# Shellfish

http://www.cf.adfg.state.ak.us/geninfo/shellfsh/shelhome.php

**Overview**

Alaska's commercial fisheries produce large volumes of shellfish, including several types of crab and various shrimp. Commercial fishers also harvest scallops, clams, sea urchins, sea cucumbers, octopus, and squid, and these species are defined as "miscellaneous shellfish" in state regulations. All commercial shellfish fisheries in state and federal waters of Alaska are managed by the Alaska Department of Fish and Game.

Alaska is famous for its king crab, which includes 4 species in Alaska: red, blue, golden, and scarlet. Red king crab are the predominant king crab in commercial harvests, with the largest harvests coming from Bristol Bay and smaller harvests coming from Southeast Alaska, Norton Sound, and the Adak area. Historically, very large harvests came from the Kodiak area, but that fishery has failed to recover since being closed in 1983. Several other once important king crab fishing grounds are also now closed due to conservation concerns. Other commercially important crabs include golden king crabs, Tanner crabs, snow crabs, and Dungeness crabs.

Trawl caught shrimp were a major component of shellfish harvests in the Gulf of Alaska through the early 1980s. The primarily Kodiak-based fishery declined following a climate-induced regime shift accompanied by an increase in Pacific cod, a major shrimp predator. Small trawl fisheries continue in Southeast Alaska and Prince William Sound and the Kodiak area, and a large pot fishery for the spot prawns occurs in southeast Alaska.

Weathervane scallops, the world's largest commercial species, are dredged by a small fleet working historic beds from the Eastern Gulf of Alaska near Yakutat to the Bering Sea. Commercial clam fisheries in Alaska include a dive fishery for Geoduck clams in Southeast Alaska and intertidal fisheries for hard shell clams, principally littleneck clams and razor clams in Cook Inlet. Dive fisheries for sea cucumbers and red sea urchins have been important in providing winter-time economic opportunities in Southeast Alaska. A once productive abalone fishery in Southeast Alaska has been closed since 1996 due to low stock size.

Commercial harvests of octopus and squid occur in the Bering Sea and Gulf of Alaska, primarily as bycatch in other fisheries.

## Crab

**Overview**

The Bering Sea, Aleutian Islands, and Gulf of Alaska together produce approximately one-third or more of total U.S. crab catches on average. Ten species of crabs are caught in Alaskan crab fisheries, and seven of these have commercial importance: red king crab, *Paralithodes camtschaticus*; blue king crab, *P. platypus*; golden king crab, *Lithodes aequispinus*; Tanner crab, *Chionoecetes bairdi*; snow crab, *C. opilio*; hair crab, *Erimacrus isenbeckii*; and Dungeness crab, *Cancer magister*. The three minor species,

scarlet king crab, *Lithodes couesi*; grooved Tanner crab, *Chionoectes tanneri*; and Triangle Tanner crab, *C. angulatus*, are landed mostly as incidental catch in other crab fisheries. Besides commercial fisheries, subsistence and sport fisheries occur in many areas, but their contributions to total harvest remain small.

**History**

The history of crab fisheries extends back to 1930, but substantial commercial efforts were not undertaken until the 1950s when the king crab fisheries were developed in the Bering Sea. The history of harvests for the various crab species shows a wide range of fluctuations (Alaska crab harvests, 1974-2004 graphic) and most of the stocks are currently in depressed conditions. A number of explanations for these conditions have been given: overharvest, decline in recruitment due to adverse climatic conditions, unintentional bycatch of broodstock in other fisheries, and others. Despite a variety of restrictions and regulations in the past two decades, most of the depressed stocks have failed to recover. Consequently, a number of precautionary management measures have been taken by the federal and state agencies to conserve these stocks.

**Crab Stock Distribution**

Red king crabs are distributed throughout the Bering Sea, Aleutian Islands, and Gulf of Alaska, with historical fishing centers in Bristol Bay, Norton Sound, Petrel Bank, the Pribilof Islands, Kodiak Island, and northern Southeast Alaska (crab management activities map). In contrast, blue king crabs are found as discrete small populations around St. Matthew Island, the Pribilof Islands, St. Lawrence Island, Nunivak Island, and in isolated cold water areas in the Gulf of Alaska. The two king crab species are found in greater abundance at depths less than 180 m. Golden (brown) king crabs primarily inhabit waters along continental slopes of the Aleutian Islands, Bering Sea, and Gulf of Alaska at depths greater than 180 m. Fisheries in the Aleutian Islands have accounted for most of the golden king crab landings. Scarlet king crabs are a deepwater species living in waters deeper than 600m. They are caught primarily as bycatch in the grooved Tanner crab and golden king crab fisheries.

Hair crabs are mostly found near the Pribilof Islands. Tanner crabs are distributed in the eastern Bering Sea, Aleutian Islands, and the Gulf of Alaska with major concentrations restricted to less than 300 m. Snow crabs occur in the northern and central Bering Sea on the continental shelf with major concentrations restricted to less than 300 m. Grooved Tanner crabs and Triangle Tanner crabs are other deepwater species found at depths greater than 200m in the Bering Sea and Aleutian Islands. Dungeness crabs are found in estuaries and open ocean areas from Dixon Entrance to Unalaska Island. They occur from the intertidal zone to depths greater than 300 m. Prince William Sound, Cook Inlet, Kodiak, Alaska Peninsula, eastern Aleutian Islands, and Southeast Alaska are historical centers for Dungeness crab fisheries.

**Statewide Management**

The U.S. federal government through the North Pacific Fishery Management Council (NPFMC) and the State of Alaska jointly manage the Bering Sea and Aleutian Islands crab stocks, whereas the State of Alaska solely manages the Gulf of Alaska crab stocks.

Harvest strategies vary among areas and species, but all crab fisheries have minimum size limits, male-only restrictions, and specific fishing seasons (i.e., size, sex, and season, or "3-S" management). Minimum size limits have been enforced to provide at least one opportunity for males to mate with females. Single-sex harvest has been in effect to protect mature females for reproduction and specific fishing seasons are set to avoid harvesting crab during mating and molting (soft-shell) periods. A number of king and Tanner crab fisheries are managed with a guideline harvest level (GHL) determined either from available abundance estimates and appropriate target harvest rates or from historical average catches. The fishery performance within a season is monitored, and if the fishery is expected to exceed the GHL before the declared closure date, then the season is closed by an ADF&G Commissioner's emergency order. Incidental mortality of crabs in other fisheries (trawl, pot, and dredge) is reduced by enforcing maximum allowable crab bycatch thresholds. Additional management measures include pot limits, permits, onboard observers, registration areas, reporting requirements, vessel tank inspections, legal gear specifications, and provisions for gear placement, removal, and storage.

Six Bering Sea crab stocks are managed by the NPFMC according to fishery management plans with thresholds for overfishing (an excessive annual rate of removal) and overfished (a minimum biomass level). These stocks are Bristol Bay red king crab, Bering Sea Tanner crab, Bering Sea snow crab, St. Matthew Island blue king crab, and Pribilof Islands red and blue king crabs. If the stock declines below the 'overfished' biomass level, then the stock is declared overfished, and management actions in the form of reducing fishing mortality or rebuilding plans must be implemented.

In addition to federal management regulations, the ADF&G has developed harvest strategies for king and Tanner crab stocks in selected fisheries of the Bering Sea and Gulf of Alaska. The harvest strategies aim to maintain sufficient spawning biomass for stock productivity by controlling the removal of mature males. Minimum stock size levels (mainly of mature portion) and minimum GHLs (for a few stocks) are estimated for assessing stock viability and for assuring manageability under continued fishing.

**Commercial Gear**

Both pots and ring nets are used in commercial crab fisheries. Pots and ring nets can be used in commercial Tanner crab fisheries and pots, ring nets, and diving gear can be used in commercial Dungeness crab fisheries. Only pots are allowed in commercial king crab fisheries. In all cases, crab pots account for the vast majority of the catch. Pot design and regulations differ by species, but all pot gear must have a biodegradable seam, panel or device that renders the pot incapable of retaining fish or shellfish for more than six months when it is lost while fishing. King crab pots are steel-framed and rectangular covered with nylon webbing of varying mesh sizes at different locations (top, bottom, sides, tunnel, door). Common sizes range from 2.0 m by 2.0 m to 2.4 m by 2.4 m, with heights varying from 0.7 m to 1.0 m.

Tanner and snow crab pots are modifications of king crab pots intended to retain smaller Tanner and snow crabs. Rectangular pots must have tunnel eye openings constrained to

less than 5 inches (13 cm) in height to prevent the larger king crabs from entering the pot. This is usually accomplished by placing wooden slats in the tunnel eye of the king crab pots. A pyramid-shaped pot with a single tunnel at the top of the pot is also used in some areas (e.g., Southeast Alaska) specifically in Tanner crab fisheries. Dungeness crab pots are round and range from 1.0 to 1.5 m in diameter and about 0.4 to 0.5 m high. King crab pots have two tunnels on the sides of the pot with one tunnel opening for crab entry and the other with a secured door for emptying the pot contents. Dungeness crab pots have two escape rings to allow undersize crabs to leave the pot.

Pots are baited with chopped herring, other fish (such as cod or salmon), squid, or clams. Pots are lowered on a single buoyed line to the bottom and allowed to soak typically for one to two days when fishing for red king crabs, blue king crabs, or Dungeness crabs. Hydraulic pullers are used to launch and retrieve pots. In the Aleutian Islands, the depths and steep bottom topography in the inter-island passes inhabited by golden king crabs necessitates the use of longlined rather than single-pot gear. Longlined pots are set using a ramp over the stern of the vessel.

Once the pot is hauled, the catch is sorted on deck and all females and undersize males are released overboard. On catcher vessels, the retained catch of large males is usually held in large recirculating seawater tanks for live delivery. For the small fleet of catcher–processor vessels, retained crabs are processed and frozen onboard. King crab vessels fishing the Bering Sea usually exceed 100 feet in length. Smaller vessels are typical in Gulf of Alaska fisheries.

Red and blue king crabs are caught at depths less than 200 m, Tanner and snow crabs between 100 m and 200 m, golden king crabs and other deepwater crabs at depths 200 m to 1000 m and Dungeness crabs mostly at depths less than 20 m.

**Recent Harvest and Status**

The crab stocks discussed here are fully exploited and a number of them are in depressed condition. During the 2000 –2004 period, an average annual total of 54 million lb (25,000 t) of crabs worth an exvessel value of $147 million was landed. Fisheries in the Bering Sea and Aleutian Islands accounted for the majority of the landings. The average annual harvests during the 2000 –2004 seasons were: 19 million lb (8,730 t) of king crabs worth $86 million, 29 million lb (13,000 t) of snow crabs worth $50 million, 1.7 million lb (790 t) of Tanner crabs worth $4 million, and 5 million lb (2,270 t) of Dungeness crabs worth $7 million (5-yr avg. harvest & value).

The Bristol Bay red king crab stock has shown an increasing trend in abundance since the late 1990s. Fishing effort in this fishery has remained high with an average number of permits at 258 during 2000–2004 (5-yr avg. harvest & value).

Norton Sound red king crabs provide small summer and winter fisheries with an average fishing effort of 43 permits during 2000–2004 (5-yr avg. harvest & value). The 2002 survey found a decrease in legal male crab abundance from that estimated in 1999 due to

weak recruitment over the previous three years. Recruitment is anticipated to be stronger over the next three years.

Considering its small stock size, the fishing effort in the Pribilof Islands red king crab fishery remained high with the number of permits at 58 in 1998. The fishery has been closed since 1999 due to the low precision of annual abundance estimates and the overlapping distribution with the closed fishery for blue king crabs for which there are bycatch concerns.

The St. Matthew Island stock is the larger of the two blue king crab stocks with 137 permits fished in 1998. There were 57 permits fished in the Pribilof Islands blue king crab fishery. Both stocks are depressed and have been closed since 1999. The NPFMC has developed rebuilding harvest strategies for both stocks. Causes of stock declines are not well understood, but a sudden drop in abundance was attributed to high natural mortality of the St. Matthew Island stock in 1999. The 2003 stock abundance estimates suggest a slight improvement of the St. Matthew Island female and prerecruit male abundances, but the Pribilof Islands stock remains weak.

The Bering Sea Tanner crab fishery was closed due to low stock abundance and poor fishery performance in 1997 and the fishery has remained closed under a rebuilding harvest strategy. As of 2005, both the St. Matthew Island and Pribilof Islands stocks of blue crab were very weak.

The Bering Sea snow crab stock is depressed and has been managed under a stock rebuilding plan with a low GHL in recent years. Fishing effort remained high with an average of 261 permits from 2000–2004 (5-yr avg. harvest & value). Abundances of legal and pre-recruit males continue to decline and these trends are likely to persist for some years.

The Bering Sea Hair crab stock has been declining for several years and recruitment trends are unclear due to poor representation of small crabs in the surveys. The fishery is small with only 3 permits fishing in 2000. The fishery has been closed since 2001.

Aleutian Islands and Gulf of Alaska king and Tanner crab stocks are small and most are depressed. The red king crab fisheries in Kodiak, the Alaska Peninsula, Cook Inlet, and Prince William Sound areas are closed due to low abundance. Aleutian Islands (Adak and Dutch Harbor) golden king crab populations support fisheries with harvest levels averaging nearly 6 million pounds. The average participation during 2000–2004 was 33 permits (5-yr avg. harvest & value). The western Aleutian Islands (Petrel Bank area) red king crab fishery was started recently with a small GHL in 2002 and 2003 after high densities of legal crabs were encountered in a pot survey. The fishery was closed in 2004 and 2005. The Tanner crab fisheries in the Aleutian Islands, Cook Inlet, Prince William Sound, and Yakutat areas are closed due to low stock abundances. The Alaska Peninsula Tanner crab stock showed some improvement and a fishery occurred with a small GHL in 2001 but has been closed since then. Parts of the Kodiak District opened for a limited commercial Tanner crab fishery beginning in 2001 after a prolonged closure as the stock

exhibited some improvement. Tanner crabs in Southeast Alaska support a modest fishery with an average fishing effort of 146 permits during 2000–2004 (5-yr avg. harvest & value). The harvest has been declining in recent years. The Southeast Alaska red king crab stock trend and fishery are very similar to that of the region's Tanner crab. Golden king crabs in Southeast Alaska have recently outstripped red king crabs in landings, and blue king crabs are harvested largely as incidental catches in the region's red king crab fishery.

Even though fisheries for Dungeness crab have occurred throughout the Alaskan coast in the past, stocks in the Prince William Sound, Copper River delta, and Kachemak Bay areas have collapsed. Sport and personal use fisheries exist in these areas at low levels. Suspected causes for stock collapse include overfishing, sea otter predation, and adverse climatic changes. The Dungeness crab fishery in Yakutat also collapsed in 2000 and the fishery has been closed since 2001. In contrast, Dungeness crab stocks in Southeast Alaska and the Kodiak area continue to support mainly small boat fisheries with harvests fluctuating due to recruitment variability.

**Processing and Marketing**

U.S. domestic production of king, Tanner, and snow crabs comes entirely from Alaska, but only a relatively small amount of commercially harvested crabs is moved to consumers in Alaska. Commercially harvested crabs in the Bering Sea and Aleutian Islands are sold alive to catcher–processor vessels, floating processor vessels, or shore-based processors. In Prince William Sound, Kodiak, and Southeast Alaska, processing is mostly done in shoreside facilities. King, Tanner, and snow crabs are cleaned and either cooked and brined or left raw. The final product forms include crab clusters, claws, and meat. The product is frozen, packed in bulk and shipped for reprocessing in Seattle or the Far East. The products for retail market are also shipped to reprocessors for packaging, labeling, cold storage, and marketing. A very small amount of king crab is shipped live to Far East markets. Hair crabs are cooked whole. Dungeness crabs are processed by shore-based processors, catcher processors, and floating processors. Cooked and processed Dungeness crabs are sold whole or in sections as a fresh or frozen product. Dungeness crabs are also sold alive.

**Conservation and Other Issues**

A number of measures have been taken to limit bycatch in other fisheries. These include a prohibited species catch limit in groundfish trawl fisheries, which are set annually as a function of Bristol Bay red king crab effective spawning biomass, and a year-round closure for non-pelagic trawling in the red king crab savings area in the Bering Sea. The NPFMC has also closed an area surrounding the Pribilof Islands to trawl fishing to protect blue king crabs. In the Gulf of Alaska, nearshore crab habitat from Kodiak Island to Unalaska Island has been closed to bottom trawling and scallop dredging to protect king and Tanner crabs.

With the decline in abundances in Alaskan crab stocks, the price per pound has systematically increased. The average per pound ex-vessel prices during 1998–2002 for some major crab stocks are: Bristol Bay red king crab $4.95, Southeast Alaska blue king

crab $3.58, Aleutian Island golden king crab $3.00, Bering Sea hair crab $2.76, Bering Sea snow crab $1.27, Southeast Alaska Tanner crab $3.14, and Southeast Alaska Dungeness crab $1.55.

Crab product quality has occasionally been affected by Paralytic Shellfish Poisoning (PSP) and Bitter Crab Syndrome. The PSP in Dungeness crabs and Bitter Crab Syndrome in Tanner crabs have prompted some fishery curtailments and closures in some areas in Southeast Alaska and Kodiak. However, the incidences were few and affecting only a small proportion of the population at any time.

## Shrimp

### Overview

Shrimp are an important component of Alaskan marine ecosystems. They once supported large and historically important commercial fisheries in the late 1950s through the early 1980s, particularly in the central and western Gulf of Alaska. Recent commercial harvests are much smaller in volume and are predominantly from Southeast Alaska.

Northern (formerly "pink") shrimp (*Pandalus borealis*) are the primary species by weight, and these are targeted with bottom trawls and beam trawls. Most of the catch of northern shrimp is shelled by mechanical peelers and then frozen. Recent ex-vessel prices for northern shrimp have averaged 17 cents per pound. Spot shrimp (*Pandalus platyceros*) are the largest and most valued of the Alaskan shrimp and are marketed as live, fresh, or frozen product. These are targeted with pots in generally steep and rough bottom terrain, with ex-vessel values averaging around $2.50 per pound. Other shrimp harvested include sidestripe shrimp (*Pandalopsis dispar*) with trawls, coonstripe shrimp (*Pandalus hypsonotus)* targeted with pots, and humpy shrimp (*Pandalus goniurus*), mostly caught incidentally in trawls. All of these species are pandalid shrimp, which are protandric hermaphrodites, meaning they first mature and spawn as males, transition to females, and then spawn as large females for the remainder of their lives.

### History

A beam trawl fishery for northern shrimp began in the Petersburg area in 1915 (harvests, 1969-2004). This fishery peaked at 7.6 million pounds in 1958, and continues to this day in central Southeast Alaska with relatively stable harvests capped at 1.75 million pounds per year with permits capped at 41.

The state's largest shrimp fishery targeted northern shrimp with otter trawls in the Kodiak area beginning in 1958, extending west to the Alaska Peninsula in the Chignik and South Peninsula districts in 1968 (Jackson and Ruccio 2003). Catches, mainly with trawl gear, averaged 115 million pounds annually at the peak from 1973 to 1977.

The shrimp populations in the western and central Gulf crashed in the late 1970s and early 1980s. In retrospect, the crash is attributed in part to a climate regime shift beginning in 1977 (Anderson and Piatt 1999) when waters warmed dramatically. The crash was associated with large increases in groundfish populations, including walleye pollock, Pacific cod, and flatfish. Declines in shrimp population abundance in both fished

and unfished areas suggest that fishing played a limited role in the shrimp population collapse; however, fishing effort was very high in many areas before the collapse. Commercial shrimp fishing ceased in the South Peninsula district after 1979, and in the Chignik district after 1981 (Jackson and Ruccio 2003). Catches in the Kodiak district have averaged less than 10,000 pounds per year since 1986, with no more than 4 vessels participating. Most of the formerly productive trawl fishing areas in the central and western Gulf of Alaska are closed to trawling pending stock recovery. This includes all of Cook Inlet and many areas around Kodiak Island and the south side of the Alaska Peninsula. A small scale trawl fishery is conducted in the northwest corner of Prince William Sound. Recent small mesh trawl surveys conducted jointly by NMFS and ADF&G suggest that shrimp populations may be recovering in some areas near Kodiak Island.

Prior to the shrimp crash in the late 1970s and early 1980s, northern shrimp accounted for over 85% of the total catches (harvests, 1987-2004). Beginning in 1987, following the crash when identification of catch to species became routine, the percentage of the catch attributable to northern shrimp has averaged 64%, with 18% spot shrimp, 8% side-stripe shrimp, 8% humpy shrimp, and 2% coon-stripe shrimp.

Pot fisheries targeting spot shrimp have historically occurred in protected embayments, largely in Southeast Alaska and to a lesser extent in Prince William Sound. The pot fisheries in Southeast Alaska grew rapidly in the 1990s and are now capped at about 800,000 lb. with most of the harvest being taken in southern and central Southeast. Pot fishing in Prince William Sound has been closed since the early 1990s due to low stock abundance. A pot fishery for coon-stripe shrimp in Cook Inlet is now closed due to low stock abundance.

**Statewide Management**

Shrimp fisheries are managed by the State of Alaska from zero to 200 nautical miles offshore (shrimp management activities). Management strategies vary between regions based on the availability of stock assessment information. The historically productive fishing grounds of Kodiak, Chignik and South Peninsula districts have been closed since 1984, and are not scheduled to open until surveys demonstrate that abundance has reached “minimum acceptable biomass index” criteria established in the Westward Region Shrimp Fishery Management Plan. Some sections in those areas that are outside of the historically productive grounds are open seasonally each year to trawl gear to allow a small fishery to continue during rebuilding periods (Jackson and Ruccio 2003). Shrimp fishing with pots is open year round in most of the Westward region, with the exception of 6 sections in the Kodiak and Chignik districts.

Commercial shrimp harvests in Southeast Alaska are managed to stay within guideline harvest ranges. The upper ends of the guideline harvest ranges are established largely by examination of historic catch records, with annual harvest levels adjusted based on available information on stock status, including commercial catch rates, as well as age and size structure of the landed catch. Pot surveys of spot shrimp are conducted in the

major harvest areas of Southeast Alaska to gauge the relative strength of local populations.
Shrimp fishing seasons are set to avoid the biologically sensitive egg hatch period, and are generally closed for at least two months between mid-February and mid-June, depending on the area.

**Commercial Gear**
Otter and beam trawls are used to target northern, humpy, and side-stripe shrimp, whereas pots are used to target spot and coon-stripe shrimp. Otter trawls were the predominant bottom trawl used in the historic Kodiak and Alaska Peninsula area shrimp fisheries. Otter trawls use a double bridle and “otter boards” to deploy and maintain the net opening. They are most effective on smooth and level bottom, but can be outfitted with roller gear (wheels) to allow fishing on rougher substrates where the net might become snagged. The design and greater size of otter trawls relative to beam trawls allow larger catches.

In comparison, the beam trawl is a relatively simple gear type in appearance and function. A strong wooden or metal beam acts as a head rope, and metal "shoes" connected directly to each end of the beam act as the breast of the trawl. Thus, two important net dimensions are controlled by rigid members: 1) the width of the mouth is determined by the length of the beam; and 2) the opening height of the net is determined by the height of the metal "shoes." Vessel length limits beam length. Most beam trawls are deployed with a single bridle and fish best on flat substrates. However, they can effectively fish some gradual side slopes and irregular bottoms. Beam trawls are the only shrimp trawl allowed in Southeast Alaska where otter trawls were prohibited in 1997 by the Board of Fisheries. Beam trawls were also used in the Kodiak area in bays and nearshore beginning in 1971, with peak participation of 16 beam trawl vessels in the 1974/75 season.

Shrimp pots are typically cone shaped, covered with webbing having three tunnel openings and a pucker string on the bottom, which is opened to empty the pot and during bating. These pots are often fished in strings.

**Recent Harvest and Status**
Statewide catches averaged 2.0 million pounds valued at $4.2 million for the five year period 2000–2004 (5-yr avg harvest & value). Given that much of the historic fishing grounds in the central and western Gulf of Alaska are closed to shrimp trawling, that Cook Inlet is closed to all shrimp harvests, and that Prince William Sound is closed to commercial shrimp pot fishing, the bulk of recent harvests have come from Southeast Alaska. Pot fisheries for spot and coon-stripe shrimp and beam trawl fisheries for northern and side-stripe shrimp in Southeast Alaska are largely stable.

**Conservation and Other Issues**
The impact of oceanographic and climate regime changes on shrimp populations is apparently profound. Regime changes are not readily predictable in timing or in their effect on constituent species and their relative abundances. Given the history of Alaska’s shrimp fisheries and the depleted status of shrimp stocks in the central and western Gulf

of Alaska, the management of shrimp fisheries will remain conservative and precautionary.

## Scallops

### Overview

Weathervane scallops, *Patinopecten caurinus* are the only scallop species targeted by commercial harvesters in Alaska at this time. Weathervanes are the largest scallops in the world and are prized for their large muscle (the adductor muscle) that pulls the two shell halves (the "valves") together. Small commercial harvests of smaller species (*Chlamys* spp.) have been taken in prior years, and rock scallops (*Crassadoma gigantea*) are harvested by divers for personal use, largely in Southeast Alaska.

Commercial fishing for weathervane scallops occurs in the Gulf of Alaska, Bering Sea, and Aleutian Islands (scallop management activities map) where they occur in distinct "beds," usually on sand, silt, and clay substrates (Turk 2000) on the continental shelf at depths of 120 to 750 ft (37 to 229 m). Highest catch rates are at depths of 240 to 360 ft (73 to 110 m) (Barnhart and Rosenkranz 2000). These beds are typically elongated and oriented in the direction of the prevailing currents. The major commercial scallop beds are in the vicinity of Yakutat, Kayak Island at the southeast end of Prince William Sound, Kamishak Bay in lower Cook Inlet, Kodiak Island (east side), Shelikof Strait, the south side of the Alaska Peninsula, Umnak Island in the eastern Aleutian Islands, and north of Unimak Island in the Bering Sea.

Harvesters target these beds with heavy dredges, typically making repeated tows until catch rates fall off, at which time they move to another bed where catch rates are expected to be higher. Scallops are shucked at sea and sold as frozen meats largely to domestic markets.

### History

The commercial scallop fishery began in Alaska in the Kodiak area in 1967 and the Yakutat area in 1968. The fishery expanded to the Alaska Peninsula in 1975, Southeast Alaska in 1980, Cook Inlet in 1983, the Bering Sea in 1987, and Prince William Sound in 1992. The early 1990s saw an influx of scallop boats from the U.S. east coast (Shirley and Kruse 1995). The scallop fishery changed during this period from a short trip fishery to a long trip fishery with fewer deliveries as the vessels converted from icing to freezing of shucked product. By 1996, all vessels were converted to catcher–processors capable of producing frozen products at sea (Barnhart 2000).

The catch history illustrates a progression of large catches from virgin scallop beds in the early years with subsequent influx of effort in the early 1990s (harvests, 1967-2004) which triggered the imposition of the state's "High Impact Emerging Fishery" regulations in 1993. Those regulations effectively closed the fishery, allowing time for the state to develop a fishery management plan (FMP) to prevent overharvest. Today, the scallop fishery is fully exploited.

**Statewide Management**

The state fishery management plan invoked in 1993 imposed a sweeping suite of new regulations to meet the state's constitutional mandate for sustainability. The plan required 100% observer coverage, a ban on automatic shucking machines on scallop vessels, a maximum crew size of 12, crab bycatch caps, dredge gear specifications, limitation on number of dredges per vessel (a maximum of one or two depending on area), and establishment of scallop guideline harvest ranges (GHRs). That plan was followed by a federal fishery management plan (FMP) in 1995 and subsequent amendments that essentially frameworked the existing state plan under a cooperative state–federal management regime. Under this FMP framework, nearly all management measures in the EEZ are delegated to the State of Alaska; exceptions include license limitation in federal waters. The fishing season runs from July 1 to February 15 in all registration areas except in Cook Inlet, where the season is August 15 to October 31 in the Kamishak District.

The observer program has proven to be a significant and positive feature of the scallop fishery. Observers collect data on bycatch (notably crab and halibut bycatch), retained and discarded scallop catch, scallop size composition, scallop meat weight recovery, locations and depths fished, and catch rates. Scallop harvests, crab bycatch, tows, and area fished are reported three times a week, and these data are used for in season management.

Crab bycatch limits are imposed to protect stocks of king, Tanner, and snow crabs, some of which are in depleted or closed status. Depending on area, the bycatch limits are set at 0.5% or 1.0% of estimated crab abundance, or as a fixed number of crabs. In the Bering Sea, the bycatch limits for Tanner and snow crabs are established as fixed numbers of crab in 3 tiers, depending on crab stock abundance.

Statewide harvests are capped at 1.24 million lb of shucked meats, which is the estimate of maximum sustainable yield (MSY), based on the average catch for 1990 to 1997, excluding 1995. In addition to the statewide cap, ADF&G establishes GHRs in 9 registration areas and manages the fishery independently in each one. Currently there are no statewide estimates of stock size, and populations in each area are independently assessed with methods that vary by region.

ADF&G conducts biennial dredge surveys in the Kamishak District of the Cook Inlet Registration Area and near Kayak Island in the Prince William Sound Registration Area. These surveys provide area-swept estimates of abundance that are uncorrected for the proportion of scallops in the dredge path that are not captured; hence, the estimates are conservative. In both areas, estimated abundances in relation to the GHRs are considered in light of biomass trends, age composition, and other factors to set annual guideline harvest levels.

For registration areas without surveys, stocks are assessed and managed conservatively based on data collected by the scallop observer program. Areas may be closed due to concerns about localized depletion, overall trends in CPUE, or high crab bycatch. ADF&G research personnel are also developing methodology for fishery-independent

video surveys of scallop stocks, but these methods must undergo further refinement and review before the estimates are used for scallop fishery management. To date, the video assessments have shown promising results in tests conducted in Shelikof Strait, the Yakutat area, and in the Bering Sea.

**The Fishing Cooperative**

There are currently 10 scallop vessels licensed for the Alaska scallop fishery, but fewer actively participate. In 2000, six of the licensed scallop vessel owners formed a voluntary fishing cooperative that is self-regulatory, allocating harvest shares based on prior fishing history. Several vessels owners chose not to fish and to have their shares caught by other cooperative vessels. With the cooperative program, harvest rates have slowed and fishing extends much longer in the open season. Formation of the cooperative has allowed vessel owners to reduce crab bycatch. They provide confidential catch and bycatch information to an independent contractor that reviews the catch and location data to identify high crab bycatch areas. This allows the vessels to be directed to other areas and to avoid reaching the bycatch limits.

**Commercial Gear**

Weathervane scallops are captured by vessels towing one or two New Bedford style dredges; when paired, dredges are fished on each side of the vessel. Dredges are similar to trawls, but have a fixed bottom bar, rather than a foot rope, and the "net" on a dredge is composed of metal rings with inside diameters that by regulation must be at least 4 in (102 mm). Dredge openings cannot be more than 15 ft (4.6 m) wide and chafing gear (to protect the bottom of the dredge) is prohibited. Vessels fishing in the Kamishak, Central, and Southern districts of Lower Cook Inlet are limited to just one dredge with an opening of 6 ft (1.8 m).

**Recent Harvests and Status**

Harvests in the period 2001 to 2005 averaged 471,894 pounds of shucked meats by an average of X permitted vessels each year. Given an average value of $5.17/lb, the annual landed value of the harvest was slightly over $2.4 million statewide. The largest harvests are taken from Yakutat (Area D) and Shelikof Strait (Kodiak) areas, with harvests averaging about X lb of shucked meats from each area in the past 5 years (2001–2005).

**Conservation and Other Issues**

In response to a history of scallop overfishing worldwide, state management of the scallop fishery is intentionally conservative, imposing a series of measures including area-specific catch limits that are reviewed annually. In response to concerns regarding bycatch, the fishery requires 100% observer coverage in federal waters, and crab bycatch limits are imposed in areas where incidental catches of crabs have been significant. In response to concerns about habitat degradation by dredges, a number of scallop beds in crab or juvenile fish habitats remain permanently closed to scallop dredging. Research on habitat changes due to dredging has not been conducted in Alaska, and therefore is unknown for beds actively fished; however, research elsewhere has shown that scallop dredges disturb the substrate, reducing habitat complexity and potentially reducing diversity of benthic organisms.

## Other Shellfish

### Introduction

Besides crab, shrimp, and scallops, the State of Alaska also regulates harvests of other invertebrates, including three species of echinoderms (sea cucumbers, red urchins, and green urchins), various clams, as well as octopus and squid. Sea cucumbers, urchins, and geoduck clams are harvested by divers. Beach clams, including razor and little-neck clams, are dug from the intertidal by hand, whereas octopus and squid are taken as bycatch in pots and trawls, respectively.

### History

Fisheries for these "other" shellfish have mostly a recent history. For example, dive fisheries for cucumbers and urchins started in the 1980s and achieved large levels by the early to mid 1990s.

## Sea Cucumbers

### Overview

The giant red sea cucumber (*Parastichopus californicus*) is the only commercially harvested sea cucumber in Alaska. The species is common in many nearshore areas from Baja California (Mexico) north and west to the Gulf of Alaska to at least Chignik where it inhabits a variety of intertidal and subtidal habitats to at least 816 ft (249 m) (Lambert 1997). Alaska's largest fishery occurs in Southeast Alaska and a smaller scale fishery occurs in the Kodiak and Chignik areas (sea cucumber management activities map).

The red sea cucumber is a slow moving benthic detritus feeder. Ecologically, it functions as a bioturbator, ingesting significant amounts of fine substrate and recycling detritus into nutrients for primary producers in the marine food web. This species is most common in protected embayments on hard and sandy substrates, avoiding mud bottoms and areas with freshwater or glacial runoff. The species is an important subsistence food resource; traditional harvest methods include use of spears on long poles. Commercial harvesting is by divers, who deliver eviscerated but live animals to shore based processors. The animals are processed by hand by separating the five longitudinal muscles bundles from the skin with a scraper or knife. The skin is cooked or boiled and then dried into a product known as trepang or beche de mer. The frozen muscles and dried skin products are marketed domestically and in Asia.

### History

The first commercial harvest of sea cucumbers was in 1983 in the Ketchikan area under an experimental harvest permit. The fishery accelerated beginning in 1986 (harvest, 1983-2002) with an influx of participants in southern Southeast Alaska, driven in part by increasing restrictions on harvests imposed by rapidly developing sea cucumber fisheries in Washington State and British Columbia. Harvesting peaked in 1989 with 2.3 million pounds of eviscerated product landed by 205 permit holders. The rapid expansion of the fishery in Southeast Alaska and the state's lack of authority to control effort under the existing permit system led to closure of the fishery in May 1990. The fishery reopened in October 1990 following development of the Southeast Alaska Sea Cucumber

Commercial Fisheries Management Plan, later adopted by the Board of Fisheries (5 AAC 38.140). This plan seeks to protect subsistence opportunities and provides for sustained commercial fishing harvests. The essence of that plan, requiring abundance surveys and maximum harvest rates, is in effect today.

Entry into the fishery was restricted by moratorium in 1996, with entry limited to 436 permit holders in 2000. This relatively large allowance for permits is over twice the 2004 participation. The limit was imposed based largely on overwhelming public opposition to open access, fearing further influx of participants.

An exploratory sea cucumber fishery began in the Kodiak area in 1991. The fishery peaked in 1993 with 564,000 lb (256 mt) harvested by 50 permit holders. Harvests then dropped steeply in subsequent years to a recent 5-year average of about 150,000 lb.

**Management**

The Southeast Alaska sea cucumber fishery management plan (5 AAC 38.140) requires that harvest rates be set as a conservative percentage (maximum of 6%) of the estimated biomass. Biomass surveys are conducted by department divers prior to fishery openings in each management area, with areas opening on a 3-year rotational basis such that about one-third of approximately 46 areas are open each year, beginning in October. The 3 year rotation was put into place as a means of reducing management costs for surveys and management, and not as a method to allow stock rebuilding between harvests. An additional safeguard is a biomass density threshold of 1 kg of sea cucumbers per linear meter of shoreline. The plan also identifies 20 areas closed to commercial sea cucumber fishing to provide for subsistence harvests and research sites.

Kodiak area harvests are managed using separate GHLs for 8 areas corresponding to Tanner crab management areas. GHLs are set each season depending on fishery performance as measured by catch rate information obtained from logbooks. Recent experimentation with drop video cameras has shown promise for remotely assessing sea cucumber densities but the methods are still under development. Recent (2004/05) season GHLs have totaled 150,000 lb. The Chignik harvest is limited to a GHL of 25,000 lb, and the Alaska Peninsula, Aleutian Islands, and Bering Sea each have GHLs of 5,000 lb to allow for exploratory fishing.

**Gear**

Sea cucumber harvesting is restricted to hand picking. Divers use scuba or surface supplied air and gather the animals in mesh bags for transport to the surface.

**Recent Harvest and Status**

Statewide harvests have averaged slightly over 1.6 million lb per year taken by 229 divers. Harvests in Southeast Alaska have stabilized at around 1.47 million lb per year with about 210 divers participating. Kodiak area harvests have averaged around 153,000 lb in the past 5 years with an average of 19 participants. (harvest, 2000-2004).

**Conservation and Other Issues**

Commercial harvests of sea cucumbers in tropical areas of the Pacific and elsewhere have generated concerns for over harvest. It was recognition of these and similar concerns that led the department to impose a conservative management program in Southeast Alaska, requiring stock assessments prior to harvests. Commercial divers in Southeast Alaska have expressed concerns that favorite harvest areas are not recovering between each 3 year rotational harvest. These highly localized depletions, occurring principally in areas offering some protection from inclement fall weather and sea conditions, would not be expected to recover during the three year management cycle given the slow growth rates and sporadic recruitment of sea cucumbers. The goal of the current management approach is to provide sustained harvests over larger areas of approximately 100 km of shoreline. An alternative management strategy will be needed if concerns of highly localized depletions are to be addressed.

**Sea Urchins**

**Overview**

Two sea urchins species are commercially harvested in Alaska. The red sea urchin (*Strongylocentrotus franciscanus*) is the larger, longer-spined species and is the target in the state's largest urchin fishery in Southeast Alaska (sea urchin management activities). The green sea urchin (*S. droebachiensis*) is a smaller species with shorter spines taken in a small commercial fishery principally in the Kodiak area. Red sea urchins occur from Baja California north to the Gulf of Alaska and sparingly to Kodiak, whereas the green sea urchin is circumpolar in the northern hemisphere, occurring in the eastern Pacific from Washington State to the Arctic Ocean. Red sea urchins occur primarily on rocky shorelines of the outside coast with highest densities in the subtidal range down to 40 feet. Green sea urchins are found in a wider variety of habitats, and especially in more protected waters and embayments. Highest concentrations occur from the intertidal to depths of 30 feet. Both species feed on kelps and other algae.

**History**

The urchin fishery on the west coast of North America began in Southern California where urchins were originally considered pests. Prior to the realization that urchin roe was a valuable commodity, kelp harvesters would spread lime to kill urchins, and divers would manually crush urchins to promote kelp bed growth. As the Japanese market developed for California urchins in the 1970s, fisheries expanded north to include Oregon, Washington, and British Columbia.

Harvests of urchins in Alaska began in 1980 in the Kodiak area where a small green sea urchin fishery began and continues at a minimal level to this day (harvests, 1980-2002). Harvests in Southeast Alaska began in 1981 near Ketchikan, for both red and green sea urchins, with the vast majority of the harvest comprised of red urchins. This fishery closed in 1989 in the Ketchikan area due to marketing difficulties. A subsequent small scale harvest of red sea urchins in the Sitka area from 1991 to 1993 succumbed to marketing difficulties and extreme predation by sea otters.

The Southeast Alaska fishery was jump-started in 1995–1996 when a large, 3 million lb test fishery for red sea urchins was conducted in the Ketchikan area to evaluate the economic feasibility of the fishery and to provide funds for stock assessments. A management plan was adopted by the Board of Fisheries in 1997 establishing a conservative harvest rate approach, and requiring stock assessment surveys prior to harvests. The Commercial Fisheries Entry Commission limited entry of harvesters into the fishery in 2000.

In response to interests in developing a green sea urchin fishery in Southeast Alaska, the department, in consultation with the Southeast Alaska Regional Dive Fishery Association (SARDFA) developed an exploratory stock assessment program funded largely with Federal monies beginning in 1999. The program included reconnaissance surveys by commercial dive harvesters and subsequent biomass surveys conducted by the department. The conclusion from these assessments was that the green urchin resource was inadequate to support a commercial dive fishery, primarily because population densities were too low and urchin sizes were too small.

**Management**
Red sea urchin management in the panhandle is guided by the Southeastern Alaska Red Sea Urchin Fishery Management Plan (5 AAC 38.145), which specifies a conservative harvest rate of no more than 6% of the biomass of large (> 60mm shell diameter) red sea urchins. Biomass estimates are made once every three years in 20 or more harvest areas coinciding with salmon statistical areas that average roughly 75 km in length. Several control areas where no harvests occur are also monitored for environmental effects on urchin populations that are independent of urchin harvesting. The department works in close cooperation with SARDFA in developing proposals for new or revised regulations to present to the Board of Fisheries for consideration.

The green sea urchin fishery in Kodiak and areas westward is managed under the authority of a Commissioner's permit for miscellaneous species (5 AAC 38.062) that specifies harvest locations, season length, and guideline harvest levels. Boundary lines established for Tanner crab and sea cucumbers are used for green urchin management in the Kodiak area, with maximum GHLs of 10,000 and 5,000 lb depending on historical production.

**Gear**
Urchin harvests are limited to hand picking and use of an urchin rake. Divers typically use surface supplied air or scuba gear and collect urchins in mesh bags that are lifted to the surface.

**Recent Harvest and Status**
Statewide urchin harvests have been tailing off due to lower market demand for uni. Average harvests in the 5-year period ending in 2004 were 2.8 million lb at an average price of about 33 cents per lb. (5-yr avg harvest, 2000-2004).

**Conservation and Other Issues**
The major emphasis of the management program for red sea urchins in Southeast Alaska has been to avoid over harvest as has occurred in urchin fisheries elsewhere; however, the impact of expanding sea otter populations may be of much greater magnitude. Fishery development efforts in the Sitka area in the early 1990s were thwarted when the local sea otter population underwent a significant expansion south of town, decimating urchin stocks. Sea otter populations are just a few miles outside the boundaries of existing stocks of red sea urchins in southern Southeast Alaska that now support much of the fishery.

## Clams

### Overview

Commercial clam fisheries in Alaska include a dive fishery for Geoduck clams (*Panopea abrupta*) in Southeast Alaska and intertidal fisheries for hard shell clams (principally littleneck clams, *Protothaca staminea*) and razor clams (*Siliqua patula* and *S. alta*) in Cook Inlet.

Geoducks are large clams found from southern California to the Gulf of Alaska, with commercial quantities in Washington, British Columbia, and Southeast Alaska. The shells are up to 20 cm long and the animals can live well over 100 years. The meat of geoducks is prized as a fresh product, but due to paralytic shellfish poisoning concerns, requirements for testing, and the large distance between the state's testing lab in Palmer and harvest areas in Southeast Alaska, it is difficult to market live clams. The dive fishery for geoducks has historic roots similar to those of the sea cucumber and urchin dive fisheries in Southeast Alaska, that is, the fishery developed in Alaska once similar fisheries developed and markets were established in Washington and British Columbia. Geoducks are managed according to the Southeastern Alaska Geoduck Fishery Management Plan, which requires that GHLs to be based on surveys done within the preceding 12 years. The maximum harvest rate is about 2% and openings are established for discreet beds. Divers use a handheld water jet to dig the clams out from the substrate where the clams may be over a meter deep.

Littleneck and other hard shell clams (cockles and butter clams) are dug by hand shovel in the Kachemak Bay area. A commissioner's permit is required. GHLs are set annually based on intertidal clam surveys conducted by the department. Razor clams are dug with shovels and clam "guns." Current and historical harvest areas are sandy beaches of lower Cook Inlet, the Alaska Peninsula, and near Cordova.

Recent statewide clam harvests have averaged about 750,000 lb worth slightly more than $1 million (5-yr avg harvests and clam harvests, 1984-2004).

Based on excerpts from the publication, Commercial Fisheries in Alaska, Woodby et al. Alaska Department of Fish and Game, Special Publication 05-09, June 2005 (PDF - 1,059K). Information or data may have been updated and may no longer match the original publication.