RETURN TO SER AR INDEX

NEW BEDFORD MARINE COMMERCE TERMINAL

INVASIVE SPECIES MONITORING PLAN FACILITY, BULKHEAD AND PILINGS

October 2012

STATE ENHANCED REMEDY IN NEW BEDFORD, SOUTH TERMINAL

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

SDMS Doc ID 523846

INVASIVE SPECIES MONITORING PLAN
FACILITY, BULKHEAD AND PILINGS

TABLE OF CONTENTS

1.0 INTRODUCTION 3

2.0 GOALS, OBJECTIVES, AND SCHEDULING..... 4

3.0 METHODS OF INSPECTION 4

4.0 METHODS OF CONTROL.....5

5.0 REPORTING 7

LIST OF APPENDICES

Appendix A: *Phragmites australis* ID Sheet

Appendix B: *The Evaluation of Non-Native Plant Species for Invasiveness in Massachusetts-List*

Appendix C: *Aquatic Invasive Species Cards*

NEW BEDFORD MARINE COMMERCE TERMINAL

INVASIVE SPECIES MONITORING PLAN
FACILITY, BULKHEAD AND PILINGS

1.0 ***INTRODUCTION***

The New Bedford Marine Commerce Terminal is the site selected by the Commonwealth of Massachusetts to be one of the primary staging points for future offshore renewable energy projects in New England. Construction of the New Bedford Marine Commerce Terminal involves the extension of an existing marine terminal (South Terminal in New Bedford). The site is located in New Bedford Harbor.

The proposed New Bedford Marine Commerce Terminal is a filled structure adjacent to the shoreline, bounded by sheet piling, capped by crushed stone. It is currently anticipated that approximately 130,000 cubic yards of clean sand from navigational dredging would be incorporated into the construction of the facility. Approximately 1,200 linear feet of berthing space will be available at the facility.

As part of the construction of the new marine commerce terminal this Invasive Species Monitoring Plan is presented to monitor and control for invasive flora and fauna that could be introduced via future cargo operations, or could colonize the newly created facility. Future cargo operations have the capability of transporting invasive species via multiple methods, including transportation in the ballast tank water of international ocean vessels, incidental incorporation of plants or seeds into cargo, or via intentional transport of species by humans. The new cargo facility, once constructed, will also need to be monitored to prevent the colonization of invasive species. The areas of interest for this monitoring plan are the coastline of the new facility, the upland areas (including stormwater drainage structures that could harbor invasive species), and the bulkhead and pilings around the berthing zone of the Marine Terminal. Invasive species would be identified during annual inspection of the facility, bulkheads and pilings by trained inspectors, including divers (as applicable for marine portions of the inspections). If located, invasive species would either be

handled via the methodologies outlined within this document, or separate mitigation measures would be devised.

2.0 *GOALS, OBJECTIVES, AND SCHEDULING*

The goal of this plan is to verify the presence of invasive organisms within the upland areas, coastline areas, and the vessel berthing zone associated with the New Bedford Marine Commerce Terminal. These invasive plant species, particularly brackish invasive species such as Phragmites australis (see **Appendix A**) and other known invasive species (see **Appendix B**: Invasive Plant List) dominant around the periphery of the drainage swale and have a high potential to spread into the restored areas undermining the ecological integrity of restoration efforts. Organisms located within the upland areas of the facility will be inspected by a wetland scientist and removed if found to be invasive in origin.

Organisms found on pilings and bulkheads will be analyzed by dive teams using underwater video and photography with the objective of documenting any invasive organisms. Although organisms found on pilings and bulkheads, if invasive, may be species that have been previously located within the United States or Massachusetts, the invasive species may also represent a new transplant, that may have not previously been noted, and that should be addressed immediately. As previous strategies for invasive removal may not have been developed, developing a comprehensive mitigation plan specifically geared towards eliminating the threat to the local environment from the invasive species will be a priority. Annual surveys will be conducted for the presence of non–native species.

The removal of invasive species beyond the property boundaries of the restoration area is deemed out of scope for this invasive plant management plan due to adjacent land not being within the control of the Commonwealth. Where possible, invasive removal will take place on the periphery of the restoration area; however, the Commonwealth can not commit to removing invasive species on property not within its control.

3.0 **METHODS OF INSPECTION**

A general investigation for the presence of invasive species will be conducted on the upland areas of the facility and also along the coastline areas of the facility from land. Typically, plant growth should be minimal at the facility in general; therefore, only areas of noted post-construction plant growth will be inspected to assess for the presence of invasive species.

Inspection of the bulkhead and pilings will involve a three person dive inspection team, a boat, and photographic equipment, onsite for several day duration (due to the cloudy conditions found commonly in New Bedford). Approximately 1/3 of the pilings will be inspected at each event. The section of pilings to be inspected will be rotated between events, such that 100% of the pilings will have been inspected every three inspection events. Equipment needed for the inspection will include a diver, a tender, and a dive supervisor on location during the inspection operation. All three team members will be in constant communication via underwater communication devices. During the winter months, divers will be equipped with appropriate environmental gear to cope with adverse weather conditions common in New England. All team members will meet EM 385-1-1/OSHA/Coast Guard/ADCI consensus standards requirements for safe diving practices.

Some existing aquatic invasive species present in New England (as listed on the Commonwealth's Office of Coastal Zone Management, Aquatic Invasive Species Program website) are included within **Appendix C**. In the event that an invasive species is identified during the annual inspection (and the species has not heretofore been identified in New England), the Commonwealth will inform the Commonwealth's Office of Coastal Zone Management, Aquatic Invasive Species Program.

Occurrences of those species will be noted and the species will be removed via methodology discussed in **Section 4.0**.

4.0 METHODS OF CONTROL

4.1 UPLAND INVASIVE SPECIES

Control operations will be based upon invasive species present and suited to the actual site conditions. Manual operation of hand removal, or the use of mechanical enhancement will be employed to cut and remove target species, if necessary. This method is typically implemented in

areas where the use of chemicals is prohibited or to reduce the heights of dense stands of vegetation to a more efficient and effective treatment height where chemical use can more be appropriately and adequately applied to targeted vegetation.

The use of federally-approved, state, and registered herbicides following guidelines set down by MassDEP may be used to eliminate targeted vegetation. This method is used to eliminate the targeted plant species through the destruction of the plant's ability to sustain necessary metabolic functions to survive and grow. Herbicide applications will be performed where allowed, to individual shoots. Contractors licensed and certified by the Massachusetts Pesticide Bureau within the Department of Food and Agriculture (MDFA) will apply herbicide applications. Only those herbicides approved by the MDFA and the MassDEP for application in sensitive areas will be used. Sensitive areas include areas within 400 feet of a public ground water supply well, within 100 feet of a public surface water supply, within 50 feet of private water supplies, within 10 feet of surface waters and wetlands, and within agricultural and habitated areas. All other federal, state, and local regulations will also be followed including the Wetlands Protection Act.

The state-listed invasive species Phragmites australis (see **Appendix A**) and other known invasive species (see **Appendix B**: Invasive Plant List) are the primary target vegetation species of concern observed on the Marine Commerce Terminal property. Phragmites australis invades wetland/marsh areas, crowding out native vegetation, forming monoculture species stands. Phragmites australis out compete native vegetation spreading rapidly in brackish soils at full maturity due to an extensive fibrous root system and runners. Phragmites australis is known to re-sprout vigorously when cut. A small amount of herbicide can be applied directly to the shoots with a hand-held spray bottle, or hand-operated sprayer. Prior to cutting the Phragmites, if efforts are not made to kill the plants using a herbicide applied to a cut, then preparations should be made anticipating substantial root sucker growth within 60 days of the first growing season after the cut.

4.2 AQUATIC INVASIVE SPECIES

Control operations will be based upon the specified invasive species present and suited to the actual site conditions. In the event that an invasive species is identified during the annual inspection (and the species has not heretofore been identified in New England), the Commonwealth will work with the Commonwealth's Office of Coastal Zone Management, Aquatic Invasive Species Program

to assess the ecological risk posed by the new invasive species. With the Aquatic Invasive Species Program, the Commonwealth will develop and implement an invasive species control plan for the new species. Methods for control would likely include mechanical removal; however, additional potential alternatives could be considered, if likely to succeed and if in compliance with Federal, State and Local law and regulations. Assuming the new species poses an ecological risk and the control plan is adequate, said plan would be implemented.

5.0 **REPORTING**

Following each annual monitoring event, a report outlining field results, actions, recommendations, and conclusions will be generated to document the overall success of the restoration efforts at the site. Monitoring and control of invasive species will continue based on the success of initial restoration actions, if attempts prove unsuccessful the corrective measures will be made to the management plan and successive monitoring will follow.

For aquatic inspections, the reporting will include video and photographic footage of each area of interest with supporting documentation and/or voice overs outlining the location of the footage and possible biological organisms of interest.

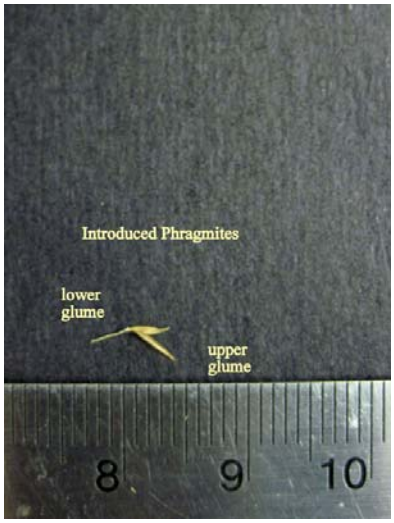
Any monitoring schedule will be increased or adjusted to assess the adequacy of any control plan implemented to address the presence of invasive species.

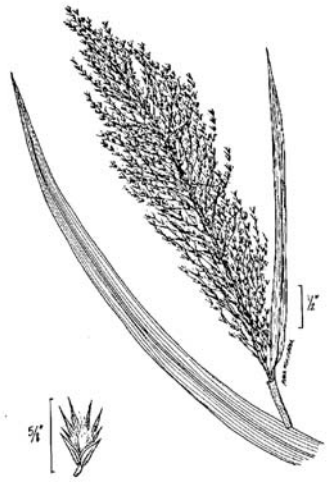
APPENDIX A

***PHRAGMITES AUSTRALIS* ID SHEET**

Phragmites australis

Common reed is a tall, perennial grass that can grow to heights of 15 ft. (4.6 m) or more. Broad, pointed leaves arise from thick, vertical stalks. Leaves are 6-23.6 in. (15-60 cm) long, 0.4-2.4 in. (1-6 cm) wide, flat and glabrous. The flower heads are dense, fluffy, gray or purple in color and 5.9-15.7 in. (15-40 cm) long. Flowering occurs from July to October. Common reed is usually found in dense thickets growing in or near shallow water. These thickets displace native wetlands plants, alter hydrology and block sunlight to the aquatic community. Exotic common reed is native to Eurasia and Africa. Native Phragmites do occur in the United States and they are sometimes very difficult to distinguish from the exotics. (Massachusetts - Noxious Weed Law).





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APPENDIX B

The Evaluation of Non-Native Plant Species for Invasiveness in Massachusetts-List

The Evaluation of Non-Native Plant Species for Invasiveness in Massachusetts

(with annotated list)

Massachusetts Invasive Plant Advisory Group

Partnering Organizations

American Nursery and Landscape Association
Arnold Arboretum of Harvard University
Brewster Conservation Administration
NSTAR Electric
Ecological Landscaping Association
Massachusetts Audubon Society
MA Department of Agricultural Resources
Div. of Regulatory and Consumer Services
MA Department of Conservation & Recreation
Div. of Water Supply Protection
MA Division of Fisheries and Wildlife
Natural Heritage and Endangered Species Program
Massachusetts Natural Heritage & Endangered Species Advisory Committee
Massachusetts Nursery and Landscape Association
New England Nursery Association
New England Wild Flower Society
Northeastern Weed Science Society
Silvio O. Conte National Fish & Wildlife Refuge
The Nature Conservancy
University of Massachusetts Extension Service

Research funded by:

Massachusetts Nursery and Landscape Association

Horticultural Research Institute

Massachusetts Executive Office of Environmental Affairs

Massachusetts Department of Fish and Game, Div. of Fisheries & Wildlife

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Research conducted by:

Leslie J. Mehrhoff, Ph.D.
Invasive Plant Atlas of New England
University of Connecticut
George Safford Torrey Herbarium

Coordination provided by:

Silvio O. Conte National Fish & Wildlife Refuge with funding from the National Fish & Wildlife Foundation, U.S. Department of Agriculture and U.S. Fish & Wildlife Service

Update: April 1, 2005

For most recent update, visit www.mnla.com or www.newfs.org

Table of Contents

Purpose and organizing principles of the Massachusetts Invasive Plant Advisory Group ….2

MIPAG Member Representatives and Alternates ……. 3

Criteria for Evaluating Non-Native Plant Species for Invasiveness ……5

Definitions …….. 7

Annotated Species List for Massachusetts

Invasive plants …….....… 8

Likely Invasive plants ……...……. 11

Potentially Invasive plants ……..…….. 14

Evaluated plants not meeting criteria …….. 15

Species Reviewed Listed Alphabetically (Phases I and II): …… 17

Species Reviewed Listed by Category (Phases I and II): ...……...…… 19

Purpose and organizing principles of the Massachusetts Invasive Plant Advisory Group (MIPAG)

Formerly known as the Massachusetts Invasive Plant Group, the Massachusetts Invasive Plant Advisory Group (MIPAG) was formed in 1999 by the Ad Hoc Native Plant Advisory Committee to begin addressing the invasive plant issue in Massachusetts. The Executive Office of Environmental Affairs recognized it as part of the Massachusetts Council on Invasive Species. This Council was intended to serve as a coordinating mechanism for the various invasive species management activities undertaken by state agencies, federal agencies, and private organizations.

The Massachusetts Invasive Plant Advisory Group is a voluntary collaboration between public and private organizations concerned about the problem of invasive plants in Massachusetts. Eighteen entities are represented including state and federal governmental agencies in fish and wildlife, agriculture, and natural resources; the horticulture industry; academic science institutions; land management and nonprofit conservation organizations. Its members affirm their commitment to working within their individual organizations to substantially address the impact of species determined by scientific criteria to be Invasive, Likely Invasive, or Potentially Invasive in the Commonwealth of Massachusetts.

The first order of business of the MIPAG has been to determine which plant species are invasive in Massachusetts. With the assistance of Dr. Leslie Mehrhoff of the University of Connecticut, the group adopted a definition and set of biologically based criteria upon which to objectively evaluate plants suspected to be invasive in the state. The group contracted with Dr. Mehrhoff to gather existing data about these species and help the group assess which are currently invasive and which have the potential to become problematic in Massachusetts.

Findings from plant evaluations of 85 species (conducted in two phases) include an annotated list of Invasive, Likely Invasive, and Potentially Invasive species. The annotated list, as well as information about the evaluation process, definitions and criteria, and group member composition, are contained within this document and can also be found online at *www.mnla.com* and *www.newfs.org*. Also included on the annotated list are species that were considered but for which sufficient information or evidence is currently lacking for an adequate evaluation.

The MIPAG makes all its important decisions at its scheduled meetings by voting. In certain instances, representatives of the same member organization voluntarily share a vote and alternate their attendance. Quorum for any meeting must be 2/3 of the voting membership (currently 12), and any decision must pass by a 2/3 majority of members present. The only exception is when a vote is taken at a meeting to determine the status of a species under assessment by MIPAG criteria for invasiveness in Massachusetts. In this case, all voting members have the right to vote, with those absent from the meeting having not more than two additional weeks after the initial vote to submit their votes to the MIPAG recorder. Only one vote per organization is allowed. Agreed by quorum on 6/12/2002, "a 2/3 majority will be calculated only using affirmative and negative votes cast. Abstentions will not be included."

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Massachusetts Criteria for Evaluating Non-Native Plant Species for Invasiveness

(THESE CRITERIA HAVE NO OFFICIAL STATUS FOR MASSACHUSETTS)

The Massachusetts Invasive Plant Advisory Group (MIPAG) defines invasive plants as *"non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems.* As defined here, "species" includes all synonyms, subspecies, varieties, forms, and cultivars of that species unless proven otherwise by a process of scientific evaluation.

The following criteria are being used to objectively evaluate and categorize plant species suspected of being, or with the potential to become, invasive in Massachusetts. They were developed by the George Safford Torrey Herbarium at the University of Connecticut and a subcommittee of the Massachusetts Invasive Plant Group representing science, nursery, and conservation professionals.

The criteria enable the separation of plants into the following categories:

- *Invasive Plants in Massachusetts*
- *Likely Invasive Plants in Massachusetts*
- *Potentially Invasive Plants in Massachusetts (species not currently known to be naturalized in Massachusetts, but that can be expected to become invasive within minimally managed habitats within the Commonwealth)*

For a species to be included on the list of species determined to be **Invasive, Likely Invasive or Potentially Invasive** in Massachusetts, it must be substantiated by scientific investigation (including herbarium specimens, peer-reviewed papers, published records and other data available for public review) to meet specific criteria**.** The process of reviewing individual plant species for their invasiveness in Massachusetts is ongoing and may result in a change in status pending new data and further review.

Tabular summary of criteria to be met

	Criteria that must be met
Base criteria	1-4
Invasive	1-9
Likely Invasive	1-5, at least one of 6-9, at least one of 10-12
Potentially Invasive	1-4, (not 5), 13-15

For a species to be designated as "INVASIVE", "LIKELY INVASIVE" or "POTENTIALLY INVASIVE" it must to meet certain base criteria (#1-4 below). The species must:

1. Be nonindigenous to Massachusetts.
2. Have the biologic potential for rapid and widespread dispersion and establishment in minimally managed habitats.
3. Have the biologic potential for dispersing over spatial gaps away from site of introduction.
4. Have the biologic potential for existing in high numbers away from intensively managed artificial habitats.

If a species does not meet all four of the previous criteria, stop here. The species cannot be listed at this time. If a species meets all four, go on to #5.

5. Be naturalized in Massachusetts (persists without cultivation in Massachusetts)

If a species meets Criteria 1-4 and Criterion 5, it may be considered "INVASIVE " or "LIKELY INVASIVE" in Massachusetts. Go to Criteria 6-9.

If it does <u>not</u> meet Criterion 5, it may be considered "POTENTIALLY INVASIVE" if it meets Criteria 13-15.

6. Be widespread in Massachusetts**,** or at least common in a region or habitat type(s) in the state.
7. Have many occurrences of numerous individuals in Massachusetts that have high numbers of individuals forming dense stands in minimally managed habitats
8. Be able to out-compete other species in the same natural plant community.
9. Have the potential for rapid growth, high seed or propagule production and dissemination, and establishment in natural plant communities.

If a species meet the initial five Criteria and Criteria 6-9 it may be considered a "INVASIVE" species in Massachusetts.

If a species meets the initial five Criteria, but does not meet all of Criteria 6-9 at this time, it may be considered a "LIKELY INVASIVE" species in Massachusetts if in addition it meets at least one of the following three Criteria (#10-12).

10. Have at least one occurrence in Massachusetts that has high numbers of individuals forming dense stands in minimally managed habitats
11. Have the potential, based on its biology and its colonization history in the northeast or elsewhere, to become invasive in Massachusetts.
12. Be acknowledged to be invasive in nearby states but its status in Massachusetts is unknown or unclear. This may result from lack of field experience with the species or from difficulty in species determination or taxonomy.

If the species meets the basic criteria for invasiveness (Criteria 1-4) but is not naturalized in Massachusetts (Criterion 5), the species may be considered "POTENTIALLY INVASIVE" in Massachusetts if it meets the following three criteria (#13-15):

13. The species, if it becomes naturalized in Massachusetts, based on its biology and biological potential, would pose an imminent threat to the biodiversity of Massachusetts **and**
14. Its naturalization in Massachusetts is anticipated, **and**
15. The species has a documented history of invasiveness in other areas of the Northeast.

DEFINITIONS TO ACCOMPANY "CRITERIA FOR EVALUATING NON-NATIVE PLANT SPECIES FOR INVASIVENESS IN MASSACHUSETTS"

Biologic potential - The ability of a species to increase its number, either sexually and/or asexually.

Invasive plants – Non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems. *As defined here, "species" includes all synonyms, subspecies, varieties, forms, and cultivars of that species unless proven otherwise by a process of scientific evaluation.*

Indigenous species - otherwise A species that occurs natively in Massachusetts. Indigenous species often have a pre-colonial presence (pre 1500) or have arrived in the region more recently without the aid of human intervention. Synonymous with native species.

Intensively managed habitats - Intensively managed habitats are habitats or land systems where management efforts and investments of time, money and labor occur frequently. Examples include manicured lawns, landscaped grounds, gardens, roadsides or agricultural lands for crops or livestock.

Likely Invasive plants – non-native species that are naturalized in Massachusetts but do not meet the full criteria that would trigger an "Invasive plant" designation.

Minimally managed habitats - Minimally managed habitats are habitats where management efforts and investments of time, money and labor are infrequent or non-existent. These habitats may have been intensively managed for anthropogenic reasons at one time in their history. In some instances, management may be more intense but management is done for conservation purposes and is primarily aimed at preserving elements of biological diversity such as imperiled species or critical natural communities. Minimally managed habitats are similar to "natural areas" but the distinction is made in order to remove bias, misconceptions or ambiguities that surround the term "natural area".

Non-indigenous species - A species that is not native or naturally occurring (based on its biology, phylogeny, distribution and current knowledge about the species) within Massachusetts. A species may be indigenous to North America but non-indigenous in Massachusetts. Synonymous with non-native species.

Naturalized species - A non-indigenous taxon that occurs without the aid and benefits of cultivation in Massachusetts. Further, it implies two biological points: it freely and regularly reproduces in the wild, sexually or asexually, and occurrences persist over time.

Natural plant community - A natural plant community is an association or assemblage of plant species that repeatedly occur together in reoccurring patterns in a specific type of habitat. This assemblage can be characterized by dominant species and biological properties. A natural plant community implies a minimally managed situation where all or most of the species that make up the assemblage are indigenous to the defined area.

Occurrence – Existing example of a species on the landscape.

Potentially invasive plants – Non-native species not currently known to be naturalized in Massachusetts, but that can be expected to become invasive within minimally managed habitats within the Commonwealth.

Spatial gaps - This term is used in reference to the ability of a species to disperse away from existing occurrences. The concept of crossing spatial gaps is used to distinguish those species that can disperse over discontinuities and become established elsewhere from species that spread across a habitat only by continual, uninterrupted growth.

Invasive, Likely Invasive, and Potentially Invasive Plants in Massachusetts: Findings from the Assessment Process by the Massachusetts Invasive Plant Advisory Group

Plants voted as: INVASIVE

"Invasive plants" are non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems. As defined here, "species" includes all synonyms, subspecies, varieties, forms, and cultivars of that species unless proven otherwise by a process of scientific evaluation.

Acer platanoides L. **(Norway maple)**
A tree occurring in all regions of the state in upland and wetland habitats, and especially common in woodlands with colluvial soils. It grows in full sun to full shade. Escapes from cultivation; can form dense stands; out-competes native vegetation, including sugar maple; dispersed by water, wind and vehicles.

Acer pseudoplatanus L. **(Sycamore maple)**
A tree occurring mostly in southeastern counties of Massachusetts, primarily in woodlands and especially near the coast. It grows in full sun to partial shade. Escapes from cultivation inland as well as along the coast; salt-spray tolerant; dispersed by wind, water and vehicles.

Aegopodium podagraria L. **(Bishop's goutweed; bishop's weed; goutweed)**
A perennial herb occurring in all regions of the state in uplands and wetlands. Grows in full sun to full shade. Escapes from cultivation; spreads aggressively by roots; forms dense colonies in flood plains.

Ailanthus altissima (P. Miller) Swingle **(Tree of heaven)**
This tree occurs in all regions of the state in upland, wetland, & coastal habitats. Grows in full sun to full shade. Spreads aggressively from root suckers, especially in disturbed areas.

Alliaria petiolata (Bieb.) Cavara & Grande **(Garlic mustard)**
Synonym: *Alliaria officinalis* Andrz. Ex Bieb.
A biennial herb occuring in all regions of the state in uplands. Grows in full sun to full shade. Spreads aggressively by seed, especially in wooded areas.

Berberis thunbergii DC. **(Japanese barberry)**
A shrub occuring in all regions of the state in open and wooded uplands and wetlands. Grows in full sun to full shade. Escaping from cultivation; spread by birds; forms dense stands.

Cabomba caroliniana A.Gray **(Carolina fanwort; fanwort)**
A perennial herb occuring in all regions of the state in aquatic habitats. Common in the aquarium trade; chokes waterways.

Celastrus orbiculatus Thunb. **(Oriental bittersweet; Asian or Asiatic bittersweet)**
A perennial vine occuring in all regions of the state in uplands. Grows in full sun to partial shade. Escaping from cultivation; berries spread by birds and humans; overwhelms and kills vegetation.

Plants voted as: INVASIVE *(continued)*

Cynanchum louiseae Kartesz & Gandhi **(Black swallow-wort, Louise's swallow-wort)**
Synonyms: *Cynanchum nigrum* (L.) Pers. non Cav.; *Vincetoxicum nigrum* (L.) Moench
A perennial vine occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to partial shade. Forms dense stands, out-competing native species: deadly to Monarch butterflies.

Elaeagnus umbellata Thunb. **(Autumn olive)**
A shrub occurring in uplands in all regions of the state. Grows in full sun. Escaping from cultivation; berries spread by birds; aggressive in open areas; has the ability to change soil.

Euonymus alatus (Thunb.) Sieb. (**Winged euonymus; Burning bush)**
A shrub occurring in all regions of the state and capable of germinating prolifically in many different habitats. It grows in full sun to full shade. Escaping from cultivation and can form dense thickets and dominate the understory; seeds are dispersed by birds.

Euphorbia esula L. **(Leafy spurge; wolf's milk)**
A perennial herb occurring in all regions of the state in grasslands and coastal habitats. Grows in full sun. An aggressive herbaceous perennial and a notable problem in western USA.

Frangula alnus P. Mill. **(European buckthorn; glossy buckthorn)**
Synonyms: *Rhamnus frangula* L.; *R. frangula* var. *angustifolia* Loud.
Shrub or tree occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Produces fruit throughout the growing season; grows in multiple habitats; forms thickets.

Glaucium flavum Crantz **(Sea or horned poppy; yellow hornpoppy)**
A biennial and perennial herb occurring in southeastern MA in coastal habitats. Grows in full sun. Seeds float; spreads along rocky beaches; primarily Cape Cod and Islands.

Hesperis matronalis L. **(Dame's rocket)**
A biennial and perennial herb occurring in all regions of the state in upland and wetland habitats. Grows in full sun to full shade. Spreads by seed; can form dense stands, particularly in flood plains.

Iris pseudacorus L. **(Yellow iris)**
A perennial herb occurring in all regions of the state in wetland habitats, primarily in flood plains. Grows in full sun to partial shade. Out-competes native plant communities.

Lepidium latifolium L. **(Broad-leaved pepperweed; tall pepperweed)**
A perennial herb occurring in eastern and southeastern regions of the state in coastal habitats. Grows in full sun. Primarily coastal at upper edge of wetlands; also found in disturbed areas; salt tolerant.

Lonicera japonica Thunb. **(Japanese honeysuckle)**
A perennial vine occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Rapidly growing, dense stands climb and overwhelm native vegetation; produces many seeds that are bird dispersed; more common in southeastern Massachusetts.

Lonicera morrowii A.Gray **(Morrow's honeysuckle)**A shrub occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Part of a confusing hybrid complex of nonnative honeysuckles commonly planted and escaping from cultivation via bird dispersal.

Plants voted as: INVASIVE *(continued)*

Lonicera x bella Zabel [*morrowii* x *tatarica*] **(Bell's honeysuckle)**
This shrub occurs in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade. Part of a confusing hybrid complex of nonnative honeysuckles commonly planted and escaping from cultivation via bird dispersal.

Lysimachia nummularia L. **(Creeping jenny; moneywort)**
A perennial herb occurring in all regions of the state in upland and wetland habitats. Grows in full sun to full shade. Escaping from cultivation; problematic in flood plains, forests and wetlands; forms dense mats.

Lythrum salicaria L. **(Purple loosestrife)**
A perennial herb or subshrub occurring in all regions of the state in upland and wetland habitats. Grows in full sun to partial shade. Escaping from cultivation; overtakes wetlands; high seed production and longevity.

Myriophyllum heterophyllum Michx. **(Variable water-milfoil; Two-leaved water-milfoil)**
A perennial herb occurring in all regions of the state in aquatic habitats. Chokes waterways, spread by humans and possibly birds.

Myriophyllum spicatum L. **(Eurasian or European water-milfoil; spike water-milfoil)**
A perennial herb found in all regions of the state in aquatic habitats. Chokes waterways, spread by humans and possibly birds.

Phalaris arundinacea L. **(Reed canary-grass)**
This perennial grass occurs in all regions of the state in wetlands and open uplands. Grows in full sun to partial shade. Can form huge colonies and overwhelm wetlands; flourishes in disturbed areas; native and introduced strains; common in agricultural settings and in forage crops.

Phragmites australis (Cav.) Trin. ex Steud. subsp. **australis (Common reed)**
A perennial grass (USDA lists as subshrub, shrub) found in all regions of the state. Grows in upland and wetland habitats in full sun to full shade. Overwhelms wetlands forming huge, dense stands; flourishes in disturbed areas; native and introduced strains.

Polygonum cuspidatum Sieb. & Zucc. **(Japanese knotweed; Japanese or Mexican Bamboo)**
Synonym: *Fallopia japonica* (Houtt.) Dcne.; *Reynoutria japonica* Houtt.
A perennial herbaceous subshrub or shrub occurring in all regions of the state in upland, wetland, and coastal habitats. Grows in full sun to full shade, but hardier in full sun. Spreads vegetatively and by seed; forms dense thickets.

Potamogeton crispus L. **(Crisped pondweed; curly pondweed)**
A perennial herb occurring in all regions of the state in aquatic habitats. Forms dense mats in the spring and persists vegetatively.

Ranunculus ficaria L. **(Lesser celandine; fig buttercup)**
A perennial herb occurring on stream banks, and in lowland and uplands woods in all regions of the state. Grows in full sun to full shade. Propagates vegetatively and by seed; forms dense stands especially in riparian woodlands; an ephemeral that outcompetes native spring wildflowers.

Rhamnus cathartica L. **(Common buckthorn)**
A shrub or tree occurring in all regions of the state in upland and wetland habitats. Grows in full sun to full shade. Produces fruit in fall; grows in multiple habitats; forms dense thickets.

Plants voted as: INVASIVE *(continued)*

Robinia pseudoacacia L. **(Black locust)**
A tree that occurs in all regions of the state in upland habitats. Grows in full sun to full shade. While the species is native to central portions of Eastern North America, it is not indigenous to Massachusetts. It has been planted throughout the state since the 1700's and is now widely naturalized. It behaves as an invasive species in areas with sandy soils.

Rosa multiflora Thunb. **(Multiflora rose)**
A perennial vine or shrub occurring in all regions of the state in upland, wetland and coastal habitats. Grows in full sun to full shade. Forms impenetrable thorny thickets that can overwhelm other vegetation; bird dispersed.

Trapa natans L. **(Water-chestnut)**
An annual herb occurring in the western, central, and eastern regions of the state in aquatic habitats. Forms dense floating mats on water.

Plants votes as: LIKELY INVASIVE

"Likely Invasive plants" are non-native species that are naturalized in Massachusetts but do not meet the full criteria that would trigger an "Invasive plant" designation. As defined here, "species" includes all synonyms, subspecies, varieties, forms, and cultivars of that species unless proven otherwise by a process of scientific evaluation.

Ampelopsis brevipedunculata (Maxim.) Trautv. **(Porcelain-berry; Amur peppervine)**
A woody vine found primarily in southeastern counties of Massachusetts but known from some western counties as well. Occurs in upland woodland edges and thickets and grows in full sun to partial shade. Escapes from cultivation and is bird dispersed.

Anthriscus sylvestris (L.) Hoffmann **(Wild chervil)**
Synonym: *Chaerophyllum sylvestre* L.
A biennial or short-lived perennial herb with a few reported sites in minimally managed habitats scattered across the state. It occurs in old fields, wetlands, roadsides and proliferates in floodplain soils. Grows in full sun to partial shade. It has a very long taproot and is reported to be spreading in Vermont and Connecticut.

Berberis vulgaris L**. (Common barberry; European barberry)**
A shrub occurring in all regions of the state, primarily in uplands. It grows in full sun to full shade. The potential of this plant to spread is high; once common but widely eradicated because it is an alternate host for wheat rust; it hybridizes with Japanese barberry.

Cardamine impatiens L. **(Bushy rock-cress; narrowleaf bittercress)**
A winter annual or biennial herb found in western Massachusetts occurring in rich woods, rocky ledges, roadsides, and stream banks. It grows in full sun to full shade. Disperses seeds easily and is spreading rapidly in other parts of New England.

Centaurea biebersteinii DC. **(Spotted knapweed)**
Synonym: *Centaurea maculosa* auct. non Lam.
A biennial or perennial herb occurring in all regions of the state in upland and coastal habitats. Grows in full sun. Aggressively grows in well-drained, disturbed soils; serious problem in western states where it out-competes native grassland species, literature reports are currently lacking for this in the northeast.

Plants voted as: LIKELY INVASIVE *(continued)*

Cynanchum rossicum (Kleopov) Borhidi **(European swallow-wort; pale swallow-wort)**
Synonym: *Vincetoxicum rossicum* (Kleopov) Barbarich
A perennial herb occurring in the western region of the state in upland habitats. Grows in full sun to partial shade. Forms dense stands; found primarily in the lower Connecticut River Valley.

Egeria densa Planchon **(Brazilian waterweed; Brazilian elodea)**
Synonyms: *Anacharis densa* (Planch.) Victorin; *Elodea densa* (Planch.) Caspary
A perennial herb occurring in the eastern and southeastern regions of the state in aquatic habitats. Common in the aquarium trade; chokes waterways; currently only found in a few MA ponds.

Epilobium hirsutum L. **(Hairy willow-herb; Codlins and cream)**
A perennial herb occurring in all regions of the state in wetlands. Grows in full sun. Seeds dispersed by wind and water; evidence currently lacking that this species out- competes other vegetation in minimally managed habitats.

Euphorbia cyparissias L. **(Cypress spurge)**
A perennial herb occurring in all regions of the state in upland habitats. Grows in full sun. Persists in open areas; evidence currently lacking that this species out-competes other vegetation in minimally managed habitats.

Festuca filiformis Pourret **(Hair fescue; fineleaf sheep fescue)**
A perennial grass occurring in all regions of the state, in grasslands and open woodlands. Grows in full sun to partial shade. Common in minimally managed grassland habitats; more data needed on its ability to outcompete native species.

Glyceria maxima (Hartman) Holmburg **(Tall mannagrass; reed mannagrass)**
A perennial grass currently known from one marsh in Essex County. Grows in full sun to partial shade. Spreads vegetatively and produces viable seeds; forms dense stands.

Heracleum mantegazzianum Sommier & Levier **(Giant hogweed)**
A perennial herb occurring in scattered sites across all regions of the state; thrives in multiple habitats. Grows in full sun to full shade. Escapes from cultivation; seeds can be dispersed by water; can cause severe skin reactions.

Humulus japonicus Sieb. & Zucc. **(Japanese hops)**
An annual herbaceous vine with current records in western MA, but historical records from all regions of the state. Grows in floodplain forests and riverbanks in full sun to partial shade. Escapes from cultivation; capable of prolific growth.

Hydrilla verticillata (L.f.) Royle **(Hydrilla; water-thyme; Florida elodea)**
A perennial aquatic herb occurring in the southeastern region of the state. Only found in one MA pond currently (2004); easily dispersed by birds and humans; chokes entire water bodies.

Ligustrum obtusifolium Sieb. & Zucc. **(Border privet)**
A shrub occurring in all regions of the state in woodlands and woodland edges. Grows in full sun to full shade. Widespread and shade tolerant, bird dispersed; more data needed on density and distribution; flowers are needed to identify species.

Lonicera tatarica L. **(Tatarian honeysuckle)**
A shrub found from Boston westward in thickets, woods, and edges of woods. Can grow in full sun to full shade. Commonly confused with other non-native honeysuckles; crosses with Morrow's honeysuckle *(L. morrowii)* to produce the invasive hybrid Belle's honeysuckle *(L.* x*bella)*.

Plants voted as: LIKELY INVASIVE *(continued)*

Microstegium vimineum (Trin.) A. Camus **(Japanese stilt grass; Nepalese browntop)**
An annual grass occurring in the western region of the state in upland and wetland habitats. Grows in full sun to full shade. Forms dense stands; currently localized in the lower Connecticut River Valley; spreads in flood plains.

Miscanthus sacchariflorus (Maxim.) Franch. **(Plume grass; Amur silvergrass)**
This perennial grass is currently known to occur in central MA in wetland margins and roadsides. Grows in full sun. Spreads by rhizomes and develops dense stands along roadsides and adjacent native habitats.

Myosotis scorpioides L. **(Forget-me-not)**
A perennial herb occurring in all regions of the state in wetlands. Grows in full sun to full shade. Escaping from cultivation; prolific in open wooded streams, stream-banks and wet meadows; evidence about its persistence is needed.

Myriophyllum aquaticum (Vell.) Verdc. **(Parrot-feather; water-feather; Brazilian watermilfoil)**
Synonym: *Myriophyllum brasiliense* Camb.
A perennial herbaceous aquatic occurring in southeastern MA along a shallow pond edge.
Grows in full sun to partial shade. Reproduces from fragments; commonly used in the water garden trade.

Najas minor All. **(Brittle water-nymph; lesser naiad)**
An annual herb occurring in the western region of the state in aquatic habitats. Chokes waterways; spread by humans and possibly birds; currently found only in Berkshire County (2002).

Nymphoides peltata (Gmel.) Kuntze **(Yellow floating heart)**
This aquatic perennial occurs in ponds in central MA. Grows in full sun to partial shade. Can create a dense floating mat on ponds and can reproduce from fragments.

Phellodendron amurense Rupr. (sensu lato) **(Amur cork-tree)**
Synonyms: *Phellodendron japonicum* Maxim.; *Phellodendron amurense* var. japonicum (Maxim.) Ohwi; *Phellodendron sachalinense* (F. Schmidt) Sarg.; *Phellodendron amurense* var. sachalinense F. Schmidt; *Phellodendron lavallei* Dode; *Phellodendron amurense* var. lavallei (Dode) Sprague
This tree occurs in uplands of eastern to central MA. Grows in full sun to full shade. A bird dispersed species that has escaped cultivation.

Pueraria montana (Lour.) Merrill **(Kudzu; Japanese arrowroot)**
Synonym: *Pueraria montana* var. *lobata* (Willd.) Maesen & S. Almeida
A perennial herbaceous vine found in southeastern MA. Occurs at Arnold Arboretum; uplands. Grows in full sun to partial shade. Present in MA and subject to control; marginally hardy in MA but has the potential to invade minimally-managed areas based on its performance elsewhere.

Ranunculus repens L. **(Creeping buttercup)**
A perennial herb occurring in all regions of the state in wetlands. Grows in full sun to full shade. Common around springs and wetlands; evidence currently lacking that this species out- competes other vegetation in minimally managed habitats.

Rorippa amphibia (L.) Bess. **(Water yellowcress; great yellowcress)**
Synonyms: *Nasturtium amphibium* (L.) Ait. f.; *Sisymbrium amphibium* L.
A perennial herb occurring in central MA. Grows in wetlands in full sun to partial shade. Common and increasing in central MA river drainages; a major threat to riparian habitats forming dense stands at some locations.

Plants voted as: LIKELY INVASIVE *(continued)*

Rubus phoenicolasius Maxim**. (Wineberry; Japanese wineberry; wine raspberry)**
A shrub found in uplands of southern MA. Can grow in full sun to partial shade.
Animal and human dispersed; forms thickets.

Senecio jacobaea L. **(Tansy ragwort; stinking Willie)**
A biennial herb occurring in a few sites east of the Connecticut River; habitat is open uplands. Grows in sun or partial shade. This species is highly invasive in the Canadian Maritimes; may also spread from disturbed areas.

Tussilago farfara L. **(Coltsfoot)**
A perennial herb occurring in all regions of the state in upland and wetland habitats. Grows in full sun to full shade. Particularly problematic in lime seeps and disturbed sites; evidence currently lacking that this species out-competes other vegetation in minimally managed habitats.

Plants voted as: POTENTIALLY INVASIVE

"Potentially invasive plants" are non-native species not currently known to be naturalized in Massachusetts, but that can be expected to become invasive within minimally managed habitats within the Commonwealth. As defined here, "species" includes all synonyms, subspecies, varieties, forms, and cultivars of that species unless proven otherwise by a process of scientific evaluation.

Arthraxon hispidus (Thunb.) Makino (**Hairy joint grass; jointhead; small carpetgrass)**
An annual grass historically known from Franklin County but not currently known from the state. Habitats elsewhere include roadsides, shores, ditches, and low woods and fields. Grows in full to partial shade. Is problematic in Connecticut and southward.

Carex kobomugi Ohwi **(Japanese sedge; Asiatic sand sedge)**
A perennial sedge established mainly in sand dunes and growing in full sun. There is only one current New England location--in Rhode Island; it can spread rapidly in dune systems.

Lonicera maackii (Rupr.) Herder **(Amur honeysuckle)**
A shrub having specimens and reports from a number of MA counties, but verification of naturalization at these locations is needed. The likely habitats are woods and woodland edges. Can grow in full sun or shade. Escapes from cultivation, but documentation needed regarding naturalized populations in MA; recognized as invasive in the Midwest and portions of the southeastern USA.

Polygonum perfoliatum L. **(Mile-a-minute vine or weed; Asiatic tearthumb)**
Synonym: *Ampelygonum perfoliatum* (L.) Roberty & Vautier
This annual herbaceous vine is not currently known to exist in MA, but has been found in RI and CT. Habitats include streamside, fields, and road edges in full sun to partial shade. Highly aggressive; bird and human dispersed.

EVALUATED PLANTS NOT MEETING CRITERIA
(Do not list at this time)

The following plants were evaluated for invasiveness by the Massachusetts Invasive Plant Advisory Group. They did not meet the necessary criteria to list them as Invasive, Likely Invasive or Potentially Invasive at the time of evaluation.

Actinidia arguta (Sieb. & Zucc.) Planchon ex Miq. (**Hardy kiwi; tara vine)**
A woody vine that is dioecious (i.e., with male and female flowers on separate individuals). It grows in full sun to partial shade. Can form dense stands; evidence needed to evaluate its reproductive ability and potential to establish new populations away from cultivation.

Akebia quinata (Houtt.) Dcne. (**Five-leaved Akebia; chocolate vine)**
A woody vine that grows in full sun to full shade. Can form dense stands; evidence needed to evaluate its reproductive ability and potential for establishment away from cultivation.

Catalpa speciosa (Warder) Warder ex Engelm. (**Northern catalpa)**
A tree that grows in full sun to partial shade. Preliminary data suggest that this species could be invasive in floodplain forests; more data is needed on its ability to out compete native species.

Cytisus scoparius (L.) Link (**Scotch broom; English broom)**
A shrub that grows in full sun to partial shade. Current evidence does not show that it is spreading rapidly from cultivation and out competing native species in Massachusetts.

Elaeagnus angustifolia L. (**Russian olive)**
A small tree or shrub that grows in full sun to full shade. Not currently known from minimally managed habitats in Massachusetts; invasive elsewhere in the United States; commonly confused with autumn olive (*Elaeagnus umbellata*).

Festuca ovina L. (**Sheep fescue)**
A perennial grass that grows in full sun. More data needed on its ability to outcompete native species in minimally managed habitats.

Ligustrum ovalifolium Hassk. **(California privet)**
Shrub. Because of the difficulty in identifying privet species and the current lack of data, we have chosen not to rank most privets; further research is needed in identification and invasiveness.

Ligustrum sinense Lour. **(Chinese privet)**
A shrub that can tolerate full sun or shade. Because of the difficulty in identifying privet species and the current lack of data, we have chosen not to rank most privets; further research is needed on identification and invasiveness.

Ligustrum vulgare L. **(European privet)**
Shrub. Because of the difficulty in identifying privet species and the current lack of data, we have chosen not to rank most privets; further research is needed in identification and invasiveness.

Lonicera xylosteum L. **(Dwarf honeysuckle)**
Shrub. Reports of naturalized occurrences need verification in MA.

Miscanthus sinensis Anderss. **(Eulalia; Chinese silvergrass)**
A perennial grass that grows in full sun. More data needed for minimally managed habitats.

EVALUATED PLANTS NOT MEETING CRITERIA *(continued)*

Morus alba L. **(White mulberry)**
A tree that grows in full sun to partial shade. Reports of naturalized occurrences and invasiveness need verification in MA.

Polygonum sachalinense F. Schmidt ex Maxim. **(Giant knotweed)**
Synonyms: *Fallopia sachalinensis* (F. Schmidt ex Maxim.) Dcne.;
Reynoutria sachalinensis (F. Schmidt ex Maxim.) Nakai
A perennial herb that grows in full sun. Data needed on occurrences in minimally managed areas in MA; highly invasive in the maritime provinces of Canada.

Populus alba L. **(White poplar)**
A tree that grows in full sun. Data needed on occurrences in minimally managed areas.

Rorippa microphylla (Boenn. ex Reichenb.) Hyland ex A. & D. Löve **(Watercress; onerow yellowcress)**
Synonym: *Nasturtium microphyllum* Boenn. Ex Reichenb.
A perennial aquatic that grows in full sun to partial shade. There is difficulty in separating this species from *Rorippa nasturtium-aquaticum*; more data needed on its current status on the landscape and its impact on minimally managed habitats.

Rorippa nasturtium-aquaticum (L.) Hayek **(Watercress)**
Synonym: *Nasturtium officinale* Ait. f.
A perennial aquatic that grows in full sun to partial shade. There is difficulty in separating this species from *Rorippa microphylla*; more data needed on its current status on the landscape and its impact on minimally managed habitats.

Rosa rugosa Thunb. **(Japanese rose; rugosa rose)**
A shrub that grows in full sun. This is a widely planted urban & coastal plant; listing it as Invasive or Likely Invasive does not accurately reflect all the properties of this plant; there are no data at this time to suggest that this species is disruptive to native plant habitats in MA.

Sedum telephium L. ssp. telephium **(Live-forever; orpine; witch's moneybags)**
A perennial herb that can grow in full sun to shade. More data needed on taxonomy, nomenclature, and occurrences in minimally managed areas.

Verbascum thapsus L. **(Common mullein; flannel mullein; velvet plant)**
A biennial herb that grows in full sun. Although MIPAG does not feel this species meets the criteria for listing at this time, its occurrence in critical habitats (especially limestone cliff communities) is of concern; species has not been proven to have outcompeting qualities; more data needed on this species and the very similar *Verbascum phlomoides*, including taxonomy, persistence, and their impact on minimally managed habitats.

Species Reviewed (Phases I and II): Listed Alphabetically

Species	Common name	Category
Aegopodium podagraria	Bishop's goutweed; bishop's weed; goutweed	Invasive
Acer platanoides	Norway maple	Invasive
Acer pseudoplatanus	Sycamore maple	Invasive
Actinidia arguta	Hardy kiwi; tara vine	Do not list at this time
Ailanthus altissima	Tree of heaven	Invasive
Akebia quinata	Five-leaved Akebia; chocolate vine	Do not list at this time
Alliaria petiolata	Garlic mustard	Invasive
Ampelopsis brevipedunculata	Porcelain-berry; Amur peppervine	Likely invasive
Ampelygonum perfoliatum – see Polygonum perfoliatum		
Anacharis densa – see Egeria densa		
Anthriscus sylvestris	Wild chervil	Likely invasive
Arthraxon hispidus	Hairy joint grass; jointhead; small carpet grass	Potentially Invasive
Berberis thunbergii	Japanese barberry	Invasive
Berberis vulgaris	Common barberry; European barberry	Likely Invasive
Cabomba caroliniana	Carolina fanwort; fanwort	Invasive
Cardamine impatiens	Bushy rock-cress; narrowleaf bittercress	Likely Invasive
Carex kobomugi	Japanese sedge; Asiatic sand sedge	Potentially Invasive
Catalpa speciosa	Northern catalpa	Do not list at this time
Celastrus orbiculatus	Oriental bittersweet; Asian or Asiatic bittersweet	Invasive
Centaurea biebersteinii	Spotted knapweed	Likely Invasive
Centaurea maculosa – see Centaurea biebersteinii		
Chaerophyllum sylvestre – see Anthriscus sylvestris		
Cynanchum louiseae	Black swallow-wort; Louise's swallow-wort	Invasive
Cynanchum nigrum – see Cynanchum louiseae		
Cynanchum rossicum	European swallow-wort; pale swallow-wort	Likely Invasive
Cytisus scoparius	Scotch broom; English broom	Do not list at this time
Egeria densa	Brazilian water weed, Brazilian elodea	Likely Invasive
Elaeagnus umbellata	Autumn olive	Invasive
Elaeagnus angustifolia	Russian olive	Do not list at this time
Elodea densa – see Egeria densa		
Epilobium hirsutum	Hairy willow herb; Codlins and cream	Likely Invasive
Euonymus alatus	Winged euonymus; burning bush	Invasive
Euphorbia cyparissias	Cypress spurge	Likely Invasive
Euphorbia esula	Leafy spurge; wolf's milk	Invasive
Fallopia japonica - see Polygonum		

cuspidatum		
Fallopia sachalinensis - see Polygonum sachalinense		
Festuca filiformis	Hair fescue; fineleaf sheep fescue	Likely Invasive
Festuca ovina	Sheep fescue	Do not list at this time
Frangula alnus	European buckthorn; glossy buckthorn	Invasive
Glaucium flavum	Sea or horned poppy; yellow hornpoppy	Invasive
Glyceria maxima	Tall mannagrass; reed mannagrass	Likely Invasive
Hesperis matronalis	Dame's rocket	Invasive
Heracleum mantegazzianum	Giant hogweed	Likely Invasive
Humulus japonicus	Japanese hops	Likely Invasive
Hydrilla verticillata	Waterthyme, Florida elodea	Likely Invasive
Iris pseudacorus	Yellow iris	Invasive
Lepidium latifolium	Broad-leaved pepperweed; tall pepperweed	Invasive
Ligustrum obtusifolium	Border privet	Likely Invasive
Ligustrum ovalifolium	California privet	Do not list at this time
Ligustrum sinense	Chinese privet	Do not list at this time
Ligustrum vulgare L.	European privet	Do not list at this time
Lonicera japonica	Japanese honeysuckle	Invasive
Lonicera maackii	Amur honeysuckle	Potentially Invasive.
Lonicera morrowii	Morrow's honeysuckle	Invasive
Lonicera tatarica	Tatarian honeysuckle	Likely invasive
Lonicera xylosteum	Dwarf honeysuckle	Do not list at this time
Lonicera x bella [morrowii x tatarica]	Bell's honeysuckle	Invasive
Lysimachia nummularia	Creeping jenny; moneywort	Invasive
Lythrum salicaria	Purple loosestrife	Invasive
Microstegium vimineum	Japanese stilt grass; Nepalese browntop	Likely Invasive
Miscanthus sacchariflorus	Plume grass; Amur silvergrass	Likely Invasive
Miscanthus sinensis	Eulalia; Chinese silvergrass	Do not list at this time
Morus alba	White mulberry	Do not list at this time
Myosotis scorpioides	Forget-me-not	Likely Invasive
Myriophyllum aquaticum	Parrot feather; water-feather; Brazilian water-milfoil	Likely Invasive
Myriophyllum brasiliense - see Myriophyllum aquaticum		
Myriophyllum heterophyllum	Variable water-milfoil; two-leaved water-milfoil	Invasive
Myriophyllum spicatum	Eurasian or European water-milfoil; spike water-milfoil	Invasive
Najas minor	Brittle water-nymph; lesser naiad	Likely Invasive
Nasturtium amphibium - see Rorripa amphibia		
Nasturtium microphyllum – see Rorippa microphylla		
Nasturtium officinale - see Rorippa nasturtium-aquaticum		
Nymphoides peltata	Yellow floating heart	Likely Invasive

Phalaris arundinacea	Reed canary-grass	Invasive
Phellodendron amurense	Amur cork-tree	Likely Invasive
Phellodendron amurense var. japonicum - see Phellodendron amurense		
Phellodendron amurense var. lavallei - *see Phellodendron amurense*		
Phellodendron amurense var. sachalinense - see Phellodendron amurense		
Phellodendron lavallei - see Phellodendron amurense		
Phellodendron sachalinense - see Phellodendron amurense		
Phragmites australis	Common reed	Invasive
Polygonum cuspidatum	Japanese knotweed; Japanese or Mexican bamboo	Invasive
Polygonum perfoliatum	Mile-a-minute vine or weed; Asiatic tearthumb	Potentially Invasive
Polygonum sachalinense	Giant knotweed	Do not list at this time
Populus alba	White poplar	Do not list at this time
Potamogeton crispus	Crisped pondweed; curly pondweed	Invasive
Pueraria montana	Kudzu; Japanese arrowroot	Likely Invasive
Pueraria montana var. lobata – see Pueraria montana		
Ranunculus ficaria	Lesser celandine; fig buttercup	Invasive
Ranunculus repens	Creeping buttercup	Likely Invasive
Reynoutria sachalinensis – see Polygonum sachalinense		
Reynoutria japonica – see Polygonum cuspidatum		
Rhamnus cathartica	Common buckthorn	Invasive
Rhamnus frangula – see Frangula alnus		
Robinia pseudoacacia	Black locust	Invasive
Rorippa amphibia	Water yellowcress; great yellowcress	Invasive
Rorippa microphylla	Watercress; onerow yellowcress	Do not list at this time
Rorippa nasturtium-aquaticum	Watercress	Do not list at this time
Rosa multiflora	Multiflora rose	Invasive
Rosa rugosa	Japanese rose; rugosa rose	Do not list at this time
Rubus phoenicolasius	Wineberry; Japanese wineberry; wine raspberry	Likely Invasive
Sedum telephium ssp. telephium	Live-forever; orpine; witch's moneybags	Do not list at this time
Senecio jacobaea	Tansy ragwort; stinking Willie	Likely Invasive
Sisymbrium amphibium - see Rorripa amphibia		

Trapa natans	Water-chestnut	Invasive
Tussilago farfara	Coltsfoot	Likely Invasive
Verbascum thapsus	Common mullein; flannel mullein;	Do not list at this time
	velvet plant	
Vincetoxicum nigrum – see Cynanchum nigrum		
Vincetoxicum rossicum – Cynanchum rossicum		

Species Reviewed (Phases I and II): Listed by Category

Species	Common name	Category
Acer platanoides	Norway maple	Invasive
Acer pseudoplatanus	Sycamore maple	Invasive
Aegopodium podagraria	Bishop's goutweed, bishop's weed; goutweed	Invasive
Ailanthus altissima	Tree of heaven	Invasive
Alliaria petiolata	Garlic mustard	Invasive
Berberis thunbergii	Japanese barberry	Invasive
Cabomba caroliniana	Carolina fanwort; fanwort	Invasive
Celastrus orbiculatus	Oriental bittersweet; Asian or Asiatic bittersweet	Invasive
Cynanchum louiseae	Black swallow-wort; Louise's swallow-wort	Invasive
Elaeagnus umbellata	Autumn olive	Invasive
Euonymus alatus	Winged euonymus, burning bush	Invasive
Euphorbia esula	Leafy spurge; wolf's milk	Invasive
Frangula alnus	European buckthorn, glossy buckthorn	Invasive
Glaucium flavum	Sea or horned poppy, yellow hornpoppy	Invasive
Hesperis matronalis	Dame's rocket	Invasive
Iris pseudacorus	Yellow iris	Invasive
Lepidium latifolium	Broad-leaved pepperweed, tall pepperweed	Invasive
Lonicera japonica	Japanese honeysuckle	Invasive
Lonicera morrowii	Morrow's honeysuckle	Invasive
Lonicera x bella [morrowii x tatarica]	Bell's honeysuckle	Invasive
Lysimachia nummularia	Creeping jenny, moneywort	Invasive
Lythrum salicaria	Purple loosestrife	Invasive
Myriophyllum heterophyllum	Variable water-milfoil; two-leaved water-milfoil	Invasive
Myriophyllum spicatum	Eurasian or European water-milfoil; spike water- milfoil	Invasive
Phalaris arundinacea	Reed canary-grass	Invasive
Phragmites australis	Common reed	Invasive
Polygonum cuspidatum	Japanese knotweed; Japanese or Mexican bamboo	Invasive
Potamogeton crispus	Crisped pondweed, curly pondweed	Invasive
Ranunculus ficaria	Lesser celandine; fig buttercup	Invasive
Rhamnus cathartica	Common buckthorn	Invasive
Robinia pseudoacacia	Black locust	Invasive
Rosa multiflora	Multiflora rose	Invasive
Trapa natans	Water-chestnut	Invasive
Ampelopsis brevipedunculata	Porcelain-berry; Amur peppervine	Likely invasive
Anthriscus sylvestris	Wild chervil	Likely invasive
Berberis vulgaris	Common barberry; European barberry	Likely Invasive
Cardamine impatiens	Bushy rock-cress; narrowleaf bittercress	Likely Invasive
Centaurea biebersteinii	Spotted knapweed	Likely Invasive
Cynanchum rossicum	European swallow-wort, pale swallow-wort	Likely Invasive
Egeria densa	Brazilian water weed; Brazilian elodea	Likely Invasive
Epilobium hirsutum	Hairy willow herb; Codlins and cream	Likely Invasive

Euphorbia cyparissias	Cypress spurge	Likely Invasive
Festuca filiformis	Hair fescue; fineleaf sheep fescue	Likely Invasive
Glyceria maxima	Tall mannagrass; reed mannagrass	Likely Invasive
Heracleum mantegazzianum	Giant hogweed	Likely Invasive
Humulus japonicus	Japanese hops	Likely Invasive
Hydrilla verticillata	Hydrilla; water-thyme; Florida elodea	Likely Invasive
Ligustrum obtusifolium	Border privet	Likely Invasive
Lonicera tatarica	Tatarian honeysuckle	Likely invasive
Microstegium vimineum	Japanese stilt grass, Nepalese browntop	Likely Invasive
Miscanthus sacchariflorus	Plume grass; Amur silvergrass	Likely Invasive
Myosotis scorpioides	Forget-me-not	Likely Invasive
Myriophyllum aquaticum	Parrot-feather; water-feather; Brazilian water-milfoil	Likely Invasive
Najas minor	Brittle water-nymph, lesser naiad	Likely Invasive
Nymphoides peltata	Yellow floating heart	Likely Invasive
Phellodendron amurense	Amur cork-tree	Likely Invasive
Pueraria montana	Kudzu; Japanese arrowroot	Likely Invasive
Ranunculus repens	Creeping buttercup	Likely Invasive
Rorippa amphibia	Water yellowcress; great yellowcress	Likely Invasive
Rubus phoenicolasius	Wineberry; Japanese wineberry; wine raspberry	Likely Invasive
Senecio jacobaea	Tansy ragwort; stinking Willie	Likely Invasive
Tussilago farfara	Coltsfoot	Likely Invasive
Arthraxon hispidus	Hairy joint grass; jointhead; small carpetgrass	Potentially Invasive
Carex kobomugi	Japanese sedge, Asiatic sand sedge	Potentially Invasive
Lonicera maackii	Amur honeysuckle	Potentially Invasive.
Polygonum perfoliatum	Mile-a-minute vine or weed; Asiatic tearthumb	Potentially Invasive
Actinidia arguta	Hardy kiwi; tara vine	Do not list at this time
Akebia quinata	Five-leaved Akebia; chocolate vine	Do not list at this time
Catalpa speciosa	Northern catalpa	Do not list at this time
Cytisus scoparius	Scotch broom; English broom	Do not list at this time
Elaeagnus angustifolia	Russian olive	Do not list at this time
Festuca ovina	Sheep fescue	Do not list at this time
Ligustrum ovalifolium	California privet	Do not list at this time
Ligustrum sinense	Chinese privet	Do not list at this time
Ligustrum vulgare L.	European privet	Do not list at this time
Lonicera xylosteum	Dwarf honeysuckle	Do not list at this time
Miscanthus sinensis	Eulalia; Chinese silvergrass	Do not list at this time
Morus alba	White mulberry	Do not list at this time
Polygonum sachalinense	Giant knotweed	Do not list at this time
Populus alba	White poplar	Do not list at this time
Rorippa microphylla	Watercress; onerow yellowcress	Do not list at this time
Rorippa nasturtium-aquaticum	Watercress	Do not list at this time
Rosa rugosa	Japanese rose; rugosa rose	Do not list at this time
Sedum telephium ssp. telephium	Live-forever; orpine; witch's moneybags	Do not list at this time
Verbascum thapsus	Common mullein; flannel mullein; velvet plant	Do not list at this time

APPENDIX C

Aquatic Invasive Species Cards

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

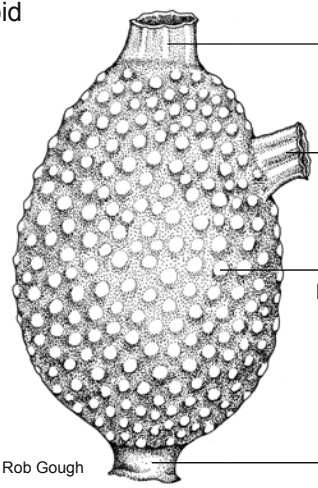
Ascidiella aspersa

European sea squirt, tunicate

Robert Buchsbaum

PHYSICAL DESCRIPTION

- Thin, grayish, semi-translucent, exterior with pinkish hue, often covered with debris
- Firm, rigid surface with tiny bumps (papillae)
- Two prominent siphons: a fluted oral siphon at top, and fluted atrial siphon located 1/3 of the way down the side of the body
- Variable shape; typically ovoid or egg-shaped
- Adheres to substrate on one end by basal attachment
- Grows up to 2 in (5 cm)



Ascidiella aspersa

© Rob Gough

HABITAT PREFERENCE

- Found in shallow, subtidal waters attached to docks, pilings, ropes, and other submerged structures
- Prefers calm, protected waters with steady current
- Occurs in both marine and estuarine waters

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Ascidiella aspersa

European sea squirt, tunicate

INVASION STATUS & ECOLOGICAL CONCERNS

Ascidiella aspersa, a native of Europe, was most likely introduced to the United States shorelines from hull fouling and/or ballast water discharge. It was first discovered in New England waters in the 1980's, and it can now be found in the Gulf of Maine from Massachusetts to Connecticut. Like other invasive tunicates, *A. aspersa* is a tough competitor that outcompetes and replaces native solitary tunicates. This species is able to withstand variable salinities, enabling it to spread to estuaries. *A. aspersa* is a fouling organism on ship hulls, anchor chains, marina floats, shellfish beds, and other firm surfaces.

SIMILAR SPECIES

Styela clava (club tunicate) encrusted with debris

Andrew Martinez

Styela clava: Elongate colonies of *Ascidiella aspersa* may be mistaken for the solitary tunicate *Styela clava* (club tunicate), particularly when covered with encrusting debris. Perhaps the most helpful feature for distinguishing these species is the presence of two prominent, closely positioned siphons on the apex of *Styela clava*, vs. siphons separated by 1/3 of body length in *Ascidiella aspersa.*

Ciona intestinalis: *Ascidiella aspersa* may be mistaken for *Ciona intestinalis*, another invasive, solitary tunicate. However, *C. intestinalis* always has yellow marks around the siphons and is typically more slender and not as firm as *A. aspersa*.

Molgula spp.: Small specimens of *A. aspersa* may also be mistaken for *Molgula spp.* (sea grapes). However, *Molgula spp.* are spherically shaped with two siphons very close together at the top of their body.

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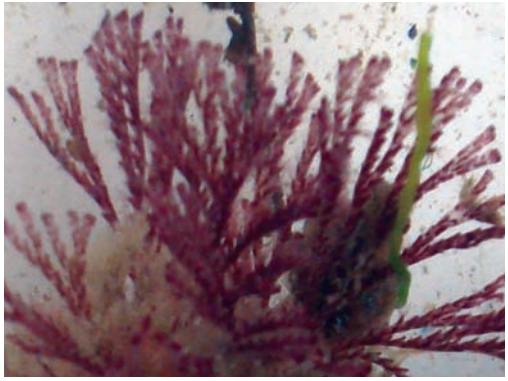
GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Bugula neritina

purple bushy bryozoan



Salem Sound Coastwatch

PHYSICAL DESCRIPTION

- A deep purple to brownish red bushy branching colonial animal
- Looks like a small clump of purple seaweed, but actually consists of individual filter-feeding zooids (animals) that are visible with the naked eye
- Colony branches are made up of alternating double strands of connected zooids
- Each zooid is only about 1mm in length, while the overall colony can be several centimeters across

Adriann Gittenberger

HABITAT PREFERENCE

- Attaches to hard substrates, such as on low intertidal or subtidal rocks and on the sides of floating dock
- Live in marine waters with salinity 30-35 ppt
- Common in warmer waters around the world but tolerant of temperature ranges found in New England

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Bugula neritina

purple bushy bryozoan

INVASION STATUS & ECOLOGICAL CONCERNS

Bugula neritina is now found world-wide and has become a common fouling organism on floating docks. So far in New England waters, it is not as dominant or abundant as it has become in other portions of its non-native range, but further study is necessary to determine its local ecological impact.

SIMILAR SPECIES

There are three native *Bugula* species in the region. They are similar in appearance to *B. neritina*, except in color, being generally tan or off-white. Additionally, *B. neritina* shape is more bushy than the native *Bugula turrita*, which has an overall whorled or spirally-branching appearance, or the native *Bugula simplex* that has a flattened, fan-like appearance. More definitive identification requires microscopic examination of zooid structures.

Colonies of hydroids (animals that also use small tentacles to feed) grow in a similar manner and on similar surfaces, but their branches are not made up of zooid chains.

There are several species of red algae that appear similar at first glance, but none of them are comprised of zooids.

Salem Sound Coastwatch

Native *Bugula turrita* (left) and invader *Bugula neritina (right)*

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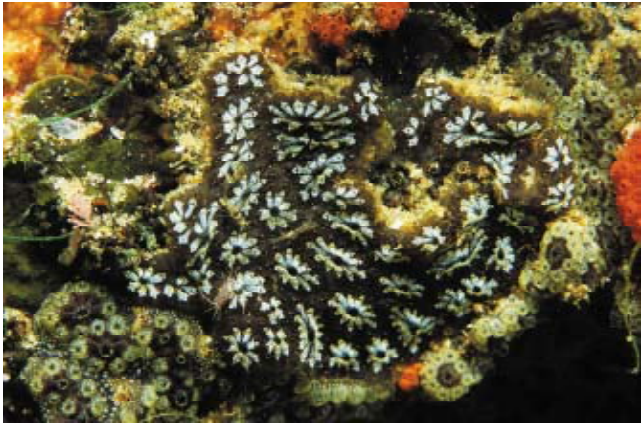
GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Botryllus schlosseri

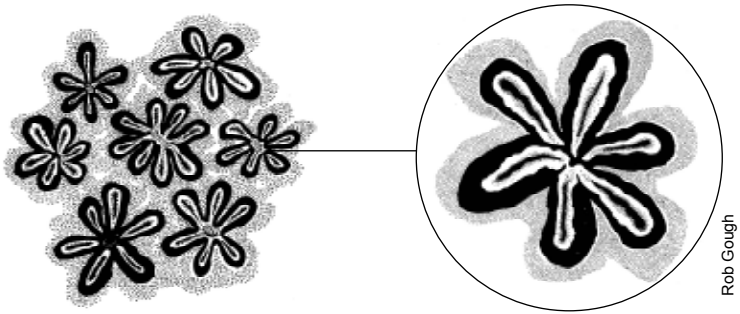
star tunicate (colonial tunicate, ascidian)



Andrew Martinez

PHYSICAL DESCRIPTION

- Colonies of zooids (individual animals) arranged in conspicuous starlike systems
- Each zooid 0.06 in (2-4 mm) across with 5-20 zooids in a system
- Colonies grow up to 3-4 in (7.5-10 cm) wide
- May form lobes when mature
- Color variable: green, violet, blue-black, brown and yellow



Botryllus schlosseri colony

system of zooids (5-20)

Rob Gough

HABITAT PREFERENCE

- Grows on a variety of stable substrates including algae, rocks, docks, pilings and ships
- Primarily subtidal; occasionally found in lower intertidal zone
- Can survive in estuaries with low salinities (18 ppt or less)

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Botryllus schlosseri

star tunicate (colonial tunicate, ascidian)

INVASION STATUS & ECOLOGICAL CONCERNS

This fouling organism is found in lower intertidal to subtidal waters from the Bay of Fundy to North Carolina. It was introduced from Europe where it is abundant along rocky shores of the Mediterranean and other European seas. Although *B. schlosseri* can grow on nearly any submerged hard surface, star tunicates often grow on mussels and oysters. The tunicate colonies can negatively impact these mollusks by competing for food and resources. The entire colony replicates every week through a synchronized asexual budding process. *B. schlosseri* can shed eggs that are fertilized in the water. A single free-swimming larva settles within 36 hours and begins dividing into genetically identical clones to form a colony. Colonies appear to fuse with close relatives, providing the advantage of a larger colony that may be more resistant to overgrowth and may reach sexual maturity earlier.

SIMILAR SPECIES

Mature *Botryllus schlosseri* may be initially confused for a sponge because of the protruding lobes typically observed in this tunicate's mature stage. *Botrylloides violaceus* (right) is another invasive colonial tunicate that is bright orange, red, or purple and does not have the star-like configuration of *Botryllus schlosseri*.

Botrylloides violaceus

Andrew Martinez

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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Botrylloides violaceus

orange or red sheath tunicate

Andrew Martinez

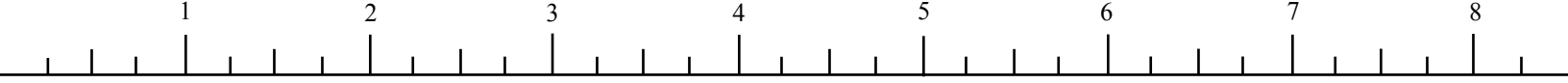
PHYSICAL DESCRIPTION

- Dense clusters of individual animals (zooids) sometimes forming extensive colonies
- Zooids (0.1in) arranged in loose circles, rows, or dense colonies
- Forms firm gelatinous covering; sometimes forms lobes
- Color variable: typically bright orange, red, or dull purple

Andrew Martinez

HABITAT PREFERENCE

- Found primarily in the subtidal zone; occasionally in protected areas within the intertidal zone
- Attaches to submerged structures, algae, slow moving organisms



GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Botrylloides violaceus

orange or red sheath tunicate

INVASION STATUS & ECOLOGICAL CONCERNS

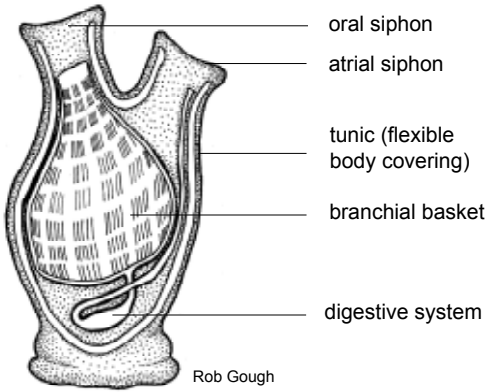
This tunicate is found throughout the entire coastline of the eastern United States. *Botrylloides violaceus* was probably introduced to the United States from its native home in the Northwest Pacific via ship fouling. Since its arrival in the 1970s, it has spread from Maine to Florida. It was also introduced to the British Isles, Norway, and the Mediterranean, Adriatic, and Black Seas. Like other colonial tunicates, it may grow over other organisms, possibly leading to the organism's death.

SIMILAR SPECIES

At first glance, this colonial tunicate may look much like other encrusting marine animals, such as sponges. However, when examined under a microscope, you will see that they have the same structures as solitary tunicates (see diagram on right).

B. violaceus may look similar to orange or red sponges and other colonial tunicates such as *Didemnum vexillum* and *Botryllus schloserri.* However, the texture of *B. violaceus* is more rigid than that of a sponge, and the zooids are arranged in a chain-like pattern, distinguishing it from other colonial tunicate species.

Anatomy of an individual tunicate



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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Codium fragile ssp. *tomentosoides*

green fleece, dead man's fingers

Andrew Martinez

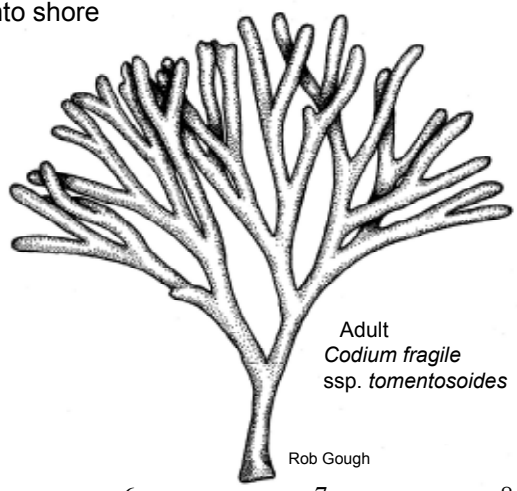
PHYSICAL DESCRIPTION

- Green, spongy seaweed with cylindrical branches
- Attaches by a broad, sponge-like holdfast
- Upright when small, but droops as it gets larger, up to 36 in (91 cm) in length
- Juvenile stages appear as fuzzy, moss-like mats
- Bleaches white when washed onto shore

Andrew Martinez

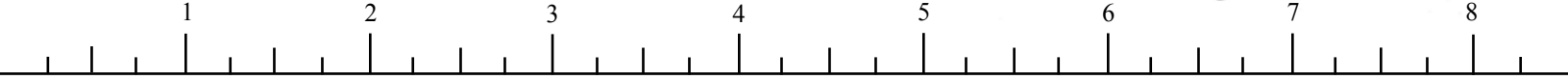
HABITAT PREFERENCE

- Attaches to hard surfaces, e.g. rocks, shells, ship hulls
- Inhabits subtidal zone
- May be found in permanent tidepools and in shallow waters along the coastline



Adult
Codium fragile
ssp. *tomentosoides*

Rob Gough



GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Codium fragile ssp. *tomentosoides*

green fleece, dead man's fingers

INVASION STATUS & ECOLOGICAL CONCERNS

This alga is distributed along nearly the entire coastline of the eastern United States. *Codium fragile* ssp. *tomentosoides* is originally from the Pacific Ocean around Japan. After being introduced into New York from Europe in 1957, it now covers a region from the Gulf of St. Lawrence, Canada to North Carolina. It was first documented in the Gulf of Maine in 1964 at Booth Bay, Maine. A dominant species in the subtidal zone, *C. fragile* ssp. *tomentosoides* may radically change subtidal community composition, structure, and function. It attaches to nearly any hard surface, increasing maintanance labor for aquaculturists and reducing the productivity of cultured species. When this species becomes established in shellfish beds, wave energy can lift the alga. As the alga floats away, it carries its host shellfish away from its normal habitat (resulting in another common name for this species, "oyster thief"). The rapid growth of this species and its ability to regenerate from broken fragments assist it in outcompeting native eelgrass and kelp beds, the primary shelter for many finfish and invertebrates. Dense, low-lying *C. fragile* ssp. *tomentosoides* meadows on the seafloor make movement difficult for lobsters, fish, and other organisms. When washed ashore by storms in great abundance, this alga has fouled beaches.

SIMILAR SPECIES

Codium fragile ssp. *tomentosoides* is occasionally mistaken for a sponge. However, there are no native sponges in the northwest Atlantic Ocean with a similar appearance to this alga.

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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Caprella mutica

spiny red Caprellid amphipod, skeleton shrimp

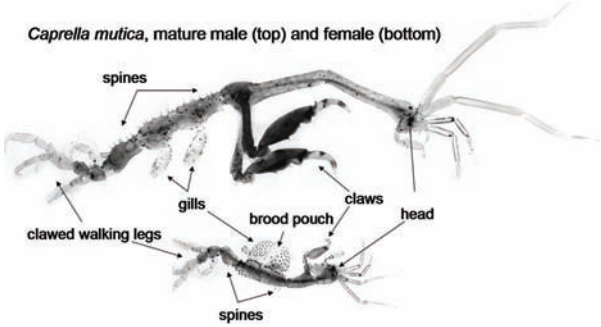
Andrew Martinez

PHYSICAL DESCRIPTION

- Slender crustacean with a skeletal appearance, long robust antennae and large claws
- Distinct ridges of small spines visible on the main body segments that begin at base of neck where the clawed forelegs join the body
- Found at all sizes, but full-grown males reach over 2” (5+ cm) in length, nearly twice as long as adult females
- Males have much longer neck segments and larger claws than females
- Body is often mottled red in color, particularly on full-grown adults
- Highly mobile, animated in appearance, seen “waving” back and forth on substrate, often in large groups; attached to substrate using small posterior legs

HABITAT PREFERENCE

- Abundant in fouling communities on docks, pilings and ropes, as well as on many living substrates, particularly hydroids and macroalgae
- Prefers typical marine salinities but can survive in waters from 20 ppt to over 40 ppt
- Capable of surviving varied water temperatures from ~35°- 85°F (2°- 30°C)



Salem Sound Coastwatch

1 2 3 4 5 6 7 8

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Caprella mutica

spiny red Caprellid amphipod, skeleton shrimp

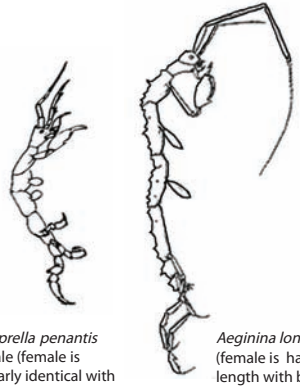
INVASION STATUS & ECOLOGICAL CONCERNS

A native of the western Pacific, *Caprella mutica* is a particularly successful invader, now common throughout the northern hemisphere and parts of the southern Pacific. It can be locally abundant to such an extent that all native Caprellids, and possibly other small crustaceans, may be excluded. Much remains to be studied about their ecology and probable impact but, given their large size, high abundance, and predatory capacity, they are likely one of the most successful invaders in coastal marine habitats.

SIMILAR SPECIES

Several other species of Caprellid amphipods are native to coastal New England, but most have become rare since *C. mutica*'s arrival. Few get much larger than half the length of a full grown *C. mutica* male, and none have the same dense spines found along the back of *C. mutica*'s three main body segments. *Aeginina longicornis* is the only common native that is both of comparable length to mature *C. mutica* and bears spines, though these are found over the entire back of an adult. Additionally, mature *A. longicornis* males lack the long necks of *C. mutica* males.

Caprella penantis, once a common native, is much shorter than *C. mutica*, with males only reaching ½" (14mm), lacking the long neck, and having no body spines. A distinguishing mark is a single small "horn" on its head. Immature specimens can be difficult to distinguish, but if *C. mutica* is present at a site, it is likely that there will be no shortage of large adults to identify. Smaller individuals require more detailed identification using features difficult to distinguish in the field.



Caprella penantis male (female is nearly identical with brood pouch)

Aeginina longicornis (female is half the length with brood pouch)

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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Diadumene lineata

orange-striped anemone

Robert Buchsbaum

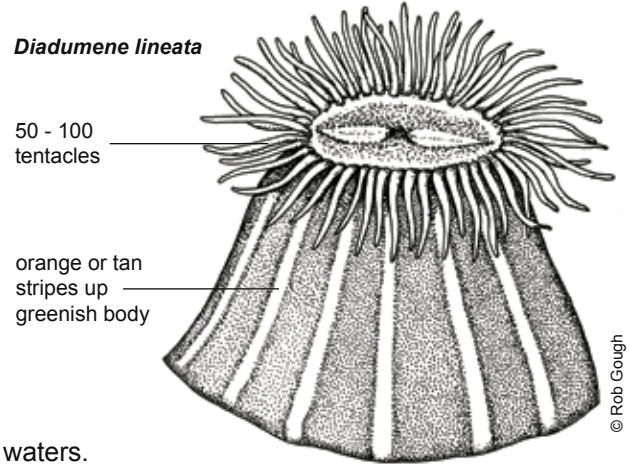
D. lineata with tentacles extended

Andrew N. Cohen

D. lineata with tentacles retracted

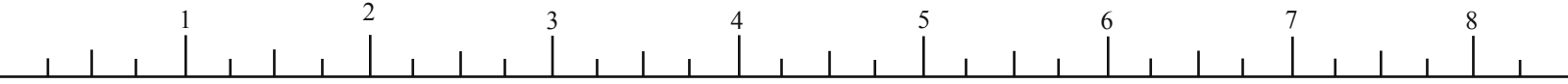
PHYSICAL DESCRIPTION

- Small anemone with crown of 50 - 100 tentacles
- Cylindical light greenish to brown body, typically with thin, vertical, orange or tan stripes
- Grows up to 1.5 in (< 4 cm)



HABITAT PREFERENCE

- Found attached to firm surfaces in shallow, subtidal waters, including tidepools, docks, and other protected areas
- Often associated with mussels or oysters
- May occur in brackish waters
- Occassionally found in mud or on vegetation in marshes and other calm waters.



GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Diadumene lineata

orange-striped anemone

INVASION STATUS & ECOLOGICAL CONCERNS

Diadumene lineata is native to the Western Pacific (Japan, China, Hong Kong), but has a current distribution that also includes Indonesia, New Zealand, and both the Pacific and Atlantic coasts of North America. On Atlantic Ocean shores, this species can be found from Massachusetts to Florida. *D. lineata* was likely spread unintentionally, via fouling on ship hulls and/or by commercial shellfish.

The ecological impact of this species is not well understood. However, it is known as a fouling organism and can negatively impact the structures and organisms on which it grows. For example, mussels and oysters may have difficulty feeding and growing when covered by *D. lineata* colonies. In addition, *D. lineata* shows an ability to tolerate a wide range of abiotic conditions (e.g. temperature and salinity), perhaps tipping the scales in this species' favor in the competition with native anemones for available habitats. This species, like other anemones, can spread rather quickly as a result of its ability to reproduce sexually via external fertilization and asexually by simply splitting themselves in half.

SIMILAR SPECIES

		Body Column	Tentacles	Max. Size	Notes
Metridium senile frilled anemone (right)	native	Variable color; often white, cream, pink; no stripes	100 to 1000 tiny tentacles; form bushy lobes (adults)	18 in (46 cm)	Largest and most common anemone in Gulf of Maine
Fagesia lineata lined anemone	native	Slender, white to brownish body; pale vertical stripes	40 tentacles; positioned in 3 crown-like rings	1.25 in (3 cm)	Prefers steady, swift current amid rocks or sand
Sagartia elegans purple anemone	invasive	Tan to brown body color; no stripes	Up to 200 purple or pink tentacles	8 in. (20 cm)	Introduced from Europe, Prefers calm waters

Lisa Gough

Young *Metridium senile*

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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

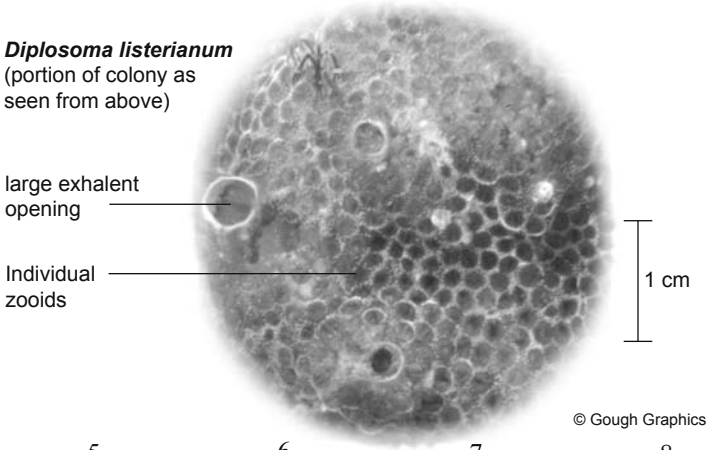
Diplosoma listerianum

compound sea squirt, diplosoma tunicate

Picton, B.E., and Morrow, C.C.

PHYSICAL DESCRIPTION

- Colonial tunicate with small, cylindrical zooids (0.2 cm long)
- Grows in thin, flat, soft, gelatinous sheets on a variety of surfaces
- Milky, translucent appearance, often with white or grey spots
- Individual animals (zooids) are grouped around common large, exhalent openings (atriopore) within the colony
- Colony can grow up to 8 in (20 cm)



© Gough Graphics

HABITAT PREFERENCE

- Grows subtidally, attached to algae, eelgrass, molluscs, and nearly any hard, submerged surface
- Typically found in shallow water, but may occur at depths up to 250 ft (80 m)

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Diplosoma listerianum

compound sea squirt, diplosoma tunicate

INVASION STATUS & ECOLOGICAL CONCERNS

Diplosoma listerianum, likely a native of Europe, was most likely introduced to the Gulf of Maine as a result of its tendency to grow on the hulls of ships, hitchhiking to new locations as these vessels travel. This species can now be found from New Hampshire to Connecticut.

Like other invasive species that grow on both living and non-living surfaces, *D. listerianum* can alter a variety of habitats and may foul submerged pipes, ship hulls, docks, pilings, and other structures. On living organisms such as algae, *D. listerianum* colonies can block light and limit nutrient absorption, weaking their hosts. This species may also outcompete slower growing native species for suitable space.

SIMILAR SPECIES

Ascidiella aspersa

The translucent, milky colonies of *D. listerianum* may cause observers to mistake it for *Ascidiella aspersa*, an invasive, solitary tunicate. However, a closer examination will reveal that *A. aspersa* are firm, bumpy, oval structures, rather than the thin encrusting layers formed by *D. listerianum* colonies.

Robert Buchsbaum

Ascidiella aspersa

Botryllus schlosseri

The sheet-like, gelatinous colonies of *D. listerianum* may also be mistaken for those of other invasive tunicates, including *Botryllus schlosseri* (right). However, *B. schlosseri* zooids are arranged in a star-like pattern, while D. listerianum zooids are randomly positioned around large exhalent openings. In addition, *D. listerianum* is mostly translucent, vs. the light and dark patterning of *B. schlosseri.*

Andrew Martinez

Botryllus schlosseri

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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Didemnum vexillum
(colonial tunicate, ascidian)

Salem Sound Coastwatch

PHYSICAL DESCRIPTION

- Dense colonies of microscopic zooids (individual animals)
- Color variable, including cream, white, tan, or yellow
- On hard substrates, may form long hanging, rope-like lobes, or beard-like colonies
- On sea floor, may form low, undulating mats with short lobes on surface

Dann Blackwood, USGS

Salem Sound Coastwatch

HABITAT PREFERENCE

- Found on hard substrates including docks, pilings, moorings, ship hulls, and rocks
- Primarily a subtidal species; may occur from lower intertidal zone to continental shelf

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Didemnum vexillum

(colonial tunicate, ascidian)

INVASION STATUS & ECOLOGICAL CONCERNS

Observed covering a large area of the continental shelf off New England in the Gulf of Maine region in 2003, *Didemnum vexillum*, a Pacific tunicate, appears to be spreading in the Gulf of Maine. It was first collected in New England in 1993 at Fort Island Narrows, Damariscotta River, Maine as a colony living at 40 ft (12 m; at high tide) on shell-hash and gravel bottom. It has also been observed on dock pilings in Walpole, Maine and Woods Hole, Massachusetts since 1988. It has since been reported in California, and from Maine to Connecticut. As a fouling organism, it grows over a variety of surfaces, altering marine habitats and threatening to interfere with fishing, aquaculture, and other coastal and offshore activities. It aggressively grows over bivalves and may smother them or interfere with their growth. It has no known predators.

Gretchen Lambert, UW

SIMILAR SPECIES

As a result of its lobed, irregular shape, *Didemnum vexillum* may be confused with other mature colonial tunicates, including *Botrylloides violaceus*. However, *Didemnum vexillum* does not have the red and orange coloring of *B. violaceus*. This species may also resemble a sponge, but colonies of *Didemnum vexillum* are firm and have a smoother texture than a sponge.

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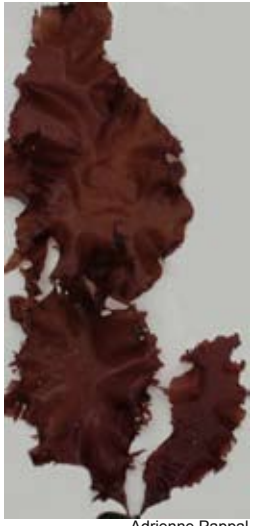
GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Grateloupia turuturu
red algae

Emily Jones



Adrienne Pappal

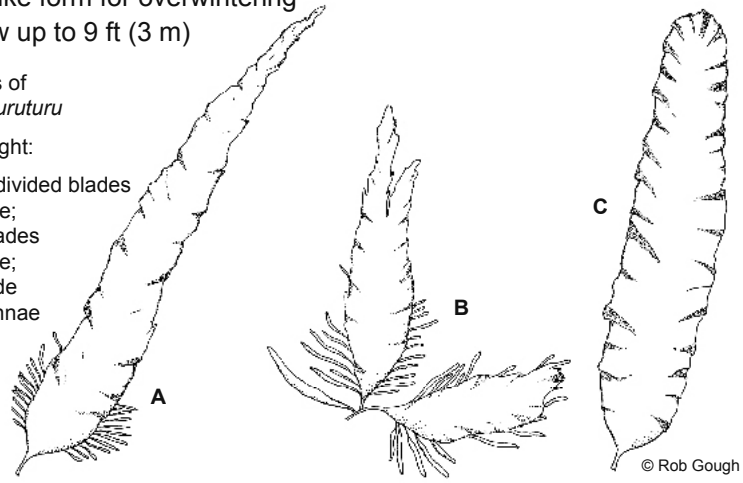
PHYSICAL DESCRIPTION

- Red alga with thin, pink to maroon blades, often with bladelets (pinnae) at base, and a distinctly gelatinous, slippery texture
- Variable growth forms (divided or undivided, varying blade shapes)
- Grows singly, but more typically in clumps of up to 8 individuals
- Grows to full lengths in late summer and early fall, then reduces to crust-like form for overwintering
- Can grow up to 9 ft (3 m)

Various forms of *Grateloupia turuturu*

From left to right:

A. Single, undivided blades with pinnae;
B. Divided blades with pinnae;
C. Single blade without pinnae



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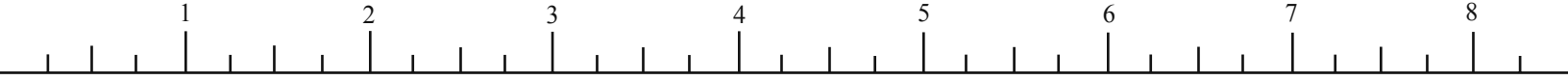
HABITAT PREFERENCE

- Found in shallow water down to 2m below mean low water, attached to firm surfaces
- Prefers protected waters such as tidal pools
- Believed to be unable to survive very cold water



GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Grateloupia turuturu

red algae

INVASION STATUS & ECOLOGICAL CONCERNS

Grateloupia turuturu (formerly known as *Grateloupia doryphora*) was introduced from the Pacific Ocean, possibly originating from Japan, and was first found on eastern North American shores in Narragansett Bay, RI (1996). This alga has since spread south to Long Island Sound and north to Cape Cod, Mt. Hope Bay and Boston Harbor, MA. The initial method of introduction was probably spores released in ballast water discharge. To date, its expansion northward into the Gulf of Maine seems limited by its apparent inability to tolerate very cold water.

This alga reproduces by spores that settle onto hard surfaces and form crusts that soon sprout into long red leaves. Detached blades can also survive and attach elsewhere as new individuals. While the impact of this species is not yet well understood, its growth pattern and habitat preferences make it a threat to native red algal species, particularly *Palmaria palmata* and *Chondrus crispus*. Studies of *G. turuturu* are also focusing on the impacts of shading caused by its broad blades which may prevent other algae from growing nearby, and how its winter die-back affects local ecology. For example, *G. turuturu* may be replacing algal species such as *C. crispus* that provide an important winter food source for snails and other invertebrates.

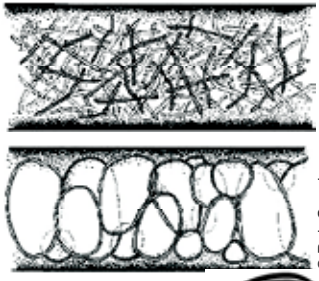
SIMILAR SPECIES

Palmaria palmata (dulse)
Grateloupia turuturu may easily be mistaken for *Palmaria palmata*, a native red alga with a similar appearance. However, careful study reveals several key physical differences. *P. palmata* has thicker, more leathery blades that typically branch dichotomously or palmately (see right). The gelationous and slippery texture of the *G. turuturu's* thallus (body), and the filamentous medulla (internal tissue) (Fig. A at right), vs. rounded cells (Fig. B) are useful in clearly separating these two species.

Palmaria palmata

R. Gough

Cross-section of Medulla (tissue)



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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Membranipora membranacea
lacy crust bryozoan

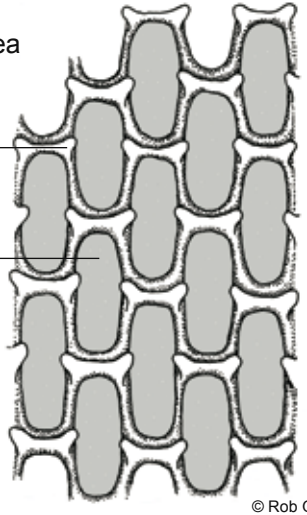
Rob Gough

M. membranacea colonies on base of kelp blades

PHYSICAL DESCRIPTION

- Bryozoan encrusts algae and other firm surfaces
- Colonies form a white or gray net or lace of tiny rectangular (or rhomboid) zooids, often beginning as a round colony spreading outward
- Each animal (zooid) has short spines (tubercles), giving the colony a sandpaper texture
- Thin, encrusting colonies vary in surface area

Close-up of *M. membranacea* colony on kelp



Membranipora membranacea
(portion of colony)

© Rob Gough

HABITAT PREFERENCE

- Found in shallow, subtidal waters on kelp and other algae
- Grows best in areas of fast flowing water or high tidal exchange

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Membranipora membranacea

lacy crust bryozoan

INVASION STATUS & ECOLOGICAL CONCERNS

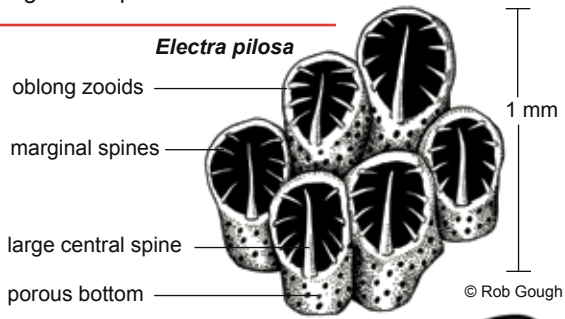
M. membranacea is a native of European waters as well as North America's Pacific coast from Alaska to Baja California. This species was first discovered at the Isles of Shoals in 1987, probably introduced via ballast water. Within a few years, the species had spread throughout the entire Gulf of Maine, first growing primarily on kelp, then on a variety of species.

While the full impact of this species is still being investigated, it appears to have a negative affect on the algal species that often serve as its host. As a *M. membranacea* colony grows, it forms a sheet across the surface of its host plant, reducing its ability to photosynthesize and making the algal body brittle, often causing it to break under the surrounding wave energy. As kelp beds become damaged or destroyed, they then may serve as ideal locations for the establishment of other invasives plants, including *Codium fragile* ssp. *tomentosoides.* The synergistic relationship between these two opportunistic species increases the potential for negative impacts.

Below: A specimen of *Fucus* sp. nearly completely covered by *M. membranacea*.

SIMILAR SPECIES

M. membranacea may at first glance be mistaken for *Electra pilosa*, another encrusting bryozoan. However, closer inspection using a hand lens, reveals that *E. pilosa* zooids are ovoid (vs. rectangular), surrounded by 4-12 spines (typically nine) including one larger central spine, and contain large pores throughout the bottom third (see right). Perhaps the most apparent difference is the often spiny appearance of *E. pilosa*, caused by the protruding central spine and the rounded zooids.



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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Ostrea edulis

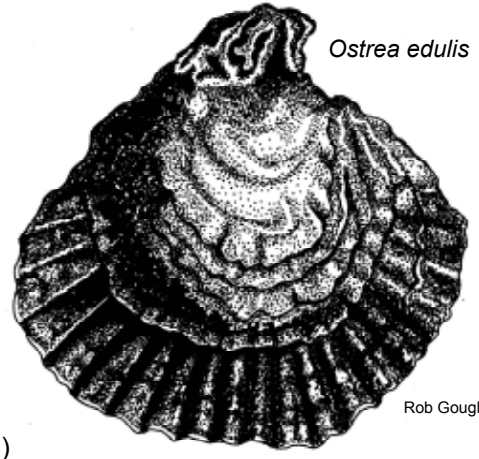
European flat oyster

Salem Sound Coastwatch

PHYSICAL DESCRIPTION

- Shell slightly scalloped and usually rounder than native oyster, *Crassostrea virginica*
- Flat, grayish-white shell, typically with a white muscle scar on internal surface
- Grows up to 8 in (20 cm) in length

Salem Sound Coastwatch



Rob Gough

Salem Sound Coastwatch

HABITAT PREFERENCE

- Estuarine, intertidal to subtidal
- Found on hard, stable surfaces or structures from the low water line to depths of 30 feet (9.2 m)
- Observed in muddy areas attached to debris or any available hard surface
- Does not appear to overlap with native oysters, but occasionally is found with blue mussels

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Ostrea edulis

European flat oyster

INVASION STATUS & ECOLOGICAL CONCERNS

Introduced from Europe where it occurs from Norway to Morocco and into the Mediterranean and Black seas, *Ostrea edulis* has been cultivated in the United States in the Pacific Northwest and northern New England. The European oyster was imported to Maine in the 1950s for aquaculture. It is believed to have escaped from the former Salem Harbor marine aquaculture facility in Massachusetts during the 1980s. A 1997 survey revealed dense concentrations of *O. edulis* in Salem Harbor, Danvers River, and Manchester Bay (Salem Sound), Massachusetts. Lower densities were observed north to Cape Ann and south to Boston Harbor. *O. edulis* continue to be harvested in Casco Bay, Maine, while all shellfish harvesting for human consumption is prohibited in Salem Sound. In the Northeast, *O. edulis* appears to occupy a different niche than the native oyster population, and it is yet to be determined if there are ecological impacts. There is ecological concern over *O. edulis* hosting a parasite *(Bonamia ostreae)* that infects and kills oysters. Although this parasite does not appear to affect *Crassostrea virginica*, there is concern that the parasite might eventually "jump" over to this native species.

SIMILAR SPECIES

Crassostrea virginica - NATIVE
Common, Eastern, Atlantic, or Virginia oyster;
Native commercial oyster found from
the Gulf of St. Lawrence to the West Indies,
including the northern Gulf of Mexico.

- Grayish, rough, elongated shell
- Highly variable shape and wavy margins
- Narrow at hinge, gradually widens
- Typically has a purple muscle scar
- Grows up to 10 in (25 cm) in length

Crassostrea virginica

Salem Sound Coastwatch

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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Styela clava

club tunicate (sea squirt, ascidian)

Andrew Martinez

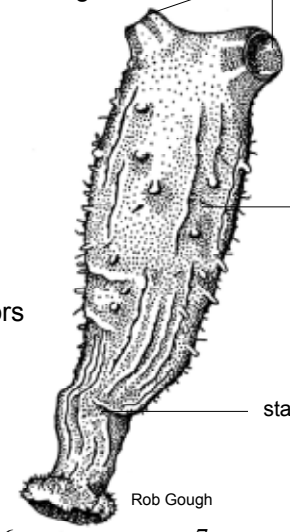
PHYSICAL DESCRIPTION

- Club-shaped with two siphons; anchored to substrate by a stalk
- Tough, leathery, bumpy exterior; often covered with other organisms
- Up to 8 in (20 cm) with stalk approximately 1/3 of its total length

Andrew Martinez

HABITAT PREFERENCE

- Found in shallow subtidal waters on hard surfaces
- Abundant within sheltered areas like docks and harbors



Styela clava

Rob Gough

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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Styela clava

club tunicate (sea squirt, ascidian)

INVASION STATUS & ECOLOGICAL CONCERNS

Abundant in sheltered, subtidal waters attached to hard surfaces, *Styela clava* was introduced from Japan into Newport Harbor, California in the 1920s, where it went unidentified until 1933. By 1949, it was one of the two dominant tunicates in the bay, replacing native solitary tunicates. It first appeared in Long Island Sound, Connecticut in 1973 and rapidly spread north to Prince Edward Island and south to New Jersey. This species is a tough competitor for settlement space and food and is a fouling organism on ship hulls, mussels, and oyster beds. The transport of oysters and the movement of ships has probably advanced its rapid dispersal.

SIMILAR SPECIES

Molgula manhattensis
Sea grape

- Translucent gray or greenish-blue
- Often occurring in dense clusters
- Encrusted with debris
- More rounded shape than *Styela clava*

Boltenia ovifera
Stalked sea squirt, sea onion

- White, tan, orange or red bulb-like body
- Translucent stalk two to four times longer than body
- Entire animal reaching 12 in (30 cm) or more in length
- Siphons on one side; incurrent aimed upwards, excurrent aimed downward

Stalked sea squirts, *Boltenia ovifera*, (right) have a stouter, more bulb-like shape than club tunicates, *Styela clava*.

Andrew Martinez

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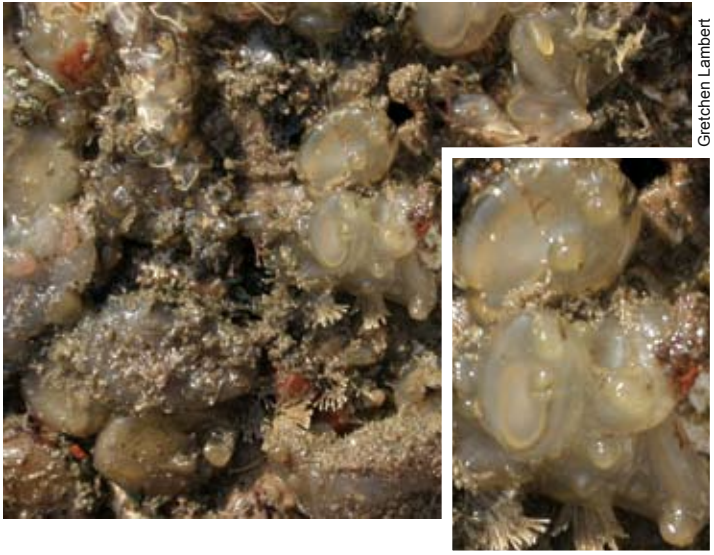
GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Corella eumyota
tunicate

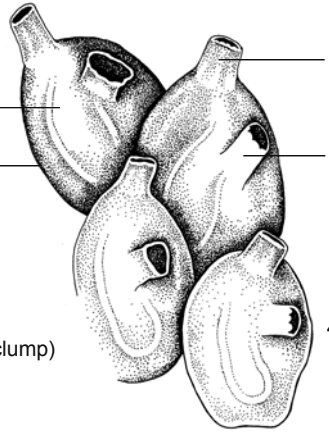
Potential Invader



Gretchen Lambert

PHYSICAL DESCRIPTION

- Grayish, semi-translucent tunic (exterior skin) revealing internal gut and gonads, but occasionally covered with debris
- Rounded, oval or egg-shaped body
- Two prominent siphons: an oral siphon at top, and an atrial siphon located 1/3 of the way down the side of the body
- Often found adhering very tightly to one another in clumps
- Typically grow to 1.5 in (4 cm) in length



Corella eumyota
(4 indiv. shown, portion of clump)

© Rob Gough

HABITAT PREFERENCE

- Found in shallow, subtidal waters attached to docks, pilings, ropes, and other submerged structures
- Prefers calm, protected waters

GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Corella eumyota
tunicate

Potential Invader

INVASION STATUS & ECOLOGICAL CONCERNS

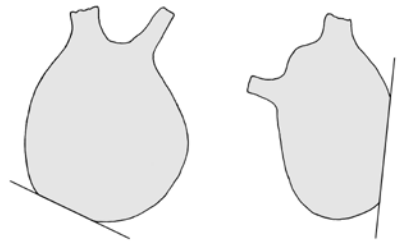
Corella eumyota is abundant and widespread throughout much of the southern hemisphere's oceans, including waters of South America, South Africa, Australia, Tasmania, and New Zealand. In 2002, this tunicate was discovered at two marinas in the English Channel waters of France, representing a range expansion into the northern hemisphere.

Like other invasive tunicates, *C. eumyota* is a fouling organism. In addition to growing in large clumps on floating docks, piers, ropes, ship hulls, and other submerged structures, this species can grow over other organisms and eventually lead to the death of the 'host' organisms. This pattern makes *C. eumyota* a threat to shellfish colonies, as well as other sessile invertebrates.

SIMILAR SPECIES

***Molgula* spp.** (sea grapes)
Like *Corella eumyota*, these tunicates are semi-translucent, often occur in dense clusters, are approximately the same size, and are frequently encrusted with debris. However, *Molgula spp.* typically have more spherical body shapes than the ovoid or egg-shaped *C. eumyota*. *Molgula manhattensis*, one of the most common species of 'sea grape', has a greenish gray body covering. All *Molgula* spp. have both siphons (oral and atrial) positioned at the top of the body versus separated by approx. one third of the body length as in *C. eumyota* (see figure at right).

Body shape, siphon positioning, and typical attachment location of *Molgula* spp. and *Corella eumyota*



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GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Sargassum muticum
Japanese seaweed, wireweed

Potential Invader

Kevin Britton-Simmons

Sargassum muticum underwater during high tide

Luis A. Solorzano / californiabiota.com

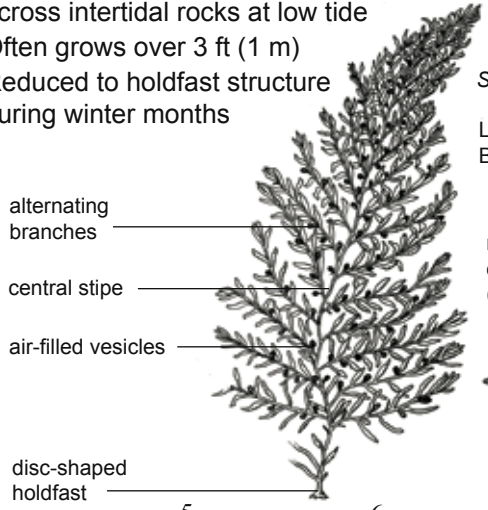
Sargassum muticum exposed on rocks during low tide

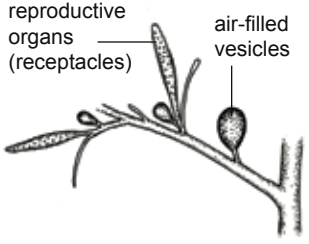
PHYSICAL DESCRIPTION

- Golden-brown alga with alternating, leafy branches off central stipe
- Pea-size, air-filled floats (vesicles) on branches amid leaf-like blades
- Fertile branches have elongate reproductive organs (receptacles)
- Central stipe grows from a disc-shaped holdfast
- Floats upright when completely submerged, then drapes in thick mat across intertidal rocks at low tide
- Often grows over 3 ft (1 m)
- Reduced to holdfast structure during winter months

Sargassum muticum

Left: Stalk of mature individual
Below: Close-up of a fertile branch

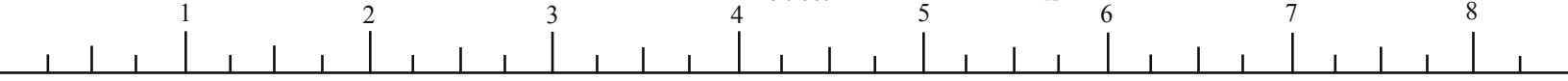




© Rob Gough

HABITAT PREFERENCE

- Found attached to rocky or cobble surfaces in lower intertidal and shallow subtidal zones
- Prefers calm sheltered bays, particularly in physically disturbed areas



GUIDE TO MARINE INVADERS
IN THE GULF OF MAINE

Sargassum muticum

Japanese seaweed, wireweed

Potential Invader

INVASION STATUS & ECOLOGICAL CONCERNS

Sargassum muticum is a native of the Sea of Japan but now occupies most areas of North America's Pacific Coast and Europe's Atlantic Coast. Likely methods of introduction include ship ballast water, ship hull fouling, and hitchhiking on commercially transported shellfish. Once introduced, *S.muticum* spreads rapidly, largely a result of its very effective methods of reproduction. Each individual algae contains both male and female reproductive parts (within the receptacles), facilitating easy reproduction within a single season. This species is also quite resilient. Broken fronds can survive for months, often reproducing during this period. In fall, when waters become colder, *S. muticum* 's fronds die off, leaving behind the holdfast. This holdfast will over-winter and begin rapid growth again in early spring.

The ecological impact of *S. muticum* is not fully known. However, in places where this invader is well established, it reduces the abundance of native alga and eelgrass by shading. When attached to shellfish, the bouyancy of this algae has been strong enough to lift the molluscs and set them adrift, giving cause for some to describe this algae as an "oyster thief". Although *S.muticum* does provide cover for many species and serves as food for others, it is typically not eaten by sea urchins, a fact that aids its ability to outcompete many native algal species that sea urchins readily consume.

SIMILAR SPECIES

Other *Sargassum* species

Should this species be discovered on New England shores, it is most likely to be mistaken for ***Sargassum filipendula***, which is found in southern New England. Like *S. muticum*, *S. filipendula* is found attached to rocks and shells in the subtidal zone to 90 ft (30 m). However, *S. filipendula* has small dark spots on its blades and has longer blades than *S. muticum*.

Other *Sargassum* species include *S. natans* and *S. fluitans*, which comprise the algal rafts that occasionally drift into the Gulf of Maine's offshore waters, carried by currents from the warmer waters of the tropics. It is important to note that these free-floating species differ from *S. muticum* and *S. filipendia* in that the latter must be attached to the bottom by a holdfast to survive.

This identification card is one of a series produced by Salem Sound Coastwatch (www.salemsound.org) highlighting introduced species that pose a threat to the marine environments of Massachusetts and the Gulf of Maine. The original development of these cards was funded by the MA EOEEA Office of Coastal Zone Management with funding from the U.S. Fish and Wildlife Service.
For additional species information or to report sightings, please visit www.mass.gov/czm/invasives/monitor/reporting.htm.

CZM

Undaria pinnatifida

undaria kelp, wakame seaweed

Potential Invader

Photos: Steve Lonhart /Monterey Bay NMS

PHYSICAL DESCRIPTION

- Brown kelp with wide, brown to yellow-tan blades
- Mature plants have a divided blade (with pinnae) with conspicuous midrib, holdfast, stipe (stem), and spiral, folded sporophyll
- Young plants have holdfast, stipe, undivided blade, and initially no midrib
- Grows rapidly to 3-9 ft (1-3 m) long

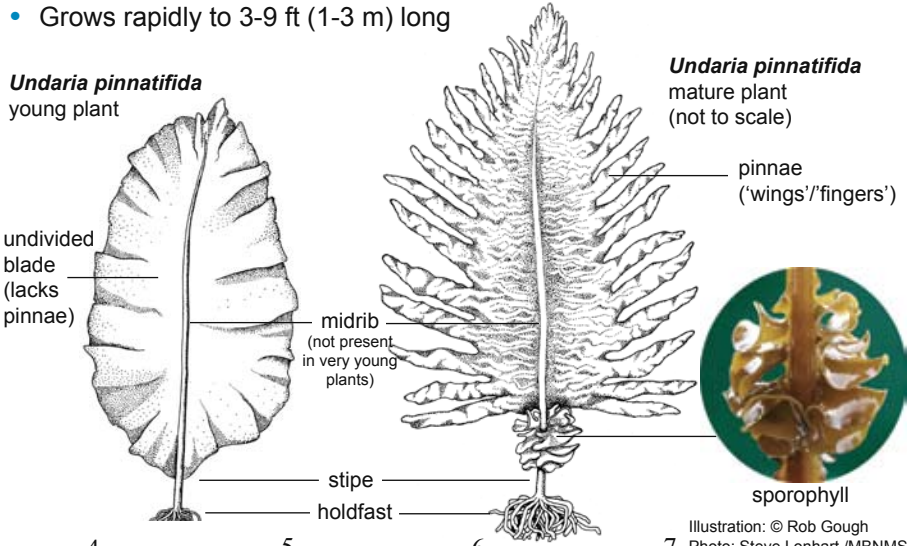


Illustration: © Rob Gough
Photo: Steve Lonhart /MBNMS

HABITAT PREFERENCE

- Found from low intertidal to subtidal depths of approx. 15 ft (5 m)
- Grows on hard surfaces including rocks, ropes, docks, pilings, moorings, and other structures
- Can form dense 'kelp forests' in sheltered waters

GUIDE TO MARINE INVADERS
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Undaria pinnatifida

undaria kelp, wakame seaweed

Potential Invader

INVASION STATUS & ECOLOGICAL CONCERNS

Undaria pinnatifida is an invasive kelp native to Japan. Commonly known as 'wakame', an ingredient in miso soup, this alga is commercially grown throughout Asia for human consumption. It has invaded many of the world's ocean's, from European waters, to waters off New Zealand. In 2001, *U. pinnatifida* was discovered on North American shores in Monterey Bay, CA, where efforts to manually remove it continue today.

This alga is a very prolific and hardy species, with a growth rate measured at 1-2 cm per day, and a max. length of 9 ft (3 m). It can establish itself on a wide variety of surfaces. As a result of its amazing growth rate and wide blades, this seaweed quickly starves the natural understory algae of light. As these algae die, fish and invertebrates must move elsewhere to find food, thus creating extra feeding pressure on adjacent areas. *U. pinnatifida* has drastically affected the ecosystem of many waters that it has invaded. In addition to such ecological damages, it is a fouling species on ship hulls, nets, fishing gear, moorings, ropes, and other structures, and as such, increases labor and maintenance costs.

SIMILAR SPECIES

Photos (left to right):
1. *S. latissima* blade, stipe and holdfast
2. *S. latissima* blade showing absence of midrib
3. *Alaria sp.* showing midrib

Saccharina latissima (sugar kelp)
Undaria pinnnatifida may be mistaken for our region's native brown kelps, particularly *Saccharina latissima*. However, *S. latissima* has ruffled edges along undivided blades with no midrib, vs. divided blades and conspicuous midrib of *U. pinnatifida*.

Other local kelps
While several of the Gulf of Maine's native kelp species possess some of the features of *U. pinnatifida* (i.e. midrib in *Alaria* sp., divided blades of *Laminaria digitata*), none possess the folded, spiral sporophyll.

1.

Lisa Gough
2.

Lisa Gough
Robert Buchsbaum
3.

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