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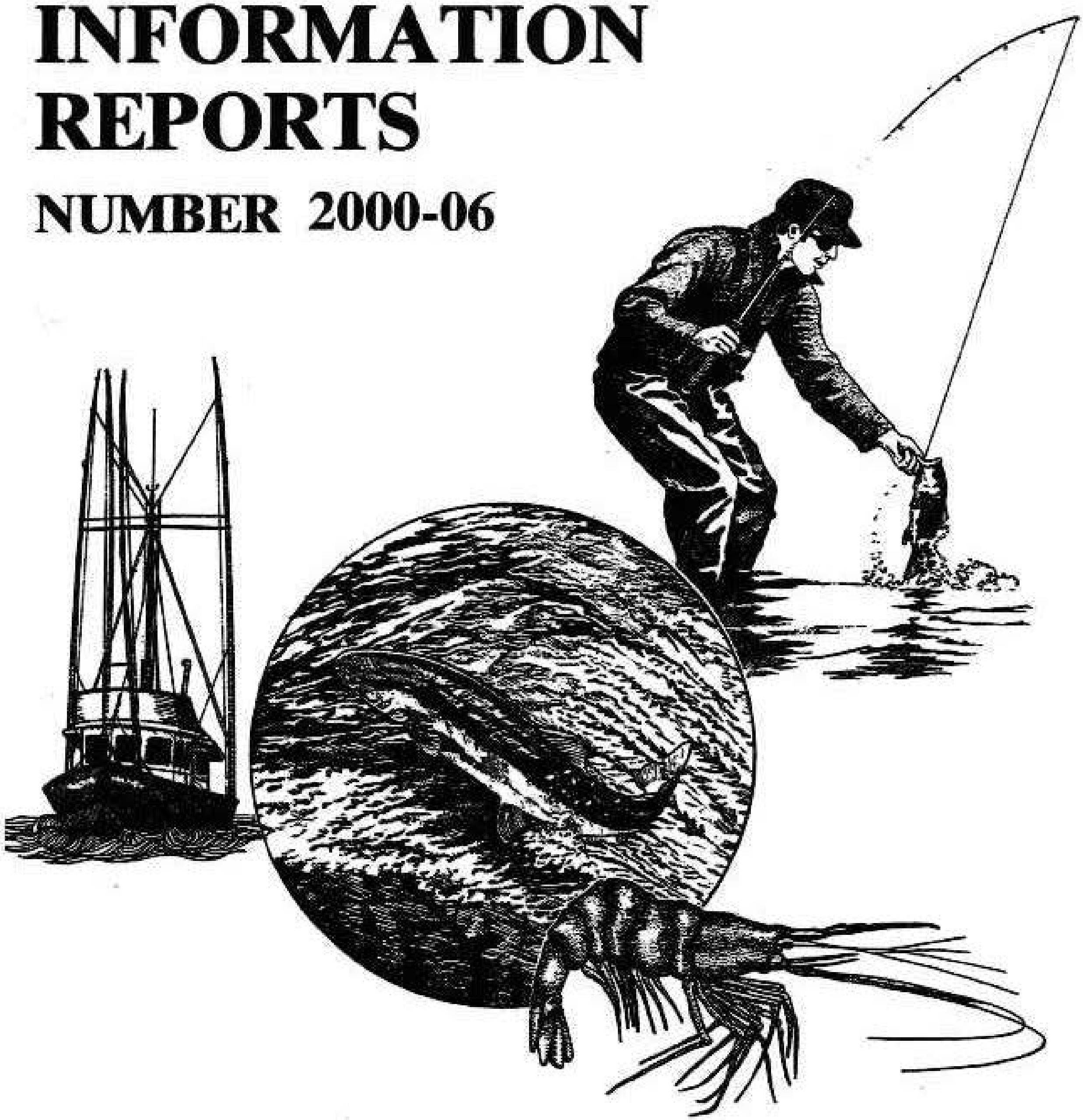

## FISH DIVISION

### Oregon Department of Fish and Wildlife

History and Status of Oregon's Pacific Razor Clam Resource

# History and Status of Oregon's Pacific Razor Clam Resource

by

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## INTRODUCTION

The Pacific razor clam (*Siliqua patula*) is found in near-shore subtidal waters and on intertidal beaches along the Pacific coast from southern California to northern Alaska. They are found along the Oregon coast, but over 90% of the harvest is taken in the 18 miles of shoreline north of Tillamook Head, Oregon, called Clatsop Beach. This area has had a fishery since before the turn of the century. It is where most of the biological information, recreational and commercial fishery data in this report were collected. Pacific razor clams are considered to be the finest food clam on the coast, resulting in a popularity that has caused conflicts between user groups and harvest pressure on the resource. This report summarizes what is known about Oregon's Pacific razor clams, the fisheries and their effect on the resource, and the management of razor clams.

## THE RESOURCE

The Pacific razor clam is a bivalve mollusk distinguished by elongated shells, which are thin, flat and smooth; and covered by a glossy, olive-green to yellowish-brown periostracum. The clam lives about a foot beneath the surface of the sand and only has the ability to move vertically in the sand by extending and hydraulically enlarging its foot, which acts as an anchor while its muscles push or pull its shell up or down (Weymouth et al., 1925). It has a short neck slightly longer than its shell, which can extend 6 to 8 inches. The neck can retract quickly, leaving diggers pondering how the clam digs so fast. Actually, its vertical shell mobility is 9 to 12 inches per minute (McMillin, 1924), with observations of clams digging to a depth of 4 feet-9 inches. The meat is mild flavored, white in color and has a pleasing appearance.

Oregon clams have a life span of 7 years and maximum shell length of about 6 inches. The razor clam resource is thought to be one population with a lack of discrete stocks. This is based on genetic studies by Leclair and Phelps (1994) which showed little variation in allele frequency between areas from Clatsop Beach, OR to Clam Gulch, AK. The high within area variation at the allele level indicates gene flow along the coast. If harvested from subtidal areas, *Siliqua patula* is often confused with the similar looking species *Siliqua sloati*, which generally lives in deeper subtidal water.

### Life History

The Pacific razor clam exhibits an equal sex ratio and reproduces annually. The time of spawning is dependent on the availability of food and rising water temperatures reaching to 55° F (Breeze and Robinson, 1981). Spawning usually occurs May through June or occasionally later in the summer, with some spawning known to occur throughout the year. Spawning success is thought to be related to clam density. A female matures in her second year and produces six to ten million eggs annually depending on her size (McMillin, 1924). Males detect the secretion of eggs from the female and then release sperm into the water, where fertilization takes place. The "pear shaped" eggs float free for about 10 days, forming into veliger larvae. Veligers free swim for 5 to 16 weeks with a rate of development dependent on water temperatures (McMillin, 1924). In later larval stages, shells develop and young (set) settle into the first few inches of sand with their hinge side orientated toward the waves. Growth is rapid with a shell length of 3 1/2 inches attained the first year.

Body condition varies through the year but it reaches peak condition before spawning. After spawning, body condition drops quickly, stressing the animal. This may cause the death of older animals. Razor clams are filter feeders consuming surf species of plankton, which vary from area to area and time of year.

Habitat

Pacific razor clams are found along the Oregon coast and inside some of our larger bays, in near-shore subtidal waters and on stable intertidal beaches (Figure 1). They live in suitable flat or low sloped sandy habitat that is free of silt-laden sediments, and has water with a high oxygen and salinity content. The size of sand particles is important to beach stability and clam production. Beaches with grains of sand having a uniform 0.16 mm to 0.19 mm diameter are the most productive (Nickerson, 1975).

In Oregon, clams have been found in subtidal waters as deep as 10 fathoms, but the largest numbers are found on berms or flats beyond the surf zone, with scattered clams in deeper water. Little research has been done on the subtidal portion of the population, but some information has been collected on distribution (ODFW, unpublished data). SCUBA divers commercial digging beyond the surf zone off Clatsop Beach in 1975 harvested several hundred pounds of Pacific razor clams. Pacific razor clams were also found by using an experimental clam dredge just beyond the surf zone off the southern Oregon coast in the early 1980's. Oregon Department of Fish and Wildlife (ODFW) biologists dove in the subtidal zone off Newport in the 1980's, finding a band of clams thought to be Pacific razor clams out to the 8 feet depth contour, with a few clams on the steep slope and pocket of clams to 20 feet (Darrell Demory, personal communication). The Army Corps of Engineers in 1985 also found and identified Pacific razor clams taken from subtidal waters off the mouth of the Columbia River and inside the Columbia River on the edge of the channel. ODFW biologists dove off Seaside Beach in 1992, with subtidal clams being observed and thought to be Pacific razor clams, but none were collected for species identification. Commercial crab pots fished as deep as 8 fathoms have also taken razor clams. The fishing vessel *Lady Rosemary* in 1998, fishing with an experimental gear permit, surveyed the coast for commercial quantities of clams using a clam dredge. Pacific razor clams were found in highest densities on offshore berms between 3 and 10 fathoms. Scattered clams were found off Clatsop Beach, south of the Columbia River. Harvestable numbers were found north of Winchester Bay and north of the Coquille River. The sloat razor clam was found in lower numbers at ten to 28 fathoms (McCrae and Daniels, 1998).

The intertidal portion of the population is found on many Oregon beaches. Figure 1 shows the location of some of these beaches. Stability of intertidal habitat is affected by many factors that affect clam survival and availability of beach for harvest. The erosion phases of the annual beach cycle affects the beach profile by moving sand shoreward during the summer and seaward in the winter (Shepard, 1950). Summer upwelling causes the displacement of sand away from the beach (Demory, 1971). Freshwater discharge from

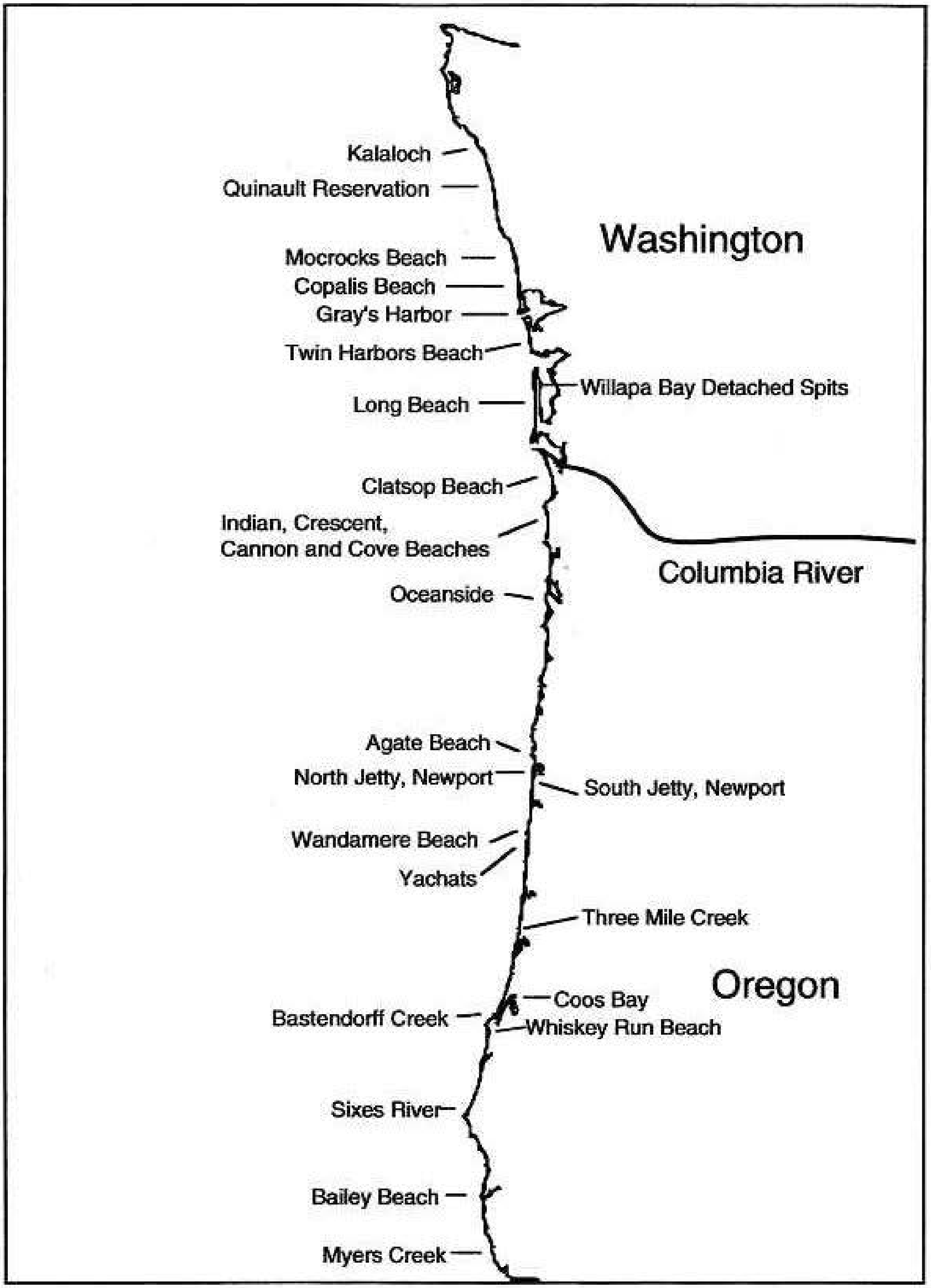


Figure 1. Locations of intertidal populations of razor clams along the Oregon and Washington coasts (Lassuy and Simons 1989).

rivers often lies along the beaches causing sand instability and vulnerability to erosion (Nickerson, 1975).

The construction of jetties at the mouth of rivers has built and altered many beaches. The first construction was the Columbia River's south jetty in 1895, which altered the mouth of the river and stabilized 18 miles of Clatsop Beach. This area has the most stable beach on the Oregon coast. Its razor clam productivity is due to the beach's flat slope of 1:70 and a deep base of sand made of a uniform grain size of 0.2mm (Hirschhorn, 1962). The eddying and southerly along shore currents between Tillamook Head and the Columbia River probably also contribute to set success (Demory, 1971).

Beaches south of Tillamook Head are steeper and tend to have a shallow sand layer making beaches unstable. Sand grains lack uniformity and often are larger than 0.2mm diameter, which makes for poor razor clam production (Demory, 1961).

Abundance

Natural variation in the ocean and atmosphere are thought to control the abundance of razor clams by altering habitat, dispersal of larvae, inducing mortality of set, and causing the loss of older clams. Changes in ocean conditions may contribute to the increase or spread of diseases and parasites that also cause clam mortality. On Clatsop Beach, where over 90% of the Oregon coast harvest is taken, clam numbers fluctuate annually and tend to be cyclic, with low abundance occurring about every 15 years up to 1976. The warmer ocean since 1976 has produced 20.5% fewer clams and more annual variation. The warmer regime has produced more frequent El Niños that tend to coincide with the years of low clam numbers (Table 1). Clams tend to do better in long term colder water.

Table 1. Periods of El Niños and Low Clam Abundance on Clatsop Beach.

| | | |
|---|---|---|
| 1914-1915 | 1959-1963 | 1996-1999 |
| 1930 | 1970-1974 | |
| 1940-1945 | 1981-1984 | |

The deposition and survival of larvae is totally dependent on good ocean conditions, with survival after setting normally less than 5% (Nickerson, 1975). Darrell Demory found that "set" abundance was not an indicator of recruitment to Oregon's fisheries and discontinued set sampling in the late 1960's. As most clams in the catch are 1-to-2 years of age, one or more years of poor "set" survival will seriously depress razor clam catch.

High natural mortality rates, often higher than 60%, can quickly reduce the number of established bivalves. The winters of 1982 and 1999 caused extensive erosion on Clatsop

Beach with lack of clams noted subsequently. Beach erosion is often too rapid for clams to avoid, washing them out of the sand. Several incidences of this have occurred; one being a deep-water cusp that cut through outside bars off Coos Bay North Spit, washing thousands of clams up on the beach (Darrell Demory, personal communication). Die-offs have also occurred from fresh water on the beach. One incident was the loss of 3- to 7-year-old clams from Indian Beach in 1972, when flooding stream water was trapped on the beach (Link, personal log). One- to three-year-old clams were lost from Seaside beach in 1994, and thought to be caused from hot weather on minus tides (Link, 1994). Later, water samples collected at the same site by Seaside Aquarium and Oregon Department of Agriculture found fresh water from the Necanicum River ran along the beach contributing to the loss of clams. Spring freshets usually wipe out established clams inside the Columbia River each year.

The losses of clams from "NIX" (Nuclear Inclusion Unknown) occurred after the warm waters of the 1982-83 El Niño in the state of Washington and "NIX" continues to be a problem. Clatsop Beach clams could have been affected by this parasite, as suspicious losses of older clams occurred during that period of time.

Growth

Clam growth varies from year to year depending on habitat, ocean conditions, beach elevation and time of set. Random sampling indicates clams tend to grow slower on the south coast than on the north coast. On Clatsop Beach, clams are usually larger on the south end of the beach than on the north, which is due to the fresh water from the Columbia River, that lays heavily along the beach south of the south jetty. Faster growth rates occur near the low tide line and slower rates are found higher in the intertidal zone (Quale and Bourne, 1972). Annual variations in feed (amounts of plankton in the area) will affect growth and a very dense clam set may stunt the growth of some age classes (Hirschhorn, 1962; Tegelberg and Magoon, 1969). Year class age-length data has shown variations in mean length. First year clams usually have a bimodal length frequency that indicates two periods of setting. This effect is usually gone by the second year.

Ageing Oregon's razor clams has been accomplished by counting annuli. The annual ring is laid down as the shell grows. Growth is slower during the winter, making the shell denser and darker in coloration (Hirschhorn, 1962). False rings may be formed from spawning, injury or other events that affect growth. Most false rings are incomplete rings which are generally distinguishable from annuli.

Parasites

The nemertean worm, *Malacobdella grossa*, lives commensally in the siphon and body cavity. The worm's appearance often causes users to be concerned, but they are not harmful to the clam or consumer (Oregon Fish Commission, 1963). Small white cysts or granules embedded in the siphon and sometimes the foot of the clam are the intermediate stages of the parasitic nematode (round worm) of the skate. Although the infected clam is usually discarded, cooked clams are not harmful to humans.

Razor clams in 1984 were found to be infected by the prokaryotic pathogen "NIX" (Nuclear Inclusion Unknown), which causes extreme dilation of gill cell nuclei and rupture of the cytoplasmic membrane (Elston, 1986). The percentage of animals infected was 100% in Clatsop Beach clams and 92% in Agate Beach clams, but the intensity rate (amount of gill tissue destruction) was low and not thought to have caused losses in the population. Elevated intensity rates were found in several clams, which may have been life threatening if coupled with another injury or stress (Olson, 1985). Although the amount of gill tissue damage was found to be low in 1984, this parasite could be the cause of the suspicious lack of older clams in sport and commercial catches between 1982 and 1987.

Biological Toxins

Razor clams are filter feeders that feed on phytoplankton. Some species of phytoplankton manufacture biological toxins, which if ingested can be stored in clams. If warm-blooded animals consume contaminated clams the stored toxins can be harmful, affecting the gastrointestinal and neurological systems. Clams contaminated with low levels of toxins had a higher toxin rate in the necks, gills and digestive systems. As the level of contamination increases, toxin rates go up in muscle and gonad tissues (Link, 1991-93 personal communication with Washington Dept. of Fisheries and OR Public Health). Depuration rates vary to the levels of contamination: low levels flush out in weeks, moderate levels may last months and high levels may last years. Some variation in depuration rates occur between toxins (Link, 1994).

Paralytic shellfish toxin accumulates in clams that ingest the dinoflagellate (*Alexandrium catenella*). Rates of over 80 mg/g are considered unsafe for human consumption and higher rates can cause paralytic shellfish poisoning. Toxins with rates below 500 mg/g contamination are stored in the clam's neck, gills and digestive system and usually flush from the clam in several months. Clams contaminated by a high level of toxin reacted differently, storing toxin in the muscle tissues. At high toxin levels ($3000^{+}$ mg/g), clams did not flush toxins and only growth or death of the clams reduced toxicity in samples (Link, 1994).

Domoic acid was discovered for the first time in razor clams on the West Coast in 1991. This toxin is stored in clams that feed on the suspected diatom *Pseudonitzschia australis*. Rates of over 20 ppm of toxin are considered unsafe for human consumption and higher levels can cause amnesic shellfish poisoning. Contaminated clams flush out low levels of toxin quickly, but higher concentrations of toxin are stored in muscle tissue, with high levels found in the clams gonads. Depuration rates of domoic acid vary as to the level of contamination, but a reduction in domoic toxin levels occurred in 1991 and 1999 when the clams spawned. Figure 2 shows this rate of depuration. More research is needed on different levels of contamination and the clams ability to depurate toxins from its body (Link, 1999).

When collecting razor clams for toxin sampling, random samples are often difficult to get. Levels of clam toxicity may vary as to location, height on the beach and age. Toxin levels in clams were found to vary between beach elevations (Link and Hannah, 1994). Toxicity in young clams can be reduced with clam growth (juveniles grow rapidly, increasing

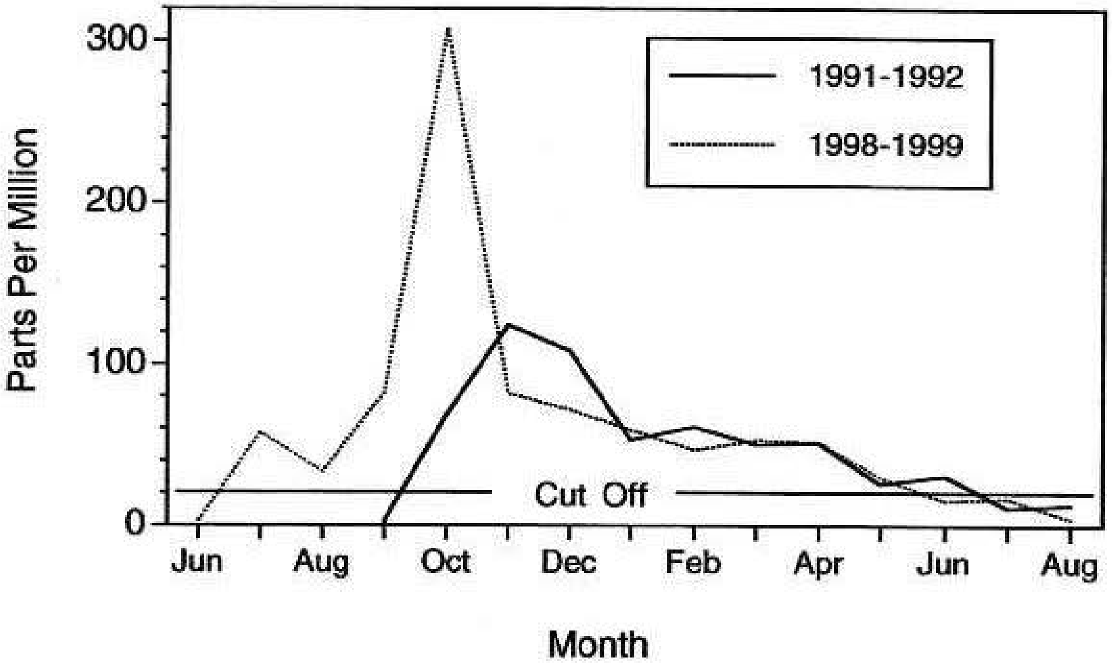


Figure 2. Domoic acid levels in razor clam samples (ppm) by month in 1991-92 and 1998-99.

body mass) reducing toxin levels quickly; whereas in older clams mass increases slowly, reducing toxin levels slowly (Link, 1994).

Before 1991, whole clams were tested for toxins but, due to the fact that razor clams are usually eaten after being cleaned, the test was changed to testing cleaned (tip of neck, gills and digestive tract removed) clams. This standardized lab practice eliminated the problem of some people thinking that cleaning clams would eliminate toxins.

Many short duration (several months or less) beach closures have occurred in the past due to biological toxins. The longest closure occurred on the north coast in the fall of 1991 and continued to the fall of 1994. Domoic acid in clams caused the closing of beaches to digging in November, 1991 and beaches remained closed until July, 1992. Before the ban was lifted, record high rates of PSP ($3000^{+}$) occurred in August, 1992, keeping beaches closed to digging until November, 1994. The presence of toxins does not seem to affect the clam population, but causes the loss of harvest opportunity.

<u>Pollution</u>

Pollution comes in many forms and some can be detrimental to the clams or the health of the consumer of contaminated clams. Clatsop Beach has had oil on it many times over the years, but not until 1991 were the beaches closed to digging, when oil was found on the clam flats at low tide. Clams were sampled for petroleum after oil drifted ashore from a spill off northern Washington (Link, 1992). Clams were found to have a petroleum smell, but tests found no traces of petroleum in the meat. This contamination was gone in weeks and beaches opened to digging. The beaching and spilling of oil by the vessel *New Carissa* in 1999 at Coos Bay led to beach closures on the south coast, but losses to the clam resource were not determined.

In 1997, after several years of testing the surf in front of the Necanicum River, Oregon Department of Agriculture reported that high rates of fecal coliform bacteria persisted many months of the year. They reported in 1999 that an area in front of the Necanicum River would be closed to commercial harvesting for human consumption, if product was shipped out-of-state. Clams are filter feeders that can easily become contaminated and testing was started in 1999 to determine if, indeed, there is a problem.

## THE FISHERIES

<u>History</u>

Examination of coastal Indian middens (refuse heaps) indicated that Native Americans utilized razor clams long before the arrival of settlers. It was reported that in the late 1800's, several wagon trails to the beach were strewn with razor clam shells, from settlers cleaning clams on their way home from the beach. These clams then would be pickled for winter use. The first record of clams being commercially pickled and sold was in the late 1880's by Pete Halferty in Clatsop County (Sigurdson, unknown date). In 1890, a plant was built on the

Skipanon River by Mr. Halferty and in 1894, he developed a cooking and canning process that pioneered the clam industry (Pac. Fish Yrbk., 1916). A small canning plant built in 1890 by Charlie Wiley processed razor clams from Netarts spit in Tillamook County. Mr. Wiley canned razor clams for three years until beaches were stripped of sand, leaving only rock by winter storms (*Tillamook Lest We Forget*, pg. 205). Processing plants continued to come and go, as did the abundance of razor clams.

The first increase in sport diggers came with the completion of the Astoria & Southcoast Railroad in July, 1890, to Seaside (Astoria Historical Society, personal communication, 1997). Tent cabins were set up in the Seaside area with clam cleaning areas for out-of-town diggers. Sport digging became popular after World War II, and effort increased in the early 1950's when new roads and better beach access made more beach areas available to diggers. An influx of out-of-state diggers occurred in 1984 after the closure of Washington's beaches. The recreational fishery on Clatsop Beach took about 10% of the harvest in the early 1940's, but presently takes about 90% of the harvest. Traditionally, the harvest of razor clams by sport and commercial diggers has been by shovel with some sport diggers now using the clam tube. Razor clamming has become a highly popular seashore activity.

<u>Regulations</u>

The recreational fishery had no bag limit prior to the early 1940's, when the bag limit of 36 clams was established. This limit lasted to September, 1954, when the daily limit was reduced to the first 24 clams taken, with a possession limit of 48 clams. In 1997, the daily limit was reduced to the first 15 clams taken, with a possession limit of 30 clams. A closed season on Clatsop County Beaches, (north of Tillamook Head) from July 15 to August 31 was instituted in 1967, to reduce wastage and harvest of small, previous year class clams. The summer closure was extended in 1997 from July 15 to September 30.

In 1992, a rule (OAR 635-39-135) banning the harvest of clams during biotoxin warnings issued by Oregon Department of Agriculture was implemented for user's safety. A disabled clam digging permit, enabling another digger to assist a disabled digger, was established in 1995. No license has been required to dig clams for recreational use.

Commercial harvesters had no clam size restrictions prior to 1927, at which time the industry set a 3 1/2 inch minimum shell length requirement, which was later instituted by the Oregon Fish Commission. The minimum shell length was increased in 1954 to 4 1/4 inches, but in October, 1972, the minimum size was reduced to 3 3/4 inches to reduce spring wastage. This minimum size has remained to date. Commercial digging was prohibited in the "Cove" area of Seaside Beach prior to 1966, after which the area was opened to all diggers. The July 15 to August 30 summer closure was established in 1967 and extended to September 30 in 1997. A commercial license to harvest clams is required. The fee has increased over time to the present fee of $50 for resident and $100 for nonresident diggers. In 1985, regulations were enacted requiring commercial diggers to sell their catches within 48 hours, obtain a free ODFW harvest permit, and keep a logbook on digging activities. Commercial diggers tried in 1989 to legislate a specific fee to harvest razor clams, which would have reduced the commercial effort. This legislation failed when Senate Bill (SB1156) was tabled. The Oregon Department of Public Health program, which tests shellfish, required commercial diggers to obtain a $10 permit for harvesting shellfish for human consumption in 1972. This program was transferred to Oregon Department of Agriculture in 1993 and the permit fee was raised to $75. This permit is not required for those digging for bait. Commercial diggers are subject to the same biotoxin closures as recreational diggers.

Recreational Fishery On Clatsop Beach

The recreational fishery was traditionally a spring and summer fishery, with little fall and winter effort. The implementation of the summer closure in 1967 increased spring effort, but little increase was noted in fall and winter effort. Digging effort remained stable until 1991, when a biological toxin ban closed beaches for three years. The opening of beaches in 1994 saw an 800% increase in fall effort.

Digging effort from 1986-95 averaged 69,625 digger trips per year (Tables 2 and 3). Effort has fluctuated annually, with high effort usually occurring on years of high clam abundance. For example, a record 119,000 digger trips was recorded in 1976, when effort was spurred by a very abundant year class in its second year. By contrast, in 1984, a record low 23,000 trips were made when clam numbers dropped. In 1995, after a three-year closure, 91,000 digger trips were made. Annual effort has increased 8.4% over the last forty years to an average 69,625 digger trips (Table 3).

The annual harvest from 1986-95 averaged 798,375 clams (Table 3). Figure 3 shows the annual number of clams dug has fluctuated extremely over the last forty years. For example, a record catch of 1.7 million clams occurred in 1958. The fourth highest harvest of 1.4 million clams were taken in 1976, with the lowest catch of 0.1 million occurring in 1983. A 20% decrease in harvest resulted from the summer closure (Table 3), and a decline of 6% has occurred since the late 1970's. Another decrease in harvest is expected as a result of the reduction in bag limit to 15 clams in 1997.

Catch rates vary from year to year as does clam abundance but it dropped from 16.0 clams per digger trip (1954-66) to 12.3 after the summer closure went into effect in 1967-75 (Table 3). This was due to a shifting of summer effort back to spring tides, giving crowded conditions which lowered the success rate. Analysis of the summer closure indicated little drop in yearly effort and an earlier take of juvenile clams. The 1997 decrease in the bag limit has caused a lowering of catch per unit of effort. Clams not harvested by experienced diggers do not seem to be taken by inexperienced diggers.

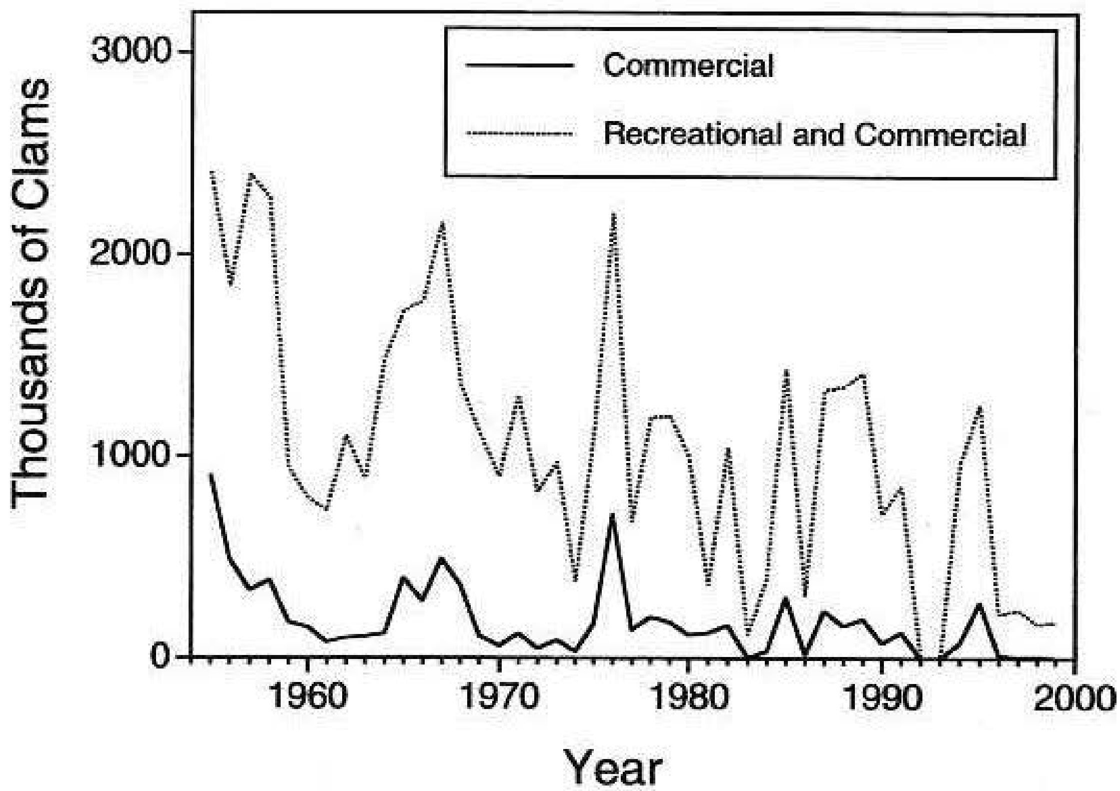


Figure 3. Harvest of razor clams from Clatsop Beach, 1955-99.

Table 2. Sport Effort and Harvest Data from Clatsop Beach

| | COMMERCIAL FISHERY | | SPORT FISHERY | | | | |
|---|---|---|---|---|---|---|---|
| YEAR | NO. OF DIGGERS | NO. OF CLAMS | NO. OF TRIPS | CLAMS/ TRIP | CLAMS DUG | CLAMS WASTED | TOTAL CLAMS HARVESTED |
| 1955 | 295 | 904000 | 56000 | 22 | 1212000 | 295000 | 2411000 |
| 1956 | 253 | 490000 | 60000 | 18 | 1061000 | 295000 | 1846000 |
| 1957 | 193 | 336000 | 77000 | 21 | 1646000 | 416000 | 2398000 |
| *1958 | 221 | 386000 | 89000 | 19 | 1679000 | 218000 | 2283000 |
| 1959 | 118 | 179000 | 54000 | 12 | 646000 | 124000 | 949000 |
| 1960 | 93 | 154000 | 48000 | 12 | 596000 | 46000 | 796000 |
| 1961 | 58 | 80000 | 51000 | 11 | 583000 | 70000 | 733000 |
| 1962 | 79 | 102000 | 56000 | 16 | 892000 | 105000 | 1099000 |
| 1963 | 77 | 107000 | 55000 | 13 | 713000 | 70000 | 890000 |
| 1964 | 125 | 125000 | 71000 | 16 | 1098000 | 264000 | 1487000 |
| 1965 | 213 | 399000 | 76000 | 15 | 1134000 | 186000 | 1719000 |
| 1966 | 217 | 282000 | 78000 | 14 | 1052000 | 434000 | 1768000 |
| 1967 | 297 | 494000 | 74000 | 20 | 1472000 | 195000 | 2161000 |
| 1968 | 340 | 361000 | 64000 | 13 | 831000 | 162000 | 1354000 |
| 1969 | 185 | 111000 | 59000 | 14 | 851000 | 155000 | 1117000 |
| 1970 | 79 | 61000 | 56000 | 13 | 715000 | 125000 | 901000 |
| 1971 | 134 | 123000 | 77000 | 13 | 968000 | 213000 | 1304000 |
| 1972 | 76 | 49000 | 69000 | 9 | 636000 | 139000 | 824000 |
| *1973 | 111 | 89000 | 76000 | 10 | 725000 | 159000 | 973000 |
| 1974 | 58 | 32000 | 44000 | 8 | 347000 | 5000 | 384000 |
| 1975 | 146 | 171000 | 75000 | 10 | 785000 | 157000 | 1113000 |
| 1976 | 391 | 717000 | 119000 | 12 | 1431000 | 63000 | 2211000 |
| *1977 | 269 | 143000 | 51000 | 10 | 499000 | 33000 | 675000 |
| 1978 | 253 | 205000 | 72000 | 12 | 849000 | 137000 | 1191000 |
| 1979 | 236 | 180000 | 90000 | 11 | 958000 | 63000 | 1201000 |
| 1980 | 145 | 116000 | 70000 | 11 | 747000 | 143000 | 1006000 |
| 1981 | 91 | 128000 | 30000 | 6 | 187000 | 49000 | 364000 |
| 1982 | 209 | 165000 | 84000 | 9 | 758000 | 123000 | 1046000 |
| *1983 | 9 | 1000 | 32000 | 3 | 105000 | 12000 | 118000 |
| 1984 | 34 | 37000 | 23000 | 15 | 341000 | 15000 | 393000 |
| 1985 | 340 | 303000 | 94000 | 10 | 984000 | 147000 | 1434000 |
| 1986 | 51 | 18000 | 46000 | 5 | 260000 | 33000 | 311000 |
| 1987 | 173 | 236000 | 68000 | 15 | 1010000 | 83000 | 1329000 |
| 1988 | 178 | 161000 | 84000 | 11 | 1016000 | 168000 | 1345000 |
| 1989 | 228 | 195000 | 97000 | 11 | 1082000 | 136000 | 1413000 |
| 1990 | 151 | 75000 | 55000 | 11 | 579000 | 61000 | 715000 |
| *1991 | 192 | 130000 | 57000 | 11 | 643000 | 80000 | 853000 |
| 1992 | | NO SEASON BECAUSE OF DOMOIC ACID AND PSP | | | | | |
| 1993 | | NO SEASON BECAUSE OF PSP | | | | | |
| 1994 | 107 | 78000 | 59000 | 15 | 885000 | 0 | 963000 |
| 1995 | 159 | 276000 | 91000 | 10 | 912000 | 67000 | 1255000 |
| *1996 | 75 | 17000 | 21000 | 9 | 192000 | 11000 | 220000 |
| 1997 | 13 | 8000 | 27000 | 7 | 186000 | 47000 | 241000 |
| 1998 | 18 | 11000 | 21000 | 7 | 149000 | 12000 | 172000 |
| 1999 | 12 | 2000 | 32000 | 5 | 167000 | 10000 | 179000 |

* OCCURRENCE OF EL NIÑO

FALL SPORT HARVEST INCLUDED IN TOTAL FOR 1984 TO PRESENT

Table 3. Average Harvest and Effort by 10 Year Periods on Clatsop Beach

| | COMMERCIAL FISHERY | | RECREATIONAL FISHERY | | | |
|---|---|---|---|---|---|---|
| Period of Time | No. of Diggers | No. of Clams | No. of Diggers | Catch/ Effort | No. of Clams | Wastage |
| 1954-66 | 162 | 295,333 | 64,250 | 16.0 | 1,026,000 | 210,350 |
| 1967-75* | 158 | 165,667 | 66,000 | 12.3 | 814,444 | 145,556 |
| 1976-85 | 198 | 199,500 | 66,500 | 10.3 | 685,900 | 78,500 |
| 1986-95 | 147 | 146,125 | 69,625 | 11.5 | 798,375 | 78,500 |

* 1967 was the first year of summer closure

Areas of clam abundance vary annually depending on where larval clams settle. On the average, over 60% of the recreational digging occurs on the 3.2 miles of Gearhart and Seaside beaches. Years of reduced clam numbers show more digging on the north end of the beach. Age composition of recreational clams varies from year to year (Table 4), but has changed little over time. Most of the harvested clams are second and third year clams, with wastage being mostly first year clams. The 1991-94 closure did not increase the percent of older clams in the catch significantly, but clams were larger due to opening the season in the fall, after maximum spring and summer growth occurred.

<u>Recreational Digging South of Tillamook Head</u>

Clam abundance south of Tillamook Head has been sporadic and the harvest has been low. Effort tends to be low, except for years when clams are abundant. Some of the producing beaches are: Indian Beach, Crescent Beach, Falcon Cove Beach, Short Sands Beach, Agate Beach, North Umpqua Beach, Bastendorf Beach, Sacci Beach, Whiskey Run Beach, Sixes River Beach, Port Orford Beach, Bailey Beach and Myers Creek Beach. Beaches inside of Tillamook Bay and Coos Bay provide small numbers of clams depending on bar development.

Clams from beaches off Newport, Oregon and southern beaches tend to grow slower and are usually older than Clatsop Beach clams. The lack of annual beach development prevents harvest of some clams, which are taken at an older age under more favorable digging conditions. For example, Bailey Beach, which normally has little digging, developed a lot of beach width in 1983, and had great digging with seven year classes present (Link, 1984).

Table 4. Age Composition of Sport Dug Clams from Clatsop Beach.

| YEAR OF HARVEST | AGE COMPOSITION IN PERCENT | | | | | | CLAMS DUG IN 1,000's |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | |
| 1955 | 29.2 | 64.6 | 4.3 | 1.7 | 0.2 | 0 | 1212 |
| 1956 | 36.9 | 48.4 | 11.2 | 2.8 | 0.7 | 0 | 1061 |
| 1957 | 26.1 | 51.7 | 15.4 | 5.7 | 0.9 | 0.2 | 1646 |
| 1958 | 7.6 | 74.8 | 13 | 3.8 | 0.7 | 0.1 | 1679 |
| 1959 | 10.7 | 38.9 | 39.3 | 10 | 1.1 | 0 | 646 |
| 1960 | 9.6 | 66.4 | 11.8 | 10.7 | 1.5 | 0 | 596 |
| 1961 | 30.7 | 51.2 | 10.9 | 4.9 | 2.2 | 0.1 | 583 |
| 1962 | 33.8 | 58.4 | 6 | 1.3 | 0.4 | 0.1 | 892 |
| 1963 | 34.4 | 52.9 | 10.9 | 1.4 | 0.4 | 0 | 713 |
| 1964 | 57.9 | 31.8 | 7.6 | 2.5 | 0.2 | 0 | 1098 |
| 1965 | 27.1 | 62.4 | 7 | 3.4 | 0.1 | 0 | 1134 |
| 1966 | 41.5 | 40.1 | 15.2 | 2.6 | 0.6 | 0.1 | 1052 |
| 1967 | 23.5 | 70 | 5.5 | .09 | 0.1 | 0.1 | 1472 |
| 1968 | 10.9 | 56.6 | 27.7 | 3.7 | 1 | 0.1 | 831 |
| 1969 | 19.1 | 55.8 | 18.4 | 5.9 | 0.7 | 0.1 | 851 |
| 1970 | 25.1 | 64.7 | 8 | 1.7 | 0.4 | 0.1 | 715 |
| 1971 | 33 | 54.2 | 8.6 | 3.3 | 0.7 | 0.2 | 968 |
| 1972 | 24.2 | 53.8 | 18.2 | 3.4 | 0.3 | 0.1 | 636 |
| 1973 | 32.4 | 49.9 | 8.1 | 8.5 | 1 | 0.1 | 725 |
| 1974 | 10 | 55.3 | 24.3 | 6.9 | 3.3 | 0.2 | 347 |
| 1975 | 24 | 46 | 17.6 | 9.8 | 2.3 | 0.3 | 785 |
| 1976 | 14.6 | 78.9 | 2.8 | 2 | 1.3 | 0.4 | 1431 |
| 1977 | 37.5 | 15.7 | 33.5 | 6.6 | 3.8 | 2.9 | 499 |
| 1978 | 28.7 | 61.8 | 4 | 3.5 | 1.3 | 0.7 | 849 |
| 1979 | 12.3 | 75.3 | 11.1 | .09 | 0.3 | 0.1 | 958 |
| 1980 | 44.6 | 32 | 16.7 | 6.1 | 0.5 | 0.1 | 747 |
| 1981 | 44.1 | 51.4 | 3.1 | 1.3 | 0.1 | 0 | 187 |
| 1982 | 18.1 | 80.7 | .06 | .05 | 0.1 | 0 | 758 |
| 1983 | 29.5 | 55.7 | 13.7 | 1.1 | 0 | 0 | 105 |
| 1984 | 46.8 | 46.7 | 6.2 | .03 | 0 | 0 | 341 |
| 1985 | 13 | 83.7 | 3.2 | .01 | 0 | 0 | 984 |
| 1986 | 52.3 | 29 | 18.5 | .02 | 0 | 0 | 260 |
| 1987 | 14.2 | 82.2 | 3.6 | 0 | 0 | 0 | 1010 |
| 1988 | 5.5 | 61.5 | 31.1 | 1.9 | 0 | 0 | 1016 |
| 1989 | 28.2 | 55.3 | 12.1 | 3.4 | 1 | 0 | 1082 |
| 1990 | 14.3 | 52.1 | 25.5 | 5.9 | 2.1 | 0.1 | 579 |
| 1991 | 16 | 26.5 | 47 | 8.5 | 1.6 | 0.4 | 643 |
| 1992 | NO SEASON | | | | | | |
| 1993 | NO SEASON | | | | | | |
| 1994 | 3.1 | 44.6 | 47.6 | 4.5 | 0.2 | 0 | 885 |
| 1995 | 1.9 | 27.9 | 39.2 | 23.9 | 5.5 | 1.6 | 912 |
| 1996 | 10.5 | 40.3 | 27.4 | 15.2 | 5.6 | 1 | 192 |
| 1997 | 40.2 | 29.9 | 19.8 | 7.8 | 1.5 | 0.8 | 186 |
| 1998 | 15.5 | 44.5 | 27.9 | 9.7 | 2 | 0.4 | 149 |
| 1999 | 8.8 | 34.9 | 38.2 | 14.4 | 3.5 | 0.2 | 167 |

Commercial Fishery On Clatsop Beach

The annual harvest fluctuates, but has averaged 210,000 clams since 1955. A record harvest of 1.9 million clams occurred in 1954, and a record low of 1,000 occurred in 1983. No clams were landed in 1992-93, because of biological toxin closures. The 1955-95 commercial fishery landed an average 19.9% of the total clams harvested. A higher percentage of clams are taken by commercial diggers when clams are abundant. In 1976, 391 diggers participated, the largest number since 1954 when 430 people dug (Table 5). Age composition of the catch fluctuates annually, but has changed little over time (Table 6).

The majority of the commercial harvest of clams are taken from areas that have the largest number of clams available. Harvest, most often starts in southern areas and works northward during the spring. On the average, Seaside and Gearhart beaches produce 60% of the catch. Catch per unit of effort is a poor index of clam numbers, as diggers continue to move to where clams are most numerous and quit when digging gets poor.

Most commercial diggers dig for the enjoyment of it and for the supplementary income. Very few diggers in the fishery use it as their sole income. The digging expertise of individuals participating in the fishery has diminished over time. Most of the digging in the past was on outside bars, where most recreational diggers did not go. Now, much of the commercial catch comes from high on the beach, where the recreational diggers do most of their harvesting. Many diggers participating in the commercial fishery use it as a means to take more than their recreational limit of clams.

The controversial use of razor clams for bait, became an issue in the 1930's, 1970's and again in 1994-95. This issue offends sport diggers as expensive, good eating, and hard to get clams are being sold for bait. Processors of clams for human consumption feel selling clams for bait reduces the amount of product they need for their plant (Sigurdson, date unknown). The harvesting of clams for bait can not be fully documented because many diggers sell directly to crab boats. Although this practice is illegal, it continues because of: the lack of enforcement time, often low prices of clams for human consumption, high bait prices, digging at night, and the availability of clams in late fall before crab season. Washington crab fishermen often come to Oregon to dig for bait, when clams are abundant. The presence of the commercial digger with their large bags of clams creates social problems between the commercial digger and the sport digger. Digging high on the beach, using their commercial license to take more than a sport limit home, and the selling for bait has always antagonized sport diggers. Based on commercial diggers interviewed leaving the beach the percent of commercial catches not sold to legal buyers was 41% in 1978, 46% in 1984 and 56% in 1989. Only 38% of the diggers getting harvest permits in 1995 landed and sold clams.

Table 5. Commercial Diggers and Landing Data.

| YEAR | NO. OF POUNDS | NO. OF CLAMS | NO. OF LANDINGS | POUNDS/ LANDING | NO. OF DIGGERS | NO. OF PERMITS | LANDINGS/ DIGGER | CLAMS/ POUND |
|---|---|---|---|---|---|---|---|---|
| 1935 | | | | | 93 | | | |
| 1936 | | | | | 161 | | | |
| 1937 | | | | | 135 | | | |
| 1938 | | | | | 107 | | | |
| 1939 | | | | | 202 | | | |
| 1940 | | | | | 243 | | | |
| 1941 | 123934 | | | | 238 | | | |
| 1942 | 13353 | | | | 192 | | | |
| 1943 | 15697 | | | | 57 | | | |
| 1944 | 57787 | | | | 197 | | | |
| 1945 | 81794 | | | | 242 | | | |
| 1946 | 151477 | 606000 | | | 719 | | | |
| 1947 | 166355 | 666000 | 2662 | 62.5 | 558 | | 4.8 | 4 |
| 1948 | 206835 | 827000 | 6849 | 30.2 | 505 | | 13.6 | 4 |
| 1949 | 200486 | 802000 | 6683 | 30.0 | 681 | | 9.8 | 4 |
| 1950 | 335091 | 1340000 | 12416 | 27.0 | 790 | | 15.7 | 4 |
| 1951 | 255631 | 1534000 | 8283 | 30.9 | 574 | | 14.4 | 6 |
| 1952 | 319165 | 1915000 | 11095 | 28.8 | 613 | | 18.1 | 6 |
| 1953 | 264278 | 1320000 | 8527 | 30.9 | 592 | | 14.4 | 4.99 |
| 1954 | 156215 | 781000 | 7628 | 20.5 | 430 | | 17.7 | 5 |
| 1955 | 180818 | 904000 | 5496 | 32.9 | 295 | | 18.6 | 5 |
| 1956 | 97899 | 490000 | 3231 | 30.3 | 253 | | 12.8 | 5.01 |
| 1957 | 67157 | 336000 | 2469 | 27.2 | 193 | | 12.8 | 5 |
| 1958 | 82140 | 386000 | 2832 | 29.0 | 221 | | 12.8 | 4.7 |
| 1959 | 48401 | 179000 | 1518 | 31.9 | 118 | | 12.9 | 3.7 |
| 1960 | 34126 | 154000 | 1258 | 27.1 | 93 | | 12.8 | 4.51 |
| 1961 | 17845 | 80000 | 671 | 26.6 | 58 | | 11.6 | 4.48 |
| 1962 | 24221 | 102000 | 910 | 26.6 | 79 | | 11.5 | 4.21 |
| 1963 | 23822 | 107000 | 889 | 26.8 | 77 | | 11.5 | 4.49 |
| 1964 | 35300 | 125000 | 1245 | 28.3 | 125 | | 10.0 | 3.54 |
| 1965 | 79767 | 399000 | 2192 | 36.4 | 213 | | 10.3 | 5 |
| 1966 | 82852 | 282000 | 2208 | 37.5 | 217 | | 10.2 | 3.4 |
| 1967 | 120452 | 494000 | 4130 | 29.2 | 297 | | 13.9 | 4.1 |
| 1968 | 92462 | 361000 | 3119 | 29.6 | 340 | | 9.2 | 3.9 |
| 1969 | 25124 | 111000 | 975 | 25.8 | 185 | | 5.2 | 4.4 |
| 1970 | 14806 | 61000 | 635 | 23.3 | 79 | | 8.0 | 4.1 |
| 1971 | 30135 | 123000 | 1450 | 20.8 | 134 | | 10.8 | 4.09 |
| 1972 | 12550 | 49000 | 688 | 18.2 | 76 | | 9.1 | 3.93 |
| 1973 | 16030 | 89000 | 721 | 22.2 | 111 | | 6.5 | 5.57 |
| 1974 | 8553 | 32000 | 461 | 18.6 | 58 | | 7.9 | 3.78 |
| 1975 | 41412 | 171000 | 1785 | 23.2 | 146 | | 12.2 | 4.12 |
| 1976 | 118019 | 717000 | 5160 | 22.9 | 391 | | 13.2 | 6.08 |
| 1977 | 41055 | 143000 | 1338 | 30.7 | 269 | | 5.0 | 3.47 |
| 1978 | 4000 | 205000 | 1810 | 22.1 | 253 | | 7.2 | 5.14 |
| 1979 | 36140 | 180000 | 1637 | 22.1 | 236 | | 6.9 | 4.99 |
| 1980 | 20291 | 116000 | 919 | 22.1 | 145 | | 6.3 | 5.71 |
| 1981 | 22414 | 128000 | 1011 | 22.2 | 91 | | 11.1 | 5.7 |
| 1982 | 26524 | 165000 | 1806 | 14.7 | 209 | | 8.6 | 6.25 |
| 1983 | 100 | 1000 | 13 | 7.7 | 9 | | 1.4 | 6 |

Table 5, (Continued).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1984 | 5803 | 37000 | 323 | 17.9 | 34 | | 9.5 | 6.3 |
| 1985 | 58219 | 303000 | 3842 | 15.2 | 340 | | 11.3 | 5.2 |
| 1986 | 2935 | 18000 | 302 | 9.7 | 51 | 134 | 5.9 | 6.15 |
| 1987 | 29197 | 236000 | 2344 | 12.5 | 173 | 278 | 13.5 | 8.07 |
| 1988 | 33910 | 161000 | 2695 | 5 | 178 | 229 | 15.1 | 4.75 |
| 1989 | 321010 | 195000 | 2592 | 12.4 | 228 | 301 | 11.4 | 6.08 |
| 1990 | 13474 | 75000 | 1337 | 10.1 | 151 | 255 | 8.9 | 5.55 |
| 1991 | 28471 | 130000 | 1691 | 16.8 | 129 | 202 | 13.1 | 4.55 |
| 1992 | 7 | ND | 1 | 7 | NO SEASON CLATSOP BEACH | | | |
| 1993 | | ND | | | NO SEASON CLATSOP BEACH | | | |
| 1994 | 18902 | 78000 | 651 | 29 | 107 | 170 | 6.1 | 4.11 |
| 1995 | 58830 | 276000 | 2705 | 21.7 | 159 | 257 | 17 | 4.1 |
| 1996 | 2911 | 17000 | 214 | 13.6 | 33 | 75 | 6.5 | 5.7 |
| 1997 | 1779 | 8000 | 191 | 93 | 13 | 49 | 14.7 | 4.5 |
| 1998 | 2526 | 10862 | 224 | 11.3 | 18 | 51 | 12.4 | 4.3 |
| 1999 | 510 | 2397 | 45 | 11.3 | 12 | 50 | 3.8 | 4.7 |

Table 6. Age Composition of Commercially Dug Razor Clams, 1952-99.

| YEAR OF HARVEST | AGE IN PERCENT | | | | | | CLAMS DUG IN 1000's |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | |
| 1952 | 61.9 | 26.6 | 6.0 | 2.8 | 1.8 | 0.9 | 1915 |
| 1953 | 21.0 | 76.6 | 2.0 | 0.2 | 0.1 | 0.1 | 1320 |
| 1954 | 27.0 | 24.0 | 35.0 | 10.0 | 2.0 | 2.0 | 781 |
| 1955 | 7.2 | 60.5 | 10.8 | 17.3 | 3.6 | 0.6 | 904 |
| 1956 | 4.5 | 52.6 | 29.9 | 8.9 | 3.9 | 0.2 | 490 |
| 1957 | 1.6 | 60.3 | 27.1 | 9.2 | 1.7 | 0.1 | 336 |
| 1958 | 0.6 | 55.2 | 27.9 | 13.2 | 2.9 | 0.2 | 386 |
| 1959 | 0.3 | 19.5 | 61.2 | 15.9 | 2.9 | 0.2 | 179 |
| 1960 | 0.4 | 53.9 | 25.0 | 16.6 | 3.7 | 0.4 | 154 |
| 1961 | 0.5 | 17.2 | 27.4 | 39.9 | 14.2 | 0.8 | 80 |
| 1962 | 3.1 | 69.4 | 19.8 | 6.5 | 1.0 | 0.2 | 102 |
| 1963 | 0.5 | 65.0 | 28.5 | 4.8 | 1.0 | 0.2 | 107 |
| 1964 | 0.3 | 55.0 | 27.2 | 13.0 | 4.0 | 0.5 | 125 |
| 1965 | 2.4 | 69.2 | 18.8 | 7.9 | 1.5 | 0.2 | 399 |
| 1966 | 0.2 | 31.3 | 47.4 | 12.3 | 8.0 | 0.8 | 282 |
| 1967 | 1.6 | 63.2 | 14.8 | 17.2 | 2.2 | 1.0 | 494 |
| 1968 | 0.1 | 39.0 | 39.3 | 12.6 | 7.5 | 1.5 | 361 |
| 1969 | | | | | | | 111 |
| 1970 | 1.0 | 30.3 | 28.5 | 27.0 | 12.2 | 1.0 | 61 |
| 1971 | 5.1 | 68.8 | 15.9 | 5.7 | 4.1 | 0.4 | 123 |
| 1972 | 0.0 | 9.9 | 78.0 | 11.4 | 0.7 | 0.0 | 49 |
| 1973 | 2.0 | 67.4 | 13.3 | 15.8 | 1.3 | 0.2 | 89 |
| 1974 | 0.7 | 40.0 | 35.9 | 13.0 | 10.2 | 0.2 | 32 |
| 1975 | 0.4 | 50.8 | 14.7 | 20.6 | 11.9 | 1.6 | 171 |
| 1976 | 8.7 | 87.4 | 2.6 | 0.9 | 0.4 | 0.0 | 717 |
| 1977 | 1.6 | 8.7 | 60.0 | 12.0 | 10.6 | 7.1 | 143 |
| 1978 | 0.8 | 70.8 | 10.7 | 12.6 | 3.4 | 1.7 | 205 |
| 1979 | 0.0 | 61.9 | 26.1 | 7.1 | 4.0 | 0.9 | 180 |
| 1980 | 0.7 | 90.9 | 7.5 | 0.7 | 0.0 | 0.2 | 116 |
| 1981 | 1.4 | 89.8 | 8.8 | 0.0 | 0.0 | 0.0 | 128 |
| 1982 | 0.4 | 98.7 | 0.7 | 0.2 | 0.0 | 0.0 | 165 |
| 1983 | 2.5 | 65.5 | 24.0 | 8.0 | 0.0 | 0.0 | 1 |
| 1984 | 93.7 | 5.1 | 1.2 | 0.0 | 0.0 | 0.0 | 37 |
| 1985 | 11.2 | 85.8 | 2.7 | 0.2 | 0.1 | 0.0 | 303 |
| 1986 | 10.0 | 30.0 | 58.0 | 2.0 | 0.0 | 0.0 | 18 |
| 1987 | 0.0 | 98.4 | 1.6 | 0.0 | 0.0 | 0.0 | 236 |
| 1988 | 15.6 | 60.0 | 21.6 | 2.6 | 0.2 | 0.0 | 161 |
| 1989 | 6.5 | 87.1 | 2.2 | 3.7 | 0.3 | 0.2 | 195 |
| 1990 | 0.0 | 52.3 | 42.9 | 3.7 | 0.8 | 0.3 | 75 |
| 1991 | 4.5 | 18.5 | 60.4 | 13.8 | 2.2 | 0.6 | 130 |
| 1992 | NO SEASON | | | | | | |
| 1993 | NO SEASON | | | | | | |
| 1994 | 1.5 | 38.5 | 46.4 | 12.0 | 1.5 | 0.1 | 78 |
| 1995 | 0 | 20.7 | 43.2 | 22.9 | 10.4 | 2.8 | 276 |
| 1996 | 0.3 | 49.1 | 23.4 | 16.0 | 11.2 | 0.0 | 17 |
| 1997 | 0 | 26 | 33.8 | 39 | 1.2 | 0 | 8 |
| 1998 | 1.8 | 40.7 | 36.3 | 16.4 | 4.3 | 0.5 | 11 |
| 1999 | 0 | 25 | 34.8 | 37 | 3 | 0.2 | 2 |

Commercial Fishery South of Tillamook Head

No commercial fishery operates on southern beaches except during summer months when Clatsop Beach is closed. Most of the harvesters are Clatsop Beach diggers that go south if clams are abundant. Beaches that have had a commercial harvest are: Cannon Beach, Arch Cape, Falcon Cove, Agate Beach, South Beach and Myers Creek Beach. When landings were made from these areas, they have been few and digging was considered poor by the commercial diggers, except for the exceptional year. Beaches in state parks are closed to commercial harvest south of Tillamook Head.

Mechanical Harvesters

Subtidal clams had been protected in the past because of their potential recruitment to the intertidal beaches. Pacific razor clams had been found in some subtidal areas along the beaches but knowledge of their numbers was lacking. A commercial harvester was allowed an experimental permit in 1978 to harvest subtidal clams on the south coast in deeper water areas. This was allowed where little intertidal digging occurred, to get some information on razor clams abundance. Only a few small catches of Pacific razor clams were taken.

An experimental permit was issued by the Developmental Fisheries Board in 1998 to survey clam areas along the coast. Clams were found along the coast, with areas north of Winchester Bay and north of Coquille River having harvestable numbers. Pacific razor clams were found off Clatsop Beach, but not in large numbers. The sloat razor clam was found in deeper water (out to 28 fathoms), but not in any concentrations that would be commercially harvestable. Incidental catches of cockle clams were found in depths between 2-27 fathoms.

Wastage

Wastage is the loss of clams in the process of harvesting. Many recreational diggers feel only clams of a certain minimum size are acceptable, and clams smaller than acceptable are discarded or buried. Some clams are damaged in the attempt of being dug and left in holes, while others are not found by the digger. Wastage was considered to be a recreational problem, but as more inexperienced commercial diggers entered the fishery, returning clams smaller than the legal commercial size limit has become a problem. These discarded clams are lost to predators, or die because of injuries when improperly placed back in the sand. Wastage samples indicate that about 80% of the returned clams have major shell or siphon damage. Based on tagging data (Link, 1979), clams with minor shell or siphon damage, not thought to be life threatening, had half the survival rate of non-damaged clams.

Three factors make small clams available for wastage. The rapid growth of young clams makes them available to diggers. The annual change in beach profile reduces the availability of older clams. Fishing and natural mortality reduce the number of older clams.

Some clams spawn all year long, but most adults spawn in late spring or summer, with juveniles reaching 2-3 inches in shell length by the following spring. These juveniles are often very abundant and found high on the beach, leaving a "show" (mark) in the sand, which attracts diggers. The beach profile changes with the transition from southwest winter winds to northwest summer winds, moving sand from lower levels to high on the beach in the summer. This summer sand movement reduces the beach width, making older clams inaccessible. Fishing and natural mortality, up to 90% per year, reduces the number of large clams in the populations at a time when small clams becoming visible causes wastage.

Wastage of first year clams occurs May through December. Daily wastage of sport dug clams can reach 10-20% and as high as 50% in the past (Table 2). As it is impossible to take wastage samples from digging in the water, it is felt that wastage estimates are minimal estimates. The summer closure (July 15 through August 3) was enacted to reduce the average loss of 211,000 first year clams. Since the 1967 summer closure, wastage has been reduced (Table 3), but the harvest of small clams has increased in months prior to the summer closure. In Washington, increased wastage was noted when they decreased their bag limit (Simons, unknown date, personal communication from Washington Dept. of Fisheries). This concern should be evaluated in Oregon after the reduction in bag limits in 1997. In the fall, commercial diggers often return 80% of the clams they dig to the beach, with 50% dying. Commercial diggers discarding clams and not returning them to the sand caused a warning to be issued to diggers by the Fish Commission in the 1970's (Link, 1970's).

Wastage of small clams by the use of a mechanical harvester must be considered if harvest is allowed, as most of the catch is mangled and only larger clams were retained whole. Small clams probably disintegrate under the pressure.

Wastage is minimized when large clams are available in good numbers, effort is low, or there are no small clams. Education of diggers is an important tool for controlling waste of clams, as enforcement has been reluctant to make cases. The regulation to keep the first 15 clams dug has not been a deterrent and the incentive to keep only large clams dug increased when the bag limit was reduced to 15 clams.

## EFFECT OF THE FISHERY ON THE RESOURCE

Little is known about the proportion of the population taken by the fishery, except that the harvest from the subtidal zone is zero in most years, and very little on the years when there has been harvest activity. In the intertidal zone, high harvest rates of 60% may be a problem in years of low clam abundance. Clam abundance fluctuates markedly from year to year, independent of the effects of the fisheries, due to natural mortality rates of 33% to 50%. The fishery waxes and wanes in direct proportion to clam abundance. Only a year of exceptional clam abundance brings increases in digging effort into the fishery. The fluctuations in the harvest can be seen in annual catch data (Table 2). The resource has been self-sustaining in spite of heavy digging pressure and fluctuating abundance of clams.

## MANAGEMENT DISCUSSION

ODFW's goal has been to protect and enhance the razor clam resource, for the use and enjoyment of present and future generations. Early management decisions have been based on investigation of the fishery by Twohy in 1949 (Twohy, 1949) and on growth and mortality studies conducted by George Hirschhorn in 1954 (Hirschhorn, 1962). After reductions in bag limits and summer closures occurred in the fishery, an update study on mortality rates was done by Link in 1973 (Link, 1979). The use of other razor clam research and over 40 years of monitoring data has provided scientific information to base management decisions on.

As the habitat and population is driven by dynamic environmental conditions and man's harvest has little effect on it, management must focus on good utilization of the resource and communicate why we support our recommendations.

Management Basis:

1. The subtidal portion of the population provides significant "seeding" for the intertidal beaches that are utilized by the recreational and commercial fishery.
2. Razor clams are very fecund. A female reaches maturity in her second year of life, producing 6-10 million eggs at each spawning.
3. Recruitment is environmentally driven. When ocean currents and other environmental conditions are favorable, clam larvae are deposited in the intertidal area. If environmental conditions are right, survival and growth are good, and clams become abundant. If these conditions are unfavorable for a year or two clam abundance declines.

Recommendations:

1. Protect subtidal portion of the population seaward of popular sport or commercial intertidal digging areas.
2. Provide long harvest seasons that allows users to harvest clams without hindrance of the "opening day" syndrome and provide diggers quality time on the beach. Avoid opening and closing short seasons.
3. Resource education needs to keep users informed and involved.
4. Oregon's small commercial fishery and recreation fishery should be managed on a 20%-80% plan.
5. Wastage is a loss of the resource that must be controlled and an evaluation of the new sport limit must be made. As abundance cannot be manipulated, management must take care of what the environment provides. More enforcement at times will be necessary to stop the problem of wastage. The razor clam resource needs little management but users must be controlled.
6. Continue biotoxin sampling for public information on the safety of eating clams. Continue close contact with Department of Agriculture on toxin closures to inform users of seasons.

Future Management Problems:

1. A license survey of razor clam users in 1983 indicates that 84.5% of the diggers favored a shellfish license (Link, 1983). A shellfish license would help control the fisheries and could reduce sport diggers by about 10%.
   - Option 1. Create a shellfish license.
   - Option 2. Create a razor clam stamp.
2. The commercial fishery reduces the number of clams available for the sport fishery, but it does not affect the resource. The commercial fishery has had enforcement problems, with some people obtaining commercial licenses to harvest more than their sport limit for their own use. This problem puts the commercial fishery in a bad light and has always been a problem that needs to be corrected.
   - Option 1. Eliminate digging for bait.
   - Option 2. Require the dyeing of all clams dug for bait, before leaving beach.
   - Option 3. Eliminate the commercial fishery.
   - Option 4. Require developmental fishery permit or otherwise limit entry
3. The high price of razor clam may entice more vessels into trying to harvest subtidal razor clams. Intertidal populations are low at this time and subtidal harvest may damage the resource with wastage of small clams and removal of adult spawners.
   - Option 1. No subtidal harvesting north of Tillamook Head.
4. Close beaches to driving.
   - Option 1. This would limit diggers ability to reach all harvest areas and restrict older and handicapped diggers from enjoying and participating in the fishery.

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