APPENDIX A: Marine Wildlife

American Oyster 2
Horseshoe Crab 10
Softshell Clam 17
Northern Shrimp 26
Atlantic Sea Scallop 31
Fin Whale 38
North Atlantic Right Whale 44
Humpback Whale 50

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

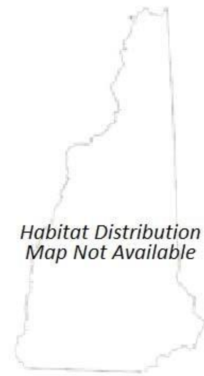
The American (or Eastern) oyster ranges from the Gulf of Mexico, up along the Atlantic seaboard in estuaries and marshes through the Gulf of Maine to the Canadian Provinces. Populations are also found in the Gulf of St. Lawrence.

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)

Oil introduced into the marine environment can have lethal and sublethal 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 occur in 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 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.

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2005 Authors:
Bruce Smith, NHFG

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.

Horseshoe Crab

Limulus polyphemus

Federal Listing	N/A
State Listing	SGCN
Global Rank	NR
State Rank	SNA
Regional Status	

Photo by Rachel Stevens

Justification (Reason for Concern in NH)

Horseshoe crabs are ecologically important for diverse reasons. Horseshoe crab eggs are an excellent source of nutrition for migrating shorebirds and finfish and are used as bait for American eel and conch fisheries. Approximately 500,000 horseshoe crabs are collected each year by the biomedical industry for Limulus amebocyte lysate (LAL), a component of their unique blue blood that can detect foreign bacteria on medical instruments and in drugs. Once they collect a portion of their blood, the horseshoe crabs are returned back to the ocean; however, some mortality occurs through this process.

Distribution

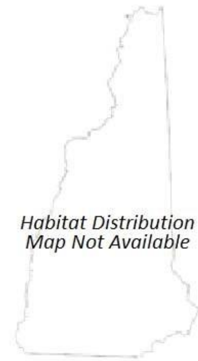
Horseshoe crabs range from northern Maine to the Yucatan peninsula, and are most abundant between New Jersey and Virginia. In New Hampshire, horseshoe crabs exhibit a seasonal pattern of movement in the Great Bay estuary (Watson et al., 2009). During the spring in the Great Bay Estuary, horseshoe crabs move into shallow waters and are highly active during the summer. In the fall, most animals move downriver into deeper water and remain throughout the colder months. Nearshore, shallow water, intertidal, and subtidal flats are considered essential habitat for the development of juvenile horseshoe crabs.

Habitat

Horseshoe crabs are benthic arthropods that prefer sandy habitat. They occupy estuaries and continental shelf habitats. Adults prefer water depths of less than 30 meters but have been observed in depths of greater than 200 meters. During spawning season, which reaches its peak in May and June, horseshoe crabs utilize sandy beaches. Horseshoe crabs typically select beach habitats within bays and coves for protection from the surf. Eggs hatch in approximately 14-30 days after fertilization, depending on temperature. For the first two years of their life, juvenile horseshoe crabs live on intertidal flats. During the first year of development, horseshoe crabs shed their exoskeleton two to three times. As they grow larger, the molting frequency decreases. It generally takes 9 to 11 years and 16-17 molts to reach sexual maturity.

NH Wildlife Action Plan Habitats

- Marine



Distribution Map

Current Species and Habitat Condition in New Hampshire

Populations of horseshoe crabs in New Hampshire (NH) exist in Great Bay Estuary. According to the most current ASMFC stock assessment (ASMFC, 2013) horseshoe crab abundance is declining in New England.

Population Management Status

Harvest of horseshoe crabs in NH is limited to 10 per day and reporting of catch is required. There is no closed season for the harvest of horseshoe crabs. The resource is managed by New Hampshire Fish and Game Department with careful consideration of horseshoe crab population biomass.

Regulatory Protection (for explanations, see Appendix I)

- Harvest permit - season/take regulations

Quality of Habitat

Horseshoe crabs in NH overwinter in the deepest parts of Great Bay estuary and move into shallow water and tributaries of Great Bay in late April and early May (Schaller et al., 2010). Horseshoe crab movement is limited when temperatures are below 8*C, generally between December and March. During the spring, when water temperatures exceed 11*C animals move out of wintering locations and travel to shallow subtidal mudflats prior to spawning. Tidal flats are important nursery areas for horseshoe crabs.

Habitat Protection Status

Currently there is no formal habitat management plan for horseshoe crabs in New Hampshire, however, as a member of the ASMFC abides by the Horseshoe Crab Interstate Fishery Management Plan.

Habitat Management Status

Currently there is no formal habitat management plan for horseshoe crabs in New Hampshire, however, as a member of the abides by the goals and objectives of the ASMFC Horseshoe Crab Interstate Fishery Management Plan.

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.

Species and habitat impacts from increasing sea surface temperatures (Threat Rank: High)

Increased water temperatures may have interactive effects with ocean pH, ultimately decreasing survivorship of larvae and reducing growth of horseshoe crabs.

Both high temperatures and salinities significantly affected the success of embryonic development in horseshoe crabs. Temperatures 35°C and above are lethal to horseshoe crab embryos and adversely affect larval growth and development (Ehlinger and Tankersley, 2004).

Species and habitat impacts from ocean acidification (Threat Rank: Medium)

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

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

Horseshoe crabs are harvested recreationally during the spring and summer for bait in the lobster and eel fishery. There is also unintentional catch by commercial trawling that could reduce local population size.

The harvest of horseshoe crabs is managed by the ASMFC as outlined in the Horseshoe Crab Interstate Management Plan and addendums. Harvest occurs in the state of New Hampshire and is therefore managed through licenses and harvest regulations. All harvesters are required to obtain a coastal harvest permit and report all horseshoe crab effort and catch on a trip level basis.

Habitat impacts from gear effects related to commercial harvest (Threat Rank: Medium)

Habitat degradation from shoreline hardening (Threat Rank: Medium)

Shoreline hardening or armoring, often by the construction of seawalls, has proven beneficial in preserving valuable yet vulnerable waterfront properties thus reducing, if not eliminating damage caused by coastal storm surge. Shoreline barriers can interfere with the formation of beaches, dunes, and intertidal areas, and conceivably devalue the beneficial function of those areas lost (O'Connell, 2010). Collectively, the construction of shoreline barriers and accelerated rate of sea level rise pose environmental risks to coastal marine dwellers.

Research has revealed that intertidal rocky shores adjacent to seawalls had less biological diversity than areas not fragmented by anthropogenic structures (Goodsell et al., 2007). Additionally, artificial infrastructure (i.e., breakwater) can prompt a shift from consumer- to producer-dominated communities, resulting in a dynamic alteration of the ecosystem structure (Martins et al., 2009).

Habitat degradation due to siltation and turbidity from multiple sources (Threat Rank: Medium)

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

Horseshoe crabs, though armored are vulnerable to various pathogens including algae, fungi, cyanobacteria, gram-negative bacteria, and a variety of parasites (Nolan et al., 2009). Green algal infection is the most common pathogen identified from the horseshoe crab (Leibovitz and Lewbart, 1987, 2003). Since horseshoe crabs cease to molt once maturity is reached, severity of green algal disease increases with age (Harrington et al., 2008). Importation of frozen Asian horseshoe crabs for use as bait are a cause for concern and could potentially expose native populations of horseshoe crabs to foreign pathogens and disease.

Green algal disease can lead to loss of tissue structure and function, including deformed shells, degeneration and loss of ocular structures, erosion of the arthrodial membrane, and cardiac hemorrhage (Braverman et al., 2013). The ASMFC recommends that states ban the importation of Asian horseshoe crabs (ASMFC, 2013).

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 organism results in reduced oxygen levels (anoxic) in the environment.

Large rain events can result in nutrient runoff from farmlands, which create large algae bloom, eventually leading to a dead zone, an area of low oxygen where species struggle to obtain oxygen to survive. Increased nutrient loads could increase algae growth. Green algal disease can lead to loss of tissue structure and function in horseshoe crabs, including deformed shells, degeneration and loss of ocular structures, erosion of the arthrodial membrane, and cardiac hemorrhage (Braverman et al. 2013).

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

Crustaceans are sensitive to excessive nutrients, toxic chemicals, and/or sediment originating from water-borne sewerage and non-point run-off from housing and urban areas.

Excessive nutrients cause eutrophication increasing the likelihood of disease.

Habitat impacts from mercury deposition (Threat Rank: Medium)

Mercury is released into the environment as a result of human activity such as coal burning, mining, and industrial processes. Mercury ultimately makes its way into the marine environment through river and watershed inputs, as well as atmospheric deposition.

Horseshoe crab eggs are vulnerable to heavy metals, with mercury, organotin, and cadmium being the most toxic (Botton, 2000). Impacts of heavy metal toxicity include mortality, lower limb regenerative abilities, segment defective embryos, and abnormal eyes (Itow et al.; 1998a, 1998b).

Habitat degradation from oil spills (Threat Rank: Medium)

Oil introduced into the marine environment can have lethal and sublethal 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.

Horseshoe crabs are relatively tolerant of petroleum hydrocarbons, but their tolerance decreases with increasing temperature. Exposure to oil and chlorinated hydrocarbons results in delayed molting and elevated oxygen consumption in horseshoe crab eggs and juveniles (Laughlin and Neff, 1977).

List of Lower Ranking Threats:

Habitat impacts from marine debris

Habitat degradation from emerging or unmonitored contaminants

Habitat degradation from shore-based contamination

Habitat degradation from shoreline hardening

Habitat degradation from dredging and the dumping of spoils

Habitat impacts from recreational boating

Species impacts and habitat impacts from aquaculture

Habitat impacts from increased wave action that causes bottom disturbance

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

References, Data Sources and Authors

Data Sources
Information on horseshoe crab habitat and population was obtained from New Hampshire Fish and Game Department harvesting regulations, scientific literature, and consultation with experts.

Data Quality

New Hampshire is one of the few New England/Mid-Atlantic states that do not participate in an annual horseshoe crab survey (ASMFC, 1998). Little is known about the dynamics of the horseshoe crabs in Great Bay estuary and the environmental parameters that influence the timing of mating. Currently, little is known about the population of horseshoe crabs that reside in the Great Bay Estuary, NH. Scientific studies have mapped the locations of where horseshoe crabs aggregate within the estuary, but populations numbers are unknown (Schaller et al. 2010). In addition, New Hampshire is the only state in New England that does not currently participate in an annual horseshoe crab survey, however did conduct an annual survey between 2001 and 2013.

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2005 Authors:

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Literature

Atlantic States Marine Fisheries Commission (ASMFC). 1998. Interstate Fishery Management Plan for Horseshoe Crab. Fishery Management Report No. 32. Atlantic States Marine Fisheries Commission, Washington, D.C.

Atlantic States Marine Fisheries Commission. 2013. 2013 Horseshoe Crab Stock Assessment Update. Stock Assessment Report of the Atlantic States Marine Fisheries Commission. Washington D.C. 73pp.

Atlantic States Marine Fisheries Commission. 2013. Resolution to Ban the Import and Use of Asian Horseshoe Crabs as Bair. Resolution 13-01. Arlington, VA. 31 pp.

Botton, M. L. 2000. Toxicity of cadmium and mercury to horseshoe crab (*Limulus polyphemus*) embryos and larvae. Bull. Environ. Contam. Toxicol. 64: 137-143.

Botton, M. L., R. E. Loveland, and T. R. Jacobsen. 1988. Beach erosion and geochemical factors: influence on spawning success of horseshoe crabs (*Limulus polyphemus*) in Delaware Bay. Marine Biology 99:325-332.

Braverman, H., L. Leibovitz, and G. A. Lewbart. 2013. Green Algal Infection of American Horseshoe Crab (*Limulus polyphemus*) Exoskeletal Structures. J Invertebr Pathol. 111(1): 90-93.

Ehlinger, G. S., and R. A. Tankersley. 2004. Survival and Development of Horseshoe Crab (Limulus polyphemus) Embryos and Larvae in Hypersaline Conditions. Biol. Bull. 206:87-94.

Goodsell, P. J., M. G. Chapman, and A. J. Underwood. 2007. Differences between biota in anthropogenically fragmented habitats and in naturally patchy habitats. Mar Ecol Prog Ser 351:15-23.

Harrington, J., M. Leippe, P. B. Armstrong. 2008. Epithelial immunity in a marine invertebrate: a cytolytic activity from a cuticular secretion of the American horseshoe crab, *Limulus polyphemus*. Mar. Biol. 153:1165–1171.

Itow, T., R. E. Loveland, and M. L. Botton. 1998a. Developmental abnormalities in horseshoe crab embryos caused by exposure to heavy metals. Arch. Environ. Contam. Toxicol. 35: 33-40.

Itow, T., T. Igarashi, M. L. Botton, and R. E. Loveland. 1998b. Heavy metals inhibit limb regeneration in horseshoe crab larvae. Arch. Environ. Contam. Toxicol. 35: 457-463.

Laughlin, R. B., Jr., J. M. Neff. 1977. Interactive effects of temperature, salinity shock and chronic exposure to No. 2 fuel oil on survival, development rate and respiration of the horseshoe crab, Limulus Polyphemus. In: Wolfe, D. A. (ed.) Fate and effects of petroleum hydrocarbons in marine organisms and ecosystems. Pergamon Press, New York, P. 182-191.

Leibovitz, L., and G. A. Lewbart. 2003. Diseases and symbionts: Vulnerability despite tough shells. In: Shuster CN, Barlow RB, Brockmann HJ, editors. The American Horseshoe Crab. Harvard University Press; Cambridge, MA: 245–275.

Leibovitz, L., and G. A. Lewbart. 1987. A green algal (Chlorophycophytal) infection of the exoskeleton and associated organ structures in the horseshoe crab, *Limulus polyphemus*. Biol. Bull. 173:430.

Martins, G. M., A. F. Amaral, F. M. Wallenstein, and A. I. Neto. 2009. Influence of a breakwater on nearby rocky intertidal community structure, Marine Environmental Research, Volume 67, Issues 4–5, Pages 237-245, ISSN 0141-1136.

Nolan, M., S. A. Smith, and D. R. Smith. 2009. Clinical evaluation, common diseases, and veterinary care of the horseshoe crab, *Limulus polyphemus*. In: Tanacredi JT, Botton ML, editors. Biology and Conservation of Horseshoe Crabs. Springer Science; New York: 479–499.

O'Connell, J. F. 2010. Shoreline armoring impacts and management along the shores of Massachusetts and Kauai, Hawaii , in Shipman, H., Dethier, M.N., Gelfenbaum, G., Fresh, K.L., and Dinicola, R.S., eds., 2010, Puget Sound Shorelines and the Impacts of Armoring—Proceedings of a State of the Science Workshop, May 2009: U.S. Geological Survey Scientific Investigations Report 2010-5254, p. 65-76.

Schaller, S.Y., C. C. Chabot, and W. H. Watson III. 2010. Seasonal movements of American horseshoe crabs Limulus Polyphemus in the Great Bay Estuary, New Hampshire (USA). Curr. Zoll. 56: 587-598.

Watson W. H., S. Y. Schaller, C. C. Chabot. 2009. The relationship between small- and large-scale movements of horseshoe crabs in the Great Bay Estuary and Limulus behavior in the laboratory. IN D. Smith, M. L. B. Botton & J. T. Tanacredi (Eds.),Biology and Conservation of Horseshoe Crabs, (pp. 131-148) New York:Springer.

Softshell Clam

Mya arenaria

Federal Listing	N/A
State Listing	SGCN
Global Rank	NR
State Rank	SNR
Regional Status	

Justification (Reason for Concern in NH)

Softshell clam are a valued recreational harvest resource in New Hampshire. Because of this, they are a highly regulated species with laws and rules controlling their take. Annually, the New Hampshire Fish and Game Department (NHF&G) issues recreational licenses; ranging from over 2,000 licenses to about 1,000 licenses over the past decade. Annual sale of licenses reflect the availability of legally harvestable clams with license sales rising when clam densities rise and drop with declines in their numbers. In addition to softshell clams being the most popular recreational shellfish fishery in New Hampshire, there is also interest in the aquaculture potential of this species.

Distribution

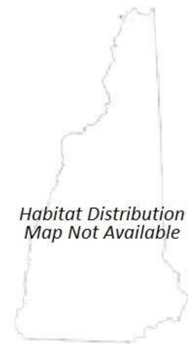
Softshell clam is native to the North American east coast from Labrador to Cape Hatteras. Throughout its range, adult clams occupy the soft (gravel/sand/mud) substrates of the upper intertidal to shallow subtidal zones. There they are found in burrows as deep as 30 cm below the surface and filter-feed by extension of siphons that may project above the substrate surface about an inch. In New Hampshire, the most renowned softshell clam population is within the Hampton- Seabrook Estuary where sizable sandy flats are available. Significant clam flats also exist in Rye, Little Harbor, and throughout the Great Bay/Piscataqua River complex. Currently the population within the Hampton-Seabrook Estuary is monitored by the environmental consulting firm, Normandeau Associates (NAI) who are retained by the owner/operators of Seabrook Station, a large nuclear power generating facility. NAI have annual surveys directed at both the planktonic larval stage and the settled clams from newly set young-of-year to large adults.

Habitat

The softshell clam (*Mya arenaria*) is found on the Atlantic seaboard from Labrador to Cape Hatteras in bays, harbors, and estuarial waters along the coastline (Hanks, 1963). They are found in a wide variety of sediments, but typically intertidally burrowed into sand/mud substrates. Subtidal clams are well established too but far less known as to their distribution. While relatively clean sandy intertidal flats are the most favored habitat, softshell clams are also found in mud/sand/rock intertidal sites. Dependent on temperature and food, softshell clams become sexually mature in their second to third year and spawn from June to September, when they broadcast both sperm and egg into the water column resulting in fertilization. Fertilized eggs develop into free swimming planktonic larvae, during which they are extensively distributed throughout coastal waters as neritic plankters. Larvae in the northeast develop normally at temperatures between 100 – 250C and salinities greater than 15 ppt (NHFG, 1991). During the larval stage they undergo a series of physical changes for a period of 12-21 days, before metamorphosing into an adult form and settling on suitable substrate. Juveniles will wander using their foot, attach to sand grains by byssus threads, or float in the water in search of more suitable habitat. This movement decreases with age and growth before finally establishing permanent burrows in substrate (Newell & Hidu, 1986).

NH Wildlife Action Plan Habitats

- Marine



Distribution Map

Current Species and Habitat Condition in New Hampshire

In New Hampshire, softshell clams exist in the Piscataqua River basin and the coastal basin. The Piscataqua River basin includes Great Bay, Little Bay, Piscataqua River and Little Harbor. The Piscataqua River basin covers 3,275 acres of tidal water clam flats and about 100 miles of shoreline. The coastal basin consists of Rye Harbor and Hampton-Seabrook Estuary. The coastal basin contains over 244 acres of tidal water clam flats (NHF&G, 1991)

Population Management Status

New Hampshire has regulations pertaining to the harvest of softshell clam where harvest is allowed. On Saturdays only one half hour before sunrise to sunset, a ten-liquid quart daily limit (no size limitation) is allowed from the day after Labor Day to May 31st ; except for Hampton/Seabrook Harbor which typically opens in November. Licensing of all residents six years of age and older is required and there is no allowed sale of clams. Handheld tools with handles not greater than 18 inches long are the legal means of digging clams. In addition to the above limitations on clam harvesting, it is worth mentioning that the allowable times for taking may be significantly altered by closures due to unfavorable health related conditions (e.g., high bacterial numbers or red tide conditions). The resource is controlled New Hampshire Fish and Game Department with careful consideration of clam stock biomass.

Regulatory Protection (for explanations, see Appendix I)

- RSA 211:61- 211:64; 214:11a: Gear/season/harvest/permit regulations
- RSA 143:21: Closures of shellfish beds to harvesting due to high bacteria or red tide
- FIS 606.1- 606.7 NHFG rules on the harvest of softshell clams

Quality of Habitat

Softshell clams inhabit sandy, sand-mud, or sandy-clay bottoms of bays, harbors, estuaries, and inlets. Clams burrow 30 cm in the sediment with maximum adult densities of 6 to 8 clams per square foot, requiring temperatures below 28°C, and salinities not less than 4-5 ppt (Abraham & Dillon, 1986).

Significant clam beds in New Hampshire exist in the Hampton-Seabrook Estuary with lesser densities occurring in the Great Bay Estuary, Little Harbor, and Rye Harbor.

Habitat Protection Status

Softshell clams beds located in shellfish closed areas are protected from harvest. Currently areas in Great Bay, Piscataqua River complex, and New Hampshire's coastal waters have regulations that prohibit the harvest of softshell clams in designated shellfish closed areas. Motor vehicles are prohibited on all designated clam flats, to reduce damage to softshell clam beds.

Habitat Management Status

Currently there is no habitat management for softshell clams in New Hampshire.

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 and species impacts from resource depletion resulting from commercial harvest (Threat Rank: High)

Softshell clams are harvested recreationally by New Hampshire residents from the day after Labor Day until May 31st, subject to closures. No commercial harvesting is allowed. Clams are dug with handheld tools only with minimal damage to surrounding habitat. Harvest limits on softshell clams manage the amount harvested.

The harvest of softshell clams occurs in the state of New Hampshire and is therefore managed through issuing licenses and specific harvest regulations (Fis 606.1- 606.7)

Species impacts from disease (neoplacia, oyster-specific and others) (Threat Rank: High)

The effect of disease on shellfish is of great concern. There is an increased risk of exposure to harmful human pollutants as softshell clams inhabit tidal and estuarine waters. Pollutants collect and concentrate in various tissues of bivalves, and these harmful chemicals and pathogens could results in human health risks. Furthermore, the continuous year-round filter feeding behavior of bivalves and their ability to establish large dense shellfish beds, pose serious potential for large pervasive outbreaks.

Sarcomatous neoplasia, a lethal cancer-like disease, has reported correlation with *M. arenaria* mortality and was identified in New Hampshire's Hampton Estuary in 1986 (Normandeau Associates Inc., 2013). A significantly higher mortality among shellfish infected with S. neoplasia in comparison to individuals lacking the disease has been observed (Brousseau & Baglivot, 1991). Although sources of the disease is not well established, temperature and increased contaminants (e.g., heavy metals, PCB's, PAH's, etc.) may increase the vulnerability of young softshell clams to S. neoplasia (Böttger et al., 2013).

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

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 event.

Fluctuations in salinity found in estuarine environments inhabited by softshell clams are frequent and scientific investigation of the species exposed to diverse salinities reveal the species have a short-term tolerance to such salinity swings (Matthiessen, 1960; Perkins, 1974). Research suggests warm temperatures decrease the tolerance to low salinities, specifically in juveniles (Abraham & Dillon, 1986). Additionally, low salinities have been directly linked to not only a reduction in feeding (Perkins, 1974), but also reduced amino acid uptake (Stewart & Bamford, 1976; Abraham & Dillon, 1986).

Species and habitat impacts from ocean acidification (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. More acidic oceans due to increased CO2 would affect organisms that require calcium carbonate to synthesize and maintain shell. The effect of ocean acidification is suggested to inhibit the growth and survival of larval shellfish, which may adversely affect shellfish populations (Talmage et al., 2010).

Habitat impacts from gear effects related to commercial harvest (Threat Rank: Medium)

Habitat degradation from dredging and the dumping of spoils (Threat Rank: Medium)

Dredging is a process typically used to remove or dispose sediments (sand/mud) to assist shipping and boat traffic. The physical process of dredging can result in disturbance of structure among benthic communities, the loss of seafloor habitat and the suspension of materials, potentially resulting in the release of nutrients and metal contaminants into the water column (Mercaldo-Allen & Goldberg, 2011).

Dredging can alter the arrangement of benthic substrate, potentially reducing the conditions of the original habitat. Research on the recovery of benthic communities (biomass and taxonomic richness) following a dredge suggests that some benthic biota will reestablish in a matter of hours, days, weeks and often complete recovery in one year (Mercaldo-Allen & Goldberg, 2011). Altering the bathymetry of the seafloor can change the circulation and mixing of freshwater and saltwater within an estuary and the scale of the alteration could diminish water quality, ultimately leading to reduced settlement of juvenile shellfish.

Habitat degradation from shoreline hardening (Threat Rank: Medium)

Global sea level rise driven by thermal expansion, melting of glaciers, and ice sheets, and to some extent reduction of liquid water storage on land is a growing concern to coastal regions (Church et al., 2013). Shoreline hardening or armoring, often by the construction of seawalls, has proven beneficial in preserving valuable yet vulnerable waterfront properties thus reducing, if not eliminating damage caused by coastal storm surge. Shoreline barriers can interfere with the formation of beaches, dunes, and intertidal areas, and conceivably devalue the beneficial function of those areas lost (O'Connell, 2010). Collectively, the construction of shoreline barriers and accelerated rate of sea level rise pose environmental risks to coastal marine dwellers, notably shellfish.

Research has revealed that intertidal rocky shores adjacent to seawalls had less biological diversity than areas not fragmented by anthropogenic structures (Goodsell et al., 2007). Additionally, artificial infrastructure (i.e., breakwater) can prompt a shift from consumer- to producer-dominated communities, resulting in a dynamic alteration of the ecosystem structure (Martins et al., 2009).

Habitat degradation due to siltation and turbidity from multiple sources (Threat Rank: Medium)

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 has contributed. Reduced light and poor water quality typically result, and can limit or conceivably eliminate the ability for bivalves to filter feed.

Urbanization along coastal areas is undergoing continuous growth and expansion, and this growth is resulting in increased runoff which intensifies siltation, and could alter circulation patterns in tidal zones typically inhabited by shellfish. Research on the effects of suspended intertidal sediments results in reduced oxygen consumption by softshell clams, and the long-term effects of turbidity may cause starvation (Grant & Thorpe., 1991).

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

Introduced or invasive species are commonly transported and introduced into marine environments not previously inhabited by them through vessels, bilge water, and marine debris. 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.

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 drastic reductions in softshell clams (Hanks, 1963). Research indicates the presence of green crabs resulted in reduced clam bed densities, and increased burrowing depth and longer siphons (Whitlow, 2010).

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

The immediate proximity to the intertidal zone, an area 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, along with cultural, social and ecological benefits (Abraham and Dillon, 1986). Shellfish exposed to PCB and PAH contaminants can result in reduce growth, survival, reproductive success, and increased susceptibility to disease (McDowell et al., 1999).

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 organism results in reduced oxygen levels (anoxia) in the environment.

Large rain events can result in nutrient runoff from farmlands which may create large algae blooms, eventually leading to a dead zone, an area of low oxygen where species struggle to obtain oxygen to survive. While food (phytoplankton) quality (C: N ratio) remains unchanged in nitrogen enriched estuaries, food quantity proliferates and subsequent increases in growth rates of softshell clams result (Weiss et al., 2002).

Habitat impacts from mercury deposition (Threat Rank: Medium)

Mercury is released into the environment as a result of human activity such as coal burning, mining, and industrial processes. Mercury ultimately makes its way into the marine environment through river and watershed inputs, as well as atmospheric deposition.

Shellfish which live sedentary benthic lives filtering seawater are susceptible to chemical influences, which collect and concentrate in their tissues. Mercury and other heavy metals have been shown to affect oysters on the cellular level, impacting their immune functions (Gagnaire et al., 2004).

Habitat degradation from oil spills (Threat Rank: Medium)

Oil introduced into the marine environment can have lethal and sublethal 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 occur in 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 crude oil have been shown to exhibit changes in respiration, reproductive development, feeding, growth rates, behavior, biochemistry, and increased mortality. Shellfish exposed to crude oil in the marine environment could lead to population decreases (Stekoll et al., 1980).

List of Lower Ranking Threats:

Habitat impacts from marine debris

Habitat impacts and mortality from power plant effluent causing thermal pollution

Habitat degradation from emerging or unmonitored contaminants

Habitat impacts from moorings

Habitat degradation from docks

Habitat impacts from non-motorized boating

Habitat impacts from motorized boating (eelgrass)

Habitat conversion from turbine development and underwater lines, and oil and gas drilling

Habitat impacts from increased wave action that causes bottom disturbance

Habitat impacts from increased storm events that send plumes including erosion, sedimentation, and salinity changes

Habitat and species impacts from phenology shifts

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

Assess impacts of invasive species and other anthropogenic-threats on softshell clam populations

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:
Assess impact of invasive and anthropogenic threats on softshell clams.

General Strategy:
Collect and analyze data on the impacts of invasive or introduced species on softshell clam populations and habitat. Research other threats to softshell clams to better understand the impacts in New Hampshire.

Political Location:
Rockingham County

Watershed Location:
Coastal Watershed

Evaluate the distribution and abundance of softshell clams in New Hampshire waters

Primary Threat Addressed: Habitat and species impacts from resource depletion resulting from commercial harvest

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

Objective:
Have a complete dataset of the distribution & abundance of softshell clams and use this information to update harvest limits.

General Strategy:
Conduct a complete evaluation of the distribution and abundance of softshell clams in New Hampshire waters. In conjunction, assess recreational harvest limits.

Political Location:
Rockingham County

Watershed Location:
Coastal Watershed

References, Data Sources and Authors

Data Sources
Information on population management was obtained from New Hampshire Fish and Game Department data, technical reports, and scientific literature.

Data Quality
The softshell clam population has been monitored in the Hampton-Seabrook Estuary extensively since 1974 by Normandeau Associates, with additional mapping done in 1991 by New Hampshire Fish and

Game Department. In Great Bay various surveys have been conducted on softshell clam bed distribution and abundance (Smith, 2002; Grizzle et al., 2006) but these surveys lack the long term value that the Hampton-Seabrook Estuary receives.

2015 Authors:
Conor O'Donnell, NHFG

2005 Authors:
Bruce Smith, NHFG

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.

Böttger, S. A., Amarosa, E. J., Geoghegan, P., & Walker, C. W. (2013). Chronic Natural Occurrence of Disseminated Neoplasia in Select Populations of the Soft-Shell Clam, *Mya arenaria*, in New England. Northeastern Naturalist, 20(3), 430-440.

Brousseau, J. Diane and Baglivo, A. Jenney 1991. Field and laboratory comparisons of mortality in normal and neoplastic *Mya arenaria*, Journal of Invertebrate Pathology, Volume 57, Issue 1, Pages 59-65, ISSN 0022-2011

Church, J.A. et al., 2013: Sea Level Change. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Gagnaire, B., Thomas-Guyon, H., Renault, T. (2004). In vitro effects of cadmium and mercury on Pacific oyster, *Crassostrea gigas* (Thunberg), haemocytes. Fish & Shellfish Immunology, 16(4), 501-512.

Goodsell PJ, Chapman MG, Underwood AJ (2007) Differences between biota in anthropogenically fragmented habitats and in naturally patchy habitats. Mar Ecol Prog Ser 351:15-23

Grant, J. and Thorpe B. 1991. Effects of Suspended Sediment on Growth, Respiration, and Excretion of the Soft-Shell Clam (*Mya arenaria*) Canadian Journal of Fisheries and Aquatic Sciences 48:1285-1292, 10.1139/f91-154.

Grizzle, R.E., Jennifer K . Greene, and Holly Abeels. 2006. Soft-shell Clam (*Mya arenaria*) Distribution & Abundance at Selected Sites in the Great Bay Estuary, New Hampshire. Final Report, New Hampshire Estuaries Project. Concord, NH.

Gustavo M. Martins, André F. Amaral, Francisco M. Wallenstein, Ana I. Neto. 2009. Influence of a breakwater on nearby rocky intertidal community structure, Marine Environmental Research, Volume 67, Issues 4–5, Pages 237-245, ISSN 0141-1136.

Hanks, R. W. (1963). The soft-shell clam. US Department of the Interior.

Matthiessen, G.C. 1960. Observations on the ecology of the soft clam, *Mya arenaria*, in a salt pond. Limnology and Oceanography. 5:291-300.

McDowell, J. E., Lancaster, B. A., Leavitt, D. F., Rantamaki, P., Ripley, B. 1999. The Effects of Lipophilic Organic Contaminants on Reproductive Physiology and Disease Processes in Marine Bivalve Molluscs. Limnology and Oceanography, Volume 44, Number 3, Pages 903-909, ISSN 00243590.

Mercaldo-Allen R., and Goldberg, R. 2011. Review of the Ecological Effects of Dredging in the

Cultivation and Harvest of Molluscan Shellfish. NOAA Tech Memo NMFS NE 220; 78 pp.

New Hampshire Fish and Game Department. 1991. Softshell clam management plan.

Newell, C.R., and H. Hidu. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic). Softshell clam. U.S. Fish & Wildlife Service. Biol. Rep. 82(11.53). U.S. Army Corps of Engineers, TR EL-82-4. 17 pp.

Normandeau Associates Inc., 2013. Seabrook Station 2013 Environmental Monitoring in Hampton, Seabrook Area. Technical Report.

O'Connell, J.F. 2010, Shoreline armoring impacts and management along the shores of Massachusetts and Kauai, Hawaii , in Shipman, H., Dethier, M.N., Gelfenbaum, G., Fresh, K.L., and Dinicola, R.S., eds., 2010, Puget Sound Shorelines and the Impacts of Armoring—Proceedings of a State of the Science Workshop, May 2009: U.S. Geological Survey Scientific Investigations Report 2010-5254, p. 65-76.

Perkins, E. J. 1974. The biology of estuaries and coastal waters. Academic Press, New York. Pages 678.
Smith, B. 2002. Shellfish population and bed dimension assessment in the Great Bay Estuary. Final Report, New Hampshire Estuaries Project. Concord, NH.

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.

Stewart, G. Michael & Bamford, R. David. 1976. The effect of environmental factors on the absorption of amino acids by isolated gill tissue of the bivalve, *Mya arenaria* (L.), Journal of Experimental Marine Biology and Ecology, Volume 24, Issue 2, Pages 205-212, ISSN 0022-0981.

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.

Weiss E.T., Carmichael, R.H., Valiela I. 2002. The effect of nitrogen loading on the growth rates of quahogs (Mercenaria mercenaria) and soft-shell clams (*Mya arenaria*) through changes in food supply, Aquaculture, Volume 211, Issues 1–4, 23. Pages 275-289, ISSN 0044-8486.

Whitlow, W. L. (2010), Changes in survivorship, behavior, and morphology in native soft-shell clams induced by invasive green crab predators. Marine Ecology, 31: 418–430.

Northern Shrimp

Pandalus borealis

Federal Listing	N/A State
Listing	SGCN
Global Rank	Unknown
State Rank	SNA
Regional Status	

Photo by NHFG

Justification (Reason for Concern in NH)

In New England, the northern shrimp fishery provides valuable income to harvesters during the winter months and who may be limited out of other fisheries. Northern shrimp are an important component in marine food webs as they feed on plankton and benthic invertebrates and are preyed upon by commercially important species such as white and silver hake, Atlantic cod, and Acadian redfish. Northern shrimp are a short-lived species so they are vulnerable to changes in their environment. The increase in coastal development leads to increased pollutant run-off into the ocean which can damage crucial habitats of northern shrimp. Changes in ocean temperature due to global climate change or the North Atlantic Oscillation could have an effect on larval/juvenile development and/or adult migratory behavior.

Distribution

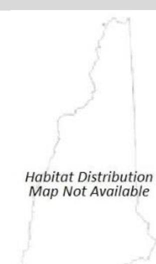
Northern shrimp are found in cold boreal waters of the North Atlantic, North Pacific, and Arctic Oceans. The Gulf of Maine has the most southern population in the range.

Habitat

Northern shrimp inhabit deep, cold water basins in the Atlantic Ocean and prefer depths of 90-180 meters consisting of soft substrates such as sand, clay or mud. They are protandric hermaphrodites that utilize different habitats depending on their life stage. As larvae and juveniles they inhabit inshore waters typically within ten miles of the coast. After a year, juveniles move offshore to continue their development into the male life stage. Females inhabit offshore waters during the spring and summer months and migrate inshore in the late fall-early winter to lay their eggs.

NH Wildlife Action Plan Habitats

- Marine



Distribution Map

Current Species and Habitat Condition in New Hampshire

Northern shrimp inhabit coastal waters off of New Hampshire in the Gulf of Maine. Results of the 2013 stock assessment report indicated that the Northern shrimp stock is overfished and overfishing is occurring in the Gulf of Maine. Northern shrimp abundance has been declining since 2006.

Population Management Status

The Northern shrimp commercial fishery was restricted between 2010 and 2012 due to declining stock populations. In 2013, only 49% of the total allowable catch was harvested. In response to the declining population the Northern Shrimp Section of ASMFC established a moratorium for the 2014 fishing season to protect the remaining spawning population and reduce pressure on the collapsed stock. The moratorium was expanded to the 2015 fishing season.

Regulatory Protection (for explanations, see Appendix I)

- Harvest permit - season/take regulations

Quality of Habitat

Northern shrimp are located in the cold waters of the Gulf of Maine. Spawning occurs in offshore waters during the late summer. During the winter, egg-bearing females move inshore, where the eggs hatch.

Habitat Protection Status

The Northern Shrimp Section established a moratorium for the 2014 and 2015 fishing season to protect the remaining spawning population and reduce pressure on the collapsed stock.

Habitat Management Status

The Northern Shrimp Section established a moratorium for the 2014 and 2015 fishing season to protect the remaining spawning population in the Gulf of Maine.

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.

Species and habitat impacts from increasing sea surface temperatures (Threat Rank: High)

New Hampshire is located within the southern limit of the Northern shrimp distribution. Ocean temperatures have an important influence on northern shrimp in the Gulf of Maine (Apollonio et al. 1986; Richards et al. 1996; Richards et al. 2012).

Recruitment of Northern shrimp has been low during years when winter water temperatures were high. Colder temperatures are associated with higher recruitment of shrimp (Richards et al. 2012). Lower water temperatures can possibly stimulate population growth (Apollonio et al. 1986).

Habitat and species impacts from resource depletion resulting from commercial harvest (Threat Rank: High)

Fishing and harvesting causes direct mortality to the species. Commercial harvest may add additional stress on the Northern shrimp population that is being negatively impacted by warming water temperatures.

The harvest of Northern shrimp is managed by the ASMFC as outlined in the Interstate Fishery Management Plan. Commercial harvest can occur in the state of New Hampshire and is therefore managed through licenses and harvest regulations.

Species and habitat impacts from ocean acidification (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).

Habitat impacts from gear effects related to commercial harvest (Threat Rank: Medium)

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.

Black Gill Syndrome was also documented in the Gulf of Maine in 1966 (Apollonio and Dunton, 1969; Rinaldo and Yevich, 1974). Affected shrimp display melanized, or blackened gills, with inflammation, necrosis, and significant loss of gill filaments.

Habitat impacts from mercury deposition (Threat Rank: Medium)

Mercury is released into the environment as a result of human activity such as coal burning, mining, and industrial processes. Mercury ultimately makes its way into the marine environment through river and watershed inputs, as well as atmospheric deposition.

Mercury exposure showed a reduction of swimming activity and the onset of paralysis in Northern shrimp (St-Amand et al., 1999). The ecological significance of the alteration of larval swimming activity by mercury pollution will be an increase in mortality and its ripple effect through the community dynamics (St-Amand et al., 1999).

Habitat degradation from oil spills (Threat Rank: Medium)

Oil introduced into the marine environment can have lethal and sublethal 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.

List of Lower Ranking Threats:

Habitat impacts from marine debris

Habitat degradation from nutrients from shore and ships

Habitat degradation from shore-based contamination

Habitat degradation from dredging and the dumping of spoils

Habitat impacts from increased wave action that causes bottom disturbance

Habitat impacts from increased storm events that send plumes including erosion, sedimentation, and salinity changes

Actions to benefit this Species or Habitat in NH

Reduced harvest of or moratorium on fishery

Primary Threat Addressed: Habitat and species impacts from resource depletion resulting from commercial harvest

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

Objective:
Implement rules to limit the harvest of Northern shrimp when stocks are low in order to allow the stock to rebuild.

General Strategy:
Implement rules to limit the harvest of Northern shrimp. The Atlantic State Marine Fisheries Commission manages northern shrimp in partnership with the states of Maine, Massachusetts and New Hampshire. When the Northern shrimp stock is low the states can implement rules to limit harvest.

Political Location:

Watershed Location:

References, Data Sources and Authors

Data Sources
Information on northern shrimp habitat and population was obtained from ASMFC management plan,

scientific literature, and consultation with experts.

Data Quality

The Atlantic States Marine Fisheries Commission (ASMFC) manages northern shrimp in partnership with the states of Maine, Massachusetts, and New Hampshire. Members from each state form the Northern Shrimp section which follows a Fishery management plan for the species.
Trends in abundance of Gulf of Maine northern shrimp have been monitored since the late 1960's. Sea surface temperature has been measured daily since 1906 at Boothbay Harbor, Maine, near the center of the inshore nursery areas for northern shrimp.

2015 Authors:

Robert Eckert, NHFG

2005 Authors:

Bruce Smith, NHFG

Literature

Apollonio, S. and E.E. Dunton. 1969. The northern shrimp *Pandalus borealis*, in the Gulf of Maine. Dept. Sea and Shore Fisheries MS, Augusta, Maine, 82p.

Apollonio, S., D.K. Stevenson, and E.E. Dunton. 1986. Effects of temperature on the biology of the northern shrimp, *Pandalus borealis*, in the Gulf of Maine. NOAA Tech. Rep., NMFS 42.

Richards, A., M. Fogarty, D. Mountain, and M. Taylor. 2012. Climate change and northern shrimp recruitment variability in the Gulf of Maine. Marine Ecology Progress Series 464:167-178.

Richards, A., M. Fogarty, S. Clark, D. Schick, P. Diodati, and B. O'Gorman. 1996. Relative influence of reproductive capacity and temperature on recruitment of *Pandalus borealis* in the Gulf of Maine. ICES CM 1996/K:13

Rinaldo, R.G. and P. Yevich. 1974. Black spot gill syndrome of the northern shrimp *Pandalus borealis*. J. Invertebrate Pathology 24(2): 224-233.

St-Amand, L., R. Gagnon, T. T. Packard, and C. Savenkoff. 1999. Effects of inorganic mercury on the respiration and the swimming activity of shrimp larvae, *Pandalus borealis*. Comparative Biochemistry and Physiology 122: 33-43.

Stekoll, M. S., L. E. Clement, and D. G. Shaw. 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.

Atlantic Sea Scallop

Placopecten magellanicus

Photo by Sherie Gee, NOAA

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

Justification (Reason for Concern in NH)

Sea Scallops are a highly prized edible bivalve mollusk harvested for its adductor muscle. While a significant commercial fishery exists in other eastern US states, the commercial effort in New Hampshire is not well established or highly productive. Annual New Hampshire landings over the last decade range from 177,000 pounds to less than 1,000 pounds unshucked, with a clear drop in recent years. Recreationally, scallops are taken by dredge and SCUBA diving. Little is known about the population dynamics of scallop in New Hampshire waters except for anecdotal information from commercial harvesters and by sport divers. A limited qualitative survey was accomplished in 1997 but this only covered the Isles of Shoals (Gosport Harbor), waters offshore New Castle Island, and the outer reaches of Portsmouth Harbor (NHF&G, 1998. Because sea scallops are a valued molluscan bivalve, subject to both limited commercial and recreational harvest, it is important to consider the species in this document.

Distribution

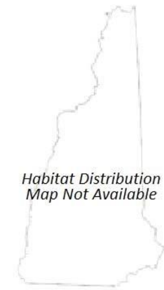
Atlantic sea scallops occur on the continental shelf of the eastern US seaboard from Gulf of St. Lawrence to North Carolina. In New Hampshire, they are found along the coast with concentrations near New Castle Island, along outer Portsmouth Harbor, and at the Isles of Shoals. Commercial harvest has produced modest catches offshore of the Isles of Shoals (NHF&G, 1997). Sea scallops may be found elsewhere along the New Hampshire coast, but there is a lack of information to document their location.

Habitat

The Atlantic sea scallop (*Placopecten magellanicus*) is a bivalve mollusk that inhabits the coastal waters of the continental shelf on the eastern seaboard (Packer, & Cargnelli, 1999). Scallops, unlike most bivalve mollusks, live on the surface of the bottom on a variety of substrate, but are most abundant on coarse firm sand/gravel which keeps them in waters relatively close to shore at depths less than 75 to 100 meters (Serchuk et al., 1983). Scallops synchronously spawn in later summer or fall, when both sperm and eggs are broadcast into the water column (Culliney, 1974). As free swimming planktonic larvae, they are distributed widely by ocean currents during a period of 30 to 40 days, after which they seek suitable substrate and attach using byssus threads (Tremblay et al, 1994). Once settled, their short range movement is possible but very limited. As adults, optimal growth occurs in cold water between 8°C and 12°C, and salinities consistent with open ocean (Mullen & Moring, 1986).

NH Wildlife Action Plan Habitats

● Marine



Distribution Map

Current Species and Habitat Condition in New Hampshire

Historically the sea scallop has been recognized as indigenous to New Hampshire. The scallop stocks were assessed in the late 1970’s and 1990’s by New Hampshire Fish and Game Department and even though it was determined no commercially significant scallop beds exist in New Hampshire, there is considerable recreational and limited commercial interest. Documented scallop beds exist from the mouth of the Piscataqua River in Portsmouth south to Fort Stark and at the Isle of shoals.

Population Management Status

In New Hampshire, sea scallops are strictly managed both for commercial harvest and for recreational taking (NEFMC, 1982). No special license is required for recreational harvesters, however commercial harvesters must obtain a resident commercial saltwater license. Harvesters must adhere to a minimum of three and a half inch shell height and a daily limit of 75 pounds shucked meat or 625 pounds unshucked shell. Recreational takers may use SCUBA or dredge and cannot sell their catch. Commercial gear for harvest is a specifically described dredge. All takers of scallop are held to a season of November 1 to April 14.

Regulatory Protection (for explanations, see Appendix I)

● Harvest permit - season/take regulations
● NHFG Rule FIS 607.02: addresses the harvest of sea scallops
● RSA 211.49 a & b: Licenses required to sell marine species
● RSA 211.62 New Hampshire law that outlines gear/season/harvest/permit regulations
● 50 CFR 648: Scallop fishery regulations managed by New England Fishery Management Council (NEFMC) and NOAA Marine Fisheries Service (NMFS) in Federal waters

Quality of Habitat

Sea scallops require adequate substrate and cold temperatures (8-12°C). The coastal waters of the New Hampshire/Maine border provide suitable sand/gravel substrate near shore and out to the Isle of Shoals. Optimal temperatures occur just offshore and in depths less than 100 feet. Suitable habitat exists from the mouth of the Piscataqua River south to Fort Stark, and at the Isle of Shoals. It is possible a more extensive survey of the nearshore coastal waters could reveal more suitable scallop habitat.

Habitat Protection Status

Currently there is no habitat management plan for sea scallops in New Hampshire.

Habitat Management Status

Currently there is no habitat management plan for sea scallops in New Hampshire.

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.

Species and habitat impacts from increasing sea surface temperatures (Threat Rank: High)

Climate change is expected to increase sea surface temperatures. Increases in sea surface temperatures may lead to shifts and or expansions of species range that could negatively influence scallop by competition or predation. Temperature induced changes would have significant impacts on suitable scallop habitat, growth, disease, or mortality.

Temperature plays a vital role in the survival and distribution of sea scallop larvae in the Gulf of Maine (NEMFC, 1982). Shellfish larvae exposed to higher temperatures are more susceptible to disease and increased bacteria growth. Mass mortality has been observed when scallop larvae exceed thermal tolerances (Culliney, 1974).

Habitat and species impacts from resource depletion resulting from commercial harvest (Threat Rank: High)

Fishing and harvesting causes direct mortality to the species. Commercial harvest, although not significant in New Hampshire, may adversely impact a variety of benthic species associated with scallop habitat. Both commercial and recreational scallop harvesters must adhere to strict harvest regulations.

The harvest of sea scallops is managed by the New England Fisheries Management Council, and is outlined in the comprehensive management plan for scallops. Commercial and recreational harvest occurs in the state of New Hampshire and is therefore managed through license and harvest regulations (Fis 607.02).

Species and habitat impacts from ocean acidification (Threat Rank: Medium)

Anthropogenic sources of CO2 in the atmosphere react with seawater to form carbonic acid (H2CO3). 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 sea scallops and other shellfish.

One third of all anthropogenic sources of CO2 over the past 200 years have been stored in the ocean. More acidic oceans due to increased CO2 would affect organisms that require calcium carbonate to synthesize and maintain shell. The effect of ocean acidification is suggested to inhibit the growth and survival of larval shellfish, which may adversely affect shellfish populations (Talmage et al., 2010).

Habitat impacts from gear effects related to commercial harvest (Threat Rank: Medium)

Commercial harvesters in the state of New Hampshire use specific size dredges to fish for sea scallops. Scallop dredges use teeth that dig and scour the sediment collecting scallops and anything else in its path. The use of dredges causes physical damage to the seafloor (habitat) as well as direct mortality to a variety of benthic organisms.

The implications of commercial scallop gear on habitat and benthic fauna is well documented in literature (Collie et al., 1997; Thrush et al., 2002). Dredges are designed to specifically target and collect scallops on the seafloor. The effects of dredges can also be observed to cause destruction and mortality to large epifaunal and infaunal organisms within the path of the gear (Eleftheriou et al., 1992).

Habitat impacts from disease (neoplasia) (Threat Rank: Medium)

The effect of disease on shellfish is of great concern. There is an increased risk of exposure to harmful human pollutants as sea scallops inhabit tidal and nearshore waters. Pollutants collect and concentrate in various tissues of bivalves, and these harmful chemicals and pathogens could result in human health risks. Furthermore, the continuous year-round filter feeding behavior of bivalves and their ability to establish large dense shellfish beds, pose serious potential for large pervasive outbreaks.

A significantly higher mortality among shellfish infected with neoplasia in comparison to individuals lacking the disease has been observed (Brousseau & Baglivot, 1991). Although sources of the disease is not well established, environmental stressors such as water temperature, pollutants, industrial contaminants (i.e., hydrocarbons), and anoxic zones resulting from eutrophication, may have the greatest role in shellfish mortality.

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

Introduced or invasive species are commonly transported and introduced to marine environments by vessels, bilge water, and debris. 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.

Green crabs (*Carcinus maenas*) are well known predators of scallops and many species of shellfish (Ropes, 1968). Green crabs are a pervasive threat to native shellfish communities and have been implicated in the reduction and destruction of many shellfish species. Colonial tunicates (e.g., *Didemnum vexillum*) can also pose a threat to sea scallops by inhibiting larval settlement and survival (Morris et al., 2009).

Habitat impacts from mercury deposition (Threat Rank: Medium)

Mercury is released into the environment as a result of human activity such as coal burning, mining, and industrial processes. Mercury ultimately makes its way into the marine environment through river and watershed inputs, as well as atmospheric deposition.

Shellfish, which live sedentary benthic lives, filtering seawater are susceptible to chemical influences, which collect and concentrate in their tissues. Mercury and other heavy metals have been shown to affect oysters on the cellular level, impacting their immune functions (Gagnaire et al., 2004).

Habitat degradation from oil spills (Threat Rank: Medium)

Oil introduced into the marine environment can have lethal and sublethal 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 occur in 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 crude oil have been shown to exhibit changes in respiration, reproductive development, feeding, growth rates, behavior, biochemistry, and increased mortality. Shellfish exposed to crude oil in the marine environment could lead to population decreases (Stekoll et al., 1980).

List of Lower Ranking Threats:

Habitat impacts from marine debris

Habitat degradation from nutrients from shore and ships

Habitat impacts and mortality from power plant effluent causing thermal pollution

Habitat degradation from lead

Habitat degradation from shore-based contamination

Habitat degradation from dredging and the dumping of spoils

Habitat conversion from turbine development and underwater lines, and oil and gas drilling

Habitat and species impacts from phenology shifts

Habitat impacts from increased wave action that causes bottom disturbance

Habitat impacts from increased storm events that send plumes including erosion, sedimentation, and salinity changes

Actions to benefit this Species or Habitat in NH

Consistent and timely comprehensive surveys of suitable habitat and scallop stocks to determine the full extent and health of sea scallop populations in New Hampshire.

Objective:
More research on scallop distribution and abundance would be beneficial in determining the health of the scallop population in New Hampshire, which is necessary for the management of a sustainable fishery.

General Strategy:
Although sea scallops are managed for harvest, few surveys or assessments have been conducted on the scallop populations that inhabit our coastal waters. Quantitative monitoring of known sea scallop beds around Portsmouth Harbor south to Fort Stark. Exploratory scallop dredging and SCUBA dives to find and map potentially unknown scallop populations and habitat along New Hampshire’s coast.

Political Location:
Statewide

Watershed Location:
Coastal Watershed

References, Data Sources and Authors

Data Sources

Information on Atlantic sea scallops threats was taken from agency data, scientific literature, and Fisheries Management Plan.

Data Quality

Threats to Atlantic sea scallops and their habitat are outlined in the NEFMC Fisheries Management Plan. While every threat may not be covered by the Fisheries Management Plan various threats to shellfish are well documented in scientific literature.

2015 Authors:

Conor O'Donnell, NHFG

2005 Authors:

Bruce Smith, NHFG

Literature

Brousseau, D. J., & Baglivo, J. A. (1991). Field and laboratory comparisons of mortality in normal and neoplastic *Mya arenaria*. Journal of invertebrate pathology, 57(1), 59-65.

Collie, J. S., Escanero, G. A., & Valentine, P. C. (1997). Effects of bottom fishing on the benthic megafauna of Georges Bank. Marine Ecology Progress Series, 155(0), 159-172.

Culliney, John L. 1974. Larval Development of the Giant Scallop *Placopecten magellanicus*. Biological Bulletin: Vol. 147, No.2, pp. 321-332.

Eleftheriou, A., Robertson, M. 1992. The Effects of Experimental Scallop Dredging on the Fauna and Physical Environment of a Shallow Sandy Community. Netherlands Journal of Sea Research. 30, 289-299.

Gagnaire, B., Thomas-Guyon, H., & Renault, T. (2004). In vitro effects of cadmium and mercury on Pacific oyster, *Crassostrea gigas* (Thunberg), haemocytes. Fish & Shellfish Immunology, 16(4), 501-512.

Morris, J. A., Carman, M. R., Hoagland, K. E., Green-Beach, E. R., & Karney, R. C. (2009). Impact of the invasive colonial tunicate *Didemnum vexillum* on the recruitment of the bay scallop (*Argopecten irradians irradians*) and implications for recruitment of the sea scallop (*Placopecten magellanicus*) on Georges Bank. Aquatic Invasions, 4(1), 207-211.

Mullen, D.M., and J.R. Moring. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) – Sea Scallop. U.S Fish Wildlife serv. Biool. Rep. 82(11.67). U.S Army Corps of Engineers, TR EL- 82-4 13 pp.

New England Fishery Management Council (NEFMC). 1982. Fishery Management Plan, Final Environmental Impact Statement, Regulatory Impact Review for Atlantic Sea Scallops (*Placopecten magellanicus*). New England Fishery Management Council, Newburyport, MA.

New Hampshire Fish and Game Department. 1998. New Hampshire Fish & Game memoranda on Sea Scallop qualitative survey.

Packer DB, Cargnelli LM, Griesbach SJ, Shumway SE. 1999. Essential fish habitat source document: Sea scallop, *Placopecten magellanicus*, life history and habitat characteristics. NOAA Tech Memo NMFS NE 134; 21 p.

Ropes, J. W. (1968). The feeding habits of the green crab, *Carcinus maenas* (L.). Fish. Bull, 67(2), 183-203.

Serchuk, F.M. and R.S. Rak. 1983. Biological characteristics of offshore Gulf of Maine sea scallop populations: size distributions, shell height-meat weight relationships and relative fecundity patterns. U.S. Natl. Mar. Fish. Serv. Northeast Fish. Cent., Woods Hole Lab. Ref. Doc. 83-07. 42p.

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., 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.

Thrush, S. F., & Dayton, P. K. (2002). Disturbance to marine benthic habitats by trawling and dredging: implications for marine biodiversity. Annual Review of Ecology and Systematics, 449-473.

Tremblay, M., Loder, J., Werner, F., Naimie, C., Page, F., Sinclair, M. 1994. Drift of sea scallop larvae *Placopecten magellanicus* on Georges Bank – a model study of the roles of mean advection, larval behavior and larval origin. Deep-Sea Research Part II – Topical Studies in Oceanography 41, 7–49.

Fin Whale

Balaenoptera physalus

Federal Listing	E
State Listing	not tracked
Global Rank	G3G4TNR State
Rank	
Regional Status	Very High

Photo by Christin Khan, NOAA/NEFSC

Justification (Reason for Concern in NH)

The fin whale is of high regional conservation concern. However state regulatory responsibility is low as this species is managed by the NOAA's Office of Protected Resources who has authored, and regularly updates, a species specific recovery plan. New Hampshire supports the implementation of recommended practices in these plans in state waters and the Fish and Game Department has a joint agreement with NOAA to help enforce Federal regulations. Warming ocean temperatures may result in reduction in biomass of prey species on which the arrival and reproductive success of this species is dependent. Changes in the magnitude and timing of the peak abundance of prey species may significantly alter whale migration, behavior, and population abundance (Kenney et al. 1997).

Distribution

Fin whales are found worldwide. Those in the North Atlantic are currently considered an independent subspecies *B. physalus physalus* (Bérubé et al., 1998). The large scale migratory nature of this species means the importance of an individual state's jurisdictional waters are challenging to evaluate. Their main summer range in the Northwest Atlantic extends from Cape Hatteras northward. One individual has been documented within state jurisdictional waters via vessel-based observation during the period 2009 - 2013 (Blue Ocean Society, personnel communication).

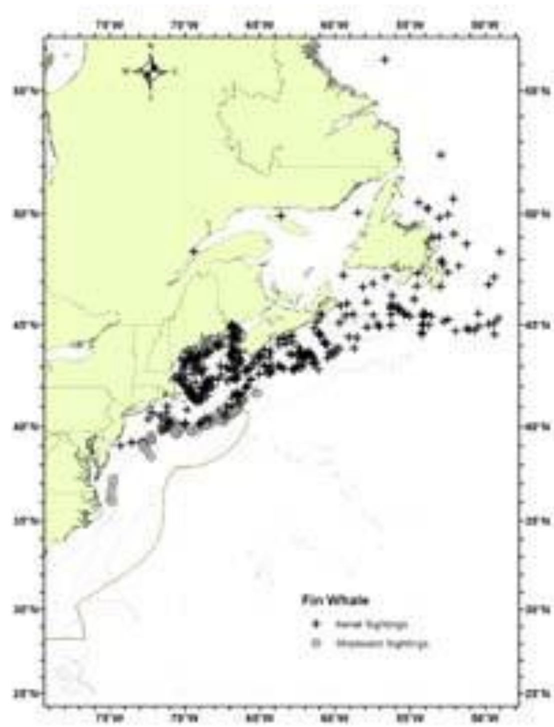
Habitat

Fin whales are pelagic and found in deep waters of all major oceans, predominately in temperate to polar latitudes. Although primarily an offshore species, fin whales have been documented in NH state jurisdictional waters. New England waters represent a major feeding ground for fin whales.

Based on neonate stranding data, it is suggested calving takes place during October to January in latitudes of the U.S. mid-Atlantic region Hain et al. (1992). However, it is unknown where calving, mating, and wintering occurs for most of the population.

NH Wildlife Action Plan Habitats

● Marine



Distribution Map

Current Species and Habitat Condition in New Hampshire

Key populations of this species are located outside state jurisdictional waters. However, this species is endangered globally so conservation prioritization of individuals that enter NH waters is extremely important. Little is known about the social and mating systems of fin whales.

Population Management Status

Population management primarily takes place outside state waters. The NOAA Fisheries Service established the Atlantic Large Whale Take Reduction Plan to reduce injuries and deaths of large whales due to incidental entanglement in fishing gear. This is an evolving plan that changes as more is learnt about why whales become entangled and how fishing practices might be modified to reduce the risk of entanglement. It has several components including restrictions on where and how gear can be set; research into whale populations and whale behavior, as well as fishing gear interactions and modifications; outreach to inform and collaborate with fishermen and other stakeholders; and a large whale disentanglement program.

Regulatory Protection (for explanations, see Appendix I)

● CITES - Convention on International Trade of Endangered Species of Wild Fauna and Flora
● Endangered Species Conservation Act (RSA 212-A)
● Marine Mammal Protection Act (1972)

Quality of Habitat

Key habitat units are located outside state jurisdictional waters.

Habitat Protection Status

Key habitat units are located outside state jurisdictional waters.

Habitat Management Status

Key habitat units are located outside state jurisdictional waters.

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.

Mortality from collisions with ships (Threat Rank: Medium)

Direct impact of ships with individuals causing injury or mortality (Laist et al., 2001). Of all species of large whales, fin whales are most often reported as hit by vessels (Jensen and Silber, 2004).

NOAA regularly publishes reports documenting ship strikes and consequences to individual whales. The northeast has a regional stranding coordinator in Gloucester MA who these strikes are reported to.

List of Lower Ranking Threats:

Disturbance from increasing anthropogenic ocean noise

Species impacts from over-fishing that reduces prey abundance (herring)

Mortality from entanglement in fishing gear

Species impacts from reduced prey abundance

Actions to benefit this Species or Habitat in NH

Assess population status of prey species that are not commercially harvested.

Primary Threat Addressed: Species impacts from reduced prey abundance

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

Objective:
Assess changes in abundance of prey species due to non-commercial harvest pressures.

General Strategy:
Enhance knowledge of causes of alteration in whale presence or behavior. Very little can be done to mitigate large scale effects of climate change in the marine environment, but understanding impacts of these changes can help inform management decisions to support whale conservation.

Political Location: **Watershed Location:**

Support regulations within the "Endangered Fish and Wildlife; Final Rule to Implement Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales" and its amendments.

Primary Threat Addressed: Mortality from collisions with ships

Specific Threat (IUCN Threat Levels): Transportation & service corridors

Objective:
Reduce ship strikes with whales.

General Strategy:
Enforce vessel speed restrictions within specified areas at certain times and encourage ship strike reporting. It is hoped actions within this federal rule will also reduce impacts to other whale species.

Political Location: **Watershed Location:**

Support the Atlantic Large Whale Take Reduction Plan (National Marine Fisheries Service, 1997) regulations and amendments. This plan applies to both state and federal waters.

Primary Threat Addressed: Mortality from entanglement in fishing gear

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Reduce the number of fishing gear-related injuries and mortalities of North Atlantic large whale species that occur from Maine through Florida.

General Strategy:
The plan consists of regulatory and non-regulatory components, including broad gear modification, gear and whale research, seasonal area closures and disentanglement and outreach efforts.

Political Location: **Watershed Location:**

Conduct prey species stock assessments.

Primary Threat Addressed: Species impacts from over-fishing that reduces prey abundance (herring)

Specific Threat (IUCN Threat Levels): Biological resource use / Fishing & harvesting aquatic resources / Unintentional effects: large scale (species being assessed is not the target) [harvest]

Objective:
Maintain prey species abundance by setting harvest limits based on scientifically accurate stock assessments.

General Strategy:
Conduct fish stock assessments in order to set harvest limits and maintain whale prey species abundance.

Political Location: **Watershed Location:**

Increase awareness of impacts of anthropogenic ocean noise on whales to encourage voluntary reduction when possible.

Primary Threat Addressed: Disturbance from increasing anthropogenic ocean noise

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance / Recreational activities / Noise

Objective:
Enhance awareness of simple changes in timing, or site selection, of causes of ocean noise that may mitigate impacts on whale behavior.

General Strategy:
Multiple sources of anthropogenic ocean noise include vessels, oil refineries, seismic survey and military sonar. Since whale presence is seasonally, and somewhat spatially, predicable, encouraging voluntary changes in timing or location of these activities should be encouraged.

Political Location: **Watershed Location:**

References, Data Sources and Authors

Data Sources
Literature review.

Data Quality
NOAA's Office of Protected Resources has regularly published Marine Mammal Stock Assessment Reports for four management areas within US waters. New Hampshire is located within the Western Atlantic stock assessment unit which has been assessed for population status since 1995. Although reliable and recent estimates of fin whale abundance are available for large portions of the North Atlantic Ocean, these assessments do not cover the entire species range and there are insufficient data to determine the global or state population trend for fin whales. The Blue Ocean Society includes documentation of this species in its vessel-based sightings database.

2015 Authors:
Rachel Stevens, NHFG, Hal Weeks, Shoals Marine Lab

2005 Authors:

Literature

Bérubé, M., Aguilar, A., Dendato, D., Larsen, F., Notarbartolo Di Sciara, G., Sears, R., Singurjonsson, J., Urban-R., J. and Palsbøll, P. J. 1998. Population genetic structure of North Atlantic, Mediterranean Sea and Sea of Cortez fin whales, Balaenoptera

Cole, T., Hartley, D. and Garron, M. 2006. Mortality and serious injury determinations for large whale stocks along the eastern seaboard of the United States 2000-2004

Hain, J. H. W., M. J. Ratnaswamy, R. D. Kenney, and H. E. Winn. 1993. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. Rep. Int Whal. Commn.42: 653-669

http://www.nmfs.noaa.gov/pr/sars/species.htm#largewhales

http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/finwhale.htm#threats

Jensen, A.S. and G.K. Silber. 2003. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR- , 7 pp.

Kenney, R. D., G. P. Scott, T. J. Thompson, and H. E. Winn. 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. J. Northw. Atl. Fish. Sci. 22: 155-171

Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S. and Podesta, M. 2001. Collisions between ships and whales. Marine Mammal Science 17(1): 35-75.

National Marine Fisheries Service. 2010. Recovery plan for the fin whale (*Balaenoptera physalus*). National Marine Fisheries Service, Silver Spring, D.121pp

Perry S.L., DeMaster, D.P. and Silber G.K.. 1999. The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61:1, pp.44-51. Department of Commerce.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2013. *Balaenoptera physalus*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucn

North Atlantic Right Whale

Eubalaena glacialis

Photo by Christin Khan, NOAA/NEFSC

Federal Listing	E
State Listing	
Global Rank	G1
State Rank	
Regional Status	Very High

Justification (Reason for Concern in NH)

The North Atlantic right whale is of high regional conservation concern. However state regulatory responsibility is low as this species is managed by the NOAA's Office of Protected Resources who has authored, and regularly updates, a species specific recovery plan. New Hampshire supports the implementation of recommended practices in these plans in state waters and the Fish and Game Department has a joint agreement with NOAA to help enforce Federal regulations. The North Atlantic Right Whale is critically imperiled globally and has recently been documented in NH state waters. Any individual found in State waters should be of the highest conservation prioritization. The zooplankton species *Calanus finmarchicus* is the primary food source of right whales. The arrival, and reproductive success, of these mammals is dependent on the abundance and distribution of *C. finmarchicus*. Changes in the magnitude and timing of the peak abundance of *C. finmarchicus* due to warming ocean temperatures may significantly alter right whale migration, behavior, and population abundance. NOAA Fisheries recently published a proposed rule to revise right whale critical habitat (80 FR 9313; February 20, 2015). Although not final at the point of publication of this Wildlife Action Plan, the draft rule would move right whale critical habitat closer to NH state waters.

Distribution

One individual has been documented within state jurisdictional waters via vessel-based observation during the period 2009 - 2013 (Blue Ocean Society, personnel communication).

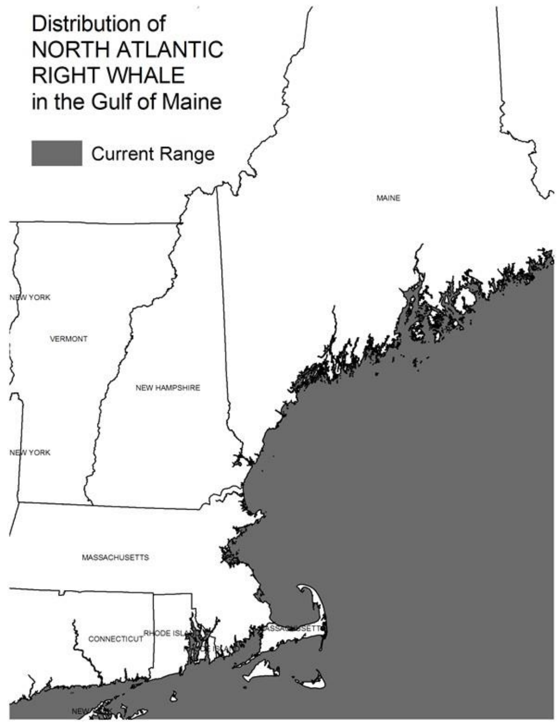
Habitat

Right whales have occurred historically in all the world's oceans from temperate to subpolar latitudes. They primarily occur in coastal or shelf waters, although movements over deep waters are known. The Cape Cod Bay and Great South Channel are two critical habitat areas that have been identified in the north east. Each are located off Massachusetts and do not extend into NH jurisdictional waters. The International Whaling Commission has identified four categories of right whale habitats:

1. Feeding areas, with copepod and krill densities that routinely elicit feeding behavior and are visited seasonally.
2. Calving areas, routinely used for calving and neonatal nursing.
3. Nursery aggregation areas, where nursing females feed and suckle.
4. Breeding locations where mating behavior occurs.

NH Wildlife Action Plan Habitats

● Marine



Distribution Map

Current Species and Habitat Condition in New Hampshire

Key populations of this species are located outside state jurisdictional waters. However, this species is critically endangered globally so conservation prioritization of individuals that enter NH waters is extremely important.

Population Management Status

Population management primarily takes place outside state waters. The NOAA Fisheries Service established the Atlantic Large Whale Take Reduction Plan to reduce injuries and deaths of large whales due to incidental entanglement in fishing gear. This is an evolving plan that changes as more is learnt about why whales become entangled and how fishing practices might be modified to reduce the risk of entanglement. It has several components including restrictions on where and how gear can be set; research into whale populations and whale behavior, as well as fishing gear interactions and modifications; outreach to inform and collaborate with fishermen and other stakeholders; and a large whale disentanglement program.

Regulatory Protection (for explanations, see Appendix I)

● CITES - Convention on International Trade of Endangered Species of Wild Fauna and Flora
● Endangered Species Conservation Act (RSA 212-A)
● Marine Mammal Protection Act (1972)

Quality of Habitat

Key habitat units are located outside state jurisdictional waters.

Habitat Protection Status

Key habitat units are located outside state jurisdictional waters.

Habitat Management Status

Key habitat units are located outside state jurisdictional waters.

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.

Mortality from collisions with ships (Threat Rank: Medium)

Direct impact of ships with individuals causing injury or mortality (Laist et al., 2001).

NOAA regularly publishes reports documenting ship strikes and consequences to individual whales. The northeast has a regional stranding coordinator in Gloucester MA who these strikes are reported to.

List of Lower Ranking Threats:

Disturbance from increasing anthropogenic ocean noise

Species impacts from over-fishing that reduces prey abundance (herring)

Mortality from entanglement in fishing gear

Species impacts from reduced prey abundance

Actions to benefit this Species or Habitat in NH

Support the Atlantic Large Whale Take Reduction Plan (National Marine Fisheries Service, 1997) regulations and amendments. This plan applies to both state and federal waters.

Primary Threat Addressed: Mortality from entanglement in fishing gear

Specific Threat (IUCN Threat Levels): Biological resource use

Objective:
Reduce the number of fishing gear-related injuries and mortalities of North Atlantic large whale species that occur from Maine through Florida.

General Strategy:
The plan consists of regulatory and non-regulatory components, including broad gear modification, gear and whale research, seasonal area closures and disentanglement and outreach efforts.

Political Location: **Watershed Location:**

Assess population status of prey species that are not commercially harvested.

Primary Threat Addressed: Species impacts from reduced prey abundance

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

Objective:
Assess changes in abundance of prey species due to non-commercial harvest pressures.

General Strategy:
Enhance knowledge of causes of alteration in whale presence or behavior. Very little can be done to mitigate large scale effects of climate change in the marine environment, but understanding impacts of these changes can help inform management decisions to support whale conservation.

Political Location: **Watershed Location:**

Support regulations within the "Endangered Fish and Wildlife; Final Rule to Implement Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales" and its amendments.

Primary Threat Addressed: Mortality from collisions with ships

Specific Threat (IUCN Threat Levels): Transportation & service corridors

Objective:
Reduce ship strikes with whales.

General Strategy:
Enforce vessel speed restrictions within specified areas at certain times and encourage ship strike reporting. It is hoped actions within this federal rule will also reduce impacts to other whale species.

Political Location: **Watershed Location:**

Conduct prey species stock assessments.

Primary Threat Addressed: Species impacts from over-fishing that reduces prey abundance (herring)

Specific Threat (IUCN Threat Levels): Biological resource use / Fishing & harvesting aquatic resources / Unintentional effects: large scale (species being assessed is not the target) [harvest]

Objective:
Maintain prey species abundance by setting harvest limits based on scientifically accurate stock assessments.

General Strategy:
Conduct fish stock assessments in order to set harvest limits and maintain whale prey species abundance.

Political Location: **Watershed Location:**

Increase awareness of impacts of anthropogenic ocean noise on whales to encourage voluntary reduction when possible.

Primary Threat Addressed: Disturbance from increasing anthropogenic ocean noise

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance / Recreational activities / Noise

Objective:
Enhance awareness of simple changes in timing, or site selection, of causes of ocean noise that may mitigate impacts on whale behavior.

General Strategy:
Multiple sources of anthropogenic ocean noise include vessels, oil refineries, seismic survey and military sonar. Since whale presence is seasonally, and somewhat spatially, predicable, encouraging voluntary changes in timing or location of these activities should be encouraged.

Political Location: **Watershed Location:**

References, Data Sources and Authors

Data Sources
Literature review.

Data Quality
NOAA’s Office of Protected Resources has regularly published Marine Mammal Stock Assessment Reports for this species. They maintain an online mapping browser and a reporting app to note right whale locations. However, because whales swim continuously, exact locations are obsolete within minutes of a sighting. A specific day or date range may contain few or no sightings. This means right whales were not observed but still may have been present. The Blue Ocean Society includes documentation of this species in its vessel-based sightings database.

2015 Authors:
Rachel Stevens, NHFG, Hal Weeks, Shoals Marine Lab

2005 Authors:

Literature

Bérubé, M., Aguilar, A., Dendato, D., Larsen, F., Notarbartolo Di Sciara, G., Sears, R., Singurjonsson, J., Urban-R., J. and Palsbøll, P. J. 1998. Population genetic structure of North Atlantic, Mediterranean Sea and Sea of Cortez fin whales, Balaenoptera

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http://www.nmfs.noaa.gov/pr/sars/species.htm#largewhales

International Whaling Commission. 2001. Report of the workshop on the comprehensive assessment of right whales: a worldwide comparison. Journal of Cetacean Research and Management 2: 1-60.

Jensen, A.S. and G.K. Silber. 2003. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR- , 7 pp.

Kenney, R. D., G. P. Scott, T. J. Thompson, and H. E. Winn. 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. J. Northw. Atl. Fish. Sci. 22: 155-171

Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S. and Podesta, M. 2001. Collisions between ships and whales. Marine Mammal Science 17(1): 35-75.

National Marine Fisheries Service, 2014. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2013. NOAA Technical Memorandum NMFS-NE-228. Web document www.nefsc.noaa.gov/nefsc/publications/

National Marine Fisheries Service. 1997. Atlantic Large Whale Take Reduction Plan (ALWTRP) Interim Final Rule. Federal Register 62 FR 39157.

Perry S.L., DeMaster, D.P. and Silber G.K.. 1999. The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61:1, pp.44-51. Department of Commerce.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2013. *Balaenoptera physalus*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucn

Humpback Whale

Megaptera novaeangliae

Photo by Christin Khan, NOAA/NEFSC

Federal Listing	E
State Listing	
Global Rank	G4TNR
State Rank	
Regional Status	Very High

Justification (Reason for Concern in NH)

The humpback whale is of high regional conservation concern. However state regulatory responsibility is low as this species is managed by the NOAA's Office of Protected Resources who has authored, and regularly updates, a species specific recovery plan. New Hampshire supports the implementation of recommended practices in these plans in state waters and the Fish and Game Department has a joint enforcement agreement with NOAA to help enforce Federal regulations. Warming ocean temperatures may result in reduction in biomass of prey species on which the arrival and reproductive success of this species is dependent. Changes in the magnitude and timing of the peak abundance of prey species may significantly alter whale migration, behavior, and population abundance (Kenney et al. 1997). NOAA Fisheries recently completed a status review for humpback whales, which resulted in publication of a proposed rule to de-list the West Indies Distinct population segment of humpbacks (80 FR 22303; April 21, 2015). Although not final at the point of publication of this Wildlife Action Plan, this rule would result in humpbacks found off the Atlantic coast being de-listed under the Endangered Species Act.

Distribution

No individuals have been documented within state jurisdictional waters via vessel-based observation during the period 2009 - 2013 (Blue Ocean Society, personnel communication).

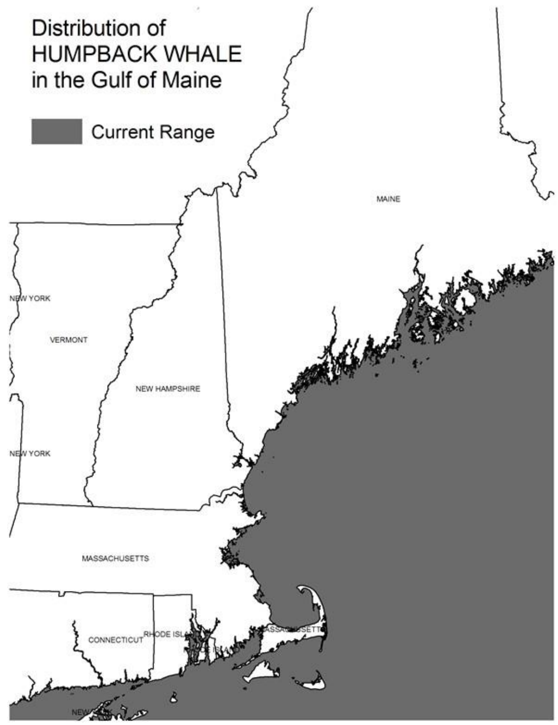
Habitat

While feeding and calving, humpbacks prefer relatively shallow ocean waters. During calving, humpbacks are usually found in the warmest waters available at that latitude. Calving grounds are commonly near offshore reef systems, islands, or continental shores.

Humpback feeding grounds are in cold, productive coastal waters. During migration, humpbacks stay near the surface of the ocean.

NH Wildlife Action Plan Habitats

- Marine



Distribution Map

Current Species and Habitat Condition in New Hampshire

Key populations of this species are located outside state jurisdictional waters. However, this species is endangered globally so conservation prioritization of individuals that enter NH waters is extremely important.

Population Management Status

Population management primarily takes place outside state waters. The NOAA Fisheries Service established the Atlantic Large Whale Take Reduction Plan to reduce injuries and deaths of large whales due to incidental entanglement in fishing gear. This is an evolving plan that changes as more is learnt about why whales become entangled and how fishing practices might be modified to reduce the risk of entanglement. It has several components including restrictions on where and how gear can be set; research into whale populations and whale behavior, as well as fishing gear interactions and modifications; outreach to inform and collaborate with fishermen and other stakeholders; and a large whale disentanglement program.

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Direct impact of ships with individuals causing injury or mortality (Laist et al., 2001). Of all species of large whales, fin whales are most often reported as hit by vessels (Jensen and Silber, 2004).

NOAA regularly publishes reports documenting ship strikes and consequences to individual whales. The northeast has a regional stranding coordinator in Gloucester MA who these strikes are reported to.

List of Lower Ranking Threats:

Disturbance from increasing anthropogenic ocean noise

Species impacts from over-fishing that reduces prey abundance (herring)

Mortality from entanglement in fishing gear

Species impacts from reduced prey abundance

Actions to benefit this Species or Habitat in NH

Increase awareness of impacts of anthropogenic ocean noise on whales to encourage voluntary reduction when possible.

Primary Threat Addressed: Disturbance from increasing anthropogenic ocean noise

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance / Recreational activities / Noise

Objective:
Enhance awareness of simple changes in timing, or site selection, of causes of ocean noise that may mitigate impacts on whale behavior.

General Strategy:
Multiple sources of anthropogenic ocean noise include vessels, oil refineries, seismic survey and military sonar. Since whale presence is seasonally, and somewhat spatially, predicable, encouraging voluntary changes in timing or location of these activities should be encouraged.

Political Location: **Watershed Location:**

Conduct prey species stock assessments.

Primary Threat Addressed: Species impacts from over-fishing that reduces prey abundance (herring)

Specific Threat (IUCN Threat Levels): Biological resource use / Fishing & harvesting aquatic resources / Unintentional effects: large scale (species being assessed is not the target) [harvest]

Objective:
Maintain prey species abundance by setting harvest limits based on scientifically accurate stock assessments.

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Political Location: **Watershed Location:**

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Specific Threat (IUCN Threat Levels): Biological resource use

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Enhance knowledge of causes of alteration in whale presence or behavior. Very little can be done to mitigate large scale effects of climate change in the marine environment, but understanding impacts of these changes can help inform management decisions to support whale conservation.

Political Location: **Watershed Location:**

References, Data Sources and Authors

Data Sources
Literature review.

Data Quality
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http://www.nmfs.noaa.gov/pr/sars/species.htm#largewhales

Jensen, A.S. and G.K. Silber. 2003. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR- , 7 pp.

Kenney, R. D., G. P. Scott, T. J. Thompson, and H. E. Winn. 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. J. Northw. Atl. Fish. Sci. 22: 155-171

Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S. and Podesta, M. 2001. Collisions between ships and whales. Marine Mammal Science 17(1): 35-75.

National Marine Fisheries Service, 2014. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2013. NOAA Technical Memorandum NMFS-NE-228. Web document www.nefsc.noaa.gov/nefsc/publications/.

National Marine Fisheries Service. 1997. Atlantic Large Whale Take Reduction Plan (ALWTRP) Interim Final Rule. Federal Register 62 FR 39157.

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