fish; risk to commercial shellfish stocks	11, 18, 34, 39, 43, 46
fish Black sea silverside *(Aphanius boyeri)*	No	NEK	**High**	**NEK**	Ponto-Caspian Sea	bait; aquaculture		18
fish Bleak *(Alburnus alburnus)*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	aquaculture; bait	invasive in Baltic; feed on crustaceans	11,18
fish Blue catfish *(Ictalurus furcatus)*	No	**Yes**	**Med**	**Med**	North America	aquaculture; sport fish	spreading outside natural range; will eat any species of fish they can catch, along with crayfish, freshwater mussels, frogs, and other readily available aquatic food sources	11, 18
fish Blue tilapia *(Oreochromis aureus)*	No	**Yes**	**NEK**	**NEK**	Africa/ Eurasia	aquaculture; sport fish	spreading in U.S.; invasive in FL; local abundance and high densities in certain areas have resulted in marked changes in fish community structure; private culture in Ontario	11,17, 18, 42, 52
fish Blueback herring *(Alosa aestivalis)*	**Yes**	No	**Present**	**High**	Atlantic coast of North America	canals	invasive in L. Ontario; impede recovery of depressed populations of indigenous fishes such as cisco and lake trout; cold water may prevent establishment	9, 11, 28, 29, 44, 52, 53
fish Bullhead *(Cottus gobio)*	No	NEK	**High**	**NEK**	Europe	bait	often behave aggressively towards one another, and competition for shelter and foraging space can be intense	11, 18
fish Caspian shad *(Caspialosa caspia)*	No	NEK	**Med**	**NEK**	Ponto-Caspian Sea	fish market		11, 18
fish Caucasian goby *(Knipowitschia caucasica)*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	ballast water	invasion in Baltic; predators which feed on small benthic animals	11, 18

fish Cherry salmon *(Oncorhynchus masou)*	No	NEK	**Med**	**NEK**	North Pacific; Japan	sport fish	widespread	11, 18
fish Chub *(Leucaspius cephalus)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian Sea	ornamental; live bait; sport fish		11, 18
fish Chum salmon *(Oncorhynchus keta)*	No	NEK	**High**	**NEK**	Asia/North Pacific	sport fish	widespread	11, 18
fish Clown loach *(Botia macracanthus)*	No	NEK	**NEK**	**NEK**	Indonesia	ornamental	potential there but have slow growth rate	11, 31
fish Common dace *(Leuciscus leuciscus)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	bait	widespread in Europe, showed invasion in one country	11, 18
fish Common tilapia *(Oreochromis mossambica)*	No	NEK	**NEK**	**NEK**	Africa	fish market; aquaculture	private culture in Ontario	11, 17, 18, 42
fish Eurasian minnow *(Phoxinus phoxinus)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	bait	invasive in Baltic	11, 18
fish European perch *(Perca fluviatilis)*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	sport fish	widespread prized for angling (introduced in many countries); because widespread, designated as invasive due to impacts on native species; cannibalism is common	11, 18, 49
fish European ruffe *(Gymnocephalus cernuus)*	**Yes**	**Yes**	**Present**	**High**	Ponto-Caspian Sea	ballast water; canals; bait	invaded L. Superior, Huron; now in L. Michigan; invasive history in Europe; displace native species; predation on native fish eggs; competition with native fish; L. Superior native fish declined since introduction of ruffe	11, 16, 23, 29, 30, 37, 43, 16, 48, 49, 52, 56
fish European whitefish (Vendace) *(Coregonus albula)*	No	**Yes**	**High**	**NEK**	Europe	sport fish	some invasion history	11, 18
fish Fourspine stickleback *(Apeltes quadracus)*	**Yes**	NEK	**NEK**	**NEK**	Europe/ Atlantic coast of North America	ballast water; ornamental	confined to coasts; rapid increases of *Apeltes* in Thunder Bay (L. Superior) suggests the species is displacing native sticklebacks at a rapid rate	11, 52

fish Ghost (or glass) catfish *(Kryptopterus bicirrhis)*	No	NEK	**NEK**	**NEK**	Asia	ornamental	potential there but have slow growth rate	11, 31
fish Giant or red snakehead *(Channa micropeltes)*	No	NEK	**NEK**	**NEK**	Asia	ornamental	potential there but have slow growth rate	11, 31
fish Goldfish *(Carassius auratus)*	**Yes**	**Yes**	**High**	**High**	China/ Japan	ornamental	of the large established populations are recorded from the vicinity of western L. Erie, widespread; extensive invasion history; concern of impacts on community, increasing turbidity, predation of native fish, help facilitate algal blooms; tolerate low temperatures	9, 11, 31, 49
fish Grass carp *(Ctenopharyngodon idella)*	No	**Yes**	**High**	**High**	Eastern Asia	aquaculture; fish market	found isolated in L. Erie, Ontario, Huron; grazes on aquatic vegetation reducing plant density or removing all aquatic vegetation from a body of water; competes with native fish; tolerate low temperatures; invasion history	11, 14, 17, 31, 43, 44, 46, 52
fish Inland silverside *(Menidia beryllina)*	No	**Yes**	**NEK**	**NEK**	Eastern U.S. coast	aquaculture; sport fish	could replace native fish; replaced native fish in CA, OK; found in Mississippi conclave of Illinois and Ohio Rivers	11, 18, 52
fish Koi (common) carp *(Cyprinus carpio)*	**Yes**	**Yes**	**High**	**High**	Eurasia	ornamental; aquaculture	found in Great Lakes; extensive invasion history; globally widespread; uproot and destroy submerged aquatic vegetation and therefore may be detrimental to duck and native fish populations; tolerate low temperatures	11, 31, 49
fish Longtail goby *(Ctenogobius sagittula)*	No	NEK	**NEK**	**NEK**	Eastern Pacific			11, 18
fish Monkey goby *(Neogobius fluviatilis)*	No	**Yes**	**High**	**High**	Eurasia	ballast water	invasion history in Europe; mass invasion of monkey goby is connected with the intensive consumption of plankton crustaceans; competes with other small fish for food and space	11, 14, 18, 30, 51
fish Mummichog *(Fundulus heteroclitus)*	No	NEK	**NEK**	**NEK**	Western Atlantic/ Eastern U.S. coast	bait; aquarium		11, 18
fish Nile tilapia *(Oreochromis niloticus)*	No	NEK	**NEK**	**NEK**	Africa	fish market; aquaculture	private culture in Ontario; Mississippi	11, 17,18, 42

fish Oriental weatherfish *(Misgurnus anguillicaudatus*	**Yes**	**Yes**	**High**	**Med**	Asia	ornamental; aquaculture	established in Shiawassee River and L. Michigan; reduce populations of aquatic insects important as food to native fishes; invasion history; tolerate low temperatures	11, 14, 31, 44
fish Pacu *(Colossoma macropomum)*	No	NEK	**NEK**	**NEK**	South America	aquaculture; ornamental	may compete with larvae of native fish species for plankton	11,18
fish Pike killifish *(Belonesox belizanus)*	No	NEK	**NEK**	**NEK**	Central America	aquarium	voracious predator and has been known to reduce populations of eastern mosquitofish (*Gambusia holbrooki*) and other native poeciliid and cyprinodontid populations	11,18
fish Pontic shad *(Alosa pontica)*	No	NEK	**Med**	**NEK**	Ponto-Caspian Sea	fish market; aquarium		11,18
fish Racer goby *(Neogobius gymnotrachelus*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	canals; ballast water	spreading in Europe	11,18, 51
fish Rainbow smelt *(Osmerus mordax)*	**Yes**	**Yes**	**Med**	**High**	Atlantic coast of Central America	sport fish	Erie Canal; Lake Ontario, Michigan, Superior; Minnesota; dominant prey form for salmonids; contributed to extinction of blue pike; affect imperiled species	11, 44, 52, 53, 55, 56
fish Red tail botia *(Botia modesta)*	No	NEK	**NEK**	**NEK**	Asia	ornamental	potential there but have slow growth rate	11, 31
fish Redear sunfish *(Lepomis microlophus)*	**Yes**	NEK	**High**	**NEK**	Atlantic coast of North America	aquaculture; sport fish	found in L. Michigan; introduced redear are associated with ecological changes in populations of pumpkinseed *L. gibbosus*, a native molluscivore; preference for mollusks	11, 18, 52
fish Roach *(Rutilus rutilus)*	No	**Yes**	**High**	**Med**	Ponto-Caspian Sea	sport fish	invasive in Baltic; nuisance once established	11, 18
fish Round goby *(Neogobius melanostromus)*	**Yes**	**Yes**	**Present**	**High**	Ponto-Caspian Sea	ballast water	found in Great Lakes; invasion history; spreads rapidly; zebra mussels dominate diet; altering benthic communities; aggressive; lake trout egg, sturgeon egg predators	3, 9, 11, 29, 30, 32, 43, 46, 48, 49, 51, 52, 53, 56
fish Rudd *(Scardinius erythrophthalmus)*	**Yes**	**Yes**	**Present**	**High**	Eurasia	bait fish; ballast water	introduced into L. Ontario; expanded in L. Erie; habitat degradation for native fish; rudd introduced to open waters will hybridize with golden shiner	11, 17, 29, 41, 46, 49

fish Ukranian or nine-spined stickleback *(Pungitius platygaster)*	**Yes**	NEK	**Present**	**NEK**	Ponto-Caspian Sea	canal?; bait?	found in L. Huron, Michigan	11, 18, 52
fish Weather fish *(Misgurnus fossilis)*	No	**Yes**	**NEK**	**NEK**	Europe	ornamental	tolerate low temperature; established invasion in Italy, Spain, Croatia	11, 31
fish White cloud mountain minnow *(Tanichthys albonubes)*	No	**Yes**	**High**	**Med**	China	ornamental	tolerate low temperature; extensive invasion history; high occurrence frequency	11, 14, 31
fish White perch *(Morone americana)*	**Yes**	**Yes**	**Present**	**High**	Atlantic coast of North America	fish market; canals	already invaded Great Lakes; competition with native fish; potential to cause declines of walleye populations; prey on eggs of walleye	9, 11, 17, 31, 44, 46, 48, 52, 53, 56
fish Zander *(Sander lucioperca)*	No	**Yes**	**High**	**High**	Ponto-Caspian Sea	sport fish; canals; aquaculture	found everywhere in Europe; depleted stocks of native fish; hunts in packs	11, 18
flatworm Flatworm *(Dendrocoelum romanodanubiale)*	No	NEK	**NEK**	**NEK**	North Sea basin	ballast water	not established yet, may be introduced	13
flatworm Trematode *(Apophallus muehlingi)*	No	NEK	**NEK**	**NEK**	Black Sea	ballast water	not established yet, may be introduced	13
flatworm Trematode *(Nicolla skrjabini)*	No	NEK	**NEK**	**NEK**	Black Sea	ballast water	not established yet, may be introduced	13
flatworm Trematode *(Rossicotrema donicum)*	No	NEK	**NEK**	**NEK**	Black Sea	ballast water; fish host	not established yet, may be introduced	13
insect Apterogote (wingless) *(Campodea staphylinus)*	No	**Yes**	**High**	**NEK**	Eurasia	ballast water	widespread; been recorded in North American fresh waters; tolerate range of salinity	10
microcrustacean Baltic water flea *(Bosmina coregoni)*	**Yes**	**Yes**	**Present**	**High**	Eurasia/ Ponto-Caspian	ballast water	established in L. Ontario, Superior; invasion history	13
microcrustacean Calanoid copepod *(Eurytemora affinis)*	**Yes**	**Yes**	**Present**	**NEK**	Ponto-Caspian Sea	ballast water	widespread; invasion history; established in Great Lakes; high populations	13

microcrustacean Calanoid copepod *(Heterocope appendiculata)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	established in Baltic Sea basin	13
microcrustacean Calanoid copepod *(Calanipeda aquae-dulcis)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	established in Baltic Sea basin	13
microcrustacean Calanoid copepod *(Heterocope caspia)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	established in Baltic Sea basin	13
microcrustacean Cladoceran *(Daphnia cristata)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	established in Baltic Sea basin	13
microcrustacean Cladoceran *(Bosmina obtusirostris)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	established in Baltic Sea basin	13
microcrustacean Cladoceran *(Podonevadne trigona ovum)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	established in Baltic Sea basin	13
microcrustacean Cladoceran (water flea) *(Daphnia lumholtzi)*	No	**Yes**	**Med**	**NEK**	Australia; SE Asia	ballast water; boating; waterfowl	expanding in U.S.; widespread; prefers warm water; competes with native daphnia for food and of its ability to avoid predation	14, 34, 52, 53
microcrustacean Cladoceran *(Cornigerius maeoticus maeoticus)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	established in Baltic Sea basin	13
microcrustacean Cyclopoid copepod *(Cyclops strenuus)*	**Yes**	**Yes**	**Present**	**NEK**	Eurasia	ballast water	established in Great Lakes	10
microcrustacean Cyclopoid copepod *(Cyclops kolensis)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	established in Baltic Sea basin	13
microcrustacean Fishhook waterflea *(Cercopagis pengoi)*	**Yes**	**Yes**	**Present**	**High**	Ponto-Caspian Sea	ballast water; boating	established in Great Lakes except L. Huron, Superior; Baltic Sea basin; compete with small fish for zooplankton; invasive in Europe; clogs nets for fisheries; damage cost data available	9, 13, 19, 20, 29, 32, 38, 49, 52, 53, 54, 56
microcrustacean Harpactacoid copepod *(Ectinosoma abrau)*	No	NEK	**High**	**NEK**	Ponto-Caspian Sea	ballast water	potential to invade Great Lakes	13

microcrustacean Harpactacoid copepod *(Onychocamptus mohammed)*	**Yes**	NEK	**Present**	**NEK**	Ponto-Caspian Sea	ballast water	established in L. Ontario	13, 14
microcrustacean Harpactacoid copepod *(Paraleptastacus spinicaudata triseta)*	No	**Yes**	**High**	**NEK**	Ponto-Caspian Sea	ballast water	invasion history	13
microcrustacean Harpactacoid copepod *(Schizopera borutzkyi)*	**Yes**	**Yes**	**Present**	**High**	Danube River delta of Black Sea	ballast water	established in L. Michigan; altering species composition of nearshore communities	1, 10, 13, 14, 15, 28
microcrustacean Harpactacoid copepod *(Nitocra incerta)*	**Yes**	**Yes**	**Present**	**NEK**	Black Sea	ballast water	established in L. Michigan	13
microcrustacean Spiny waterflea *(Bythotrephes longimanus)*	**Yes**	**Yes**	**High**	**High**	Great Britain; Europe	ballast water; boating	established in Great Lakes; Great Lakes - has caused major changes in the zooplankton community structure; invasion history; reproduce rapidly; competes directly with small fish and can have impact on zooplankton community; damage cost data available	13, 21, 33, 38, 48, 49, 52, 53, 54
microcrustacean Spiny waterflea *(Bythotrephes cederstroemi)*	**Yes**	**Yes**	**Present**	**High**	Eurasia	ballast water	established in Great Lakes; the invasion into the Laurentian Great Lakes has resulted in substantial and sustained decreases in the populations of a number of (mostly cladoceran) native zooplankton species; coincided with dramatic declines in abundance of Daphnia	32, 49, 50, 56
microsporidian Fish parasite *(Heterosporis sp.)*	**Yes**	**Yes**	**NEK**	**NEK**	Europe/ Asia ?	fish release; bait	found in L. Ontario, attacks muscle cells in yellow perch; found in Wisconsin	9, 46
mollusc Asian clam *(Corbicula fluminea)*	**Yes**	**Yes**	**NEK**	**NEK**	Asia	ornamental; fish market/bait	established in L. Michigan, Superior, Erie; does not tolerate low temperatures; fouled water plants; damage cost data available	13, 46, 49, 52, 54
mollusc Basket (European) shell *(Corbula gibba)*	No	NEK	**NEK**	**NEK**	Atlantic coast of Europe	ballast water	capacity to achieve very high population densities, giving it the potential to affect the growth and recruitment of a wide range of soft bottom organisms	13

mollusc Clam *(Hypanis colorata)*	No	NEK	**NEK**	**NEK**	Caspian Sea	ballast water	potential to invade Great Lakes	13, 30
mollusc European fingernail clam *(Sphaerium corneum)*	**Yes**	**Yes**	**Present**	**NEK**	Eurasia	unknown - canals?	found in L. Huron, Ontario; effect unknown	52
mollusc Golden mussel *(Limnoperna fortunei)*	No	**Yes**	**Med**	**Med**	China/ Asia	ballast water	produces a rapid change in benthic communities and threatens native biodiversity; produces macrofouling in the water systems of facilities; spreading in South America	27, 49
mollusc Chinese mystery snail [(prosobranch] *(Cipangopaludina chinensis malleata)*	**Yes**	**Yes**	**High**	**Med**	Asia	fish market; ornamental	isolated pop. in L. Erie and upper St. Lawrence River; established L. Michigan; clog screens of water intake pipes; vectors for the transmission of parasites and diseases	31, 42, 46, 52
mollusc New Zealand mudsnail [hydrobid] *(Potamopyrgus antipodarum)*	**Yes**	**Yes**	**Present**	**High**	New Zealand	ballast water	established in L. Ontario, Superior; invasion history; reduce native species, harm trout populations; suspected that can alter primary production of streams; spread rapidly	13, 23, 28, 44, 46, 49, 52
mollusc Quagga mussel *(Dreissena bugensis)*	**Yes**	**Yes**	**Present**	**Med**	Ukraine/ Ponto-Caspian Sea	ballast water	found in L. Erie, Ontario; invasion history; historically dominated the biomass of transition(30-50m) and profundal regions(>50m); negative impact on raw water-using industries, potable water treatment plants; damage cost data available	9, 26, 29, 30, 32, 44, 49, 52, 53, 54, 56
mollusc Snail (hydrobid) *(Lithoglyphus naticoides)*	No	NEK	**NEK**	**NEK**	Ponto-Caspian	ballast water	potential to invade Great Lakes	13
mollusc Snail (neritid) *(Theodoxus fluviatilis)*	No	NEK	**NEK**	**NEK**	Baltic/ Black Sea	ballast water	potential to invade Great Lakes	13
mollusc Snail (neritid) *(Theodoxus pallasi)*	No	NEK	**NEK**	**NEK**	Caspian Sea	ballast water	potential to invade Great Lakes	13
mollusc Zebra mussel *(Dreissena polymorpha)*	**Yes**	**Yes**	**Present**	**High**	Ponto-Caspian Sea	ballast water	already established in Great Lakes; invasion history; interferes with native molluscs' ecological functions; damage cost data available	2, 9, 29, 32, 44, 48, 49, 52, 53, 54, 56

plant Curly-leaf pondweed *(Potamogeton crispus)*	**Yes**	**Yes**	**Present**	**Med**	Eurasia	ornamental; horticulture	established in U.S.; invasion history; causes problems due to excessive growth	22, 41, 47, 48, 49, 56
plant Dwarf hygrophila *(Hygrophila polysperma)*	No	**Yes**	**High**	**Med**	India	ornamental	tolerate low temp; established in FL, TX, VA; invasion history; clogs irrigation and flood-control canals	14, 31
plant Brazilian elodea or waterweed *(Egeria densa)*	No	**Yes**	**Med**	**High**	Central/ South America	ornamental	established in OR, NY, MD, CT; invasion history; slow dispersal; create dense mats that can impede water recreation; water movement is restricted causing fish population imbalances; cause fluctuations in water quality	14, 31, 36, 46, 49
plant Eurasian watermilfoil *(Myriophyllum spicatum)*	**Yes**	**Yes**	**High**	**High**	Eurasia	ornamental; boaters	invaded L Ontario; interferes with water recreation; canopy can crowd out important native plants; decrease oxygen levels when plant decays; rapid colonization; damage cost data available; threat factor to fish	9, 17, 23, 47, 48, 49, 54, 55, 56
plant European frogbit *(Hydrocharis morus-ranae)*	**Yes**	**Yes**	**Med**	**High**	Eurasia	ornamental; horticulture; boaters	invaded L. Ontario (only lake found); creates dense mats of vegetation and thus prevents light and nutrients from reaching submerged vegetation; plants die in the fall so depleted dissolved oxygen is possible	9, 17, 22, 36, 41, 46, 49, 56
plant European water clover *(Marsilea quadrifolia)*	**Yes**	**Yes**	**Med**	**Med**	Eurasia	ornamental	found in L. Ontario; poses a realistic nuisance threat to ecosystems; affect local molluscan communities	36
plant Fanwort *(Cabomba caroliniana)*	**Yes**	**Yes**	**Present**	**High**	Southeast United States	ornamental	Already invaded L. Michigan; clogs drainage canals and freshwater streams; form dense stands crowding out previously well-established plants	17, 31, 36, 49,
plant Flowering rush *(Butomus umbellatus)*	**Yes**	**Yes**	**Med**	**NEK**	Eurasia	ornamental; horticulture	spread in limited areas in Great Lakes (Erie, Ontario, Michigan); actively expanding; competes with native shoreline vegetation	22, 46, 48, 49, 56
plant Giant salvinia *(Salvinia molesta)*	No	**Yes**	**Med**	**Med**	South America	ornamental; horticulture	established in lower U.S.; invasion history; impede the flow of water to irrigation pipes and other water intake pipes; rapidly expanding populations can overgrow and replace native plants,resulting dense surface cover prevents light and atmospheric oxygen from entering the water; decomposing material drops to the bottom, greatly consuming dissolved oxygen needed by fish and other aquatic life	22, 41, 46, 49

plant Hydrilla *(Hydrilla verticillata)*	No	**Yes**	**High**	**High**	Central Africa	ornamental; horticulture	established in southern U.S.; high movement; invasion history; adaptable; dense mats of hydrilla will alter the waters chemistry by raising pH, cause wide oxygen fluctuations, and increase water temperature; eliminate native plants	22, 36, 41, 46, 49, 56
plant Minor (slender) naiad *(Najas minor)*	**Yes**	**Yes**	**NEK**	**NEK**	Europe	ornamental	limited in L. Erie; can form dense, monospecific stands in shallow water and hinder swimming, fishing, boating, and other forms of water contact recreation	36,
plant Parrot's feather *(Myriophyllum aquaticum)*	No	**Yes**	**High**	**High**	South America	ornamental	invasion history; very adaptive to variety of environments	14, 31, 49
plant Purple loosestrife *(Lythrum salicaria)*	**Yes**	**Yes**	**Present**	**High**	Eurasia	ornamental; horticulture	established in Great Lakes; invasion history; plant can form dense, impenetrable stands which are unsuitable as cover, food, or nesting sites for a wide range of native wetland animals; damage cost data available	22, 23, 41, 47, 48, 53, 54, 56
plant Sessile joyweed *(Alternanthera sessilis)*	No	**Yes**	**Med**	**NEK**	Asia	ornamental; horticulture	invasion history; aggressive	22
plant Spiny naiad *(Najas marina)*	**Yes**	**Yes**	**Med**	**NEK**	Eurasia	ornamental	found in L. Ontario; widespread; interferes with recreational boating; pose a realistic nuisance threat to ecosystems	36
plant Variable-leaved watermilfoil *(Myriophyllum heterophyllum)*	No	**Yes**	**High**	**Med**	Eastern North America	ornamental; boaters	spreading in New England states; out compete native aquatic vegetation, resulting in nearly monotypic growth with less habitat value; interferes with recreational boating; pose a realistic nuisance threat to ecosystems	31, 36, 40
plant Water primrose *(Ludwigia uruguayensis)*	No	NEK	**NEK**	**NEK**	South America	ornamental	large colonies can prevent small boat navigation and recreational use of shoreline areas	36
plant Waterchestnut *(Trapa natans)*	**Yes**	**Yes**	**High**	**Med**	Eurasia	ornamental; horticulture	released in L. Ontario; reproduce rapidly; habitat degradation through floating mats, hindering navigation of waters and inhibiting the growth of native aquatic plant species; damage cost data available	9, 36, 44, 46, 49, 54, 56

plant Yellow floating heart *(Nymphoides peltata)*	No	**Yes**	**High**	**Med**	Eurasia	ornamental; horticulture	spreading in New England; grows in dense patches, excluding native species and even creating stagnant areas with low oxygen levels underneath the floating mats	36, 46, 49
protozoans Amoebae (testate*) (Psammonobiotus communis)*	**Yes**	**Yes**	**NEK**	**NEK**	Baltic Sea	ballast water	found in L. Ontario; newly discovered in Great Lakes	9, 24
protozoans Amoebae (testate) *(Psammonobiotus dziwnowii)*	**Yes**	**Yes**	**NEK**	**NEK**	Baltic Sea	ballast water	found in L. Ontario; newly discovered in Great Lakes	9, 24
protozoans Amoebae (testate) *(Psammonobiotus linearis)*	**Yes**	**Yes**	**NEK**	**NEK**	Baltic Sea (?)	ballast water	found in L. Ontario and other Great Lakes	9
virus Largemouth bass virus *(Iridoviridae family)*	**Yes**	**Yes**	**High**	**Med**	?	bait fish	extended range in southeast basin; spreading in L. Michigan; kills fish (commercial, native, invasive)	34, 45, 46
worm Oligochaete *(Potamothrix bedoti)*	**Yes**	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	established in Great Lakes; invasion history in Baltic	13
worm Oligochaete (tubificid) *(Potamothrix heuscheri)*	No	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	invasion history in Baltic; continuously dispersing to the west over Central Europe and to the north-west towards the Baltic Sea	13
worm Oligochaete *(Potamothrix moldaviensis)*	**Yes**	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	established in Great Lakes; invasion history in Baltic	13
worm Oligochaete *(Potamothrix vejdovskyi)*	**Yes**	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	established in Great Lakes; invasion history in Baltic	13
worm Polychaete worm *(Hypania invalida)*	No	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	invasion history in Baltic; slow spread in Europe	13, 30

worm Polychaete worm *(Hypaniola kowalevskyi)*	No	**Yes**	**NEK**	**NEK**	Ponto-Caspian Sea	ballast water	invasion history in Baltic; slow spread in Europe	13

[a]Present in Great Lakes is scored "yes" if the organism has been reported for any of the Lakes.
[b]Invasion history is scored "yes" if the species is reported to have an invasion history/exotic in any other country of the papers cited for that species.
[c]Spread potential within the Great Lakes after introduction scored "High" or "Med" based on comments in two or more of the papers cited for that species, or NEK (not enough known).
[d]Ecological impact if a species becomes established in Great Lakes scored as "High" or "Med" if so reported in at least two of the papers cited for that species; else, it is scored as NEK (not enough known).
[e]Species origin notes the probable native area or region of occurrence for the species in question, as cited in the papers reviewed for the species.
[f]The known, suspected, or probable mechanism of introduction of the species prior invasion history is listed based on the papers cited and prior invasion history.
[g]Comments related to investigators' concerns about the consequences of invasion for the species in question are abstracted from papers cited for the species in question.
[h]Articles referenced here were identified on the basis of species names plus reference to "Great Lakes". Thus, the listed references do not include many papers that consider the biology of the organism in its native range.