American Oyster

Crassostrea virginica

Federal Listing	N/A
State Listing	SGCN
Global Rank	G5
State Rank	S5
Regional Status	

Justification (Reason for Concern in NH)

Oysters are a highly prized edible shellfish and have served as a food source throughout time in coastal New Hampshire. Pre-European inhabitants (Native Americans) took them as evidenced by shell middens along the shores of Great Bay. Colonial and post-colonial settlers first took them in small numbers to supplement their diets and later began to exploit them for commercial gain. Today native oysters are taken only by recreational shellfish harvesters for personal consumption. The commercial taking of oysters presently is restricted to licensed aquaculture operations that rely mainly on imported spat that is grown to market size in two to three years. Aside from the taking of oysters by man and their natural predators, they are beset with substantial environmental challenges. The sustainability of oysters requires replacement by successful reproduction and this has not been seen over the past several decades. Successful annual recruitment of young oysters to the oyster
beds is a documented problem of principal importance. Secondarily, once settled they may be subject to the anthropogenic environmental challenges of pollution.

Distribution

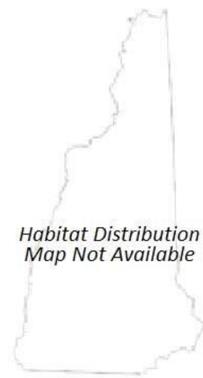
The American (or Eastern) oyster ranges from the Gulf of Mexico, up along the Atlantic seaboard in estuaries and marshes through the Gulf of Maine to the Canadian Provinces. Populations are also found in the Gulf of St. Lawrence.

Habitat

The American oyster is found in New Hampshire's estuaries and near shore waters. Great Bay and its tributaries serve as the principal location for them with small patches in Rye Harbor and at the Isles of Shoals. Oysters become established initially where there is a hard, rocky bottom and once oyster growth begins at a particular location it is added upon by subsequent sets of oyster spat on existing shell. During their reproductive cycle, larval systems are planktonic and may distribute over a sizeable area dependent on water movement during the 2 to 4 week planktonic stage. At the completion of their planktonic existence, those that are at areas suitable for settlement (i.e. at locations with hard bottom or ideally with already established oyster beds) attach and will remain at that location for the remainder of their life.

NH Wildlife Action Plan Habitats

● Estuarine



Distribution Map

Current Species and Habitat Condition in New Hampshire

Historically, American oysters occurred throughout Great Bay Estuary (Goode 1887). Rampant oyster harvesting with tongs and dredges thru the ice during winter months resulted in deterioration of oyster reefs in the late 1800's (Bolster 2012). Outbreaks of the oyster disease causing parasites Multinucleated Sphere Unknown (MSX) (*Haplosporidium nelson*) in 1995 and Dermo (*Perkinsus marinus*) in 1996 resulted in very sharp declines in the oyster population from over 25 million in 1993 to 1.2 million in 2000. Oyster populations increased slightly in 2011 to 2.2 million (PREP 2013). Key legally harvestable oyster beds in the Great Bay estuary system include Adams Point, Woodman Point, and Nannie Island; closed oyster beds include the Squamscott River, Oyster River, and Piscataqua River. Restoration efforts between 2000 and 2011 have restored over 12 acres of oyster bed in the Great Bay Estuary (PREP 2013).

Population Management Status

No commercial harvest of wild oysters is allowed in NH. A recreational oyster license is available to NH residents only and allows for the daily harvest of ½ bushel of unshucked oysters. Recreational harvest is allowed from September 1st to June 30th. Habitat restoration efforts are ongoing in Great Bay Estuary and include both shell-planting and setting of spat-on-shell.

Regulatory Protection (for explanations, see Appendix I)

● Harvest permit - season/take regulations

Quality of Habitat

American oysters require adequate substrate and are highly tolerant to a wide range of temperatures and salinities. However, temperatures much above 32*C can be stressful and lethal (Kennedy 1996). The optimum salinity range is between 14 to 28 ppt. Suitable habitat exists throughout Great Bay Estuary and in tributaries.

Habitat Protection Status

Oyster beds located in closed shellfish harvest areas in Great Bay are protected from harvest. Oyster aquaculture is only allowed within Little Bay and in areas that do not contain eel grass (*Zostera marina*).

Habitat Management Status

Current restoration techniques used in Great Bay Estuary include both shell planting and remote setting. These techniques are used to create habitat for the settlement and growth of oysters.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Habitat degradation from oil spills (Threat Rank: High)

Oil introduced into the marine environment can have lethal and sub lethal effects on a variety of marine life across all life stages. Oil has the potential to come in contact with marine life through various industrial and shipping processes that inhabit our coastal waters. Oil spills pose the biggest threat with the potential to disperse large amounts of oil into the marine environment.

Shellfish exposed to oil have been shown to exhibit changes in respiration, reproductive development, feeding, growth rates, behavior, biochemistry, and mortality (Stekoll et al., 1980). Early stages of shellfish are more susceptible to effects of oil pollution than adults.

Habitat impacts from increased freshwater run-off (Threat Rank: Medium)

Siltation from erosion, tidal activity, storms (i.e., hurricane), and dredging can negatively alter oyster habitat. The majority of marine pollutants originate from terrestrial environments. Erosion from farmland and urban development can result in siltation of aquatic environments (turbidity), although more recent extensive dredging for shipping channels have contributed. Reduced light and poor water quality typically result and can limit or conceivably eliminate the ability for bivalves to filter feed. Proliferation of impervious surfaces, driven primarily by residential and industrial development, amplifies freshwater runoff to our lakes, rivers, and ultimately our marine environments. The extent this influence has on the environment is dependent on the duration and intensity of the meteorological or anthropogenic event.

Urbanization along coastal areas is undergoing continuous growth and expansion resulting in increased runoff and siltation, which could alter circulation patterns in tidal zones typically inhabited by shellfish. Fresh water runoff results in decreased salinity which can cause oyster mortality and low spatfall (Galtsoff 1972). Research suggests warm temperatures decrease oyster tolerance to low salinities (Galtsoff 1972). Oysters from low-salinity areas tend to be small and growth is slow (Kennedy 1996).

Habitat impacts from coastal acidification related to climate change and nutrient run-off (Threat Rank: Medium)

Anthropogenic CO2 in the atmosphere reacts to form carbonic acid (H2CO3) in the ocean. Carbonic acid dissociates to form bicarbonate (HCO3) and hydrogen (H+) resulting in a decrease in seawater pH. The formation of additional hydrogen ions favors the increased formation of bicarbonate ions over carbonate ions (CO23-). Fewer carbonate ions hinders the formation of calcium carbonate (CaCO3) which is an important process for building and maintaining shells in shellfish.

One third of all anthropogenic sources of CO2 over the past 200 years have been stored in the ocean. This increase in CO2 is making the oceans more acidic. The effect of ocean acidification is suggested to inhibit the growth and survival of larval shellfish, having potentially negative effects on shellfish populations (Talmage and Gobler, 2010). Talmage and Gobler (2009) have found that American oysters exposed to the CO2 levels projected to occur in the near future, could have lowered growth and delayed metamorphosis.

Habitat and species impacts from harvesting (Threat Rank: Medium)

Oysters are harvested recreationally by New Hampshire residents from September 1st to June 30th, subject to closures. No commercial harvesting is allowed. Oysters are taken by hand or tong only and the use of a rake is prohibited. Harvest is limited to ½ bushel unshucked oysters per day with no size limit.

The harvest of oysters occurs in the state of New Hampshire and is therefore managed through issuing licenses and specific harvest regulations.

Habitat impacts from introduced or invasive species (Threat Rank: Medium)

Introduced or invasive species are commonly transported and introduced in the marine environment through vessels, bilge water, and marine debris across the globe. Some exotic pets or aquarium fish released also have the potential to become established and compete with native species. Warming sea temperatures and large storm events play a role in introducing historically non-native species into new environments. Several diseases are known to mortally affect American oyster populations. Dermo is transmitted from oyster to oyster and is released into the water column as dead oyster tissue disintegrates. The free-swimming zoophore phase is ingested by living oysters (Kennedy 1996). Dermo proliferates rapidly in warm, high salinity waters. The mechanism by which MSX is transmitted is unknown and the disease is suppressed by low temperatures as well as low salinities (Kennedy 1996).

Green crabs (*Carcinus maenas*) are well known predators of softshell clam and many species of shellfish. Green crabs are a pervasive threat to native shellfish communities and have been implicated in the reduction and destruction of many shellfish species. Menzel et al., (1996) reported that the blue crab (*Callinectes sapidus*) become serious predators when oysters are weakened by high temperatures. Outbreaks of the oyster disease causing parasites MSX in 1995 and Dermo in 1996 resulted in very sharp declines in the oyster population from over 25 million in 1993 to 1.2 million in 2000 (PREP 2013).

Habitat impacts from excess nutrients (waste water) (Threat Rank: Medium)

The immediate proximity of the intertidal zone, generally colonized by shellfish, can result in an increased risk and susceptibility to anthropogenic pollutants. Contaminants enter the marine environment through waste treatment facilities discharge, industrial processes, along with domestic and agricultural runoff.

Untreated sewage discharged to marine environments has triggered numerous shellfish bed closures, and in effect, large economic losses to the industry, along with an adverse effect on cultural, social, and ecological benefits (Abraham and Dillon 1986).

Habitat degradation from contamination of studied contaminants (Threat Rank: Medium)

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Habitat degradation from excess nutrients (including algal blooms) (Threat Rank: Medium)

Eutrophication is an environmental response to excess nutrients, primarily nitrogen (N) and phosphorous (P) that enter an aquatic environment though industrial, domestic, and agricultural runoff. Surplus nutrients stimulate algae and phytoplankton growth, resulting in blooms. Large concentrations of algae can reduce light penetration to ecologically important species that inhabit the seafloor, ultimately reducing biological diversity if prolonged. Typically, the algae eventually die and settle to the seafloor, where biological decay of the organisms result in reduced oxygen levels (anoxia) in the environment.

Large rain events can result in nutrient runoff from farmlands that create large algae blooms eventually leading to a dead zone; an area of low oxygen where species struggle to obtain oxygen to survive. Algal blooms can be enhanced through eutrophication in turn causing mortality and inhibiting oyster growth and survival at all life stages. Increases in phytoplankton can result in an increase in filter-feeding predators which can decrease larval oyster abundances (Kennedy 1996).

List of Lower Ranking Threats:

Habitat degradation from emerging or unmonitored contaminants

Habitat impacts from problematic native species

Habitat degradation from docks

Habitat impacts from moorings

Habitat impacts from non-motorized boating

Habitat impacts from motorized boating

Species impacts and habitat impacts from aquaculture

Habitat impacts from higher temperatures that cause anoxia

Habitat degradation from sea level rise that alters communities

Actions to benefit this Species or Habitat in NH

Find ways to limit oil spills and increased response time to oil spills

Primary Threat Addressed: Habitat degradation from oil spills

Specific Threat (IUCN Threat Levels): Pollution / Industrial & military effluents / Oil spills

Objective:
Increase response time in the event of an oil spill.

General Strategy:
Coordination of all agencies responsible for oil spill clean-up and monitoring of water bodies for signs of smaller oil spills. The impact of oil spills can vary depending on the grade of the oil and their size and location in coastal waters. A quick repose time is needed to limit the damage an oil spill can have on oyster reefs and other marine resources. Coordination between agencies and the public with strategies for quick response by agencies when an oil spill occurs will help limit the damage an oil spill can have on the environment.

Political Location:
Statewide

Watershed Location:
Coastal Watershed

Assess native oyster populations response to ocean acidification and educate the public about this issue

Primary Threat Addressed: Habitat impacts from coastal acidification related to climate change and nutrient run-off

Specific Threat (IUCN Threat Levels): Climate change & severe weather / Other impacts / Climate change & severe weather

Objective:
Inform the public on how ocean acidification is impacting native oyster populations.

General Strategy:
Assess native oyster populations through yearly oyster population surveys and determine how ocean acidification is impacting native oyster beds. Ocean acidification will cause stress on oysters throughout Great Bay. Oysters filter excess nutrients from the water column and create complex habitat that is utilized by numerous species of invertebrates and fish. Public outreach on ocean acidification will inform people on how native oyster populations and coastal waters will be impacted.

Political Location:
Statewide

Watershed Location:
Coastal Watershed

Monitor the impact of oyster diseases

Primary Threat Addressed: Habitat impacts from introduced or invasive species

Specific Threat (IUCN Threat Levels): Invasive & other problematic species, genes & diseases / Invasive non-native/alien species/diseases / Invasive & other problematic species, genes & diseases

Objective:
Monitor the impact of oyster diseases and possibly introduce disease resistant oyster strains.

General Strategy:
Collect oysters throughout Great Bay to determine extent of disease. Monitor the impact oyster diseases are having on native populations throughout Great Bay Estuary. There may be areas in Great Bay less prone to oyster diseases which could be site locations for future oyster restoration

projects. Disease resistant oyster strains could be planted in areas throughout Great Bay to rebuild oyster populations and habitat. Yearly oyster surveys conducted by the New Hampshire Fish and Game Department will assess the conditions of the oyster populations in Great Bay.

Political Location:
Statewide

Watershed Location:
Coastal Watershed

Oyster restoration

Primary Threat Addressed: Habitat and species impacts from harvesting

Specific Threat (IUCN Threat Levels): Biological resource use / Fishing & harvesting aquatic resources / Biological resource use

Objective:
Rebuild oyster population in Great Bay Estuary by restoring oyster beds.

General Strategy:
Restore oyster beds in in Great Bay Estuary. Shell planting in Great Bay Estuary will provide substrate for the settlement of oyster larvae. Restoration of oyster beds will increase the population of oysters throughout Great Bay. Yearly oyster surveys conducted by the New Hampshire Fish and Game Department will assess the conditions of the oyster populations in Great Bay.

Political Location:
Rockingham County

Watershed Location:
Coastal Watershed

References, Data Sources and Authors

Data Sources
Literature review and New Mapshire Fish & Game reports were used to identify distribution and habitat requirements.
Information on oyster habitat and population was obtained from New Hampshire Fish and Game Department harvesting regulations, scientific literature, and consultation with experts.

Data Quality
Since the 1990's, oysters have been monitored annually at the principal beds of the Great Bay system. The survey gathers information on newly settled (spat) and adult oysters. Adult oysters are also tested for prevalence of MSX and Dermo.

2015 Authors:
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2005 Authors:
N/A

Literature

Abraham, B.J., and P. L. Dillon. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic) Softshell clam. U.S. Fish & Wildlife Service. Biol . Rep. 82(11.68). U. S. Army Corps of Engineers, TR EL-82-4. 18 pp.

Bolster, J. W. 2012. The Mortal Sea: Fishing the Atlantic in the age of sail. Belknap Press, Cambridge, Massachusetts.

Galtsoff, P.S. 1972. Bibliography of oysters and other marine organisms associated with oyster bottoms and estuarine ecology. G.K. Hall, New York. 857p.

Goode, G. B. 1887. The Fisheries and fishery industries of the United States, Part II: 105-112. Washington, DC.

Kennedy, V.S., R.I.E. Newell, A.F. Eble (eds.). 1996. The Eastern oyster: *Crassostrea virginica*. Maryland Sea Grant, College Park, Maryland.

Menzel, R.W., N.C. Hulings and R.R. Hathaway. 1996. Oyster abundance in Apalachicola Bay, Florida in relation to biotic associations influenced by salinity and other factors. Gulf Res. Report 2:73-96.

New Hampshire Fish and Game Department, 2009, Testing of Great Bay Oysters for Two Protozoan Pathogens, Piscataqua Region Estuarine Partnership Report.

PREP. 2013. State of our estuaries 2013. Piscataqua Region Estuaries Partnership, Durham, New Hampshire.

Stekoll, M. S., Clement, L. E., Shaw, D. G. (1980). Sublethal effects of chronic oil exposure on the intertidal clam *Macoma balthica*. Marine Biology, 57(1), 51-60.

Talmage, S., and Gobler, C. 2010. Effects of past, present, and future ocean carbon dioxide concentrations on the growth and survival of larval shellfish. Proc. Natl Acad. Sci. USA 107, 17246–17251.

Talmage, S.C. and C.J. Gobler. 2009. The effects of elevated carbon dioxide concentrations on the survival of hard clams (*Mercenaria mercenaria*), bay scallops (*Argopecten irradians*), and Eastern oysters (*Crassostrea virginica*). Limnol. Oceanogr. 54(6):2072-2080.