# MAINE DEPARTMENT OF MARINE RESOURCES

# COASTAL FISHERY RESEARCH PRIORITIES

# SEA SCALLOPS

***(Placopecten magellanicus)***

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**for**

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**SEA SCALLOP FISHERY RESEARCH PRIORITIES**



## Preface

The 2010 research priority setting workshops follow a decade of research since the Maine Department of Marine Resources held the last series of workshops in 2000. There has been a great deal of information gathered and new insights gained over these ten years. Most importantly, Maine fishermen have become full partners in establishing the research questions and pursuing the answers to those questions through collaborative research. Maine has been a leader in the region for engaging fishermen, scientists, and managers in the quest for better information on which to manage its fisheries. While there has been great progress, there remain many unanswered questions and further work to be done. Through this collaborative approach to research, drawing upon Maine's creative and innovative spirit, we are optimistic that the most pressing questions will continue to be addressed in the next decade.

# I. Scallop Background

Maine's sea scallop (*Placopecten magellanicus*) resource occurs primarily within three miles of shore and is predominantly harvested in the eastern part of the state. Since reaching a high of 3.8 million pounds (meat weight) in the early 1980s, the resource has experienced a sharp decline in landings and has remained below 700,000 pounds (meat weight) during the last decade (www.maine.gov/dmr/commercialfishing/historicaldata.htm).

The Maine fishery is harvested primarily by trawling vessels approximately 40 feet or less and is a secondary fishery for most Maine fishermen. A few vessels also harvest scallops in the federal Gulf of Maine waters offshore throughout the year. Although these waters periodically experience a "bloom" resulting in a dramatic increase in landings, in recent years, the landings from these waters have been minimal. There were 683 dragging licenses issued in 2009 compared to 741 dragger licenses issued in 1999. Divers historically made up a greater portion of the licenses with 353 diver licenses issued in 1999, but have dropped considerably to 135 diver licenses in 2009. In 2008, the Maine Legislature established limited entry in the commercial scallop fishery; beginning in 2009, commercial licenses were limited to those individuals who held a commercial license between January 1, 2005 and April 30, 2008. Beginning in 2010, an individual could only obtain a commercial license if he held that license in the previous calendar year. The Department is currently in the process of developing a means to allow entry into the commercial fishery via a lottery system.

Scallop management is the responsibility of both federal and state management agencies. The New England Fisheries Management Council administers the federal portion of the fishery (www.nefmc.org/scallops/index.html). As a result of effort reductions, gear restrictions, and closed areas established to reduce fishing mortality, the Atlantic sea scallop population in federal waters has been rebuilt to sustainable levels since 2001. In 2008 the Northern Gulf of Maine Management Area was established as all federal waters north of 42'20, and this area is managed separately from federal waters to the south. The vast majority of federal landings occur outside the Northern Gulf of Maine. There are currently 48 individuals (52 vessels) that hold both a federal permit and a state permit. Only three vessels hold a federal limited access permit which allows them to operate under a days-at-sea system while all the remaining federal scallop permit vessels hold general category permits which are managed under individual fishing limits and a total allowable catch.

The inshore scallop resource is managed by the State of Maine using a suite of management measures (www.maine.gov/dmr/rm/scallops/index.htm). Changes implemented in recent years include establishment of limited entry to the commercial fishery in May of 2008, a reduction of the fishing season from 132 to 70 days, an increase in scallop drag ring size to 4 inches, implementation of a commercial limit of 200 meat pounds, and the establishment of large conservation closures.

In 2003, the Maine legislature established a Scallop Research Fund that is supported through a surcharge on scallop licenses and created the Scallop Advisory Council to advise the Department of Marine Resources (DMR) on issues pertaining to scallops. Most recently, Maine made a significant management decision to designate several areas along the coast as conservation areas

which are now closed to scallop fishing (Casco Bay Area; Damariscotta/Sheepscot Area; Muscongus/ Western Penobscot Area; Eastern Penobscot Area; Blue Hill Harbor/ Morgan Bay Area; Mt. Desert Area; Gouldsboro Bay Area; Jonesport/ Machias Area; St. Croix Area; Whiting and Dennys Bay Area).

## II. Research Priority Meetings

The Maine Department of Marine Resources (DMR), in collaboration with the Gulf of Maine Research Institute and Maine Sea Grant, conducted a series of meetings in November and December 2010 to develop research priorities for scallops, herring, and lobsters. For scallops and lobsters, these meetings provided an opportunity to update the DMR Research Priorities established through a similar initiative in 2000 for five on Maine's major commercial species (soft-shell clams, lobsters, scallops, sea urchins, and shrimp; see http://www.maine.gov/dmr/research/table_of_contents.htm).

Fishermen, academic scientists, government scientists, fisheries managers, and others interested in fisheries issues gathered together in a non-regulatory, open discussion about the scientific questions they had about each species. The meetings were not structured to address management questions or to decide how to use scallop or lobster research funding. Rather, the result of these meetings is a prioritized list of research questions that can be used to stimulate new research by the marine science community and to help ensure that fishery management decisions are made on the best information.

These meetings followed the formats of the 2000 initiative and a recent symposium on rockweed (see http://www.maine.gov/dmr/rm/rockweed/symposium2010/index.htm). Scientists with expertise on each species were invited to give brief presentations on specific topics along with their ideas for major scientific gaps and potential research questions. The presentations were followed by a facilitated discussion that provided an opportunity for exchanging ideas and observations. These ideas formed the basis for a list of research questions. Meeting participants were asked to prioritize among the research questions at the end of the meeting in two ways; first with regard to overall priority and second with regard to the most important research questions to address initially.

## III. Report Format

The scallop meeting was divided into four segments: Habitat, Life History, Stock Structure, and Stock Assessment. A brief overview of each presentation is given in Section IV followed by the priority research questions. Where appropriate, additional topics have been added to reflect the questions and concerns articulated at the meeting, not necessarily how the meeting was structured.

The priority research needs were generated throughout the day and are arranged below under the topic area that is most appropriate, not necessarily the segment where they were discussed. The research needs are listed in priority order within each section.

A detailed, categorized list of questions, observations, and opinions articulated during the

meeting is presented in Section V.

## IV. Priority Research Questions

### Scallop Priority 1: Habitat

Brian Beal from the University of Maine at Machias presented background information about habitat issues related to the Maine scallop resource. The full presentation can be found at http://www.maine.gov/dmr/research/priorities10/scallops/beal.pdf.

He started his presentation by noting that there are many of the research priorities identified at the 2000 research priority-setting meeting for scallops that are still applicable research questions today. He also noted that the landings have continued to decline in the past decade and scallops remain an unhealthy fishery.

Cobscook Bay has had the most productive scallop fishery within Maine waters for a number of years. An estimated 80-90% of Maine's annual scallop landings come from Cobscook Bay. However, with rare exception, areas outside the Cobscook Bay area have abysmally low densities. For example, scallop densities in Cobscook Bay varied in 2009 from 0.1 to 0.6 animals per square meter. While other areas along the coast were much lower - at Machias Seal Island (0.018 $m^2$), Mt. Desert Rock (0.016 $m^2$), Pemaquid Point to W. Penobscot Bay (0.018 $m^2$) and Kittery to Cape Elizabeth (0.06 $m^2$). There are many questions regarding why Cobscook Bay remains such a productive area.

Large areas along the Maine coast have been closed to scallop fishing, including some areas within Cobscook Bay. These closed areas provide a unique opportunity to conduct a coastwide experiment to study how the lack of scallop fishing in these habitats effects the scallop spat, recruitment of juveniles and adult population both within and between these geographic areas.

#### *Priority Research Needs:*

1. *Use closed areas to study factors for scallop recruitment and growth.*
2. *Research smaller spawning sanctuaries.*
3. *Investigate the toxic impact of waste water systems*
4. *Determine how many scallops are needed for a successful spawning sanctuary.*
5. *Explore what factors are leading to success in Cobscook Bay.*

### Scallop Priority 2: Life History

Jonathan Grabowski from the Gulf of Maine Research Institute gave the scallop life history presentation. The full presentation can be found at http://www.maine.gov/dmr/research/priorities10/scallops/grabowski.pdf.

The scallop life cycle includes a pelagic phase when scallops are tiny larvae for 5-15 days until they settle as juveniles of approximately 1 mm in shell length, which is the benthic phase. Scallops reach adulthood after 3-4 years and are then able to reproduce. Scallop recruitment along the Maine coast, based on spat counts between 2000-2002, appears to be significant around

Matinicus Island. However, spat collection has been extremely variable and sporadic along the coast so conclusions concerning larval potential of various areas or even overall cannot be made at this point.

More recent work from 2002-2007 shows the greatest densities of seed scallops, sublegal and legal scallops around the Cobscook Bay and St. Croix area (Scallop Zone 1), while the other areas of the coast are very low. For a number of reasons, Cobscook Bay has received more intensive and regular scallop sampling than other areas of the coast. When looking at the relationship among seed scallops, sublegal scallops and adults, it is very difficult to determine the limiting factors due to the low levels of scallop data outside of Cobscook Bay.

Scallops are broadcast spawners with males and females releasing sperm and eggs into the water column for fertilization. Therefore, density is incredibly important and egg limitation and sperm limitation is a factor in reproductive success. Size also matters for scallops as the bigger the scallop, the more productive (i.e., there is large difference in reproduction between a three inch scallop and a six inch scallop). Aggregation is an important component for reproductive success and scallops tend to aggregate in clumps when not disturbed by fishing.

Historical scallop fishing grounds match circulation patterns in the Gulf of Maine. But more work could be done to use the physical models of Maine's coastal currents to increase the likelihood that inshore closures and enhancement efforts are effective. If you look at coastal currents, you may be able to place larvae in areas where they will actually repopulate the right areas.

Predation and habitat availability are important factors to the success of juvenile scallops. Grabowski raised several questions about which predators are the most significant for scallops (i.e., sea stars, crabs, and/or lobsters) and trying to determine how much predation pressure varies along the coast of Maine. Water temperature and bottom habitat may also be affecting the success of newly settled scallops.

### *Priority Research Needs:*

1. *Examine if scallops are limited by recruitment, spawning, or predation.*
2. *Investigate whether or not predation pressure varies along the coast.*
3. *Explore whether areas with high densities of juvenile scallops also have high densities of predators (i.e. crustaceans or other predators like starfish).*

## Scallop Priority 3: Enhancement

Although not presented as a separate topic, scallop enhancement was discussed along with the habitat issues. In the 2000 research priority report, there were several suggestions made to research methods of enhancing the scallop resource. While there have been some experiments with spat collection methods, there remain several unanswered research questions. Brian Beal described a current project he is conducting to enhance scallop stocks in eastern Maine and Jonathan Grabowski also made several suggestions about potential factors affection scallop enhancement methods.

Spat collection can be used as an enhancement tool but also may be useful to assess scallop stocks. There was a great deal of discussion and much energy around finding ways for the fishing industry to actively participate in spat collection for assessments and scallop enhancement studies. In 2008, a graduate student at the University of Maine (Danielle Brzezinski) conducted a literature review of scallop enhancement activities around the world, focusing on those projects of greatest potential applicability to Maine waters. This review is available at http://www.maine.gov/dmr/rm/scallops/brzesinskilitrev08.pdf.

### *Priority Research Needs:*

1. *Explore whether current modeling can help identify areas for closures and enhancement (where's the source or sink).*
2. *Collect data to determine when and at what depths to deploy spat bags.*
3. *Conduct a standardized fishermen-based spat bag study.*

## Scallop Priority 4: Stock Structure

Erin Fisher Owen of Husson University gave an overview of the population structure of sea scallops in coastal Maine. Please see www.maine.gov/dmr/research/priorities10/scallops/owen.pdf for the full presentation.

In general, a population, or stock, is maintained by "local" processes. Therefore, fishing on one population does not affect neighboring populations. If there is high migration of larvae among adjacent areas on the coast you would see small genetic differences (open populations). However, low migration would lead to large genetic differences among adjacent areas (closed populations). Closed populations do not rely on migration from other locations to sustain the population, and thus can be considered separate stocks.

Owen collected legal size scallops in 2003 along the coast of Maine in four areas and offshore on Georges Bank to examine the genetic differences. In Cobscook Bay, scallops were also collected during different years. The results showed that Cobscook Bay and Gouldsboro are as different from each other genetically as they are from the rest of the Gulf of Maine. Therefore, it is likely that a number of closed populations exist among locations sampled in the Gulf of Maine. In Cobscook Bay, Year 2, 3, and 4 were similar but they were significantly different than Year 5+. These genetic differences among year classes in Cobscook Bay suggest more than one source of recruits. Georges Bank scallops were not really seen as the source for Casco Bay and Penobscot Bay because of circulation patterns.

### *Priority Research Needs:*

1. *Determine how many scallop populations exist in eastern Maine.*
2. *Explore the potential sources of larvae for closed areas.*
3. *Study the level of migration from eastern Canada.*

## Scallop Priority 5: Stock Assessment

Kevin Kelly presented information on the Maine DMR scallop assessment. His full presentation is available at www.maine.gov/dmr/research/priorities10/scallops/kelly.pdf. In direct response to the 2000 research priority report, Maine DMR started an abundance survey in 2002 under a Northeast Consortium grant. The survey is conducted annually during late October to November, prior to the opening of the commercial season, within 14 different zones (or strata). The survey rotates between Cobscook Bay, eastern Maine and western Maine with a systematic survey of 86 stations within Cobscook Bay. Random sampling takes place within known fishing grounds of each stratum with fixed station sampling and additional changes in 2009 to augment sampling within the closed areas. The survey takes place aboard a contracted commercial fishing vessel with a 7-foot style New Bedford style chain sweep dragging for 3-5 minutes (2 ½ minutes in Cobscook Bay) tows covering a 300-500 m swatch at each station. A minimum of 100 scallops or 10% of each tow are measured. Accumulated length frequencies are divided into three size classes (seed, sublegal, or harvestable).

The size class and composition of scallops in Cobscook Bay for 2009 showed increased harvestable scallops in the Eastport (Moose Is.) area. Moose Is. and South Bay each contained 32% of the harvestable biomass. Overall abundance in Cobscook Bay has been relatively constant since 2003, as has the density of seed scallops. Cobscook Bay has seen an increased amount of seed in 2009, particularly in Johnson Bay, Whiting Bay/Dennys Bay, and around Moose Is.. There were also a large number of pre-recruits within 10 mm of legal size.

The DMR takes meat weight samples approximately every three (3) tows to calculate a shell height vs. meat weight curve, which along with density is used to calculate a harvestable biomass estimate for Cobscook Bay. DMR will be able to compare this number to 2009 landings (the first year harvester reporting was required). The estimated harvestable biomass in 2009 (196.5 $\pm$ 28.0 thousand pounds) was above average for the four-year time series. There was also an increased biomass in Johnson Bay and Moose Island substrata. The estimated harvestable density of scallops for eastern and western Maine correlate very well with the reported Maine scallop landings for the years where both data are available (2005, 2006, 2008, and 2009).

The DMR also conducts port sampling, which indicate that catch rates in Cobscook Bay normally appear to drop off within 15 days after the season opens. Therefore, the effective fishing season for many fishermen is much less than the allowed 70-day season.

Scallop abundance has remained low and slightly declined for eastern Penobscot Bay to Quoddy Head since 2006. This is similar to results in contiguous areas of the Canadian coast where landings and survey indices have either remained unchanged or declined since 2006 (Smith et al. 2008)). In slight contrast, the eastern Penobscot Bay to western Blue Hill Bay area has showed minor improvement since 2006. There have been some small recruitment signals (indicated by

presence of seed) in six areas along the eastern Penobscot Bay to Quoddy Head region. These areas may benefit from closed area protection.

The survey from the New Hampshire border to the western Penobscot Bay shows improvement in scallop abundance since 2005. Sublegal scallops were the predominant size class and scallop densities were lower in closed areas than open areas with the exception of lower Damariscotta River.

The DMR is collecting more information on scallops than they have in the past, but there are still many unanswered questions. Cobscook Bay is currently growth overfished, but it is not clear whether it is recruitment overfished. Fishermen have seen areas of very high production for scallops in the past in other areas and then a rapid decline.

There was a great deal of concern among fishermen about the stock assessment several years ago when DMR was looking at using the stock assessment to determine a hard total allowable catch for Cobscook Bay. Because the Cobscook Bay fishermen use a 5 ½ foot dredge, they couldn't participate as contract vessels in the survey. One question discussed at length was whether a local methodology among Cobscook Bay fishermen could be designed so that they can participate in the assessment process in a meaningful way.

## *Priority Research Needs:*

1. *Determine how closed areas could be surveyed to mobilize industry. (i.e., How can we mobilize industry to evaluate closed areas?)*
2. *Establish how high the scallop biomass should be to open the closed areas.*
3. *Explore criteria to divide recovered stocks between commercial take and further recruitment.*

## V. Scallop Observations and Questions from Discussion

**Ecology:**

- Are numbers and varieties of plankton a limiting factor?
- Difficult and costly to identify larval shellfish (bivalves)
- What are factors leading to success in Cobscook Bay?
- What factors need to change to bring scallops back?
- Are spread of mussel beds taking over scallop beds?
- Is food availability a factor?
- Is there threshold density?

**Habitat:**

- What is the impact of predation – how does predation vary with habitat?
- What is juvenile habitat?
- Does habitat structure and flow effect juvenile scallop survival?
- What are the effects of benthic disturbances (both positive and negative impact)?
- Is habitat more important than geographic location?

**Water Quality**

- Toxic impact of waste water systems
- Measure concentration of pollutants

**Life History:**

- Should we protect larger scallops? Is there a reproductive benefit to protecting larger scallops?
- Are large scallops contributing more to the fishery?

- Research smaller spawning sanctuaries?
- How many scallops are needed for a successful spawning sanctuary
- Research cages for successful spawning aggregations
- Are scallops limited by recruitment, spawning, or predation?
- What factors limit fertilization success in Maine?
- Develop constant gonadal index for years.
- Using closed areas to study factors for scallop recruitment and growth.
- What are the numbers of scallop larvae in the water column?

**Enhancement:**

- Where do spat bags/trays do best in comparison to scallop density?
- Has anyone looked at settlement on trays vs. spat bags?
- Can current modeling help identify areas for closures and enhancement (where's the source or sink)?
- Need for data on when to deploy spat bags (and depths)
- What triggers settlement?
- Standardized fishermen-based spat bag study.

**Predator/Prey Interactions:**

- Impact of parasites/diseases (polydora; boring sponge; shell blister)
- Does predation pressure vary along the coast?
- Research mapping of different species – overlaying.
- Do areas with high densities of juvenile scallops also have high densities of predators = crustaceans.
- Impact of Didemnum on scallop habitat, juveniles, adults, and quality of scallop meats

- Other predators like starfish

**Stock Structure:**

- How many populations exist in eastern Maine?
- Genetic sampling of closed areas
- How many genetically distinct stocks are there?
- Evaluate using offshore scallops for inshore spawning sanctuaries.
- Using non-neutral markers to identify whether scallops are locally adapted.
- Is there a relationship between shell morphology and genetics?
- Are genetic differences ecologically significant?
- How can larvae be tracked on ecological time scales?

**Oceanography:**

- What are mechanisms that keep stocks separate?
- Mapping genetics with fine scale oceanographic work?
- Study larval behavior to understand dispersal patterns.
- What are the potential sources of larvae for closed areas?
- What is the level of migration from eastern Canada?

**Assessment and Surveys:**

- Meat count by region
- How high should the biomass be to open the closed areas?
- How should closed areas be surveyed (how to mobilize industry)?
- (i.e., How can we mobilize industry to evaluate closed areas?)
- What survey methods are easily transferable from one vessel to another?

- How are assessments influencing recruitment?
- How can fishermen participate in stock assessment in Cobscook Bay?
- Can population modeling help our knowledge of recovery levels?
- How do we determine stock recovery?

**Management**

- How do you divide recovered stocks between commercial take and further recruitment?
- How effective were the closed areas for fisheries management
- Can we research level of poaching in closed areas?

## VI. Scallop Meeting Participants

Annie Tselikis, Togue Brawn, Shelly Tallack, Brian Beal, Jonathan Grabowski, Sharron Mack, Ty Babb, Carla Guenther, Barry Huckins, Chris Bartlett, Kevin Kelly, David Libby, William E. Soukup, Andy Mays, Erin Owen, Linda Mercer, Jason Gordius, Brian Gordius, James Ackley, Maurice Alley, Will Hopkins, Dennis Damon, Kate Burns, Laura Taylor Singer


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