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Harmonizing Great Lakes Regulated Species: Progress towards reconciling a regional patchwork

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"An invasive species is defined as a species that is not native and whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health." -- National Invasive Species Council 2012

Background

Aquatic invasive species (AIS) threaten the ecology, economy, and quality of life in the Great Lakes region. The total economic impact of AIS in the Great Lakes region is estimated at hundreds of millions of dollars per year (Anderson Economic Group 2012). Historically, the importation and sale of aquatic species is the second most important invasion pathway to the Great Lakes (Ricciardi 2006). Each of the eight Great Lakes states and two provinces have established regulations to manage this pathway, and the importation and sale of a small number of well-known, nuisance species are regulated in most, but not all, of the 10 jurisdictions (e.g. zebra and quagga mussel, non-native carp, Round Goby, Northern Snakehead, Eurasian Ruffe). The criteria used to identify problematic species across Great Lakes' states and provinces is inconsistent, and consequently substantial differences exist in prohibited species lists. Some jurisdictions regulate more than 100 plant and/or animal species, and others prohibit fewer than 30. Inconsistency in regulated species lists across the shared waters of the Great Lakes undermines the collective prevention efforts of the region, resulting in a "weakest link" problem, wherein the success of AIS management efforts is limited to the weakest regulatory approach (Peters & Lodge 2009).

In recognition of this problem, the Great Lakes Panel on Aquatic Nuisance Species identified the development of consistent risk assessment processes and regulated species policies across Great Lakes jurisdictions as a regional priority (Research and Policy strategies). In June 2013, the Council of Great Lakes [and St Lawrence] Governors (now the Great Lakes St. Lawrence Governors and Premiers or "GSGP") identified a list of sixteen "least wanted" AIS that they considered a grave threat to the region's economy and ecology [link]. On May 4, 2018, the GSGP announced the addition of five more species to the "least wanted" list [link]. The Governors and Premiers called for specific steps to manage these least wanted species, including taking executive action within each state or province to prohibit or restrict the transfer of these species, and cross-jurisdictional collaboration to harmonize related state and provincial policies.

Here we provide an assessment of progress toward harmonization over the last decade, including a comparison of current regulated species lists across the Great Lakes basin to regulations that existed in 2012, the first time that a comprehensive list of all regulated aquatic invasive species was compiled for the basin. We also compiled available data from a subset of regionally relevant risk assessment processes to identify a group of species for which there are multiple lines of evidence to justify regulatory action across the basin.

[1] For more information on the underlying data please contact Andrew Tucker (atucker@tnc.org, (574) 208-6487) or Lindsay Chadderton lchadderton@tnc.org, (574) 217-0262.

Goal

Compile available data to support regional harmonization of regulations pertaining to the sale and possession of aquatic species in Great Lakes states and provinces.

Regulated Species Lists and Risk Assessment Methods

State and provincial administrative code and statutes were referenced to compile a comprehensive list of regulated aquatic nuisance and nonnative species (and dates for listing) for all Great Lakes states and provinces. The analysis was limited to the subset of aquatic plants and animals for which sale, possession, and/or import is restricted, prohibited, or otherwise regulated. For plants, only those species designated as obligate or facultative wetland plants (per US Army Corps of Engineers National Wetland Plant list for Northcentral and Northeast region) were considered. Six algal species and the diatom *Didymospenia geminate* were also included on the list. For animals, all regulated fish and aquatic invertebrates were included, as well as one mammal (Nutria, *Myocastor coypus*), one frog (African clawed frog, *Xenopus laevis*), and one turtle (Red eared slider, *Trachemys scripta elegans*). In instances where entire families or genera of species are regulated by a jurisdiction, all relevant species were counted towards that jurisdiction's total number of regulated species (e.g., all individually listed snakehead species were counted as regulated in those jurisdictions where Channa, Parachanna, or Channidae are regulated). The state of Illinois publishes an "Aquatic Life Approved Species List" and prohibits possession, sale, and import of any aquatic species not on the approved list. However, for the purposes of this analysis, only those species that are identified as "injurious species" under part 805 of the Illinois Administrative Code and relevant plant species under the Illinois Exotic Weed Act were considered regulated. Similarly, although Wisconsin and Pennsylvania both have general regulations prohibiting the possession or sale of non-native crayfish, only those species that are specifically named under state law were considered regulated.

Six species' risk assessment frameworks were consulted to evaluate the invasive potential for each species identified as regulated in at least one jurisdiction. Three risk assessments evaluated risk for both plants and animals, the other three were specific to one or the other taxonomic group (see Appendix 1). The assessments range from semi-quantitative questionnaire based assessments, to screening level assessments based on literature review and a climate matching tool. A simple binary framework was used to score invasiveness of each species based on species specific results from each of the risk assessment approaches (i.e., "1" if predicted invasive, "0" if predicted not invasive *or* if not assessed). Cumulative "risk scores" were tallied for each species, and species were ranked from highest total score (considered highest risk) to lowest total score (considered lowest risk).

Results & Discussion

A total of 164 aquatic species are regulated by at least one jurisdiction (74 plant species and 90 animal species). For plants, all but four of the species have been evaluated as "high" or "moderate" risk invasive species by at least one (out of five) risk assessments (Table 1). Seven plant species were evaluated as "high" or "moderate" risk invasive species by all five of the risk assessments, including six (of seven) species identified by the GSGP as "least wanted." Nevertheless, these seven species, including the "least wanted" species, are regulated by no more than seven of the ten Great Lakes jurisdictions (Table 1, Figure 2).

For animals, 78 species are considered “high” or “moderate” risk invasive species by at least one (of four) risk assessment tools (Table 2). Nine animal species were evaluated as “high” or “moderate” risk AIS by all (four) of the risk assessment tools, including six (of 14) species identified by the GSGP as “least wanted.”

Not all species were evaluated by each risk assessment tool, so the relatively low risk scores (e.g. 1 or 2) assigned to some high profile and widely regulated species (e.g. the “least wanted” species) should be considered underestimates of likely risk.

The majority of the regulated species are listed in no more than half (i.e., ≤ 5) of the Great Lakes jurisdictions (84% of plants/algae and 76% of animals; Figure 1). The number of regulated species varies widely across jurisdictions for both taxonomic groups (Figure 2). For both plants and animals, Wisconsin regulates the largest number of species (121 in total). Ontario (33), Quebec (27), and Pennsylvania (23) regulate the fewest number of species. All jurisdictions have increased the total number of regulated species over the last five years. For plants, Illinois, New York, Ontario, and Wisconsin have made notable improvements in the number of species currently listed relative to 2012 (Fig. 3a) and these actions have contributed to the growing number of species listed across five or more Great Lakes jurisdictions. For animals, New York, Ohio, and Minnesota show the largest increase in regulated species in terms of relative percent change in number of listed species relative to 2012 (Fig. 3b). The frequency of “least wanted” species listingshas increased over time. The number of “least wanted” species regulated in at least half of all jurisdictions increased from only 5 in 2008 to 19 in 2017 (exceptions are New Zealand Mudsnail and marmokrebs which was only announced as least wanted in May 2018; Fig. 4). No jurisdiction regulates all 21 “least wanted” species (Fig. 5).

There is an overall increase in the number of species that are regulated in one or more jurisdictions, but eight (of 10) jurisdictions regulate fewer than 50% of the animal or plant species that are regulated in at least one jurisdiction (Fig. 3). The biggest gains towards regional efforts to harmonize regulated species lists across the region could be achieved through progress on aquatic plants by a subset of jurisdictions (notably Ontario, Pennsylvania, and Quebec). Regulatory harmonization efforts are underway between Ohio, Michigan, and Ontario to address aquatic plants, and understanding impediments to regulatory progress in these jurisdictions might inform regional harmonization efforts.

Consideration of a cumulative “weight of evidence risk score” as determined from existing risk assessments (per our analysis; see Table 1 and 2) could also be instructive for regional harmonization efforts. The weight of multiple lines of evidence across varied assessment approaches (analytical and expert based) provides a scientific basis that could be used to justify regulatory action to minimize the economic, social, and environmental risk associated with “high risk” species.

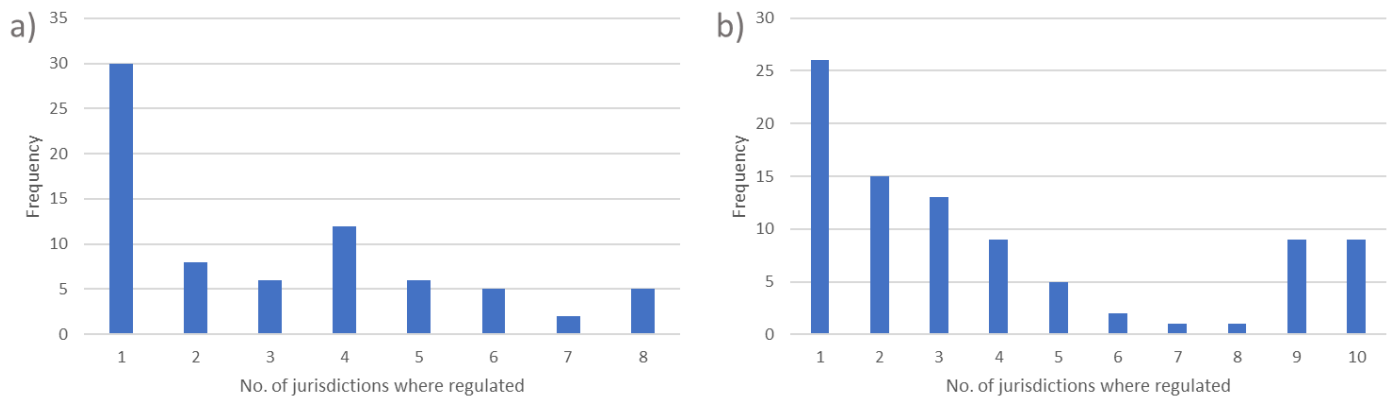

Figure 1. Frequency histogram showing total number of plant species (a) or animal species (b) regulated across the Great Lakes jurisdictions (e.g. only nine animal species are regulated in all 10 Great Lakes jurisdictions).

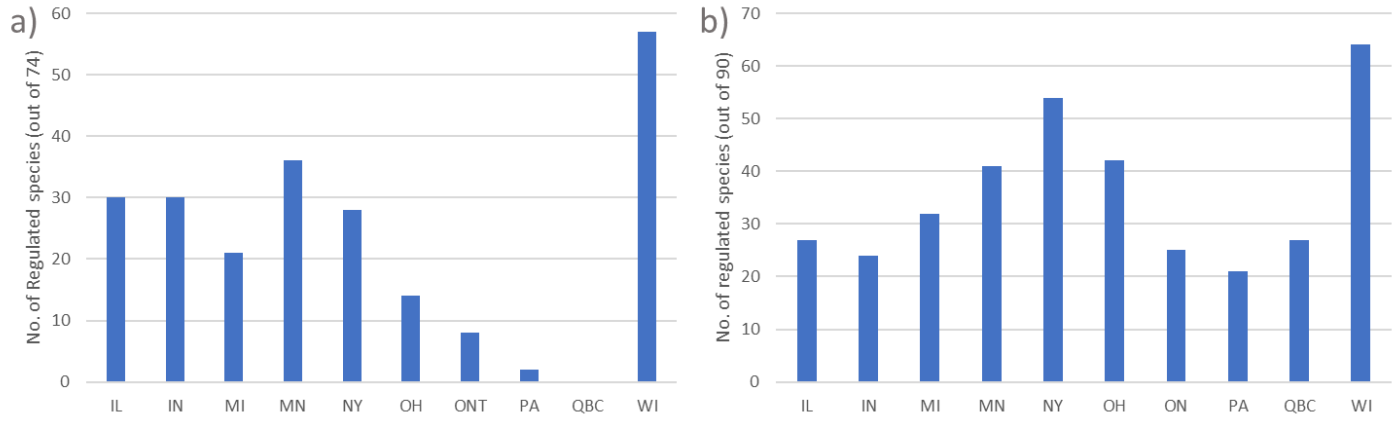

Figure 2. Number of plant (a) and animal (b) species regulated by jurisdiction as of July 2018.

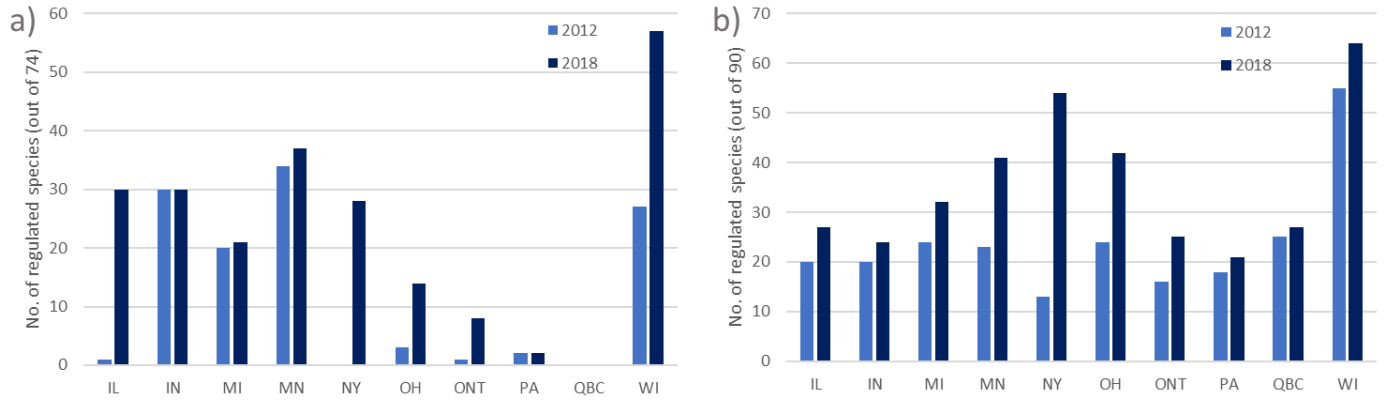

Figure 3. Number of plant (a) and animal (b) species regulated by jurisdiction in 2012 versus 2018.

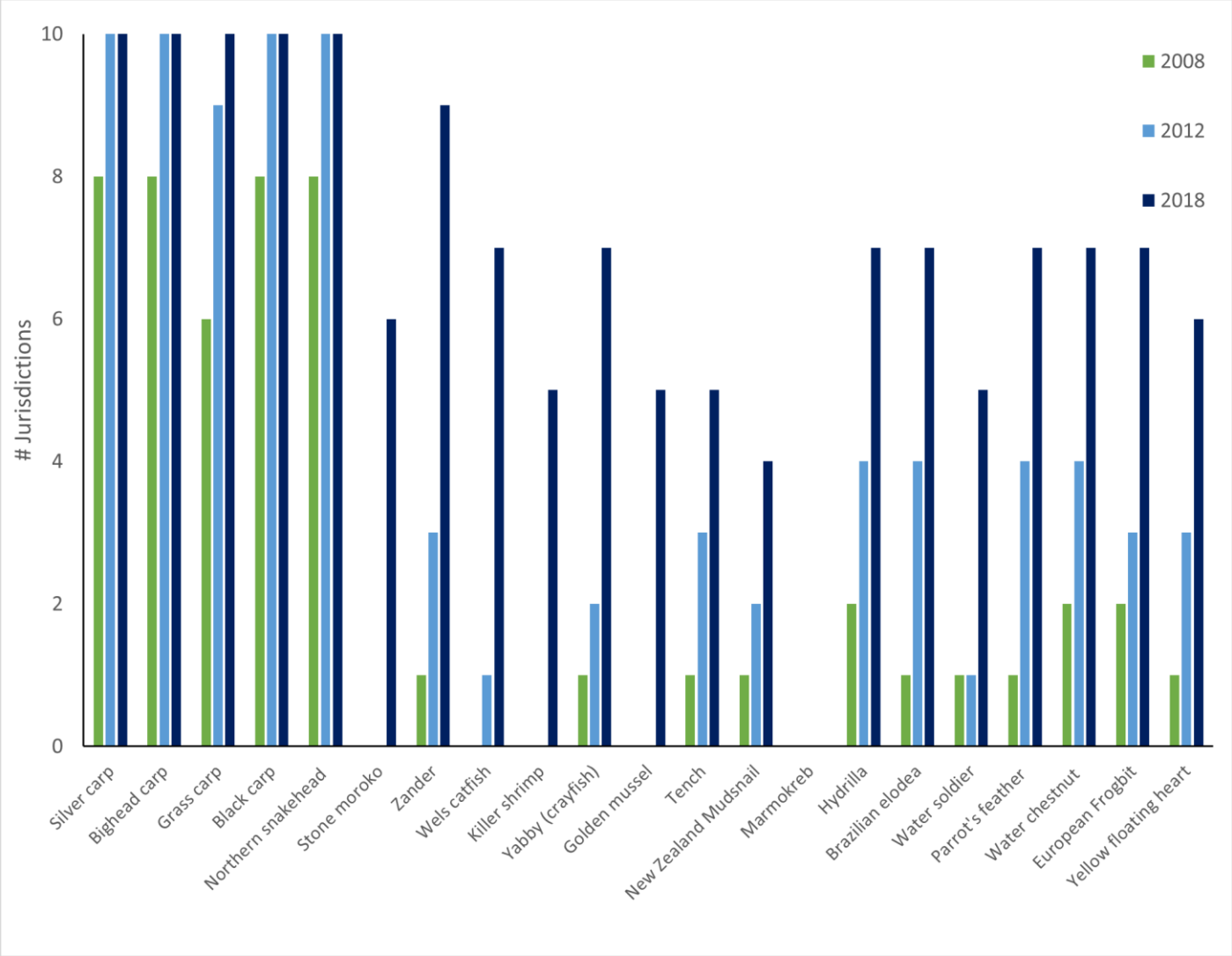

Figure 4. Number of jurisdictions regulating the GSGP “least wanted” species by year.

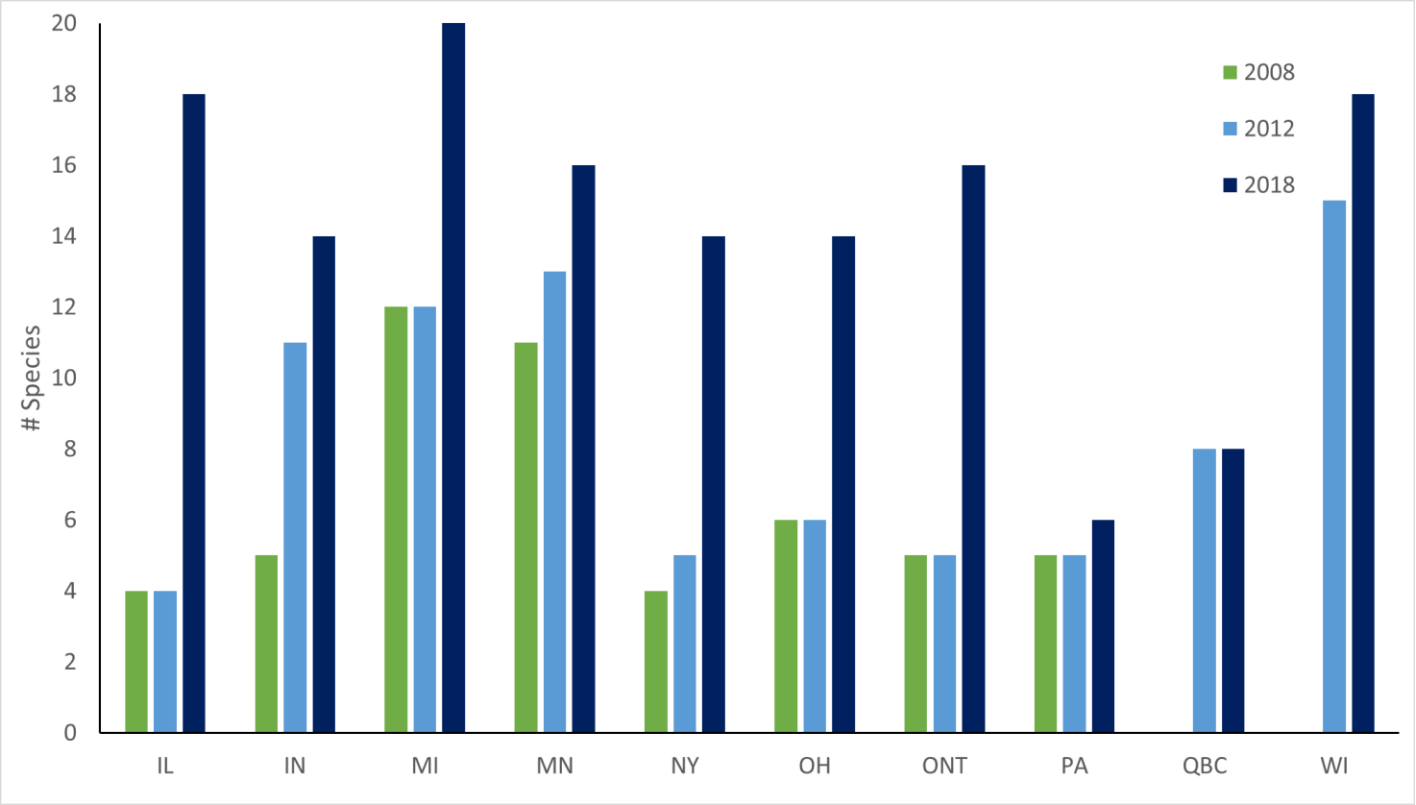

Figure 5. Number of GSGP “least wanted” species regulated by each jurisdiction by year.

Table 1. Ranked list of regulated plant/algae species based on "weight of evidence (WOE) risk scores." Note: Not all species were evaluated by each risk assessment tool. The far-right column indicates the number of assessments (out of 5) completed for each species. The low risk scores assigned to some species of concern (e.g. the "least wanted" species) should be considered underestimates of likely risk. *Indicates a species included on the GSGP "least wanted" list.

Species name	**Common name**	**Jurisdictions regulated**	**TOTAL WOE score (0-5)**	**# assessment completed (0-5)**
Cabomba caroliniana [a]	Carolina fanwort	4	5	5
*Egeria densa**	Brazilian elodea	7	5	5
*Hydrilla verticillata**	Hydrilla or water thyme	7	5	5
*Hydrocharis morsus-ranae**	European frogbit	6	5	5
*Myriophyllum aquaticum**	Parrot feather	7	5	5
*Nymphoides peltate**	Yellow floating heart	5	5	5
*Trapa natans**	Water chestnut	7	5	5
Glyceria maxima	Reed manna grass	2	4	4
Lythrum salicaria	Purple loosestrife	8	4	4
Myriophyllum spicatum	Eurasian watermilfoil	6	4	4
Najas minor	Brittle naiad	4	4	5
Potamogeton crispus	Curlyleaf pondweed	6	4	4
Alnus glutinosa	European alder	1	3	3
Butomus umbellatus	Flowering rush	5	3	4
Cirsium palustre	Marsh Thistle	1	3	3
Eichhornia crassipes	Water hyacinth	2	3	4
Epilobium hirsutum		1	3	3
Hygrophilia polysperma	Miramar weed, Indiana swampweed	4	3	3
Iris pseudacorus	Yellow flag iris	5	3	3
Lagarosiphon major	Oxygen weed or African elodea	5	3	3
Lysimachia vulgaris	Garden loosestrife	2	3	3
Nelumbo nucifera	Sacred lotus	1	3	4
Phragmites australis	Common reed	4	3	3
Pistia stratiotes	Water lettuce	1	3	4
Arundo donax	Giant reed	1	2	2
Azolla pinnata	Mosquito fern	4	2	2
Crassula helmsii	Australian stonecrop	2	2	2
Didymosphenia geminata	Didymo	2	2	2
Eichhornia azurea	Anchored water hyacinth	4	2	2
Fallopia japonica	Japanese knotweed	6	2	2
Hydrocotyle ranunculoides	Floating Marsh Pennywort	1	2	2
Ipomoea aquatica	Chinese waterspinach or	4	2	2

	swamp morning-glory			
Limnophila sessiliflora	Asian marshweed or ambulia	4	2	3
Ludwigia hexapetala (*L. grandiflora*)	Uruguayan Primrose Willow	1	2	3
Ludwigia peploides	Floating Primrose Willow	1	2	2
Lysimachia nummularia	Creeping jenny	1	2	2
Lythrum virgatum	Wanded loosestrife	4	2	2
Murdannia keisak	Marsh Dewflower	1	2	3
Myriophyllum heterophyllum	Broadleaf Water-milfoil	1	2	2
Nitellopsis obtusa	Starry stonewort	3	2	2
Oenanthe javanica	water -celery	1	2	2
Phalaris arundinacea	Reed Canary Grass	1	2	2
Prymnesium parvum	Golden Algae	2	2	2
Sagittaria sagittifolia	Arrowhead	4	2	3
Salix atrocinerea	Gray Florist's Willow	1	2	2
Salvinia molesta	Giant salvinia	5	2	4
*Stratiotes aloides**	Water soldier	5	2	3
Typha angustifolia	Narrow leaf cattail	2	2	2
Typha domingensis	Southern Cat-Tail	1	2	2
Typha laxmannii	Graceful cattail	1	2	3
Typha x *glauca*		1	2	3
Ulva species, including species previously known as Enteromorpha	Green Alga	1	2	2
Valeriana officinalis	Garden valerian	1	2	3
Arthraxon hispidus	Small carpet grass	1	1	2
Caulerpa taxifolia	Caulerpa or Mediterranean killer algae	5	1	2
Conium maculatum	Poison hemlock	3	1	1
Glossostigma cleistanthum	Mudmats	1	1	3
Impatiens balfourii	Balfours touch-me-not	1	1	2
Melaleuca quinquenervia	Broad-leaved paperbark	1	1	1
Monochoria hastata	Monochoria, arrowleaf, or false pickerelweed	3	1	2
Monochoria vaginalis	Heartshape or false pickerelweed	3	1	2
Myosotis scorpioides	True Forget-Me-Not	1	1	3
Myriophyllum heterophyllum x *M. laxum*	Broadleaf Water-milfoil hybrid	1	1	1
Najas marina		1	1	2
Ottelia alismoides	Duck lettuce	4	1	3

Salvinia herzogii	Giant salvinia	5	1	2
Silphium perfoliatum	Cup-plant	1	1	1
Solanum tampicense	Wetland nightshade	1	1	1
Solidago sempervirens	Seaside Goldenrod	1	1	2
Cylindrospermopsis raciborskii	Cylindro	2	0	0
Salvinia auriculata	Eared watermoss, African payal, and butterfly fern	4	0	1
Salvinia biloba	Giant salvinia	4	0	1
Sparganium erectum	Exotic bur-reed	3	0	2

[a] *Cabomba*, while not native to the Great Lakes basin, is native to some portion of at least four Great Lakes states [USGS NAS]

Table 2. Ranked list of regulated animal species based on "weight of evidence (WOE) risk scores." Note: Not all species were evaluated by each risk assessment tool. The far-right column indicates the number of assessments (out of 4) completed for each species. The low risk scores assigned to some species of concern (e.g. the "least wanted" species) should be considered underestimates of likely risk. *Indicates a species included on the GSGP "least wanted" list. ^Indicates a species listed as "injurious wildlife" under the Lacey Act (18 U.S.C. 42).

Species name	**Common name**	**Jurisdictions regulated**	**Total WOE (out of 4)**	**# assessments completed (0-4)**
Channa argus^	Northern snakehead	10	4	4
*Ctenopharyngodon idella**	Grass carp	10	4	4
Gymnocephalus cernuus	Eurasian River ruffe	10	4	4
Hypophthalmichthys nobilis^	Bighead carp	10	4	4
*Limnoperna fortunei**	Golden mussel	5	4	4
Misgurnus anguillicaudatus	Weatherfish	4	4	4
Potamopyrgus antipodarum	New Zealand mud snail	4	4	4
Sander (*Stizostedion*) *lucioperca*^	Zander	9	4	4
Scardinius erythrophthalmus	Rudd	10	4	4
Alosa pseudoharengus	Alewife	2	3	3
Cyprinella lutrensis	Red Shiner	2	3	3
Cyprinus carpio	Common carp	3	3	3
*Dikerogammarus villosus**	Killer shrimp	5	3	3
Dreissena bugensis	Quagga mussels	9	3	3
Dreissena polymorpha^	Zebra mussel	9	3	3
Eriocheir sinensis^	Chinese mitten crab	5	3	3
Hemimysis anomala	Bloody red shrimp	2	3	3
Hypophthalmichthys molitrix^	Silver carp	10	3	4
Morone americana	White perch	4	3	3
Neogobius melanostomus	Round goby	10	3	3
Orconectes rusticus	Rusty crayfish	6	3	3
Perca fluviatilis^	European perch	3	3	3
Rutilus rutilus^	Roach	2	3	3
Tinca tinca	Tench	5	3	3
Alosa aestivalis	blueback herring	1	2	2
Bithynia tentaculata	Faucet snail	3	2	2
Bythotrephes longimanus (*cederstroemi*)	Spiny waterflea	3	2	2
Carassius auratus	Goldfish	4	2	2
Carassius gibelio^	Prussian carp	2	2	2

Channa bleheri^	Rainbow snakehead	9	2	2
Channa gachua^	Dwarf snakehead	9	2	2
Channa maculata^	Blotched snakehead	9	2	2
Channa marulius^	Bullseye snakehead	9	2	2
Channa punctata^	Spotted snakehead	9	2	2
Channa striata^	Chevron snakehead	9	2	2
*Cherax destructor**	Yabby	5	2	2
Cipangopaludina (*Bellamya*) *chinensis*	Chinese mystery snail	3	2	2
Corbicula fluminea	Asian clam	3	2	3
Daphnia lumholtzi	Water Flea	2	2	3
Gambusia affinis	Western mosquitofish	3	2	2
Gambusia holbrooki	Eastern mosquitofish	2	2	2
Gasterosteus aculeatus	Three spine stickleback	2	2	2
Lepomis microlophus	Redear sunfish	1	2	3
*Mylopharyngodon piceus**	Black carp	10	2	4
Myocastor coypus	Nutria	4	2	2
Osmerus mordax	Rainbow smelt	2	2	2
Perccottus glenii^	Amur sleeper	2	2	2
Phoxinus phoxinus^	Eurasian minnow	2	2	3
Procambarus clarkii	Red Swamp crayfish	3	2	2
Proterorhinus marmoratus (*semilunaris*)	Tubenose goby	10	2	3
*Pseudorasbora parva**^	Stone moroko	6	2	2
Rhodeus sericeus	Bitterling	3	2	2
*Silurus glanis**^	Wels-catfish	7	2	2
Acipenser ruthenus	Sterlet	1	1	2
Carassius carassius^	Crucian carp	2	1	2
Cercopagis pengoi	Fishhook waterflea	2	1	1
Clarias batrachus^	Walking catfish	4	1	1
Cherax tenuimanus	Marron	1	1	1
Cipangopaludina (*Bellamya*) *japonica*	Japanese trap door snail	3	1	2
Channa micropeltes^	Giant snakehead	9	1	2
Hypophthalmichthys harmandi^	Largescale silver carp	4	1	1
Lates niloticus^	Nile perch	1	1	1
Leuciscus idus	Ide	3	1	2
Melanoides tuberculata	Malaysian trumpet snail	1	1	1
Myxocyprinus asiaticus	Chinese hi-fin banded shark	1	1	1
Oncorhynchus gorbuscha	pink salmon	1	1	1

Oncorhynchus kisutch	coho salmon	1	1	1
Oncorhynchus mykiss	rainbow trout	1	1	1
Oncorhynchus tshawytscha	chinook salmon	1	1	1
Oreochromis aureus	Blue Tilapia	4	1	2
Oreochromis niloticus	Nile Tilapia	4	1	2
Petromyzon marinus	Sea lamprey	5	1	1
Pterois volitans	Red Lionfish	1	1	1
Salmo salar	Atlantic salmon	1	1	1
Salmo trutta	Brown trout	1	1	1
Salvelinus alpinus	arctic char	1	1	2
Salvelinus fontinalis and Salmo trutta hybrid	tiger trout	1	1	1
Trachemys scripta elegans	Red eared slider	2	1	1
Valvata piscinalis	European valve snail	1	1	2
Viviparus georgianus	Banded mystery snail	2	1	2
Xenopus laevis	African Clawed Frog	1	1	1
Carcinus maenas	European Green Crab	1	0	0
Crassostrea ariakensis	Suminoe Oyster	1	0	0
Fundulus diaphanus diaphanus	Eastern banded killifish	1	0	1
Hemigrapsus takanoi (*H. penicillatus*)	Brush-clawed Shore Crab, Grapsid Crab	1	0	0
Hemigrapsus sanguineus	Asian shore crab	1	0	0
Monopterus albus	Asian Swamp Eel	1	0	0
Pterois miles	Common Lionfish	1	0	0
Rapana venosa	Veined Rapa Whelk	1	0	0
Styela plicata	Asian Sea Squirt	1	0	0

Appendix 1.
PLANTS & ANIMALS

1. **Wisconsin Literature Review**: Wisconsin uses a review of existing literature (peer reviewed, agency reports, other "grey" literature) to evaluate invasion risk. Wisconsin provides an online archive of regulated and non-regulated AIS literature reviews for plants and animals. The Wisconsin approach includes information on current status and distribution (native range, abundance/range, range expansion, density, habitat, state regulation status), establishment potential and life history traits, damage potential (ecosystem, socio-economic), and control and prevention potential. The depth of information is not consistent across species; Some, but not all, have information on establishment in the Great Lakes basin, climate match, history of invasion, and prediction of invasion. For this study, any species that is regulated in Wisconsin was assigned a score of "1" (i.e. predicted invasive based on the state review process). For species that are not regulated in Wisconsin, we cannot distinguish whether the species was assessed by the state as non-invasive or whether the species was simply not assessed by the state. In either case, species that are not regulated in Wisconsin were assigned a score of "0." *Reference:* http://dnr.wi.gov/topic/invasives/species.asp?filterBy=Aquatic&filterVal=Y

2. **EPA (2008)**: This 2008 US EPA report, "Predicting future introductions of nonindigenous species to the Great Lakes" identified 156 "species of concern" based on evidence in the literature to suggest history of invasion, spread potential, and potential for ecological impact in the Great Lakes. For this study, species were assigned a score of "1" (i.e. predicted invasive) if ecological impact in the Great Lakes was evaluated as "high" or "medium." Species not included in the report or species with "low" or "not enough known" rankings were assigned a score of "0." *Reference:* EPA. 2008. Predicting future introductions of nonindigenous species to the Great Lakes. National Center for Environmental Assessment, Washington, DC; EPA/600/R-08/066F is available from the National Technical Information Service, Springfield, VA, and http://www.epa.gov/ncea).

3. **Great Lakes Aquatic Nonindigenous Species Risk Assessment (GLANSRA) framework**: The GLANSRA framework uses a consistent approach across all taxonomic groups to identify the potential for introduction, establishment, and impact of species identified in published literature as being highly likely to invade the Great Lakes Basin. GLANSRA assessments are completed using an exhaustive literature review that includes online species registries, aquatic invasive species databases, major bibliographic databases, peer-reviewed literature, published state and federal agency reports, reliable Internet sources on a variety of search terms, librarian services, expert consultation, and best professional judgment. Review is deemed sufficient after such searches exhaust these sources of information. For each assessment component, semi-quantitative scores are categorized into low, moderate, high, or unknown categories. An "unknown" classification indicates information is not available to answer a minimum number of questions for a given assessment component. For this study, species were assigned a score of "1" (i.e. predicted invasive) if assessed as having a categorical probability of high or moderate environmental and/or socio-economic impact (as determined by the quantitative score for those assessment components). Species assessed as "low" or "unknown" probability of impact , were assigned a score of "0." Species that have not been assessed with this method were also assigned a score "0."

Reference: Davidson, A. D., Fusaro, A. J., Sturtevant, R. A., Rutherford, E. S., & Kashian, D. R. (2017). Development of a risk assessment framework to predict invasive species establishment for multiple taxonomic groups and vectors of introduction. Management of Biological Invasions 8: 25-36.

ANIMALS ONLY

1. **Ecological Risk Screening Summaries, U.S. Fish and Wildlife Service:** This screening level assessment focuses on aquatic animal species and considers especially history of invasiveness and whether a species could develop self-sustaining populations based on climatic requirements. A peer-reviewed climate matching model that predicts a species' potential range by matching climate data in source and receiving ecosystems is used to predict an approximate geographic range in the U.S. International databases and peer-reviewed and/or other scientific literature are consulted to assess the species history of invasiveness (including impacts of introduction in other parts of the world). is factored into the risk-screening model. For this study, species were assigned a score of "1" (i.e. predicted invasive) if assessed as "High Risk" *or* if a species risk assessment was not publicly available but the species is listed as "injurious wildlife" under the Lacey Act (18 U.S.C. 42). Species assessed as "Low Risk" or "Uncertain Risk" were assigned a score of "0." Species that have not been assessed with this method and/or not listed as "injurious wildlife" were also assigned a score "0."
   Reference: https://www.fws.gov/fisheries/ans/species_erss_reports.html

PLANTS ONLY

1. **New York State Ranking System**: This semi-quantitative questionnaire based ranking system assesses the invasive nature of non-native plant species that are established in New York State, the potential invasiveness of species that are new arrivals or not yet present, and their impact on New York native species and natural ecosystems. This ranking system is a two-stage process: First, a species is ranked using a form containing a series of questions in four broad categories (Ecological impact=40 points, Biological characteristics and dispersal ability=25 points, Ecological amplitude and distribution=25 points, Difficulty of control=10 points) for a total of 100 points possible. A "New York Invasiveness Rank" is assigned based on the "relative maximum score" (i.e. points accrued as a percent of the maximum possible points for the questions that could be answered). For this study, species were assigned a score of "1" (i.e. predicted invasive) if assessed as rank "Very High," "High," or "Moderate Risk" (i.e. relative maximum score > 50). Species assessed as rank "Low," "Insignificant," or "Not Assesseable" were assigned a score of "0." Species that have not been assessed with this method were also assigned a score "0."
   Reference:
   http://www.nyis.info/pdf/New_York_State_Invasive_Plant_Ranking_System_Rev_2012.pdf

2. **Great Lakes Aquatic Weed Risk Assessment (GL AqWRA)**: This semi-quantitative questionnaire based risk assessment tool was modified from a system originally developed by New Zealand's Biosecurity Program. Responses to 38 questions that address biological, historical and environmental tolerance traits result in a total score for each plant species, indicating its risk of invasion. Based on assessments from a calibration data set of species with known invasion status (e.g. not established and established, not invasive vs. established, invasive), the threshold score maximizing model accuracy was 57. For this study, species were assigned a score of "1"

(i.e. predicted invasive) if the risk assessment resulted in a score > 57 (i.e. high risk). Species scoring lower than 57 were assigned a score of "0." Species that have not been assessed with this method were also assigned a score "0."

Reference: Gantz, C. A., Gordon, D. R., Jerde, C. L., Keller, R. P., Chadderton, W. L., Champion, P. D., & Lodge D.M. (2015). Managing the introduction and spread of non-native aquatic plants in the Laurentian Great Lakes: a regional risk assessment approach. Management of Biological Invasions 6: 45-55.

Appendix 2. GLANSRA pathway scores (score =100 indicates high probability of introduction via the respective pathway, per Davidson et al. 2017). Introduction potential has not been assessed for all species. See footnote for a description of the assessment questions associated with each pathway. *Indicates a species included on the GSGP "least wanted" list.

Species name	Dispersal	Hitchhiking /Fouling	Intentional Release	Escape - Recreation	Escape - Commercial	Shipping
Cabomba caroliniana	100	100	100	Unknown	0	0
*Egeria densa**	Unk	50	100	25	Unknown	0
*Hydrilla verticillata**	100	100	10	Unknown	Unknown	0
*Hydrocharis morsus-ranae**	100	100	100	Unknown	0	0
*Myriophyllum aquaticum**	100	100	100	75	Unknown	0
*Nymphoides peltate**	100	100	10	0	0	0
*Trapa natans**	100	100	0	0	0	0
Glyceria maxima	100	100	0	0	0	0
Lythrum salicaria						
Myriophyllum spicatum						
Najas minor	100	100	0	0	0	100
Potamogeton crispus						
Alnus glutinosa	100	100	100	100	0	0
Butomus umbellatus	100	100	100	100	0	0
Cirsium palustre	100	100	0	0	0	0
Eichhornia crassipes	100	100	100	75	75	0
Epilobium hirsutum	100	100	0	0	0	0
Hygrophilia polysperma	0	10	50	0	0	0
Iris pseudacorus						
Lagarosiphon major	0	10	Unknown	Unknown	0	0
Lysimachia vulgaris	100	0	100	100	0	0
Nelumbo nucifera	75	50	100	100	100	0
Phragmites australis						
Pistia stratiotes	100	100	100	100	Unknown	0
Arundo donax	100	100	100	100	0	0
Azolla pinnata	0	10	Unknown	0	0	0
Crassula helmsii	0	0	Unknown	0	0	0
Didymosphenia geminata	100	100	0	0	0	0
Eichhornia azurea	0	10	100	Unknown	0	0
Fallopia japonica						
Hydrocotyle ranunculoides	100	100	100	100	100	0
Ipomoea aquatica	0	10	100	0	0	0
Limnophila sessiliflora	0	10	10	25	0	0

Ludwigia hexapetala (*L. grandiflora*)	0	100	100	100	0	0
Ludwigia peploides	100	100	10	100	0	0
Lysimachia nummularia						
Lythrum virgatum	0	10	100	100	0	0
Murdannia keisak	0	10	10	0	0	0
Myriophyllum heterophyllum						
Nitellopsis obtusa	100	100	0	0	0	100
Oenanthe javanica	100	100	100	100	0	0
Phalaris arundinacea						
Prymnesium parvum	0	10	0	0	0	40
Sagittaria sagittifolia	0	0	10	25	0	0
Salix atrocinerea	100	100	0	0	0	0
Salvinia molesta	0	10	0	0	0	0
*Stratiotes aloides**	100	100	10	100	0	0
Typha angustifolia						
Typha domingensis	25	10	10	0	0	0
Typha laxmannii	0	0	100	Unknown	0	0
Typha x *glauca*	100	100	0	0	0	0
Ulva species	100	100	100	0	0	100
Valeriana officinalis	100	100	100	0	0	0
Arthraxon hispidus	0	10	0	0	0	0
Caulerpa taxifolia						
Conium maculatum						
Glossostigma cleistanthum	0	10	100	0	0	0
Impatiens balfourii	100	100	100	100	0	0
Melaleuca quinquenervia	0	10	0	0	0	0
Monochoria hastata	0	0	0	0	0	0
Monochoria vaginalis	0	0	0	0	0	0
Myosotis scorpioides						
Myriophyllum heterophyllum x *M. laxum*	0	10	Unknown	Unknown	0	0
Najas marina						
Ottelia alismoides	0	10	0	0	0	0
Salvinia herzogii	0	0	0	0	0	0
Silphium perfoliatum						
Solanum tampicense	0	0	0	0	0	0
Solidago sempervirens	100	100	100	100	0	0
Grateloupia turuturu						
Salvinia auriculata	0	10	100	0	50	0
Salvinia biloba	0	0	0	0	0	0

Sparganium erectum	0	0	10	0	0	0

Dispersal – Does this species occur near waters (natural or artificial) connected to the Great Lakes basin* (e.g., streams, ponds, canals, or wetlands)? ***Hitchhiking/Fouling*** – Is this species likely to attach to or be otherwise transported by, or along with, recreational gear, boats, trailers, fauna (e.g., waterfowl, fish, insects), flora (e.g., aquatic plants), or other objects (e.g., packing materials), including as parasites or pathogens, entering the Great Lakes basin? ***Intentional Release*** – Is this species sold at aquarium/pet/garden stores ("brick & mortar" or online), catalogs, biological supply companies, or live markets (e.g., purchased for human consumption, bait, ornamental, ethical, educational, or cultural reasons) ***Escape from Recreational Culture*** – Is this species being stocked/planted to natural waters or outdoor water gardens around the Great Lakes region? ***Escape from Commercial Culture*** – Is this species known to be commercially cultured in or transported through the Great Lakes region? ***Shipping*** – Is this species likely to be taken up in ballast, and capable of surviving adverse environments?

Appendix 3. GLANSRA pathway scores (score =100 indicates high probability of introduction via the respective pathway, per Davidson et al. 2017). Introduction potential has not been assessed for all species. See footnote for a description of the assessment questions associated with each pathway. *Indicates a species included on the GSGP "least wanted" list. ^Indicates a species listed as "injurious wildlife" under the Lacey Act (18 U.S.C. 42).

Species name	**Dispersal**	**Hitchhiking/ Fouling**	**Intentional Release**	**Escape - Recreation**	**Escape - Commercial**	**Shipping**
Channa argus*^	25	0	50	Unknown	0	0
Ctenopharyngodon idella*	100	0	50	75	25	0
Gymnocephalus cernuus	100	0	10	0	0	100
Hypophthalmichthys nobilis*^	75	0	50	25	50	0
Limnoperna fortunei*	0	0	0	0	0	8
Misgurnus anguillicaudatus	100	100	100	U	0	0
Potamopyrgus antipodarum*	100	100	0	0	0	100
Sander lucioperca*^	25	10	0	Unknown	0	0
Scardinius erythrophthalmus	100	0	U	0	0	0
Alosa pseudoharengus						
Cyprinella lutrensis	75	50	100	100	0	0
Cyprinus carpio						
Dikerogammarus villosus*	0	0	0	0	0	40
Dreissena bugensis						
Dreissena polymorpha^						
Eriocheir sinensis^	100	100	Unknown	Unknown	0	100
Hemimysis anomala	100	100	0	0	0	100
Hypophthalmichthys molitrix*^	75	0	50	0	50	0
Morone americana						
Neogobius melanostomus						
Orconectes rusticus	100	0	100	0	0	0
Perca fluviatilis^	0	0	0	0	0	40
Rutilus rutilus^	0	0	10	0	0	40
Tinca tinca*	25	10	0	U	0	0
Alosa aestivalis	100	100	0	0	0	0

Bithynia tentaculata						
Bythotrephes longimanus						
Carassius auratus						
Carassius gibelio^	0	Unknown	Unknown	Unknown	Unkwown	0
Channa bleheri^						
Channa gachua^						
Channa maculata^						
Channa marulius^						
Channa punctata^						
Channa striata^						
Cherax destructor*	0	0	50	0	0	0
Cipangopaludina (Bellamya) chinensis						
Corbicula fluminea						
Daphnia lumholtzi	100	100	0	0	0	100
Gambusia affinis	100	100	100	100	0	0
Gambusia holbrooki	100	100	100	100	0	0
Gasterosteus aculeatus	100	100	0	0	0	100
Lepomis microlophus	100	0	U	0	0	0
Mylopharyngodon piceus*	25	U	0	0	0	0
Myocastor coypus	25	0	0	0	0	0
Osmerus mordax						
Perccottus glenii^	0	0	10	0	0	40
Phoxinus phoxinus^	0	0	0	0	0	40
Procambarus clarkii	100	100	100	U	0	0
Proterorhinus marmoratus	100	100	0	0	0	100
Pseudorasbora parva*^	0	10	Unknown	0	0	0
Rhodeus sericeus	0	10	100	0	0	0
Silurus glanis*^	0	0	Unknown	0	0	0
Acipenser ruthenus	0	0	10	Unknown	0	0
Carassius carassius^	0	0	10	0	0	0
Cercopagis pengoi						
Clarias batrachus^						
Cherax tenuimanus	0	0	10	0	0	0
Cipangopaludina (Bellamya) japonica	100	100	Unknown	Unknown	0	0
Channa micropeltes^						
Hypophthalmichthys harmandi^						

Lates niloticus^						
Leuciscus idus	Unknown	0	100	100	0	0
Melanoides tuberculata						
Myxocyprinus asiaticus						
Oncorhynchus gorbuscha						
Oncorhynchus kisutch						
Oncorhynchus mykiss						
Oncorhynchus tshawytscha						
Oreochromis aureus						
Oreochromis niloticus						
Petromyzon marinus						
Pterois volitans						
Salmo salar						
Salmo trutta						
Salvelinus alpinus	0	10	0	0	100	0
Salvelinus fontinalis and Salmo trutta hybrid						
Trachemys scripta elegans	100	100	100	100	U	0
Valvata piscinalis	100	100	0	0	0	100
Viviparus georgianus	100	100	100	U	0	0
Xenopus laevis	0	0	100	0	100	0
Carcinus maenas						
Crassostrea ariakensis						
Cylindrospermopsis raciborskii						
Fundulus diaphanus diaphanus	100	100	0	0	0	0
Hemigrapsus takanoi (H. penicillatus)						
Hemigrapsus sanguineus						
Monopterus albus						
Pterois miles						
Rapana venosa						
Styela plicata						

Dispersal – Does this species occur near waters (natural or artificial) connected to the Great Lakes basin* (e.g., streams, ponds, canals, or wetlands)? ***Hitchhiking/Fouling*** – Is this species likely to attach to or be otherwise transported by, or along with, recreational gear, boats, trailers, fauna (e.g., waterfowl, fish, insects), flora (e.g., aquatic plants), or other objects (e.g., packing materials), including as parasites or pathogens, entering the Great Lakes basin? ***Intentional Release*** – Is this species sold at aquarium/pet/garden stores (“brick & mortar” or online), catalogs, biological supply companies, or live

markets (e.g., purchased for human consumption, bait, ornamental, ethical, educational, or cultural reasons) ***Escape from Recreational Culture*** – Is this species being stocked/planted to natural waters or outdoor water gardens around the Great Lakes region? ***Escape from Commercial Culture*** – Is this species known to be commercially cultured in or transported through the Great Lakes region? ***Shipping*** – Is this species likely to be taken up in ballast, and capable of surviving adverse environments?

Appendix 4. Regulated plant species showing date of first listing for each jurisdiction (as of Oct 2017).

Spp name	Common name	IL	IN	MI	MN	NY	OH	ONT	PA	QBC	WI
Alnus glutinosa	European alder										2015
Arthraxon hispidus	Small carpet grass					2014					
Arundo donax	Giant reed										2015
Azolla pinnata	Mosquito fern	2013	2012		2008						2015
Butomus umbellatus	Flowering rush	2013	2012	2005	2008						2009
Cabomba caroliniana	Carolina fanwort			2009	2012	2014					2009
Caulerpa taxifolia	Caulerpa or Mediterranean killer algae	2013	2012		2008	2014					2015
Cirsium palustre	Marsh Thistle										2009
Conium maculatum	Poison hemlock11						1994	1990			2009
Crassula helmsii	Australian stonecrop				2008						2009
Didymosphenia geminata	Didymo					2014					2009
Egeria densa	Brazilian elodea, Brazilian waterweed	2013	2012	2005	2012	2014		2016			2009
Eichhornia azurea	Anchored water hyacinth3	2013	2007		2008						2015
Eichhornia crassipes	Water hyacinth				2014						2015
Epilobium hirsutum											2009
Fallopia japonica	Japanese knotweed	2016		2004		2014	2010	2016			2009
Glossostigma cleistanthum	Mudmats										2015
Glyceria maxima	Reed manna grass					2014					2009
Grateloupia turuturu	Red algae					2014					
Hydrilla verticillata	Hydrilla or water thyme	2013	2012	2005	2008	2014		2016			2009
Hydrocharis morsus-ranae	European frogbit or common frogbit	2013	2012	2005	2008	2014					2009
Hydrocotyle ranunculoides	Floating Marsh Pennywort										2015
Hygrophilia polysperma	Miramar weed, Indiana swampweed or hygro	2013	2012		2008						2015
Impatiens balfourii	Balfours touch-me-not										2015
Ipomoea aquatica	Chinese waterspinach or swamp morning-glory	2013	2012		2012						2015
Iris pseudacorus	Yellow flag iris or tall yellow iris	2013	2012		2012	2014					2015
Lagarosiphon major	Oxygen weed or African elodea	2013	2012	2005	2008						2009
Limnophila sessiliflora	Asian marshweed or ambulia	2013	2012		2008						2015
Ludwigia hexapetala (L. grand	Uruguayan Primrose Willow					2014					
Ludwigia peploides	Floating Primrose Willow					2014					
Lysimachia nummularia	Creeping jenny										2009
Lysimachia vulgaris	Garden loosestrife					2014					2015
Lythrum salicaria	Purple loostrife2,4	1987	1996	2005	2008	2014	1986		1997		2009
Lythrum virgatum	Wanded loosestrife		1996		2008				1989		2015
Melaleuca quinquenervia	Broad-leaved paperbark				2008						
Monochoria hastata	Monochoria, arrowleaf, or false pickerelweed	2013	2012		2008						
Monochoria vaginalis	Heartshape or false pickerelweed	2013	2012		2008						
Murdannia keisak	Marsh Dewflower					2014					
Myosotis scorpioides	True Forget-Me-Not										2015
Myriophyllum aquaticum	Parrot feather or parrot feather watermilfoil	2013	2012	2005	2012	2014		2016			2009
Myriophyllum heterophyllum	Broadleaf Water-milfoil					2014					
Myriophyllum heterophyllum	Broadleaf Water-milfoil hybrid					2014					
Myriophyllum spicatum	Eurasian watermilfoil	2013	2012	2005	2008	2014					2009
Najas marina											2015
Najas minor	Brittle naiad or brittle water nymph	2013	2012		2008						2009
Nelumbo nucifera	Sacred lotus										2015
Nitellopsis obtusa	Starry stonewort			2009	2016						2009
Nymphoides peltata	Yellow floating heart	2013	2012	2005		2014					2009
Oenanthe javanica	water -celery										2015
Ottelia alismoides	Duck lettuce	2013	2012		2008						2015
Phalaris arundinacea	Reed Canary Grass										2015
Phragmites australis	Common reed			2005	2013	2014		2016			2009
Pistia stratiotes	Water lettuce										2015
Potamogeton crispus	Curlyleaf pondweed	2013	2012	2005	2008	2014					2009
Prymnesium parvum	Golden Algae					2014					2009
Sagittaria sagittifolia	Arrowhead	2013	2012		2008						2015
Salix atrocinerea	Gray Florist's Willow					2014					
Salvinia auriculata	Eared watermoss, African payal, and butterfly fern	2013	2012	2005	2008						
Salvinia biloba	Giant salvinia	2013	2012	2005	2008						
Salvinia herzogii	Giant salvinia	2013	2012	2005	2008						2015
Salvinia molesta	Giant salvinia	2013	2012	2005	2008						2015
Silphium perfoliatum	Cup-plant					2014					
Solidago sempervirens	Seaside Goldenrod										2015
Sparganium erectum	Exotic bur-reed	2013	2012		2008						
Stratiotes aloides	Water soldier7	2015		2015	2008			2016			2015
Trapa natans	Water chestnut	2013	2012	2005	2008	2014		2016			2009
Typha angustifolia	Narrow leaf cattail		2012								2009
Typha domingensis	Southern Cat-Tail										2015
Typha X glauca											2009
Typha laxmannii	Graceful cattail										2015
Valeriana officinalis	Garden valerian										2015
Solanum tampicense	Wetland nightshade				2008						
Ulva species, including specie	Green Alga										2009

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Appendix 5. Regulated animal species showing date of first listing for each jurisdiction (as of Oct 2017).

Spp name	Common name	IL	IN	MI	MN	NY	OH	ONT	PA	QBC	WI
Acipenser ruthenus	Sterlet										2009
Alosa aestivalis	blueback herring									2012	
Alosa pseudoharengus	Alewife				2012						2009
Bithynia tentaculata	Faucet snail				2014	2014					2009
Bythotrephes longimanus (cederstroemi)	Spiny waterflea				2012	2014					2009
Carassius auratus	Goldfish				2012	2015				2012	2009
Carassius carassius	Crucian carp				2014		2016				
Carassius gibelio	Prussian carp				2014		2016				
Carcinus maenas	European Green Crab					2014					
Cercopagis pengoi	Fishhook waterflea					2014					2009
Channa argus	Northern snakehead	2003	2003	2004	2008	2004	2002	2004	2002	2012	2009
Channa bleheri	Rainbow snakehead	2003	2003	2004		2004	2002	2004	2002	2012	2009
Channa gachua	Dwarf snakehead	2003	2003	2004		2004	2002	2004	2002	2012	2009
Channa maculata	Blotched snakehead	2003	2003	2004		2004	2002	2004	2002	2012	2009
Channa marulius	Bullseye snakehead	2003	2003	2004		2004	2002	2004	2002	2012	2009
Channa micropeltes	Giant snakehead	2003	2003	2004		2004	2002	2004	2002	2012	2009
Channa punctata	Spotted snakehead	2003	2003	2004		2004	2002	2004	2002	2012	2009
Channa striata	Chevron snakehead	2003	2003	2004		2004	2002	2004	2002	2012	2009
Cherax destructor	Yabby	2015		2014	2016		1989	2016			
Cherax tenuimanus	Marron						2016				
Cipangopaludina (Bellamya) chinensis	Chinese mystery snail				2012	2014					2009
Cipangopaludina (Bellamya) japonica	Japanese trap door snail				2012	2014					2015
Clarias batrachus	Walking catfish	2003	1998			2014	1985				
Corbicula fluminea	Asian clam		1998			2014					2009
Crassostrea ariakensis	Suminoe Oyster					2014					
Ctenopharyngodon idella	Grass carp	2015	1992	2004	2008	2012	1985	2004	1987	2012	2009
Cylindrospermopsis raciborskii	Cylindro			2009		2014					
Cyprinella lutrensis	Red Shiner					2014					2009
Cyprinus carpio	Common carp				1998	2015					2009
Daphnia lumholtzi	Water Flea					2014					2009
Dikerogammarus villosus	Killer shrimp	2015		2014			2014	2016			2015
Dreissena (rostriformis) bugensis	Quagga mussels	2003	1998	2009	2008	2014	2000	2015	2003		2009
Dreissena polymorpha	Zebra mussel	2003	1998	2009	2008	2014	2000	2015	2003		2009
Eriocheir sinensis	Chinese mitten crab	2003				2014	2016			2012	2009
Fundulus diaphanus diaphanus	Eastern banded killifish						2000				
Gambusia affinis	Western mosquitofish				2014	2014					2009
Gambusia holbrooki	Eastern mosquitofish					2014					2009
Gasterosteus aculeatus	Three spine stickleback						2000				2009
Gymnocephalus cernuus	Eurasian River ruffe	2003	1998	2009	2008	2014	1997	2007	2006	2012	2009
Hemigrapsus takanoi (H. penicillatus)	Brush-clawed Shore Crab, Grapsid Crab					2014					
Hemigrapsus sanguineus	Asian shore crab					2014					
Hemimysis anomala	Bloody red shrimp					2014					2009
Hypophthalmichthys harmandi	Largescale silver carp				2014	2014	2016			2012	
Hypophthalmichthys molitrix	Silver carp	2005	2003	2004	2008	2004	1985	2004	2003	2012	2009
Hypophthalmichthys nobilis	Bighead carp	2005	2003	2004	2008	2004	1985	2004	2003	2012	2009
Lates niloticus	Nile perch						2016				
Lepomis microlophus	Redear sunfish										2009
Leuciscus idus	Ide			2004			2016				2009
Limnoperna fortunei	Golden mussel	2015		2014			2014	2016			2015
Melanoides tuberculata	Malaysian trumpet snail										2015
Misgurnus anguillicaudatus	Weatherfish			2004	2014	2014					2009
Monopterus albus	Asian Swamp Eel					2014					
Morone americana	White perch		2013		2008		2000				2009
Mylopharyngodon piceus	Black carp	2003	2003	2004	2008	2004	1985	2004	2003	2012	2009
Myocastor coypus	Nutria			2009		2014					2015
Myxocyprinus asiaticus	Chinese hi-fin banded shark										2009
Neogobius melanostomus	Round goby	2003	1998	2009	2008	2000	1997	2007	2003	2012	2009
Oncorhynchus gorbuscha	pink salmon										2009
Oncorhynchus kisutch	coho salmon										2009
Oncorhynchus mykiss	rainbow trout										2009
Oncorhynchus tshawytscha	chinook salmon										2009
Orconectes rusticus	Rusty crayfish	2003		2009	2012	2014			2005	2012	2009
Oreochromis aureus	Blue Tilapia				1998	2014			1987		2009
Oreochromis niloticus	Nile Tilapia				1998	2014			1987		2009
Osmerus mordax	Rainbow smelt				1998						2009
Perca fluviatilis	European perch				2014		2016			2012	
Perccottus glenii	Amur sleeper				2014		2016				
Petromyzon marinus	Sea lamprey				2008	2014	2000			2012	2009
Phoxinus phoxinus	Eurasian minnow				2014		2016				
Potamopyrgus antipodarum	New Zealand mud snail			2014	2008	2014					2009
Procambarus clarkii	Red Swamp crayfish			2014	2014						2009
Proterorhinus marmoratus (semilunaris)	Tubenose goby	2003	1998	2009	2008	2014	1997	2007	2003	2012	2009
Pseudorasbora parva	Stone moroko	2015	2015	2014	2014		2014	2016			
Pterois miles	Common Lionfish					2015					
Pterois volitans	Red Lionfish					2015					
Rapana venosa	Veined Rapa Whelk					2014					
Rhodeus sericeus	Bitterling			2004			2016				2009
Rutilus rutilus	Roach				2014		2016				
Salmo salar	Atlantic salmon										2009
Salmo trutta	Brown trout										2009
Salvelinus alpinus	arctic char										2009
Salvelinus fontinalis and Salmo trutta hybrid	tiger trout										2009
Sander (Stizostedion) lucioperca	Zander	2015	2015	2014	2008	2014	2014	2016		2012	2009
Scardinius erythrophthalmus	Rudd	2003	1998	2004	2008	2014	2000	2007	2003	2012	2009
Silurus glanis	Wels-catfish	2015	2015	2014	2014		2014	2016		2012	
Styela plicata	Asian Sea Squirt					2014					
Tinca tinca	Tench			2004		2014	2016			2012	2009
Trachemys scripta elegans	Red eared slider				2014	2015					
Valvata piscinalis	European valve snail										2015
Viviparus georgianus	Banded mystery snail				2014						2015
Xenopus laevis	African Clawed Frog					2015					