



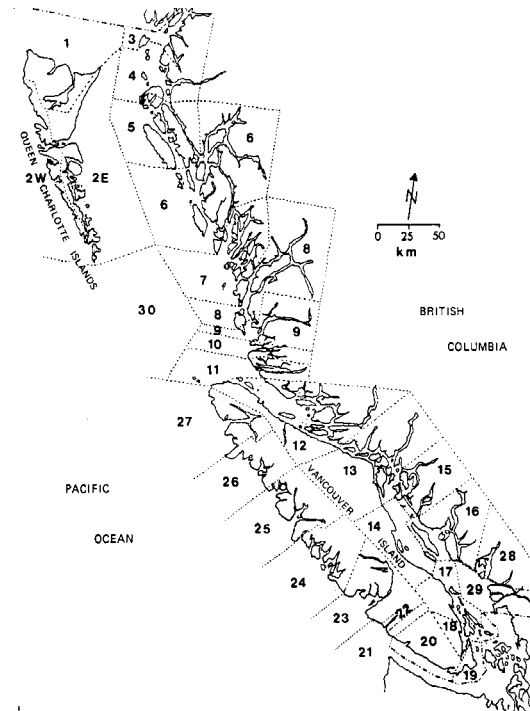
Giant Red Sea Cucumber

Background

The giant red or California sea cucumber (*Parastichopus californicus*) is the largest of approximately 30 sea cucumber species in British Columbia and the only one that is commercially harvested. The species ranges from the Gulf of Alaska to southern California, in water depths from the intertidal to 250 m. Sea cucumbers occupy the sea bed in a wide variety of substrates and current regimes, but are most abundant in areas of moderate current on cobbles, boulders or crevassed bedrock. Individuals have limited mobility but can travel up to 4 metres per day while feeding and are reputed to undertake seasonal migrations to different depths. Sea cucumbers feed by picking up organic detritus with their mop-shaped adhesive tentacles as they move over the sea floor.

Individual sea cucumbers are either male or female, and broadcast spawning occurs from spring through summer. Eggs and sperm are released directly into the water and the developing larvae remain planktonic for two to four months. Juveniles grow from 0.25 mm at settlement to approximately 1 cm in one year and to 4 to 10 cm at the end of two years. Although juveniles are reported to be found in many different habitats, they are most commonly observed attached to the underside of rocks and in mats of stringy red algae. Adult populations tend to be made up of uniform-sized individuals and rarely contain sea cucumbers less than 15 cm in length. Small (5 to 15 cm) sea cucumbers have been found in only 8% of the surveyed transects. Based on an analysis of length frequency data for the first three years of growth, age at recruitment to the fishery is thought to be at least 4 years.

Sea cucumbers cannot be aged, and so information on mortality and growth rates, age at sexual maturity, and longevity is unknown. The animals undergo annual fluctuations in body mass, skin thickness, and muscle weight during their yearly cycle of resorbing and regenerating their internal organs.



Pacific Fisheries Management Areas (PFMA) for the coast of B.C.

Summary

- The commercial fishery is a small limited-entry (85 licences) dive fishery that is managed by individual quota (IQ).
- Quotas are calculated by multiplying estimates of shoreline length, sea cucumber density, individual weight and harvest rate. The total allowable catch (TAC) can be increased in surveyed areas when the measured density estimates are calculated to be higher than the precautionary baseline density estimate.
- Only 25% of the coast is open to the commercial fishery. Up to an additional 25% may be used to conduct research, and the remaining

50% is closed to harvesting until biologically-based management is possible.

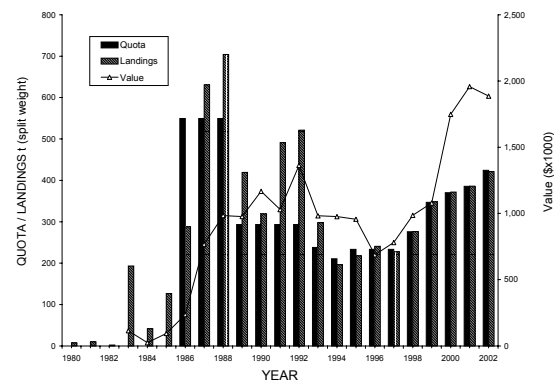
- Abundance surveys and experimental fisheries are being conducted to estimate biomass and evaluate exploitation rate options.
- Results from initial surveys suggest that the fishery has potential for growth.
- The clumped distribution of fishing effort is a source of concern due to the potential for localized depletion.

The Fishery

The annual sea cucumber fishery lasts for about three weeks in October, when muscle weight is greatest and the animals have resorbed their internal organs. Individuals are hand-picked from the substrate by SCUBA divers. They are cut open longitudinally and viscera and internal fluids are removed in a process called 'splitting'. The animals are processed into two products; frozen muscle strips and dried skin, known as 'trepan'. Final destinations for these products include Hong Kong, Taiwan, mainland China and Korea, as well as Canada and the U.S. The annual landed value of sea cucumbers is just over \$1.8 million.

The first commercial landings of sea cucumbers in B.C. were recorded in 1971. The fishery expanded rapidly after 1980 with annual landings exceeding 1,900 tonnes round weight (700 t split weight) in 1988. Fishing was initially permitted in South Coast areas only (PFMA 12 to 27; see map) and the majority of landings were taken in the Strait of Georgia (PFMA 13 to 20) until 1987. The north coast was opened in 1986 with a TAC of 500 tonnes round weight, although fishing did not occur

there until 1987. To date, landings of sea cucumbers have been recorded from all PFMA's, with the exception of the north and west Queen Charlotte Islands (Area 1 and 2W). The central and north coast (PFMA 3 to 10) currently supports about 80% of the fishery.



Value is calculated as product of validated landings and price per lb for year 2001 and 2002, otherwise from sales slips.

Initial management controls consisted of area-closures and arbitrary regional TAC's, first implemented in 1986. This did little to limit the fishery, since landings and the number of licences issued continued to increase and quota over-runs were common. This, and concerns that stemmed from declining catch per unit effort in some areas, led to arbitrary TAC reductions in 1989, the implementation of licence limitation in 1991, and further TAC reductions in 1993. Currently, 85 licences are eligible for participation in the fishery. A pilot Individual Quota (IQ) program was introduced in 1995, which requires the validation of all landings.

Sea cucumbers are of continuing importance to First Nations, who harvest them for food, social and ceremonial use. The level of First Nations' sea cucumber harvest is unknown at this time. A small recreational fishery occurs for sea cucumbers, however landings

are unrecorded and the extent of recreational use of this resource is also unknown.

Adaptive Management

Although sea cucumbers have been harvested for over 20 years, little biological information is available upon which to base TAC's and harvest practices. Therefore, assessment and management approaches have been developed according to the Pacific Region Policy for New and Developing (data-limited) Fisheries. Following a review of existing biological and fishery information for *P. californicus* in B.C. and elsewhere, a framework was designed to allow for the precautionary management and sustainable development of the fishery. This adaptive management strategy, implemented for the 1997 fishery, included a division of the B.C. coastline into open areas, closed areas and experimental areas. Commercial harvesting was restricted to only 25% of the British Columbia coastline. Up to an additional 25% of the total coastline was designated for research and experimental fisheries. The remaining 50% is closed until sufficient information has been gathered that will ensure conservative biologically-based TAC's and management practices.

When this strategy was initiated, the existing arbitrary TAC of 233 tonnes (split weight) was retained over static, non-contiguous areas, using the most conservative density and exploitation rate estimates available. The original baseline density estimate of 2.5 sea cucumbers per metre of shoreline (c/m-sh) was the minimum of the lower 90 % confidence limits from all large-scale surveys conducted in Southeast Alaska

(the nearest location which has been comprehensively surveyed) and was considered to be conservative for B.C. waters. The Management Plan allows for TAC modifications in areas where abundance surveys are conducted. These survey areas must be resurveyed every four years. Since 1998, seven such surveys have been conducted, in six different areas, amounting to 30% of the shoreline open to fishing. These surveys have ultimately resulted in an 82% increase in TAC, to 424 t. In 2002, the baseline density estimate was revisited using B.C. data and a new estimate of 5.08 c/m-sh, the minimum of the lower 90% confidence limits of all surveys, was adopted for most unsurveyed areas to replace the estimate of 2.5 c/m-sh.

An exploitation rate of 4.2% has been applied to estimates of biomass for quota calculation purposes since 1997. This rate is the most conservative of estimates used in the management of Alaska and Washington State sea cucumber fisheries. Experimental fisheries are being used to test the effects of varying exploitation rates on population dynamics. Four experimental fisheries are underway: one in the Strait of Georgia, two in the north coast of B.C. and one on the west coast of Vancouver Island. The locations of the experimental fisheries were selected to encompass a variety of habitat types, from protected shores of soft substrate to rocky steep-sided channels and fjords. Experiments include a pre-fishery survey in each of five 10-km sites, followed by harvesting at 0% (control) and 2%, 4%, 8% and 16% exploitation rates. No significant decrease in catch per unit effort has been observed in the experiments thus far (five years into the experiments) and all experimental quotas have been

fished to completion. Surveys and experimental fisheries will continue until at least 2008, or until negative impacts are noticeable. Collaborative surveys involving DFO, stakeholders and First Nations groups are key to the project success.

Mean individual split weight estimates are derived from market sampling of harvested product, and range from 168 to 489 grams, depending on the area.

Resource Status

Early in the fishery, harvesters targeted sea cucumber populations in southern B.C., in areas close to port, and where diving was logistically easy and the animals plainly visible. At that time, researchers and managers felt that only a small proportion of the stock was being harvested, and that many sea cucumbers were left untouched in fished areas. The fishery has since expanded to more remote northern areas, but fishermen still prefer to target easily-harvested areas, even if densities are lower than elsewhere. Presently, extensive areas of the coast have not been visited by the commercial sea cucumber fleet.

Surveys conducted in various areas of the coast indicate that sea cucumber population density varies considerably with habitat type. Areas of moderate current with irregular hard substrates have higher density populations than areas of low current and soft substrate, although sea cucumbers have been found in virtually every habitat regime examined to date. Density estimates from almost all surveys are significantly higher than the conservative estimate of 5.08 cucumbers per metre of shoreline used to calculate TAC's.

Sea cucumber populations extend below the safe diving depth of 20 m where extensive harvesting cannot be conducted. These deep-water stocks may provide a spawning reserve, however their reproductive potential may be lower than animals in shallower water, since they are generally smaller and have lower meat recoveries, based on a limited experimental trawl harvest in 1986/87.

Outlook

The initial uncontrolled expansion in landings and effort has been halted, and annual TACs are closely adhered to through the port validation of all landings. With over 50% of the B.C. coast closed to commercial harvest, there is presently no risk of overall stock collapse from the fishery. Although there are many unanswered questions regarding the productivity of sea cucumbers in different habitat regimes and their response to harvesting pressure, it seems likely that this fishery has potential for expansion in the long-term.

Management Considerations

Fishermen will typically harvest all of the adult sea cucumbers that they see, and densities are therefore reduced to low levels at any one dive site. The concentration of annual fishing effort in relatively small areas may lead to localized depletion of sea cucumber stocks. The recovery time from such depletion in the wake of the fishery has not been investigated. Sea cucumber populations may be fairly tolerant to small-scale depletion because of the long planktonic larval period. Depleted areas could also be repopulated through immigration from adjacent areas.

Localized removal of these detritus feeders may have an impact on sea-bed ecosystems. Since the importance of this ecological niche has not been investigated and may be difficult to assess, a conservative management approach to harvest is appropriate.

References

Boutillier, J. A., A. Campbell, R. Harbo and S. Neifer. 1998. Scientific advice for management of the sea cucumber (*Parastichopus californicus*) fishery in British Columbia. P. 309-340. In: G. E. Gillespie and L. C. Walther [Eds.]. Invertebrate working papers reviewed by the Pacific Stock Assessment Review Committee (PSARC) in 1996. Can Tech. Rep. Fish. Aquat. Sci. 2221.

Campagna, S. and C. M. Hand. 2002. Sea cucumber quotas based on British Columbia survey data. DFO Can. Sci. Advis. Sec. Res. Doc. 2002/XX. 34 p.

Cameron, J. L. and P. V. Fankboner. 1989. Reproductive biology of the commercial sea cucumber *Parastichopus californicus* (Stimpson) (*Echinodermata: Holothuroidea*). II. Observations on the ecology of development, recruitment, and the juvenile life stage. J. Exp. Mar. Biol. Ecol. Vol. 127: 43-67.

Lambert, Philip. 1997. Sea cucumbers of British Columbia, Southeast Alaska and Puget Sound, Royal British Columbia Museum Handbook, UBC Press, Vancouver, Canada.

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