



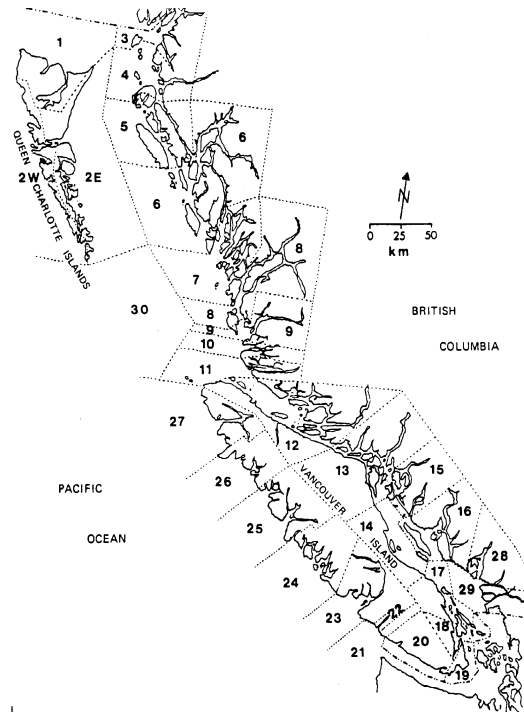
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Giant Red Sea Cucumber

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 metres. Sea cucumbers occupy the sea bed in a wide variety of substrate 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. They feed by picking up organic detritus with their mop-shaped adhesive tentacles as they move over the sea floor.

Sea cucumbers have separate sexes, and spawning occurs from spring through summer. Eggs and sperm are released directly into the water and the developing larvae remain planktonic for 2 to 4 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 have been reported from 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 cucumbers less than 15 cm in length. Appreciable concentrations of small (5 to 15 cm) sea cucumbers have not been found in any location. 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.



Pacific Fisheries Management Areas for the coast of B.C.

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

Summary

- This is a small limited-entry dive fishery that is managed by conservative quotas.
- The coast is divided into three categories, with approximately 25 % for the commercial fishery, 25 % for experimental fisheries and the remaining 50 % closed to harvesting until the information that will ensure a sustainable fishery is known.

- The commercial fishery is managed by individual quota (IQ). IQs can be increased when density surveys show that the abundance of cucumbers is higher than the average value used to calculate the initial quota.
- Abundance surveys and experimental fisheries are being conducted to evaluate sustainable 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.

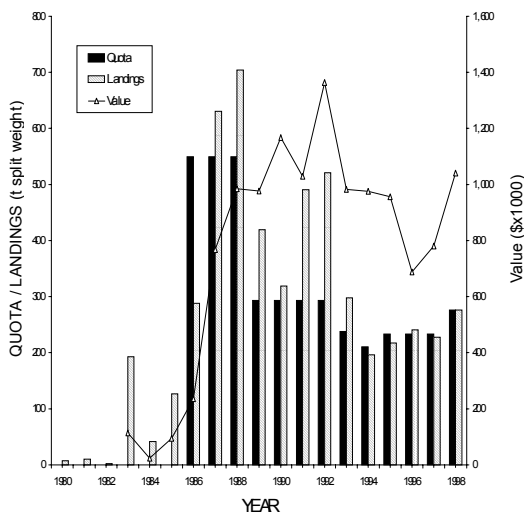
The Fishery

The annual sea cucumber fishery lasts for about 3 weeks during the autumn or winter months, when muscle weight is greatest and the animals usually have no internal organs. Individuals are hand-picked from the substrate by SCUBA divers. They are cut open longitudinally and any viscera and internal fluids are removed in a process called “splitting.” The animals are processed into two products; frozen muscle strips and the skin dried, known as “trepang.” 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 million.

The first commercial landings of sea cucumbers were recorded in 1971. The category C licensed fishery began on an experimental basis in 1980 and expanded rapidly, with annual landings exceeding 1,900 tonnes round weight (700 tonnes split weight) in 1988. Area closures and arbitrary regional quotas were 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 stemming from declining catch per unit effort in some areas, led to arbitrary quota reductions in 1989, the implementation of licence limitation in 1991 and further quota reductions in 1993. From 1993 to 1996, a 3-year rotation was introduced in the south coast to allow for a 2-year period of recovery between harvests. The fishery is no longer rotational. Currently, 85 licences are eligible for participation in the fishery. A pilot Individual Quota (IQ) program was introduced in 1995 which required the validation of all landings.

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 quota of 500 tonnes round weight (RW), although fishing did not occur there until 1987. Landings of sea cucumbers have since been recorded from all PFMAs, 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.

Sea cucumbers are of continuing importance to First Nations, who harvest 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 quotas and harvest practices. The fishery has therefore been incorporated into the “phased approach” described in the Pacific Region Policy for New and Developing (data-limited) Fisheries. Following a “Phase 0” review of existing biological and fishery information for *P. californicus* in B.C. and elsewhere, a “Phase 1” framework was designed for an experimental fishery that was to provide data on stock abundance and the response of populations to various levels of exploitation.

This framework was developed into an adaptive management process that was implemented for the 1997 sea cucumber fishery. The existing arbitrary quota of 233 tonnes, split weight, is maintained in static, non-contiguous areas that equal about 25 % of the B.C. coastline. The quota was calculated over this proportion of the coast by assuming a density of 2.5 sea cucumbers per metre of shoreline, an exploitation rate of 4.2 % and a mean individual split weight ranging from 263 to 327 grams, depending on the area. The estimate of density is 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 is considered to be conservative for B.C. waters. The exploitation rate is the most conservative of estimates used in Alaska and Washington sea cucumber management. Mean weight estimates are from biological sampling of B.C. harvested product. The management plan allows for abundance surveys to be undertaken in the open areas in order to refine quota levels.

Another 25 % of the B.C. coastline is designated for experimental fishing, designed to test the effects of varying exploitation rates on sea cucumber population dynamics. 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. These

bracket the current 4.2 % exploitation rate. To date, four experimental fisheries are underway; one in the Strait of Georgia, two in the north coast and one on the west coast of Vancouver Island. These encompass a variety of habitat types, from protected shores of soft substrate to rocky steep-sided channels and fjords. Surveys and experimental fisheries will continue in these and other locations for at least 10 years or until negative impacts are noticeable. An understanding of sea cucumber population dynamics will only be achieved through a careful testing, learning and building process. Collaborative multi-agency surveys are key to the project success.

The remaining 50 % of the B.C. coastline is closed to commercial harvest until sufficient information has been gathered that will ensure conservative biologically-based quotas and management practices.

Resource Status

Early in the fishery, harvesters targeted southern sea cucumber populations 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 dive in easily harvested areas, even if densities are higher elsewhere. Presently, extensive areas of the coast remain untouched by the commercial sea cucumber fleet.

Initial results from surveys conducted in various areas of the coast indicate that sea cucumber populations vary considerably with habitat type. Areas of moderate current with irregular hard substrates are more productive than areas of low current and soft substrate, although sea cucumbers have been found in virtually every habitat regime examined to date. It is because of this wide distribution that stocks are assessed on the basis of a mean density per metre of shoreline. Density

estimates from almost all surveys conducted to date are significantly higher than the conservative estimate of 2.5 per metre of shoreline used to calculate quotas. The exception, based on one survey, is fjord-type habitat where an average density of 2.6 sea cucumbers per metre of shoreline was obtained. Inlets or fjords have been roughly estimated to make up 25 % of the B.C. coastline. Other surveys conducted in channels and island archipelagos have produced average density estimates ranging from 10 to 17 sea cucumbers per metre of shoreline.

Sea cucumber populations extend below the safe diving depth of 20 metres, 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 fishery in 1986/87.

Outlook

The initial uncontrolled expansion in landings and effort has been halted, and annual quotas 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. 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 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 yet been investigated. Sea cucumber populations may be fairly tolerant of small-scale depletion, however, 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 may be warranted.

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invertebrate fisheries. Reviews in Fish
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End Note

1. Line drawing from Royal British Columbia
Museum handbook on Sea Cucumbers by Philip
Lambert.

This report is available:

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