

The Maine  
Sea Cucumber  
(*Cucumaria frondosa*)  
Fishery



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## **SUMMARY**

The Maine sea cucumber fishery is a limited entry fishery that initially consisted of 16 participants and currently consists of 10 license holders. Current license holders must renew their licenses yearly in order to remain eligible for the fishery. According to landings data, there are two processors who handle whole product and one company that utilizes sea cucumber waste for health and wellness products (chondroitin). Current management regulations include: a maximum drag width (5'6"), no nighttime fishing, a seasonal closure from July 1 through September 30, and no incidental take of sea cucumbers in other fisheries.

## **BACKGROUND**

### **Biology**

*Cucumaria frondosa*, also called orange-footed sea cucumbers or 'pickles' by fishermen, are the only commercially important sea cucumber among four other species found along Maine's shore. Along with sea urchins it is the only other echinoderm fished in the Gulf of Maine. This sea cucumber is distributed over a wide range (Box 1). It is a slow growing animal with few predators. Body shape is variable (Figure 1). When disturbed, the animal retracts its tentacles and contracts itself into a football shape (contracted state). When feeding, the animal is elongated into its 'active' state. When left out of water for some time, the animal expels water and flattens into a 'slump' state.

Eggs are spawned in late March to May. The embryo develops into a blastula and 'hatches' out after 2-3 days. The larvae develop into planktonic, ciliated gastrula (called the vitellariae stage after the yolk reserves that the larvae feed on) and then further progress to the "pentacula" stage. After 43-48 days, these larvae slowly lose their cilia and sink to the bottom. Larvae 'explore' the substrate for a short time before permanently settling and growing into juveniles- essentially miniature adults. Little is known about their ecological role, but in some areas, sea cucumbers may be the dominant benthic organism.

**Box 1 – Biology Synopsis**

*Cucumaria frondosa*; Phylum Echinodermata, Class Holothuroidea, Subclass Dendrochirotea

**Range:** Wide distribution in North Atlantic and Arctic Ocean including the Norwegian, Barents and North Sea and in waters around Iceland. The southern range along the western Atlantic extends to Cape Cod and Nantucket. Population densities can reach to 5 individuals/ m<sup>2</sup> or 15 kg/ m<sup>2</sup>. In some areas they comprise a large proportion (>50%) of the benthic biomass.

**Depth:** Intertidal to 300 meters (most commonly 30-60m). Juveniles in shallower areas.

**Habitat:** Found on many bottom types with some solid substrate (including loose gravel, shell debris, rocks, and even mud). Very fine silts are avoided and moderate current is preferred. Juveniles may be associated with shallow areas and kelp and mussel beds.

**Feeding:** Feeds passively on phytoplankton (especially diatoms) and organic detritus. Particles adhere to mucous coated set of 10 branched and retractable tentacles.

**Body:** Color ranges from dark brown, dark purple, black to grayish, yellowish, pink and albino (rare) with the dorsal side often lighter in color (Figure 2). Spicules found in body wall. Extremely flexible body.

**Locomotion:** Uses five rows of tube feet (more developed on the ventral side) or body contractions. Speeds to 0.5 m per minute.

**Physiology:** Nutrients are distributed by a hemal system of vessels. Two large respiratory trees in body cavity extract oxygen from water circulated by cloacal muscles. Nerve ring near oral end. Animal retracts tentacles and contracts body when disturbed.

**Growth:** Slow growing. Grow to approximately 20 cm (active length - mouth to anus) or 500 g close to shore, and to 50 cm (1.5 - 2 kg) in deep offshore waters. In two years at a size of 3.5cm displays the full adult morphology. It takes an estimated 5.5 years to grow to 12 cm. Estimated life span is roughly 10 years. Unknown but presumed low natural mortality. Seasonal variations in growth are apparent.

**Predators:** Relatively few – especially for larger sized animals. Urchins and nereid worms may prey on small sea cucumbers, also starfish (*Asterias vulgaris* and *Solaster endeca*).

**Reproduction:** Broadcast spawners. Male and females are separate sexes (dioecious). Mature eggs are approximately 800 microns in diameter and large sea cucumbers may spawn approximately 9000 eggs. Spawning time varies with latitude. In Maine, spawning takes place sometime between Late March- early May (noted only at one location to date) to June in the Gulf of St. Lawrence. Animals exhibit modified direct development:

Time line:	0	72 hours	11 days	46 days	3-4 months
Egg	Zygote	Gastrula	Pentacula	Settlement	Juvenile

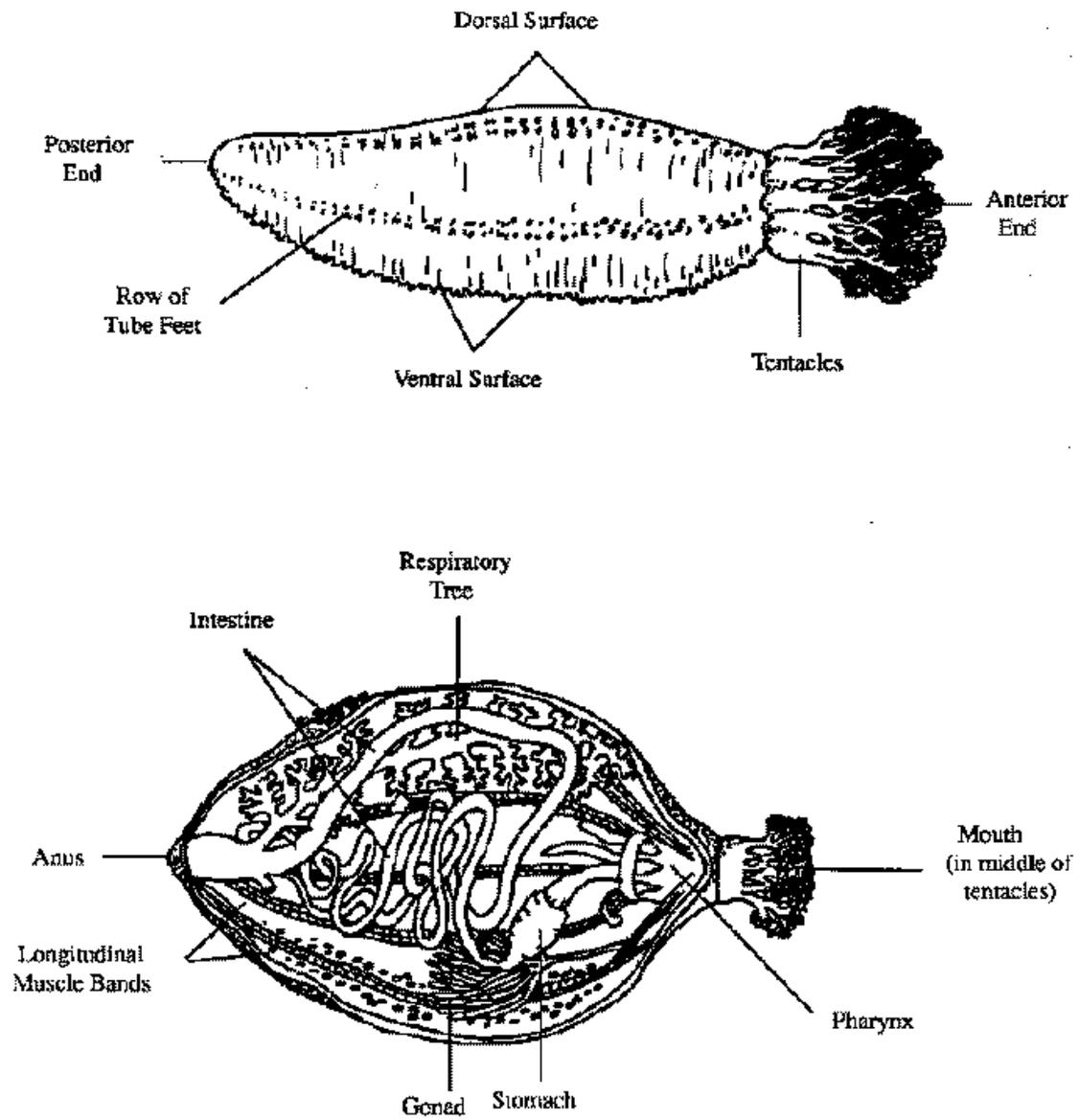


Figure 1. Body plan and anatomy of the sea cucumber, *Cucumaria frondosa* (from Chenoweth and McGowan, 1997).



Figure 2. Sea cucumber shape/ color/ size variability.

## History of the Fishery

The fishery in Maine began with one operation in 1988, but started expanding in 1994 when Asian markets opened up (Chenoweth and McGowan, 1997). Boats ranged from 40-90 feet in length with the capacity to harvest between 70 and 200 totes of sea cucumbers per day. Either scallop chain sweeps or light urchin drags were used as gear. Activity was centered in Washington and Hancock Counties with catch landed in Winter Harbor, Jonesport and Beales Island and in Eastport. Three processors were active during this time, and product was also being trucked out of state for processing in Massachusetts and Seattle. There were also reports of other large operations interested in converting over to sea cucumbers. In 1995, the industry employed approximately 75-100 people in processing in addition to 15-20 fishermen harvesting. Between 1994-1996 recorded landings were between 1 and 3 million pounds. In 1999, reported landings were over 8 million pounds, and in 2000- over 9 million pounds (Figure 3).

In response to gear conflict issues between lobstermen and a growing number of sea cucumber druggers, the DMR met with concerned parties. On further evaluating this fishery there was great concern over a rapid depletion of the resource as interest in the industry peaked. This resulted in the enactment of regulations under the 1999 Sustainable Development of Emerging Fisheries Act in March 2000– limiting the fishing season, drag size, and number of endorsements for this species and requiring the submission of harvester logbooks. In 2005 a limited entry license was established to replace the expiring endorsement regulations.

**Figure 3. A typical day's catch – 134 totes stacked 3 high on deck and weighing over 20,000 lbs (below).**



## Market

The sea cucumber is a low value - bulk fishery. The price paid to fishermen is currently \$40 per tote (less than \$0.30 per pound). Thus, large catches per boat are required for the fishery to be economically viable. Likewise processors need a minimum amount per day of operation to remain viable.

Products derived from the sea cucumber include the internal muscle bands stretching along the length of the body (frozen) and the dried body wall, which is reconstituted and used in soups and stews. This latter product is known as Trepang in the Indo-Pacific or more common - *Beche-de-mer*. This is translated as “spade of the sea” and refers to the deposit feeding or ‘sediment shoveling’ behavior of some of the more traditionally harvested sea cucumber species. Major consuming countries include: China, Hong Kong, South Korea, Singapore, Taiwan and Japan. Yield from the sea cucumber is roughly 10-15 % of the drained whole weight (3-4% muscle mass; 10% body wall).

In order to process sea cucumbers: the end containing the tentacles is removed, the body is slit lengthwise, the viscera is removed, and the muscles scraped off the body wall. Muscles are packaged and frozen in plastic bags and the body wall is put through a drying process and packed in large burlap bags.

The by-product from processing is also used as a nutritional supplement providing chondroitin - which purportedly aids in cartilage building. It is sold as a treatment for arthritis and is marketed for both humans and pets. By-product may also be marketed as compost. Protein is the major constituent of sea cucumbers and there has been some interest in the use of by-product in animal feeds.

## CURRENT STATUS

Overall, both catch and effort have declined during the ten years that the DMR has collected landings data, while prices have increased. DMR’s current management strategies include mandatory reporting through harvester log books, limited entry into the fishery, and dock side sampling.

Figure 1 (following page) shows the number of active licenses (defined as landing at least one pound) compared to the total landings for each year that the DMR has data. The highest total landings occurred in 2003 with 9,945,710 lbs landed by 10 boats. The lowest total landings occurred in 2009 with 3,342,248 lbs landed by 8 boats.

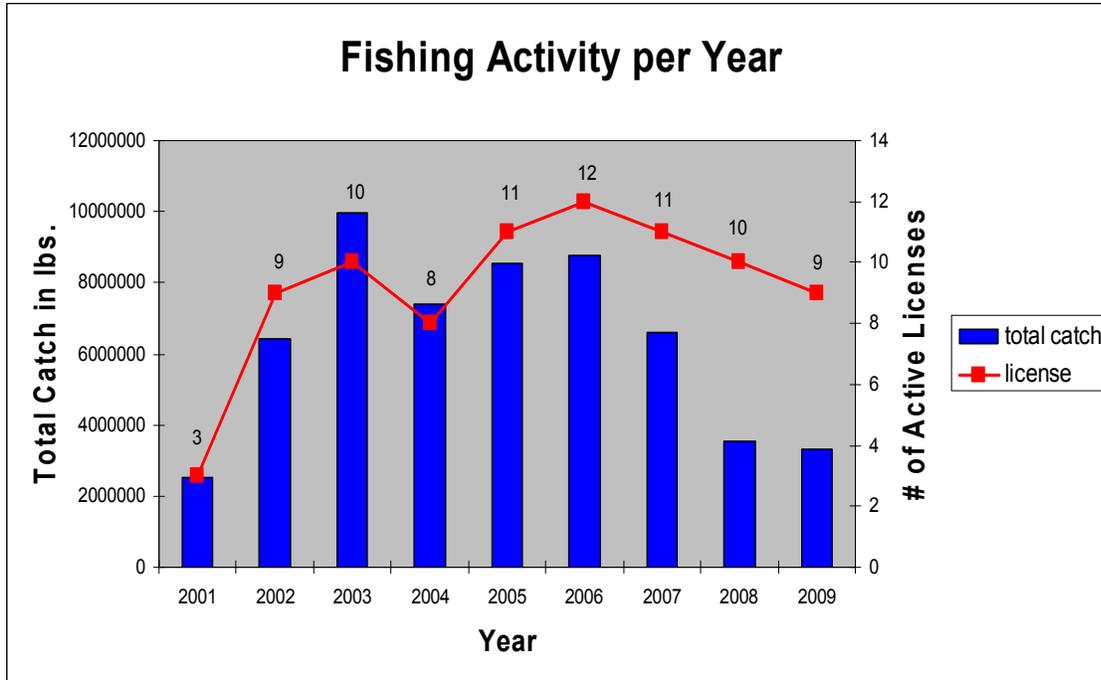


Figure 2 shows the average catch-per-unit-effort (CPUE) by year. The CPUE is defined as the average poundage of sea cucumbers caught per minute towed. The highest average CPUE occurred in 2003 with 121 lbs per minute towed and the lowest average CPUE occurred in both 2008 and 2009 with 20 lbs per minute towed.

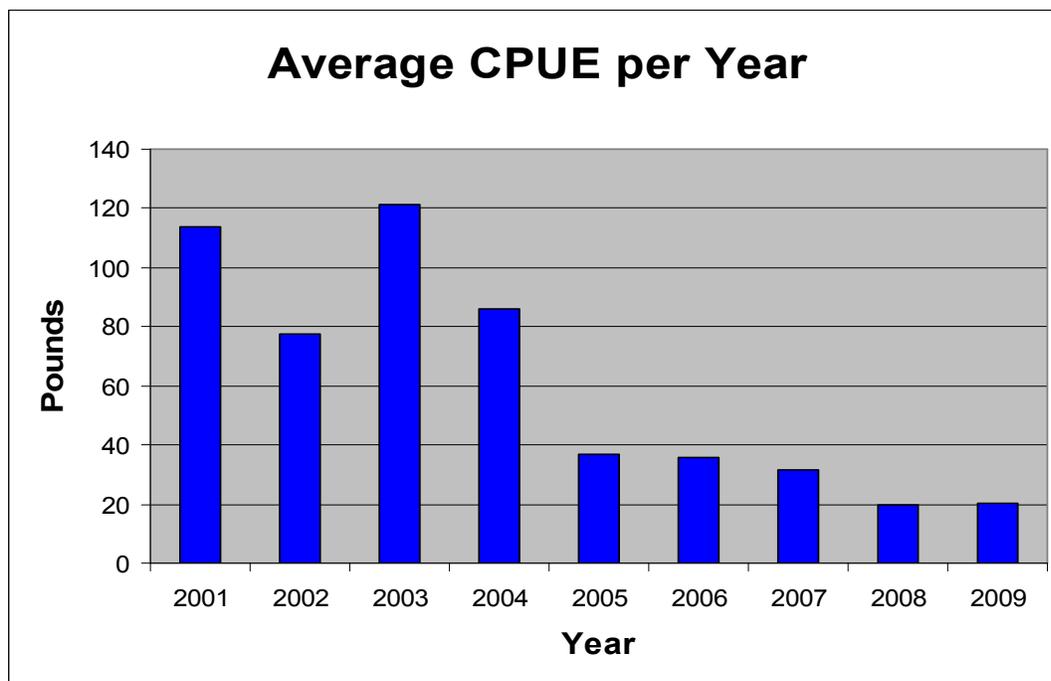


Figure 5 shows the total value of sea cucumber landings in Maine. Values were at their lowest in 2006 (8,770,309 lbs.) with a total value of \$296,070. In 2009, total landings (3,342,248 lbs.) were valued at \$874,234.

