NEW YORK
FISH & AQUATIC INVERTEBRATE INVASIVENESS RANKING FORM

Scientific name:	Gambusia holbrooki
Common names:	Eastern Mosquitofish, Plague Minnow, Eastern gambusia
Native distribution:	Gambusia holbrooki is native to Atlantic and Gulf Slope drainages as far west as southern Alabama; G. affinis occurs throughout rest of the range (USGS 2013).
Date assessed:	2/3/2013
Assessors:	E. White
Reviewers:	
Date Approved:	Form version date: 3 January 2013

New York Invasiveness Rank: Very High (Relative Maximum Score >80.00)

Distribution and Invasiveness Rank (*Obtain from PRISM invasiveness ranking form***)**			
	Status of this species in each PRISM:	Current Distribution	PRISM Invasiveness Rank
1	Adirondack Park Invasive Program	Not Assessed	Not Assessed
2	Capital/Mohawk	Not Assessed	Not Assessed
3	Catskill Regional Invasive Species Partnership	Not Assessed	Not Assessed
4	Finger Lakes	Not Assessed	Not Assessed
5	Long Island Invasive Species Management Area	Not Assessed	Not Assessed
6	Lower Hudson	Not Assessed	Not Assessed
7	Saint Lawrence/Eastern Lake Ontario	Not Assessed	Not Assessed
8	Western New York	Not Assessed	Not Assessed

Invasiveness Ranking Summary (see details under appropriate sub-section)		Total (Total Answered*) Possible	Total
1	Ecological impact	30 (30)	24
2	Biological characteristic and dispersal ability	30 (28)	24
3	Ecological amplitude and distribution	30 (25)	25
4	Difficulty of control	10 (10)	7
	Outcome score	100 (93)[b]	76[a]
	Relative maximum score †		81.72
	New York Invasiveness Rank §	Very High (Relative Maximum Score >80.00)	

* For questions answered "unknown" do not include point value in "Total Answered Points Possible." If "Total Answered Points Possible" is less than 70.00 points, then the overall invasive rank should be listed as "Unknown."
†Calculated as 100(a/b) to two decimal places.
§Very High >80.00; High 70.00−80.00; Moderate 50.00−69.99; Low 40.00−49.99; Insignificant <40.00

A. DISTRIBUTION (KNOWN/POTENTIAL): Summarized from individual PRISM forms

A1.1. Has this species been documented in NY? (reliable source; voucher not required)	
☒	Yes – continue to A1.2
☐	No – continue to A2.1; Yes ☐ NA; Yes ☐ USA
A1.2. In which PRISMs is it known (see inset map)?	
☐	Adirondack Park Invasive Program
☐	Capital/Mohawk
☐	Catskill Regional Invasive Species Partnership
☐	Finger Lakes
☐	Long Island Invasive Species Management Area
☐	Lower Hudson

☐	Saint Lawrence/Eastern Lake Ontario
☐	Western New York

Documentation:
Sources of information:
USGS indicated they have been stocked in New York, but more specificity is not known and populations do not show up on the USGS map

A2.0. Is this species listed on the Federal Injurious Fish and Wildlife list?
☐ Yes – the species will automatically be listed as Prohibited, no further assessment required.
☒ No – continue to A2.1

A2.1. What is the likelihood that this species will occur and persist given the climate in the following PRISMs? (obtain from PRISM invasiveness ranking form and/ or Climatch score)

Not Assessed	Adirondack Park Invasive Program
Not Assessed	Capital/Mohawk
Not Assessed	Catskill Regional Invasive Species Partnership
Not Assessed	Finger Lakes
Not Assessed	Long Island Invasive Species Management Area
Not Assessed	Lower Hudson
Not Assessed	Saint Lawrence/Eastern Lake Ontario
Not Assessed	Western New York

Documentation:
Sources of information (e.g.: distribution models, literature, expert opinions):

If the species does not occur and is not likely to survive and reproduce within any of the PRISMs, then stop here as there is no need to assess the species.

A2.2. What is the current distribution of the species in each PRISM? (obtain rank *from PRISM invasiveness ranking forms*)

	Distribution
Adirondack Park Invasive Program	Not Assessed
Capital/Mohawk	Not Assessed
Catskill Regional Invasive Species Partnership	Not Assessed
Finger Lakes	Not Assessed
Long Island Invasive Species Management Area	Not Assessed
Lower Hudson	Not Assessed
Saint Lawrence/Eastern Lake Ontario	Not Assessed
Western New York	Not Assessed

Documentation:
Sources of information:

A2.3. Describe the potential or known suitable habitats within New York. Natural habitats include all habitats not under active human management. Managed habitats are indicated with an asterisk.

Aquatic Habitats	Wetland Habitats	Upland Habitats
☐ Marine	☒ Salt/brackish marshes	☐ Cultivated*
☒ Salt/ brackish waters	☐ Freshwater marshes	☐ Grasslands/old fields
☐ Freshwater tidal	☐ Peatlands	☐ Shrublands
☒ Rivers/streams	☐ Shrub swamps	☐ Forests/woodlands
☒ Natural lakes and ponds	☐ Forested wetlands/riparian	☐ Alpine
☐ Vernal pools	☐ Ditches*	☐ Roadsides*
☐ Reservoirs/ impoundments*	☐ Beaches/or coastal dunes	☐ Cultural*

Other potential or known suitable habitats within New York:
Tidal rivers

Documentation:

Sources of information:
They are also found in disturbed habitats (Froese and Pauly 2011, Invasive Species Specialist Group (ISSG) 2013)

B. INVASIVENESS RANKING

1. ECOLOGICAL IMPACT

1.1. Impact on Ecosystem Processes and System-wide Parameters (e.g., water cycle, energy cycle, nutrient and mineral dynamics, light availability, or geomorphological changes (erosion and sedimentation rates).

A.	No perceivable impact on ecosystem processes based on research studies, or the absence of impact information if a species is widespread (>10 occurrences in minimally managed areas), has been well-studied (>10 reports/publications), and has been present in the northeast for >100 years.	0
B.	Influences ecosystem processes to a minor degree, has a perceivable but mild influence	3
C.	Significant alteration of ecosystem processes	7
D.	Major, possibly irreversible, alteration or disruption of ecosystem processes	10
U.	Unknown	

Score 3

Documentation:
Identify ecosystem processes impacted (or if applicable, justify choosing answer A in the absence of impact information)
Some studies found the introduction of this species to cause algal blooms (Nico and Fuller 2013). Hurlbert and Mulla (1981) found Gambusia caused higher pH and oxygen levels, presumably due to their effect on phytoplankton populations.
Sources of information:
(Hurlbert and Mulla 1981, Nico and Fuller 2013)

1.2. Impact on Natural Habitat/ Community Composition

A.	No perceived impact; causes no apparent change in native populations	0
B.	Influences community composition (e.g., reduces the number of individuals of one or more native species in the community)	3
C.	Significantly alters community composition (e.g., produces a significant reduction in the population size of one or more native species in the community)	7
D.	Causes major alteration in community composition (e.g., results in the extirpation of one or several native species, reducing biodiversity or change the community composition towards species exotic to the natural community)	10
U.	Unknown	

Score 7

Documentation:
Identify type of impact or alteration:
Studies show this species to have an impact on the decline and even endangerment in some cases of native amphibians, fish, and beneficial invertebrates, while actually increasing in mosquito numbers as they sometimes feed on the larger invertebrate predators of mosquito larvae (Baber and Babbitt 2004, Gambusia Control Network 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013). In addition to tadpoles and small insects, they are known to feed on zooplankton, small insects and detritus (Nico and Fuller 2013).
Sources of information:
(Baber and Babbitt 2004, 2004, Gambusia Control Network 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013)

1.3. Impact on other species or species groups, including cumulative impact of this species on other organisms in the community it invades. (e.g., interferes with native

predator/ prey dynamics; injurious components/ spines; reduction in spawning; hybridizes with a native species; hosts a non-native disease which impacts a native species)

A.	Negligible perceived impact	0
B.	Minor impact (e.g. impacts 1 species, <20% population decline, limited host damage)	3
C.	Moderate impact (e.g. impacts 2-3 species and/ or 20-29% population decline of any 1 species, kills host in 2-5 years, ,)	7
D.	Severe impact on other species or species groups (e.g. impacts >3 species and/ or ≥30% population decline of any 1 species, kills host within 2 years, extirpation)	10
U.	Unknown	

Score 10

Documentation:
Identify type of impact or alteration:
Studies show this species to have an impact on the decline and even endangerment in some cases of native amphibians, fish, and beneficial invertebrates, while actually increasing in mosquito numbers as they sometimes feed on the larger invertebrate predators of mosquito larvae (Baber and Babbitt 2004, Gambusia Control Network 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013).
Sources of information:
(Baber and Babbitt 2004, 2004, Gambusia Control Network 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013)

Total Possible 30
Section One Total 20

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode and rate of reproduction (provisional thresholds, more investigation needed)

A.	No reproduction (e.g. sterile with no sexual or asexual reproduction).	0
B.	Limited reproduction (e.g., intrinsic rate of increase <10%, low fecundity, complete one life cycle)	1
C.	Moderate reproduction (e.g., intrinsic rate of increase between 10-30%, moderate fecundity, complete 2-3 life cycles)	2
D.	Abundant reproduction (e.g., intrinsic rate of increase >30%, parthenogenesis, large egg masses, complete > 3 life cycles)	4
U.	Unknown	

Score 2

Documentation:
Describe key reproductive characteristics:
G. holbrooki is a live-bearing fish and females have the ability to store sperm. Females brood 2-3 times per season, with about 50 young per brood.
Sources of information:
(Department of Primary Industries 2013, Invasive Species Specialist Group (ISSG) 2013)

2.2. Migratory behavior

A.	Always migratory in its native range	0
B.	Non-migratory or facultative migrant in its native range	2
U.	Unknown	

Score 2

Documentation:
Describe migratory behavior:

Sources of information:

2.3. Biological potential for colonization by long-distance dispersal/ movement (e.g., veligers, resting stage eggs, glochidia)

A.	No long-distance dispersal/ movement mechanisms	0
B.	Adaptations exist for long-distance dispersal, but studies report that most individuals (90%) establish territories within 5 miles of natal origin or within a distance twice the home range of the typical individual, and tend not to cross major barriers such as dams and watershed divides	1
C.	Adaptations exist for long-distance dispersal, movement and evidence that offspring often disperse greater than 5 miles of natal origin or greater than twice the home range of typical individual and will cross major barriers such as dams and watershed divides	2
U.	Unknown	

Score: U

Documentation:
Identify dispersal mechanisms:
Literature on dispersal generally focused on frequency of very local dispersal rather than maximum distance. Range extensions have occurred through natural dispersal far from sites where they were originally introduced, but that distance is not specified. Rehage and Sih (2004) found that G. affinis has greater dispersal tendency than G. holbrooki. There is also the potential for G. holbrooki to be dispersed to new areas by wading birds and flooding.
Sources of information:
(Rehage and Sih 2004, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013)

2.4. Practical potential to be spread by human activities, both directly and indirectly – possible vectors include: commercial bait sales, deliberate illegal stocking, aquaria releases, boat trailers, canals, ballast water exchange, live food trade, rehabilitation, pest control industry, aquaculture escapes, etc.)

A.	Does not occur	0
B.	Low (human dispersal to new areas occurs almost exclusively by direct means and is infrequent or inefficient)	1
C.	Moderate (human dispersal to new areas occurs by direct and indirect means to a moderate extent)	2
D.	High (opportunities for human dispersal to new areas by direct and indirect means are numerous, frequent, and successful)	4
U.	Unknown	

Score: 2

Documentation:
Identify dispersal mechanisms:
Possible vectors for this species include aquaria releases, use as bait fish, and introductions to new areas as a method for mosquito control.
Sources of information:
(Department of Primary Industries 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013)

2.5. Non-living chemical and physical characteristics that increase competitive advantage (e.g., tolerance to various extremes, pH, DO, temperature, desiccation, fill vacant niche, charismatic species)

A.	Possesses no characteristics that increase competitive advantage	0
B.	Possesses one characteristic that increases competitive advantage	4
C.	Possesses two or more characteristics that increase competitive advantage	8
U.	Unknown	

Score: 8

Documentation:

Evidence of competitive ability:
This species and can survive in water with some salinity, but are restricted to freshwater and brackish waters (Nordlie and Mirandi 2005, Alcaraz and Garcia-Berthou 2007). McKinsey and Chapman (1998) suggested this species to belong to a fish community generally characterized as having a low DO tolerance. Pyke (2005) recognized that mosquitofish can tolerate a wide range of environmental conditions and have the ability to adapt to changes. They are also tolerant of a wide range of temperatures and water quality (Department of Primary Industries 2013).
Sources of information:
(Nordlie and Mirandi 1996, McKinsey and Chapman 1998, Pyke 2005, Alcaraz and García-Berthou 2007, Department of Primary Industries 2013)

2.6. Biological characteristics that increase competitive advantage (e.g., high fecundity, generalist/ broad niche space, highly evolved defense mechanisms, behavioral adaptations, piscivorous, etc.)

A.	Possesses no characteristics that increase competitive advantage	0
B.	Possesses one characteristic that increases competitive advantage	4
C.	Possesses two or more characteristics that increase competitive advantage	8
U.	Unknown	

Score: 8

Documentation:
Evidence of competitive ability:
In addition to tadpoles and small insects, they are known to feed on zooplankton, small insects and detritus and are omnivorous (Department of Primary Industries 2013, Nico and Fuller 2013). They have also been described as extremely aggressive and known from attacking other fish (Invasive Species Specialist Group (ISSG) 2013, Department of Primary Industries 2013). Females have the ability to store sperm and the species are potential hosts of parasites, which have been transmitted to native fishes.
Sources of information:
(Baber and Babbitt 2004, Pyke 2005, Department of Primary Industries 2013, Gambusia Control Network 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013)

2.7. Other species in the family and/ or genus invasive in New York or elsewhere?

A.	No	0
B.	Yes	2
U.	Unknown	

Score: 2

Documentation:
Identify species:
Gambusia holbrooki. Gambusia geiseri and G. nobilis are also nonindigenous, and many other genera in the family Poeciliidae .
(Invasive Species Specialist Group (ISSG) 2013, U.S. Geological Survey 2013)

Total Possible: 28
Section Two Total: 24

3. ECOLOGICAL AMPLITUDE AND DISTRIBUTION

3.1. Current introduced distribution in the northern latitudes of USA and southern latitude of Canada (e.g., between 35 and 55 degrees).

A.	Not known from the northern US or southern Canada.	0
B.	Established as a non-native in 1 northern USA state and/or southern Canadian province.	1
C.	Established as a non-native in 2 or 3 northern USA states and/or southern Canadian provinces.	2

D. Established as a non-native in 4 or more northern USA states and/or southern Canadian provinces, and/or categorized as a problem species (e.g., "Invasive") in 1 northern state or southern Canadian province. 3

U. Unknown

Score 3

Documentation:
Identify states and provinces:
AK, AZ, CA, CO, CT, IL, IN, IA, KS, KY, MA, MI, MN, MS, MO, MT, NE, NJ, NM, NY, NC, OH, OR, PA, TN, TX, UT, WA, VA, WV, WI WY, Puerto Rico
Sources of information:
- See known introduced range at www.usda.gov, and update with information from states and Canadian provinces.

(U.S. Geological Survey 2013)

3.2. Current introduced distribution of the species in natural areas in the eight New York State PRISMs (Partnerships for Regional Invasive Species Management)

A. Established in none of the PRISMs 0
B. Established in 1 PRISM 1
C. Established in 2 or 3 PRISMs 3
D. Established in 4 or more PRISMs 5
U. Unknown

Score U

Documentation:
Describe distribution:
While listed as stocked in NY, the USGS map does not show established locations.
Sources of information:
(U.S. Geological Survey 2013)

3.3. Number of known, or potential (each individual possessed by a vendor or consumer), individual releases and/ or release events

A. None 0
B. Few releases (e.g., <10 annually). 2
C. Regular, small scale releases (e.g., 10-99 annually). 4
D. Multiple, large scale (e.g., ≥100 annually). 6
U. Unknown

Score 6

Documentation:
Describe known or potential releases:
While the number of aquaria releases, use as bait fish, or stocking for mosquito control is not stated, this is expected to be an on-going, widespread, and current occurrence.
Sources of information:
(Department of Primary Industries 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013)

3.4. Current introduced population density, or distance to known occurrence, in northern USA and/ or southern Canada.

A. No known populations established. 0
B. Low to moderate population density (e.g., ≤1/4 to < 1/2 native population density) with few other invasives present and/ or documented in 1 or more non-adjacent state/ province and/ or 1 unconnected waterbody. 1

C. High or irruptive population density (e.g., ≥1/2 native population density) with numerous other invasives present and/ or documented in 1 or more adjacent state/ province and/ or 1 connected waterbody. 2
U. Unknown

Score 2

Documentation:
Describe population density:
This species has been introduced in over 30 US states; many are adjacent to each other.
Sources of information:
(U.S. Geological Survey 2013)

3.5. Number of habitats the species may invade

A. Not known to invade any natural habitats given at A2.3. 0
B. Known to occur in 2 or 3 of the habitats given at A2.3, with at least 1 or 2 natural habitat(s). 2
C. Known to occur in 4 or more of the habitats given at A2.3, with at least 3 natural habitats. 3
U. Unknown.

Score 3

Documentation:
Identify type of habitats where it occurs and degree/type of impacts:
This species is known to invade brackish marshes and other waters, lakes/ponds and rivers/streams as well as unspecified disturbed habitats.
Sources of information:
(Froese and Pauly 2011, Invasive Species Specialist Group (ISSG) 2013, U.S. Geological Survey 2013)

3.6. Role of anthropogenic (human related) and natural disturbance in establishment (e.g. water level management, man-made structures, high vehicle traffic, major storm events, etc).

A. Requires anthropogenic disturbances to establish. 0
B. May occasionally establish in undisturbed areas but can readily establish in areas with natural or anthropogenic disturbances. 2
C. Can establish independent of any known natural or anthropogenic disturbances. 3
U. Unknown.

Score 3

Documentation:
Identify type of disturbance:

Sources of information:

3.7. Climate in native range (e.g., med. to high, ≥5, Climatch score; within 35 to 55 degree latitude; etc.)

A. Native range does not include climates similar to New York (e.g., <10%). 0
B. Native range possibly includes climates similar to portions of New York (e.g., 10-29%). 4
C. Native range includes climates similar to those in New York (e.g., ≥30%). 8
U. Unknown.

Score 8

Documentation:
Describe known climate similarities:
72% of NY stations >5 score on Climatch.
Sources of information:
(Austrailian Department of Agriculture, Fisheries, and Forestry (ADAFF) 2013)

Total Possible	25
Section Three Total	25

4. DIFFICULTY OF CONTROL

4.1. Re-establishment potential, nearby propagule source, known vectors of re-introduction (e.g. biological supplies, pets, aquaria, aquaculture facilities, connecting waters/ corridors, mechanized transportation, live wells, etc.)

A.	No known vectors/ propagule source for re-establishment following removal.	0
B.	Possible re-establishment from 1 vector/ propagule source following removal and/ or viable <24 hours.	1
C.	Likely to re-establish from 2-3 vectors/ propagule sources following removal and/ or viable 2-7 days.	2
D.	Strong potential for re-establishment from 4 or more vectors/ propagule sources following removal and/or viable >7 days.	3
U.	Unknown.	

Score: 3

Documentation:
Identify source/ vectors:
Aquaria releases, use as bait fish, mosquito control agency stocking, and connecting waters/corridors are potential re-introduction vectors. Flooding events and dispersal by wading birds are natural vectors.
Sources of information:
(Department of Primary Industries 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013)

4.2. Status of monitoring and/ or management protocols for species

A.	Standardized protocols appropriate to New York State are available.	0
B.	Scientific protocols are available from other countries, regions or states.	1
C.	No known protocols exist.	2
U.	Unknown	

Score: 1

Documentation:
Describe protocols:
Management protocols are available for Austrailia for this species and other areas have guidelines for non-native fish such as New Zealand and the UK and these may be applicable (ISSG 2013).
Sources of information:
(Invasive Species Specialist Group (ISSG) 2013)

4.3. Status of monitoring and/ or management resources (e.g. tools, manpower, travel, traps, lures, ID keys, taxonomic specialists, etc.)

A.	Established resources are available including commercial and/ or research tools	0
B.	Monitoring resources may be available (e.g. partnerships, NGOs, etc)	1
C.	No known monitoring resources are available	2
U.	Unknown	

Score: 0

Documentation:
Describe resources:
Management protocols are available for Austrailia for this species and other areas have guidelines for non-native fish such as New Zealand and the UK and these may be applicable (ISSG 2013). Control methods may include piscicides, pond draining, or predatory fish, but research is still needed on effective native predatory fish to use for control and if there may

be a species-specific parasite.
Sources of information:
(Gambusia Control Network 2013, Invasive Species Specialist Group (ISSG) 2013)

4.4. Level of effort required

A.	Management is not required. (e.g., species does not persist without repeated human mediated action.)	0
B.	Management is relatively easy and inexpensive; invasive species can be maintained at low abundance causing little or no ecological harm. (e.g., 10 or fewer person-hours of manual effort can eradicate a local infestation in 1 year.)	1
C.	Management requires a major short-term investment, and is logistically and politically challenging; eradication is difficult, but possible. (e.g., 100 or fewer person-hours/year of manual effort, or up to 10 person-hours/ year for 2-5 years to suppress a local infestation.)	2
D.	Management requires a major investment and is logistically and politically difficult; eradication may be impossible. (e.g., more than 100 person-hours/ year of manual effort, or more than 10 person hours/year for more than 5 years to suppress a local infestation.)	3
U.	Unknown	

Score 3

Documentation:
Identify types of control methods and time required:
Antimycin, a piscicide, has been used on pest fish populations in Scotland (Clearwater et al. 2008). Large, predatory fish have been suggested as a use for controlling Gambusia populations (Gambusia Control Network 2013), but further research on both methods is needed. Disease agents (pathogens or parasites) have been suggested as a means to control the species, if those specific to Gambusia hosts can be identified (Gambusia Control Network 2013). Rotenone is listed as a possible control for this species, but is an indiscriminate piscicide, so native fish may be affected and need to be removed (ISSG 2013). Returning habitats to ideal conditions for native fish (issues such as water quality, flow, fish passage, and snags) will improve native fishes ability to outcompete pest species (Department of Primary Industries 2013) and pond draining for confined waterbodies can minimize impacts to native species (ISSG 2013). Controlling further spread is advised, since they are difficult to remove once established (Nico and Fuller 2013).
Sources of information:
(Clearwater et al. 2008, Department of Primary Industries 2013, Gambusia Control Network 2013, Invasive Species Specialist Group (ISSG) 2013, Nico and Fuller 2013)

Total Possible	10
Section Four Total	7
Total for 4 sections Possible	93
Total for 4 sections	76

C. STATUS OF GENETIC VARIANTS AND HYBRIDS:

At the present time there is no protocol or criteria for assessing the invasiveness of genetic variants independent of the species to which they belong. Such a protocol is needed, and individuals with the appropriate expertise should address this issue in the future. Such a protocol will likely require data on cultivar fertility and identification in both experimental and natural settings.

Genetic variants of the species known to exist:

Hybrids (crosses between different parent species) should be assessed individually and separately from the parent species wherever taxonomically possible, since their invasiveness may differ from that of the

parent species. An exception should be made if the taxonomy of the species and hybrids are uncertain, and species and hybrids can not be clearly distinguished in the field. In such cases it is not feasible to distinguish species and hybrids, and they can only be assessed as a single unit.

Hybrids of uncertain origin known to exist: Gambusia affinis x. G. holbrooki

References for species assessment:

Alcaraz, C., and E. García-Berthou. 2007. Life history variation of invasive mosquitofish (< i> Gambusia holbrooki) along a salinity gradient. Biological Conservation 139:83−92.

Austrailian Department of Agriculture, Fisheries, and Forestry (ADAFF). 2013. Climatch Mapping Tool [Online]. Available: http://adl.brs.gov.au:8080/Climatch/. [Accessed: 23-Jan-2013].

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Clearwater, S. J., C. W. Hickey, and M. L. Martin. 2008. Overview of potential piscicides and molluscicides for controlling aquatic pest species in New Zealand. Science & Technical Publishing, Department of Conservation.

Department of Primary Industries. 2013. Eastern gambusia (Gambusia holbrooki). NSW Government, Austrailia [Online]. Available: http://www.dpi.nsw.gov.au/fisheries/pests-diseases/freshwater-pests/species/gambusia.

Froese, R., and D. Pauly. 2011, February 1. Fishbase [Online]. Available: www.fishbase.org.

Gambusia Control Network. 2013. Gambusia control homepage [Online]. Available: http://www.gambusia.net/. [Accessed: 31-Jan-2013].

Hurlbert, S. H., and M. S. Mulla. 1981. Impacts of mosquitofish (Gambusia affinis) predation on plankton communities. Hydrobiologia 83:125−151.

Invasive Species Specialist Group (ISSG). 2013. Global Invasive Species Database. [Online]. Available: http://www.issg.org/database/species/ecology.asp?si=217&fr=1&sts=sss&lang=EN. [Accessed: 11-Jan-2013].

McKinsey, D. M., and L. J. Chapman. 1998. Dissolved oxygen and fish distribution in a Florida spring. Environmental biology of fishes 53:211−223.

Nico, L., and P. Fuller. 2013. Gambusia holbrooki. USGS Nonindigenous Aquatic Species Database, Gainesville, FL [Online]. Available: http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=849. [Accessed: 03-Feb-2013].

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Nordlie, F., and A. Mirandi. 1996. Salinity relationships in a freshwater population of eastern mosquitofish. Journal of Fish Biology 49:1226−1232.

Pyke, G. H. 2005. A review of the biology of Gambusia affinis and G. holbrooki. Reviews in Fish Biology and Fisheries 15:339−365.

Rehage, J. S., and A. Sih. 2004. Dispersal behavior, boldness, and the link to invasiveness: a comparison of four Gambusia species. Biological Invasions 6:379−391.

U.S. Geological Survey. 2013. Nonindigenous Aquatic Species Database. Gainesville, Florida. [Online]. Available: http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=214. [Accessed: 03-Jan-2013].

Citation: The New York Fish & Aquatic Invertebrate Invasiveness Ranking Form is an adaptation of the New York Plant Invasiveness Ranking Form. The original plant form may be cited as: Jordan, M.J., G. Moore and T.W.

Weldy. 2008. Invasiveness ranking system for non-native plants of New York. Unpublished. The Nature Conservancy, Cold Spring Harbor, NY; Brooklyn Botanic Garden, Brooklyn, NY; The Nature Conservancy, Albany, NY.

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