NEW YORK
FISH & AQUATIC INVERTEBRATE INVASIVENESS RANKING FORM

Scientific name:	Carcinus maenas
Common names:	Green Crab, European Green Crab, Shore Crab (British Isles),
Native distribution:	Belgium, Denmark, France, Germany, Iceland, Ireland, Mauritania, Morocco, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom (UK), Western Sahara. Note: contradictory information stating a Mediteranean form (Carcinus aestuarii) south of the Strait of Gibralter, would exclude Western Sahara and Marocco from native range (Rogers, 2001).
Date assessed:	12/19/2012
Assessors:	E. Schwartzberg
Reviewers:	
Date Approved:	Form version date: 8 June 2009

New York Invasiveness Rank:

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)	23
2	Biological characteristic and dispersal ability	30 (30)	17
3	Ecological amplitude and distribution	30 (30)	19
4	Difficulty of control	10 (10)	4
	Outcome score	100 (100)[b]	63[a]
	Relative maximum score †		63.00
	New York Invasiveness Rank §	Moderate (Relative Maximum Score 50.00-69.99)	

* 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:
iMapInvasives, 2012.

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)

Zero likelihood	Adirondack Park Invasive Program
Zero likelihood	Capital/Mohawk
Zero likelihood	Catskill Regional Invasive Species Partnership
Zero likelihood	Finger Lakes
Very Likely	Long Island Invasive Species Management Area
Very Likely	Lower Hudson
Zero likelihood	Saint Lawrence/Eastern Lake Ontario
Zero likelihood	Western New York

Documentation:
Sources of information (e.g.: distribution models, literature, expert opinions):
ADAFF, 2012.

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:
Checking to see if LIISMA has a ranking.

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:
Can tolerate salinity as low as 4%

Documentation:
Sources of information:
Klassen and Locke, 2007.

B. INVASIVENESS RANKING

1. ECOLOGICAL IMPACT

1.1. Impact on Natural Ecosystem Processes (e.g., water cycle, energy cycle, mineral and cycle)

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)
Minor cascading top-down effects of predators on algae may play a role on nutirnt cycling, but Green Crabs not manipulated in this study. Cause bottom pitting and burrows up to 15 cm, but not implicated in any geomorphological changes.
Sources of information:
Worm et al., 2000; Cohen et al., 1995.

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 10

Documentation:
Identify type of impact or alteration:
Thought to be cause of widespread decline of soft-shell clams, and to influence mussels, sea urchins, dog whelks, and periwinkles. Predator on many species. Cause bottom pitting and burrows up to 15 cm.
Sources of information:
Cohen et al., 1995; Ropes, 1968.

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:
Predation on gastropods and bivalves, including soft-shell clams, mussels, and barnacles. Competes with and preys upon oysters and dongenous crabs and has been shown to negatively impact juvenile winter flounder.

Sources of information:
Klassen and Locke, 2007; Lafferty and Kuris, 1996; Ropes, 1968.

Total Possible 23
Section One Total 30

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 1

Documentation:
Describe key reproductive characteristics:
Lifespan of 3-7 years.
Sources of information:
Klassen and Locke, 2007; ISSG, 2012.

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:
Non-migratory, Cannot survive in deep water.
Sources of information:
Klassen and Locke, 2007.

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 0

Documentation:
Identify dispersal mechanisms:
Cannot cross large bodies of water on own.
Sources of information:
Roman and Palumbi, 2004.

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 4

Documentation:
Identify dispersal mechanisms:
Can be carried by several means, including fisheries products, balasts, wooden objects, and fouled seawater pipes.
Sources of information:
Cohen et al., 1995.

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 4

Documentation:
Evidence of competitive ability:
Can osmoregulate to tolerate salinity as low as 4%.
Sources of information:
Cieluch et al., 2004; Cohen et al., 1995.

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 4

Documentation:
Evidence of competitive ability:
Generalist and feeds on 104 Families of prey. No other biological or competitive advantages documented.
Sources of information:
Cohen et al., 1995.

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:
C. aestuarii

Total Possible 17
Section Two Total 30

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:
United States: Maine, New hampshire, Massachusetts, Rhode Island, Connecticut, New Jersey, New York, Maryland, Canada: British Columbia, Newfoundland and Labrador, New Brunswick, Nova Scocia, Prince Edward Island.
Sources of information:
- See known introduced range at www.usda.gov, and update with information from states and Canadian provinces.

Klassen and Locke, 2007.

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 1

Documentation:
Describe distribution:
Costal areas of Long Islands.

Sources of information:
iMapInvasives, 2012.

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 0

Documentation:
Describe known or potential releases:
None
Sources of information:

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:
Densities of upwards of 20 crabs per square meter in Europe.
Sources of information:
Cohen et al., 1995.

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 2

Documentation:
Identify type of habitats where it occurs and degree/type of impacts:
Has invaded both pacific and Atlantic waters in North America.
Sources of information:
Cohen et al., 1995.

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:
No documentation of being established via anthropogenic 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:
Wide range in Europe, established in San Francisco Bay area.
Sources of information:
ISSG, 2012.

Total Possible 19
Section Three Total 30

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 1

Documentation:
Identify source/ vectors:
Mechanized transport does occur.
Sources of information:
Cohen et al., 1995; Klassen and Locke, 2007.

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:
Protocol developed, but not specific for New York State.
Sources of information:
Groshilz and Ruiz, 2002; WDFWC, 2012.

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 plan has been developed. Biological control options documented.
Sources of information:
DeRivera et al., 2005; Groshilz and Ruiz, 2002; McEnnulty et al., 2006.

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: 2

Documentation:
Identify types of control methods and time required:
Possible options for control are manual removal, commercial harvesting, trapping, and parasitic castrators.
Sources of information:
DeRivera et al., 2005; Groshilz and Ruiz, 2002; WDFWC, 2012.

Total Possible	10
Section Four Total	4
Total for 4 sections Possible	100
Total for 4 sections	63

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:

Roman and Palumbi, 2004.

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: European Green Crab described by (Rogers, 2001) as a hybrid between an Atlantic form (Carcinus maenas) and a Mediteranean form (Carcinus aestuarii).

References for species assessment:

Austrailian Department of Agriculture, Fisheries, and Forestry (ADAFF). 2012. Climatch Mapping Tool. <http://adl.brs.gov.au:8080/Climatch/climatch.jsp>; [Accessed on December 17, 2012].

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Cohen, A.N., J.T. Carlton, and M.C. Fountain. 1995. Introduction, dispersal and potential impacts of the green crab Carcinus maenas in San Francisco Bay, California. Marine Biology 122(2): 225−237.

DeRivera, C.E., G.M. Ruiz, A.H. Hines and P. Jivoff. 2005. Biotic resistance to invasion: Native predator limits abundance and distribution of an introduced crab. Ecology 86(12): 3367−3376.

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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.

Acknowledgments: The New York Fish and Aquatic Invertebrate Invasiveness Ranking Form incorporates components and approaches used in several other systems, cited in the references below. Valuable contributions by members of the Invasive Species Council and Invasive Species Advisory Committee were incorporated in revisions of this form. Members of the Office of Invasive Species Coordination's Four-tier Team, who coordinated the effort, included representatives of the New York State Department of Environmental Conservation* (Division of Fish, Wildlife and Marine Resources, Division of Lands and Forests, Division of Water); The Nature Conservancy; New York Natural Heritage Program; New York Sea Grant*; Lake Champlain Sea Grant*; New York State Department of Agriculture and Markets (Division of Plant Industry and Division of Animal Industry); Cornell University (Department of Natural Resources and Department of Entomology); New York State Nursery and Landscape Association; New York Farm Bureau; Brooklyn Botanic Garden; Pet Industry Joint Advisory Council*; Trout Unlimited*; United States Department of Agriculture Animal and Plant Health Inspection Service (Plant Protection and Quarantine and Wildlife Services); New York State Department of Transportation; State University of New York at Albany and Plattsburgh*; and Cary Institute of Ecosystem Studies. Those organizations listed with an asterisk comprised the Fish and Aquatic Invertebrate Working Group.

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