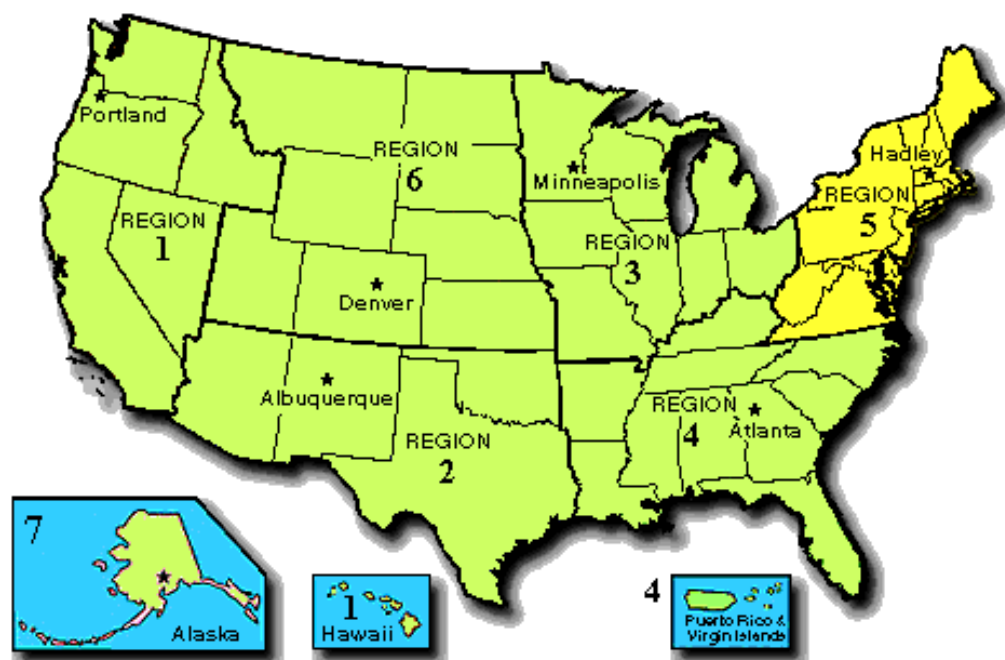


## Summary Report of Nonindigenous Aquatic Species in U.S. Fish and Wildlife Service Region 5



**U.S. Fish & Wildlife Service Regions**



# Summary Report of Nonindigenous Aquatic Species in U.S. Fish and Wildlife Service Region 5

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## Introduction

Distribution information on nonindigenous aquatic species is generally widely scattered and difficult to find. Resource managers, scientists, policymakers, and even the public could benefit from accessibility of distribution, status, identification, and habitat information about nonindigenous species. When more information is accessible, better decisions can be made for managing or possibly eradicating nonindigenous species that are invasive or have the potential to become invasive. With that in mind, the focus of the Nonindigenous Aquatic Species (NAS) Database has been to document and verify these species known to have been introduced in the United States.

The northeast region of the US from Virginia to Maine, U.S. Fish and Wildlife Service Region 5, is important in terms of nonindigenous and invasive species. The following summary report provides an inventory of all known freshwater macrophytes that are present or have become established (i.e. naturalized) and marine and freshwater aquatic animals which may or may not be naturalized in New England and the Mid-Atlantic United States. Specific information has been compiled from the Nonindigenous Aquatic Species Database (<http://nas.er.usgs.gov/>), an online inventory developed for tracking aquatic introductions in the United States. Occurrence data is derived from monitoring programs, herbarium and museum voucher specimens, published accounts, and professional observations. In some cases species distribution is known only superficially due to significant gaps in collection and monitoring data. Increased efforts in the collection and provision of spatial data are needed at the local, regional, and national levels to permit more precise mapping of aquatic introductions.

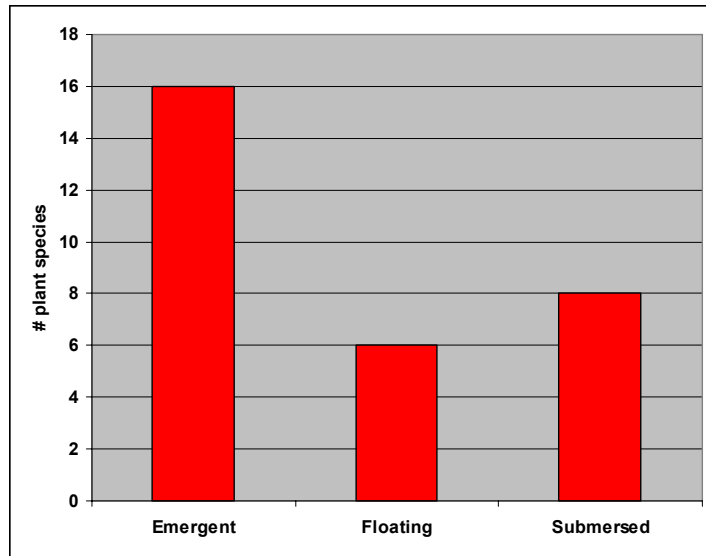
This summary report is in the form of species profiles which contain information about identification, habitat, reproduction, distribution, impacts, and methods of introduction of each species found in the region. Aquatic macrophyte and animal distributions are mapped according to river drainage to relate locality data within natural drainage systems. River drainages are described by the U.S. Geological Survey's (USGS) Hydrologic Unit Codes (HUC), a nested classification which identifies hydrologic regions at four levels in the United States. Maps herein employ the smallest drainage level (8-digit HUC) where the species has been either, naturalized, collected, or observed. Red stars (★) on the map indicate the presence of a species within a state when locality information is not known. Green stars (★) represent species presence within a particular area of a state, such as a county, when the drainage can not be determined. The US map highlights all states which have had a particular species introduced at some instance in time. Shaded areas on both maps do not necessarily imply occurrence throughout the drainage or state, but at a minimum, a collection or observation was made. The native ranges of these species are described in the text, not on the maps. The description of the **Nonindigenous Range** in each profile gives some details for locations in the New England and Mid-Atlantic region. For easier reading, information in the profiles is not cited. However, sources for information are listed in the **Reference** section at the end of this report.

The early settlers to North America knowingly introduced many plants and animals from Europe, Asia, and Africa to satisfy various agricultural, horticultural, and aquacultural needs. At the same time, many of these imported species were contaminated with non-target species. For example, before water was used for ballast, dry ballast aboard ships from Europe was dumped at American ports which contained a variety of contaminants including seeds of foreign plants. Since those early days until today, 250 species of aquatic animals and 30 species of aquatic plants having been introduced to this region. The most widely recognized methods of more recent freshwater introductions include the annual stocking of game fish, bait bucket introductions, manmade canals which have allowed the flow of organisms from one waterbody to another, nursery and water garden trade, and aquarium enthusiasts who discard animals and especially plants into open waters. In the marine and estuarine environments, ballast water and mariculture have been primarily responsible for introductions. All of these methods have led to the establishment of non-native species in the Mid-Atlantic and New England states.

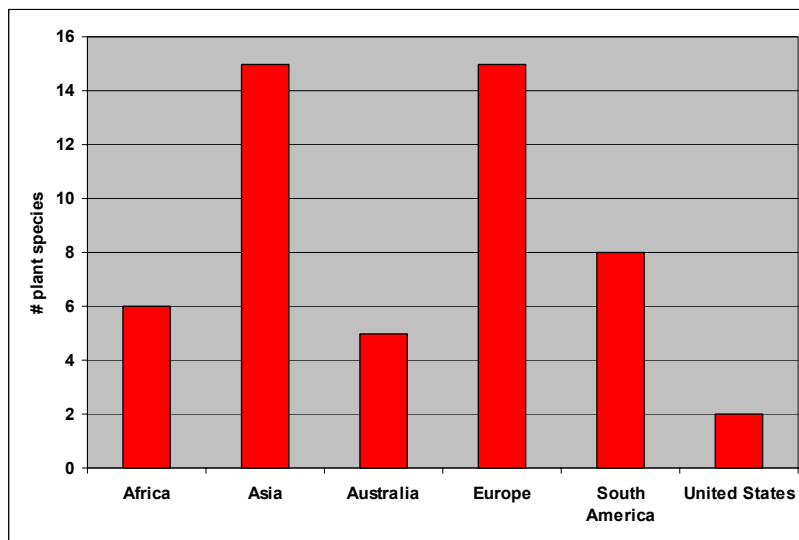
## Aquatic Macrophytes

Nonindigenous plants are stressors of aquatic ecosystems. Many species can form large monocultures that alter the abundance and diversity of the native flora or disturb physical aspects such as water flow, light penetration and dissolved oxygen concentration. While not all introduced aquatic plants convey extreme impacts, the consequences of most introductions have yet to be understood. Fundamentally, the establishment of nonindigenous plants preempts habitat for native species. As new taxa are introduced and the range of previously introduced species increases, specific knowledge of their distribution and potential range is imperative for resource management.

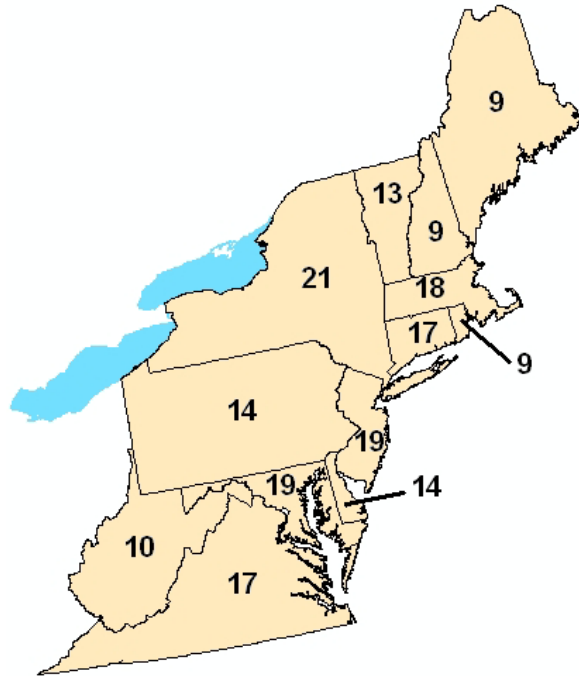
Thirty nonindigenous aquatic plant species representing twenty-four families are catalogued herein as established or present in the thirteen states comprising Region 5. Sixteen species grow as emergent plants, six grow floating, and eight grow submersed (Figure 1). All thirty species originate from every continent except Antarctica (Figure 2). Species native to more than one continent, therefore, are represented as such. Two tropical species *Pistia stratiotes* (water lettuce) and *Eichhornia crassipes* (water hyacinth) appear to pose little threat to Region 5 ecosystems. However, others such as *Myriophyllum spicatum* (Eurasian water milfoil) and *Potamogeton crispus* (curly pondweed) are more climatically adapted and aggressively persistent. Two species, *Cabomba caroliniana* (Carolina fanwort) and *Myriophyllum heterophyllum* (two-leaf water milfoil), are native to North America and have been introduced to the Mid-Atlantic region. New York hosts the highest number of introduced aquatic plant species (21); Maryland and New Jersey each have 19 (Figure 3).



**Figure 1.** Growth form categories of aquatic plant species introduced to Region 5.

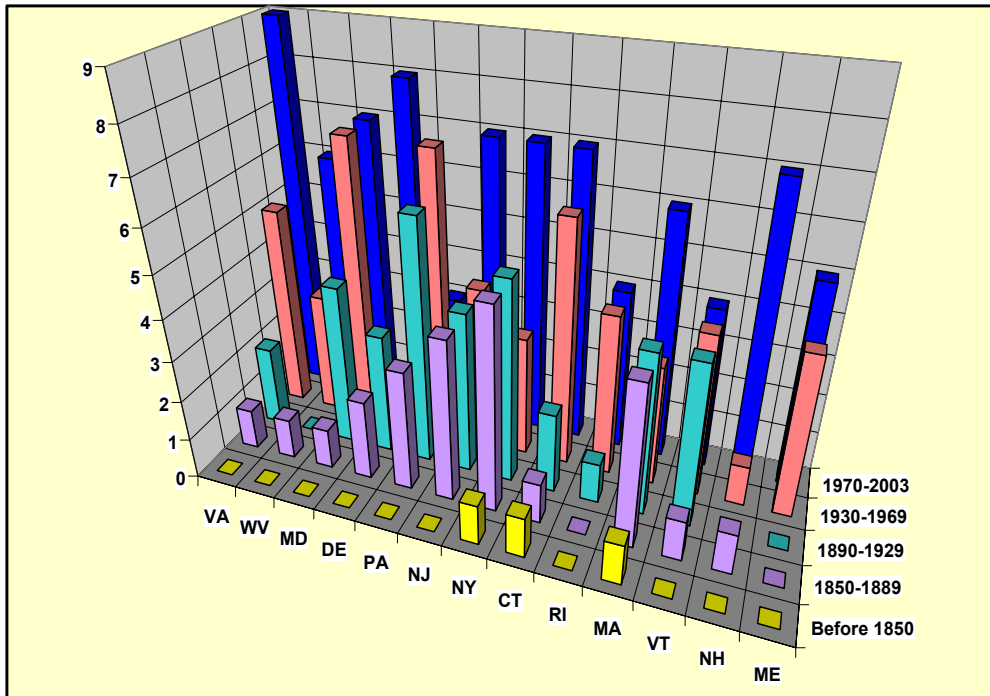


**Figure 2.** Origin of aquatic plant species introduced to Region 5.



**Figure 3.** Total number of nonindigenous aquatic macrophytes introduced by state within Region 5.

Long time introductions *Iris pseudacorus* (yellow iris), *Lythrum salicaria* (purple loosestrife) and *Nasturtium officinale* (watercress) are widely distributed in all thirteen Region 5 states. *Myriophyllum spicatum* and *Potamogeton crispus* occur in twelve (Table 1). In the last thirty years, more new species have appeared in Region 5 than in the earlier 30 year time frames designated since 1850 (Figure 4). *Hydrilla verticillata* (hydrilla), *Egeria densa* (Brazilian waterweed) and a newly described hybrid form of *Myriophyllum heterophyllum* are highly invasive and currently expanding to new territories within the region. The most recent introductions; *Glyceria maxima* (reed mannagrass), *Glossostigma diandrum* (mudmat) and *Marsilea mutica* (nardoo) are still limited in range.



**Figure 4.** Introductions of aquatic plant species to Region 5 states over forty-year time increments from 1850 to present. Bars represent the number of species making their first appearance in a given state. Quantities are not cumulative but indicate the number of new introductions per time increment. Species are added either as range expansions from adjoining states or new introductions from outside of the region. The earliest introductions, *Lythrum salicaria* and *Nasturtium officinale* were recorded in 1831.

Species are categorized as submersed, emergent, or floating plants. Each is detailed in an account that includes a chart indicating the earliest known occurrence in each state. Dates with an asterisk (\*) indicate that the actual year of introduction is not known. The date provided is the publication date of the citation where this species was first recorded. Additional records of nonindigenous species from refuge or other lands and waters are welcomed at: <http://nas.er.usgs.gov/reportcol.htm>.



| Family                  | Species Name   | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|-------------------------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|
| <b>Alismataceae</b>     | <i>Sagittaria montevidensis</i> subsp. <i>montevidensis</i> (long-lobed arrowhead) |    |    |    |    |    | X  |    |    |    |    |    |    |    |
| <b>Amaranthaceae</b>    | <i>Alternanthera philoxeroides</i> (alligatorweed)                                 | X  |    |    |    |    |    |    |    |    |    |    |    |    |
| <b>Araceae</b>          | <i>Pistia stratiotes</i> (water lettuce)   |    |    | X  | X  |    | X  | X  |    | X  |    |    |    |    |
| <b>Brassicaceae</b>     | <i>Nasturtium officinale</i> (watercress)  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
|                         | <i>Rorippa amphibia</i> (amphibious yellowcress)                                   |    |    |    |    |    |    | X  | X  |    | X  | X  |    | X  |
| <b>Butomaceae</b>       | <i>Butomus umbellatus</i> (flowering rush)   |    |    |    |    | X  |    | X  | X  |    |    | X  |    | X  |
| <b>Cabombaceae</b>      | <i>Cabomba caroliniana</i> (Carolina fanwort)                                      |    |    |    | X  | X  | X  | X  | X  | X  | X  | X  |    |    |
| <b>Callitrichaceae</b>  | <i>Callitriche stagnalis</i> (pond water-starwort)                                 | X  |    | X  |    | X  | X  | X  | X  |    | X  |    |    |    |
| <b>Commelinaceae</b>    | <i>Murdannia keisak</i> (marsh dewflower)  | X  |    | X  | X  |    |    |    |    |    |    |    |    |    |
| <b>Haloragaceae</b>     | <i>Myriophyllum aquaticum</i> (parrot feather)                                     | X  | X  | X  | X  | X  | X  | X  | X  |    |    |    |    |    |
|                         | <i>Myriophyllum heterophyllum</i> (two-leaf water milfoil)                         |    |    |    |    |    | X  | X  | X  | X  | X  |    | X  | X  |
|                         | <i>Myriophyllum spicatum</i> (Eurasian water milfoil)                              | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| <b>Hydrocharitaceae</b> | <i>Egeria densa</i> (Brazilian waterweed)  | X  |    | X  | X  | X  | X  | X  | X  |    | X  | X  | X  |    |
|                         | <i>Hydrilla verticillata</i> (hydrilla)  | X  |    | X  | X  | X  | X  |    | X  |    | X  |    |    | X  |
|                         | <i>Hydrocharis morsus-ranae</i> (European frogbit)                                 |    |    |    |    |    |    | X  |    |    |    | X  |    |    |
| <b>Iridaceae</b>        | <i>Iris pseudacorus</i> (yellow iris)  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| <b>Lemnaceae</b>        | <i>Landoltia punctata</i> (dotted duckweed)  | X  |    | X  | X  | X  |    |    |    |    | X  |    |    |    |
| <b>Lythraceae</b>       | <i>Lythrum salicaria</i> (purple loosestrife)                                      | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| <b>Marsileaceae</b>     | <i>Marsilea quadrifolia</i> (European watercress)                                  |    |    | X  |    | X  | X  | X  | X  |    | X  |    |    | X  |
|                         | <i>Marsilea mutica</i> (nardoo)  | X  |    |    |    |    |    |    |    |    |    |    |    |    |
| <b>Menyanthaceae</b>    | <i>Nymphoides peltata</i> (yellow floatingheart)                                   |    |    | X  |    | X  | X  | X  | X  | X  | X  | X  |    |    |
| <b>Najadaceae</b>       | <i>Najas minor</i> (brittle naiad)   | X  | X  | X  |    | X  |    | X  |    |    | X  | X  | X  |    |
| <b>Nelumbonaceae</b>    | <i>Nelumbo nucifera</i> (sacred lotus)   |    | X  | X  |    |    | X  | X  |    |    |    |    |    |    |
| <b>Onagraceae</b>       | <i>Ludwigia hexapetala</i> (Uruguay seedbox)                                       | X  | X  |    | X  | X  |    | X  |    |    |    |    |    |    |
| <b>Poaceae</b>          | <i>Glyceria maxima</i> (reed mannagrass)   |    |    |    |    |    |    |    |    |    | X  |    |    |    |
| <b>Pontederiaceae</b>   | <i>Eichhornia crassipes</i> (water hyacinth)                                       | X  |    | X  | X  |    | X  | X  |    |    |    |    |    |    |
| <b>Potamogetonaceae</b> | <i>Potamogeton crispus</i> (curly pondweed)  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| <b>Scrophulariaceae</b> | <i>Glossostigma diandrum</i> (mud mat)   |    |    |    |    | X  | X  |    |    |    |    |    |    |    |
|                         | <i>Veronica beccabunga</i> (European brooklime)                                    |    | X  | X  |    | X  | X  | X  | X  |    | X  |    |    | X  |
| <b>Trapaceae</b>        | <i>Trapa natans</i> (water chestnut)   | X  |    | X  |    | X  | X  | X  | X  |    | X  | X  | X  |    |

**Table 1.** Nonindigenous aquatic plant species recorded in states of Region 5.

## Submersed Plants

Family: Cabombaceae

***Cabomba caroliniana*** Gray. (Carolina fanwort)



K. Dressler, 1996



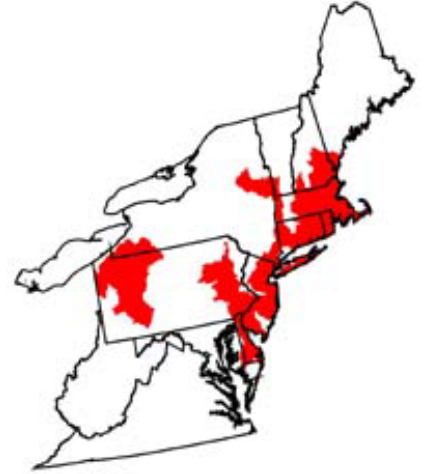
**Field Description:** Submersed aquatic perennial with low-branching stems forming two types of leaves. Submersed leaves are opposite, fan shaped and dissected into linear segments, each segment ending in a blunt tip. Floating leaves are alternate, smaller and diamond in shape. Flowers are borne singly, colored white to purple, and form elongated fruits with 3 seeds.

**Habitat:** Prefers ponds and lakes yet will colonize slow-moving streams in water 1 - 3 m deep.

**Native Range:** Southeastern United States, north to and including Virginia.

Also native to South America.

**Nonindigenous Range:** Established sporadically in the Northeast, Great Lakes and northwest regions of the United States. Introduced in the Mid-Atlantic States north of Virginia where populations have been documented since the late 1800s. Widely distributed and common throughout the coastal states, less occasional inland.



| DE   | PA   | NJ   | NY    | CT   | RI   | MA   | VT   |
|------|------|------|-------|------|------|------|------|
| 1897 | 1938 | 1901 | 1996* | 1937 | 1932 | 1895 | 1962 |

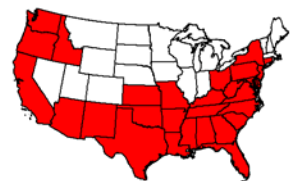
**Comments:** Persistent and competitive with the ability to form dense stands. Invasive where introduced in the U.S., as well as in Australia, India and Japan. Reproduction by seed is rare in the northeastern U.S., plants spread and perennate by vegetative fragments. Submersed plants are often mistaken for *Myriophyllum* or *Limnophila*. Historical plant of the aquarium trade still sold today.

Family: Haloragaceae

***Myriophyllum aquaticum*** (Vell.) Verdc. (parrot feather)



V. Ramley © 2001



**Field Description:** Submersed stems are lanky with widely spaced feather-like leaves. Recognize this species by the distinctive emergent leaves that form dense blue-green masses of foliage that extend to 20 cm above the water. Entire plants become amphibious with water drawdown. Inconspicuous female flowers located in the leaf axils are rarely seen.

**Habitat:** Shallow, sluggish waters to 1 m



deep, including swamps, ponds and ditches.

**Native Range:** South America.

**Nonindigenous Range:** Occurring most frequently, often to become locally dominant, in the southern United States and Hawaii. Occasionally established in more temperate states.

Introduced to the Mid-Atlantic States, especially in Virginia where it heavily colonizes sites in over ten counties. Sporadic and less occasional in the remaining states although extending recently as far north as Connecticut (Quinnipiac drainage).

| VA   | WV   | MD   | DE   | PA   | NJ   | NY   | CT   |
|------|------|------|------|------|------|------|------|
| 1970 | 1970 | 1950 | 1980 | 1950 | 1890 | 1929 | 2001 |

**Comments:** The absence of male plants in the U.S. implicates reproduction solely by vegetative propagules. Mat formation is prevalent in the southern U.S. Potentially invasive through the lower half of Region 5. Popularly sold as a water garden ornamental as well as an aquarium plant, this species readily escapes cultivation.

***Myriophyllum heterophyllum*** Michx. (two-leaf water milfoil)



**Field Description:** Submersed aquatic perennial with thick red-green stems (3-6 mm). Brittle, filamentous leaves are arranged in compacted whorls spaced closely apart (3-6 mm) on the stem. Each leaf dissected into 16-24 filaments with the lower filaments as long as or longer than the leaf axis. Tips of flowering stems emerge 15-30 cm to carry tiny sessile, reddish flowers above leafy bracts.

**Habitat:** Lakes, streams and marshes to 3 m deep.

**Native Range:** Central and eastern United States, excepting portions of the Northeast, notably New England. Considered rare and endangered in Pennsylvania, probably native in western New York.

**Nonindigenous Range:** Introduced and widely spreading in New England since the

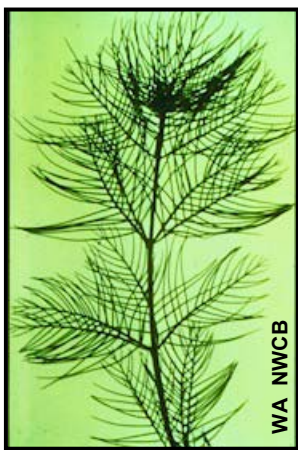
early 1930s. Locally abundant in Connecticut, Rhode Island and Massachusetts. Increasing in range in eastern New York since the 1950s where plants are reportedly introduced. Recently spreading to new drainages in New Hampshire and Maine. Native range in other Mid-Atlantic States is not adequately understood. A recent New Jersey occurrence demonstrates dense monospecific growth in deep water that dominates the water column and surface waters, a characteristic of many of the invasive New England populations.



| NJ   | NY   | CT   | RI    | MA   | NH    | ME    |
|------|------|------|-------|------|-------|-------|
| 2003 | 1953 | 1932 | 1983* | 1940 | 1983* | 1983* |

**Comments:** Molecular analysis reveals that New England populations are comprised of two distinct introduced entities *Myriophyllum heterophyllum* and a newly described hybrid *M. heterophyllum* X *M. pinnatum* (Moody and Les, 2003). The hybrid developed outside of the region. Both entities were likely introduced through the aquarium trade. *Myriophyllum heterophyllum* rarely exhibits invasive characteristics, generally growing in scattered stands interspersed with native plants. However, the introduced hybrid forms large, aggressive, dominating populations of management concern. Plants propagate primarily by vegetative stem fragments. Winter buds are produced along the stems and the rhizomes. Waterfowl eat the fruit and may aid in dispersal.

**Myriophyllum spicatum** L. (Eurasian water milfoil)



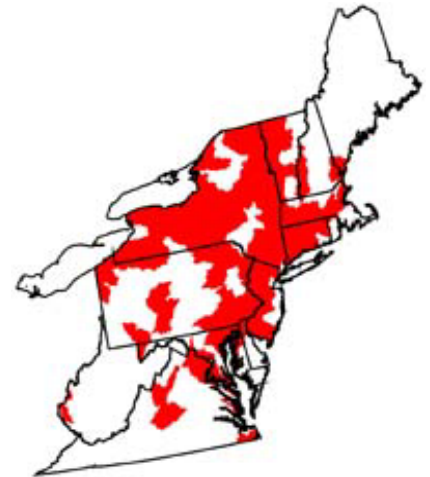
**Field Description:** A submersed, rooted, perennial herb consisting of long underwater branched stems that can reach 1.8 - 2.7 m in length and produce many whorled, finely divided feathery leaves upon nearing the surface. Leaves are divided into threadlike leaflets that are ranked in compact pairs of more than 14. Overall, the leaf shape resembles an equilateral triangle, curved at the base. Whorled flowers on emergent spikes produce a globular, 4-lobed fruit late in the season.

**Habitat:** Lakes, ponds, shallow reservoirs and low energy areas of rivers and streams, with the capability of inhabiting brackish waters.

**Native Range:** Europe, Asia, and northern Africa.

**Nonindigenous Range:** Established in nearly all parts of the United States, excepting Maine, Montana, Wyoming, Alaska, Hawaii and Rhode Island. Very frequent in the Mid-Atlantic States where the first national introductions occurred and 90 river drainages have since become infested. Common and

widely distributed in freshwater lakes and rivers, where in many states native submersed species, such as *Myriophyllum sibiricum*, are in decline. Fluctuating with salinity in tidal regions of the Chesapeake Bay. More tolerant of salt intrusion and industrial pollution than native submersed plants in the Delaware River.



| VA   | WV    | MD   | DE   | PA   | NJ   | NY   | CT    | MA   | VT   | NH   |
|------|-------|------|------|------|------|------|-------|------|------|------|
| 1992 | 1982* | 1942 | 1997 | 1950 | 1952 | 1968 | 1983* | 1971 | 1962 | 1992 |

**Comments:** Aggressive colonizer forming dense underwater stands. Particularly troublesome in waterbodies that have experienced disturbances such as nutrient loading, intense plant management, abundant motorboat use, and fluctuating water levels. Reproduces by plant fragmentation and seed. Distinguish this species from the native *Myriophyllum sibiricum* primarily by the shape of the leaf and secondly by the number of leaflets. *Myriophyllum sibiricum* has basal leaflets that are as long as the leaf, curving over and extending almost to

the top of the leaf. *Myriophyllum spicatum* leaflets are usually in pairs of more than 14 (Nichols, 1975) and are uniformly tapered so that the leaf shape is more like an equilateral triangle with a curved base.

**Family:** Hydrocharitaceae

***Egeria densa*** Planch. (**Brazilian waterweed**)



M. Richerson

**Field Description:** Continuously submersed aquatic perennial producing single (or few branching) stems, commonly 0.3 - 0.6 m long, capable of reaching 6 m. Leaves entire, sessile and in whorls, measuring to 2-3 cm or longer with lance shaped tips and minute marginal serrations. When run through the hand, plant strands are overall smooth in texture. White flowers rise above the water, but no seeds are produced, as only male plants occur in the U.S.

**Habitat:** Still and flowing waters of ponds, lakes, streams and ditches.

**Native Range:** South America.

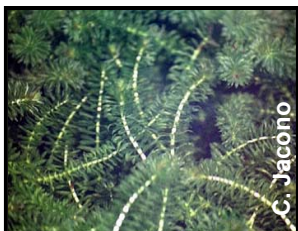
**Nonindigenous Range:** Scattered yet established from coast to coast in the continental United States, including Hawaii. Persisting at a few locales in most Mid-Atlantic States. Although several early populations were short term, the species is well established and expanding to new territories. In 2001, its first record for New Hampshire occurred in the Merrimack drainage.



| VA   | MD   | DE   | PA   | NJ    | NY   | CT   | MA   | VT   | NH   |
|------|------|------|------|-------|------|------|------|------|------|
| 1946 | 1938 | 1941 | 1917 | 1990* | 1893 | 1985 | 1939 | 1913 | 2001 |

**Comments:** Commonly forms dense populations. Potentially invasive in Region 5 where new populations could arise from the spread of vegetative propagules by birds and boats. *Hydrilla* and *Egeria* are often found growing together, yet each species may fluctuate seasonally in abundance. Resembling and often confused with *Hydrilla* or native *Elodea* species. Introduced as an escapee from aquaria and still widely sold, although often under the incorrect names of *Elodea densa* or *Anacharis densa*.

***Hydrilla verticillata*** L.f. Royle (**hydrilla**)



C. Jacquin

**Field Description:** Continuously submersed aquatic perennial with long ascending stems. Monoecious plants usually branching lower to blanket the bottom substrate, dioecious plants branching at the surface then growing horizontally to form floating mats. Leaves entire, sessile and in whorls, measuring to 1.5 cm with the opposite sides mostly parallel until reaching the tips. Teeth along leaf margins and under the midrib impart



a rough texture when strands are drawn through the hand. Translucent, white flowers with 3-6 petals rise above the water surface. Monoecious plants produce male and female flowers and rarely develop fruit - a soft, spiny, few-seeded capsule. Dioecious plants produce only female flowers and are sterile.

**Habitat:** Freshwater lakes, ponds, rivers, impoundments and canals.

**Native Range:** The dioecious type likely originated from the Indian subcontinent, the monoecious type from temperate Korea (Madeira et al., 1997).

**Nonindigenous Range:** Frequently established in the perimeter states of the continental United States. Southern populations are predominantly dioecious and plants north of South Carolina are monoecious. Established in 18 drainages and spreading in the Mid-Atlantic States, a region that appears vulnerable throughout. Dominating submersed plant beds in rivers and tidal freshwater marsh creeks in Maryland and Virginia, appearing in downtown Philadelphia in the Schuylkill River and reoccurring in ponds and reservoirs in remaining populated states. Recorded in the Pinelands National Reserve, New Jersey. New to Maine in 2002 at a pond in the Saco drainage where viable tubers overwintered in the substrate while the pond remained iced over from November to April. In 2003, the first documented occurrence for the state of New Jersey was reported from a small lake in the Lower Delaware drainage.



| VA   | MD   | DE   | PA   | NJ   | CT   | MA   | ME   |
|------|------|------|------|------|------|------|------|
| 1982 | 1982 | 1976 | 1996 | 2003 | 1987 | 2001 | 2002 |

**Comments:** Highly invasive and competitive, often to become the dominant species where introduced. Has the ability to alter physical and chemical characteristics of lakes; affects water flow and water use. Often confused with *Egeria densa* and *Elodea* spp. but readily distinguishable by its production of turions and tubers, both important features for overwintering and reproduction. Tubers are resistant to most control techniques and may be viable as a source of reinfestation for years. Propagates through the growing season by stem fragmentation.

**Family:** Najadaceae

***Najas minor*** All. (brittle naiad)



**Field Description:** Submersed stems on this annual aquatic are notably slender, to only 1 mm thick, and highly branched. Leaves are narrow, nearly linear, with serrated margins and arranged oppositely but may appear whorled. 1-seeded fruits are common and easily found late spring to fall deep in the leaf axils and surrounded by the leaf sheath.

**Habitat:** Prefers slow moving waters of



streams, ponds, lakes and canals in water up to 4.6 m deep.



**Native Range:** Europe, Turkey, northern Africa, India and Japan.  
**Nonindigenous Range:** Established occasionally through the eastern half of the United States. Scattered populations exist in the Mid-Atlantic States, with the first sighting originating from the Hudson River drainage. New populations are distributed across Region 5 suggesting the potential for establishment throughout this range.

| VA   | WV    | MD   | PA   | NY   | MA   | VT   | NH   |
|------|-------|------|------|------|------|------|------|
| 1985 | 1996* | 1982 | 1951 | 1934 | 1974 | 1965 | 1992 |

**Comments:** Often found in eutrophic and alkaline waters and in association with *Hydrilla verticillata* and *Egeria densa*. An extremely fragile plant, its fragmentation aids in its dispersal and potential for spread. *Najas* depends on seed germination for annual regrowth. Seed may also be dispersed by waterfowl.

**Family:** Potamogetonaceae

**Potamogeton crispus** L. (curly pondweed)

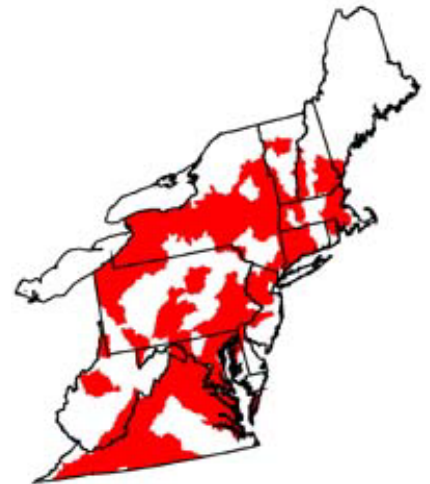


**Field Description:** Conspicuous teeth and strong undulations at the leaf margins distinguish this pondweed, which, excepting the inflorescence, has all parts submersed. Flowers are loosely arranged on emerged spikes. Reproduces by fruits and turions (budlike propagules at tips of branches) produced in early summer after which plants decline.

**Habitat:** Ponds, lakes and streams; tolerates brackish waters, as well as nutrient-rich or alkaline freshwaters.

**Native Range:** Europe, Middle East, northern Africa, India and Australia.

**Nonindigenous Range:** Established and frequent throughout the United States except Alaska and Maine. Known in the Mid-Atlantic States for over 100 years. Found through more than 80 drainages in Region 5. Especially abundant in tidal rivers and bays, such as the Chesapeake Bay and tidal Potomac.



| VA   | WV   | MD   | DE   | PA   | NJ   | NY   | CT   | RI   | MA   | VT   | NH   |
|------|------|------|------|------|------|------|------|------|------|------|------|
| 1874 | 1930 | 1877 | 1860 | 1861 | 1866 | 1879 | 1932 | 1932 | 1880 | 1911 | 1984 |

**Comments:** This is an aggressive, cool climate species that is potentially invasive to the entire Mid-Atlantic region. Turions produce new plants in late summer or fall. These new, small plants overwinter and give this species a competitive advantage by developing before other

species in the spring. Seed viability in the U.S. remains unclear. Creates eutrophic waters from the high amount of decaying plant matter when plants die off after flowering. Sold as an aquarium plant.

## Emergent Plants

**Family:** Alismataceae

***Sagittaria montevidensis* subsp. *montevidensis*** Cham. & Schlecht (long-lobed arrowhead)



**Field Description:** Emerged annual herb standing erect to 50 cm with broadly ovate leaves on stout spongy petioles. Flowers in whorls varying up to 12, having white petals, sometimes with a yellow hue and a purple spot at base.

**Habitat:** Shallow waters of streams, lakes, swamps and canals.

**Native Range:** Temperate and subtropical South America.

**Nonindigenous Range:** Very occasional species persisting in few locations in the United States. Only known in the Mid-Atlantic States from New Jersey's Lower Hudson River

drainage and may not represent a persisting population.



|      |
|------|
| NJ   |
| 1929 |

**Comments:** Still available as a water garden ornamental which may serve as an outlet for escapes to new locations.

**Family:** Amaranthaceae

***Alternanthera philoxeroides*** (Mart.) Griseb. (alligatorweed)



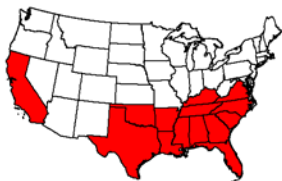
**Field Description:** Emerged perennial herb with decumbent hollow stems rooting at the nodes and growing to 1 m long. Leaves are opposite, sessile and elliptic. The inflorescence is a clover-like head on a short stalk, lacking petals but with 5 white sepals.

**Habitat:** Moist or wet sites, most often along ponds, lakes, streams, canals and ditches.

**Native Range:** South America.

**Nonindigenous Range:** Well established and common mainly in the southeastern and Gulf

coastal United States. Collected in the Mid-Atlantic States from





eight coastal counties of Virginia. Populations inhabit ditches, lakes, and swampy areas in these counties and are persisting in abundant local colonies.

|      |
|------|
| VA   |
| 1956 |

**Comments:** Viable seed is not known in the United States where reproduction is entirely vegetative. The northern distribution of alligatorweed is probably limited by the cold sensitivity of above ground vegetation.

**Family:** Brassicaceae

***Nasturtium officinale*** Ait. f. (watercress)



**Field Description:** Submersed to floating or emersed aquatic perennial usually 10 - 45 cm tall with smooth, freely rooting stems that appear succulent. Leaves are alternate and pinnately compound with 3 -11 ovate to oblong leaflets. White flowers in racemes form narrow pods containing two rows of seeds.

**Habitat:** Cold water springs and fast flowing streams.

**Native Range:** Europe.

**Nonindigenous Range:** Common and established in the United States excepting Alaska and Hawaii. Long time established in the Mid-Atlantic States at millponds, local creeks, swamps and lakes. Collected from New Hampshire, 1965, at two separate



locations in the Piscataqua-Salmon Falls drainage. Known from at least five towns in southeastern Vermont. Common throughout the state of Rhode Island in all counties and in most townships. In Maine, populations exist in Oxford, Somerset, Hancock and York counties.



| VA   | WV    | MD   | DE   | PA   | NJ    | NY   | CT   | RI    | MA    | VT    | NH    | ME   |
|------|-------|------|------|------|-------|------|------|-------|-------|-------|-------|------|
| 1892 | 1944* | 1905 | 1894 | 1879 | 1983* | 1969 | 1831 | 1952* | 1944* | 1944* | 1944* | 1932 |

**Comments:** Cultivated for its edible greens since early colonial times. Apparently has little impact on natural communities and is not considered a management concern in the Northeast, however, in arid regions of western states this species can become weedy to alter function and flow in shallow, mountain streams. Synonym: *Rorippa nasturtium-aquaticum*

**Rorippa amphibia** (L.) Bess. (amphibious yellowcress)



**Field Description:** Perennial herb often growing emergent and erect to 10 cm with hollow stems. Alternate, lanceolate leaves are undivided and roughly dentate. Flowers are golden yellow, with yellow sepals that are at least half as long as the petals. The fruit (3 - 6 mm) is an oblong to obovate silique with a straight to slightly curved beak (1 - 2 mm). The silique splits into open halves and contains one row of seeds that are large in proportion to the silique.

**Habitat:** Swamps and shallow waters of lakes and ponds.

**Native Range:** Europe.

**Nonindigenous Range:** Restricted in the United States, to occasional locals in the Mid-Atlantic States. Established in Connecticut in the Saugatuck River drainage

and in Maine, at Lake Androscoggin, and in Vermont near the mouth of the Missisquoi River. Although infrequent, it often forms dense beds and may be more prevalent in the region, perhaps just overlooked.



| NY    | CT    | MA    | VT    | ME    |
|-------|-------|-------|-------|-------|
| 1993* | 1957* | 1991* | 1996* | 1957* |

**Comments:** Sometimes confused with *Armoracia* (lake cress) for the yellow flowers, but is distinguished by its elongated pods which have a central partition that is lacking in lake cress.

**Family:** Butomaceae

**Butomus umbellatus** L. (flowering rush)



**Field Description:** Perennial aquatic herb with fleshy rhizomes and linear, basal leaves that grows either lax and submersed or emergent and upright to reach 1 m in height. Flowers pink, in terminal umbels of up to 50 on long, naked stalks. Fruits multiple in whorls with numerous seeds.

**Habitat:** Stream banks, marshes, pond and lakeshores.

**Native Range:** Temperate Eurasia.

**Nonindigenous Range:** Occasional in the northern United States west to Washington. Infrequent in the Mid-Atlantic States yet well established in major water bodies such as



Lake Erie, Lake Champlain, and the St. Lawrence River. The recent, sole record for Maine is from a pond near Hooper Brook Inlet in the Lower Androscoggin drainage.

| PA   | NY   | CT   | VT   | ME   |
|------|------|------|------|------|
| 1941 | 1929 | 1943 | 1927 | 1999 |

**Comments:** Cultivated as a decorative water garden plant. Produces dense stands; use of herbicides has had limited success. Means of dispersal unknown.

**Family:** Callitrichaceae

***Callitriche stagnalis*** Scop. (pond water-starwort)



**Field Description:** Submersed to floating or amphibious herb. Rooted shoots grow to the surface to form floating rosettes with tiny, opposite leaves, up to 10 mm wide, that are entire, yet diverse in shape. Monoecious plants form tiny flowers with 2 whitish basal bracts and round fruits with marginal wings.

**Habitat:** Static or flowing water of ponds, streams, marshes and ditches.

**Native Range:** Europe and northern Africa.

**Nonindigenous Range:** Established along the West Coast and in a few other regions of the United States. Common and locally abundant from Virginia north to



Massachusetts in the Mid-Atlantic States. Locally common and established almost throughout the state of New Jersey, where it is found in 16 counties. Persisting in Pennsylvania since the early 1900s where it now exists in 15 counties in the southeastern region of the state.



| VA   | MD   | PA   | NJ   | NY   | CT   | MA   |
|------|------|------|------|------|------|------|
| 1952 | 1942 | 1911 | 1885 | 1861 | 1994 | 1911 |

**Comments:** Reproduces sexually by seed and clonally by fragmentation to form dense mats. The species is a prolific seed producer, although seed production may not occur in all populations. Unlikely to be confused with any other plant, except for several native species of *Callitriche*, which it closely resembles and can only be distinguished by the fruits. *Callitriche stagnalis* produces globose fruits (1.5 x 2 mm) that are distinctly winged (0.1 mm wide) along the margins. Thought to be introduced in dry ballast during the late 1800s.

**Family:** Commelinaceae

***Murdannia keisak*** (Hassk.) Hand.-Maz. (marsh dewflower)



**Field Description:** Emergent aquatic annual herb with trailing, mucilaginous stems rooted in water up to 1.5 m deep. Leaves alternate, simple, lance-shaped, 3-6 cm long by 1 cm wide. Flowers with 3 petals, pink to lavender or white to blue, axillary, either solitary or 2-4 in a raceme. Fruit an oval capsule bearing many fertile seeds

**Habitat:** Marshes, ditches and shallow lake shorelines.

**Native Range:** East Asia.

**Nonindigenous Range:** Established and becoming more abundant in the southeastern

United States where its range is increasing in the Mid-Atlantic States. Key populations occur in marshes of the Patuxent National Wildlife Refuge, Maryland and in the Mason Neck National Wildlife Refuge, Virginia. Also found in both the James and Potomac Rivers, Virginia. Known from all three counties in Delaware, both from the Piedmont and Coastal Plain where it is found in both tidal and non-tidal waterbodies, probably since the late 1980s (Keith Clancy, Delaware State University, pers. comm.).



| VA   | MD   | DE   |
|------|------|------|
| 1939 | 1949 | 1993 |

**Comments:** Introduced with early rice farming to South Carolina in 1935 (Dunn and Sharitz, 1990). Escaping cultivation practices to become a competitive plant that forms dominant colonies in natural areas.

**Family:** Iridaceae

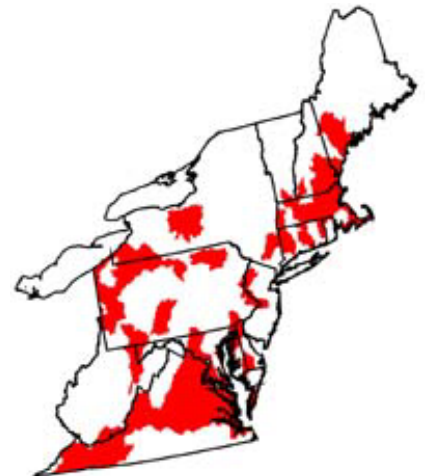
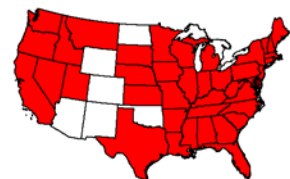
***Iris pseudacorus*** L. (yellow iris)



**Field Description:** Hearty emergent or shoreline perennial about 1.5 m tall with thick, tuberous rhizomes. Leaves long, flat and sword-like with upper and lower surfaces identical. Yellow flowers on erect stalks have sepals (called “falls”) faintly etched in brown or purple. Fruit is a large cylindrical capsule containing many flattened, fertile seeds.

**Habitat:** Shallow waters of swampy woodlands, marshes, meadows and stream banks.

**Native Range:** Europe and British Isles,



northern Africa and the Mediterranean region.

**Nonindigenous Range:** Established and widely distributed in the United States, notably along channelized river systems and in important natural public lands in the western states.

Spreading extensively to wet areas in over 45 drainages in the Mid-Atlantic States, where plants have been found in the wild for close to 140 years. Recorded from the Parker River National Wildlife Refuge, Massachusetts. Still reaching new states by the 1990s, where escapes spread locally from cultivation. Plenty of territory remains to be affected by new suburban settings.

| VA   | WV    | MD   | DE   | PA   | NJ    | NY   | CT   | RI    | MA   | VT    | NH   | ME   |
|------|-------|------|------|------|-------|------|------|-------|------|-------|------|------|
| 1992 | 1996* | 1969 | 1895 | 1923 | 1990* | 1868 | 1903 | 1952* | 1884 | 1996* | 1980 | 1974 |

**Comments:** Invasive for its robust, drought tolerant rhizomes that spread radially to produce large clonal populations that grow to the exclusion of native marsh plants. Both rhizomes and seeds may be transported downstream during floods. Poisonous and listed as an injurious weed in western states. Continues to be planted for erosion control and sewage treatment. Burning is not recommended for control because of its strong tendency to resprout from rhizomes.

**Family:** Lythraceae

***Lythrum salicaria*** L. (purple loosestrife)



**Field Description:** Erect, emergent perennial herb with stout, tough, nearly square stems reaching over 1 m tall. Fifty stems may arise from a single mature rootstock. Leaves are sessile and hairy with rounded bases that practically surround the stalk. Leaves opposite to alternate or arranged in whorls. Flowers reddish (mauve) purple in showy spikes. Seeds produced in capsules.

**Habitat:** Prefers moist or saturated soils of meadows, marshes, lakeshores and river margins.

**Native Range:** British Isles, Europe and Eurasia including parts of Russia.

**Nonindigenous Range:** Unevenly distributed across the United States, more frequently in the cooler climates. Common and aggressive in the Mid-Atlantic States where it is well established in over 60 drainages, and continues to expand in range. Key populations exist in the Parker River

National Wildlife Refuge, Massachusetts and in the Montezuma National Wildlife Refuge, New York. New to Virginia in 1996 at the James River, Lower Chesapeake, and Upper Clinch River drainages.



| VA   | WV   | MD   | DE   | PA   | NJ   | NY   | CT   | RI   | MA   | VT   | NH   | ME   |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1996 | 1858 | 1896 | 1866 | 1852 | 1864 | 1843 | 1895 | 1905 | 1831 | 1898 | 1875 | 1954 |

**Comments:** Produces monotypic, dense stands in wet habitats that displace native plant communities important for animal habitat. A copious seed producer, output depends on age, size, and vigor. A single plant is capable of producing more than 2 million seeds. Seeds spread by wind, water, or waterfowl and can remain dormant for 2-3 years until environmental conditions become favorable. Certain species of weevils and leaf-eating beetles are being used as biological control agents. Still sold as an ornamental garden plant.

**Family:** Marsileaceae

***Marsilea mutica*** Mett. (nardoo)



C. Jacono

**Field Description:** Aquatic to amphibious fern growing from creeping, fleshy, rooted rhizomes. Four-leaf clover-like leaves uniquely two toned in color, lighter in the center and darker towards the margins, often with a thin red-brown band delineating the color zones. Leaves glabrous, land leaves 2-3 cm broad. Floating leaves larger, to 6 cm broad, attached to petioles as long as 1 m. Petioles inflated at the apex to promote buoyancy of floating leaves. Sporocarps ovoid with blunt tips, completely lacking teeth, borne on short stalks that arise from the junction of the petiole and rhizome, initially covered in thick, woolly hair.



**Habitat:** Heavy clay to sandy substrates of permanent lakes and seasonal ponds, fringing shorelines and extending into deeper water.

**Native Range:** Australia and New Caledonia.

**Nonindigenous Range:** Newly introduced to the United States where locally abundant populations over winter in Oklahoma, Mississippi, Alabama, Georgia, Florida, and South Carolina. First recorded from the Mid-Atlantic States in southeastern Virginia.



|      |
|------|
| VA   |
| 1997 |

**Comments:** *Marsilea mutica* is an invasive colonizer and extensive grower that readily adapts to environmental change. Plants demonstrate few habitat preferences outside of full sun and wet periods. Unlike *Marsilea quadrifolia*, *M. mutica* appears well suited to more southern ranges in the United States. In its native range, *M. mutica* depends on dormant vegetative propagules (rhizomes) to persist through interludes of water recession and low temperature. In the U.S. the importance of sporocarps in reproduction and in dispersal is unknown. The recent influx to North America is probably through horticultural escapes.

**Marsilea quadrifolia** L. (European water-clover)



**Field Description:** Aquatic to amphibious fern from creeping, fleshy, rooted rhizomes. Four-leaf clover-like leaves monochromatic green, downy on first appearance (as fiddleheads) becoming glabrous when mature. Land leaves 1.5 - 4 cm broad. Sporocarps bear a single posterior tooth, are covered in hair that later sheds, and borne on short stalks that arise 1 – 12 mm above the junction of the petiole and rhizome. In wet conditions, male and female spores germinate and cross-fertilize to produce new plants.



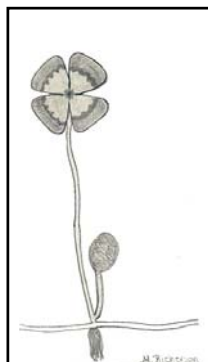
**Habitat:** Wet conditions of slow-flowing rivers and streams, muddy shorelines to roadside ditches.

**Native Range:** Europe.

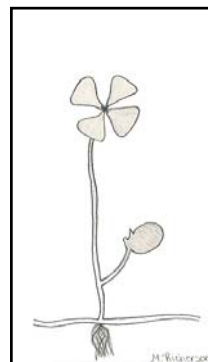
**Nonindigenous Range:** Established in the United States for more than a century, predominantly in the northeastern portion of the Mid-Atlantic States where occurrence remains occasional. United States' populations do not extend south of Maryland, Kentucky or Missouri. Massachusetts has the most extensive introductions including long-time documented sites in the Charles, Concord, Sudbury and Connecticut rivers.

| MD   | PA   | NJ   | NY   | CT   | MA   | ME    |
|------|------|------|------|------|------|-------|
| 1909 | 1894 | 1929 | 1893 | 1860 | 1868 | 1986* |

**Comments:** Becomes weedy by producing monotypic vegetative stands that over winter by underground rhizomes. While plants mainly reproduce clonally, new populations may develop from hardened sporocarps that lie dormant in the substrate for decades. As an invasive weed, *Marsilea quadrifolia* generally carries little consideration. Distinguish *M. quadrifolia* from the newly introduced *M. mutica* by *M. quadrifolia* having a solid green leaf color, peduncles that attach higher up on the petiole and sporocarps bearing a tooth.



*Marsilea mutica*



*Marsilea quadrifolia*

**Family:** Nelumbonaceae

***Nelumbo nucifera*** Gaertn. (**sacred lotus**)



**Field Description:** Perennial aquatic herb with large, orbicular leaves that arise directly from thick rhizomes embedded in the substrate. Early in the season, leaves float flat on the water surface. Later in



summer leaves emerge on petioles above the surface and become trumpet-like in shape. Flowers solitary and pink, forming woody, fruiting receptacles that contain seeds in pitted cavities.

**Habitat:** Prefers calm waters of ponds, lakes, streams and marshes.

**Native Range:** Southeastern Asia and Australia.

**Nonindigenous Range:** Established scarcely in the southeastern United States likely as independent introductions from cultivation. Collected but status unknown in several Mid-Atlantic States. Earliest and only known record from West Virginia was collected from the Lower Kanawha drainage. It has not been verified if specimens from West Virginia, Maryland, New York and New Jersey have persisted to become established.



| WV   | MD    | NJ    | NY    |
|------|-------|-------|-------|
| 1984 | 2003* | 1958* | 2003* |

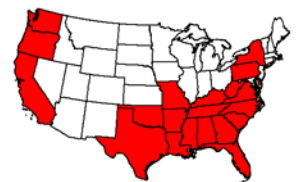
**Comments:** Spectacular ornamental cultivated in water gardens that may be intentionally introduced due to its large showy flowers. Readily distinguished from the native yellow-flowered American lotus (*Nelumbo lutea*).

**Family:** Onagraceae

***Ludwigia hexapetala*** (Hook. & Arn.) Zardini, Gu & Raven (**Uruguay seedbox**)



**Field Description:** Floating to emerged perennial aquatic herb growing rooted in water to 1.8 m deep or in wet soils. Aquatic plants in deep water appear as floating rosettes with more rotund leaves. Emergent stems are highly pubescent with lance shaped, alternate leaves. Bright yellow flowers are solitary at the leaf axils. Seeds are enclosed in a cylindrical, hairy capsule.



**Habitat:** Marshes, swamps, ponds and lakes, ditches and small streams.

**Native Range:** South America.





**Nonindigenous Range:** Probably introduced in the southeastern United States and along the West Coast. Established yet infrequent in the Mid-Atlantic States where few populations exist. The earliest record from Pennsylvania was from the Schuylkill drainage where later occurrences were also found, and the only other population for the state was found in the Lower Delaware drainage. Known from unspecified locations in swamps and ponds in southern New York.

| VA    | WV    | DE   | PA   | NY    |
|-------|-------|------|------|-------|
| 1990* | 1996* | 1993 | 1941 | 1991* |

**Comments:** Potentially invasive becoming problematic by forming dense, floating mats in ditches and streams. Reproduction by prolific seed production, vegetative fragmentation and rhizome spread. Water garden industry sells this species under false names. Earlier known as *Ludwigia uruguayensis*.

**Family:** Poaceae

***Glyceria maxima*** (Hartman) Holmb. (**reed mannagrass**)



**Field Description:** Perennial rhizomatous aquatic grass with more or less erect, leafy stems reaching 2.5 m. Leaves flat to half folded at maturity, margins endowed with tough, short hairs that are rough to the touch. Inflorescence is an open panicle producing small, smooth brown seeds.

**Habitat:** Primarily found in marshes, swamps and wetlands but can exist along shorelines of lakes and ponds.

**Native Range:** Eurasia.

**Nonindigenous Range:** Uncommon in the United States where it was first recorded in 1975 in the Upper Fox drainage of Wisconsin, appearing again four years later in the nearby Pike-Root drainage. The remaining occurrences lie in the Mid-Atlantic region in

Massachusetts at the Ipswich River

Wildlife Sanctuary, where populations at four sites appear to be under management control.



|      |
|------|
| MA   |
| 1990 |

**Comments:** Making its first appearance in North America in 1940 in Ontario, Canada. This species impacts wetland ecosystems by forming dense monospecific stands. It is a poor food source and provides unfavorable nesting substrate for wildlife. Reproduces vegetatively by rhizomes. Seed viability has not been studied in the United States. Has the potential to become a troublesome wetland plant where introduced.

**Family:** Scrophulariaceae

***Glossostigma diandrum*** (L.) Kuntze (mud mat)



C. Jacono



**Field Description:** Minute aquatic to amphibious perennial herb recognized as unusual, bright green patches on muddy substrate of littoral zones in full sun. Creeping rhizomes support tiny (1-2 cm) leaves, opposite and spatulate in shape. Flowers are bell-shaped, pastel colored and produced on short stalks when water recedes. Closed, self-fertilizing flowers, called cleistogams are produced underwater among the roots. Seeds are produced in capsules.

**Habitat:** Prefers shallow waters, swamps, marshes, backwaters and inundated areas.

**Native Range:** New Zealand, Australia, India and eastern Africa.

**Nonindigenous Range:** Sparingly distributed in the United States, recorded only from 6 sites in 2 adjacent drainages in the Mid-Atlantic States of New Jersey and Pennsylvania. First collected from a reservoir in Middlesex County, New Jersey, where plants are abundant in shallow areas around the impoundment. Later found in Mercer, Monmouth, and Ocean counties, New Jersey. First appeared in Pennsylvania at Lake Galena in the Crosswicks-Neshaminy drainage where the populations appear to fluctuate along the shoreline.



| PA   | NJ   |
|------|------|
| 1995 | 1991 |

**Comments:** Densely mat forming in shallow waters. *Glossostigma* resembles the native *Limosella* (mudwort) species and may also be confused with emergent leaf forms of some members of *Utricularia* (bladderwort). Sepal lobes, petal lobes and stamens are used to separate *Limosella* from *Glossostigma*.

***Veronica beccabunga*** L. (European brooklime)



A. Smith & G. Smith

**Field Description:** Emerged perennial aquatic herb with creeping, branching stems. Leaves short, petiolate, opposite, shiny, broadest near the middle, and scalloped at the margins. Axillary flowering racemes of 10-30 bright blue flowers. Fruit a many-seeded orbicular capsule.

**Habitat:** Prefers muddy edges of cold, oxygen-rich waters, but found in wetlands, floodplains, lakes and rivers.



**Native Range:** Europe, the Middle East, and Asia.



**Nonindigenous Range:** Infrequent in the United States, more common in the Great Lakes and Mid-Atlantic States where limited colonies are scattered. Also recorded from unspecified locals in Maryland, Connecticut, and Massachusetts. Occurring along the Delaware River in Pennsylvania. Status of a single, early collection could not be verified in Hudson County, New Jersey.

| WV   | MD    | PA   | NJ   | NY   | CT    | MA    | ME   |
|------|-------|------|------|------|-------|-------|------|
| 1931 | 2003* | 1891 | 1876 | 1880 | 2003* | 2003* | 1937 |

**Comments:** Apparently posing little threat to aquatic communities. May be confused with native species of *Veronica*, especially *V. americana* that grows in similar habitats, yet has leaves broadest at the base. Reproduces by seed and through fragmentation. Reportedly can form large stands.

## Floating Plants

**Family:** Araceae

***Pistia stratiotes*** L. (water lettuce)



**Field Description:** Free floating perennial herb consisting of hefty, velvety rosettes suspended above fibrous underwater roots. Leaves can reach 15 cm in length and are light yellow to gray green and densely pubescent with grooved, parallel veins. Offshoots develop during the growing season at stolon tips. White to green spathes hidden in the central axis of the leaf bases form flattened, oval fruits.

**Habitat:** Low velocity water bodies, canals, ponds and swampy backwaters.

**Native Range:** Pantropical.

**Nonindigenous Range:** Established populations limited to the most southern portions

of the lower United States, including Hawaii. Abundant where established along the eastern coastal plain, north to the Waccamaw River drainage of South Carolina. Disjunct occurrences have been recorded in more northern ranges, including Illinois and Ohio and in the Mid-Atlantic States from New York, Delaware and Rhode Island. It is not known if these colonies originate each year from new escapes or if the plants reoccur each summer from a seed source in the substrate.

| MD    | DE   | NJ    | NY   | RI   |
|-------|------|-------|------|------|
| 2003* | 1993 | 2003* | 2000 | 2001 |



**Comments:** *Pistia* vegetation is intolerant to frost. Sexual reproduction has been found to be important in the dynamics of some populations in the Netherlands, Australia, and Florida.

Seeds survive prolonged experimental periods in water at 4°C and several weeks in ice at – 5°C after which germination occurred between 20°C and 25°C. With appropriate springtime germination conditions (i.e. silty/muddy substrates, clear shallow water and warm temperatures), overwintering by seed could account for population reoccurrence in temperate regions of the U.S. Seedlings are light green, pubescent and about the size of *Spirodela polyrhiza*. Though a weedy, prolific grower, *Pistia* remains a popular ornamental water garden plant.



*Pistia stratiotes* seedlings with *Wolffella* and *Lemna*

**Family:** Hydrocharitaceae

***Hydrocharis morsus-ranae* L. (European frogbit)**



**Field Description:** Floating (sometimes emergent) perennial herb producing floating leaves (1.2 – 6 cm x 1.2 – 6.4 cm) on long petioles that arise from a central whorl. Roots rarely anchor plants. Leaves are leathery and cordate with arching veins that mimic the leaf outline. Flowers white with 3 showy petals that exceed the sepals. Fruit a globose, many-seeded berry with seeds measuring nearly 1 mm.

**Habitat:** Quiet, shallow edges of rivers, lakes and open marshes.

**Native Range:** Europe.

**Nonindigenous Range:** Few sites exist in the United States where most occurrences, especially that in Washington, are rather recent.

Established in the Mid-Atlantic States in New York and Vermont. The earliest U.S. record was from the Oswegatchie River, east of the St. Lawrence River, New York. By the early 1980s plants had spread to inland sites south of the St. Lawrence. By the early 1990s, bays and marshes along Lake Ontario had



become affected and plants first appeared in Vermont at Lake Champlain.

|      |      |
|------|------|
| NY   | VT   |
| 1974 | 1993 |

**Comments:** An upcoming invasive in Region 5. Forms dense floating mats when roots become entangled in other aquatic vegetation. Resembles the closely related, native American frog-bit (*Limnobium spongia*), the latter distinguished by a convex layer of spongy, gelatinous, red tinged tissue beneath the leaf. Primarily reproducing vegetatively, through stolons and turions. First entered Canada in the 1930s as an escapee from ornamental cultivation, later spread encouraged by motorboats.

**Family:** Lemnaceae

***Landoltia (Spirodela) punctata*** (G. Mey.) Les & D.J. Crawford (**dotted duckweed**)



©2000, V. Ramey

**Field Description:** Tiny aquatic plants composed of free-floating fronds with fine roots. Fronds are longer than broad, measuring 1.5 to 6 mm long and 1-3 mm broad. Fronds are narrowly egg-shaped to slightly kidney-shaped and intensely green in color. A waxy cuticle induces plants to sparkle in the sunlight. Roots generally number from 2-4, but can range up to 7. Nerves commonly seen as 3-5, or only as a median ridge. Flowers, nearly microscopic, are enclosed in a pouch under the frond.

**Habitat:** Quiet, slow-moving, nutrient-rich water - ponds, ditches and swamps.

**Native Range:** Australia and Southeast Asia.

**Nonindigenous Range:** Well established in

the United States, more frequent in the Southeast, occasionally found along the West Coast and in Hawaii. Rather recently established in the Mid-Atlantic States, not only along the milder coastal plain of DelMarVa, but extending west to the colder climates of western Pennsylvania and Massachusetts.



| VA   | MD   | DE   | PA   | MA    |
|------|------|------|------|-------|
| 1966 | 1970 | 1991 | 1956 | 1986* |

**Comments:** Colonizes quickly, commonly to form extensive, pure stands. *Landoltia punctata* can readily be distinguished from native duckweeds, especially with a 10X lens. *Lemna* species always have one root per frond, while *Spirodela polyrhiza* has as many as 5-21 roots. *Landoltia* fronds are sensitive to severe frost. In milder temperate climates plants generally perennate from starch filled resting fronds that develop in late summer. However, resting fronds do not overwinter in zones with severe winters. Additionally, *Landoltia* cannot produce turions and its seeds are sensitive to cold, thereby spread into the coldest regions of the Mid-Atlantic should be limited.

**Family:** Menyanthaceae

***Nymphoides peltata*** (Gmel.) Kuntze (**yellow floatingheart**)



**Field Description:** Attractive perennial herb, with branching stems arising from rooted rhizomes and leathery floating leaves. Leaves cordate, upper surfaces smooth, lower surfaces rough in texture. Flowers, 2-3 cm across, carried above the water on slender stalks, petals yellow with margins sometimes fringed. Elongated fruits contain flat seeds.

**Habitat:** Permanent, quiet waters; river shorelines, ponds, reservoirs and ditches.

**Native Range:** Europe, India, China and

Japan.

**Nonindigenous Range:** Established at disjunct locales around the United States, a bit more commonly, and for many years, in the Mid-Atlantic States. Locally frequent along the Hudson-Hoosic River drainage in New York. Found in state game lands in the Upper Susquehanna drainage in Pennsylvania in the early 1980s. Known from Newport County, Rhode Island, in the Narragansett drainage.



| MD   | PA   | NJ   | NY   | CT   | RI   | MA   | VT   |
|------|------|------|------|------|------|------|------|
| 1957 | 1915 | 1940 | 1929 | 1939 | 1977 | 1882 | 1863 |

**Comments:** Naturally dispersed by seed. Seeds float when wet, are picked up and transported by waterfowl. When the bird returns to water, the seeds detach and sink to later germinate (Cook, 1990). Introduced for water gardening and still sold today.

**Family:** Pontederiaceae

***Eichhornia crassipes*** (Mart.) Solms (**water hyacinth**)

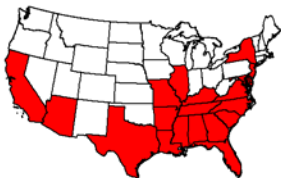


**Field Description:** Inflated petioles, submersed stolons, and hanging roots produce an extremely buoyant free-floating aquatic herb. Thick, glossy leaves, nearly round to kidney shaped arise from a central cluster. Flowers are arranged in a terminal spike with 5-20 showy blue to purple, sometimes white flowers with a yellow spot surrounded by a darker purple hue. Fruits a many-seeded dehiscent capsule.

**Habitat:** Ponds, lakes and sluggish streams.

**Native Range:** Upper Amazon Basin, Brazil.

**Nonindigenous Range:** Established in the more southern United States, including Hawaii. Recorded from Missouri, Illinois, Kentucky and Tennessee where plants apparently escape



summertime cultivation to grow as annuals, but do not persist vegetatively through the winter. Verified as perennating in the Mid-Atlantic States only in southeastern Virginia. Collected in New York and Maryland. Found at the Great Cypress Swamp, Delaware, and at isolated, natural sites along the Delaware River in New Jersey. Seed could play a role in the recurring populations of these temperate states.

| VA    | MD   | DE   | NJ   | NY    |
|-------|------|------|------|-------|
| 1988* | 1998 | 1993 | 2002 | 1994* |

**Comments:** A popular plant in the water gardening industry, water hyacinth proliferates clonally and also by seed.

**Family:** Trapaceae

***Trapa natans*** L. (water chestnut)



L. J. Mehrhoff

**Field Description:** Floating terminal rosettes of this large annual plant are usually rooted on long stems in muddy substrates. Leaves alternate above, and sharply toothed. Submersed leaves filiform. Flowers small, white, attached to the central axis on short stalks. Fruit a sturdy sharp-spined nut produced underwater.

**Habitat:** Lakes, ponds, and streams, often under eutrophic conditions, and in freshwater intertidal zones.

**Native Range:** Eurasia.

**Nonindigenous Range:** Known in the United States only from the Mid-Atlantic States where populations are long time established yet still advancing into new

territory. Reported from the Great Meadows National Wildlife Refuge, Massachusetts. Recently introduced to New Hampshire, in the Nashua River, and to Connecticut in the Connecticut River. A repeat offender to tributaries of the Chesapeake Bay, where plants reappeared in the late 1990s on the Bird and Sassafras Rivers, tributaries of the Chesapeake Bay, Maryland. Well known from Lake Champlain and the Lake George drainage, Vermont. Problematic in lakes and ponds in Pennsylvania.

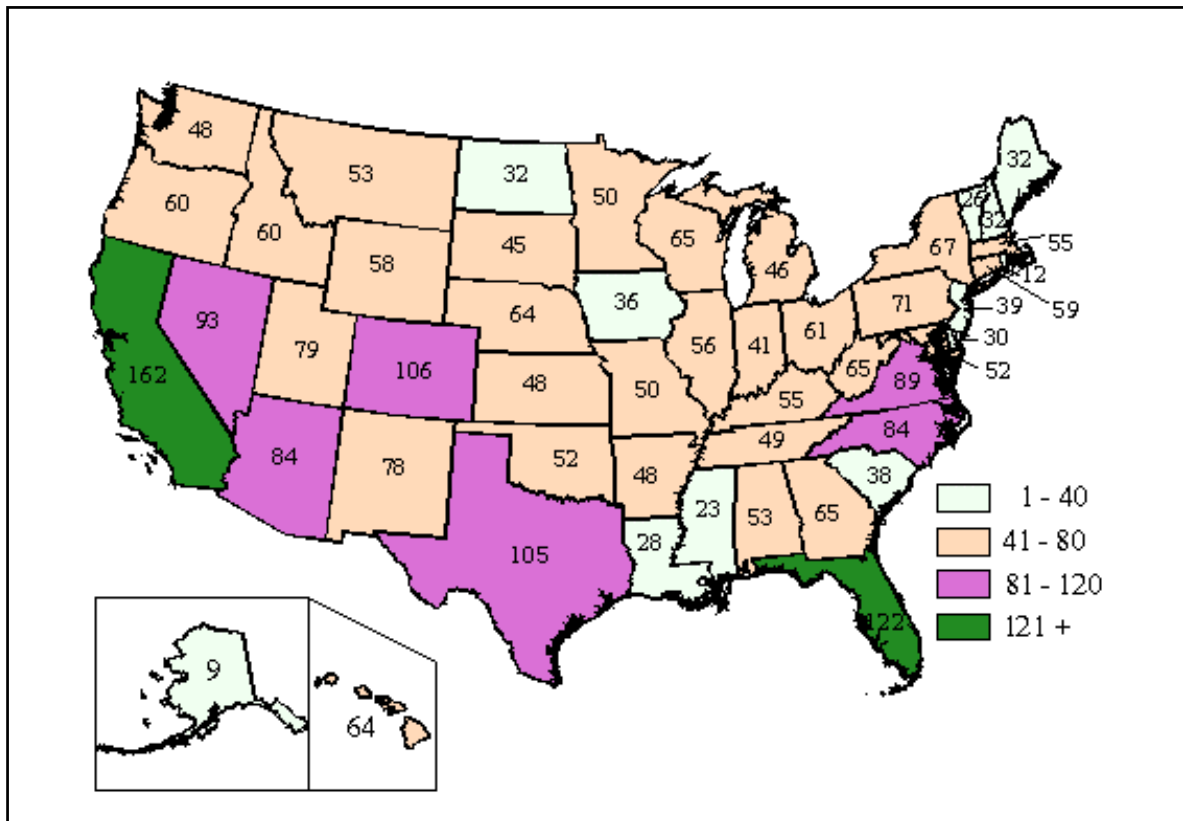


| VA   | MD   | PA   | NJ    | NY   | CT    | MA   | VT   | NH   |
|------|------|------|-------|------|-------|------|------|------|
| 1923 | 1923 | 1977 | 1956* | 1884 | 1999* | 1875 | 1942 | 1998 |

**Comments:** Invasive, aggressive species with spiny fruits inflicting wounds to feet and paws. The species may be difficult to extirpate, as fruits may remain viable for up to 12 years in the substrate. Each nut can produce 10-15 rosettes and each rosette produces approximately 20 seeds (IPANE, 2001). Reproduction by seed and fragmentation, fragments often spread by water, waterfowl and motorboats.

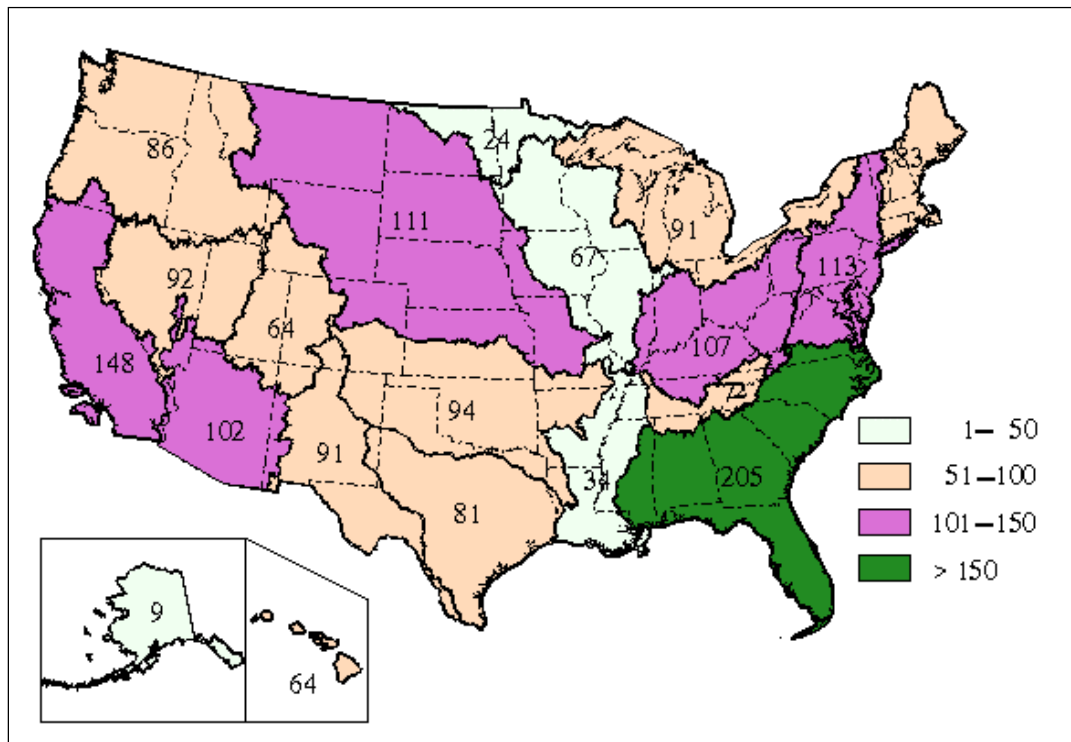
## FISHES

A total of 206 fish species have been introduced into the 13 states within USFWS Region 5 (Appendix A). Of these, 151 are species native to the United States but have been transplanted outside their native range, and 42 are species introduced from other countries (exotic). Fifty-six percent of the native transplants became established and fifty percent of the exotic species introduced into the region have resulted in established populations. The number of introductions in the New England states is low when compared to states in the southern portion of the country (Figure 5). This is likely a factor of the reduced human population in this area and the cold weather that makes many of the tropical and subtropical species less likely to survive and subsequently be discovered. States farther south in Region 5 have had approximately twice the number of introduced species as does New England (Figure 5). Region 5 includes the regional drainages of New England, the Mid Atlantic and the lower Great Lakes. The Mid-Atlantic has the greatest number of introduced fish species of any of these (Figure 6).



**Figure 5.** Number of fish species introduced into each state (Fuller et al. 1999).

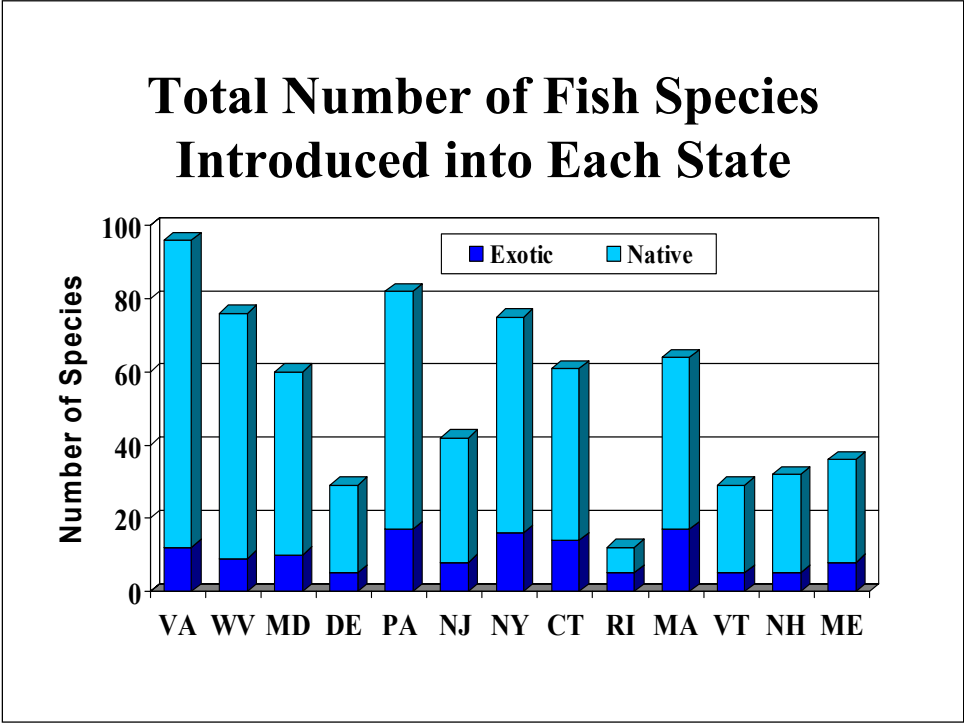




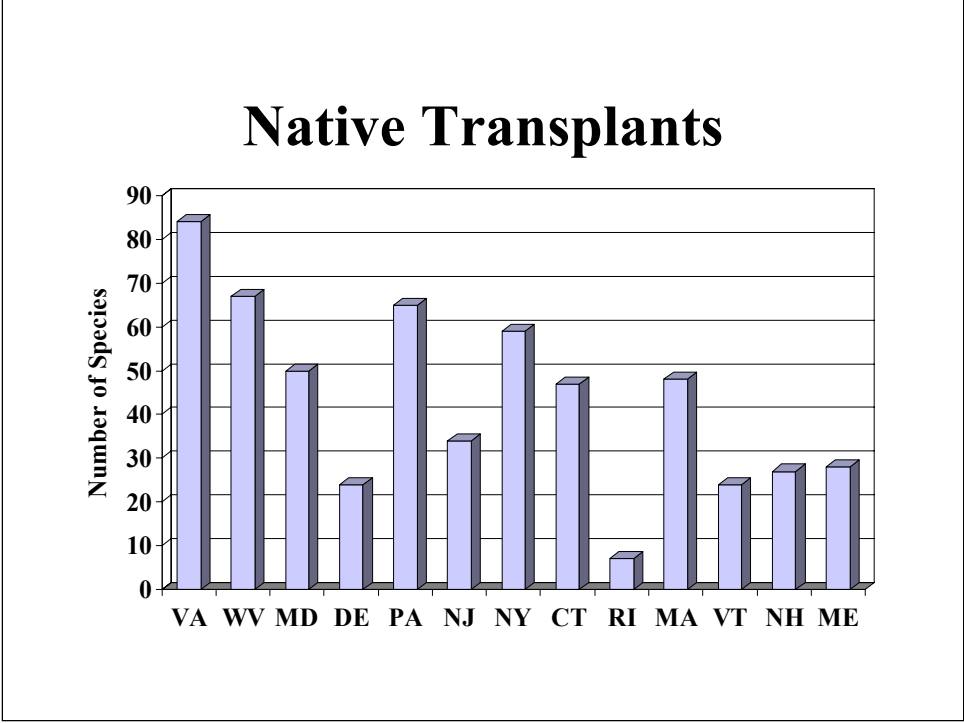
**Figure 6.** Number of fish species introduced into regional drainages (Fuller et al. 1999).

### Numbers of Introduced Species and Established Species in Each State

In the Northeast, Virginia and Pennsylvania have the most species introduced and the most species established (Figure 7). All states in this region have a low proportion of exotic species introduced. Appendix A contains a complete list of species introduced into each state. Virginia and West Virginia are the two states in Region 5 with the highest number of native transplants (Figure 8). Virginia has a large number of minnow species that are thought to have been introduced outside their native range as the result of bait releases. Small portions of the Tennessee and Ohio drainages fall within these two states. The Tennessee drainage has many species that differ from the other drainages in these states. Many of the native species have been moved between the Tennessee drainage and into other drainages in these states. In the Northeast, an average of 89% of native species transplanted outside their native range became established.

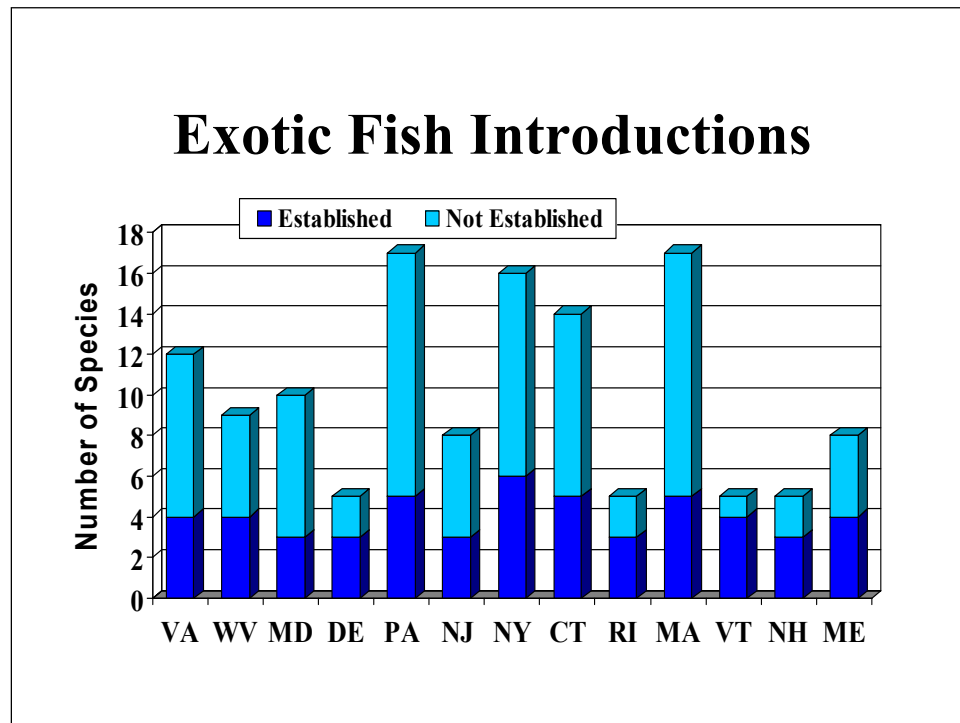


**Figure 7.** Total number of species introduced to each state.



**Figure 8.** Number of native fish species transplanted in each state.

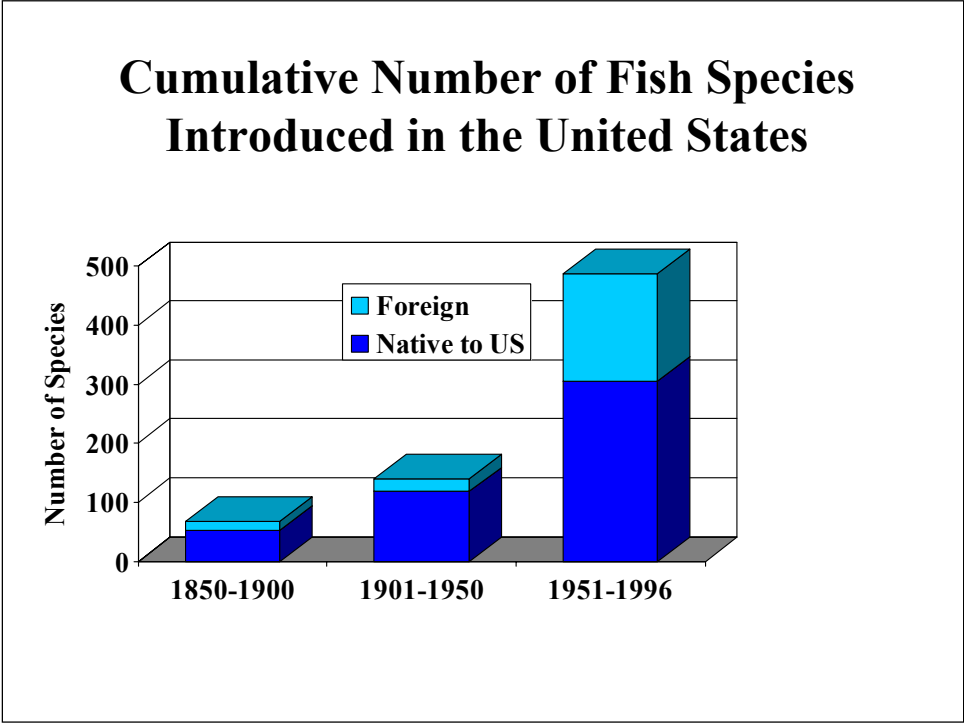
All states in the Northeast have roughly the same number of established exotic fishes (Figure 9). There are only a handful of exotic fish species able to survive in the cold, northern climates. Those species have been widely introduced and have become established throughout the region.



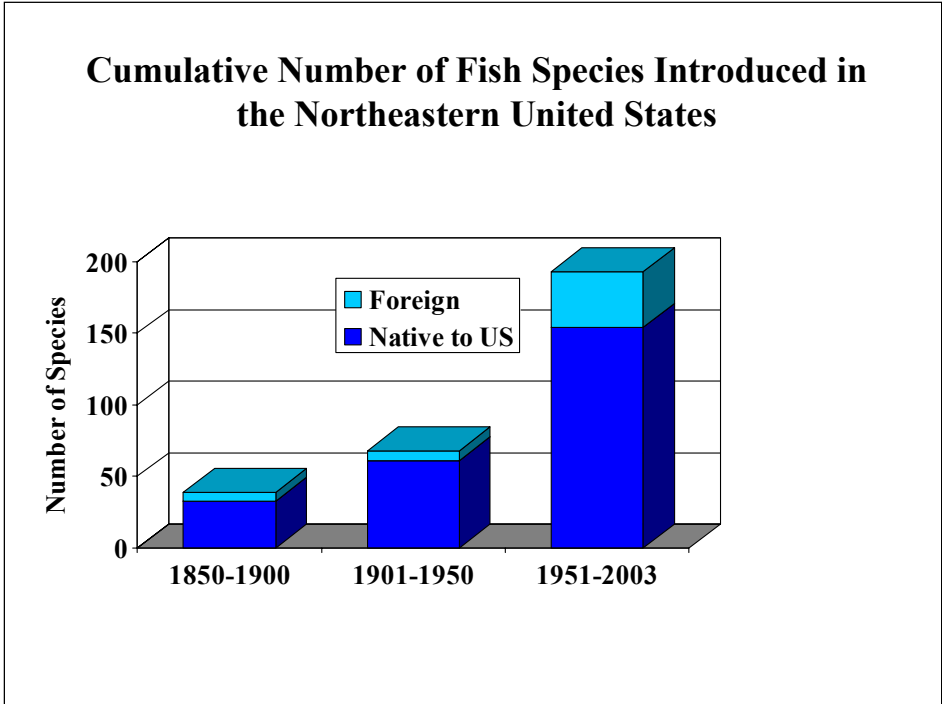
**Figure 9.** Number of exotic fish species introduced into each state.

### Introduction Trends Over Time

Introductions in the Northeast mirror the nation-wide trend of an increase in the number of species introduced since the 1950s (Figure 10a, 10b). However, the proportion of exotic fishes introduced in the past 50 years is less than the county as a whole.

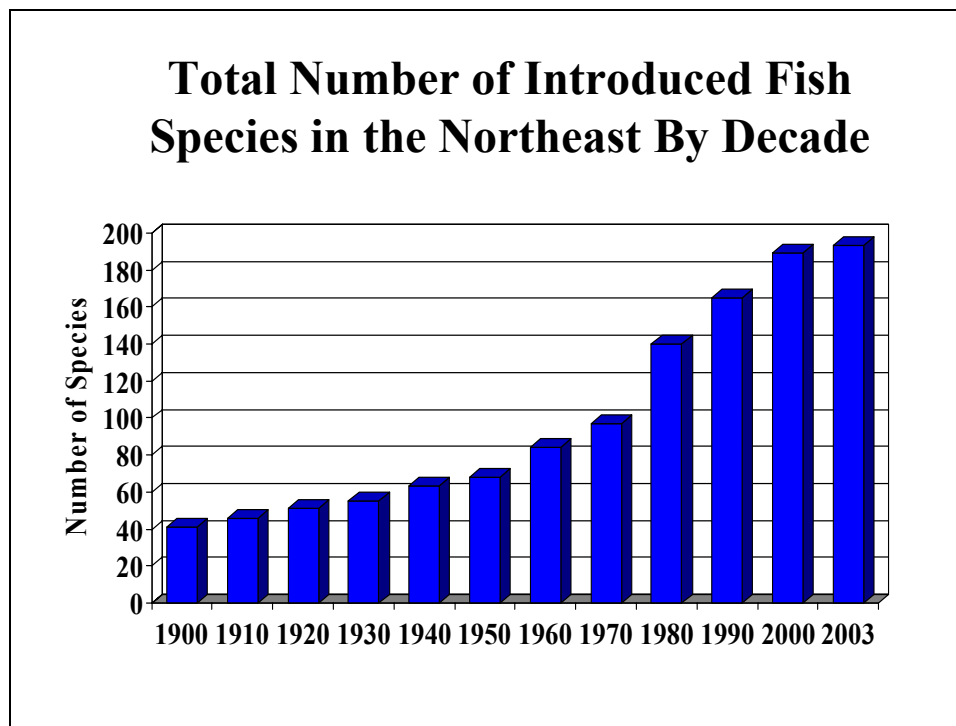


**Figure 10a.** Cumulative number of fish species introduced into the United States (Fuller et al. 1999).



**Figure 10b.** Cumulative number of fish species introduced into Northeastern United States.

The total number of species that have been introduced in the Northeast is 2.5 times higher in 2000 than it was in 1950 (Figure 10b). The increase in the Northeast by decade has been fairly constant, with no obvious dramatic jumps (Figure 11).



**Figure 11.** Cumulative number of fish species introduced into the Northeast by decade.

## Pathways

The major pathway of fish introductions for all states in Region 5 is intentional stocking for sport fishing or forage. Species stocked in these states include: various species of sunfish and bass, pike, muskellunge, bullheads, catfish, yellow perch, walleye, and several species of trout and salmon.

Nationally, stocking for sport or forage is the most dominant pathway for introduced fishes. The aquarium trade is next and accounts for ~25% (Figure 12). Bait releases are believed to be responsible for another ~16%. Fewer introductions are attributable to ballast water releases, stocking for bio-control, stocking of endangered species for conservation purposes, and miscellaneous methods such as canal connections, research releases, and escapes from aquaculture that are not related to aquarium fishes. In the Northeast, stocking is the dominant pathway, accounting for nearly 50% of the introductions. Bait release is the second most commonly used pathway and aquarium releases (or escapes from tropical fish farms) are third, followed closely by introductions arising from canal connections (Figure 13).

## Pathways of Introduction for Fishes in the United States

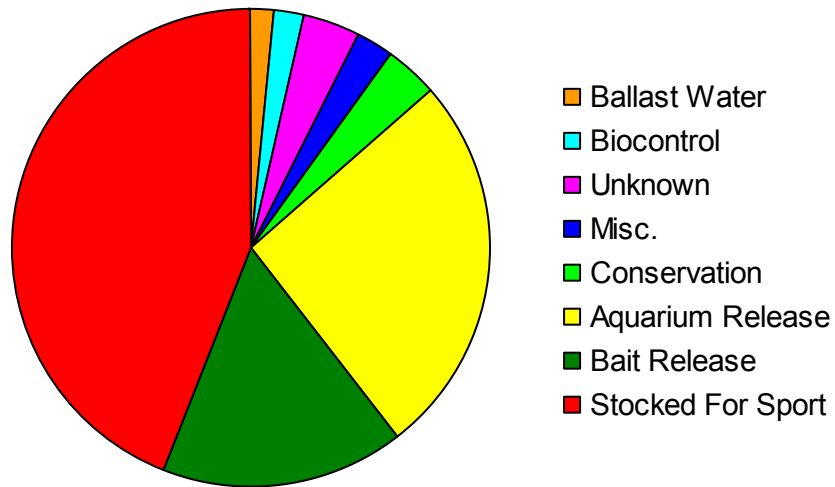


Figure 12. Pathways of fish introductions in the United States (Fuller et al. 1999).

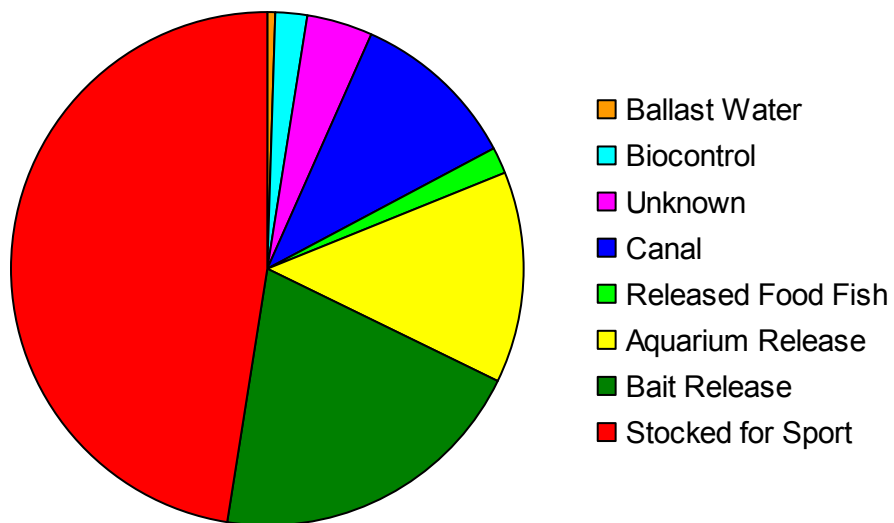
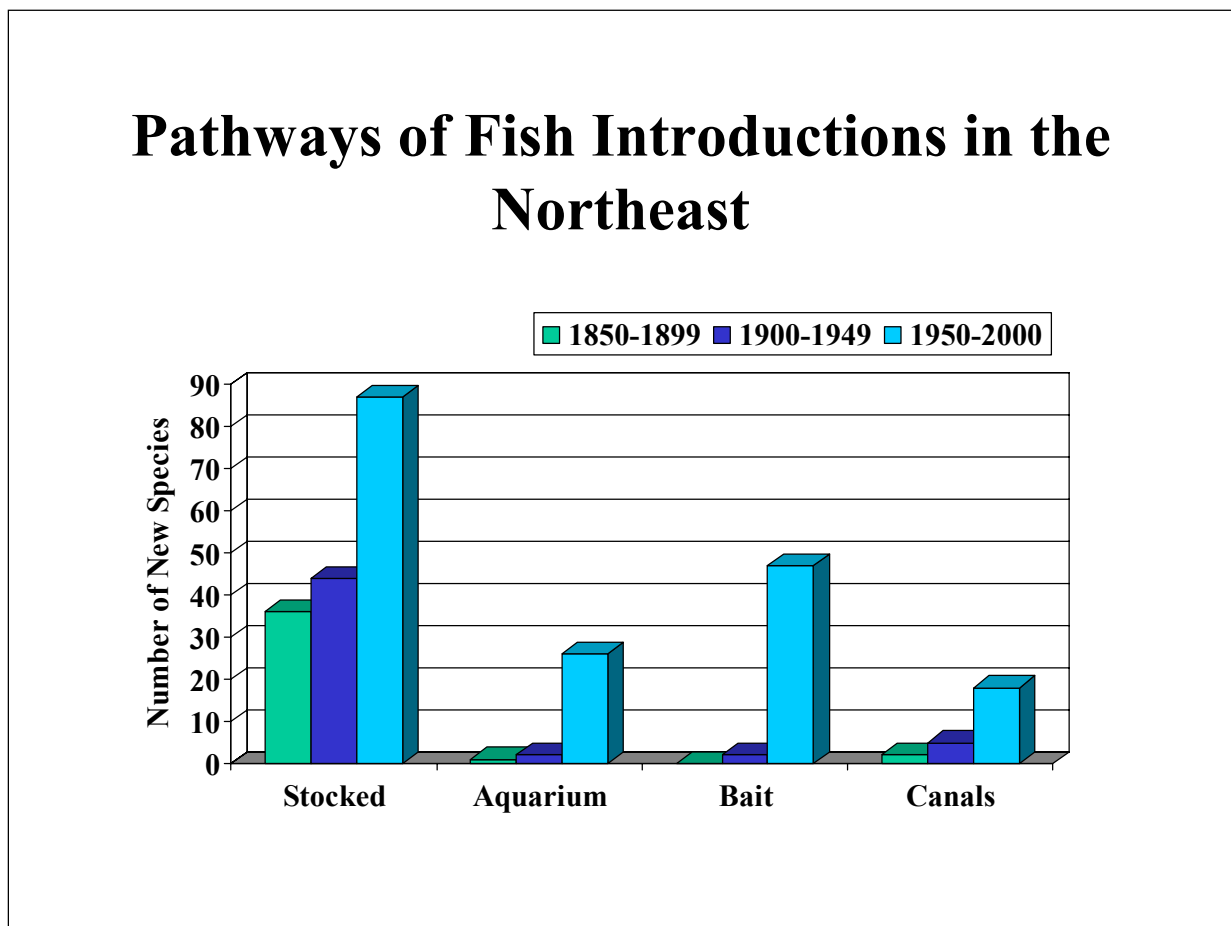


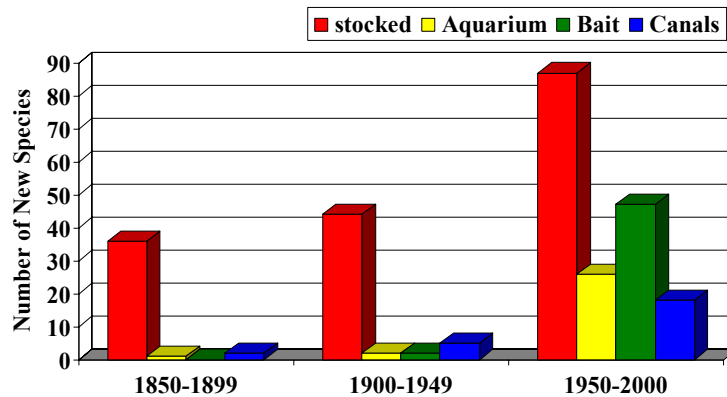
Figure 13. Pathways of fish introductions in Region 5.

An analysis of the three main pathways in the Northeast shows all three have increased dramatically in strength (Figure 14, 15). However, stocking remains the dominant pathway in the Northeast, just as it does nationwide.



**Figure 14.** Number of new species introduced via the four major pathways over the course over the last 150 years by pathway.

## Pathways of Fish Introductions in the Northeast



**Figure 15.** Number of new species introduced via the four major pathways over the course of the last 150 years over time.

### Geographic Origin of the Introduced Species

The majority of species introduced in the Northeast are native to the United States but transplanted outside their native ranges (Figures 16). Included are various species of minnows, sunfishes, bullheads and catfishes, salmon, and darters. Of the exotic species, contrary to other areas of the country where most are associated with the aquarium trade, exotics in the Northeast are mostly intentionally stocked as either sport fish or bait.

Eurasia is the source region that provides the largest number of species to the Northeast. These include common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), grass carp (*Ctenopharyngodon idella*), ide (*Leuciscus idus*), brown trout (*Salmo trutta*), tench (*Tinca tinca*), rudd (*Scardinius erythrophthalmus*), bitterling (*Rhodeus sericius*), and snakeheads (*Channa* spp.).

Central and South America is the next largest contributor to the Northeast, and includes cichlids: midas cichlid (*Cichlasoma citrinellum*), oscar (*Astronotus ocellaris*), guppies (*Poecilia reticulata*), armored catfish (*Hypostomus* spp.) and (*Callichthys callichthys*), and pacus (*Colossoma* sp. and *Piaractus* sp.) and piranhas (*Pygocentrus* spp.).

Africa is the source of a few cichlid species such as the blue tilapia *Oreochromis aureus*, and mozambique tilapia *O. mossambicus*. Figure 17 shows the continental origin of fish species introduced in 50-year increments. Although North America (the United States) has always



been the major source of introductions, those from other continents have grown in recent decades.

### Source Region of Introduced Fishes in the Northeast

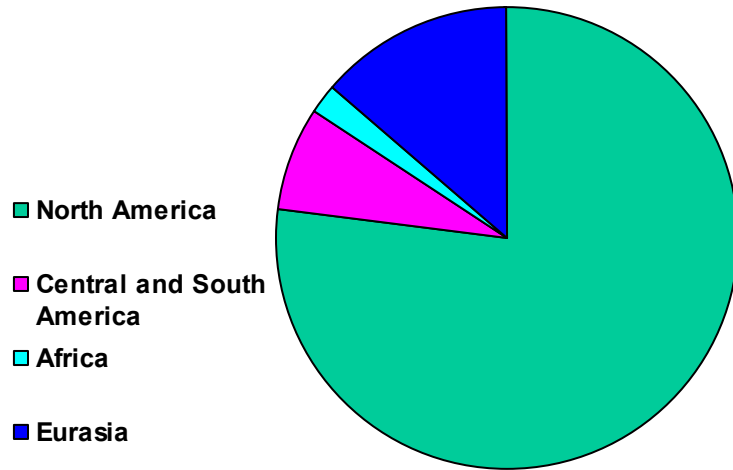


Figure 16. Geographic origin of introduced fishes in Region 5.

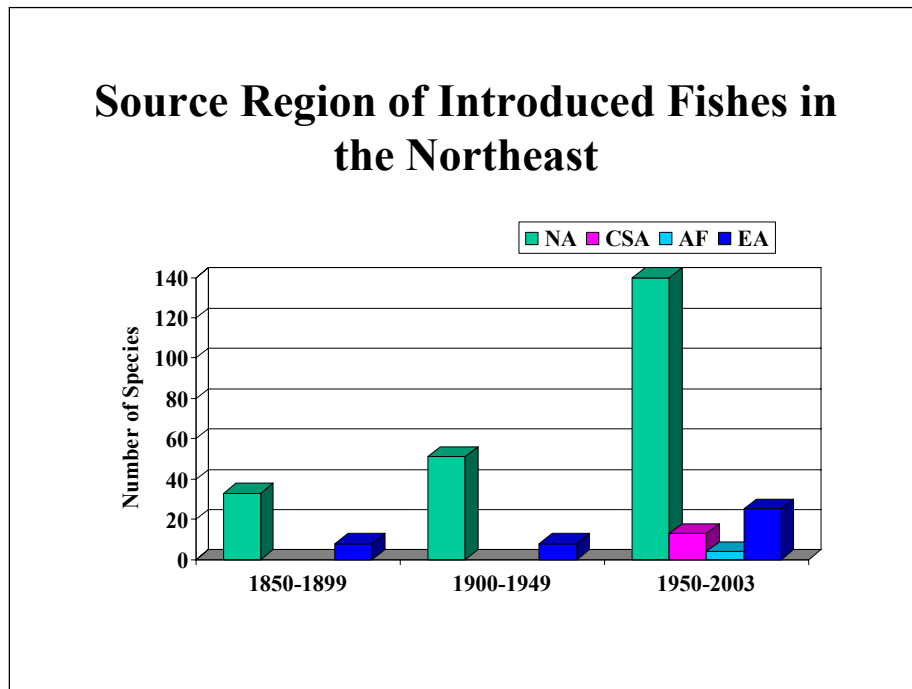
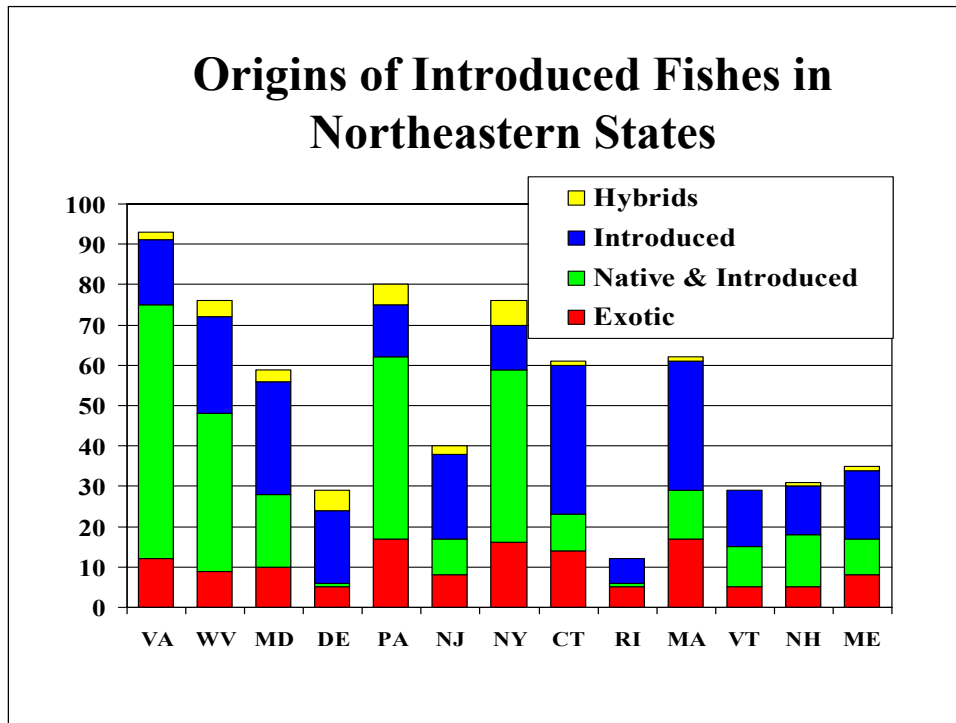


Figure 17. Geographic origin of introduced fishes in Region 5 over time.

When the origin of introductions is examined on a state by state basis, the predominant origination varies somewhat between the states (Figure 18). New York, Pennsylvania and Virginia have high percentages of species native to the state but moved outside of their native range (usually across the Appalachian Divide). These states also contain the Great Lakes, Atlantic Slope, and Ohio drainages, each with a unique fauna. Some of these species have been moved between the two drainages.



**Figure 18.** Composition and origin of introduced fishes in northeastern states.

Introduced = native to the US, but not to that state

Native and Introduced = native to part of the state

but introduced outside its native range in the state

Exotic - species not native to the US

Hybrids - stocked hybrids (wiper, tiger muskie, etc.)

Similarly, the states of Pennsylvania, Virginia and West Virginia have experienced faunal interchanges between the Atlantic, Ohio, and Tennessee drainages. The states of Connecticut, Massachusetts, and Maryland have high proportions of species that have been introduced from outside the state such as sunfishes, bass, bullhead, and salmonids.

## Vulnerable Areas

As a general rule, rivers, lakes and reservoirs near metropolitan areas throughout the Northeast are areas vulnerable to introductions. These waters are the most likely to be stocked with sport and forage fish for recreational fishing for nearby city residents. Also, they are the waterbodies most likely to receive unwanted pet and aquarium releases. Specific examples of vulnerable areas include the Susquehanna, Delaware, and Potomac drainages and the Great Lakes.



***Channa argus*** (Cantor 1841) (northern snakehead)



**Habitat:** Stagnant shallow ponds, swamps and slow streams with mud or vegetated substrate, with temperatures ranging from 0 to >30°C.

**Life History:** It reaches sexual maturity in 2 to 3 years at approximately 30-35 cm (12-14 inches) in length. Maximum size exceeds 85 cm (33 inches). Females

release 1,300 to 15,000 eggs per spawn, which can occur 1 to 5 times per year. The floating eggs take 28 hours to hatch at 31°C, 45 hours at 25°C and much longer at cooler temperatures. Larvae remain in a nest guarded by their parents until yolk absorption is complete at approximately 8 mm in length. At approximately 18 mm the young begin feeding on small crustaceans and fish larvae. The northern snakehead has been reported to be an obligate air breather, which means that it can live in oxygen-depleted waters by gulping air at the water's surface and survive several days out of water if kept moist.

**Native Range:** Eastern Asia; introduced to western Asia and eastern Europe during the 20<sup>th</sup> century.

**Nonindigenous Range:** Formerly established in a pond in Crofton, Maryland. Collected from Newton Pond, Shrewsbury, Massachusetts.

**Impacts:** These predatory fishes compete with native species for food and habitat. Juveniles eat zooplankton, insect larvae, small crustaceans, and the fry of other fish. As adults they feed mostly on other fishes, with the remainder of their diet comprised of crustaceans, frogs, small reptiles, and some times small birds and mammals.

**Comments:** There is no evidence that juveniles or adult snakeheads escaped from the Crofton ponds. The northern snakehead has a wider latitudinal range and temperature tolerance than other snakehead species. It also seems to be adaptable to a wide range of aquatic environments, as evidenced by the spread of reproducing, introduced populations in Asia and Japan. The presence of juveniles in the Crofton pond, evidence of reproduction there, demonstrates the significant potential that the northern snakehead would invade ponds, lakes and rivers in Maryland. Rotenone can be used to eradicate northern snakeheads from lakes and ponds, however this chemical treatment will kill non-target fish species. Rotenone should be applied to the pond or lake with both surface spray application and injected underwater over the entire pond sufficient to achieve a dosage of at least 3 parts per million.





***Channa maculata* (Lacepède 1802) (blotched snakehead )**

**Habitat:** Shallow, vegetated freshwater bodies; especially ditches, lakes, ponds and streams. Although blotched snakeheads are native to the tropics, they can survive for seven days out of water in 7°C temperatures.

**Life History:** Where introduced in Japan, spawning occurs in early summer. Eggs are laid in an open, circular nest in vegetation then eggs float to the surface where they are guarded by parents (Okada, 1960).

**Native Range:** China south of the Yangtze basin and northern Vietnam.

**Nonindigenous Range:** Collected from a bridge over the Charles River in Boston, Massachusetts in late July 2002.

**Impacts:** This predatory fish can impact native fauna; it feeds on crustaceans, large insects, frogs and fishes.

**Comments:** The species is available in at least one ethnic market in Boston.



***Channa marulius* (Hamilton 1822) (bullseye snakehead)**

**Habitat:** Deep clear lakes and rivers with rocky or sandy substrate.

**Life History:** Spawning apparently occurs once to twice during warmer times of the year and

brood size varies tremendously, from 350 to over 3600 young. Parents guard the nest containing pale red-yellow eggs (2mm in diameter) and they guard the young until they reach 10 cm in length.

**Native Range:** Pakistan, India, Sri Lanka, Bangladesh, southern Nepal and Southern China, Myanmar, Thailand, Laos, and Cambodia.

**Nonindigenous Range:** Collected from Baltimore Inner Harbor, Maryland.

**Impacts:** This predatory species has the potential impact native fish and crustaceans through predation if it ever became established.

**Comments:** The species is available in some live fish markets and obtainable, but rare, in the aquarium trade.





***Channa micropeltes* (= *C. micropeltis*) (Cuvier 1831)  
(giant snakehead)**

**Habitat:** Lakes, reservoirs, canals, and rivers; most commonly deep, standing or slow

flowing water.

**Life History:** Nest in a circular area, which the parents clear of vegetation. Eggs rise and drift in the water column where they are guarded by parents. *C. micropeltes* ferociously guard their eggs, even attacking humans who approach the nest.



**Native Range:** Tropical Asia. Southeast Asia including India, Burma, Thailand, Laos, Malay Peninsula, Sumatra, Borneo, Java, Banka, and Billiton.

**Nonindigenous Range:** Collected from the Rocky Gorge Reservoir on the Patuxent River (Maryland) in 2000; and three additional specimens from Maryland in 2002, but the specific localities were not disclosed. In the 1970s specimens were collected below the Springvale Dam on the Mousam River, York County and from the Saco River (Maine). Identification was never confirmed for the Saco River specimens. Also collected from Poms Pond, Andover (Massachusetts); as well as an unspecified pond and Johnston Pond, Coventry (Rhode Island). The two Rhode Island records may reflect duplicate reports of a single collection.

**Impacts:** In its native habitat, this aggressive predator is destructive to other fishes, killing all kinds and sizes in excess of actual needs. Anglers and swimmers have been attacked by this species in its native range.

**Comments:** Juveniles are sold in the aquarium trade.



H. Jelks

***Astronotus ocellatus* (Agassiz 1831) (oscar)**

**Habitat:** Freshwater canals and ponds.

**Life History:** Where introduced in Florida, eggs are laid in June to October at 28 to 33°C and are incubated by both parents.

Young are also guarded by parents.



**Native Range:** South America including the Orinoco and Amazon basins; also French Guiana, and the northern part of Paraguay drainage, Parana basin.

**Nonindigenous Range:** Collected from island waters near Martha's Vineyard and Nantucket (Massachusetts) and from an unspecified location in Massachusetts. Also collected from an unspecified location in Pennsylvania; a pond in northern Rhode Island; the Millstone River near its confluence with the Raritan River, New Jersey; and a Virginia Beach, Virginia area pond.



**Impacts:** Oscars are considered potential competitors with native centrarchids (sunfishes) for food and spawning areas.

**Comments:** Oscars are common in the aquarium trade. Future research may determine that some oscar in the aquarium trade, as well as those collected in U.S. waters, are not *A. ocellatus* but another member of the genus. To confound the issue, artificial breeding has produced several color variants.



***Oreochromis aureus* (Steindachner 1864) (blue tilapia)**

**Habitat:** Subtropical fresh and brackish waters, 8 to 30°C, including lakes ponds, and rivers

**Life History:** Able to reproduce in fresh or brackish waters with multiple spawnings in one season. Nest in colonies when water temperature exceeds 22°C; male builds nest and female incubates eggs in her mouth.

**Native Range:** Tropical and subtropical Africa and Middle East. Native range includes Senegal, Niger,

and many smaller drainages and lakes in Africa and Middle East.

**Nonindigenous Range:** Once established in warm water effluents of a power plant on the Susquehanna River (Pennsylvania), after escaping from Pennsylvania Power and Light's Brunner Island Aquaculture Facility sometime after October 1982 . Populations in the vicinity of Brunner Island were eradicated in February 1986, when condenser cooling water was temporarily released at lethal, lower temperatures; however *O. aureus* may still survive farther downstream. Before the eradication, tilapia were collected 78 km downstream from the Brunner Island site where warm water effluents are not influential.

**Impacts:** The blue tilapia is considered a competitor with native species for spawning areas, food, and space. In certain streams where *O. aureus* are abundant, most vegetation and nearly all native fishes are reportedly lost. Also implicated as the cause for unionid mussel declines in two Texas water bodies, Tradinghouse Creek and Fairfield reservoirs.

**Comments:** Not able to withstand temperatures lower than 6-7° C and will not feed below 16-17° C.



***Tilapia buttikoferi* (Hubrecht 1881) (zebra tilapia)**

**Habitat:** Freshwater lakes and ponds; typically tropical.

**Life History:** Male-female pairs cooperatively excavate a depression or pit in the sediment until they reach a solid substrate.

**Native Range:** Western Africa; lower reaches of coastal rivers from Guinea-Bissau (Geba and Corubal Rivers) to west Liberia (St. John River).

**Nonindigenous Range:** A single large fish, identified by two independent experts, was collected from the



Rappahannock River near Fredericksburg, Virginia in July 2000. This is the first report of this species in the country.

**Impacts:** Unknown. Due to temperature constraints, it is unlikely this tropical species would establish in the Mid-Atlantic region.



D. Raver/USFWS

***Alosa aestivalis* (Mitchill 1814) (blueback herring)**

**Habitat:** Anadromous; living in marine systems and spawning in deep, swift freshwater with hard

substrate.

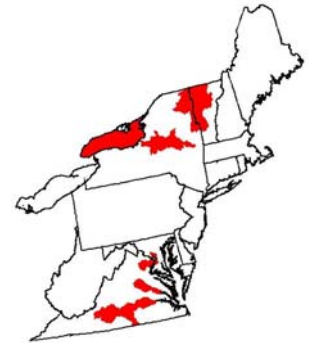
**Life History:** Migrate to spawning grounds in the spring. In Connecticut, blueback herring spawn in 14 – 27°C temperatures. Young travel to the sea at about one month of age.

**Native Range:** Atlantic Coast from Cape Breton,

Nova Scotia, to the St. Johns River, Florida. Ascends coastal rivers during spawning season.

**Nonindigenous Range:** Collected from Oneida Lake, the Oswego River in Minetto, and Lake Ontario (New York); and Lake Champlain (New York-Vermont). Stocked in several inland reservoirs including Smith Mountain Lake, Occoquan Reservoir, Kerr Reservoir, Lake Anna, Lake Brittle, and Lake Chesdin (Virginia); stocked in unspecified locations in Pennsylvania.

**Impacts:** Unknown. Established in New York, North Carolina, Vermont, and Virginia.



***Dorosoma petenense* (Günther 1867) (threadfin shad)**

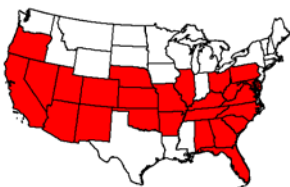
**Habitat:** Lakes, ponds, rivers, reservoirs and estuaries. Does not endure cold water (7 – 14°C).

**Life History:** Spawning occurs often before one year of age over vegetation or logs in open water at 21°C.

**Native Range:** The Ohio River (Indiana and Illinois) and the Mississippi River, (southern Illinois) south through the Mississippi River basin to the Gulf; Atlantic Slope drainages of Florida; Gulf drainages from south central Florida to northern Guatemala.

**Nonindigenous Range:** Collected from an unspecified location in Pennsylvania; established in the Potomac River (Maryland-Virginia-West Virginia); established in numerous drainages in Virginia; possibly established in the lower Kanawha and Ohio drainages of West Virginia. Also, stocked, but failed or extirpated in Coursey Pond (Delaware) and numerous locations in West Virginia.

**Impacts:** Populations in several West Virginia lakes extirpated by cold weather but established in other areas. Concern exists regarding possible impacts on other fish species with planktonic larvae, such as minnows and suckers, and on young centrarchids. Threadfin may compete



with young centrarchids for food and have apparently destroyed kokanee fishing in some areas.

**Comments:** Some evidence indicates that this species is not native, but introduced, east of the Mississippi River as a forage fish in the early 1900s. There are no published records of the species east of the Mississippi River prior to the 1940s and a range expansion after 1940 may have resulted from a combination of natural range extension and human introduction.



***Ctenopharyngodon idella* (Valenciennes 1844) (grass carp)**



**Habitat:** Rivers, large streams, ponds, and reservoirs with salinity up to 10 ppt, oxygen concentrations as low as 0.0005 ppt, and temperatures ranging from 0 to 35°C. Require running water (rivers) in order to spawn. Will not reproduced in lakes.

**Life History:** Spawns during the warmer, rainy months in China.



**Native Range:** Eastern Asia from the Amur River of eastern Russia and China south to West River of southern China.

**Nonindigenous Range:** Throughout the northeastern United States except Maine, Rhode Island and Vermont.

**Impacts:** Effects of a grass carp introduction on a water body apparently depend on the stocking rate, macrophyte abundance, and community structure of the ecosystem. Negative effects reported in the literature include inter-specific competition for food with invertebrates (e.g., crayfish) and other fishes, significant changes in the composition of macrophyte, phytoplankton, and invertebrate communities, interference with the reproduction of other fishes, and decreases in refugia for other fishes. Grass carp are often used to control selected aquatic weeds, but often consume non-target plant species. Secondly, grass carp cause an increase in phytoplankton populations. Grass carp may carry parasites and diseases potentially transmissible to native fishes such as the Asian tapeworm (*Bothriocephalus opsarichthydis*).

**Comments:** Both authorized and unauthorized stockings of grass carp have taken place for biological control of vegetation. Triploids are considered to be sterile and incapable of reproduction. However, some researchers find fertility to be low, not negated, in triploids. Triploid grass carp are indistinguishable in external morphology from normal (fertile) diploids. Thus, ensuring that grass carp being stocked are all triploid requires tissue sampling. Texas now bans grass carp for fear they will remove too much vegetation and thus destroy fish and wildlife habitat. As of 1994, the states of Alaska, Oregon, Montana, North Dakota, Minnesota, Wisconsin, Michigan, Massachusetts, Vermont, Maine, Maryland, and Rhode Island prohibit grass carp, diploid and triploid, in their state.





***Cyprinus carpio* Linnaeus 1758 (common carp)**

**Habitat:** Lakes, streams, and ponds of any substrate or water clarity

**Life History:** Spawns in spring and early summer when water reaches 17°C by congregating in groups among vegetated shallows.

**Native Range:** Eurasia.

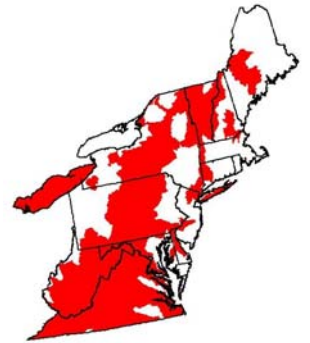
**Nonindigenous Range:** Recorded from all states except Alaska; and believed to be established in all northeastern and Mid-Atlantic states except Maine.

**Impacts:** Regarded as a pest fish because of its widespread abundance and its tendency to destroy vegetation and increase water turbidity by dislodging

plants and rooting around in the substrate. Causes deterioration of habitat for species requiring vegetation and clean water. Common carp are potential predators of native fish eggs.

**Comments:** More than 20,000 common carp were killed by a bacterial disease over a short period of time in the Merrimack River in the late 1970s.

Because common carp have a higher salinity tolerance than most freshwater fishes, they may spread from one coastal stream to another through fresh or nearly fresh coastal waters in the Gulf area during periods of heavy rainfall and run-off, periods when salinities are greatly reduced.



D. Reicke

***Hypophthalmichthys nobilis* (Richardson 1845) (bighead carp)**

**Habitat:** Filter feeder that prefers large river habitats

**Life History:** Typically spawns at water temperatures of 18 - 25.5°C in areas with rapid current or mixing

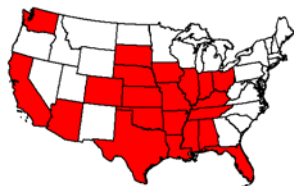
water. Averages between 660,000 and 872,000 eggs per female per year.

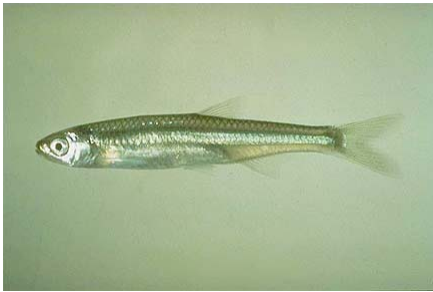
**Native Range:** Southern and central China.

**Nonindigenous Range:** Collected from the Ohio River (West Virginia); and Sandusky Bay, Lake Erie (Ontario).

**Impacts:** Unknown. Planktivorous food habits and large size suggest these carp have the potential to deplete zooplankton populations.

**Comments:** Used in many parts of the world as a food fish and sometimes introduced in combination with silver carp into sewage lagoons and aquaculture ponds. In the United States, frequently stocked into catfish culture ponds. Scientists debate whether bighead carp actually do improve water quality in culture ponds.





**Notropis atherinoides** Rafinesque 1818 (emerald shiner)

**Habitat:** Large lakes and open rivers, usually in large schools  
**Life History:** Spawns in spring to early summer over a wide range of temperatures. Larvae emerge from eggs after 24 - 32 hours. Adults reach up to 4 inches (10.1 cm) and typically live only 3 years. Feeds on terrestrial insects during the summer and caddis worms, mayfly naiads, and amphipods in winter.



**Native Range:** St. Lawrence drainage, Quebec; Hudson River drainage, New York to Mackenzie River drainage (Arctic basin), Northwest Territories, and south through Great Lakes and Mississippi River basins to Gulf; Gulf Slope

drainages from Mobile Bay, Alabama, to Galveston Bay, Texas.

**Nonindigenous Range:** Established at several unspecified locations in central and southern Maine; in the Jennings Randolph Reservoir (Maryland); and possibly native but perhaps introduced into the Kanawha drainage above the falls (West Virginia). Collected, and perhaps nonindigenous, in Lebanon and Erieville reservoirs (Susquehanna River drainage in New York) and from several large unspecified impoundments in Massachusetts. Some scientists list the emerald shiner as introduced into the Housatonic and Connecticut drainages, probably in the Massachusetts portion of these waters.

**Impacts:** Unknown.

**Comments:** The Massachusetts specimens have never been examined by specialists, but this species is sold in bait stores in that state. Dramatic increases in abundance of this sight-feeding minnow in the Missouri River (part of its native range) may be the result of decreases in turbidity and other factors relating to the construction of upstream reservoirs.



**Notropis hudsonius** (Clinton 1824) (spottail shiner)

**Habitat:** Predominantly large sluggish rivers and lakes, freshwater to brackish water (10.7 ppt salinity); also in streams.

**Life History:** Spawns in spring to early summer in various habitats; lake spawning occurs over sandy shoals. Feeds on crustaceans, filamentous algae, and insects.

**Native Range:** Atlantic and Gulf Slope drainages from St. Lawrence River, Quebec to Altamaha and upper Chattahoochee River,

Georgia; Hudson Bay, Great Lakes, and Mississippi River basins from Ontario to Mackenzie River drainage (Arctic basin), Northwest



Territories and Alberta, and south to northern Ohio, southern Illinois, and northeastern Montana.

**Nonindigenous Range:** Established, or presumably established, in Maine, New Hampshire, New York, Pennsylvania, Virginia, and West Virginia. Established in the lower Kennebec River (Maine); the Connecticut and Merrimack rivers (New Hampshire) (where it may be introduced rather than native); the Allegheny Reservoir (New York-Pennsylvania border); the New River drainage (Virginia); and above the Kanawha falls (West Virginia).

**Impacts:** Unknown.



***Pimephales promelas* Rafinesque 1820 (fathead minnow)**

**Habitat:** Wide range of habitats including ponds and flowing streams; tolerates high temperatures, high turbidity, and low oxygen; and schools near the bottom or in Mid-depths.

**Life History:** Able to spawn during second year and over an extended spawning season, which commences during spring at water temperatures around 60° F (15.6°C). Eggs are laid under floating objects in still water and guarded by the male. Feeds on algae and aquatic insect larvae.



**Native Range:** Widespread in North America from Quebec to Northern Territories, and south to Alabama, Texas, and New Mexico.

**Nonindigenous Range:** Established in all of the major and most of the coastal drainages in Connecticut; the Potomac and upper Chesapeake drainages (Maryland); the Housatonic River drainage, the Concord system, the Connecticut River drainage, and a pond in Amherst, Massachusetts; Susquehanna and Delaware river drainages in Pennsylvania; and Atlantic Slope and Ohio River basin drainages in West Virginia. Collected from the Youghiogheny River system, Maryland, the Lower Connecticut River drainage, Massachusetts; the Penobscot and (possibly) Kennebec river drainages in Maine; the Androscoggin River system in New Hampshire; various drainages in Virginia; and Mill Creek in Delaware.

**Impacts:** Unknown.

**Comments:** Popularity as a baitfish and the ease with which it is propagated have led to widespread introductions both within and outside the native range. Because the species has been so widely introduced, its natural range is somewhat obscure.



***Rhodeus sericeus* (Pallas 1776) (bitterling)**

**Habitat:** Small lakes and slow-moving back waters with soft bottoms

**Life History:** Can reach 110 mm. Breeds in

Spring; *Rhodeus* requires freshwater bivalves as spawning sites; eggs are deposited, fertilized, and hatch in live mussels.





**Native Range:** Europe from the Seine and other rivers of France eastward to Asia Minor, and northern China (there is a very wide geographical gap in the northern part of the Asian continent separating the ranges of the two subspecies).

**Nonindigenous Range:** The first records of this species (as *Rhodeus amarus*) were from the Sawmill River, a tributary of the Hudson River, at Tarrytown, Westchester County, New York in the early 1920s. Although it reportedly disappeared from this locality shortly after 1925, additional specimens were taken in subsequent years, with the last collection made in 1951. Two specimens were taken from the Bronx River at Bronxville, Westchester County, New York, in 1933; subsequent collections indicated the species was established in a localized reach of the river.

**Impacts:** Unknown.

**Comments:** Laboratory evidence has shown that this European fish will use certain U.S. native mussels (*Anadonta cataracta* and *Unio complanatus*). The reported recent decline in population of bitterling in the Bronx River apparently has resulted from a declining freshwater mussel population brought about by water pollution.



***Scardinius erythrophthalmus* (Linnaeus 1758) (rudd)**

**Habitat:** Still or slow moving freshwater.

**Life History:** Reaches 200-250 mm total length (TL) and 400 mm standard length (SL) in native range. Eggs laid in submerged aquatic vegetation nearshore.

**Native Range:** Western Europe to the Caspian Sea and Aral Sea basins.

**Nonindigenous Range:** Established in Lake Cobboseecontee in Kennebec County, (Maine); Copake Lake and downstream from Robinson Lake dam, Oneida Lake, Ostego Lake, north of Cheviot Landing (Hudson



River), Ringneck Marsh, and Schroon Lake (New York); Burr Pond in Rutland County (Vermont); and Lake Anna (Virginia). Reported in Connecticut (specific location not disclosed); the Charles River, Cambridge and Benton Lake, Otis (Massachusetts); Lake Winola, west of Scranton (Pennsylvania); Lake Champlain (Vermont); Burke Lake, Gardy's Mill Pond, and Lake Whitehurst (=Little Creek Reservoir) (Virginia); and the New River (West Virginia). Also recorded from numerous locations in New York such as: Central Park Lake, New York City; Cascadilla Creek near Ithaca in the Great Lakes basin in the early 1950s; Lake Ontario, Lake Erie; and the St. Lawrence River. Reportedly extirpated from a lake in Hudson County Park, Jersey City, New Jersey.



**Impacts:** Largely unknown. In a laboratory setting, rudd readily hybridize with native golden shiner (*Notemigonus crysoleucas*), a primary forage species of many native game fishes. Thus, rudd introduced to open waters may hybridize with golden shiner, with unknown consequences to native populations of golden shiner. The potential exists for rudd to compete

with native fishes that also feed on invertebrates. Rudd can shift its diet to plants, unlike most native fishes. Because rudd are fairly hardy, the fish will fare better than many native fishes in waters that are eutrophic or polluted.

**Comments:** The recent and rapid spread of the species is a result of its use as a baitfish for white bass. Many states now outlaw the use of rudd as live bait, apparently slowing its spread.



**Tinca tinca** (Linnaeus 1758) (tench)

**Habitat:** Lakes and backwaters of rivers; able to withstand hypoxic conditions.

**Life History:** Large numbers of eggs are laid amidst submergent aquatic vegetation during summer months; approximately 275,000 eggs are produced per pound of female's body weight. Males exhibit a thickened second pelvic ray when mature.

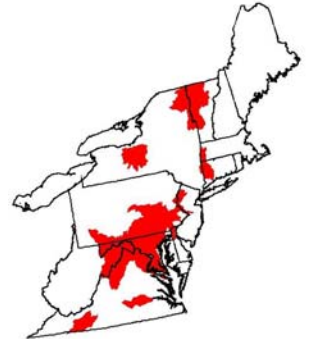
**Native Range:** Most of Europe, including the British Isles, and parts of western Asia.

**Nonindigenous Range:** In 2002, collected from

Lake Champlain (Vermont). Established in the Housatonic drainage (Connecticut); as well as in undisclosed localities in New York; and Maryland. Also stocked, but not established in various locations in Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Virginia, and West Virginia.

**Impacts:** Unknown, though as early as the 1940s reported to be an abundant nuisance in Maryland. May compete with sport fish for food; aquatic insect larvae and molluscs.

**Comments:** Imported into North America from Germany by the U.S. Fish Commission in 1877 apparently for use as a food and sport fish. Although most tench introductions were the result of intentional stockings, some introductions were the result of escape from holding facilities.



**Pylodictis olivaris** (Rafinesque 1818) (flathead catfish)

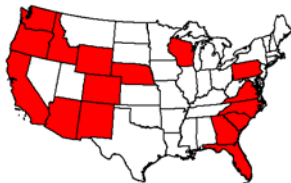
**Habitat:** Large to medium rivers usually in deep holes; young commonly found in riffles of large rivers.

**Life History:** Becomes sexually mature at 3 - 4 years and lives to 20 years. Feeds on fish and crustaceans.

**Native Range:** Lower Great Lakes and Mississippi River basins from western Pennsylvania to White-Little Missouri River system (North Dakota) and south to

Louisiana; Gulf Slope from Mobile Bay drainage (Georgia and Alabama) to Mexico.

**Nonindigenous Range:** Apparently expanding its range along the east coast and currently established the Lower Delaware drainage (Blue



Marsh Reservoir and Springton Reservoir), and the Schuylkill River drainage (Pennsylvania); as well as Occoquan Reservoir and middle Roanoke drainage (Virginia). Collected from Smith Mountain Reservoir, the upper James River (Botetourt County), and the lower James River near Surry (Virginia).

**Comments:** The flathead catfish is native to the Mississippi, Ohio, and the western Gulf drainages. It has been introduced both legally and illegally for sport fishing. They prey heavily on sunfish (*Lepomis* spp.), common carp (*Cyprinus carpio*), and bullheads (*Ameiurus* spp). Young-of-the-year feed on darters (*Etheostoma* spp.). Clupeids, Catostomids, Ictalurids (including other flatheads), Centrarchids, and crayfish are also consumed. The flathead catfish became the dominant predator in the Cape Fear drainage, North Carolina, within 15 years of the introduction. The state of Georgia is now trying to control them in the Altamaha River, and has taken an enormous amount of flathead biomass out of the river.



***Morone americana* (Gmelin 1789) (white perch)**

**Habitat:** Brackish water or coastal freshwater bodies.

**Life History:** Anadromous or remaining in freshwater; adults



spawn in shallows during the spring in water temperatures of 11 -15°C. Not all eggs are released at one time and total number of eggs for a spawning season range from 20,000 to 300,000.

**Native Range:** Atlantic Slope drainages from St. Lawrence-Lake Ontario drainage (Quebec) south to Pee Dee River (South Carolina). Populations in Lake Ontario drainage probably became established following construction of the Erie Canal.

**Nonindigenous Range:** Established in all five Great Lakes and their surrounding states, as well as in Kentucky, Massachusetts, Missouri, Nebraska, New Hampshire, and Vermont. Nonnative and established in Lake Champlain (Vermont and New York); the Great Lakes drainage (New York); Lake Erie and Allegheny Reservoir (Pennsylvania); and inland waters (localities not specified) of Massachusetts and New Hampshire. Collected from Smith Mountain Reservoir and Kerr Reservoir (Virginia); and the upper Potomac drainage (West Virginia).



**Impacts:** White perch prey on eggs of walleye (*Stizostedion vitreum vitreum*), white bass (*Morone chrysops*), eggs of its own species, and possibly eggs of other species. Apparently, fish eggs are an important component of the diet of white perch in the spring months. White perch also feed heavily on minnows (*Notropis* spp).

**Comments:** The first report of white perch in the Great Lakes drainage was from Cross Lake, central New York, in 1950. The species evidently accessed the lake via the Erie Barge Canal during the warm weather in the 1930s and 1950s. White perch were stocked in West Virginia in the early 1900s.



***Morone chrysops* (Rafinesque 1820) (white bass)**

**Habitat:** Clear lakes and reservoirs and adjoining river systems.

**Life History:** Spawning on shoals and in streams during the spring, this potamodromous species (ie. migratory within freshwater) produces 61,700 to 994,000 eggs.

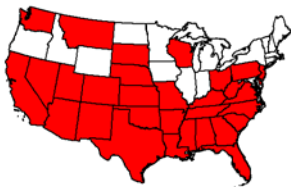
**Native Range:** St. Lawrence-Great Lakes, Hudson Bay (Red River), and Mississippi River basins from Quebec to

Manitoba and south to Louisiana; Gulf Slope drainages from Mississippi River (Louisiana) to Rio Grande (Texas) and New Mexico. Native to western New York and western Pennsylvania.

**Nonindigenous Range:** Established locally in New Jersey (specific locality not reported), southern

Pennsylvania, Virginia, and West Virginia. Collected in Delaware, where the species is known from a single record in 1888 and, presumably is extirpated. Attempts to establish the species in the Youghiogheny River, Maryland and Pennsylvania failed.

**Impacts:** Unknown.



***Morone chrysops x saxatilis* hybrid (wiper)**

**Native Range:** Artificial hybrid occurring naturally only in Arkansas.

**Nonindigenous Range:** Established in the upper Susquehanna and Chenango drainages (New York); and the Potomac drainage (Virginia). Collected from the Brandywine-Christina and

Broadkill-Smyrna drainages (Delaware). Stocked in Lake Hopatcong (New Jersey); non-specified

localities in New York; Nockamixon Lake (Pennsylvania); Leesville Lake and the Rappahannock River (Virginia); and the Ohio River and its tributaries, and the Kanawha River (West Virginia).

**Impacts:** Backcrossing, mating with the parental native species, has been observed and may cause loss of genetic integrity of the parent species or even the loss of a native species, subspecies, or of a unique population.

**Comments:** The wiper (palmetto, whiterock, Cherokee) is the result of crossing a female striped bass with a male white bass, and was first cultured in 1965. The sunshine bass, first produced in 1973, is the result of the reverse cross. Most introductions are of the wiper hybrid; however, a few sites have been stocked with sunshine bass, including some lakes in Florida. These hybrids reportedly grow faster, survive better, and are caught more readily than their parent species the striped bass. However, they don't become as large as striped bass.

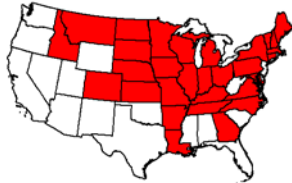




***Osmerus mordax* (Mitchill, 1814) (rainbow smelt)**

**Habitat:** Inshore coastal waters and midwaters of large lakes typically in schools; freshwater of 43° – 56°F is optimal.

**Life History:** Reproductive maturity is reached after two years; spawning is during night hours in the spring. Eggs (from 8,000 to 70,000 in number) sink and attach to gravel substrate by way of a short stalk.



**Native Range:** Atlantic drainages from Lake Melville (Newfoundland) to Delaware River (Pennsylvania) and west through Great Lakes;

Arctic and Pacific drainages from Bathurst Inlet (Northwest Territories) to Vancouver Island (British Columbia). Also, Pacific drainages of Asia.

**Nonindigenous Range:** Established in the Shetucket and Lower Connecticut drainages (Connecticut), the Upper Susquehanna-Lack drainage (Pennsylvania), Lake Erie, Lake Champlain, coastal Maine, numerous localities in New York, and unspecified localities in Massachusetts. Additional collections in several localities in Pennsylvania; and failed stocking attempts in Massachusetts, Maryland, and Virginia.



**Impacts:** In the Great Lakes, rainbow smelt compete with lake herring (*Coregonus artedii*) for food and may be responsible for the decline of whitefish (*Coregonus* spp). Atlantic salmon reportedly experienced increased growth following the introduction of smelt as a forage species in a lake in Maine.

**Comments:** This species is eaten by humans and used as bait for salmonids and walleye.



***Etheostoma zonale* (Cope 1868) (banded darter)**

**Habitat:** Small to medium rivers or riffles along shores of large rivers (Lee et al., 1980).

**Life History:** Spawning occurs June to July; adults reach 45-62 mm SL (Lee et al., 1980).

**Native Range:** Lake Michigan and Mississippi River basins from



southwestern New York to Minnesota, and south to northern Georgia, northern Alabama, and southern Arkansas. Absent from Former Mississippi Embayment; Wabash River drainage of Ohio, Indiana, and Illinois; and streams of southern Illinois, southern Iowa, and

northern Missouri.





**Nonindigenous Range:** Established in the Susquehanna River and its associated drainages (Pennsylvania & New York). Collected from the Lower Susquehanna drainage in Maryland.  
**Impacts:** Introduced banded darters are hybridizing with native tessellated darters (*E. olmstedii*) in the Susquehanna River, Pennsylvania.



A sea lamprey attached to a fish. GLFC

***Petromyzon marinus* Linnaeus 1758 (sea lamprey)**

**Habitat:** Generally marine but ascends freshwater rivers to spawn.

**Life History:** Spawn in spring and producing as many as 236,000 eggs when stream temperatures reach 11° C (52°C).

**Native Range:** Atlantic Coast from Labrador to Gulf of Mexico (Florida); landlocked in Great Lakes and several New York lakes.



Also along Atlantic coast of Europe and Mediterranean Sea.

**Nonindigenous Range:** Established in Lake Champlain (Vermont and New York), the Finger Lakes (New York), and throughout the Great Lakes.



**Impacts:** Attack and parasitic feeding on other fishes by adult lampreys often results in death of the prey, either directly from the loss of fluids and tissues or indirectly from secondary infection of the wound.

**Comments:** Some scientists suggest sea lampreys found in Lake Ontario and its tributaries, the Finger Lakes, and Lake Champlain represent relict populations from the last Pleistocene glaciation. Those contending that it is not native believe that this species, unknown in Lake Ontario prior to the 1830s, had most likely entered the inland lake from Atlantic coastal drainages via the Erie Canal (e.g., Emery 1985). Beginning in the late 1950s, sea lampreys began to be successfully controlled by use of the lampricide 3-trifluoromethyl-4-nitrophenol (TFM), a chemical agent that kills larval lampreys in their stream habitats. Continued use of TFM is apparently required to keep sea lamprey populations under control. TFM is sometimes harmful to other fish (e.g., walleye), as well as to the larvae of non-parasitic lamprey species. The demise of lake trout led to development of the splake, a hybrid between lake trout and brook trout. It was hoped that the hybrid would better avoid lampreys and mature faster, hence spawn at least once before becoming parasitized. As of 1991, it was estimated that the U.S. and Canada were spending \$8 million per year on lamprey control and another \$12 million per year on lake trout restoration.



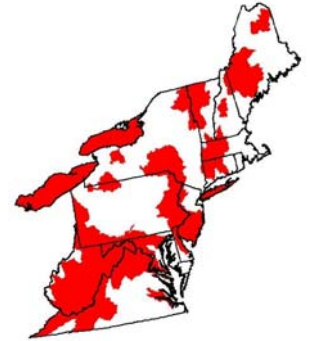
***Oncorhynchus mykiss* (Walbaum 1792) (rainbow trout)**

**Habitat:** Creeks, rivers, lakes, ponds and reservoirs.

**Life History:** In the northeastern and Mid-Atlantic U.S., spawns in streams during spring and early summer. Fry hatch in Mid-summer.



**Native Range:** Pacific Slope from Kuskokwim River (Alaska) to (at least) Rio Santa Domingo, Baja California; upper Mackenzie River drainage (Arctic basin), Alberta and British Columbia; endorheic basins of southern Oregon.



**Nonindigenous Range:** Established in numerous drainages in Connecticut (exact locations not reported); Massachusetts, Maryland, Maine, New Jersey, New York, Virginia, Vermont, and West Virginia, as well as Lake Erie. Collected or stocked at additional sites in Maine, Maryland, New Hampshire, New Jersey, Pennsylvania, Virginia, and West Virginia.

**Impacts:** The rainbow trout hybridizes with other, more rare trout species, thereby affecting their genetic integrity.



***Oncorhynchus tshawytscha* (Walbaum 1792) (chinook salmon)**

**Habitat:** Predominantly marine but migrating into large rivers to spawn. In the less common freshwater populations, such as in New Hampshire, breeding occurs along shore or in adjoining rivers.

**Life History:** Spawns at 2 to 9 years of age, with spawning season varying among chinook salmon populations or stocks. Number of eggs varies widely, as well. Average number of eggs is 8517 in Alaska and 2500 in freshwaters of New Hampshire. Eggs are orange-red and 6 - 7 mm in diameter.

**Native Range:** Arctic and Pacific drainages from Point Hope (Alaska) to Ventura River (California); occasionally strays south to San Diego (California). Also in northeastern Asia.



**Nonindigenous Range:** Established in Lake Erie; Lake Ontario; the Salmon-Sandy drainage (New York); and the Raritan and Delaware drainages (New Jersey).

Collected from unspecified areas in Connecticut and Maine; the North River (Massachusetts); throughout Maryland; western New Jersey; and the lower James and lower Potomac rivers (Virginia). Stocked locally, but failed to establish in Delaware, Maine, Massachusetts, New Hampshire, and Pennsylvania. Also reportedly extirpated in oligotrophic lakes of New Hampshire, and the Delaware River (Pennsylvania).

**Impacts:** Competes with native lake trout (*Salvelinus namaycush*). Chinook salmon are predatory fish and as such may impact populations of smaller fish. The species had totally eliminated rainbow smelt (*Osmerus mordax*) in two small New Hampshire lakes where the salmon was stocked to control the smelt.





### **Salmo trutta** Linnaeus 1758 (brown trout)

**Habitat:** Freshwater streams and lakes

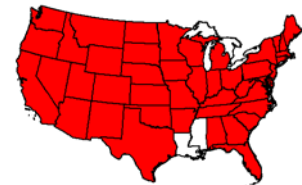
**Life History:** Spawns in late fall and early winter often after an upstream migration. Eggs are laid in a depression, known as a

redd, in the stream bottom made by the female.

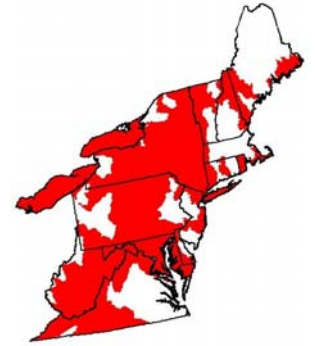
Hatching occurs in the spring.

**Native Range:** Europe, northern Africa, and western Asia.

**Nonindigenous Range:** Established throughout much of New Hampshire, New York, Pennsylvania,



and western Virginia; the Connecticut River (Connecticut); an undisclosed site in Delaware; Cape Cod and cold water streams of Berkshire Valley and the central uplands (Massachusetts); the Potomac and Upper Chesapeake drainages (Maryland); southern and coastal, lakes and streams in Maine; Cooper River and other undisclosed localities (New Jersey); and Lake Champlain and Groton Pond (Vermont).



**Impacts:** Brown trout have been implicated in reducing native fish populations (especially other salmonids) through predation, displacement, and food competition.

**Comments:** Can tolerate higher temperatures (up to 70° F) and more silt than other salmonids, but is not as valued as a food fish when compared to the brook trout (*Salvelinus fontinalis*) and rainbow trout (*Oncorhynchus mykiss*).

## **INVERTEBRATES**

In the Northeast region, 35 species of mollusks and 18 species of crustaceans are known to have been introduced into both freshwater and marine ecosystems (Appendix B and C). The former includes 18 bivalves, 15 gastropods, and two nudibranchs; the later includes crayfishes, crabs, and smaller zooplankton such as amphipods, copepods, isopods, and cladocerans. Twenty-six of these 53 species have from other continents. The others are intracontinental transfers. The marine species have been introduced via solid ballast (periwinkles), ballast water (rapa whelk), ship hull fouling (shipworms), intentional release (Asian clam), and aquaculture (oysters). While the freshwater introductions are the results of migrations through man-made canals, ballast water (Great Lakes), coincidentally with packing material, and aquarium releases.

## MOLLUSKS Bivalves



### *Dreissena polymorpha* (Pallas 1771) (zebra mussel)

**Habitat:** Temperate freshwater lakes and rivers; brackish water up to 12 ppt in Europe, 5 ppt in North America and have been found at >100 m in depth.

**Life History:** Can reach 50 mm, life span 4-5 years. Optimal water temperature for spawning is 14-16°C; 17-25°C for growth, >32°C is lethal. Over 40,000 eggs can be laid in a reproductive cycle.

**Native Range:** Eastern Europe and western Asia

**Nonindigenous Range:** First identified in 1988 in Lake St. Clair; also Lake Erie, Lake Ontario, Hudson River, Erie Canal, Finger Lakes in New York, Lake Champlain, Ohio River, Allegheny River, Monongahela River, Kanawha River (West Virginia), and in quarries in Pennsylvania and Virginia.

**Impacts:** Biofouler for industrial and recreational water users (can be spread by boating activity); competition with native mussels and zooplankton; increased water clarity.

**Comments:** In closed environments control is possible using various chemicals, manual removal, desiccation, filters, screens, copper or silicone coatings, UV light, ozone, flushing, or anoxia/hypoxia. Control is limited in open environments to predators, parasites, diseases, or desiccation.



### *Dreissena bugensis* (Andrusov 1897) (quagga mussel)

**Habitat:** Temperate freshwater lakes and rivers; salinities up to 1 ppt in Europe, 5 ppt in North America; have been found at depths of 130 m in Lake Ontario.

**Life History:** Can reach 38 mm; water temperature >30°C is lethal

**Native Range:** Dneiper River drainage of Ukraine

**Nonindigenous Range:** Lake Erie, Lake Ontario, Erie Canal, Lake George (New York), and a small reservoir in eastern Pennsylvania.

**Impacts:** Biofouler for water users; competition with native mussels and zooplankton; increased water clarity

**Comments:** Shell is more rounded than the zebra mussel and valves are asymmetrical. In closed environments control is possible using various chemicals, manual removal, desiccation, filters, screens, copper or silicone coatings, UV light, ozone, flushing, or anoxia/hypoxia. Control is limited in open environments to predators, parasites, diseases, or desiccation.





***Corbicula fluminea* (Müller 1774) (Asian clam)**

**Habitat:** Temperate to tropical freshwater lakes and rivers in sand, silt, or mud bottom; can tolerate brackish water.

**Life History:** Can reach 50 mm; breed from spring to fall; can self-fertilize; larval density can be as high as 1,000/ml; sexual maturity reached after several months.

**Native Range:** Eastern Asia including China, Korea, and Russia

**Nonindigenous Range:** Much of Virginia, West Virginia, Maryland, Pennsylvania; more recently detected in the Charles River, Massachusetts and Lake Tiogue, Rhode Island; Lake Erie.



**Impacts:** A macrofouler in power plants like the zebra mussel; in high densities probably adversely affects native mussels; can reach adult densities of 10,000/m<sup>2</sup>.

**Comments:** Introduced into the Pacific Northwest in the 1920s as possible food for the Asian population; has steadily been moving northward from southern states into New England.



***Rangia cuneta* (G. B. Sowerby I 1831) (Atlantic rangia)**

**Habitat:** Estuarine, brackish waters (0-18 ppt salinity) with soft sand bottoms, can tolerate mud and mixtures of sand and clay bottoms

**Life History:** Can reach over 90 mm in warm climates, 40-60 mm more common; spawning season in Virginia is from May to November when water temperatures reach 15°C.

**Native Range:** Gulf of Mexico

**Nonindigenous Range:** East coast of Florida to the Chesapeake Bay; James River and Potomac River in Virginia, lower portion of the Hudson River in New York.



**Impacts:** Unknown

**Comments:** Not seen on the Atlantic coast before 1956. Could have been an accidental release with oyster mariculture or perhaps with intracoastal ballast water. Harvested shells are used in roadway construction and cement production.



***Ostrea edulis* Linnaeus 1758 (edible oyster)**

**Habitat:** Estuarine waters with firm bottoms of rock, gravel, sand, silt or mud. Found to a depth of about 10 m.

**Life History:** Can reach 110 mm; females mature at 50 mm; spawns in the summer, can produce over one million eggs, larvae settle within 30 days; suspension feeders; densities can reach 300 per square yard.

**Native Range:** Northeastern Atlantic Ocean from Norway to the Mediterranean and Black Sea.

**Nonindigenous Range:** Reported off coastal areas of



Maine, Massachusetts, and Rhode Island.

**Impacts:** Unknown

**Comments:** Established on the Atlantic Coast. This species has been cultured on both coasts of North America.



***Pisidium amnicum* (Müller 1774) (greater European peaclam)**

**Habitat:** Freshwater lakes and slow-moving rivers with soft bottoms; water temperatures of 1-21°C.

**Life History:** Can reach 9 mm and live up to 3 years, mature at 4 mm (sexually mature as early as 3 months old in Europe); hermaphroditic; eggs incubated in a brood-sac in the parent; embryos develop and are released as miniature adults; suspension feeders on algae and bacteria

**Native Range:** Europe

**Nonindigenous Range:** Lake Ontario, Lake Champlain, and Hudson River



in New York.

**Impacts:** Unknown

**Comments:** Discovered in the late 1800s. High hypoxia tolerance. Common in ten of thousands per square meter in Europe.



***Sphaerium corneum* (Linnaeus 1758) European fingernailclam)**

**Habitat:** Freshwater lakes and slow-moving rivers; prefers eutrophic, shallow waters, vegetation; lives in the sediment.

**Life History:** Can reach 9 mm and live up to 3 years, mature at 4 mm (sexually mature as early as 3 months old in Europe); hermaphroditic; eggs incubated in a brood-sac in the parent; embryos develop and are released as miniature adults; suspension feeders on algae and bacteria.

**Native Range:** Europe and Asia

**Nonindigenous Range:** Lake Erie, Lake Ontario, Lake

Champlain, and Hudson River in New York

**Impacts:** Unknown

**Comments:** Pathway of introduction is unknown. High hypoxia tolerance.



***Teredo bartschi* Clapp 1923 (Bartsch shipworm)**

**Habitat:** Marine coastal areas, living in wood; tolerates wide range of salinities

**Life History:** Can reach 10 mm; shell valve located at front end of worm-like body; entire animal can be several inches long; pelagic larvae; veliger stage reached in 24 hours and lasts 3-4 weeks

**Native Range:** South Carolina to Texas and Bermuda



**Nonindigenous Range:** Long Island Sound off Connecticut and Barnegat Bay in New Jersey (prior to 1993).

**Impacts:** Can cause destroy untreated wooden structures (docks, boats)

**Comments:** Adapted for boring into wood; established in warmwater effluents of power plants; collected in Hawaii and Gulf of California; cannot distinguish the 66 species of shipworms worldwide by the shells, other structures must be used for identification; size usually indicates age. (Image is *Teredo sp.*)



***Teredo furcifera* von Martens, 1894 (deep-cleft shipworm)**

**Habitat:** Marine coastal areas, living in wood; tolerates wide range of salinities

**Life History:** Shell height about 4 mm, shell valve located at front end of worm-like body; entire animal can be several inches long; fertilization may be internal and larvae may be

retained in a brood pouch; veliger stage reached in 24 hours and last 3-4 weeks

**Native Range:** Southwestern Pacific Ocean

**Nonindigenous Range:** Barnegat Bay, New Jersey in 1974

**Impacts:** Can cause destroy untreated wooden structures (docks, boats)

**Comments:** Adapted for boring into wood; established in warmwater effluents of power plants; collected in Hawaii. (Image is *Teredo sp.*)



Parmalee and Bogan

***Alasmidonta marginata* Say, 1818 (elktoe)**

**Habitat:** Small, shallow rivers and mid-sized streams with fast current and gravel and sand bottom

**Life History:** Reaches 90 mm long; breeds from June to July; host fishes for glochidia (larvae) can be white sucker, northern hog sucker, shorthead redhorse, rock bass, and warmouth.

**Native Range:** Ohio, Tennessee, Cumberland, Susquehanna, and St. Lawrence drainages; Lake Huron.

**Nonindigenous Range:** Hudson River

**Impacts:** Unknown.

**Comments:** Probably a natural migration via the Erie Canal.



Parmalee and Bogan

***Utterbackia imbecillis* (Say, 1829) (paper pondshell)**

**Habitat:** Shallow banks of rivers in fine sand or mud

**Life History:** Can reach 100 mm; may be hermaphroditic, breeds in the fall; many species of native and exotic fish and several species of amphibians serve as the host for the glochidia.

**Native Range:** Mississippi River drainage as far west as Oklahoma; Great Lakes drainage.



**Nonindigenous Range:** Hudson River

**Impacts:** Unknown.

**Comments:** Probably a natural migration via the Erie Canal.



Parmalee and Bogan

***Pyganodon grandis* (Say, 1829) (giant floater)**

**Habitat:** Most abundant in lakes and ponds with mud bottoms and little current

**Life History:** Can reach 110 mm; spawns in August and releases glochidia in May; host fish include longnose gar and blacknose dace.

**Native Range:** The entire Mississippi River drainage including the Missouri; St. Lawrence River drainage and Lake Champlain.

**Nonindigenous Range:** Hudson River

**Impacts:** Unknown.



**Comments:** May have been intentionally introduced.



Parmalee and Bogan

***Fusconaia flava* (Rafinesque, 1820) (Wabash pigtoe)**

**Habitat:** Small streams to medium-sized and large rivers in coarse sand and gravel as deep as 15 feet

**Life History:** Reaches up to 100 mm long; breeds from May to August; host fishes for glochidia can be white crappie,

black crappie, and bluegill.

**Native Range:** The entire Mississippi drainage from western New York to South Dakota to Louisiana; also Lake Huron and Lake Erie.

**Nonindigenous Range:** Hudson River



**Impacts:** Unknown.

**Comments:** Probably migrated naturally via the Erie Canal.



Parmalee and Bogan

***Lampsilis cardium* Rafinesque, 1820 (plain pocketbook)**

**Habitat:** Rivers and creeks with sand, gravel, or mud bottoms

**Life History:** Can reach 160 mm; spawns in late July; glochidia are released the following early July

**Native Range:** Upper Mississippi and Ohio drainages; from Lake Superior to the Ottawa River and Lake Champlain; fish species

serve as a host for glochidia are white crappie, bluegill, largemouth bass, smallmouth bass, yellow perch and others.

**Nonindigenous Range:** Hudson River

**Impacts:** Unknown.



**Comments:** May have been intentionally introduced.





Parmalee and Bogan

***Lasmigona subviridis* (Conrad, 1835) (green floater)**

**Habitat:** Small to medium-sized streams with sand and gravel bottoms and low current

**Life History:** Can reach 65 mm; spawns in August and releases glochidia the following June.

**Native Range:** Atlantic drainage of North Carolina, Virginia; Susquehanna River drainage; Kanawha and New rivers, West Virginia and Virginia.

**Nonindigenous Range:** Finger Lakes drainage in New York

**Impacts:** Unknown.

**Comments:** May have been intentionally introduced into the Great Lakes drainage or migrated via the Erie Canal.



Parmalee and Bogan

***Leptodea fragilis* (Rafinesque, 1820) (fragile papershell)**

**Habitat:** Large to moderate rivers with sand, sand and gravel, silty sand, and silty mud bottoms

**Life History:** Can reach 150 mm long; spawns in late summer and releases glochidia the following July; host fish is the freshwater drum.

**Native Range:** Ohio and Mississippi drainages; St. Lawrence drainage

**Nonindigenous Range:** Oneida Lake and the Hudson River in New York

**Impacts:** Unknown.

**Comments:** May have been introduced via the Erie Canal.



Parmalee and Bogan

***Ligumia recta* (Lamarck, 1819) (black sandshell)**

**Habitat:** Varying sizes of creeks, rivers, and lakes with sand and gravel bottoms and moderate current

**Life History:** Can reach 175 mm; spawns in August, glochidia are released the following July; host fishes are

American eel, bluegill, and white crappie.

**Native Range:** Ohio and Mississippi drainages; St. Lawrence drainage to Lake Champlain

**Nonindigenous Range:** Oneida Lake, New York

**Impacts:** Unknown.

**Comments:** May have been introduced via the Erie Canal.





Parmelee and Bogan

**Potamilis alatus (Say, 1817) (pink heelsplitter)**

**Habitat:** Varying sizes and current speeds of rivers and lakes with sand to coarse gravel bottoms

**Life History:** Can reach 160 mm; spawns in August and releases glochidia the following July; possible host fish is the freshwater drum.

**Native Range:** Mississippi River drainage north of Arkansas; St. Lawrence drainage to Lake Champlain

**Nonindigenous Range:** Lake and the Hudson River in New York

**Impacts:** Unknown.



**Comments:** May have been introduced via the Erie Canal.

**MOLLUSKS Gastropods**



**Bithynia tentaculata (Linnaeus, 1758) (mud bithynia)**

**Habitat:** Commonly found in freshwater ponds, shallow lakes, and canals

**Life History:** Shell length can reach 15 mm; 5 whorls; breeds July to August; feeds on algae.

**Native Range:** Europe, from Scandinavia to Greece

**Nonindigenous Range:** Lake Erie, Lake Ontario, Lake Champlain,

widespread across New York, Potomac River in Virginia.

**Impacts:** Has been known to infest municipal water supplies in abundance. Competes with *Elimia virginica*.

**Comments:** First introduced in the Great Lakes (Lake Michigan) about 1870 possibly with packing material.



**Gillia altilis (I. Lea, 1841) buffalo pebblesnail**

**Habitat:** Freshwater lakes, streams

**Life History:** Sexes are separate; eggs are usually laid in separate capsules deposited on vegetation, stones, leaf litter; some give birth to small embryos in this family (Hydrobiidae).

**Native Range:** Atlantic coastal drainage from New Jersey to South Carolina

**Nonindigenous Range:** Lake Ontario, Erie Canal, Niagara Falls, and Oneida Lake in New York.

**Impacts:** Unknown

**Comments:** Invaded the Great Lakes via the Erie Canal; listed as a species of special concern in its native range in



New York.



**Potamopyrgus antipodarum** (J. E. Gray, 1853) (New Zealand mudsnail)

**Habitat:** Freshwater rivers and streams with gravel, cobble, or mud bottom; tolerates wide range of temperature, salinity, and turbidity; feeds on dead or dying plant or animal material, algae, and bacteria.

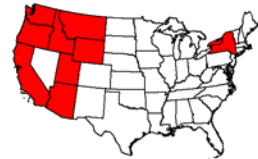
**Life History:** Populations consist of mostly asexually reproducing females that are born with developing embryos in their reproductive system.

**Native Range:** New Zealand

**Nonindigenous Range:** Southwestern and northeastern regions of Lake Ontario

**Impacts:** This species has the potential to be a biofouler for water users; most likely to compete with native snails.

**Comments:** Densities of over 300,000/m<sup>2</sup> have been reported from the West. Probably introduced with trout shipments from



outside the U.S.



**Littorina littorea** (Linnaeus, 1758) (common periwinkle)

**Habitat:** Found from coastal intertidal, rocky waters to estuarine brackish water and mud flats; depth to 60 m

**Life History:** Can reach 52 mm in shell height; lives 5-10 years; females lay 10,000-100,000 eggs contained in a horny capsule from which larvae escape and settle to the bottom; can breed all year depending on the climate; mature at 10 mm; primarily an algae grazer, but will feed on small invertebrates such as barnacle larvae.

**Native Range:** Coast of northern Spain to Scandinavia and Russia

**Nonindigenous Range:** Coastal areas from Maine to Virginia

**Impacts:** A predominant mollusk from New Jersey northward; has had large negative impacts on invaded ecosystems; competes with native gastropods.

**Comments:** May have been introduced with rock ballast in the late 1800s. This species is harvested for human consumption in Europe.



**Radix auricularia** (Linnaeus, 1758) (big-eared radix)

**Habitat:** Freshwater lakes, ponds, and slow-moving rivers with mud bottoms

**Life History:** Can reach 35 mm in height; 5 whorls; feeds on algae and decaying plant material

**Native Range:** Europe and northern Asia

**Nonindigenous Range:** Lake Erie; Charles River in Massachusetts; Cayuga Lake and Hudson River in New

York; various ponds in New Jersey, New York, and Pennsylvania; Lake Champlain in Vermont.

**Impacts:** Unknown

**Comments:** May have come with imported plants in the late 1800s.





**Rapana venosa** (Valenciennes, 1846) (veined rapa whelk)

**Habitat:** Marine and estuarine waters with sandy bottom; can tolerate low salinity, polluted and oxygen deficient waters.

**Life History:** Can reach 180 mm in shell length; reproduces by laying a cluster of egg capsules that resemble yellow shag carpeting and hatch into pelagic larvae; growth is rapid during first year, reproduction occurs in second year.

**Native Range:** Western Pacific, from the Sea of Japan, Yellow Sea, and East China Sea.

**Nonindigenous Range:** Coastal Virginia

**Impacts:** This species is carnivorous, feeding other mollusks including oysters.

**Comments:** A probable ballast water introduction.



**Physella acuta** (Draparnaud, 1805) (European physa)

**Habitat:** Freshwater rivers, streams, lakes, ponds, and swamps

**Life History:** Can reach 17 mm in length

**Native Range:** Europe, Mediterranean regions and Africa

**Nonindigenous Range:** several localized regions in Maryland, New Jersey, and Virginia.

**Impacts:** Unknown

**Comments:** Probable early aquarium introduction or with imported plants.



**Elimia livescens** (Menke, 1830) (liver elimia)

**Habitat:** Freshwater rivers and streams on rock shoals and gravel bars

**Life History:** Can reach 20 mm in length; sexes are separate and eggs usually laid in spring in *Elimia* snails; often sexually mature in a year; can live 5 years.

**Native Range:** St. Lawrence River drainage from Great Lake to Lake Champlain; tributaries of the Ohio River east of the Scioto River in Ohio; Wabash River, west to the Illinois River.

**Nonindigenous Range:** Lower Hudson River drainage

**Impacts:** Unknown

**Comments:** Migrated via the Erie Canal to the Hudson River.





***Elimia virginica* (Say, 1817) (Piedmont elimia)**

**Habitat:** Freshwater rivers and streams with cobble bottoms and boulders

**Life History:** Can reach 30 mm in length; sexes are separate and eggs usually laid in spring in *Elimia* snails; often sexually mature in a year; can live 5 years.

**Native Range:** Rivers along the Atlantic coast from Massachusetts to Virginia.

**Nonindigenous Range:** Erie Canal, Oneida Lake, and streams near Buffalo, in New York.



**Impacts:** Unknown

**Comments:** Migrated from the Atlantic drainage through the Erie Canal; range is shrinking in the native Connecticut River range.



***Pleurocera acuta* Rafinesque, 1831 (sharp hornsnaill)**

**Habitat:** Freshwater rivers and streams

**Life History:** Can reach 37 mm in length; 14 whorls; likes to burrow in sand and mud; eggs laid in the spring

**Native Range:** Ohio River and Great Lakes drainages; Mississippi River west to Kansas and Nebraska.

**Nonindigenous Range:** Lower Hudson River drainage and Oneida Lake in New York.

**Impacts:** Unknown

**Comments:** This species is listed as threatened in some Midwestern



states. Probably introduced via the Erie Canal.



***Truncatella subcylindrica* (Linnaeus, 1767) (a truncatella snail)**

**Habitat:** Marine environments on stones and pebbles, fine sediments and decomposing vegetation; prefers sheltered waters; salinity 18-40 psu.

**Life History:** Can reach 5 mm; light colored shell; sexes are separate; fertilized eggs are laid; egg capsules are attached to detritus

**Native Range:** NE Atlantic off Morocco and Mediterranean to Black



Sea

**Nonindigenous Range:** Only early records (late 1800s) for the US are in waters off Newport, Rhode Island.

**Impacts:** Unknown

**Comments:** This snail loses apical whorls as it grows, giving it a truncated and cylindrical appearance.



***Valvata piscinalis* (Müller, 1774) (European stream valvata)**

**Habitat:** Freshwater lakes and streams

**Life History:** Can reach 5 mm in length; 5 whorls; eggs deposited on vegetation and hatch in 15-30 days.

**Native Range:** Europe

**Nonindigenous Range:** Lake Erie, Lake Ontario, Hudson River and Cayuga Lake in New York.

**Impacts:** Unknown



**Comments:** May have arrived in packing material of fragile items and subsequently spread through canals in New York. First observed in North America in the late 1800s in Lake Ontario.



***Cipangopaludina chinensis malleata* (Reeve, 1863) (Chinese mysterysnail)**

**Habitat:** Slow-moving freshwater rivers, streams, and lakes with soft, muddy or silty bottoms

**Life History:** Can reach 65 mm; 7 whorls; females are livebearers giving birth to crawling young

**Native Range:** From Southeast Asia to Japan and eastern

Russia

**Nonindigenous Range:** Lake Erie; various ponds in Connecticut and Massachusetts; Potomac River, Maryland; Cocheco River, New Hampshire; Delaware River, New Jersey; Hudson River and Niagara River, New York; Schuylkill River and Susquehanna River,

Pennsylvania; Annaquatucket River, Rhode Island; and a few isolated locations in Maine and Virginia.

**Impacts:** Possible competition with native snails

**Comments:** This species was sold in Chinese food market in San Francisco in the late 1800s; collected as early as 1914 in Boston.



***Cipangopaludina japonica* (von Martens, 1861) (Japanese mysterysnail)**

**Habitat:** Freshwater rivers and lakes

**Life History:** Can reach 50 mm in length; females are livebearers giving birth to crawling young.

**Native Range:** Japan, Taiwan, Korea

**Nonindigenous Range:** Concord River, Massachusetts. Also reported from Lake Erie in Ohio.

**Impacts:** Unknown

**Comments:** This species could be synonymous with *C. chinensis*. Imported to West Coast into Asian food market about 1892.





**Viviparus georgianus** (Lea, 1834) (banded mysterysnail)

**Habitat:** Lakes and slow-moving rivers with mud bottoms

**Life History:** Shell height can reach up to 45 mm, 4-5 whorls; Prominent dark banding; 3 year life span.

**Native Range:** East of the Mississippi River and a few southeastern states

**Nonindigenous Range:** Lake Erie, Niagara River, Erie Canal, Hudson River drainage in New York and possibly Lake Champlain.

**Impacts:** This species may prey on fish embryos.

**Comments:** Earliest introductions date back to 1867 in the Hudson River. Recent populations are probably due to aquarium introductions. This species very similar to the European *Viviparus viviparus*. Anecdotal evidence suggests that mallard ducks are adapting to foraging on this species in Lake George, New York.



**MOLLUSKS** Nudibranchs



**Tenellia adspersa** (Nordman, 1845) (miniature aeolis)

**Habitat:** Coastal intertidal and shallow sublittoral zone, also found in estuaries; prefers small rock to sea grass bottom and man-made substrate as well; sheltered, low wave action waters

**Life History:** Can reach 8 mm in length; color is generally pale yellow to light brown with black speckles; females produce up to 100 eggs; larvae are pelagic; sexually mature at 20 days old; life span is less than one year usually; *T. adspersa* is a carnivore feeding primarily on hydroids such as *Cordylophora caspia*; crawls along bottom for mobility.

**Native Range:** Northeastern Atlantic Ocean, Mediterranean Sea, Black

Sea, Caspian Sea,

**Nonindigenous Range:** Chesapeake Bay, Virginia; Massachusetts (Also found in San Francisco Bay, Elkhorn Slough, and Long Beach, California; Coos Bay, Oregon).

**Impacts:** it is known to rapidly devour hydroid colonies.

**Comments:** In Britain this solitary species is referred to as the lagoon sea slug.



**Tritonia plebeia** Johnston, 1828 (lagoon sea slug)

**Habitat:** Marine, sublittoral zone to 129 mm

**Life History:** Can reach up to 30 mm; primarily yellow with brown mottling; feeds on soft corals.

**Native Range:** Northeastern Atlantic from Norway to Portugal

**Nonindigenous Range:** Coastal areas of Maine and Massachusetts.





**Impacts:** Although only present in the Gulf of Maine during the Mid-1980s, it had a severe impact on the soft coral, *Alcyonium siderium*.

**Comments:** Probable ballast water introduction.

## CRUSTACEANS Amphipods



### ***Echinogammarus ischnus*** (Stebbing, 1899) (an amphipod)

**Habitat:** Shallow margins of lakes and large rivers with gravel or rocky bottom; can tolerate lakes with mud bottoms

**Life History:** Body length can reach 8 mm; females brood sizes can have as many as 48 individuals in their native range and can reproduce all year in favorable conditions.

**Native Range:** Ponto-Caspian region of Eurasia

**Nonindigenous Range:** Lake Erie and Lake Ontario

**Impacts:** Maybe replacing the native *Gammarus fasciatus* in the Great Lakes.



**Comments:** Has become the dominant amphipod in many locations; very often associated with *Dreissena* colonies.

### ***Gammarus daiberi*** Bousfield, 1969 (an amphipod)

**Habitat:** Oligohaline estuarine species, found to be primarily pelagic but also epibenthic in estuaries, bays and sounds, also tolerates freshwater habitats

**Life History:** Size 8-12 mm; sexual maturity

reached in about 30 days; clutch size of female increases with size of individual; highest reproduction potential occurs in spring and summer months with short time required for maturation and incubation and continuous reproduction; reproductive activity remains constant until *G. daiberi*

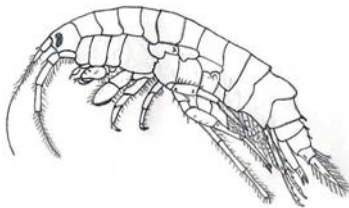
enters into overwintering cycle.

**Native Range:** Northwestern Atlantic coast from Delaware to South Carolina

**Nonindigenous Range:** Earliest record from NY is 1975 in the Hudson River estuary from the Battery to Albany and later found at Indian Point as well as in the Hudson River freshwater tidal reach.

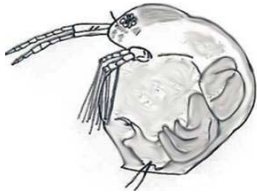
**Impacts:** Unknown

**Comments:** Dense populations have been found in the Hudson estuary; most likely a ballast water introduction.





## CRUSTACEANS Cladocerans



### ***Eubosmina coregoni*** Baird, 1857 (water flea)

**Habitat:** Freshwater ponds and lakes

**Life History:** Size 0.6 mm; algae-eating cladoceran; in less populated, homeostatic waters, *E. coregoni* infrequently reproduces sexually and instead maintains populations by parthenogenic females; maximum populations are found in late June in the US.

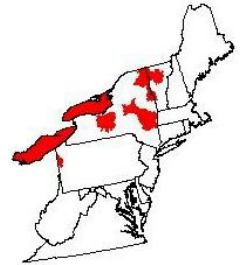
**Native Range:** Eurasia

**Nonindigenous Range:** First known occurrence in the US was in 1966 from Lake Michigan; this species has since been introduced to all of the

Great Lakes; found in NY in the Delta Reservoir, Blenheim Gilboa Reservoir, Cross Lake, Franklin Falls Pond, Ensign Pond and Snyders Lake; found in 1968 in the Pymatuning Reservoir in Pennsylvania; most recently reported from Lake Champlain, Vermont in 1994.

**Impacts:** One of the dominant zooplankton species in the Great Lakes; average numbers from a 1970 sample of Otsego Lake showed densities of 30,000 organisms per m<sup>3</sup>.

**Comments:** Probable ballast water introduction.



### ***Bythotrephes longimanus*** Schodler, 1877 (spiny waterflea)

**Habitat:** Large and small temperate lakes, can tolerate brackish water

**Life History:** Can reach 15 mm; can reproduce asexually; unfertilized eggs carried in a brood pouch; fertilized eggs layed in the fall and hatch the following spring

**Native Range:** Northern Europe and Asia

**Nonindigenous Range:** Lake Erie and Lake Ontario

**Impacts:** Compete directly with larval fish for food; fouls fishing gear

**Comments:** The tail spine can comprise over 70 percent of the animal's length and has one to three pairs of barbs; first detected in 1984 in Lake Huron, probable ballast water introduction.



### ***Cercopagis pengoi*** Ostroumov, 1891 (fishhook waterflea)

**Habitat:** Brackish and freshwater lakes

**Life History:** Body size from 1-3 mm in length without tail, 6-13 mm with tail; tail has three pairs of barbs and a characteristic loop near the end; can reproduce asexually during the summer; sexual reproduction occurs in the fall when water temperatures decline; exhibit diurnal vertical migrations in native range; predatory feeding habits on other zooplankton.

**Native Range:** Caspian, Azov, and Aral seas of Europe and Asia



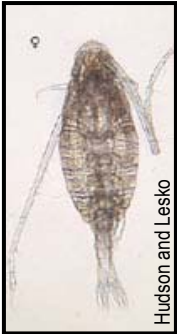


**Nonindigenous Range:** Lake Erie (Presque Isle in 2002), Lake Ontario in 1998, Fingers Lakes of New York (Canandaiga, Cayuga, Keuka, Cross, Otisco, Owasco, Seneca).

**Impacts:** Fouls fishing gear; potential for competition with other planktivores for food.

**Comments:** *C. pengoi* has been found in the stomach of some fishes in high percentages in Europe.

## CRUSTACEANS Copepods



### ***Skistodiaptomus pallidus* (Herrick, 1879) (a calanoid copepod)**

**Habitat:** Freshwater lakes

**Life History:** Females may carry up to 20 eggs; develop from egg to adult in 15 days at 25°C and in 66 days at 10°C; females average 1.2 mm in length and males average 1.0 mm; feeds on algae but is also a fierce and selective predator on small animals such as rotifers.

**Native Range:** Central United States south to Texas and Louisiana and the Mississippi drainage

**Nonindigenous Range:** First found in Lake Ontario in 1967; present in Lake Erie, Lake Huron, Lake St. Clair, Saginaw Bay and Saginaw River



**Impacts:** Impacts remain unclear; however, maximum densities in Lake Erie coastal marsh reached 10,000/m<sup>3</sup>.

**Comments:** Introduction into the Great Lakes could have been accidental by fisherman or recreational boaters, or some scientists believe this species exists in lakes and wetlands around the Great Lakes and could have been occasionally flushed into the lakes.



### ***Eurytemora affinis* (Poppe, 1885) (a calanoid copepod)**

**Habitat:** Euryhaline species, found in estuaries, saltmarshes, brackish waters and freshwater lakes, ponds and reservoirs

**Life History:** Planktonic or epibenthic grazer, feeding on plankton and organic detritus; females can produce multiple clutches of eggs; females 1.1-1.5 mm, males 1.0-1.5 mm; overwinters as eggs, juveniles and adult stages found between April and January.

**Native Range:** Europe, Asia and coastal North America

**Nonindigenous Range:** Found in a few locations in Massachusetts and Virginia; the Hudson River in New York; the District of Columbia; Lake Ontario in 1958 and Lake Erie; present in all of the Great Lakes.



**Impacts:** Unknown

**Comments:** Possibly introduced with fish stocking.

## CRUSTACEANS Crabs



### ***Hemigrapsus sanguineus*** (de Haan, 1853) (Asian shore crab)

**Habitat:** Shallow hard-bottom, marine intertidal waters; tolerates wide ranges of temperature and salinity

**Life History:** Maximum size is approximately 1.6 inches in carapace width; breeding season is from May to September; females can produce 50,000 eggs per clutch with 3-4 clutches per season.

**Native Range:** Western Pacific Ocean from Russia and Korea south to Hong Kong

**Nonindigenous Range:** Atlantic coast along every state from Virginia to Maine.



**Impacts:** Direct competition with native crabs.

**Comments:** Possible ballast water introduction; may have been introduced back in the 1960s, but specimens not identified until 1988.



### ***Carcinus maenas*** (Linnaeus, 1758) (European green crab)

**Habitat:** Marine to brackish waters; semi-protected rocky coasts, soft or hard bottoms

**Life History:** Up to 6 cm in carapace length and 10 cm in width; larvae need at least 19 ppt salinity to metamorphosize; larval settlement greatest in late summer with temperatures above 18°C; molting

peaks in winter; prey items are clams, mussels, oysters, and gastropods.

**Native Range:** Northeast Atlantic Ocean from northern Europe to northern Africa

**Nonindigenous Range:** Coastal areas from Maine to Maryland.

**Impacts:** Introductions had a negative impact on soft-shell clams, young oysters, and native crabs in the Northeast beginning in the 1950s.

**Comments:** Earliest documentation in North America from 1817 on the East Coast. First collected on the West Coast in San Francisco Bay in 1989.



## CRUSTACEANS Crayfish



### ***Orconectes immunis* (Hagen, 1870) (calico crayfish)**

**Habitat:** Shallow ditches and sloughs of medium to large rivers with plenty of aquatic plants and plant debris for cover; mud bottoms with stagnant water; can tolerate high turbidity; a burrower that will move from pond to pond

**Life History:** 1.7 to 3.5 inches long; breeding

occurs in late summer in New York and eggs are laid in the spring

**Native Range:** Great Lakes, lower Ohio, and upper Mississippi drainages

**Nonindigenous Range:** Unspecified locations in Pennsylvania; Hudson River in New York; all New England states except Maine.



**Impacts:** Unknown

**Comments:** Sold as bait; probable bait bucket introduction.



### ***Orconectes neglectus* (Faxon, 1885) (ringed crayfish)**

**Habitat:** Clear, rocky streams and rivers with significant current

**Life History:** Can live 5 years; burrows into the gravel in daylight; females up to 3 inches long; breeding begins in October and eggs are laid in late

spring.

**Native Range:** Central plains and Ozark regions

**Nonindigenous Range:** Lower Hudson River drainage in New York.

**Impacts:** May be replacing native crayfish.



**Comments:** Pathway unknown; collections from New York made in late 1990s



### ***Orconectes obscurus* (Hagen, 1870) (Allegheny crayfish)**

**Habitat:** Rocky streams

**Life History:** Can reach 40 mm in carapace length; breeding occurs in late summer; eggs laid in the spring; juveniles appear as early as April; sexually mature after first year.

**Native Range:** Southeastern Ontario, western New York and Pennsylvania, eastern Ohio, northern West Virginia and northern Virginia, and western Maryland.

**Nonindigenous Range:** Several locations in Maine and the lower Hudson River drainage

**Impacts:** Unknown



**Comments:** Probable bait bucket introduction.



***Orconectes rusticus* (Girard, 1852) (rusty crayfish)**

**Habitat:** Streams, lakes, and ponds with varying substrates from silt to rock and plenty of debris for cover; needs permanent water, they generally do not burrow to escape dry periods

**Life History:** Can reach 4 inches long; breeding occurs in the fall and eggs laid the following spring, hatching within several weeks

**Native Range:** Ohio, Tennessee, and Cumberland drainages

**Nonindigenous Range:** Unspecified locations in Maryland, Massachusetts, New Jersey, and Pennsylvania, Titicus River in Connecticut, Hudson River drainage in New York, Kanawha River in West Virginia, and the Androscoggin and Kennebec drainages in Maine.

**Impacts:** Displace native crayfish; destruction of plant bed abundance and diversity

**Comments:** Probable bait bucket introduction; the introduction of one female carrying viable sperm could start a new population.



***Orconectes virilis* (Hagen, 1870) (virile crayfish)**

**Habitat:** Streams with moderate flow and turbidity, abundant cover, stable water levels

**Life History:** Can reach 5 inches; breeding occurs in July and eggs are laid in the spring

**Native Range:** Missouri, upper Mississippi, lower

Ohio, and Great Lakes drainages

**Nonindigenous Range:** Unspecified locations in Connecticut, Maine, Massachusetts, New Hampshire, Pennsylvania, Rhode Island, Vermont, and Virginia; many creeks in Maryland, New York, and West Virginia.

**Impacts:** Unknown

**Comments:** Probable bait bucket introduction; has potential as human food resource.



***Procambarus acutus* (Girard, 1852) (white river crawfish)**

**Habitat:** Sloughs, marshes, temporary pools and other standing water

**Life History:** Can reach 5 inches long; breeding appears not to be restricted to one season.

**Native Range:** Southern Atlantic coast drainage from Georgia to Maine and from the Florida panhandle to Mexico; central Mississippi Valley to the upper Great Lakes drainages

**Nonindigenous Range:** Non-specific locations in Connecticut, Maine (east-central), Massachusetts (west-central), and Rhode Island; Lower Hudson River drainage

**Impacts:** Unknown

**Comments:** Probable bait bucket or aquaculture introductions; used as human food and in the bait industry.





***Procambarus clarkii* (Girard, 1852) (red swamp crawfish)**

**Habitat:** Flowing to non-flowing water streams and ditches with mud or sand bottoms and plenty of organic debris, growing vegetation not a necessity

**Life History:** Can reach nearly 5 inches long; breeding takes place in the fall, females are burrowers

**Native Range:** Gulf coastal plain from the Florida panhandle to Mexico; southern Mississippi River drainage to Illinois

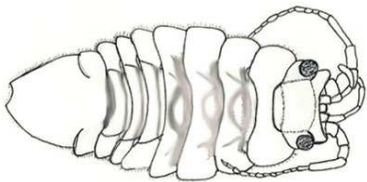
**Nonindigenous Range:** Private ponds in southern Maine; on Long Island and lower Hudson River system; unspecified locations in Maryland and Virginia.

**Impacts:** Has become an agricultural pest outside its native range

**Comments:** An important aquaculture species; probable aquaculture introduction.



**CRUSTACEANS Isopods**



***Synidotea laevidorsalis* (Miers, 1881) (an isopod)**

**Habitat:** Temperate to subtropical estuaries in shallow water; brackish water to full seawater

**Life History:** Can reach 30 mm; feeds on hydroids; larvae not pelagic

**Native Range:** Western Pacific Ocean region

**Nonindigenous Range:** Maurice River at Bivalve, New Jersey.

**Impacts:** Fouls pilings and buoys

**Comments:** Probable ship hull fouling introduction; possibly collected in South Carolina; has also been introduced in San Francisco Bay in the

US, Europe, South America, and Australia.



**CRUSTACEANS Shrimp**



***Mysis relicta* Lovén (opossum shrimp)**

**Habitat:** Deep, cold oligotrophic lakes; has been reported from brackish and estuarine waters

**Life History:** Can reach 20 mm and live for 2 years; breed in the winter; adults carry young in a brood pouch until fully developed in the spring; sexually mature at 12-14 mm

**Native Range:** Circumpolar in North America (including the Great Lakes) and Europe (including Scandinavia and northern Russia)

**Nonindigenous Range:** Moosehead Lake in Maine; probably more widespread than reported

**Impacts:** May contribute to extinction of native zooplankton communities.

**Comments:** Introduced into lakes as food for gamefish.



## AMPHIBIANS and REPTILES

### Overview

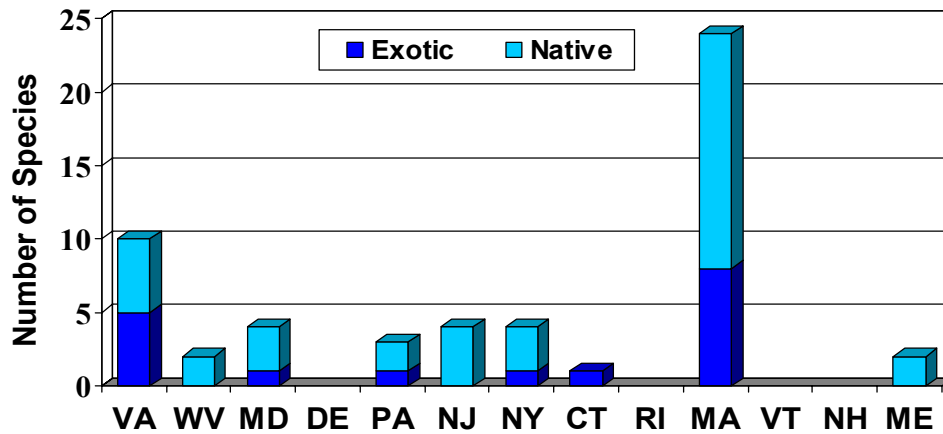
A combined total of 31 species of aquatic amphibians and reptiles have been introduced into the states encompassed by USFWS Region 5 (Appendix D) of which 20 are species native to the United States but have been transplanted outside their native range, and 11 are species introduced from other countries (referred to as exotic). Twenty-four percent of the native transplants became established and nine percent of the exotic species introduced into the region have resulted in established populations.

### Numbers of Introduced Species and Established Species in Each State

In the Northeast, Massachusetts and Virginia have the most species introduced.

Massachusetts has the most species established (Figures 19, 20). All states, except Virginia, in this region have a low proportion of exotic species introduced.

## Total Number of Amphibian and Reptile Species Introduced into Each State



**Figure 19.** Total number of amphibian and reptile species (native and exotic) introduced into each state.

## Status of Amphibian and Reptile Introductions

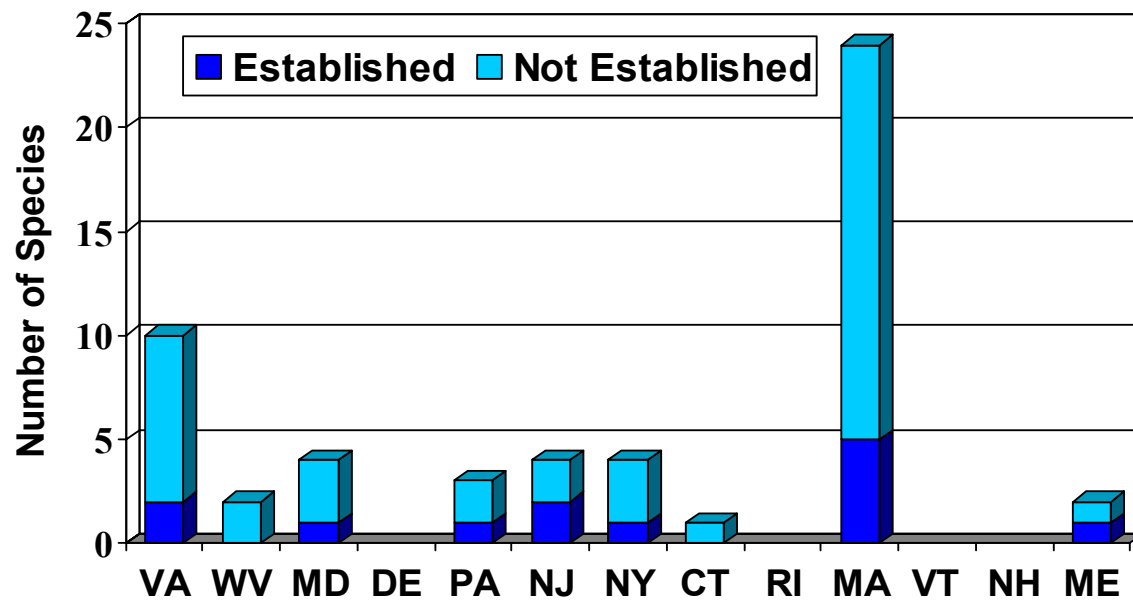


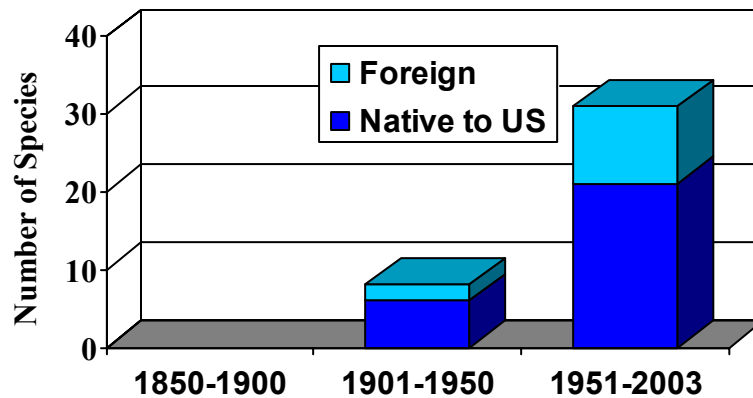
Figure 20. Status of amphibian and reptile species introduced into each state.



### Introduction Trends Over Time

Introductions in the Northeast mirror the nation-wide trend of an increase in the number of species introduced since the 1950s (Figure 21). Both the native transplants and the exotic imports have increased in recent years with the increased popularity in keeping amphibians and reptiles as pets.

## Cumulative Number of Amphibian and Reptile Species Introduced in the Northeast

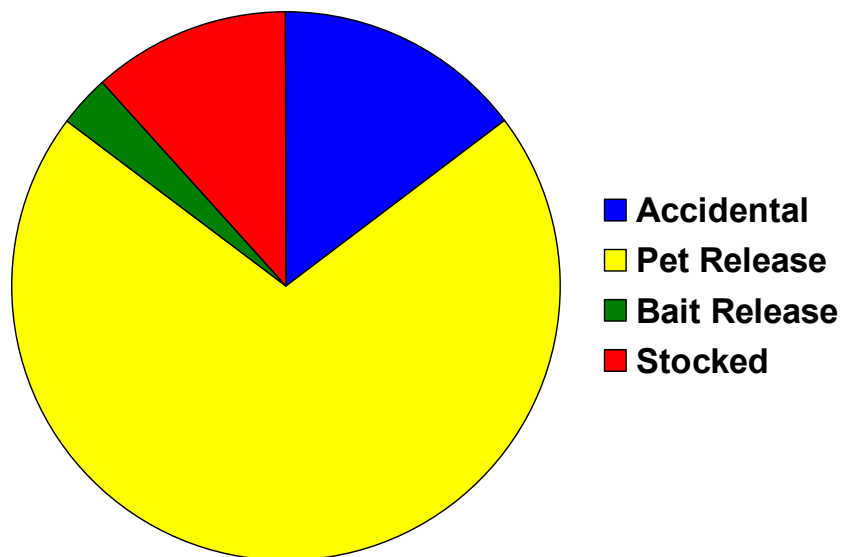


**Figure 21.** Cumulative number of amphibian and reptile species introduced into the Northeast.

## Pathways

The major pathway of amphibian and reptile introductions for all states in Region 5, is pet escape/release (Figure 22). A smaller portion can be attributed to accidental transportation, such as on landscaping plants. A few, including diamondback terrapins and bullfrogs have been intentionally stocked. The mudpuppy, *Necturus maculosus*, is thought to have been introduced into Massachusetts and Maine lakes through discarded bait.

# Pathways of Introduction for Amphibians and Reptiles in the Northeast

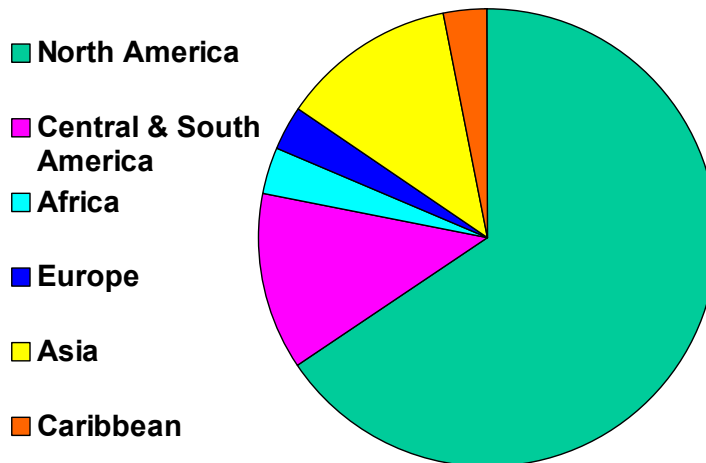


**Figure 22.** Pathways of amphibian and reptile introductions in Region 5.

### Geographic Origin of the Introduced Species

The majority of species introduced in the Northeast are native to the United States but transplanted outside their native ranges (Figure 23). Included are various species of frogs, turtles, and snakes. Of the exotic species, most are from Asia or Central and South America and are associated with the pet trade.

## Source Region of Introduced Amphibians and Reptiles in the Northeast



**Figure 23.** Source regions of introduced amphibians and reptiles in Region 5.

## AMPHIBIANS Frogs and Toads



Joyce Gross ©2001



### ***Bufo americanus*** Holbrook, 1836 (American toad)

**Habitat:** Terrestrial areas associated with shallow ephemeral wetlands, eddies in streams or shallow pools used for breeding.

**Life History:** Up to 20,000 eggs are laid during March to July depending on local climate. Sexual maturity is reached at two to three years of age.

**Native Range:** The Mid-Atlantic states except for southeastern Virginia, southern New Jersey, Long Island, and the islands of Massachusetts

**Nonindigenous Range:** Cuttyhunk Island, Massachusetts.

**Impacts:** Other than the intended shift in toad species, impacts have not been reported. *B. americanus* eats insects (100 per night), slugs, and earthworms; and is preyed upon by raccoons, herons, snakes, and birds of prey.

**Comments:** In 1976, the American toad was first documented on Cuttyhunk Island, Massachusetts and it was breeding there by 1979. It was stocked on the island after the native *Bufo woodhousii fowleri* was exterminated due to pesticide spraying.



### ***Bufo marinus*** (Linnaeus, 1758) (giant toad)

**Habitat:** Residential areas, golf courses and schoolyards. Found where food, water and basking is available such as near insect-attracting lights, wet areas for breeding, and concrete or asphalt for basking.

**Life History:** *Bufo marinus* reproduces at almost any time of the year unless the temperature is too low, laying thousands or tens-of-thousands of eggs, encased in gelatinous strings, in any temporary or permanent body of water, including brackish water.

**Native Range:** Northern South America, Central America, and Mexico

northward to extreme southern Texas.

**Nonindigenous Range:** Collected along the roadside in Middlesex County, MA.

**Impacts:** In many nonindigenous localities, such as Florida and Hawaii, the exact impact of *B. marinus* on indigenous ecosystems remains unclear. Pets that eat or bite giant toads become seriously ill from the milky venom contained within the massive parotoid glands and human poisonings occur only rarely. The complex toxic secretion from these glands can be squirted into the eyes when toads are handled roughly, causing intense pain and a potential medical emergency.

**Comments:** *Bufo marinus* was introduced intentionally in the U.S. and worldwide as a misguided attempt to control insect agricultural pests, primarily in cane fields.





Hugo Claessen ©1989

***Hyla cinerea* (Schneider, 1799) (green treefrog)**

**Habitat:** Stream or lake borders, swamps and freshwater wetlands, but also found anywhere with moisture or water; especially common amidst aquatic vegetation



**Life History:** Known as a “rain frog”, this species calls (to attract mates) during rainy or moist periods. Breeding and egg deposition occur during May to July. Eggs are laid in numerous “packets” containing five to 30 eggs with total egg yield from 300 to 500.



**Native Range:** Southeastern United States northward along the east coast into Maryland and Delaware

**Nonindigenous Range:** Collected from a shipment of plants in Norfolk County (Massachusetts).

**Impacts:** No impacts are reported because the species did not become established.



Brad Moon ©2002

***Hyla gratiosa* LeConte, 1857 (barking treefrog)**

**Habitat:** Pasture ponds, woodlands, and farmland. Their position within a habitat varies from high in the trees to ground level. They burrow in sandy soil during heat and drought, often in groups.



**Life History:** Breeding occurs during spring and summer in ponds or swamps or occasionally in brackish marshes. Females lay 1,000 or more eggs on the pond or swamp bottom, deposited singly, each in their own jelly-like envelope.



**Native Range:** Most of the southeastern United States with disjunct, native populations occurring in the Mid-Atlantic.

**Nonindigenous Range:** A nonindigenous population of *H. gratiosa* was documented in New Jersey during 1956 and 1957. The population persisted for approximately a decade, but is now presumed extirpated.

**Impacts:** No impacts were documented.



Photo courtesy of Creatures Great and Small

***Osteopilus septentrionalis* (Dumeril and Bibron, 1841) (Cuban treefrog)**

**Habitat:** Residential and commercial areas, and freshwater wetlands

**Life History:** Breeding season may last throughout most of the year in southern Florida. Females are continuously fertile, laying clutches of 1, 200 to over 16, 000 eggs. Eggs can be laid in any warm, shallow body of water, usually lacking predatory fish.



**Native Range:** Cuba, the Bahamas and the Cayman



islands.

**Nonindigenous Range:** Collected from a shipment of Cuban bananas in Baltimore and from a horticulture nursery in Warrenton, VA; the species is also established in southern Florida, Hawaii, and Puerto Rico.

**Impacts:** It is not likely this tropical species can endure winters in the Mid-Atlantic region. Where it is established, impacts are far-reaching because it voraciously preys upon frogs and invertebrates.



Alan Resetar ©1980

***Rana catesbeiana* Shaw, 1802 (bullfrog)**

**Habitat:** Lakes, ponds, cattle tanks, bogs, and sluggish portions of streams and rivers.

**Life History:** Breed in June and July producing 10, 000 to 20,000 eggs.

Tadpoles transform as quickly as 4 months in warmer climates and up to 3 years in colder locations. In colder climates, bullfrogs require year-round persistence of water for tadpoles to mature and over-winter.

**Native Range:** Eastern United States, but historically absent from the Cape

Cod archipelago and associated islands

**Nonindigenous Range:** Stocked in Nantucket, the Vineyard, and the Wellfleet Bay Sanctuary, but now established only in Wellfleet Bay Sanctuary, Massachusetts.

**Impacts:** In Wellfleet, *Rana catesbeiana* is apparently expanding its population and out-competing the native green frog (*Rana clamitans*). Where introduced populations have been studied in the Western U.S., adults consume birds, rodents, frogs, snakes, turtles, lizards, and bats. They are voracious eaters who will also prey on their own young.

**Comments:** Based on a study in western Washington, conservation of ephemeral wetlands will halt range expansions of bullfrogs. Permanently inundated wetlands are more likely to house nonindigenous species.



Joyce Gross ©2001

***Rana pipiens* Schreber, 1782 (northern leopard frog)**

**Habitat:** Streams, lakes, ponds, and wet prairies. Called the “meadow frog” due to wandering well away from water in the summer time. Individuals may congregate under submerged logs or rocks during the winter.

**Life History:** Lays eggs from March to May; tadpoles transform in late June to August.

**Native Range:** Southern Canada and the northern United States.

**Nonindigenous Range:** Considered nonindigenous in the

Cape Cod islands, the species has been established there for decades

**Impacts:** No impacts have been documented.

**Comments:** Specimens reportedly exhibiting atypical color patterns for Massachusetts were collected as early as 1915 from Cuttyhunk Island. The species was harvested in states like Minnesota, Vermont and Connecticut for



use in classroom experiments. Once experiments were completed teachers routinely released the surviving tadpoles into the wild.



John White ©2000

***Rana sphenocephala* (= *Rana utricularia*) Cope, 1886 (southern leopard frog)**

**Habitat:** Shallow, freshwater habitats and some slightly brackish marshes.

Like its northern counterpart, the southern leopard frog can be found great distances from water, usually in grassy or vegetated areas, during the summer.

**Life History:** Pairs typically mate/deposit eggs at night from April to September. Eggs hatch days later.

**Native Range:** Southeastern U.S and surrounding states

**Nonindigenous Range:** Collected from three localities in central and western Massachusetts (Sheffield, Berkshire County; Ludlow, Hampden County; and Amherst, Hampshire county).

**Impacts:** All are presumed to be pet escapes and not established, so ecological impacts are negligible. If southern leopard frogs establish in Massachusetts, hybridization with the native northern leopard frog (*Rana pipiens*) could compromise ecological integrity.



William Leonard ©2002

***Xenopus laevis* (Daudin, 1802) (African clawed frog)**

**Habitat:** Any permanent freshwater body, such as rivers, lakes, wells, swamps, and ditches.

**Life History:** Hundreds to over 2000 eggs are released and fertilized in the water column during nocturnal breeding; they are then deposited onto any available surface. Individuals live up to 15 years in captivity.

**Native Range:** Sub-Saharan Africa, but introduced throughout the world.

**Nonindigenous Range:** Acton Arboretum, Acton (Massachusetts) and Golf Branch Nature Center, Arlington (Virginia). Eradication measures were taken in Virginia, but it is unknown if any *X. laevis* migrated to other habitats before the eradication.

**Impacts:** Prey upon macroinvertebrates and some vertebrates.

**Comments:** *X. laevis* has long been used in laboratory research, and became established in many laboratory aquaria throughout the world in the 1950s and 1960s. Earliest reports of established nonindigenous populations of *X. laevis* worldwide are coincident with the end of their use in human pregnancy diagnosis.



## AMPHIBIANS Salamanders



Rich Sajdak



### ***Necturus maculosus*** (Rafinesque, 1818) (mudpuppy)

**Habitat:** Clear lakes, rivers and streams, and some weedy, turbid and mud-banked streams. It lingers in shallow aquatic habitats under rocks and logs and swims deep in lakes on occasion. Primarily nocturnal, but is known to venture out during daytime in cloudy or sheltered water.

**Life History:** Females construct underwater nests and lay up to 100 eggs (average 48-60) during May and June.

**Native Range:** Sporadically distributed from the southeastern U.S. north to New York, Vermont and Quebec and west to North Dakota and Manitoba.

**Nonindigenous Range:** Established in Hampshire County (Massachusetts) near Amherst College; and Great Pond and Belgrade, Kennebec County (Maine).

**Impacts:** Unknown.

**Comments:** The New England populations are releases or escapes from college biology programs.



Max Sparreboom ©1998



### ***Cynops pyrrhogaster*** (Boie, 1826) (Japanese fire-bellied salamander)

**Habitat:** Ponds, rice fields, swamps and streams; juveniles are more terrestrial and can be found under logs, rocks and leaf piles.

**Life History:** Up to 200 eggs are laid on aquatic plants during a breeding season; larvae metamorphose after 3 to 5 months.

**Native Range:** Japan

**Nonindigenous Range:** Two specimens collected from Ward's Pond, Plymouth County (Massachusetts) in 1932 and

another collected in 1979 from Stoneham, Middlesex County (Massachusetts).

**Impacts:** Apparently all introductions were escaped pets and did not become established, thus impacts are negligible.

**Comments:** A common pet requiring a mix of aquatic and terrestrial habitats, and eating aquatic insects and tadpoles.



## REPTILES Crocodilians



### ***Alligator mississippiensis*** (Daudin, 1801) (American alligator)

**Habitat:** Aquatic; including many types of waterways, both natural and man-made

**Life History:** Breeding begins in April; females lay over 50 eggs in a nest of leaves and vegetation up to 6 feet across. The eggs incubate for about 9



weeks; the female will defend the nest and hatchlings until they reach nine months of age.

**Native Range:** Coastal North Carolina south to southern Florida and the Keys, and westward through the deep south to central Texas and extreme southeastern Oklahoma.

**Nonindigenous Range:** Collected from Belleville and Westfield (New Jersey); North Yonkers, Pleasantville, Grassy Sprain Reservoir, New York City (sewer), Kenisco Reservoir, Middletown, East River, Brooklyn Museum Station (garbage can), and Westchester (New York); Virginia Beach, Hampton, Lucas Creek, Lake Anna, and Aquia Creek (Virginia); and unspecified localities in Lincoln and Wayne counties (West Virginia).

**Impacts:** Voracious predator feeding upon almost any fauna it can catch; despite many historic and recent introductions, harsh winters in the Mid-Atlantic region deter establishment

**Comments:** The occurrence in a New York City sewer and related tall tales may have generated the urban myth of a population of alligators inhabiting the city's sewage system.



***Caiman crocodilus* (Linnaeus, 1758) (common caiman)**

terrestrial insects.

**Habitat:** Almost any body of water, natural or man-made; with a diet that includes a variety of aquatic invertebrates and vertebrates, including

**Life History:** An average of 22 eggs are laid in a mound nest during July and August. The female guards her nest and continues maternal protection of the hatchlings.

**Native Range:** Southern Mexico to northern Argentina



**Nonindigenous Range:** Collected from Windsor, East Hartford, and North Stonington (Connecticut); Taunton and Plainfield (Massachusetts); New York City (New York); south of Pittsburgh (Pennsylvania); and Arlington, Norfolk, Lake Fairfax Park, and eastern Henrico County (Virginia).

**Impacts:** Does not seem to tolerate temperatures below 1.7° C (35° F). Not established in Mid-Atlantic states, but established in Florida and Puerto Rico. In Puerto Rico, nonindigenous *Micropterus salmoides* (largemouth bass) and *Cichla ocellaris* (peacock cichlid) that occur in waters with nonindigenous *C. crocodilus* are infested with larval caiman tongueworms (Pentastomida, Sebekidae). In Florida, caiman might transmit the same parasite to indigenous fish and crocodilians.

**Comments:** Trade in baby *Alligator mississippiensis* became illegal in the 1950s, and the pet industry imported thousands of young *C. crocodilus* into the U.S. as a substitute. Numerous pet escapes and intentional releases were a consequence of that pet trade. The common caiman is subject to international and federal trade regulations, with additional restrictions in a variety of states.





Gerald and Buff Corsi ©2001

***Crocodylus acutus* (Cuvier, 1807) (American crocodile)**

**Habitat:** Brackish to saltwater habitats in tropical climates

**Life History:** During the dry season, females lay an average of 38 eggs on a well-drained nest site. After 90 days of incubation, hatchlings (25 cm in

length) emerge. Females do not always guard the nest and hatchlings disperse from the nest site and the mother within a few days.

**Native Range:** Coasts of Mexico, Central America, northwestern South America, extreme southern Florida, and some islands in the West Indies.

**Nonindigenous Range:** A single 1 m long *C. acutus* was caught in the Great Dismal Swamp (Suffolk or Chesapeake counties), Virginia, in December 1976.

**Impacts:** It is unlikely that *C. acutus* could have survived a single winter in Virginia.

**Comments:** The American crocodile is a federally listed endangered species.



**REPTILES Snakes**



***Agkistrodon piscivorus* (Lacepède, 1789) (cottonmouth)**

**Habitat:** Semi-aquatic, foraging in aquatic and terrestrial environs, and often remaining in wait to ambush prey.

**Life History:** Females give live birth to 5-11 young in late summer or early fall; some females briefly remain with their young to provide some degree of parental care.

**Native Range:** Coast plains of Virginia, North Carolina and South Carolina, and in most of the southeastern

United States. Starting in extreme southern Illinois and Indiana the species occurs south along the Mississippi and Ohio River drainages and as far west as Kansas, Oklahoma and central Texas.

**Nonindigenous Range:** Collected from a pond in Milton, Massachusetts.

**Impacts:** No impact on native fauna is likely; this snake did not become established.



***Natrix tessellata* (Laurenti, 1768) (tessellated watersnake)**

**Habitat:** Almost any aquatic habitat; basks on land or on tree branches

**Life History:** Eight to 25 eggs are laid in moist soil or muck during July.

**Native Range:** Europe, Asia, and northern Africa

**Nonindigenous Range:** Collected from Norfolk Naval Base,



Virginia.

**Impacts:** Similarity in habits and diet to indigenous *Nerodia* and *Thamnophis*, could precipitate competition with *N. tessellata* if they became established. *N. tessellata* could also prey upon indigenous fish and amphibians.

**Comments:** Waif introduction by overseas freight shipments. In Europe, *N. tessellata* are commonly kept by snake hobbyists.

## REPTILES Turtles



William Flaxington

### **Apalone ferox** (Schneider, 1783) (Florida softshell)

**Habitat:** Lakes, ponds, ditches, large springs, and canals, rather than rivers . In rivers and creeks, they usually prefer slow moving

water. May spend some time buried in the soft bottom with only the head protruding.

**Life History:** Females lay 2 or more clutches containing four to 24 eggs each year during March to July. Hatchlings with yellow to olive carapace trimmed in yellow or orange

emerge from the nest after 56 – 83 days of incubation.

**Native Range:** Extreme southeastern U.S. including Florida, and portions of South Carolina, Georgia, and Alabama

**Nonindigenous Range:** New York Harbor

**Impacts:** Prey upon mollusks, crayfish, insects, fish, frogs, snakes, other turtles, birds, and carrion

**Comments:** In New York City, New York several *A. ferox* were sold to a Buddhist temple; then the turtles were ceremoniously released into New York Harbor (Williams, 1999).

The fate of these softshell turtles remains unknown, but it is highly unlikely that this southern species can survive the temperate climate and deep, highly urbanized harbor.



Photo courtesy of public domain website

### **Apalone spinifera** (Lesueur, 1827) (spiny softshell)

**Habitat:** Highly oxygenated rivers, but also creeks, canals, impoundments, lakes, and oxbows; especially those with a soft bottom, sandbars or mud flats. Often seen buried in the soft bottom with only the head protruding.

**Life History:** Females lay 4-39 eggs, during late spring or summer, which they bury in soil exposed to sunlight, often near sand or gravel bars, or further away from water if the proper nest environment is not close.

**Native Range:** Central and southern United States. In the Mid-Atlantic region, the species is indigenous to West Virginia and small portions of Virginia, Pennsylvania, New York, Massachusetts, and New Hampshire.

**Nonindigenous Range:** Established throughout the Maurice River System (New Jersey). Collected in Suffolk County (Massachusetts); Fairfax County (Virginia);



Cooper's Creek, Kearn's Lake, Palatine Lake, Rainbow Lake, and Willow Grove Lake (New Jersey).

**Impacts:** Prey upon fish, carrion, crayfish, insects, and a wide variety of other invertebrates.



**Chinemys reevesii** (Gray, 1831) (Chinese three-keeled pond turtle)

**Habitat:** Shallow ponds, streams and canals with muddy or sandy bottoms. It frequently basks on logs and rocks, and forages during the day.

**Life History:** The species reaches from 4-5 inches to just over a foot long depending its region of origin.

**Native Range:** Southern China, Korea and southern Japan

**Nonindigenous Range:** Collected from Marshfield in Cape Cod (Massachusetts).

**Impacts:** Unknown.



**Comments:** When collected, the turtle inhabited a wetland area and was probably an escaped or released pet. Hibernates during the winter, so it is unclear whether *C. reevesii* can survive winters in the Mid-Atlantic region.



John White ©2002

**Clemmys insculpta** LeConte, 1830 (*Glyptemys*) (wood turtle)

**Habitat:** Wetlands, streams, and rivers, as well as meadows, forests, and farmlands adjacent to water. The species hibernates in water, and is most aquatic in the northern portion of its range.

**Life History:** Mating peaks in spring and fall and nesting occurs in May and June.

Four to 18 eggs are laid in holes excavated in the soil.

**Native Range:** Northeastern United States, the Great Lakes region, New Brunswick, and Nova Scotia with

isolated populations in northern New York and Quebec. Not historically found in some portions of the Mid-Atlantic including: Virginia south of Rockingham County, most of northwestern New York, and the Cape Cod region.

**Nonindigenous Range:** Collected from Cape Cod. Translocations occurred in Newbury and Jamaica Pond (Massachusetts).

**Impacts:** The species is not established in Cape Cod, so impacts are likely minimal. Establishment could affect prey items such as: plants, fungi, mollusks, insects, tadpoles, earthworms, and eggs of birds and turtles.

Spread of disease and parasites is possible when a species is translocated, but no impacts were documented from the two releases within the native range.





George Grall, Courtesy of Tortoise Reserve

***Clemmys muhlenbergii* (Schoepff, 1801) (*Glyptemys*) (bog turtle)**

**Habitat:** Spring-fed sphagnum bogs, swamps, and marshes

**Life History:** Mating is from March to June and nests containing about three eggs are excavated in tussocks or elevated soil from

May to July.

**Native Range:** Distributed sporadically in Georgia, South Carolina, North Carolina, Tennessee, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, and Massachusetts.



**Nonindigenous Range:** Collected from Newbury (Massachusetts)

**Impacts:** A population did not establish; no impacts reported

**Comments:** The bog turtle is federally listed as a threatened species. Plant succession and hydrologic seasonality make *C. muhlenbergii* habitat largely ephemeral causing their fluctuating, discontinuous distribution. Bog turtles are omnivorous and feed on insects and insect larvae, snails, berries, seeds, plants, and various vertebrates.



Sharon Chancellor, www.chelonia.org

***Cuora flavomarginata* (Gray, 1863) (yellow-margined box turtle)**

**Habitat:** Ponds, rice paddies, and streams.

**Life History:** Clutches of 1 to 3 eggs are laid in dry, shaded soil during March through August; incubation is 75 to 90 days.

**Native Range:** Southern China, Taiwan and the Ryukyu Islands

**Nonindigenous Range:** Collected from Attleborough and Needham (Massachusetts)

**Impacts:** A population did not establish; no impacts

reported. Prey upon snails, worms and other invertebrates.



John White ©2000

***Graptemys geographica* (Le Sueur, 1817) (common map turtle)**

**Habitat:** Rivers and lakes with abundant basking sites

**Life History:** Nesting occurs from May to June and flask-shaped nests are excavated in loose soil or sand at the water's edge. Females commonly lay two clutches per season with each nest containing approximately 10 eggs.

**Native Range:** Eastern portion of the Midwest to the

southeast and central Mid-Atlantic states.

Isolated populations occur in Pennsylvania, New Jersey and New York including the Susquehanna River system of Pennsylvania, Maryland, and Delaware.



**Nonindigenous Range:** Collected from Lake Waban (Massachusetts)  
**Impacts:** A population did not establish; no impacts reported



Photo courtesy of  
graptemys.com

***Graptemys pseudogeographica* (Gray, 1831) (false map turtle)**

**Habitat:** Large rivers and backwaters, but also lakes, ponds and other wetlands

**Life History:** Two to three clutches containing 2 to 22 eggs are laid from May to July. Females usually excavate nests in the morning or on overcast days on banks or beaches.

**Native Range:** Texas, Louisiana, Mississippi and Arkansas north along the Missouri, Mississippi, and Ohio

river drainages to North Dakota, Minnesota, Wisconsin, Illinois, and Indiana. Isolated populations occur in central Ohio and northern Indiana.

**Nonindigenous Range:** Collected from a tide marsh along the shore of the Little River opposite Roosevelt Island (District of Columbia and Virginia). *Graptemys pseudogeographica kohnii* (Baur, 1890) was collected from two sites in Virginia; Custis Spring, USDA experimental farm located east of Arlington, and Norfolk.

**Impacts:** Negligible since the species is not established in Virginia. Because *G. pseudogeographica* is omnivorous, eating mollusks, insects, crayfish, aquatic plants and more, an established population could influence the food web.



William Flaxington ©2001

***Kinosternon subrubrum* (Lacepède, 1788) (eastern mud turtle)**

**Habitat:** Quiet, well-vegetated, shallow waters with soft substrates, often tolerating brackish waters.

**Life History:** Females lay 1-3 clutches annually,

consisting of 1-6 hard-shelled eggs, in well-drained soil often under some sort of terrestrial cover (Iverson, 1979; Frazer et al., 1991; Ernst et al., 1994).

**Native Range:** Gulf coast states from Texas to Florida and east coast states from Florida to New Jersey and Long

Island. Also along the Mississippi, Missouri, and Ohio rivers from the Gulf to Oklahoma, Missouri, Illinois and Indiana. An isolated population resides in northern Indiana.

**Nonindigenous Range:** A *Kinosternon subrubrum hippocrepis* (Gray, 1855) (Mississippi mud turtle) was collected from a dam on the Parker River, Ipswich (Massachusetts).

**Impacts:** No impacts are apparent since the species is not established. Should this semiaquatic omnivore become established, it can potentially impact any ecosystem by feeding on or competing with indigenous fauna (especially mollusks, insects, crustaceans, amphibians, and other turtles).

**Comments:** *K. subrubrum* does not bask often, but it is capable of wandering far from water.





John White ©2001

**Malaclemys terrapin** (Schoepff, 1793) (diamondback terrapin)

**Habitat:** Coastal salt marshes, tidal creeks and estuaries.

**Life History:** During April to July, nests containing up to 18 eggs are excavated in dunes and shoreline soil, often proximal to vegetation.

**Native Range:** Along the Gulf and Atlantic coasts from Texas to Florida and north to Massachusetts.

**Nonindigenous Range:** Collected from Tinicum Marsh

where it is presumed to be nonindigenous (Pennsylvania). While native to Massachusetts, the species has been stocked in Scusset Marshes in Sandwich and the Slocum River in Dartmouth (Massachusetts). Southern subspecies have been collected at the causeway to Plum Island in Ipswich, the Charles River in Boston, and on the outer shore of Logan Airport in Boston Harbor (Massachusetts).

**Impacts:** No impacts are reported.

**Comments:** Terrapins may be sold illegally as food in Chinatown, Boston. Terrapin mortality most commonly stems from entrapment in crab pots.



Photo courtesy of America Zoo.com

**Mauremys caspica** (Gmelin, 1774) (Caspian turtle)

**Habitat:** Vegetated ponds, swamps, lakes, and rivers

**Life History:** *M. caspica* lays clutches of 4-6 eggs.

**Native Range:** Europe and Africa from Serbia to Greece, southwestern Russia and central Iraq.

**Nonindigenous Range:** Collected from Grafton (Massachusetts).

**Impacts:** Impacts are not likely, because the species is not established.

**Comments:** The introduction and establishment of American red-eared sliders (*Trachemys scripta elegans*) in the Mediterranean region due to pet releases is a growing threat to *M. caspica* as they compete directly for food

with indigenous species.



David Scott, Savannah River Ecology Lab

**Pseudemys concinna** (LeConte, 1830) (river cooter)

**Habitat:** Aquatic habitats with vegetation and basking sites, especially slow moving rivers, lakes and wetlands

**Life History:** Nesting occurs May to July in sandy or loam soil within 30 m of water.

**Native Range:** Southern U.S. from Texas, Kansas, and Florida to eastern Virginia.

**Nonindigenous Range:** Naushon Island in Dukes County,

Hoyt's Pond in Plymouth, and Lily Ponds in West Boylston (Massachusetts). Collected in 1975 from the Patapsco River (Maryland).



**Impacts:** No impacts are reported, because it is not established.



David Scott, Savannah River Ecology Lab

***Pseudemys floridana* (LeConte, 1830) (Florida cooter)**

**Habitat:** Large slow-flowing rivers and associated backwaters and ponds.

**Life History:** Reaches maturity at three to four years and plastron length of

12 – 14 cm (males) or five to seven years and 24-25 cm in

length (females). Two to six clutches ranging from 10 to 29 eggs are laid. Nesting occurs any time of year in Florida, but usually not in summer. Elsewhere, nesting is in spring and approaching summer in the northern extent of its range.

**Native Range:** Southeastern coastal plains from southeastern Virginia to portions of the Florida Everglades

and west to Alabama.

**Nonindigenous Range:** Collected from the Wachusett Reservoir in Worcester County, Mashpee in Barnstable County, and Martha's Vineyard (Massachusetts); and from the Patapsco River (Maryland).

**Impacts:** No impacts are reported, because it is not established.



Betsy McCormick, California Tortoise and Turtle Club

***Rhinoclemmys pulcherrima* (Gray, 1855) (painted wood turtle)**

**Habitat:** Moist woodlands and scrub lands often close to streams or ponds

**Life History:** Nests in leaf litter or soil, laying several clutches of three to five eggs during May to December.

**Native Range:** Mexico to Costa Rica

**Nonindigenous Range:** Collected from a roadside near Flax Pond in Lynn (Massachusetts).

**Impacts:** No impact resulted since the species is not established. Difficult to keep in captivity, it is unlikely that this species would ever establish in the Mid-Atlantic. Consumes wildflowers, grasses, fruit, insects, worms, and fish.

**Comments:** *Rhinoclemmys pulcherrima* includes four subspecies, which are the only representatives of the subfamily Batagurinae to occur in the New World.



Mike Pingleton



***Trachemys scripta elegans* (Weid-Neuwied, 1838) (red-eared slider)**

**Habitat:** Nearly any freshwater habitat, predominantly still or slow-moving water with a soft bottom, aquatic vegetation, and basking sites.

**Life History:** Reproduction varies greatly among populations relative to climate and nutrient availability. These environmental variances affect size at sexual maturity. Females lay two to 23 eggs per clutch with up to five clutches per year.





**Native Range:** South central U.S. from West Virginia to the Gulf of Mexico (Alabama to Texas) and west Iowa, Missouri, Kansas, and Oklahoma.

**Nonindigenous Range:** Established in the vicinities of Boston and Springfield (Massachusetts); northern

Maryland; Lake Carnegie, and the Delaware and Raritan Canal (New Jersey); Pine Lake near Coram, Rochester, Buffalo, and the town of Cold Spring Harbor (New York); Lehigh River and associated canal system (Pennsylvania); and Mason Neck National Wildlife Refuge (Virginia). Collected from Cambridge Reservoir, Orleans, Hoyt's Pond in Plymouth, Wollaston, Belmont, Forest Park in Springfield, Holly Pond in Hingham, Sunset Lake in Braintree, Hamilton, Back Bay Fens and Victory Gardens in Boston, Lynn, Trailside Museum and Pope's Pond in Milton, Reading, and Great Meadows National Wildlife Refuge (Massachusetts); northern Maryland as far south as Prince George's County (Maryland); Messalonskee Lake of the Belgrade Chain; and Portland (Maine).

**Impacts:** Unknown. Diet includes a variety of algae and aquatic plants, insects, fish and carrion with more insects eaten by juveniles.



John White ©2000



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***Trachemys scripta scripta* (Schoepff, 1792) (yellow-bellied slider)**

**Habitat:** Nearly any freshwater habitat, predominantly still or slow-moving water with a soft bottom, aquatic vegetation, and basking sites.

**Life History:** Reproduction varies greatly among populations relative to climate and nutrient availability. These environmental variances affect size at sexual maturity. Females lay two to 23 eggs per clutch with up to five clutches per year.



**Native Range:** South central U.S. from West Virginia to the Gulf of Mexico (Alabama to Texas) and west Iowa, Missouri, Kansas, and Oklahoma.

**Native Range:** Southeastern U.S. from southern Virginia to northern Florida and eastern Alabama.

**Nonindigenous Range:** Collected from Belle Haven Park adjacent to the Potomac River in Alexandria (Virginia).

**Impacts:** Unknown. Diet includes a variety of plants, insects, fish and carrion with more insects eaten by juveniles.



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Appendix A. List of fishes introduced in Region 5 outside their historic ranges.

| Family           | Species Name  | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |   |
|------------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|---|
| Adrianichthyidae | <i>Oryzias latipes</i> (Japanese medaka)                          |    |    |    |    |    |    | X  |    |    |    |    |    |    |   |
| Amiidae          | <i>Amia calva</i> (bowfin)  | X  | X  | X  |    | X  | X  | X  | X  |    | X  |    |    |    |   |
| Anguillidae      | <i>Anguilla rostrata</i> (American eel)                           |    |    |    |    | X  |    |    |    |    |    |    |    |    |   |
| Atherinidae      | <i>Labidesthes sicculus</i> (brook silverside)                    |    | X  |    |    |    |    |    |    |    |    |    |    |    |   |
| Belontiidae      | <i>Betta splendens</i> (Siamese fighting fish)                    |    |    |    |    |    |    |    | X  |    |    |    |    |    |   |
|                  | <i>Colisa fasciata</i> (banded gourami)                           |    |    |    |    | X  |    |    |    |    |    |    |    |    |   |
| Callichthyidae   | <i>Callichthys callichthys</i> (cascaudo)                         |    |    |    |    |    |    | X  |    |    |    |    |    |    |   |
| Catostomidae     | <i>Carpiodes cyprinus</i> (quillback)                             | X  |    |    |    |    |    |    |    |    |    |    |    |    |   |
|                  | <i>Catostomus catostomus</i> (longnose sucker)                    |    |    |    |    |    |    |    | X  |    |    |    |    |    |   |
|                  | <i>Hypentelium nigricans</i> (northern hog sucker)                |    |    |    |    |    |    |    |    |    | X  |    |    |    |   |
|                  | <i>Ictiobus cyprinellus</i> (bigmouth buffalo)                    | X  |    |    |    |    |    |    |    |    |    |    |    |    |   |
|                  | <i>Moxostoma erythrurum</i> (golden redhorse)                     | X  | X  | X  |    |    |    |    |    |    |    |    |    |    |   |
|                  | <i>Scartomyzon cervinus</i> (black jumprock)                      | X  |    |    |    |    |    |    |    |    |    |    |    |    |   |
|                  | <i>Thoburnia rhotioeca</i> (torrent sucker)                       | X  | X  |    |    |    |    |    |    |    |    |    |    |    |   |
| Centrarchidae    | <i>Ambloplites cavifrons</i> (Roanoke bass)                       | X  |    |    |    |    |    |    |    |    |    |    |    |    |   |
|                  | <i>Ambloplites rupestris</i> (rock bass)                          | X  | X  | X  | X  | X  | X  | X  | X  |    | X  |    | X  |    |   |
|                  | <i>Centrarchus macropterus</i> (flier)                            |    |    | X  |    |    |    |    |    |    |    |    |    |    |   |
|                  | <i>Chaenobryttus gulosus</i> (warmouth)                           | X  |    | X  | X  | X  |    | X  |    |    |    |    |    |    |   |
|                  | <i>Enneacanthus gloriosus</i> (bluespotted sunfish)               |    |    |    |    | X  |    | X  |    |    |    |    |    |    |   |
|                  | <i>Lepomis auritus</i> (redbreast sunfish)                        | X  | X  |    |    |    |    |    |    |    |    |    |    |    |   |
|                  | <i>Lepomis cyanellus</i> (green sunfish)                          | X  | X  | X  | X  | X  | X  | X  | X  |    | X  |    |    |    | X |
|                  | <i>Lepomis cyanellus x macrochirus</i> (green sunfish x bluegill) |    |    |    | X  |    |    |    |    |    |    |    |    |    |   |
|                  | <i>Lepomis gibbosus</i> (pumpkinseed)                             | X  | X  | X  |    | X  |    |    |    |    |    |    |    |    |   |
|                  | <i>Lepomis humilis</i> (orangespotted sunfish)                    |    | X  |    |    |    |    |    |    |    |    |    |    |    |   |
| Centrarchidae    | <i>Lepomis macrochirus</i> (bluegill)                             | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    | X  |    |   |
|                  | <i>Lepomis megalotis</i> (longear sunfish)                        | X  | X  | X  |    | X  |    |    |    |    | X  |    |    |    |   |
|                  | <i>Lepomis microlophus</i> (redeer sunfish)                       | X  | X  |    | X  | X  |    |    |    |    |    | X  |    |    |   |
|                  | <i>Lepomis sp.</i> (sunfish)                                      |    |    |    |    |    |    |    |    |    | X  |    |    |    |   |
|                  |   |    |    |    |    |    |    |    |    |    |    |    |    |    |   |

Appendix A. List of fishes introduced in Region 5 outside their historic ranges. (Continued)

| Family     | Species Name  | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
|            | <i>Micropterus dolomieu</i> (smallmouth bass)                       | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
|            | <i>Micropterus punctulatus</i> (spotted bass)                       | X  | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Micropterus punctulatus punctulatus</i> (northern spotted bass)  | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Micropterus salmoides</i> (largemouth bass)                      | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
|            | <i>Micropterus</i> sp. (black bass)                                 |    |    |    |    |    | X  |    |    |    |    |    |    |    |
|            | <i>Pomoxis annularis</i> (white crappie)                            | X  | X  | X  | X  | X  | X  | X  | X  |    | X  | X  |    |    |
|            | <i>Pomoxis nigromaculatus</i> (black crappie)                       | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Channidae  | <i>Channa argus</i> (northern snakehead)                            |    |    | X  |    |    |    |    |    |    | X  |    |    |    |
|            | <i>Channa maculata</i> (blotched snakehead)                         |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|            | <i>Channa marulius</i> (bullseye snakehead)                         |    |    | X  |    |    |    |    |    |    |    |    |    |    |
|            | <i>Channa micropeltes</i> (giant snakehead)                         |    |    |    |    |    |    |    |    | X  | X  |    |    | X  |
| Characidae | <i>Colossoma macropomum</i> (tambaqui)                              |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|            | <i>Colossoma</i> or <i>Piaractus</i> sp. (unidentified pacu)        | X  |    |    |    | X  |    | X  |    |    |    |    |    |    |
|            | <i>Myleus rubripinnis</i> (redhook pacu)                            |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|            | <i>Piaractus brachypomus</i> (pirapatinga)                          | X  |    |    |    |    |    |    |    |    | X  |    |    |    |
|            | <i>Pygocentrus nattereri</i> (red piranha)                          | X  |    |    |    | X  |    |    |    |    | X  |    |    |    |
|            | <i>Pygocentrus</i> or <i>Serrasalmus</i> sp. (unidentified piranha) |    |    |    |    | X  |    | X  | X  |    |    |    | X  |    |
| Cichlidae  | <i>Astronotus ocellatus</i> (oscar)                                 | X  |    |    |    | X  | X  |    |    | X  | X  |    |    |    |
|            | <i>Cichlasoma citrinellum</i> (midas cichlid)                       |    |    |    |    |    |    |    |    |    | X  |    |    |    |
| Cichlidae  | <i>Cichlasoma octofasciatum</i> (Jack Dempsey)                      |    |    |    |    |    |    |    | X  |    |    |    |    |    |
|            | <i>Oreochromis aureus</i> (blue tilapia)                            |    |    |    |    | X  |    |    |    |    |    |    |    |    |
|            | <i>Oreochromis mossambicus</i> (Mozambiqua tilapia)                 |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Oreochromis, Sarotherodon, Tilapia</i> sp. (tilapia)             |    |    |    |    |    | X  |    |    |    |    |    |    |    |
|            | <i>Tilapia buttikoferi</i> (zebra tilapia)                          | X  |    |    |    |    |    |    |    |    |    |    |    |    |
| Clariidae  | <i>Clarias batrachus</i> (walking catfish)                          |    |    |    |    |    |    |    | X  |    | X  |    |    |    |
| Clupeidae  | <i>Alosa aestivalis</i> (blueback herring)                          | X  |    |    |    | X  |    | X  |    |    |    | X  |    |    |
|            | <i>Alosa chrysochloris</i> (skipjack herring)                       |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Alosa pseudoharengus</i> (alewife)                               | X  | X  | X  |    | X  |    | X  |    |    | X  | X  | X  | X  |
|            | <i>Alosa sapidissima</i> (American shad)                            | X  | X  | X  |    | X  |    | X  |    |    | X  | X  |    |    |



Appendix A. List of fishes introduced in Region 5 outside their historic ranges. (Continued)

| Family     | Species Name   | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|------------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|
|            | <i>Dorosoma cepedianum</i> (gizzard shad)                  | X  |    |    |    | X  |    | X  |    |    |    | X  |    |    |
|            | <i>Dorosoma petenense</i> (threadfin shad)                 | X  | X  | X  | X  | X  |    |    |    |    |    |    |    |    |
| Cyprinidae | <i>Brachydanio rerio</i> (zebra danio)                     |    |    |    |    |    |    |    | X  |    |    |    |    |    |
|            | <i>Campostoma anomalum</i> (central stoneroller)           | X  |    |    |    |    |    | X  | X  |    |    |    |    |    |
|            | <i>Carassius auratus</i> (goldfish)                        | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
|            | <i>Clinostomus elongatus</i> (reidside dace)               |    |    | X  |    |    |    |    |    |    |    |    |    |    |
|            | <i>Clinostomus funduloides</i> (rosyside dace)             | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Clinostomus funduloides funduloides</i> (rosyside dace) | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Ctenopharyngodon idella</i> (grass carp)                | X  | X  | X  | X  | X  | X  | X  | X  |    | X  |    | X  |    |
|            | <i>Cyprinella analostana</i> (satinfin shiner)             |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Cyprinella galactura</i> (whitetail shiner)             | X  | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Cyprinella lutrensis</i> (red shiner)                   |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|            | <i>Cyprinella spiloptera</i> (spotfin shiner)              | X  |    |    |    | X  |    |    |    |    |    |    |    |    |
|            | <i>Cyprinus carpio</i> (common carp)                       | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |
| Cyprinidae | <i>Exoglossum laurae</i> (tonguetied minnow)               |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Exoglossum maxillingua</i> (cutlips minnow)             | X  | X  |    |    |    |    |    | X  |    |    |    |    |    |
|            | <i>Hybognathus hankinsoni</i> (brassy minnow)              |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Hybognathus regius</i> (eastern silvery minnow)         |    |    |    |    |    |    |    |    |    |    |    |    | X  |
|            | <i>Hybopsis amblops</i> (bigeye chub)                      |    |    |    |    |    |    |    | X  |    |    |    |    |    |
|            | <i>Hypophthalmichthys nobilis</i> (bighead carp)           |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Leuciscus idus</i> (ide)                                | X  | X  | X  |    | X  |    | X  | X  |    |    |    |    | X  |
|            | <i>Luxilus albeolus</i> (white shiner)                     | X  | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Luxilus cerasinus</i> (crescent shiner)                 | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Luxilus chrysocephalus</i> (striped shiner)             |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Luxilus cornutus</i> (common shiner)                    |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Lythrurus ardens</i> (rosefin shiner)                   | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Margariscus margarita</i> (pearl dace)                  |    |    |    |    |    |    |    | X  |    |    |    |    |    |
|            | <i>Nocomis biguttatus</i> (hornyhead chub)                 |    |    |    |    | X  |    | X  |    |    |    |    |    |    |
|            | <i>Nocomis leptocephalus</i> (bluehead chub)               | X  |    |    |    |    |    |    |    |    |    |    |    |    |

Appendix A. List of fishes introduced in Region 5 outside their historic ranges. (Continued)

| Family     | Species Name   | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|------------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|
|            | <i>Nocomis raneyi</i> (bull chub)                          | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Notemigonus crysoleucas</i> (golden shiner)             | X  | X  |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Notropis amoenus</i> (comely shiner)                    |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Notropis ariommus</i> (pop-eye shiner)                  |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Notropis atherinoides</i> (emerald shiner)              |    | X  | X  |    |    |    | X  |    |    | X  |    |    | X  |
|            | <i>Notropis buccatus</i> (silverjaw minnow)                | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Notropis chiliticus</i> (redlip shiner)                 | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Notropis chrosomus</i> (rainbow shiner)                 |    |    |    |    |    |    |    |    |    | X  |    |    | X  |
|            | <i>Notropis hudsonius</i> (spottail shiner)                | X  | X  |    |    | X  |    | X  |    |    |    |    | X  | X  |
| Cyprinidae | <i>Notropis leuciodus</i> (Tennessee shiner)               | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Notropis ludibundus</i> (sand shiner)                   |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Notropis procne</i> (swallowtail shiner)                | X  |    |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Notropis rubellus</i> (rosyface shiner)                 |    |    |    |    | X  |    |    | X  |    |    |    |    |    |
|            | <i>Notropis rubricroceus</i> (saffron shiner)              | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Notropis telescopus</i> (telescope shiner)              | X  | X  |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Notropis volucellus</i> (mimic shiner)                  |    | X  |    |    | X  |    |    | X  |    | X  |    |    |    |
|            | <i>Phoxinus oreas</i> (mountain redbelly dace)             | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Pimephales notatus</i> (bluntnose minnow)               | X  | X  |    |    |    |    |    | X  |    | X  |    |    |    |
|            | <i>Pimephales promelas</i> (fathead minnow)                | X  | X  | X  | X  | X  |    |    | X  |    | X  |    | X  | X  |
|            | <i>Rhinichthys cataractae</i> (longnose dace)              | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|            | <i>Rhodeus sericeus</i> (bitterling)                       |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Scardinius erythrophthalmus</i> (rudd)                  | X  | X  |    |    | X  | X  | X  | X  |    | X  | X  |    | X  |
|            | <i>Semotilus corporalis</i> (fallfish)                     | X  |    |    |    |    |    | X  |    |    |    |    |    |    |
|            | <i>Tinca tinca</i> (tench)                                 | X  | X  | X  | X  | X  | X  | X  | X  |    | X  | X  |    |    |
| Esocidae   | <i>Esox americanus americanus</i> (redfin pickerel)        |    |    | X  |    | X  |    | X  |    |    |    | X  |    |    |
|            | <i>Esox lucius</i> (northern pike)                         | X  | X  | X  |    | X  | X  |    | X  | X  | X  |    | X  | X  |
|            | <i>Esox lucius x masquinongy</i> (tiger muskellunge)       | X  | X  | X  | X  | X  | X  | X  |    |    | X  |    |    |    |
|            | <i>Esox lucius x reicherti</i> (northern pike x amur pike) |    |    |    |    | X  |    |    |    |    |    |    |    |    |
|            | <i>Esox masquinongy</i> (muskellunge)                      | X  | X  | X  | X  | X  | X  | X  | X  |    | X  | X  |    | X  |

Appendix A. List of fishes introduced in Region 5 outside their historic ranges. (Continued)

| Family         | Species Name   | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|----------------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                | <i>Esox niger</i> (chain pickerel)                             | X  | X  | X  |    | X  | X  | X  | X  |    | X  | X  |    |    |
|                | <i>Esox reicherti</i> (Amur pike)                              |    |    |    |    | X  |    |    |    |    |    |    |    |    |
| Fundulidae     | <i>Fundulus catenatus</i> (northern studfish)                  |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|                | <i>Fundulus diaphanus</i> (banded killifish)                   |    |    |    |    | X  |    |    |    |    |    |    |    |    |
| Fundulidae     | <i>Fundulus diaphanus diaphanus</i> (eastern banded killifish) |    |    |    |    | X  |    |    |    |    |    |    |    |    |
|                | <i>Fundulus heteroclitus</i> (mummichog)                       |    |    |    |    | X  |    |    |    |    |    |    | X  |    |
|                | <i>Lucania parva</i> (rainwater killifish)                     |    |    |    |    |    | X  |    |    |    |    |    |    |    |
| Gadidae        | <i>Lota lota</i> (burbot)                                      |    |    | X  |    | X  | X  |    | X  |    |    |    |    |    |
| Gasterosteidae | <i>Apeltes quadracus</i> (fourspine stickleback)               |    |    |    |    | X  | X  |    |    |    |    |    |    |    |
|                | <i>Culaea inconstans</i> (brook stickleback)                   |    |    |    |    | X  |    |    | X  |    |    |    |    | X  |
|                | <i>Gasterosteus aculeatus</i> (threespine stickleback)         |    |    |    |    |    |    |    |    |    | X  |    |    |    |
| Gobiidae       | <i>Neogobius melanostomus</i> (round goby)                     |    |    |    |    | X  |    | X  |    |    |    |    |    |    |
| Hiodontidae    | <i>Hiodon tergisus</i> (mooneye)                               |    |    | X  |    |    |    |    |    |    |    |    |    |    |
| Ictaluridae    | <i>Ameiurus brunneus</i> (snail bullhead)                      | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|                | <i>Ameiurus catus</i> (white catfish)                          |    |    |    |    | X  |    |    | X  | X  | X  |    |    |    |
|                | <i>Ameiurus melas</i> (black bullhead)                         | X  | X  | X  |    |    |    |    | X  |    | X  |    |    |    |
|                | <i>Ameiurus natalis</i> (yellow bullhead)                      | X  | X  |    |    |    |    |    | X  |    | X  |    | X  |    |
|                | <i>Ameiurus nebulosus</i> (brown bullhead)                     | X  | X  |    |    |    |    |    |    |    |    |    | X  |    |
|                | <i>Ameiurus platycephalus</i> (flat bullhead)                  | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|                | <i>Ictalurus furcatus</i> (blue catfish)                       | X  | X  | X  |    |    | X  |    |    |    |    |    |    |    |
|                | <i>Ictalurus punctatus</i> (channel catfish)                   | X  | X  | X  | X  | X  | X  | X  | X  |    | X  |    |    |    |
|                | <i>Ictalurus sp.</i> (catfish)                                 |    |    |    |    | X  |    |    |    |    |    |    |    |    |
|                | <i>Noturus flavus</i> (stonecat)                               |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|                | <i>Noturus gilberti</i> (orangeфин madtom)                     | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|                | <i>Noturus gyrinus</i> (tadpole madtom)                        |    |    |    |    |    |    |    |    |    | X  |    | X  |    |
|                | <i>Noturus insignis</i> (margined madtom)                      | X  | X  | X  |    | X  |    | X  |    |    | X  |    | X  |    |
|                | <i>Noturus miurus</i> (brindled madtom)                        |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|                | <i>Pylodictis olivaris</i> (flathead catfish)                  | X  |    |    |    | X  |    |    |    |    |    |    |    |    |
| Lepisosteidae  | <i>Lepisosteus oculatus</i> (spotted gar)                      |    |    |    |    |    |    |    |    |    | X  |    |    |    |

Appendix A. List of fishes introduced in Region 5 outside their historic ranges. (Continued)

| Family          | Species Name   | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|-----------------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Loricariidae    | <i>Hypostomus plecostomus</i> (suckermouth catfish)              |    |    |    |    | X  |    |    |    |    |    |    |    |    |
|                 | <i>Hypostomus sp.</i> (suckermouth catfish)                      |    |    |    |    | X  |    |    | X  |    |    |    |    |    |
| Moronidae       | <i>Morone americana</i> (white perch)                            | X  | X  |    |    | X  |    | X  |    |    | X  | X  | X  |    |
|                 | <i>Morone americana x saxatilis</i> (white perch x striped bass) |    |    |    | X  |    |    |    |    |    |    |    |    |    |
|                 | <i>Morone chrysops</i> (white bass)                              | X  | X  | X  | X  | X  | X  |    |    |    |    |    |    |    |
|                 | <i>Morone chrysops x saxatilis</i> (wiper)                       | X  | X  | X  | X  | X  | X  | X  |    |    |    |    |    |    |
|                 | <i>Morone saxatilis</i> (striped bass)                           | X  | X  | X  |    | X  | X  |    |    |    |    |    |    |    |
| Osmeridae       | <i>Osmerus mordax</i> (rainbow smelt)                            | X  |    | X  |    | X  |    | X  | X  |    | X  | X  | X  | X  |
| Percidae        | <i>Etheostoma blennioides</i> (greenside darter)                 | X  |    | X  |    |    |    |    |    |    |    |    |    |    |
|                 | <i>Etheostoma caeruleum</i> (rainbow darter)                     |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|                 | <i>Etheostoma simoterum</i> (snubnose darter)                    | X  | X  |    |    |    |    |    |    |    |    |    |    |    |
|                 | <i>Etheostoma zonale</i> (banded darter)                         |    |    | X  |    | X  |    | X  |    |    |    |    |    |    |
|                 | <i>Perca flavescens</i> (yellow perch)                           | X  | X  | X  |    | X  | X  | X  | X  |    | X  | X  |    | X  |
|                 | <i>Percina caprodes</i> (logperch)                               |    | X  |    |    |    |    |    |    |    |    |    |    |    |
|                 | <i>Percina roanoka</i> (Roanoke darter)                          | X  | X  |    |    |    |    |    |    |    |    |    |    |    |
|                 | <i>Stizostedion canadense x vitreum</i> (saugeye)                |    | X  |    |    | X  |    |    |    |    |    |    |    |    |
|                 | <i>Stizostedion lucioperca</i> (zander)                          |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|                 | <i>Stizostedion vitreum</i> (walleye)                            | X  | X  | X  | X  | X  | X  | X  | X  |    | X  | X  | X  | X  |
|                 | <i>Stizostedion vitreum vitreum</i> (walleye)                    |    |    | X  |    |    |    |    |    |    |    |    |    |    |
| Percopsidae     | <i>Percopsis omiscomaycus</i> (trout-perch)                      |    |    |    |    |    |    |    | X  |    | X  |    |    |    |
| Petromyzontidae | <i>Ichthyomyzon unicuspis</i> (silver lamprey)                   |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|                 | <i>Lampetra appendix</i> (American brook lamprey)                |    |    |    |    |    |    |    | X  |    |    |    |    |    |
|                 | <i>Petromyzon marinus</i> (sea lamprey)                          |    |    |    |    | X  |    | X  |    |    |    | X  |    |    |
| Poeciliidae     | <i>Gambusia affinis</i> (mosquitofish)                           |    | X  |    |    | X  | X  | X  | X  |    | X  |    |    |    |
|                 | <i>Gambusia affinis affinis</i> (mosquitofish)                   |    |    |    |    | X  | X  | X  |    |    | X  |    |    |    |
|                 | <i>Gambusia holbrooki</i> (eastern mosquitofish)                 | X  |    |    |    |    | X  |    |    |    | X  |    |    |    |
|                 | <i>Heterandria formosa</i> (least killifish)                     |    |    |    |    |    | X  |    |    |    |    |    |    |    |
|                 | <i>Poecilia reticulata</i> (guppy)                               |    |    |    |    |    |    |    | X  |    |    |    |    |    |
|                 | <i>Poeciliopsis sp.</i> (livebearer, topminnow)                  |    |    |    |    |    |    |    | X  |    |    |    |    |    |

Appendix A. List of fishes introduced in Region 5 outside their historic ranges. (Continued)

| Family     | Species Name  | VA   | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |   |
|------------|---|--|----|----|----|----|----|----|----|----|----|----|----|----|---|
| Salmonidae | <i>Coregonus albula</i> (vendace)   |  |    |    |    |    |    |    |    |    |    |    |    | X  |   |
|            | <i>Coregonus artedi</i> (cisco)   |  |    | X  |    | X  |    | X  |    |    |    |    |    |    |   |
|            | <i>Coregonus clupeaformis</i> (lake whitefish)                                    |  |    |    |    |    |    | X  |    |    |    |    | X  | X  |   |
|            | <i>Coregonus lavaretus</i> (powan)  |  |    |    |    |    |    |    |    |    |    |    |    | X  |   |
|            | <i>Coregonus sp.</i> (cisco or whitefish)   |  |    |    |    |    |    |    |    |    | X  |    |    |    |   |
|            | <i>Oncorhynchus clarki</i> (cutthroat trout)                                      | X  | X  | X  |    |    | X  |    | X  |    |    |    | X  |    |   |
|            | <i>Oncorhynchus clarki carmichaeli</i> (fine-spotted Snake River cutthroat trout) |  |    | X  |    |    |    |    |    |    |    |    |    |    |   |
|            | <i>Oncorhynchus gorbuscha</i> (pink salmon)                                       |  |    | X  |    | X  |    | X  |    |    |    |    |    |    | X |
|            | <i>Oncorhynchus keta</i> (chum salmon)  |  |    |    |    |    |    |    |    |    |    |    |    |    | X |
|            | <i>Oncorhynchus kisutch</i> (coho salmon)   | X  | X  | X  | X  | X  |    | X  | X  | X  |    | X  |    | X  | X |
|            | <i>Oncorhynchus mykiss</i> (rainbow trout)  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    | X  | X  | X  | X |
|            | <i>Oncorhynchus mykiss irideus</i> (rainbow trout)                                |  | X  |    |    |    |    |    |    |    |    |    |    |    |   |
|            | <i>Oncorhynchus nerka</i> (kokanee salmon)  |  | X  |    |    | X  |    |    |    |    |    |    |    |    |   |
|            | <i>Oncorhynchus nerka kennerlyi</i> (kokanee)                                     |  |    |    |    | X  |    | X  | X  |    |    |    |    |    | X |
|            | <i>Oncorhynchus nerka nerka</i> (sockeye salmon)                                  |  |    |    |    |    |    |    | X  | X  |    | X  | X  |    |   |
|            | <i>Oncorhynchus tshawytscha</i> (chinook salmon)                                  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    | X  | X  | X  | X |
|            | <i>Prosopium cylindraceum</i> (round whitefish)                                   |  |    |    |    |    |    |    |    | X  |    |    |    |    |   |
|            | <i>Salmo salar</i> (Atlantic salmon)  | X  | X  | X  |    | X  | X  | X  | X  | X  | X  | X  |    |    | X |
|            | Salmonidae  | <i>Salmo salar salar</i> (Atlantic salmon) | X  |    |    |    |    |    |    |    |    |    |    |    |   |
|            | <i>Salmo salar sebago</i> (landlocked Atlantic salmon)                            | X  | X  | X  |    | X  | X  | X  | X  |    | X  | X  | X  | X  |   |
|            | <i>Salmo salar x trutta</i> (sambrown)  |  |    |    |    |    |    |    | X  |    |    |    |    |    |   |
|            | <i>Salmo trutta</i> (brown trout)   | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |   |
|            | <i>Salmo x Salvelinus trutta x fontinalis</i> (tiger trout)                       |  | X  |    | X  | X  |    | X  |    |    |    |    |    |    |   |
|            | <i>Salvelinus alpinus</i> (Arctic char)   |  |    |    |    |    | X  | X  | X  |    |    |    | X  |    |   |
|            | <i>Salvelinus aureolus oquassa</i> (blueback trout, Sunapee trout)                |  |    |    |    |    |    | X  |    |    | X  |    | X  | X  |   |
|            | <i>Salvelinus sp.</i> (trout)   |  |    |    |    |    |    |    |    |    | X  |    |    |    |   |
|            | <i>Salvelinus fontinalis</i> (brook trout)  | X  |    | X  | X  | X  | X  |    | X  |    |    |    |    |    |   |
|            | <i>Salvelinus fontinalis x namaycush</i> (splake)                                 |  |    | X  |    |    |    | X  |    |    |    |    | X  | X  |   |

Appendix A. List of fishes introduced in Region 5 outside their historic ranges. (Continued)

| Family | Species Name                                | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|--------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|
|        | <i>Salvelinus namaycush</i> (lake trout)    | X  | X  | X  | X  | X  | X  | X  | X  |    | X  |    | X  |    |
|        | <i>Thymallus arcticus</i> (Arctic grayling) | X  |    |    |    | X  |    | X  | X  |    |    | X  | X  | X  |

**Appendix B.** List of mollusks found in Region 5 outside of their historic ranges. An “X” denotes an introduction in a state.

| Group   | Species Name                                     | VA  | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |   |
|---|--|---|----|----|----|----|----|----|----|----|----|----|----|----|---|
| Bivalves  | <i>Corbicula fluminea</i> Asian clam             | X   | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |    |    |   |
|   | <i>Dreissena bugensis</i> quagga mussel          |   |    |    |    | X  |    | X  |    |    |    |    |    |    |   |
|   | <i>Dreissena polymorpha</i> zebra mussel         | X   | X  |    |    | X  |    | X  | X  |    |    | X  |    |    |   |
|   | <i>Pisidium amnicum</i> greater European peaclam |   |    |    |    | X  | X  | X  |    |    |    | X  |    |    |   |
|   | <i>Sphaerium corneum</i> European fingernailclam |   |    |    |    |    |    | X  |    |    |    | X  |    |    |   |
|   | <i>Alasmidonta marginata</i> elktoe              |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Utterbackia imbecillis</i> paper pondshell    |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Pyganodon grandis</i> giant floater           |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Fusconaia flava</i> Wabash pigtoe             |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Lampsilis cardium</i> plain pocketbook        |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Lasmigona subviridis</i> green floater        |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Leptodea fragilis</i> fragile papershell      |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Ligumia recta</i> black sandshell             |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Potamilus alatus</i> pink heelsplitter        |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Rangia cuneata</i> Atlantic rangia *          | X   |    | X  |    |    |    | X  |    |    |    |    |    |    |   |
|   | <i>Ostrea edulis</i> edible oyster *             |   |    |    |    |    |    |    |    |    | X  |    |    |    | X |
|   | <i>Teredo bartschi</i> Bartsch shipworm *        |   |    |    |    |    |    | X  |    | X  |    |    |    |    |   |
|   | <i>Teredo furcifera</i> a shipworm *             |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
|   | Gastropods                                       | <i>Bithynia tentaculata</i> mud bithynia  |    |    |    |    | X  | X  | X  |    |    |    | X  |    |   |
|   |  | <i>Gillia altilis</i> buffalo pebblesnail |    |    |    |    |    |    | X  |    |    |    |    |    |   |
| <i>Potamopyrgus antipodarum</i> New Zealand mudsnail  |  |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
| <i>Radix auricularia</i> big-ear radix                |  |   |    |    |    | X  | X  | X  |    |    | X  | X  |    |    |   |
| <i>Physella acuta</i> European physa                  |  | X   |    | X  |    |    | X  |    |    |    |    |    |    |    |   |
| <i>Elimia livescens</i> liver elimia                  |  |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
| <i>Elimia virginica</i> Piedmont elimia               |  |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
| <i>Pleurocera acuta</i> sharp hornsnailed             |  |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
| <i>Valvata piscinalis</i> European stream valvata     |  |   |    |    |    |    |    | X  |    |    |    |    |    |    |   |
| <i>Cipangopaludina chinensis</i> Chinese mysterysnail |  | X   |    | X  | X  | X  | X  | X  |    | X  | X  | X  | X  | X  |   |
| <i>Cipangopaludina japonica</i> Japanese mysterysnail |  |   |    |    |    |    |    |    |    |    | X  |    |    |    |   |
| <i>Viviparus georgianus</i> banded mysterysnail       |  |   |    |    |    |    |    | X  |    |    |    | X  |    |    |   |
| <i>Littorina littorea</i> common periwinkle *         |  | X   |    |    | X  |    | X  | X  | X  | X  | X  |    | X  | X  |   |
| <i>Rapana venosa</i> veined rapa whelk *              |  | X   |    |    |    |    |    |    |    |    |    |    |    |    |   |
| <i>Truncatella subcylindrica</i> a truncatella *      |  |   |    |    |    |    |    |    |    |    | X  |    |    |    |   |
| Nudibranchs   | <i>Tenellia adspersa</i> miniature aeolis *      | X   |    |    |    |    |    |    |    |    |    |    |    |    |   |
|   | <i>Tritonia plebeia</i> European nudibranch *    |   |    |    |    |    |    |    |    |    | X  |    |    | X  |   |

\* denotes marine species

**Appendix C.** List of crustaceans introduced in Region 5 outside their historic ranges. An “X” denotes an introduction in a state.

| Group       | Species Name                                       | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|-------------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Amphipods   | <i>Gammarus daiberi</i> an amphipod                |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|             | <i>Echinogammarus ischnus</i> an amphipod **       |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Cladocerans | <i>Eubosmina coregoni</i> a waterflea              |    |    |    |    | X  |    | X  |    |    |    | X  |    |    |
|             | <i>Bythotrephes cederstroemi</i> spiny waterflea   |    |    |    |    | X  |    | X  |    |    |    |    |    |    |
|             | <i>Cercopagis pengoi</i> fishhook waterflea        |    |    |    |    | X  |    | X  |    |    |    |    |    |    |
| Copepods    | <i>Skistodiaptomus pallidus</i> a calanoid copepod |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|             | <i>Eurytemora affinis</i> a calanoid copepod       | X  |    |    |    |    |    | X  |    |    |    |    |    |    |
| Crabs       | <i>Hemigrapsus sanguineus</i> Asian shore crab *   | X  |    | X  | X  |    | X  | X  | X  | X  | X  |    | X  | X  |
|             | <i>Carcinus maenas</i> green crab *                |    |    | X  | X  |    | X  | X  | X  | X  | X  |    | X  | X  |
| Crayfishes  | <i>Orconectes immunis</i> calico crayfish          |    |    |    |    | X  |    |    |    | X  | X  | X  | X  | X  |
|             | <i>Orconectes neglectus</i> ringed crayfish        |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|             | <i>Orconectes obscurus</i> a crayfish              |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|             | <i>Orconectes rusticus</i> rusty crayfish          |    | X  |    |    | X  | X  | X  | X  |    | X  | X  | X  | X  |
|             | <i>Orconectes virilis</i> virile crayfish          | X  | X  | X  |    | X  | X  | X  | X  | X  | X  | X  | X  | X  |
|             | <i>Procambarus acutus</i> white river crawfish     |    |    |    |    |    |    | X  | X  | X  | X  |    |    | X  |
|             | <i>Procambarus clarkii</i> red swamp crayfish      | X  |    | X  |    |    |    | X  |    |    |    |    |    |    |
| Isopods     | <i>Synidotea laevidorsalis</i> an isopod *         |    |    |    |    |    | X  |    |    |    |    |    |    |    |
| Shrimps     | <i>Mysis relicta</i> opossum shrimp                |    |    |    |    |    |    |    |    |    |    |    |    | X  |

\* Denotes marine species.

\*\* Denotes collected from Lake Erie and Lake Ontario, specific locations not available.



**Appendix D.** List of amphibians and reptiles introduced in Region 5 outside their historic ranges. An “X” denotes an introduction in a state.

| Group                 | Species Name   | VA | WV | MD | DE | PA | NJ | NY | CT | RI | MA | VT | NH | ME |
|-----------------------|--|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Amphibians-Frogs      | <i>Bufo americanus</i> (American toad)                             |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Bufo marinus</i> (giant toad)                                   |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Hyla cinerea</i> (green treefrog)                               |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Hyla gratiosa</i> (barking treefrog)                            |    |    |    |    |    | X  |    |    |    |    |    |    |    |
|                       | <i>Osteopilus septentrionalis</i> (Cuban treefrog)                 | X  |    | X  |    |    |    |    |    |    |    |    |    |    |
|                       | <i>Rana catesbeiana</i> (bullfrog)                                 |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Rana pipiens</i> (northern leopard frog)                        |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Rana sphenoccephala utricularia</i> (southern leopard frog)     |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Xenopus laevis</i> (African clawed frog)                        | X  |    |    |    |    |    |    |    |    | X  |    |    |    |
| Amphibians-Caudatans  | <i>Necturus maculosus</i> (mudpuppy)                               |    |    |    |    |    |    |    |    |    | X  |    |    | X  |
|                       | <i>Cynops pyrrhogaster</i> (Japanese fire-bellied salamander)      |    |    |    |    |    |    |    |    |    | X  |    |    |    |
| Reptiles-Crocodylians | <i>Alligator mississippiensis</i> (American alligator)             | X  | X  |    |    |    | X  | X  |    |    |    |    |    |    |
|                       | <i>Caiman crocodilus</i> (common caiman)                           | X  |    |    |    | X  |    | X  | X  |    | X  |    |    |    |
|                       | <i>Crocodylus acutus</i> (American crocodile)                      | X  |    |    |    |    |    |    |    |    |    |    |    |    |
| Reptiles-Snakes       | <i>Agkistrodon piscivorus</i> (cottonmouth)                        |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Natrix tessellata</i> (tessellated watersnake)                  | X  |    |    |    |    |    |    |    |    |    |    |    |    |
| Reptiles-Turtles      | <i>Apalone ferox</i> (Florida softshell)                           |    |    |    |    |    |    | X  |    |    |    |    |    |    |
|                       | <i>Apalone spinifera</i> (eastern spiny softshell)                 | X  |    |    |    |    | X  |    |    |    | X  |    |    |    |
|                       | <i>Chinemys reevesii</i> (Chinese three-keeled pond turtle)        |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Clemmys insculpta</i> (wood turtle)                             |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Clemmys muhlenbergii</i> (bog turtle)                           |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Cuora flavomarginata</i> (yellow-marginated box turtle)         |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Graptemys geographica</i> (common map turtle)                   |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Graptemys pseudogeographica</i> (false map turtle)              | X  |    |    |    |    |    |    |    |    |    |    |    |    |
|                       | <i>Kinosternon subrubrum hippocrepsis</i> (Mississippi mud turtle) |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Malaclemys terrapin</i> (diamondback terrapin)                  |    |    |    |    | X  |    |    |    |    | X  |    |    |    |
|                       | <i>Mauremys caspica</i> (Caspian turtle)                           |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Pseudemys concinna</i> (river cooter)                           |    |    | X  |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Pseudemys concinna or floridana</i> (cooter)                    |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Pseudemys floridana</i> (Florida cooter)                        |    |    | X  |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Rhinoclemmys pulcherrima</i> (painted wood turtle)              |    |    |    |    |    |    |    |    |    | X  |    |    |    |
|                       | <i>Trachemys scripta elegans</i> (red-eared slider)                | X  |    | X  |    | X  | X  | X  |    |    | X  |    |    | X  |
|                       | <i>Trachemys scripta scripta</i> (yellow-bellied slider)           | X  |    |    |    |    |    |    |    |    |    |    |    |    |