Maine Outdoor Heritage Fund
Final Report: 191-01-09

Invasive Species in Casco Bay: discovery, distribution and biological assessment

Project summary

During July to November 2019, the Maine Coastal Program (MCP), Maine Department of Environmental Protection (DEP), Wells National Estuarine Research Reserve, and the Casco Bay Estuary Partnership (CBEP) performed invasive species sampling using different methods at representative sites in Casco Bay, Maine to document the spread of two newly discovered invasive species and to understand how different sampling methods may effect invasive species detection.

In recent years, the spread of marine species beyond their native range has accelerated due to increasing global trade and marine commerce (Bax et al. 2003), changes in water temperature (Occhipinti-Ambrogi 2007) and environmental disturbance (Airoldi and Bulleri 2011). While many of these species fail to survive in their new environment, some do and outcompete native species for habitat and food, causing economic and/or environmental damage. Invasive species are considered a global threat to biodiversity and monitoring their presence and impacts is considered a prerequisite for marine environmental management and sustainable development (Lehtiniemi et al., 2015). The importance of early detection is highlighted by instances when eradication was possible (Hayes et al. 2005).

Since 2000, scientists have conducted Rapid Assessment Surveys for Marine Invasive Species at limited sites in Casco Bay as part of a regional effort with a frequency of roughly every three years (McIntyre et al. 2013). In recent years, efforts to discover and catalogue invasive species in the Bay have increased with citizen scientist and volunteer reporting programs like Vital Signs (through the Gulf of Maine Research Institute) and the Marine Invader Monitoring and Information Collaborative (MIMC, through the Wells National Estuarine Research Reserve). However, our knowledge of invasive marine species in Casco Bay is limited by the sampling almost exclusively from land, looking for invasive species on the shore or in very shallow waters, or attached to docks and other human structures.

Sampling subtidal areas of the Bay is as important to understanding the number and extent of marine invasive species, as shown by the discovery of two introduced species in summer 2018 (*Cribrilina mutabilis* and *Grandidierella japonica*, Trott and Enterline 2019, Trott et al. 2020). These species were encountered while sampling three locations in the Bay during a project with priorities not focused on invasive species. Not only are these two species new to Casco Bay, but they are new to the whole of the western North Atlantic Ocean. These species were not detected by regular Rapid Assessment Surveys for Invasive Species performed in 2018, likely because subtidal sampling is necessary to document them. With the support of the Maine Outdoor Heritage Program, this project helped expand our understanding of marine habitat and fauna communities in Casco Bay, specifically:

1) In determining how wide-spread two non-native species discovered in 2018 were in Casco Bay and the species on which they colonize,
2) By gathering information about marine habitat and species communities throughout the Bay to understand how communities differ based on location, depth, substrate, and other factors, and
3) By comparing existing invasive species monitoring at docks and piers (constructed habitat) to natural habitat close to these structures to understand the impact of documented invasive species on nearby natural communities.

Project outcomes

1. Map the distribution of invasive species discovered in Casco Bay

MCP and our project partners identified locations throughout Casco Bay to take targeted bottom samples using a 0.05m^2 Ponar grab deployed with corresponding simultaneous video recordings. We samples 13 sites throughout Casco Bay, representing both the inner and outer Bay, and northern, middle, and southern areas (Figure 1). Each site was chosen because of the presence of eelgrass or kelp, as the two invasive species (*C. mutabilis* and *G. japonica*) found in 2018 were documented in eelgrass, and could also potentially colonize kelp leaves. Each site was sampled every three weeks from July to October, with three samples being taken at each site on each sampling date in order to get an adequate representation of the fauna in the middle, edge, and outside of each eelgrass or kelp bed. In total, we collected 127 grab samples to collect fauna and take seafloor video to identify any epifauna growing on the surface or eelgrass/kelp leaves that we did not collect in our grab. We found *G. japonica* only once during the 2019 sampling on the eelgrass bed close to Spring Point Marina in South Portland on Sept. 25. Interestingly, subsequent grab sampling in 2020 found *G. japonica* again more widespread in the Bay. We found *C. mutabilis* at 10 of the sites, with wide distribution throughout the Bay. While this invasive bryozoan was found in each sampling month, it was more prevalent in September compared to earlier in the summer (Figure 1).

2. Define the physical requirements for their survival by measuring water column environmental conditions, and determine the types habitats they colonize, i.e., seaweed, eelgrass, shells, rocks, sand and muddy bottoms, to begin to understand their potential effects on native populations

A YSI Exo sonde recorded a suite of environmental measures (sea water temperature, salinity, dissolved oxygen, pH, chlorophyll) during each bottom sampling event. These data were compared to the locations of identified introduced species to establish the range physical parameters where each species survives. Plants, animals, and shells associated and/or encrusted with introduced species were also described. Our sampling found *C. mutabilis* primarily on living eelgrass blades, though in many instances we noted that the blades with large colonies were not healthy. We also found *C. mutabilis* on drift eelgrass and seaweeds including knotted wrack (*Ascophyllum nodosum*), rockweed (*Fucus vesiculosus*), Irish moss (*Mastocarpus stellatus*), sugar kelp (*Saccharina latissimi*), as well as on cobble. Though we did find *C. mutabilis* both inside and outside of eelgrass and kelp beds, it was much more likely to encounter the species inside of the bed. In the instances that the species was found outside of the beds, it was found in fouling communities or on hard bottom. The bottom temperature where we found *C. mutabilis* ranged from 14.61-20.39°C,with an average of 16.86°C. The substrate over which the eelgrass and kelp beds were growing was generally muddy sand, though some beds were the *C. mutabilis* was found grew on sediment with high proportions of sand. In one instance on gravel with coarse sand and shell hash, and in another location the bed grew on rock. Where *C. mutabilis* was encountered on kelp and other seaweeds, the substrate was rock. Outside of any beds, the substrate where the invasive species was found was human made or shell hash.

3. Thoroughly examine and classify sampled organisms to detect additional foreign species living in Casco Bay and contribute and assist the development of a marine biological assessment tool

From all 127 samples, plants and animals were sorted on board using a 1mm sieve and brought to the lab where they were identified to the lowest taxon possible, usually species, and counted for a measure of abundance. Video recordings supplemented species identifications to better characterize

habitat characteristics. The distribution and abundance of all species found among different habitats was analyzed in combination with measurements of physical parameters of the water column to describe the requirements for survival of each species within the Bay. All marine habitat data that were collected, including water quality information, sediment, video analysis, and observed marine fauna were catalogued into the Coastal and Marine Ecological Classification Standard (CMECS; FGDC, 2012). CMECS has been officially adopted by the Northeast Regional Ocean Council's Habitat Classification and Ocean Mapping Committee for state and regional mapping efforts. In order to integrate and compare our results to existing coastal and marine habitat information for Maine waters, CMECS was cross-walked with the habitats defined in the Maine State Wildlife Action Plan. The project partners are currently using this information in a project to better classify coastal habitat in Maine.Finally, the data is being provided to the Maine DEP to assess the species assemblages and correlations with marine habitat as part of an effort to develop a marine biological assessment tool similar to the DEP's freshwater biological monitoring program.

4. Comparing existing invasive species monitoring at docks and piers (constructed habitat) to natural habitat close to these structures to understand the impact of documented invasive species on nearby natural communities

The Wells National Estuarine Research Reserve (NERR) leads the program in Maine to discover and catalogue invasive marine species. The Marine Invader Monitoring and Information Collaborative (MIMIC) is a network of trained volunteers, scientists, and state and federal workers who monitor marine invasive species along the Gulf of Maine. The collaborative provides an opportunity for the general public to actively participate in an invasive species early detection network, identify new invaders before they spread out of control, and help improve our understanding of the behavior of established invaders.

MIMIC and works with other citizen scientist and volunteer reporting programs like Vital Signs (through the Gulf of Maine Research Institute) to document marine invasive species exclusively from land, looking for invasive species on the shore or in very shallow waters, or attached to docks and other human structures. As part of this project supported by the Maine Outdoor Heritage Project, we performed tandem sampling methods on August 14, 2019 and September 26, 2019 at the Spring Point Marina in South Portland and the Stone Pier on Chebeague Island to determine if underwater sampling by diving would discover additional invasive species that dock-side samplers could not see, and to determine if the invasive species found on the human-made structures like docks and piers were also present in nearby natural habitats with vertical structure. In this project, we chose nearby eelgrass beds to perform dive surveys and grab sampling to make the comparison. Scientists from the Maine Department of Environmental Protection and the Region 1 Environmental Protection Agency performed the dive surveys and Wells NERR led the dock-side surveys through matching time, and the Maine Coastal Program performed grab sampling with MOHF support and funding from NOAA.

In our tandem sampling efforts, the MIMIC lead directed divers to look for a subset of monitored invasive species that may be more prevalent sub-surface and not attached to dock fouling, and therefore may be overlooked by MIMIC surveys. We found that of these species, some were more frequently encountered by dive surveys than both dock-side samplers (Table 1). These included *Didemnum vexillum* (Mystery Colonial Tunicate), *Diplosoma listerianum* (Diplosoma Tunicate), and *Carcinus maenas* (European Green Crab). In other cases, the dock-side samplers were more likely to detect a species, for example at the Spring Point Marina, the species *Botryllus schlosseri* (Golden Star Tunicate). Comparing the species found at the dock

and pier structures to the natural communities nearby, the dive and grab sampling surveys found few to none of the invasive species observed by MIMIC dock-side samplers. This may be due to differences in seafloor vs. surface temperatures, with invasive species preferring the warmer surface temperatures at the docks. We did find, however, that the invasive bryozoan *C. mutabilis* was more likely to be found in the eelgrass beds than by dock-side samplers (Table 1). Similarly, this is likely due habitat preferences by *C. mutabilis* which seems to more readily colonize on eelgrass than other substrates.

Brief Summary of Project for use in MOHF newsletter and/or Facebook posts

During July to November 2019, the Maine Coastal Program (MCP), Maine Department of Environmental Protection (DEP), Wells National Estuarine Research Reserve, and the Casco Bay Estuary Partnership (CBEP) performed invasive species sampling using different methods at representative sites in Casco Bay, Maine to document the spread of two newly discovered invasive species and to understand how different sampling methods may effect invasive species detection. In recent years, the spread of marine species beyond their native range has accelerated due to increasing global trade and marine commerce, changes in water temperature, and environmental disturbance. Invasive species are considered a global threat to biodiversity and monitoring their presence and impacts is considered a prerequisite for marine environmental management. With the support of the Maine Outdoor Heritage Program, this project helped expand our understanding of marine invasive species and their habitat preferences by determining how wide-spread two non-native species discovered in 2018 were in Casco Bay, and comparing existing invasive species monitoring at docks and piers (constructed habitat) to natural habitat close to these structures to understand the impact of documented invasive species on nearby natural communities. We found that an invasive bryozoan *Cribrilina mutabilis* is widespread throughout Casco Bay, forming colonies on eelgrass beds and to a lesser extent kelp. We also found that current dock-side monitoring of marine invaders is detecting the prevalence of these species well, and that dive surveys may provide additional information about only some species like green crabs and certain tunicates.

Detailed Accounting

The MOHF grant provided the funding for the following:

1) A benthic fauna expert, Dr. Thomas Trott, who led the Maine Coastal Program's sample methodology, collection, benthic fauna sample preservation and analysis, and video interpretation. Dr. Trott provided in-depth analysis of the sampling results and reporting on invasive species presence and associated habitats.

Match funding supported the following:

1) Project management, data analysis, and reporting through the Maine Coastal Program's Research Coordinator
2) Through the Maine Coastal Program, collection, post-processing, and interpretation of multi-beam echosounder bathymetry and backscatter, and identification of eelgrass and other important habitat
3) Project coordination and field work by the Department of Environmental Protection, including advising sampling design and diving methods, performing dive surveys, and assisting in dock-side invasive species sampling

4) Project coordination and field work by the Wells National Estuarine Research Reserve who provided the project team with training on invasive species identification and led dock-side invasive species sampling.

Maine Outdoor Heritage Fund Project Application Budget

Project Title: Invasive Species in Casco Bay: discovery, distribution and biological assessment

Date: 2/1/2019

	(F)	(H)	(J)	(L)	(N)	(P)	(R)
1. Funding Description: *(List Cash Secured, Pending & Inkind Sources, if more space needed list in sections 8, 9 & 10 below)*	**MOHF Request**	**Cash Secured Source #1:** MCP CZM Grant	**Cash Secured Source #2:** Maine DEP EPA Grant	**Cash Secured Source #3:** Wells NERR	**Cash Pending All Sources**	**In-Kind Services**	**Total Budget**
2. Personnel Expenses							
Salary & Benefits	$0	$4,082	$10,012	$1,457	$0	$0	**$15,551**
3. Other Expenses							
Contractual Services	$11,538	$5,960	$0	$0	$0	$0	**$17,498**
Supplies	$0	$0	$0	$0	$0	$0	**$0**
Travel	$0	$0	$0	$0	$0	$0	**$0**
Other: (List)	$0	$0	$0	$0	$0	$0	**$0**
	$0	$0	$0	$0	$0	$0	**$0**
	$0	$0	$0	$0	$0	$0	**$0**
	$0	$0	$0	$0	$0	$0	**$0**
Total Other Expenses	**$11,538**	**$5,960**	**$0**	**$0**	**$0**	**$0**	**$17,498**
4. Capital/Land Acquisition *(Equipment GT $5,000 or Land)*							
Describe:	$0	$0	$0	$0	$0	$0	**$0**
5. Subtotal	**$11,538**	**$10,042**	**$10,012**	**$1,457**	**$0**	**$0**	**$33,049**
6. Indirect Costs *(30%)*	30.00%	30.00%	18.95%	39.78%			
StaCap/DiCap or Other	**$3,462**	**$3,012**	**$1,897**	**$580**			**$8,951**
7. Total Budget	**$15,000**	**$13,054**	**$11,909**	**$2,037**	**$0**	**$0**	**$42,000**

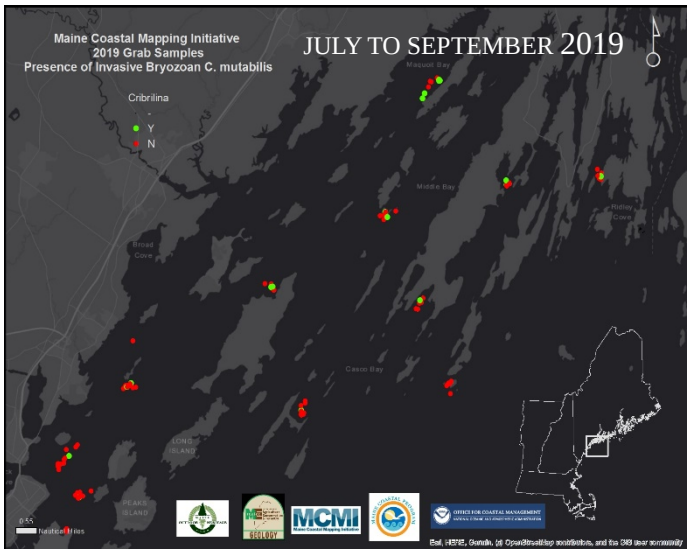
Communications

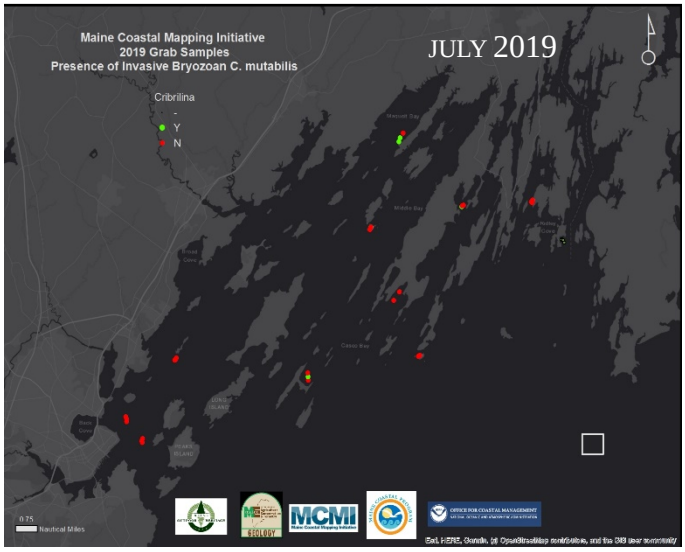
A primary goal of this project was to increase communication about invasive species and sampling for these species. To this end, the project partners met multiple times to discuss the prevalence of invasive species discoveries using different methods. During two field days, the Wells National Estuarine Research Reserve led dock-side invasive species sampling with citizen volunteers at on Chebeague Island and at Spring Point Marina in South Portland and described two new invasive species to look for in during their monitoring. The Maine Coastal Program Research Coordinator also presented the results of the project to the Casco Bay Monitoring Network during their April 2020 annual meeting. The presentation is available at: https://www.cascobayestuary.org/wp-content/uploads/2020/05/Maine-DMR-MCP-Mapping-Initiative-Enterline-4-14-20.pdf. MCP is currently finalizing a technical report detailing the project, methods used, and findings that will be publicly available on the MCP's Maine Coastal Mapping Initiative website in winter of 2021. These reports include:

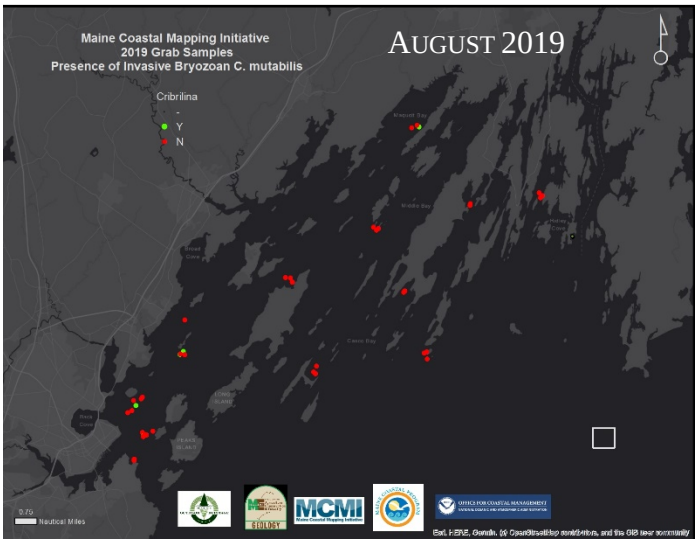
- Enterline C, TJ Trott, J Miller, and A Brewer. In preparation. Comparing methods for invasive species sampling at human structures and natural habitats. Maine Coastal Program Technical Report.
- Trott TJ, and C Enterline. In preparation. Distribution and seasonality of two invasive species (*Cribrilina mutabilis* and *Grandidierella japonica*) in Casco Bay.

Project Maps, Tables & Photos

Figure 1. The Maine Coastal Program performed grab sampling at 13 locations throughout Casco Bay in 2019 to determine the distribution and seasonality of the invasive species *Cribrilina mutabilis*. This species was found at 10 of the locations at least once during July-September, with more prevalence in September.







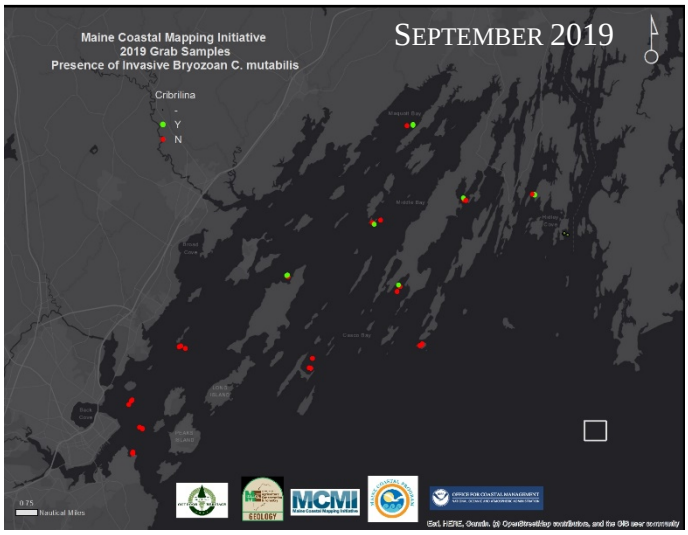


Table 1. Comparison of observations of invasive species recorded by the Marine Invader Monitoring and Information Collaborative (MIMIC) with sampling performed by diving at the dock and with diving and grab sampling at nearby natural eelgrass habitat. The observations that are in bold indicate a difference between observations at the same location using different sampling methods. The hash symbol (-) indicates that divers were not looking for that species during their sampling.

Spring Point, South Portland

		14-Aug-19				26-Sep-19			
	Effort Type	Dock-side	Dive - Dock	Dive - Eelgrass	Grab Sampling - Eelgrass	Dock-side	Dive - Dock	Dive - Eelgrass	Grab Sampling - Eelgrass
	Salinity	26.0	29.7	29.7	30.6*	26.0	29.7	29.7	31.5*
	Water Temp	19.0	18.0	18.0	15.2*	19.0	18.0	18.0	15.0*
Solitary Tunicates	*Ascidiella aspersa* (European Sea Squirt)	Abundnant	-	-	*Absent*	Common	-	-	*Absent*
	Styela clava (Club Tunicate)	Abundnant	Abundnant	*Absent*	*Absent*	**Few**	***Absent***	*Absent*	*Absent*
Colonial Tunicates	*Botrylloides violaceus* (Sheath Tunicate)	Abundnant	-	-	*Absent*	Common	Common	*Absent*	*Absent*
	Botryllus schlosseri (Golden Star Tunicate)	Abundnant	Few	*Absent*	*Absent*	Rare	Rare	*Absent*	*Absent*
	Didemnum vexillum (Mystery Colonial Tunicate)	***Absent***	**Common/Few**	*Absent*	*Absent*	*Absent*	Rare	*Absent*	*Absent*
	Diplosoma listerianum (Diplosoma Tunicate)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
Crabs	*Carcinus maenas* (European Green Crab)	***Absent***	**Common/Few**	**Few**	***Absent***	***Absent***	**Rare**	**Rare**	***Absent***
	Hemigrapsus sanguineus (Asian Shore Crab)	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	Absent	*Absent*	*Absent*
Bushy Bryozoans	*Bugula neritina* (Purple Bushy Bryozoan)	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*
	Tricellaria inopinata (Unexpected Bryozoan)	Common	-	-	*Absent*	Abundant	-	-	*Absent*
Other Fauna	*Caprella mutica* (Japanese Skeleton Shrimp)	Abundnant	-	-	*Absent*	Abundant	-	-	*Absent*
	Diadumene lineata (Orange-Striped Anemone)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
	Membranipora membranacea (Lacy Crust Bryozoan)	Common	-	-	*Absent*	Abundant	-	-	*Absent*
	Ostrea eduli s (European Oyster)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
	Palaemon elegans (European Rock Shrimp)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
Seaweeds (Marine Algae)	*Codium fragile subsp. Fragile* (Green Fleece)	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*
	Colpomenia peregrin a (Sea Potato)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
	Grateloupia turuturu (Red Algae)	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*
Encrusting Bryozoan	*Cribrilina mutabilis*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	**Present**	***Absent***
Amphipods	*Grandidierella japonica*	-	-	-	*Absent*	-	-	-	Present

Stone Pier, Chebeague Is

		14-Aug-19				26-Sep-19			
	Effort Type	Dock-side	Dive - Dock	Dive - Eelgrass	Grab Sampling - Eelgrass	Dock-side	Dive - Dock	Dive - Eelgrass	Grab Sampling - Eelgrass
	Salinity	35.0	35.0	35.0	31.3*	35.0	35.0	35.0	31.6*
	Water Temp	18.0	18.0	18.1	16.0*	18.0	18.0	18.1	16.5*
Solitary Tunicates	*Ascidiella aspersa* (European Sea Squirt)	Rare	-	-	*Absent*	*Absent*	-	-	*Absent*
	Styela clava (Club Tunicate)	Rare	Common	*Absent*	*Absent*	Rare	Few	*Absent*	*Absent*
Colonial Tunicates	*Botrylloides violaceus* (Sheath Tunicate)	Common	-	Few	*Absent*	Few	Few	*Absent*	*Absent*
	Botryllus schlosseri (Golden Star Tunicate)	**Rare**	***Absent***	**Rare**	***Absent***	*Absent*	*Absent*	*Absent*	*Absent*
	Didemnum vexillum (Mystery Colonial Tunicate)	Abundant	Abundant	**Few**	***Absent***	Common	Abundant	**Few**	***Absent***
	Diplosoma listerianum (Diplosoma Tunicate)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
Crabs	*Carcinus maenas* (European Green Crab)	***Absent***	**Few**	**Rare**	***Absent***	Rare	Rare	**Few**	***Absent***
	Hemigrapsus sanguineus (Asian Shore Crab)	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*
Bushy Bryozoans	*Bugula neritina* (Purple Bushy Bryozoan)	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	***Absent***	**Present**
	Tricellaria inopinata (Unexpected Bryozoan)	Common	-	-	*Absent*	Abundant	Abundant	*Absent*	*Absent*
Other Fauna	*Caprella mutica* (Japanese Skeleton Shrimp)	Common	-	-	*Absent*	*Absent*	-	-	*Absent*
	Diadumene lineata (Orange-Striped Anemone)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
	Membranipora membranacea (Lacy Crust Bryozoan)	Rare	-	-	*Absent*	Few	-	-	*Absent*
	Ostrea eduli s (European Oyster)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
	Palaemon elegans (European Rock Shrimp)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
Seaweeds (Marine Algae)	*Codium fragile subsp. Fragile* (Green Fleece)	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*
	Colpomenia peregrin a (Sea Potato)	*Absent*	-	-	*Absent*	*Absent*	-	-	*Absent*
	Grateloupia turuturu (Red Algae)	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*
Encrusting Bryozoan	*Cribrilina mutabilis*	*Absent*	*Absent*	**Present**	***Absent***	*Absent*	*Absent*	***Absent***	**Present**
Amphipods	*Grandidierella japonica*	-	-	-	*Absent*	-	-	-	*Absent*

Tandem sampling photos from Maine Department of Environmental Protection, Wells National Estuarine Research Reserve, and the Region 1 Environmental Protection Agency