Management of the British Columbia Geoduck Fishery

CFEC 98-3N

Ben Muse

May, 1998

Alaska Commercial Fisheries Entry Commission
8800 Glacier Highway, Suite 109
Juneau, Alaska 99801-8079
907-789-6160

Abstract:

The British Columbia commercial dive fishery for geoducks started in 1976. For its first three years this was an open access fishery without catch limits. Limited entry and total allowable catches were introduced in 1979. Excessive effort and concomitant problems led to the introduction of individual vessel quotas at industry request in 1989. This fishery has operated under individual quotas since that time. This paper reviews the history of this fishery paying particular attention to the limited entry and the individual quota programs.

Table of Contents

Introduction[1]

The British Columbia geoduck fishery started in 1976. This was an open access fishery without catch limits for the first three years; subsequently limited entry and total allowable catches (TACs) were introduced. Excessive effort and concomitant problems led to the introduction of individual vessel quotas at industry request in 1989. The fishery has operated under individual quotas since that time.

The history of this fishery shows how the fishermen and the managers of the Department of Fisheries and Oceans (DFO)[2] coped with the rapid growth of a locally important commercial fishery and provides case studies of the operation of limited entry and of individual quotas.

The Resource and Fishing Methods

Geoducks (*Panope abrupta*) are large clams widely distributed along the coast of British Columbia.[3] They are found from inter-tidal waters down to below 300 feet.[4] Divers exploit geoducks down to about 60 feet.[5]

They spawn from March to July. The planktonic larvae drift in the water for about a month before settling to the bottom as juveniles. The juveniles are moderately mobile on the bottom for several weeks and then begin to burrow down into the substrate. The adults are immobile and may live in their burrows for over 100 years.[6]

Geoducks are filter feeders taking in water and nutrients, and releasing water and waste products, through a long siphon that connects them to the surface. Divers call the tip of the siphon, poking though the top of the substrate (or the depression left in the surface of the substrate when the geoduck temporarily retracts its siphon) the geoduck's "show." Depending on the depth to which the geoduck has burrowed, this siphon can be up to three feet long. Sexual products are released into the water through these siphons.

There is no bed specific stock recruitment relationship. The larvae are pelagic for about a month. Larvae from stocks in deeper waters might be recruited into beds in the shallow water fishery to replenish stocks there, but there is no empirical information about the extent to which this happens.[7]

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[1] This report has benefited from comments by Kurt Schelle of the Alaska Commercial Fisheries Entry Commission, Steve Heizer, of the Canadian Department of Fisheries and Oceans, Jamie Austin, President of the Underwater Harvesters Association, and Eric Rome of Archipelago Marine Resources. Only the author is responsible for errors in this report.

[2] The geoduck fishery is managed by the Canadian Federal government rather than the Provincial government.

[3] Harbo, Farlinger, Hobbs and Thomas, page 1

[4] Heizer, pers. comm.; Harbo, Farlinger, Hobbs and Thomas, page 1.

[5] Harbo, Hand, and Adkins, Table 6, page 25.

[6] Doherty, page 117; Heizer pers. comm.

[7] Heizer, pers. comm.

As noted, geoducks live a long time and can live over 100 years. Further they grow slowly and recruitment is sporadic. It can take eight or 12 years for a geoduck to reach a marketable size.[8] For these reasons DFO managers have assumed that the sustainable yield of geoducks is only a small part of the stock and have taken a conservative approach to setting total allowable catches.[9]

Geoduck discard mortality may be 100%. Adult geoducks cannot rebury themselves once they have been pulled out of the ground. In addition, they are unable to completely close their shells. If they are pulled out of the ground and discarded they are completely vulnerable to predation. This means that minimum size limits are not a practical management tool and that economic or management induced high-grading can be a serious problem.[10]

A typical fishing operation uses a vessel between 23 and 56 feet in length, a tender, and two or three divers. One diver goes down at a time for a two or three hour dive. The divers use air supplied by hoses from the surface (this is called a "hookah" system). The tender's job is to monitor the diver and his air hose while he is in the water. [11]

Divers find geoducks by looking for the tip of the siphon or for depressions in the bottom where the geoduck has temporarily retracted the siphon. While he is looking the diver carries a high pressure water hose called a "stinger." When the diver spots a geoduck he inserts the stinger into the substrate, directs the flow into the soil around the geoduck and simultaneously grabs for the exposed part of the siphon. When the geoduck feels the water loosening the soil it will begin to retract the siphon. The diver pulls the geoduck up by the siphon while pushing the stinger deeper if necessary to loosen the soil around the shell of the geoduck. The diver has to be careful because it is possible to pull the siphon off of the geoduck as it is trying to retract and also to damage the geoduck by splitting open the siphon with the high pressure water from the stinger.[12]

Originally the primary markets were for processed geoduck siphons and body meat in Japan, and to a lesser extent the U.S. and Hong Kong, and for live exports to the U.S. and to a lesser extent Hong Kong. In both volume and value, processed exports were much greater than live exports.[13] In the late eighties the markets shifted from the processed markets in Japan to live markets in China. Hong Kong became a distribution center and the product was brokered from there, mainly to the mainland.[14]

Geoduck color affects market desirability. Geoduck necks range in color from white to dark brown or black; there is a strong market preference for white or light colored geoducks. Dark geoducks often bring a much lower landings price than light colored geoducks, and this can affect diver incentives to discard geoducks.

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[8] Doherty, pages 117-118.
[9] Sporer, fax, page 2
[10] Harbo, *et al.*, page 3; Shirley and Tingley, page 46; Heizer, pers. comm, 1998.; Goodwin and Pease, page 3, 6
[11] Sporer, fax, page 2; Austin. pers. comm.
[12] If the siphon were split the geoduck would have to be sold in the processed rather than the, more lucrative, live market. Austin, pers. comm.; Heizer, pers. comm.
[13] Harbo and Peacock, page 13, Tables 15-16, pages 29-30.
[14] Austin, pers. comm.

The Unlimited Fishery, 1976 to 1978

Commercial geoduck fishing started in Washington State before it did in British Columbia. Washington State had had an inter-tidal recreational fishery for many years. In 1967 the Washington Department of Fisheries began to survey sub-tidal beds. Although this survey continued until 1971, large beds were found early on. In 1969 the Washington State legislature amended state laws to permit a commercial geoduck fishery and commercial harvests began in 1970.[15] In 1976 and 1977 when the B.C. fishery was just beginning, divers were brought from Washington State to help train B.C. divers in harvesting methods.[16]

Before the start of the B.C. fishery there might have been some limited recreational and native harvest of geoducks.[17] In July 1976 special permits were given to seven persons to harvest geoducks from specific areas in the Strait of Georgia. These permits gave their holders exclusive rights to the geoducks from the areas to which they were assigned. Fishermen were required to harvest below a certain depth, and the type of "stinger" they could use was limited somewhat. Otherwise there were no limits, including limits on the harvest.[18]

The special permit system operated through the first half of 1977. However, from the start of July 1977, the fishery operated under a licensing system. Licenses were available to those who wanted them, and they did not carry exclusive harvesting rights to any specific areas. Licenses could be issued to companies as well as to natural persons and license holders did not have to be present with the operation. License holders were required to send in their geoduck sales slips weekly and to turn in harvest logs and maps for their divers. There were no TACs limiting harvests. This system continued through 1978 and the first five months of 1979[19]

During this period of unlimited entry the number of active vessels and harvests rose rapidly. In 1976 the seven license holders used five vessels to harvest about 97,000 pounds.[20] This rose to 54 license holders, 27 vessels, and about 2.2 million pounds in 1978. DFO records do not supply ex-vessel prices for 1976, but in the following years prices rose from $0.17 a pound in 1977 to $0.25 a pound in 1978.[21] As noted below, these increases in operating vessels, harvests, and prices continued into 1979, and led to important management changes that year.[22]

[15] Goodwin (1973), page 1; Goodwin and Pease, page 1.
[16] Harbo and Peacock, pages 3-4.
[17] Heizer, pers. comm.
[18] Harbo and Peacock, page 3.
[19] Harbo and Peacock, page 4. Harbo and Peacock do not provide the name for this license. It was not the current "G" vessel license, which was not introduced until 1983.
[20] Statistics reported in this paragraph, and many statistics elsewhere in this report, are summarized in a table following the list of sources.
[21] All prices in this report are in Canadian dollars.
[22] Marcus, fax.

The Limited Fishery, 1979 to 1988

In 1979 the DFO, acting in response to the increasing effort and harvest levels, imposed a moratorium on new license issuance. In 1980 and 1981 this moratorium evolved into a formal limited entry program. In addition, the DFO began to introduce total allowable catches (TACs) into the management of the fishery. TACs and limited entry were introduced at this time because management biologists wanted to slow the expansion of entry and effort in the fishery. The rapid expansion in previous years had set off "warning bells" for them. They wanted to slow the harvest down until they could learn more about the resource. [23]

Introduction of TACs

The first TACs in this fishery were separate North Coast and South Coast TACs implemented in 1979.[24] The North Coast TAC was 3.5 million pounds and the South Coast TAC was 4.5 million pounds. The available information on the stock size and recruitment was not very good. Quotas were based on some surveys of the stocks, extrapolations from the surveys, and information about license holder behavior in the past.[25]

These TACs were set well above previous landings in either management area, and were not completely harvested in either area in 1979. In fact there had been no previous harvests on the North Coast and there were none in 1979. These TACs applied to all the management areas within the two regions taken together. Although individual management areas did not have their own TACs, some management areas on the South Coast were closed before the end of the year due to heavy harvests from them.[26]

In subsequent years DFO began to allocate separate TACs to management areas within the North Coast and South Coast regions. Management areas would be closed when the TAC was taken. DFO depended on the monitoring of landings at processor plants to keep track of the extent to which TACs in different areas had been harvested. There were lags built into this arrangement and these resulted in numerous TACs being over-harvested.[27]

Aggregate coastwide TACs began at 8 million pounds in 1979. They were reduced to between about 6.2 million and 6.6 million pounds between 1981 and 1985, and then rose again up to between about 8.6 and about 9.3 million pounds in 1986 to 1988.[28]

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[23] Heizer, pers. comm.
[24] The South Coast comprises the waters south of Cape Caution (just north of the northern end of Vancouver Island). The North Coast is the waters north of Cape Caution.
[25] Harbo, Farlinger, Hobbs and Thomas, Table 5, page 35, page 99.
[26] Harbo and Peacock, pages 4-5.
[27] Harbo, Hand, and Adkins, pages 2, 5-10.
[28] Marcus, fax.

Limited entry

In 1979, 101 licenses were issued in the first part of the year. This was a large increase over the 54 licenses issued for all of 1978. This increase in the number of licenses, and concerns over the ability of the resource to support the large harvests these licenses might produce, led the DFO to stop issuing new licenses in June. License holders were also prohibited from transferring their licenses.[29] Initially it was hoped that limited entry could be implemented in 1980, but managers were unable to get the legal framework in place in time. The moratorium was, however, continued through 1980; 95 licenses were issued.[30]

In 1981 and 1982 entry was limited significantly. Licenses were issued to persons who landed more than 30,000 pounds of geoducks in 1978 or in 1979 (including the first three months of 1980). The year used depended on the year in which the applicant had first received a license. The DFO apparently allowed applicants to count horseclams against this 30,000 pound threshold.[31] Fifty-two licenses were issued in each year under these criteria.

The licenses had to be held by a person or company that owned a vessel with a "C" type vessel license which allowed the vessel to be used in the fishery.[32] License holders did not have to be present with the actual fishing operation. The licenses could not be transferred from one person to another, and they could only be transferred to another vessel if the new vessel was not larger than the one it replaced.[33]

In 1983, the current "G" type vessel license was introduced as a limited entry license. These were issued to persons who met the criteria described above for 30,000 pounds of geoducks or horse clams in 1978 or 1979, or to first time participants who harvested over 30,000 pounds between June 13, 1979 and December 31, 1980. Fifty-four "G" licenses were issued in 1983. This rose to 55 by 1985 (following an appeal).[34]

The "G" licenses were vessel licenses. They had the many of the characteristics of the licenses they replaced. They could be owned by businesses or natural persons, the owners did not have to be present with the vessel for the licenses to be used, and the licenses could only be transferred to another vessel if the new vessel was not larger than the one it replaced. It is not clear how effective the transferability limits on the previous licenses were, but the "G" licenses could be transferred.[35]

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[29] Harbo and Peacock, pg 4.
[30] Heizer, email.
[31] Heizer, email; DFO, Commercial License Handbook, page 37; Harbo Hand and Adkins, page 5. From a very early point in time, the geoduck license has been a "geoduck and horse clam" license. The horse clam fishery is not dealt with in this report.
[32] This "C' vessel permit requirement was changed when a requirement for a new "G" vessel license was instituted in 1983. Harbo, Hand, and Adkins, pg 57.
[33] Harbo, Hand, and Adkins, page 5.
[34] Harbo, Hand, and Adkins, pgs 7 and 57.
[35] Heizer, pers. comm.

Results of TACs and limited entry

Initially, from 1979 to 1981 the program may have helped reduce effort and control harvests, especially in 1981. The number of licenses issued were similar in 1979 and 1980, but dropped considerably in 1981. The number of vessels with landings dropped from 72 in 1979 to 49 in 1981.[36] The number of divers went from 213 in 1979 to 226 in 1980 and then dropped to 184 in 1981. The estimated number of dives and total hours spent diving also fell off in 1981.[37] Harvests rose in 1980, but by a much smaller percentage than in 1978 or 1979, and then fell in 1981.[38]

However, the numbers for 1982 provided an indication that the fleet's fishing capacity, if it had actually been constrained in the short run by the limitation, could easily recover. In 1982 the 52 licenses took the largest harvest to date, about 6.9 million pounds. This was 6% greater than the TAC for that year. The number of divers appears to have stayed close to 1981 levels, but the number of dives and the total dive hours reported approached the higher 1980 levels. These events may have been associated with relatively high prices for geoducks that year. The $0.40 per pound price was the highest reported in DFO statistics up to that time.[39]

1983 was a year of relatively low prices, effort, and harvests. The harvest was less than the TAC. However, any doubts about the inability of limited entry to control efforts and harvests must have been eliminated in 1984 and the following years. In 1984, 44 vessels took the largest landings to that time, about 7.7 million pounds, 16% over the TAC. The total number of divers and the number of dives actually appear to have decreased from 1982, but the average length of the dives and total diving hours increased markedly. Market price in 1984 was up from the price in 1983, but actually seems to have been a bit below the price in 1982.[40]

From 1984 on, effort and harvests took off, peaking at over 12.6 million pounds in 1987. During the five years from 1984 to 1988 the harvest exceeded the TAC in each year. The sum of the harvests over these five years was about 34% greater than the sum of the TACs. All the licenses were in use by the end of this period. The numbers of divers reported rose from 156 in 1984 to 233 in 1988. The average dive length appears to have shortened after 1984, but the number of dives appears to have increased.[41]

This was actually a period during which DFO had increasing confidence in the ability of the coastwide resource to absorb large harvests. The coastwide TAC increased substantially from about 6.6 million pounds in 1984 to about 8.6 million pounds in 1988.

[36] Since the number had also dropped from 1979 to 1980, this drop from 1980 to 1981 may have continued a trend begun before limited entry and TACs.
[37] Data on dives from fishermen's' logbooks is incomplete during this period so the numbers quoted may be minimum amounts. The numbers improve after 1989. Marcus, pers. comm.
[38] Marcus, fax.
[39] Marcus, fax.
[40] Marcus, fax.
[41] Heizer, pers. comm.; Marcus, fax.

For the industry, this was a "shotgun" fishery. Tremendous "blasts" of fishing effort would be directed at areas as they were opened and large amounts of geoducks would be marketed. All the licenses were active, the fishermen fished long hours with three or four divers to a boat. Extensive use of packers reduced the need for running time to and from the landing port. When the geoduck industry association, the Underwater Harvesters' Association (UHA) requested individual quotas from the DFO (discussed in the next section) their letter requesting the program pointed to a number of problems with the existing management program including product supply discontinuities, problems with handling and transport, safety concerns, TAC overruns, and the uncertainty caused when a breakdown could cost a fisherman a large part of his annual income from missing an opening. [42]

Marketing problems may have been a special concern to license holders. A lucrative live geoduck market was beginning to open up in China and the shotgun fisheries did not allow the industry to service this market as effectively as it would have liked.[43]

The Individual Vessel Quota Fishery, 1989 to 1998

The decision to implement individual quotas

In April 1988 the geoduck license holders, through their industry association, the UHA, requested that fishery managers start an individual quota program. UHA submissions in 1988 suggested that at least 80% of its membership were in favor of an individual quota program.[44]

DFO indicated that an individual quota program was not a budget priority. The program cost was estimated to be about a quarter million dollars. In order to get the program the fishermen agreed to underwrite this cost. With this understanding, a two year trial program was started in 1989.[45]

Nature and allocation of individual quota rights

Individual quotas

Harvest rights were divided equally among the 55 licenses. In the first year of the program each license allowed its holder to harvest 160,000 pounds of geoducks. The proposal that the harvest rights be divided equally came from within the UHA and reflected a consensus of the membership. In some cases highliners were apparently reluctant to go along with this division since they had to accept a reduction in their annual harvests. Any opposition to the program among license holders apparently disappeared during the first year of the program when fishermen saw its benefits.[46]

As the individual quotas were introduced, managers allowed license holders to "stack" up to three licenses on one vessel. To stack licenses, a license holder simply registers two or three "G"

[42] Underwater Harvesters Association, 1988, page 3.
[43] Heizer, pers. comm.; Austin, pers. comm.
[44] Turris, Attachment 3.
[45] Muse, page 3.
[46] Heizer, pers. comm.; Doherty, page 120.; Austin, pers. comm.

licenses to the same vessel in the same way that he might register separate licenses for different fisheries to the same vessel.[47] License holders were not allowed to split the quota associated with a license and sell or trade parts of it to other license holders.[48]

Geoduck license holders can't carry over unfished individual quota from one year to another. They can go over their quotas by small amounts under certain conditions without being penalized. Multiple licenses on the same boat can transfer overages between them so long as their joint totals are not exceeded. Otherwise a license can transfer 200 pounds of its overage to a license on another vessel operating in the same area at the same time and landing in the same port, so long as the quota for the other license hasn't been completely fished.[49] The revenues earned on larger overages must be turned over to the government. Since 1997, larger overages must also be deducted from the allocation in the following year as an additional incentive not to exceed quotas.[50]

Area licensing

An area licensing plan was introduced simultaneously with the individual quotas. Each license was assigned to one of three license areas along the coast each year. There is a North Coast Area, a South Coast Area between Vancouver Island and the mainland (Georgia Strait), and a South Coast area on the west coast of Vancouver Island. Initially, in 1989, the North Coast received 22 licenses, the Georgia Strait received 12, and the West Coast of Vancouver Island received 21. License holders were allowed to stack up to three licenses from different license areas on the same vessel.

The licenses were assigned to license areas in numbers that would permit the harvest of the available TAC in each area. The TACs in each license area were adjusted so that each license would be eligible to harvest the same amount of geoducks.[51] Fishermen were initially allocated to the areas of their choice. A fisherman could switch from one zone to another in different years, but he couldn't choose to fish in a new zone unless he could find someone with a license for that zone who was willing to trade zones with him.

The numbers of licenses assigned to each license area changed through time as the TACs available in the different areas changed. There has been a tendency for licenses to be reassigned from the two South Coast areas into the North Coast. By 1997 there were 29 licenses on the North Coast, 9 in Georgia Strait, and 17 on the West Coast of Vancouver Island.[52] Area assignments are made through the UHA. The basic policy when changes need to be made is "last in-first out."

[47] Heizer, pers. comm.
[48] Chamut, memo. To some extent the quotas attached to the licenses were like "blocked" QS in the Alaska halibut and sablefish fishery. All the quota attached to a license could be transferred together with the license, but none could be separated from the license.
[49] Canada, "1997 Mgt. Plan,", pages 22-23.
[50] Canada, "1997 Mgt. Plan," page 23.
[51] Harbo, Farlinger, Hobbs and Thomas, page 12.
[52] Mylchreest, fax.; Rome, pers. comm.

Otherwise the association depends on volunteers. If pressed, the UHA would probably use a lottery, but it has never needed to. [53]

Three year rotation

A third innovation introduced in 1989 was a three year rotation of fishing areas. Under this proposal management areas would be fished once every three years and the fishermen on each part of the coast would be given a different group of areas to fish each year. The proposal was meant to reduce the cost of monitoring geoduck landings by limiting the number of ports used each year and to "alleviate fishing each year at some locations."[54]

Enforcement

Under the terms of the program, the UHA has hired a private firm, Archipelago Marine Research (Archipelago), to monitor geoduck landings. At least 24 hours before fishing the fisherman must notify Archipelago and provide information on the vessel, the management area within which he will be fishing, the date and time he will be arriving on the grounds, and the expected length of time he will be fishing.[55]

The fisherman must also notify an Archipelago observer at least 24 hours before delivering. Deliveries must be made to one of several designated ports. The fishermen must tell the observer when and where the landing will be made, to whom the landing will be delivered, and the method of transporting the product to the processor. If weather conditions change the time of arrival, the fisherman must let the observer know of the changes in plans as soon as possible.[56]

The catch must be weighed by an observer from Archipelago when it is landed. Geoducks must be landed packed in standard cages used by all vessels. The cage weight is deducted from the landed weight by the observer. If for some legitimate reason the catch can't be weighed, the observer may use an average net weight of 50 pounds per cage, or a calculated vessel average cage weight may be determined by a Fishery Manager.[57]

The DFO requires that the UHA have a full time on-grounds patrolman on the North Coast. This costs the UHA about $140,000 a year. This patrolman is on the grounds seven days a week during fishing activity. The South Coast's fishing areas are not as remote and there are fewer vessels. Apparently for these reasons the DFO has not required the UHA to place a patrolman on the grounds on the South Coast.[58]

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[53] Austin, pers. comm.
[54] Harbo, Farlinger, Hobbs and Thomas, page 12.
[55] Canada, "1997 Mgt. plan," page 19.
[56] Canada, "1997 Mgt. plan,", pages 19-20.
[57] Canada, "1997 Mgt. Plan," page 21.
[58] Austin, pers. comm.

Fishermen must maintain a "Validation & Harvest Log."[59] Fishermen must have the logbooks with them while they are involved in diving operations. Information about the day's harvest must be in the logbook before midnight of the day the harvest was made or before the harvest is landed and checked by a dockside observer. Detailed information (time and place, name of diver, duration of dive, and number of cages harvested) must be provided for each dive.[60]

The UHA has also sought to monitor poaching of geoducks by persons without licenses. It has hired a private investigation firm to monitor plants and restaurants on the West Coast for poached product. This firm also monitors markets in Hong Kong through associates there.[61]

User pays

When the UHA proposed the individual quota program the DFO estimated the monitoring expenses at about $250,000 and requested that the industry pay these additional management expenses. The UHA agreed to this to get the program.

The UHA is required by DFO to hire a private company to carry out these observations and report the results to the Department. All license holders are required to use a UHA logbook as a condition of their license. The UHA collects the management fee and uses part of it to pay the contract observer firm (Archipelago) directly.[62]

Originally, cost recovery was designed to pay for the port observers, but as time passed the UHA has begun to pay for an increasing range of management services and research. To a great extent this has been a response to the evolution of the fishery under the individual quota program. For example, water quality rules are tighter for geoducks going to the fresh market than they are for geoducks going to the processed market. As the industry sought to maximize the value of its product in the fresh market the importance of water quality surveys increased. The fishermen have assumed a significant proportion of the cost of this.[63] In an example less closely related to the evolution of individual quotas, new data and new ways of interpreting the data have led the Department to become more conservative about management of the fishery and even to cut back total allowable catches. License holders have invested in stock assessment research as a response to this.[64]

Individual quotas lengthened the season. This increased the costs of monitoring harvest activity. License holders have picked up many of these incremental costs through their funding of the landings validation and the on-grounds monitoring programs.

License holders pay equal assessments for each license they hold, since each license

[59] The "Validation" and the "Harvest" logs were separate through 1994. In 1995 a pilot project with Inside Waters license holders combined the two seeking to reduce duplication and increase data accuracy. The pilot project was expanded coast wide in 1996. Canada, "1996 Mgt. Plan," page 20.
[60] Canada, "1997 Mgt. Plan," pages 24-25.
[61] Austin, pers. comm.
[62] Muse, page 4; Heizer, pers. comm.
[63] Dickson, pers. comm., reported in Muse, page 4.
[64] Dickson, pers. comm.

carries the right to an equal amount of individual quota. License holders can and do have more than one license so some license holders pay more than one assessment.[65] In 1989, the program cost about $250,000, raised in equal assessments of about $4,500 on each of the licenses.[66] Almost all of this annual management fee went to pay for the monitoring program run by Archipelago.[67]

The average assessment per license was $9,000 in 1993 and $15,000 in 1994.[68] The cost recovery fees generated revenues of about $495,000 in 1993 and of about $825,000 in 1994. These revenues were a large increase from the initial 1989 assessment. In 1994, about 41% of the revenues were budgeted for Archipelago landings monitoring and about 59% were allocated to various other purposes. Most of the money for other purposes was earmarked for research by various contractors.[69] At this time the DFO's expenses on this fishery were small.[70] The DFO spent some money on preparation of management plans and monitoring and enforcement, but this probably came to less than $25,000 a year.[71]

In 1997 the UHA budget was about $1,700,000. This was raised in equal $31,000 assessments on each of the 55 licenses. Of this, about $400,000 went to Archipelago to fund its landings and on-ground monitoring programs. In addition to paying for Archipelago, the 1997 budget was going for legal fees, including the private investigations into poaching discussed above, PSP sampling, support for Department of the Environment water sampling, support for commercial fishery lobbying, for UHA's own program of biological research into enhancement and biomass surveys, funding for DFO management support, and the administrative overhead of the association.[72]

Impacts on license holders

In 1991 the DFO did a study evaluating the impacts of the individual quotas based on the experience of the first two years. The report contained a cost and benefit analysis, which, while it generated an estimate of overall costs and benefits from the program, did not provide specific information on the net benefits to license holders. It did note the following effects, all of which should benefit license holders. The program led to:

> ...a more valuable product mix, higher quality, improved product handling, an extended fishing season and greater matching of supply with demand brought about by the new

[65] Austin, pers. comm.
[66] These numbers are estimates made by the author and confirmed as reasonable approximations by Austin. Note that in 1989 two license holders refused to pay the assessment. They subsequently began paying the following year.
[67] Austin, pers. comm.
[68] Austin, pers. comm.
[69] Underwater Harvesters Association.
[70] Dickson, pers. comm.
[71] Adkins, pers. comm.
[72] Austin, pers. comm.

> regime. Cost savings have been identified in the areas of vessel fuel consumption and labour/material used in harvesting...[73]

The study also reported on the opinions of "license holders/operators." Respondents apparently indicated that "ability to plan fishing activities, opportunity to fish for other species, ability for long term planning, fishing safety, net income, level of cooperation among fishermen, and consultation with industry by DFO" had all improved.[74]

License holders have probably earned annual rents in the hundreds of thousands of dollars in recent years. A rough estimate of average gross revenues for 1997 can be determined by multiplying the 1997 license quotas of 72,000 pounds by an estimated average ex-vessel price of $8.51. The estimated average gross revenues are then $612,720.[75] An industry representative has indicated that, for one license in 1997, costs, including crew shares, operating costs, costs of the UHA management fee, and the cost of the DFO vessel license, were $200,000. This estimate did not include costs for unusually large repairs or the opportunity costs of the vessel.[76] Deducting this from the gross revenues, the net (before tax) return could be about $412,720 a year. Because some economic costs were not considered, this probably overstates the rents accruing to this license. It seems reasonable to assume, however, that returns to license holders were between $300,000 and $400,000 in 1997.

The license market is very thin and not many licenses have changed hands. The DFO has prepared value estimates based on interviews with brokers and fishermen. These estimates must be used with a lot of caution. Value estimates for 1990 and 1991 were $200,000 and $375,000. No estimates are provided for 1992 and 1993, but annual estimates for 1994 to 1997 range between one and four million. The DFO encourages cautious use of these estimates, describing them as "suspect" because their basis is in what fishermen say they would buy or sell for, rather than in actual market prices. Values based on hypothetical, "what if" scenarios often deviate greatly from prices that would actually be offered or accepted. The DFO describes the four million dollar valuation as "really suspect."[77] An industry representative has provided anecdotal information indicating that a license, sold as part of a package in 1995 or 1996 went for $1.5 million.[78]

It is possible to make rough, "back of the envelope," estimates of the 1997 license prices that would be consistent with the estimates of net returns reported earlier ($300,000 to $400,000 in 1997). Using a 15% discount rate, and treating the estimated returns for 1997 as a perpetual annuity, the returns would be consistent with license prices between $2,000,000 and $2,700,000.

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[73] Kerr, page 5-6.
[74] Kerr, page 18.
[75] Here and in what follows, it is important to remind U.S. readers that all prices and values are given in Canadian rather than U.S. dollars. All prices and values would be considerably lower if they were expressed in U.S. dollars.
[76] Austin, pers. comm.
[77] Mylchreest, faxed table.
[78] Austin, pers. comm.

All of these estimates have weaknesses. It does appear that these licenses were valuable, worth hundreds of thousands of dollars, even early in the program when ex-vessel prices were averaging $1.21 and $1.29 a pound. By the mid to late nineties, when ex-vessel prices had risen to seven to nine dollars a pound, license values could have been millions of dollars.[79]

There are a number of uncertainties associated with holding a license. The program remains temporary in 1998 as a continuing annual extension of a "pilot" program. The large incomes associated with holding licenses may create political pressures for more licenses or other changes. Apparently Native interests have already expressed an interest in acquiring licenses. While the geoduck stock is still apparently large, no one is sure about the proportion of the remaining stock made up of geoducks with the desirable white meat. Finally there are the normal uncertainties associated with marketing a product overseas in competition with other producers.

Very few licenses have changed hands and most license holders involved at the start of the individual quota program are reported to still be involved as license holders. Many no longer fish but are involved in marketing the product from their vessels. Others continue to hold licenses but are no longer actively involved in the operations.[80]

Impacts on crews

The DFO study on the impacts of individual quotas, cited earlier in connection with impacts on license holders, also contained some information on a survey of crewmembers in 1989-90. Unfortunately, only 20 of the 125 crewmembers surveyed responded. Because of this low response rate the study's reports on crew member attitudes cannot be considered a reliable indication of typical attitudes. Persons feeling strongly about some aspect of the program may have been disproportionately represented in the responses.

The DFO study reported, on the basis of its 1989-90 opinion survey, that "All participants in the fishery...with the exception of crewmen, stated preference for the new management system." The opinions expressed by crewmembers in the survey were mixed. On a scale of 1 to 10, with 1 being a very negative response and 10 a very positive response, the majority rated their overall satisfaction with the program as 5 or less. A majority of those responding indicated that their gross income had decreased. The survey allowed fishermen to comment about the program, "The positive comments included: can supply live market year round, avoid bad weather, better paced fishery, increased safety, higher prices, better control of stocks. The negative comments included: lower diver wages, less manpower needed, poor treatment of divers, reduced job security."[81]

The number of crew members employed in the fishery appears to have dropped. Fewer vessels are active, and the average size of the crew on an active vessel is smaller.

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[79] As noted in an earlier footnote, all prices are quoted in Canadian dollars.
[80] Austin, pers. comm., 1998.
[81] Kerr, page 3, 23-24. It is not clear from the portions of the report I have whether "lower wages" meant diver income or shares.

The number of active vessels appears to have declined somewhat from the period just before individual quotas. In the mid to late eighties most or all of the 55 licenses were used each year. In the five years of rapid expansion just before individual quotas an average of 53 vessels were active. In the years since the individual quotas started, the number of vessels has averaged 45. This represents about a 15% reduction in the number of active vessels. [82] Presumably this is associated with a reduction in the number of crew members required.

Vessel crews include skippers, tenders, and divers. Data are not available on the sizes of the complete crews, but they are available for divers (who are the largest part of the crews). These data show a strong decline in the numbers of divers active in the fishery and, combined with information on the numbers of active vessels, they show a decline in the average diver crew size.. In 1988 233 divers were active in the fishery. With all licenses in use this indicates an average of 4.2 divers per vessel. The number of divers dropped to 178 in 1989, the first year of the program, and continued to decline in most years thereafter. The number of active divers in 1997 had fallen to 86. With 42 active vessels, this was about two divers per vessel.[83]

The DFO evaluation study indicates that there is some evidence that the divers who left the fishery in at the start of the program were "less active part time workers." The divers who left tended to have fished an average of 21 days in 1988, while the overall average number of fishing days for divers in 1988 was 32. About 46% of the divers who left in 1989 fished less than 10 days in 1988, as opposed to an overall average of 31% of the divers who had fished less than 10 days in 1988. [84]

It is important to note that during this period, in addition to the introduction of individual quotas, there was a large reduction in the size of the TAC. The smaller TAC would have required fewer divers to fish it and this may also have been an important determinant of the number of active vessels and divers. The TAC in 1997 was only 46% of the TAC in 1988, the last year before individual quotas. Thus, the decline in the number of divers cannot be entirely assigned to the individual quota program; a significant portion may be due to the change in the TAC.

An industry source has indicated that the shares paid to divers declined following the introduction of individual quotas. According to this source divers tended to be paid 50% of the value of the geoducks they harvested in the years before the individual quotas were introduced, but these shares were said to drop to 25% to 30% of the value of their harvest in the following years. Diver income estimates provided by this source for his own operation in 1997 were consistent with his 25% estimate.[85]

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[82] The number of separate vessels can exceed the number of separate licenses since a license may have been transferred between vessels during the year allowing both to fish. The estimates, available from DFO, of numbers of vessels fishing overestimate the average number of vessels active for this reason.

[83] Allowance in this calculation has to be made for data measurement issues. The numbers of divers are based on an analysis of vessel harvest logs. This data may miss some divers, although since 1989 it should be fairly good. The problem with measuring the number of vessels has been described above.

[84] Kerr, page 9-10.

[85] Austin, pers. comm.

"Back of the envelope" calculations, done on the basis of this information, suggest that income to divers who continued to be employed might have remained approximately constant just after the introduction of the program, and have risen subsequently. These crude estimates, reported below, are only meant to provide rough orders of magnitude.[86]

In 1988, the year before individual quotas, 233 divers harvested about 10.1 million pounds of geoducks, valued at $0.97 a pound. Note that this harvest was considerably over the TAC. With a 50% share of what he brought up, an average diver might have made about $21,000.

In 1989, 178 divers harvested about 8.8 million pounds, valued at $1.43 a pound. With the individual quotas and the associated validation system, this was just under the TAC. Assuming the drop in share percentages was immediate, the divers this year could have received 30% of their harvest value. An immediate drop in the shares of this magnitude seems unlikely, and as noted above, with much higher incomes and after a greater length of time, shares in the instance cited above had only dropped to about 25%. However, if the shares dropped from 50% to 30% of the harvest value in 1989 the divers would have received an average of $21,200. Diver income would have remained largely unchanged, despite the reduction in the size of the harvest.[87]

Even with 25% shares, diver incomes would have started to rise in 1992, when ex-vessel prices began to take off. In 1992, 137 divers harvested about 6.3 million pounds at an average price of $2.56 a pound. With 25% shares, the average income would have been about $29,400.[88]

The 1991 evaluation study argued that diver safety had improved with the advent of individual quotas. This study looked at wage loss claims for divers in the commercial fishing industry from 1988 to 1990. Wage loss claims increased in the first year of individual quotas, but the number of days lost remained about the same suggesting the injuries were less severe. In 1990, both the number of wage claims and the number of days lost dropped substantially. Assuming the changes were not due to changes in any of the other dive fisheries, the author concluded they could be ascribed to the change in geoduck management.[89]

It is hard to summarize the net impact on the crew members. The number of divers declined by a large amount. Much of this decline was probably due to efficiencies introduced with individual quotas, however the decline in TACs and the better control over harvesting due to enhanced monitoring also probably played a role in this. The speculation about incomes advanced here is based on relatively weak evidence. It is possible that crew members who retained their positions ultimately saw increases in their incomes despite declines in actual percentage shares. This seems more likely during the period of large increases in ex-vessel prices from 1992 on. Divers probably

[86] Also, as noted in the preceding paragraph, these estimates are based on information about industry practices supplied anecdotally by one person, a representative of the license holders.
[87] One shortcoming of this analysis, is that it ignores the relationship between compensation and the amount of time divers would have had to be active. As noted in a following paragraph, the number of days of diver activity probably increased under individual quotas. If divers had to spend more time diving in the geoduck fishery the opportunity costs of their time spent diving would have increased.
[88] Again, as noted in the previous paragraph, this analysis ignores changes in the amount of time spent fishing.
[89] Kerr, pages 11-12.

enjoyed better and safer daily working conditions after individual quotas, although they appear to work a larger number of days.

Impacts on fishing effort

Evidence indicates that there has been a large decrease in the amount of effort used in this fishery. The DFO evaluation study completed a year or so after the program began indicated that the number of vessels and the number of divers operating in the fishery both dropped. According to this early study, between 1988 and 1989 the number of vessels dropped from 56 to 47 and the number of divers dropped from 192 to 125 (these figures excluded owner-divers and any student divers, possibly accounting for the discrepancy with the numbers on the previous page and in the next paragraph). The average number of divers per vessel dropped from 3.43 to 2.66. According to the study increased stacking resulted in a decline of about 31 divers, while the change in the average crew size led to a drop of 36 divers.[90]

More recent, and preliminary, estimates by a DFO analyst, based on harvest logs, suggest that the number of divers dropped from 233 in 1988 to 178 in 1989 (these figures include all divers, and therefore include owner-divers and any student divers). The estimates indicate that reductions in the numbers of divers continued in most subsequent years, and that the number dropped to 86 in 1997. According to these preliminary data, the number of total dive hours dropped from about 21,784 in 1988 to about 11,316 in 1997.[91] As noted earlier, in the section on impacts on crew members, the DFO evaluation study in 1991 indicated that there was evidence that the divers who left the fishery in the first two years of the program were "less active part time workers."

This change in the number of divers could be due to a reduction in diver turnover during the year, a reduction in the average number of divers operating from a vessel, or a reduction in the number of operating vessels. The decline does not appear to be due entirely to changes in the number of vessels operating. Although there were 55 licenses, these could be stacked, and the number of vessels with landings ranged between 42 in 1997 and 47 in 1989, 1991, and 1996.[92] The number of vessels thus declined by a smaller proportion than the number of divers.

Impacts on marketing

Ex-vessel prices and the percent of the product sold live increased just after the individual quotas were started. The ex-vessel price rose from an average of $0.97 in 1988 to an average of $1.43 in 1989. The percentage of live product sold in the wholesale market rose from 39% in 1988 to 84% in 1990.[93]

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[90] Kerr, page 8-9.
[91] Marcus, fax.
[92] These numbers tend to be underestimates since they are derived from log book data and the logs may have been incomplete. Since the data have apparently improved since from 1989 on, comparisons with 1988 may lead one to underestimate the actual decline in effort. Marcus, fax; Marcus, pers. comm.
[93] Kerr, page 2.

Ex-vessel prices for geoducks appear to have been rising just before the program was adopted. DFO estimates that the ex-vessel price averaged $0.49 a pound in 1987 and jumped to an average of $0.97 a pound in 1988, the year just before the program. In the first year of the program ex-vessel prices jumped again, from $0.97 to an average of $1.43 a pound. Then for two years ex-vessel prices dropped off somewhat, to averaging between $1.20 and $1.30 a pound. However, in 1992 they began a sustained and dramatic increase. The prices jumped to an average of $2.56 a pound in 1992 and had risen to an average of $8.93 a pound by 1996. [94]

These price increases may be associated with several factors, including conditions affecting the demand for live geoducks in Asian markets.[95] The marketing efforts of the geoduck license holders and buyers were also an important factor. The individual quota program was introduced in large part to supplement these marketing efforts and made them more effective by eliminating gluts and spreading the fishery out over the season. However, these marketing efforts were apparently going on, even as the individual quotas were being developed, and may have already helped produce a large price increase in the year before the program.[96]

Impacts on management

The individual quota program was introduced at a time when coastwide fishery TACs were high. The coastwide TACs in 1989 and 1990 were 8,800,000 pounds. These were higher than the TACs, but below the actual landings, in all but one of the preceding years. After 1990 the coastwide TAC declined in every year. By 1997 the TAC was 3,960,000. The individual quotas followed the TACs down. Individual quotas were 160,000 pounds per license in 1989 and 1990, but they had fallen to 72,000 pounds per license by 1997.[97]

The TACs declined as new information, developed in ongoing DFO stock assessments, began to indicate that divers were removing more geoducks than was consistent with the low levels of the stock that managers sought to harvest. The information showed that bed sizes and geoduck densities had often been overestimated, and that past harvests had been underestimated. TACs were reduced in consequence. The rising prices for geoducks and the decreased harvesting costs during this period probably made it "slightly easier to reduce TACs," since "the increased earnings made it easier to cope with TAC reductions."[98]

The individual quotas and the validation program appear to have made it easier for managers to keep the harvest within the TAC. In the five years before these were introduced, the harvest exceeded the TAC by between 16% and 81%. After the individual quotas and validation were introduced the harvest was less than, or very close to, the TAC in every year. The TACs were met, despite the fact that they were cut by large amounts, and despite ex-vessel price increases.[99]

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[94] Marcus, fax.
[95] These conditions might include increases in income, increases in substitute prices and exchange rate movements. This report has not investigated how these "demand curve shifters" might have affected ex-vessel prices.
[96] Heizer, email; Austin, pers. comm.
[97] Marcus, fax.
[98] Heizer, email.
[99] Marcus, fax.

Quotas and validation have helped DFO manage the TAC more accurately, to "within pounds." It allows DFO to micromanage better than before. There is a lot more enthusiasm for the "long term" from fishermen.[100]

In some areas the catch per unit of effort went down under individual quotas. This could be due to resource problems, however the industry advances a different explanation: divers are taking more care of the product. They go more slowly and avoid broken shells and damaging the siphons. In the old days the processed market didn't care about these things, but the live market does. Divers also spend more time because they are trying to keep the quality of the product up a little higher. They may be more willing to leave a low quality area after a single dive and move to an area where they can get a higher average quality. However, this has meant that the catch per unit of effort in the fishery has gone down.[101]

Enforcement effectiveness

A DFO evaluation report on individual quotas in the geoduck fishery indicates that,

> ...overall enforcement...has increased due to the introduction of industry-funded port validators to monitor all geoduck offloading. Survey results from 1991 [the same survey mentioned earlier in the current report] indicate that both license holders and DFO staff feel that port observers are very thorough in their jobs.[102]

This report goes on to cite the results of the 1991 evaluation report and note that at that time license holders and managers both felt that on-grounds enforcement had not changed (even if dockside monitoring had) and that the level of on-grounds management before the individual quotas had not been high.[103] The level of enforcement is currently an issue to the industry, however, which would like to see increased DFO expenditure on it. There is a feeling that the DFO views the geoduck fishery as running itself to a great extent, and that it uses the user funded geoduck monitoring at plants and on the water as an opportunity to redeploy its enforcement assets to other fisheries. To some extent this result is looked on as a disadvantage of the high level of organization within the industry.[104]

Highgrading, with its consequent discard mortality, seems to be an enforcement concern.[105] Highgrading was a concern before the introduction of individual quotas and apparently it continues to be a concern since they were started. As in most individual quota fisheries, the extent of highgrading is not known. However, the incentives for it appear to be strong, fishery documents mention it, and conversations with people connected with the fishery indicate that it goes on. It is easy to highgrade when a diver is unobserved underwater. The low price placed on

[100] Austin, pers. comm.
[101] Austin, pers. comm.
[102] Sporer, fax.
[103] Sporer, fax.
[104] Austin, pers. comm.
[105] The UHA has taken a strong stance against it. Austin, pers. comm.

dark geoducks in the market creates an economic incentive. The high mortality rate for discarded geoducks makes it potentially dangerous for the resource.

Discussion

In 1977 the Canadians took a different direction in geoduck management from that taken in Washington State. In Washington the fishery is run by auctioning off tracts of geoduck grounds to the highest bidders, and letting them harvest those tracts. In 1976 the Canadians assigned geoduck permit holders mutually exclusive harvest grounds, however in 1977 they abandoned this approach almost immediately and substituted an open access fishery.

Open access management was evidently a failure, abandoned after about two years (July 1977 to June 1979). There was apparently little attempt to make it work by restricting the effort of individual divers with regulations on fishing time, acceptable gear or procedures, trip limits, etc. Managers moved almost immediately to implement TACs and limited entry.

A combination of limited entry and area TACs by themselves were also, ultimately, a disappointment. Despite regulations limiting increases in vessel length, this combination of regulations proved unable to control all the margins on which license holders were able to expand effort. Operators used large numbers of divers on their vessels and the divers worked long hours. When ex-vessel prices began their large increases in the late eighties individual quotas and the validation program were added to limited entry.

Individual quotas and validation have been successful in a number of respects. Excess effort has been controlled and the fishery operates relatively efficiently generating enormous fishery rents. The individual quotas have apparently assisted the industry in its efforts to develop new and lucrative markets in China. The fishery is said to be safer and easier to operate in. The available TAC has been cut in half but the industry has been able to thrive. Fishermen are paying for a large part of the costs of fisheries management.

Nevertheless, the distribution of the fishery rents generated in this fishery appears to be an issue. Rents probably accrue largely to the license holders, many of whom are said to have stopped actively fishing. To an unknown extent they are also accruing to Canadian society through income taxation. They probably are being shared to a lesser extent by skippers, tenders, and divers on the fishing operations. This distributional issue may generate some continued political uncertainty about some aspects of the program. For example, political pressure could result in a larger number of limited licenses. However, comments by industry representatives, managers, and fishery observers suggest that the program is unlikely to be abandoned.[106]

[106] Heizer, pers. comm.; Austin, pers. comm.; Rome, pers. comm.

Sources

Adkins, Bruce. (1994). British Columbia Shellfish Coordinator for the Canadian Department of Fisheries and Oceans. Personal communication, 1994.

Austin, James. (1998). President of the B.C. Underwater Harvester's Association. Personal Communication. February 12, 1998. 250-752-7205.

Canada. Fisheries and Oceans Pacific Region. "Pacific Region 1997 Management Plan Geoduck and Horse Clam."

Chamut, P.S. (1988) Director-General, Pacific Region, DFO. Memo on the "1989 Geoduck Management Plan - Enterprise Allocation." To Pierre Asselin, ADM, Pacific & Freshwater Fisheries. Dated December 7, 1988.

Dickson, Frances. (1993). British Columbia Shellfish Coordinator for the Canadian Department of Fisheries and Oceans. Personal communications, 1993.

Doherty, T.J. (1990) "Canada's Dive Fishery Comes of Age." *Pacific Fishing.* December, 1990. Pages 116-122.

Goodwin, C. Lynn. (1973) "Sub-tidal Geoducks of Puget Sound, Washington." Washington Department of Fisheries. Technical Report No. 13. August, 1973.

Goodwin, C. Lynn, and Bruce Pease. (1989) "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Northwest). -- Pacific Geoduck Clam." U.S. Fish. Wildlife Serv. Biol. Rep. 82(11.120) U.S. Army Corps of Engineers, TR EL-82-4. 14 pp.

Goodwin, C. Lynn and Bruce Pease. (1987) "The Distribution of Geoduck (Panope Abrupta) Size, Density, and Quality in Relation to Habitat Characteristics Such as Geographic Area, Water Depth, Sediment Type, and Associated Flora and Fauna in Puget Sound, Washington." Technical Report No. 102. Washington Department of Fisheries. Olympia, WA.: December 1987.

Harbo, R.M. and S.D. Peacock. (1983) "The Commercial Geoduck Clam Fishery in British Columbia, 1976 to 1981." Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1712. June, 1983.

Harbo, R.M., C.M. Hand, and B.E. Adkins. .(1986) "The Commercial Geoduck Clam Fishery in British Columbia, 1981 to 1984. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1873. July, 1986.

Harbo, R., S. Farlinger, K. Hobbs, and G. Thomas. (1992) "A Review of Quota Management in the Geoduck Clam Fishery in British Columbia, 1976 to 1990, and Quota Options for the 1991 Fishery." Canadian Manuscript Report of Fisheries and Aquatic Sciences 2178. 1992.

Harbo, R., G. Thomas, and K. Hobbs. (no date) "Geoduck Clam Dive Fishery 1993/94." Part of an unknown, longer manuscript.

Heizer, Steve. (1998) Canadian Department of Fisheries and Oceans Geoduck Manager. Personal communications. February and March, 1998. 250-756-7271.

Heizer, Steve. (1998) Canadian Department of Fisheries and Oceans Geoduck Manager. Email. February and March, 1998. 250-756-7271.

Kerr, Stuart. (1991) "The Geoduck Fishery 1988-1990: An Evaluation." Prepared for the Geoduck Steering Committee. Unpublished manuscript. July 23, 1991.

Marcus, Kerry. (1998) Shellfish Data Manager, South Coast Division, Pacific Region, Department of Fisheries and Oceans. Personal communication. March 9, 1998. 250-756-7158.

Marcus, Kerry. (1998).. Shellfish Data Manager, South Coast Division, Pacific Region, Department of Fisheries and Oceans. Faxes of tabular data on the B.C. geoduck fisheries. February 10, March 6, and March 9, 1998. 250-756-7158

Muse, Ben. (1994) "Recovering the Costs of Fishery Management." Alaska Commercial Fisheries Entry Commission. CFEC 94-11Nb. Juneau: November, 1994.

Sporer, Chris. (1998) Program Planning & Economics Branch, Department of Fisheries and Oceans, Pacific Region. Fax with material from an undated "Geoduck IVQ Program" report. February, 1998. 604-666-3862.

Turris, Bruce. "Management Options for the Geoduck Fishery. A Discussion Paper." DFO, Pacific Region. Unpublished manuscript. August, 1988.

Underwater Harvesters' Association. 1988. Untitled proposal dated April 5, 1988. Attachment #1 to Turris, Bruce "Management Options for the Geoduck fishery A Discussion Paper." Department of Fisheries and Oceans, Pacific Region. August, 1988.

Underwater Harvesters' Association. (1993) "Notice to all 'G' license holders." Leaflet dealing with the 1993 general meeting of the association and reviewing 1994 license fee rationale. Qualicum Beach, B.C. December 6, 1993.

Washington. Department of Natural Resources and Department of Fisheries. (1985) "The Puget Sound Commercial Geoduck Fishery Management Plan & Environmental Impact Statement." May, 1985.

Appendix: Annual Geoduck TAC, Landings, and Effort Information

Year	License numbers	Coast-wide TAC ('000 lbs)	Quota per license (lbs)	Coast-wide landings ('000 lbs)	Number of vessels with landings	Number of divers	Number of diver hours	Mean Ex-vessel Price ($/lb)	Limited Entry and Individual quotas
1976	7	none		97	5			N/A	no limitation
1977	30	none		541	14			0.17	no limitation
1978	54	none		2,240	27	93	7,743	0.25	no limitation
1979	101	8,000		5,430	72	213	19,250	0.31	moratorium
1980	95	8,000		6,186	63	226	19,633	0.37	moratorium
1981	52	6,176		5,961	49	184	15,722	0.36	limited entry
1982	52	6,500		6,911	53	189	19,586	0.40	limited entry
1983	54	6,500		5,811	53	145	13,452	0.31	limited entry
1984	54	6,600		7,678	44	156	20,145	0.38	limited entry
1985	55	6,550		11,839	52	189	23,428	0.40	limited entry
1986	55	8,775		11,035	55	215	24,254	0.39	limited entry
1987	55	9,345		12,643	56	191	25,885	0.49	limited entry
1988	55	8,575		10,069	56	233	21,784	0.97	limited entry
1989	55	8,800	160,000	8,784	47	178	18,023	1.43	individ. quotas
1990	55	8,800	160,000	8,722	46	146	19,510	1.21	individ. quotas
1991	55	7,425	135,000	7,347	47	133	17,205	1.29	individ. quotas
1992	55	6,311	114,750	6,314	45	137	14,750	2.56	individ. quotas
1993	55	5,363	97,500	5,365	44	112	13,047	4.99	individ. quotas
1994	55	4,950	90,000	4,909	45	108	12,362	6.87	individ. quotas
1995	55	4,622	84,030	4,624	45	108	11,313	9.36	individ. quotas
1996	55	4,058	73,785	4,058	47	93	10,636	8.93	individ. quotas
1997	55	3,960	72,000	3,960	42	86	11,316		individ quotas

The data in this table are drawn from Marcus, fax. Landings and quotas (in 92, 93, 95, and 96) have been rounded to nearest '000 pounds.