

Management of the British Columbia Sea Cucumber Fishery

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Abstract:

British Columbia sea cucumber commercial dive harvests began to take off in the early 1980s. The fishery was an open access fishery through 1990. Total allowable catches were introduced in the mid-eighties, and a license limited entry system in 1991. In 1994 fishermen tried unsuccessfully to set up a voluntary individual quota program similar to those introduced in the red and green sea urchin fisheries that year. In 1995 the Department of Fisheries and Oceans introduced a formal, departmental, individual quota program in this fishery. This report reviews the history of this fishery since the early 1980s, paying particular attention to the introduction and operation of the limited entry and the individual quota programs.

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Introduction¹

British Columbia (B.C.) sea cucumber harvests began to take off in the early 1980s. The fishery was an open access fishery through 1990. Total allowable catches (TACs) were introduced in 1986, and a license-type limited entry system in 1991.² In 1994 fishermen tried unsuccessfully to set up a voluntary individual quota program similar to those introduced in the red and green sea urchin fisheries that year. In 1995 the Department of Fisheries and Oceans (DFO) introduced a formal, departmental, individual quota program in this fishery.³

Even today, relatively little is known about the biology or distribution of the resource in B.C. The fishery provides a case study of the development of a fishery by fishermen and managers in the face of great resource uncertainty, and also provides a case study of the use of limited entry and individual quotas.

B.C.'s Sea Cucumber Resources

California sea cucumbers (*Parastichopus californicus*) are found throughout B.C.⁴ They occur in relatively shallow water, but have also been found in prawn traps at depths below 300 feet.⁵ Sea cucumber density is reported to be high in passes. Densities tend to be particularly high in Central B.C., a region with lots of islands with channels between them.⁶

California sea cucumbers can grow to be one and a half feet long. They look like stout, knobby, worms, typically five times as long as they are wide. They eat by ingesting marine sediments, cleaning them of microscopic organisms, and excreting them.⁷

Cucumbers have some mobility. They can swim a couple of feet if necessary to avoid predation by star fish. Animals have been observed moving over 300 feet in 24 hours. It

¹This report has benefited from comments by Kurt Schelle of the Alaska Commercial Fisheries Entry Commission and Eric Rome of Archipelago Marine Research. Only the author is responsible for any errors in this report.

²Canadian documents often refer to the aggregate harvest from a fishery or from an area as a quota. In this report, these aggregate harvests will be referred to as "total allowable catches" or "TACs" to distinguish them more clearly from individual quotas.

³The sea cucumber dive fishery is managed by Canada's Federal government, not by the Provincial government.

⁴The California sea cucumber is one of a number of sea cucumber species found in B.C., but it is the only one harvested commercially. Throughout this paper a reference to sea cucumbers or cucumbers is a reference to California sea cucumbers. The species is found from Baja California north to the Gulf of Alaska.

⁵Neifer, pers. comm.

⁶Neifer, pers. comm

⁷Mottet, pg 25.

is not known whether they move systematically. Some feel that they may migrate between shallower and deeper water.⁸

In B.C. they tend to spawn in June, July, and August, although they may sometimes spawn in the late spring. In September, after the spawning season, they become dormant and their internal organs shrink and atrophy. During the ensuing fall and winter months, they can lose up to 25% of their body weight. During the spring the cucumbers begin feeding again, and recover their body weight during the spring and summer.⁹

This annual pattern of spawning, atrophy, and recovery affects the timing of the harvests. Fishermen and processors prefer to harvest sea cucumbers during the period when their internal organs are atrophied, because they get a higher recovery weight from the animals, processing is easier, and the meat and skin are of a higher quality. Thus the fishery tends to be opened in the fall and winter when weather conditions are often poor.¹⁰

Larvae can drift with the currents for weeks. This means that the spawning stock may be a long way from where the larvae will settle and grow. Thus the sources of new recruits to a fishery may have come from some distance away, and there may be no tight relationship between a stock in an area and recruitment to it.¹¹

Managers do not know much about the sea cucumber resource in B.C. Information about the biology, population dynamics, response to harvest, distribution, or biomass is extremely limited. Biologists have been unable to effectively age or tag the animals. Because information is so limited, the DFO has taken a very conservative approach to setting its TACs.¹²

The sea cucumber fishery is a small scale fishery used by geoduck and urchin dive fishermen to supplement their operations.¹³ The boats used in those fisheries are used in this one. Boats may range in size from 22 foot skiffs to 40 foot salmon boats converted to diving. The median vessel size may lie between 30 and 38 feet. The typical operation has three to four persons, including two divers and a tender.¹⁴

The tender monitors the divers while they are under water. The divers move along the bottom, picking up the sea cucumbers and putting them in a bag. Divers have been shifting from a system where air is pumped from the surface (a hookah system), to the use of scuba gear. This may reflect on-going changes in the related urchin fishery. Divers on hookah gear put their cucumbers in bags attached by rope to the vessel. Divers using scuba gear also put their cucumbers in bags, but they leave their bags behind them on the

⁸Immamura and Kruse, page 6, Neifer, pers. comm.; Mottet, pg 26.

⁹Immamura and Kruse, page 2-3.

¹⁰Neifer, pers. comm; Ethelbah, pers. comm..

¹¹Smiley, in Paust, page 29.

¹²Neifer, pers. comm.

¹³Two divers can generally take the current vessel quotas in about a day. Neifer, pers. comm.

¹⁴Keith, pers. comm.

sea bottom with small buoys to the surface. Their support vessels follow behind and recover the bags. The cucumbers are then slit and eviscerated on the surface. Boats on the North Coast tend to deliver to packer vessels.¹⁵

In the earlier years of the fishery, fishermen tended to land the sea cucumbers round. However, in the late eighties, fishermen began to slit the sea cucumbers once they were caught to reduce the water content and the bulk. By the early nineties almost all sea cucumbers were landed “split” rather than round. Reported fisheries statistics generally converted to split weight in 1992 to recognize this change in the fishery practices.¹⁶

Sea cucumber markets are in China, Korea, and Japan. Sea cucumbers are a traditional East Asian food. These Asian markets used to depend on local stocks of the sea cucumber *Stichopus japonicus*. However, in the late seventies and early eighties the supply of *S. japonicus* failed to meet demand and these markets began to turn to North America and *P. californicus*.¹⁷ The principal products are the body wall, or skin, which is boiled, dried, and salted, and the muscles just inside the skin which are frozen.¹⁸

The Unlimited Fishery, 1971-1990

B.C.’s sea cucumber resource has been exploited for a long time. B.C.’s Natives harvested sea cucumbers as a traditional food resource. However, the first commercial sea cucumber landings were not reported until 1971, and they appear to have remained relatively small until the early eighties.¹⁹

During the period up to 1990, entry to the fishery was not limited. In the early years of the fishery the only licensing requirements were a “C” license for the vessel and “fisher’s registration cards” for everyone on board. The “C” vessel license allowed a vessel to be used to fish for “Schedule II” species. These were a miscellaneous group of less important commercial species including sea urchins, skates, and octopus. The C licenses were limited in 1977, but there were so many issued that they imposed no constraint on sea cucumber fishing. The fisher’s registration cards were required for everyone on board a commercial fishing vessel.

In 1983, the DFO introduced “Z” fishing licenses. These were personal licenses, allowing a person to fish for a species using a vessel with the appropriate vessel license. Various categories of these were issued for different species. Separate Z licenses were issued for sea cucumbers as well as red and green sea urchins, and several other species. A “Z-D”

¹⁵Keith, pers. comm.; Neifer, pers. comm.

¹⁶For consistency, estimates of fishery landings, or estimates of prices or CPUE based on weight measures are reported in round weight in this report. Where necessary, round weights were derived using a conversion factor of 2.73 round pounds for each pound of split weight. This conversion factor was obtained from Neifer and Rogers, Table 3.3.4.

¹⁷Da Silva, *et al.*, page 134.

¹⁸Neifer, pers. comm.; Rome, pers. comm.

¹⁹Mathews, *et al.*, page 18; Neifer and Rogers, page 1.

license was issued for sea cucumbers. These Z licenses were not limited. They could be issued to companies as well as persons and a person could get more than one of them if he fished more than one vessel. The license holder did not have to be present with the fishing vessel.

As the fishery expanded in the early eighties, prices and effort, accompanied by harvests, rose quickly. A DFO landings price series that begins in 1984 shows prices at an average of about \$195 per metric ton, round weight, in 1984, and, and rising each year to \$1,341 a ton, round weight, in 1990.²⁰

Effort followed prices up. Numbers of licenses rose from 40 in 1985 to 215 in 1990. Many of these licenses were not used, but the number of active vessels was positively correlated with license numbers. In 1985, 21 vessels made landings while in 1990, 126 vessels made landings.²¹ The available series on the numbers of divers runs from 1988 to 1990 and shows an increase in each year, from 124 in 1988 to 163 in 1990.²²

Landings also rose. Landings ranged between 5 and 27 tons, round weight, from 1980 to 1982, but jumped to 527 tons in 1983. Although they fell in 1984, they grew rapidly thereafter, rising to a peak of 1,922 tons, round weight, in 1988. Landings then fell in the next two years, dropping by about 55% (to 870 tons, round weight) in 1990, the last year before limited entry. Landings from 1987 to 1990 substantially exceeded the TACs for the fishery in each year.

The key management response to the increasing effort and harvests was the gradual implementation and tightening of TACs. TACs were introduced despite the fact that little was known about the size of the stock.²³ The first TAC was implemented on the South Coast in area 24 in 1985.²⁴ This was extended to other areas in three regional TACs covering both the North and South Coasts in 1987.²⁵ The total coastwide TAC that year was 1,500 tons. In 1989, due to concerns about stocks and catch per unit of effort (CPUE), these TACs were reduced to a total of 800 tons. In addition, the North Coast TAC was subdivided among three management areas. Aside from the “Area 24” TAC in 1985, the TACs appear to have been applied over groupings of several statistical areas.²⁶ In the absence of good information on sea cucumber stocks, these TACs were “arbitrary” and “precautionary.”²⁷

²⁰All prices and values in this paper are reported in Canadian dollars. The U.S. equivalent would be smaller in nominal value. All “tons” are metric tons. The prices and many of the other data series discussed in this paper are summarized in a table at the end of the paper.

²¹Heizer and Thomas, Table 4, page 12.; Parker, email.

²²Heizer and Thomas, Table 4, page 12.; Parker, email.

²³Heizer and Thomas, PSARC 1994, page 3.

²⁴Harbo, letter to Shirley.

²⁵I have followed Harbo in his letter to Shirley on the date for the region-wide TACs. However, DFO time series typically show the region-wide TACs beginning in 1986. DFO series are reported in the data table at the end of this paper.

²⁶Harbo, letter to Shirley.

²⁷Neifer and Rogers, Table 3.3.1; Heizer and Thomas, Tables 2 and 3.

Increases in prices, increases in the numbers of licenses, vessels and divers, and decreases in the TACs, appear to have led to shortening seasons. The total number of vessel fishing days initially rose from 249 in 1984 to peak at 1,906 in 1987. However, thereafter it tended to fall. In 1990 it was 1,153 days - 40% below the 1987 peak. In 1986, the fishery was open from January 1 to December 31. In 1990, in three of the five quota areas, the season was over in about two weeks (by mid-January). It was closed everywhere by the middle of February.²⁸

In 1991 managers responded to the increases in effort and shortening seasons in the preceding years by limiting the number of “Z-D” licenses they would issue into the fishery. In the same year DFO implemented limited entry in the red and green sea urchin dive fisheries as well.

The Limited Fishery, 1991-1994

Seventy-eight licenses were originally issued, but following appeals and the issuance of several licenses to Native bands, there were eventually a total of 85 licenses. Since 215 licenses had been issued in 1990, this was a reduction of about 60%.²⁹

Limited licenses were issued to license holders with 50,000 pounds of cumulative landings on their Z-D license during the three years from 1987 to 1989, or if they had 20 days of recorded harvests with it in any one year during this period.³⁰ A person could receive more than one of the limited licenses if they had more than one license in the base years.

The limited licenses could not be transferred. However, since the owner did not need to be on-board, they could be leased. An actual sale could be approximated with a long term lease contract. This provided a way for license holders to effectively sell or otherwise transfer their license. The limited licenses could be moved from one vessel to another, so long as the new vessel was not longer than the original vessel.

Limited entry did reduce some measures of fishery effort. The number of licenses issued in the fishery, and the number of vessels fished, both dropped following entry limitation. As already noted, the number of licenses issued dropped from 215 in 1990 to no more than 85 in any subsequent year. The number of vessels initially dropped by about half, from 126 to 60, but then rose to between 71 and 77 from 1992 to 1994. Even with the increase from 1992 to 1994, the number of vessels under limitation was about 25% below the average in the three years just before limitation.³¹

To some extent price movements for sea cucumbers, rather than entry limitation may have been responsible for these results. Prices for sea cucumbers rose to very high levels in

²⁸Neifer and Rogers, Tables 3.3.4 and 3.3.5; Harbo, letter to Shirley.

²⁹Neifer and Rogers, page 1 and Table 3.3.4.

³⁰DFO, Commercial Licensing Handbook, page 58.

³¹Neifer and Rogers, Table 3.3.4.

1990, and the number of active fishing vessels appears to have responded to these price incentives, also rising to very high levels. The number of vessels in 1990 was about 38% higher than it had been in 1989, and 1989 had had the highest number of vessels to that time. In 1991, the first year of limited entry, the price of sea cucumbers plummeted by about 43%. The number of vessels fished that year also plummeted. Limited entry may have played a role in this, but the number of active vessels dropped well below the limited number of licenses.

Despite the reduction in the number of separate vessels, the fishery appears to have remained intense following limitation. The number of divers did not drop, the seasons shortened, the number of days with landings dropped, and managers continued to have problems meeting the TAC. These statistics paint a picture of an intensifying fishery as smaller numbers of vessels were used as platforms by larger average numbers of divers in shortening fishing seasons.

The number of divers did not drop. It was actually somewhat higher in the years following limited entry. The average for the three years before limited entry was 140 divers a year, while the average during limited entry was 159 divers.

Fishing seasons shortened (although to some extent this may have been due to TAC reductions). In each of the five TAC areas the season was much shorter in 1994 than it had been in 1991. For example, on the West Coast of Vancouver Island the season dropped from 12 fishing days to 1; in the Prince Rupert District on the North Coast, the season dropped from 9 days to 4. Most of the reductions in fishing days from one year to another took place in years when there was no TAC reduction.³²

Fishing seasons may have been shortened during this period in part because of declining TACs. The coastwide TAC was 800 tons for the first two years of limited entry, but then declined by 1994 to 575 tons. However, the catch per vessel fishing day rose considerably during this period, implying more intense fishing for the available TAC. In 1991, the first year of limitation, about 2.5 metric tons were landed per vessel fishing day, by 1994, the last year before individual quotas, 3.3 metric tons were landed per vessel fishing day. Conversely, landings per diver were dropping. In 1991 landings were 9.8 metric tons per diver, in 1994 they were 3.4 metric tons.³³

Shorter seasons meant fewer vessel fishing days. The number of vessel fishing days dropped from 1,153 in 1990, the year before limitation, to 164 in 1994, the last year before individual quotas. DFO statistics on vessel fishing days may underestimate the amount of time invested by divers since one practice during this period was to fish illegally before the season and stockpile sea cucumbers on the bottom in order to increase the harvest during the fishery opening. Days spent in this activity would not be recorded by DFO.³⁴

³²Rome, Eades, and Huston, Table 3.

³³These are all round product weights. Mylchreest, fax; Parker, email.

³⁴DFO, 1995 Fishery Update, Table 5, page 13.; Heizer and Thomas, PSARC 1995, page 6.

DFO managers had trouble meeting their TAC goals even with entry limits. In three of the four years with limited entry, the TAC was exceeded. Part of the problem was that the reporting requirements worked with a lag. As the seasons shortened, the problems posed by these lags became more severe.

Initial DFO management responses to these effort increases included shortening seasons (as mentioned above) closing management areas within the five TAC regions, reducing TACs, and introducing area rotations. TACs were reduced from 800 tons in 1990 to 575 tons by 1994, the last year before individual quotas. TACs were reduced in some areas and years in response to prior year overages. In 1991 the fishing areas in the South Coast fishery were placed on a two year rotation. Each area was allowed to lie fallow every other year. In 1993 the South Coast fishery rotation was extended to three years. Thus each area was given an opportunity to lie fallow for two years after each year that it had been fished.³⁵

License holders had been expressing an interest in individual quotas since 1992.³⁶ In 1994, The Pacific Sea Cucumber Harvester's Association (PSCHA) proposed a voluntary individual quota program for the 1994 fishery. There could have been a number of reasons for this initiative at this time. As noted above, there were management problems. The short fisheries increased the risk to fishermen that if something went wrong, they would lose out on the harvest. The short fisheries would also have caused marketing problems and exacerbated safety problems in this winter fishery. To get a jump on the fishery, some fishermen were harvesting sea cucumbers before the openings and storing them in bags on the bottom for retrieval during the fishery. Managers were having a hard time meeting their TAC goals.

Fishermen may also have reacted to events in the related geoduck and sea urchin dive fisheries. The B.C. geoduck dive fishery had had a successful individual quota program since 1989. The success of the geoduck program must have been well known in diving circles at this time. In fact, geoduck ex-vessel prices had started to go up rapidly in 1992 and this appears to have increased the value of the geoduck licenses and their associated quotas. The prospect of a similar event in the cucumber fishery would have given license holders an incentive to press for individual quotas. In the early part of 1994, a voluntary individual quota program had been begun in the red urchin fishery, in which many sea cucumber fishermen worked. This program was apparently seen to be successful fairly quickly and this may have given further incentive to sea cucumber fishermen. As noted below, PSCHA's proposed voluntary program resembled the red urchin program.

Under the PSCHA proposal quotas were to be divided equally among the license holders, the North Coast and South Coast would be separate license areas, and landings were to be

³⁵Heizer and Thomas, PSARC 1995, page 3.; Harbo to Shirley.

³⁶Rome, pers. comm.

monitored by a private contractor.³⁷ Although DFO arranged its 1994 fishery plans to accommodate the PSCHA, the plan fell through before it could be implemented. Apparently one of the operators refused to cooperate with the voluntary quota program. The proposed individual quotas were small compared to the fishing power of individual operations, so one operation represented a lot of fishing power with respect to the resource, even though it was a relatively small part of the fleet.³⁸

Individual Quotas, 1995-1998

Initial allocation and the nature of the property rights

The DFO management plan for 1995 noted that “Open times for fishing have been short due to high levels of harvest and limited quotas...quota overages have been experienced in most years and quota reductions in some areas in subsequent years have occurred as a result...Due to the intensive nature of this fishery, problems with exceeding quotas and diver safety considerations, the industry has recommended that individual vessel quotas...be implemented.”³⁹

The DFO introduced a two year pilot individual quota program in 1995.⁴⁰ Under this program the TAC was divided equally among the 85 Z-D license holders. The total commercial TAC was about 636 tons, round weight, in 1995. Dividing this equally among the license holders gave each 16,514 pounds, round weight.⁴¹

With the introduction of the individual quotas, Z-D licenses were made transferable.⁴² In addition, fishermen were allowed to use three licenses on a single vessel (called stacking). Fishermen were not allowed to transfer quotas independently of the license (with the minor exceptions in the case of overages - discussed below). During the period of the individual quotas, fishermen were also allowed to transfer their licenses to vessels that were longer than the vessel length specified with the Z-D license. The DFO reserved the right to require licenses to revert to vessels with their originally assigned lengths at the end of the pilot program.⁴³

Area licensing was introduced with individual quotas. Five license areas along the coast were originally designated and given their own individual TACs. Within these five license areas the annual subarea rotations were continued. Each license was assigned to one of these areas. The number of licenses in each area was determined by the area TAC and the

³⁷This plan had a lot of similarities with the programs already adopted in the geoduck and red sea urchin fisheries.

³⁸Heizer and Thomas, PSARC 1995, page 5; Neifer, pers. comm.

³⁹DFO, 1995 Mgt Plan, page 4.

⁴⁰The pilot program was extended into 1997 and 1998. It has not yet been made permanent (in April 1998, however).

⁴¹DFO, 1995 Mgt Plan, page 6.

⁴²Except for the five Native band licenses. DFO, 1995 Mgt. Plan, page 6.

⁴³DFO, 1995 Mgt Plan, pages 6-7.

number of pounds that had been assigned to each license. License holders were free to choose the area in which they wanted to fish; when more people wanted to fish in an area than there were quota opportunities a random lottery was used to see who would get the license. License totals in the first year were:

West Coast of Vancouver Island	10
East Coast of Vancouver Island	10
Central Coast	22
Prince Rupert District	22
Queen Charlotte Islands	21

Individual license quotas were equal in all areas.⁴⁴ These license areas and numbers of licenses allocated to each area were readjusted in subsequent years. One license area, the Queen Charlotte Islands, was closed in 1996 and 1997 due to the problems and dangers in fishing there compared to those of fishing in other areas.⁴⁵

If there was more than one license being fished off of a single vessel, fishermen could transfer an overage from one license to another of the licenses, subject to no limit other than that the second license have sufficient unused quota. In 1995, quota overages of up to 100 pounds could also be transferred from a license fished on one vessel to a second license fished off of another vessel, so long as the license receiving the overage had sufficient unused quota, was being used to fish in the same quota area, and was landing in the same port (the same port restriction was eliminated in 1997). If a license holder had an overage greater than 100 pounds, and could not transfer the overage to another license on the vessel, the proceeds from the sale of the overage were turned over or “relinquished” to the government. With experience, managers adjusted the overage transfer limit to 250 pounds in 1996, and again to 200 pounds in 1997. In addition, managers introduced a rule in 1997 deducting 1997 overages from 1998 individual quotas.⁴⁶

Enforcement

Fishermen, through PSCHA, contracted with a private firm, Archipelago Marine Research (Archipelago), to monitor landings. All landings had to be monitored or “validated” by Archipelago. License holders were required to pay validation fees to PSCHA before Archipelago would validate their catch.⁴⁷

Fishermen were required to notify, or “hail,” Archipelago 24 hours before fishing in an area, and 24 hours before landing product. Landings had to be made at designated ports where dockside observers were present. At the time of landing the fishermen were to submit a detailed dive log and charts for the trip to the Archipelago observer. This dive

⁴⁴DFO, 1995 Mgt. Plan, page 8.

⁴⁵Rome and Eades, pg 4; Rome, Eades, and Huston, pg 5.

⁴⁶DFO, 1995 Mgt. Plan, pg 14; Rome and Eades, pg 8; Rome, Eades, and Huston, pg 10, 15.

⁴⁷DFO, 1995 Mgt. Plan, pg 6.

log was supposed to be filled out daily during the trip. The Archipelago observers monitor the landings and record the weight of the catch. Prior to weighing, the sea cucumbers had to be eviscerated and de-watered.⁴⁸

Problems with the monitoring system seem to have declined quickly during the 1995-1997 period as observers, managers, and fishermen learned how to make the system work. Each year Archipelago maintained a log of problems with the monitoring system. A few of these problems may have represented attempts to cheat the system, most almost certainly represented accidents. In 1995 there were 30 problems that were serious enough to lead to Archipelago “incident reports.” Of the 46 problems discussed in these 1995 incident reports, 33 had to do with a failure to turn in harvest logs and charts when the cucumbers were delivered or with other problems with the logs and charts. The requirement that fishermen turn in their logs and charts when they landed their product was a new one in 1995. There were delays in its implementation, and fishermen were unfamiliar with it. This undoubtedly contributed to the large number of problems that year. The number of incident reports dropped from 30 in 1995 to seven in 1996 and three in 1997.⁴⁹

DFO enforcement operators were also active on the water doing fishing area and vessel checks. DFO enforcement used Archipelago license holder “hails” to intercept vessel operators.⁵⁰

User pays

The dockside monitoring program is funded by management assessments collected by the PSCHA. Once these assessments are collected, the PSCHA notifies Archipelago, and a fisherman can receive a standard logbook from Archipelago. DFO regulations require fishermen to use standard logbooks supplied only by Archipelago. The PSCHA management assessments are currently \$750. The validation program has cost about \$40,000 a year in 1995, 1996, and 1997. The cost has not been equal in each year, and in fact has declined somewhat.⁵¹

With the \$40,000 cost of the monitoring program divided equally among 85 licenses, about \$470 of the management fee collected by PSCHA went to Archipelago each year for the monitoring program expenses. The remainder has been used by the PSCHA for its own expenses. The income has in fact exceeded the association’s annual operating expenses. The association has used the balance to build up its cash reserves.⁵²

⁴⁸DFO, 1995 Mgt. Plan, pg 13, attachment.

⁴⁹Rome and Clarke, pgs. 8-9; Rome, Eades, and Huston, pg 14.; Rome, pers. comm.

⁵⁰Rome and Clarke, page 7.

⁵¹The numbers in this paragraph and the next are approximate. They are based on an interview with an association representative who was not able to refer to records at the time. Keith, pers. comm.

⁵²Keith, pers. comm.

Some Program results

Changes in effort levels

The number of active vessels and the number of active divers both dropped under individual quotas, while the number of vessel fishing days initially increased but then declined. The number of vessels dropped immediately in the first year of the program and then dropped again in each of the following two years. Ultimately, the number of vessels dropped by 42% from 71 in 1994 to 41 in 1997. While these measures of resources devoted to effort shrank, the number of vessel fishing days initially rose by 71% from 164 to 280, but declined thereafter.

The reduction in the number of vessels took place through the stacking of licenses on vessels. The stacking limit was three licenses per vessel. The number of vessels fishing with only one license dropped each year from 22 vessels in 1995 to 15 vessels in 1997. The number of vessels fishing two licenses also dropped each year. The number fishing three licenses rose each year, from 12 vessels in 1995 to 17 vessels in 1997.⁵³

The number of divers also dropped under individual quotas. By 1997 the number had dropped to about 70 divers from 157 in 1994; this was a drop of about 55%. The number of divers did not drop in each year, but the numbers in all three years under individual quotas were much lower than the numbers in any of the years before individual quotas.

Lengthening of the fishing season

The fishery immediately lengthened when individual quotas were introduced. In 1994, the last year before individual quotas, the season in open areas lasted from one day on the West Coast of Vancouver Island and the Central Coast area, to six days in the Queen Charlotte Islands. In 1995, the first year with individual quotas, the season lasted from 13 days on the West Coast of Vancouver Island, to 20 days in the Central Coast area. By 1997, the season lasted 19 days in each open management area.⁵⁴

Data on license values

The DFO has prepared price estimates for sea cucumber limited entry licenses based on interviews with brokers and fishermen. These price estimates must be used cautiously. The value estimate for 1991, the first year of limited entry was \$10,000. Since licenses were not formally transferable at that time, this value estimate must be interpreted as the value of a long-term lease. No DFO estimates are provided for 1992 or 1993. In 1994, the DFO price estimate was \$35,000. The estimate rose in each year thereafter, to \$60,000 in the first year of individual quotas, to \$70,000 in 1996, and to \$80,000 in 1997.

⁵³Rome and Clarke, pg. 2; Rome and Eades, pg 5; Rome, Eades, and Huston, page 6.

⁵⁴Despite generally unchanged, or slightly smaller, aggregate coastwide TACs. Rome, Eades, and Huston, Table 3.

The DFO encourages cautious use of these estimates, describing them as “suspect” because their basis is in what fishermen say they would buy and sell for, rather than in actual market prices.⁵⁵ Values based on hypothetical, “what if” scenarios often deviate greatly from prices that would actually be offered or accepted.

These DFO estimates are, however, consistent with other estimates of \$60,000 to \$80,000 given by an industry representative on the basis of information about a sale in 1997 and rumors about recent offers. This source indicated that the market had strengthened recently due to rumors about potential TAC increases.⁵⁶

License holders and crew

The vessel license price data above suggests that vessel license owners have enjoyed an increase in net wealth from the increase in license values. To some extent this may be due to the individual quota program. Other management elements could also be affecting price expectations however. The validation program, while its cost may reduce the present value of revenues associated with the license, may also create expectations of improved TACs based on improved information in manager’s hands. The recent move towards possible increased harvests under a management regime where the traditional TACs are supplemented by exploratory harvests may also be a consideration.⁵⁷

Operators also appear to have benefited from the program in other ways. As noted above, the season has been extended and fishermen have more flexibility. A sudden, unexpected problem is less likely now to prevent an operator from fishing and losing out on a season. A guaranteed harvest reduces an important element of fishing risk and allows fishermen to plan with more confidence. There is more opportunity for fishermen to work around weather problems, improving operational safety.⁵⁸

There has been a considerable drop in the number of divers employed in the fishery. With the drop in the number of separate vessels, it seems possible that there has also been a drop in the number of crew members employed as tenders.

Without good information on possible changes in share systems it is hard to say what the impact has been on diving wages. A reduction in employed divers may have led to excess supply of diver labor and a reduction in diver wages. Alternatively, improved marketing opportunities may have led to higher sea cucumber prices than there might otherwise have been; if share systems change with a lag, divers may have enjoyed some short run rents from this. Improvements in comfort, safety, or the likelihood of harvesting the quota, discussed in an earlier paragraph, would tend to reduce shares and actual cash income from the fishery. These factors would increase the attractiveness of diving and increase

⁵⁵Mylchreest, fax.

⁵⁶Recent offers as of April, 1998. Keith, pers. comm.

⁵⁷This last was mentioned by one source. Keith, pers. comm.

⁵⁸Rome and Eades, page 7.

the expected value of the income from any given share arrangement, reducing the size of the shares operators would have to offer to attract divers.

Impacts on management

Managers feel that individual quotas and the associated validation program have had good results for management. The fishery has slowed down, and it is now possible to keep harvest within the TAC limits. There are more opportunities for cooperation between managers and industry. The validation program has meant an increase in the accuracy of harvest statistics.⁵⁹ Before individual quotas were introduced, fishermen would often fish and stockpile sea cucumbers underwater prior to the fishery opening. With the advent of individual quotas this no longer made sense and the practice is believed to have been abandoned.⁶⁰

Some area TACs were exceeded in some years by small amounts under individual quotas, but the coastwide TACs were met in all years, primarily because at least one license quota went unfished in each year. Some fishermen exceeded their license quotas in each year, but the proportion of license quotas that were exceeded also dropped each year. Twenty-eight percent of the license quotas were exceeded in 1995 but only 18% in 1997.⁶¹

The percentages of the persons who exceeded their quotas, but who were still able to stay within the “quota overage transfer limits” rose in each year, from 43% in 1995 to 67% in 1997. The large increase in the overage transfer limit from 1995 to 1996, from 100 to 250 pounds, probably helped increase this percentage, but it still increased, even when the limit was reduced somewhat, to 200 pounds, in 1997. The 1997 reductions may reflect the new rule introduced that year deducting overages above the “overage transfer limit” from the next year’s individual quota allocation.⁶²

Some fishing spots within an area with an area-wide aggregate TAC can be more attractive than others. Since sea cucumbers are not highly mobile, this raises the possibility of localized overfishing.

There have been some instances under this individual quota program where this may have been a problem. In 1995, the West Coast of Vancouver Island (WCVI) TAC covered areas 24 and 25. However, the entire TAC was taken from subarea 24-7. Fishermen took the entire TAC from 24-7 because it was closer to their homes and closer to processing plants. This appears to have led to reductions in the CPUE in 24-7 before the end of the two weeks of fishing.⁶³

⁵⁹Neifer, pers. comm.

⁶⁰Neifer and Rogers, pg 2.

⁶¹Rome and Clarke, pg 5; Rome and Eades, pg 9; Rome, Eades, and Huston, pg 10.

⁶²Rome and Clarke, pg 5; Rome and Eades, pg 9; Rome, Eades, and Huston, pg 10.

⁶³Rome and Clarke, pg 5; Rome and Eades, pg 9; Rome, Eades, and Huston, pg 10.

This problem was addressed in 1996 and 1997 through a multiplication of subarea TACs to spread out the harvest. These subarea TACs came to be referred to as “quota blocks.” Thus in 1996 in the WCVI separate TACs were established for each of two “quota blocks.” By 1997 the overall TAC for each license area on the coast was divided up into either two or four quota blocks.⁶⁴

A new approach to management

During the last 18 months preparations have been made to make major changes in the management of the sea cucumbers.⁶⁵ Different portions of the coast will be managed in different ways.

About a quarter of the B.C. coast has been set aside for a continuation of the existing fishery, although only part of this area will be harvested. In the areas included in this quarter of the coast, license holders will be able to harvest their individual quotas. In this open area the rotation of management areas (which predated in the individual quotas) will be dropped. A quarter of the coast was set aside to harvest the existing TAC on the basis of very conservative assumptions about appropriate harvest rates and sea cucumber density.⁶⁶

A portion of the coast will also be set aside for experimental sea cucumber fishing. Fishery surveys and experimental harvests would be carried out in these coastal areas to develop data on sea cucumber populations, and on how those populations respond to different harvest rates. DFO hopes to carry out controlled experiments to develop the information. Harvests would be arranged by the PSCHA which might make some money from them. These experimental harvests would be in addition to the existing fishery TAC and would not be a part of fishermen’s individual quotas. Data from these experimental harvests may be used in the future to justify increases in the existing TAC.⁶⁷

About half of the B.C. coast will be set aside and protected from harvest for the foreseeable future. Large buffer areas around the areas used for TACs and experimental harvests will be taken from this half.⁶⁸

Discussion

When this fishery began to take off, in the early to mid-eighties, managers knew very little about the status of the sea cucumber resource. In the late eighties they imposed arbitrary TACs on the fishery to control harvests. However, expanding effort by fishermen in

⁶⁴In 1996 these were Areas 26 and 27 (because of area rotation). Rome and Eades, pg 14; Rome, Eades, and Huston, pg 16.

⁶⁵This is written in April, 1998.

⁶⁶A harvest rate of 4.2% of the biomass and a density of 2.5 sea cucumbers per meter of shoreline. Parker, pers. comm.; Rome, pers. comm.

⁶⁷Parker, pers. comm.; Rome, pers. comm.

⁶⁸Parker, pers. comm.; Rome, pers. comm.

response to rising prices, made this very hard to do. In 1991, managers introduced limited entry in a further attempt to control fishery effort.

Limited entry alone, however, was not successful, particularly since TACs were also reduced. The number of active vessels was reduced, but the number of divers remained close to pre-limitation levels, and in fact was capable of exceeding pre-limitation levels. Lower TACs and intense effort led to shorter fishing seasons. The intense effort and short seasons in turn created incentives for fishermen to illegally collect and stockpile cucumbers before the fishery opening. These would then be landed on the first day of the opening. Depending on the management area, seasons could be reduced to a single day. With the shortening of the fishing seasons, managers, did manage to gradually bring coastal harvests down to the annual coastal TACs.

Due to problems in the sea cucumber fisheries, and in light of the examples of individual quotas in the related geoduck and red sea urchin fisheries, the industry was ready to attempt a voluntary individual quota program by 1994. Although this program failed to be implemented, the DFO introduced a mandatory program in 1995. This mandatory individual quota program was associated with an enhanced landings validation program. It is difficult to separate the impacts of the two.

The combined individual quotas and validation program appears to have led to reductions in the effort used in the fishery and extensions in the fishing seasons in the different management areas. Pre-fishery stockpiling of cucumbers stopped because the fishing competition which had provided the incentive for it had disappeared. Managers found it easier to manage a slower fishery, TACs were met, and fishery data improved. Cooperation between managers and fishermen is also better. License holders appear to have benefited from an increase in license prices. Fishermen appear to benefit from improved operational flexibility leading to marketing and safety advantages and to reduced likelihood of missing the fishery due to an accident. The number of persons employed in the fishery has dropped, and it is not clear what the impact has been on income for persons involved in fishing.

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Annual Sea Cucumber TAC, Landings, and Effort Information

(All weights reported in round, rather than split, weight)

Year	Limited entry and individual quotas	Number of licenses	Annual TAC (tons)	Number of vessels with landings	Total fishing days	Total landings (tons)	Average ex-vessel price (\$/ton)	CPUE (kg/diver hour)	Number of divers	Length of average diver day
1980	no limitation			9	59	20		ND		ND
1981	no limitation			11	ND	27		ND		ND
1982	no limitation			ND	ND	5		ND		ND
1983	no limitation			19	356	527		372		3.4
1984	no limitation			12	249	113	195	318		3.6
1985	no limitation	40		21	271	346	271	342		2.9
1986	no limitation	63	1,500	34	733	786	300	289		3.1
1987	no limitation	151	1,500	56	1,906	1,722	446	347		4.5
1988	no limitation	160	1,500	79	1,512	1,922	512	281	124	2.7
1989	no limitation	245	800	91	1,022	1,144	854	285	133	2.1
1990	no limitation	215	800	126	1,153	870	1,341	208	163	2.7
1991	limited entry	78	800	60	535	1,340	768	481	137	2.6
1992	limited entry	84	800	77	449	1,422	959	617	151	NA
1993	limited entry	84	650	75	201	812	1,209		192	
1994	limited entry	85	575	71	164	536	1,821		157	
1995	individ. quotas	85	636	47	280	615	1,275		79	
1996	individ. quotas	85	636	46	221	636			88	
1997	individ. quotas	85	636	41	199	631			70	

Sources: Neifer and Rogers, Table 3.3.4; Rome, Eades, and Huston, Table 1; Parker, email; Mylchreest, fax.