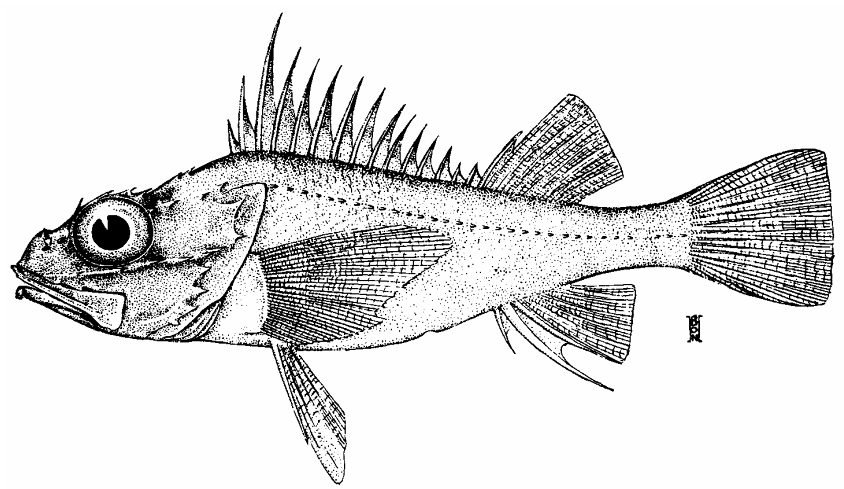
COSEWIC
Assessment and Status Report

on the

longspine thornyhead
Sebastolobus altivelis

in Canada



SPECIAL CONCERN
2007

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Production note:

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Longspine thornyhead — Longspine thornyhead *Sebastolobus altivelis* – ink drawing (Hart 1973) and photo (http://www.afsc.noaa.gov/groundfish/RockfishGuide/Rockfish_Pages/Longspine_thornyhead.htm).

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COSEWIC
Assessment Summary

Assessment Summary – April 2007

Common name
Longspine thornyhead

Scientific name
Sebastolobus altivelis

Status
Special Concern

Reason for designation
This slow growing rockfish has adapted to survive in deep waters where oxygen concentrations are minimal and productivity is low. Since the beginning of the fishery in the mid-1990s there has been an estimated decline in commercial catch per unit effort of over 50% in 8 years. Fishing is the primary and probably sole cause of this decline. While the fishery is managed by catch limits, and there is good monitoring of fishing activities, there is no management strategy in place that assures catches will be adjusted in response to abundance changes. The substantial decline in abundance indices over a short period taken together with the very conservative life history characteristics are cause for concern, but commercial catch per unit effort may not reflect abundance changes accurately and there is potential for rescue from adjoining populations in the USA.

Occurrence
Pacific Ocean

Status history
Designated Special Concern in April 2007. Assessment based on a new status report.

COSEWIC
Executive Summary

longspine thornyhead
Sebastolobus altivelis

Species information

Longspine thornyhead (*Sebastolobus altivelis* Gilbert 1893) belongs to the scorpionfish family. This species exhibits red colouration with some black on the fins. The elongate body reaches 35 cm in length, with large eyes and strong, sharp head spines.

Distribution

The species ranges from Cape San Lucas, Baja California, to the Aleutian Islands at depths from 370 m to 1600 m. In British Columbia (BC), they occur along the continental slope at depths between 500 and 1,600 m. The estimated extent of occurrence is 17,775 km^2; the observed area of occupancy is 11,700 km^2.

Habitat

The species prefers soft sand or mud bottoms in deep-water environments characterized by low productivity, high pressure, and reduced oxygen concentrations.

Biology

In spring, females release fertilized eggs in a gelatinous matrix that floats to the surface. Here, the eggs hatch and the larvae and early stage juveniles remain in the upper 200 m for 6 months. As the juveniles mature, they occur progressively deeper, generally remaining in the mesopelagic zone (~600 m) for one year. Eventually, young fish settle directly into adult habitat at 600-1,200 m. Juveniles eat euphausiids; adults target brittle stars and other benthic fauna. Longspine thornyheads have adaptations that allow them to live in deep water where oxygen is low and pressure is high. Assuming an age at 50% maturity of 20 years and a natural mortality of 0.10, the calculation of generation time yields 30 years.

Population sizes and trends

The bulk of the longspine thornyhead biomass lives in the fisheries management region WCVI (west coast Vancouver Island), with two smaller known populations in the

Tidemarks and Rennell regions further north. These populations may be continuous. Commercial trawl CPUE (catch per unit effort) indices declined 8%, 9%, and 20% in WCVI (1996-2004), Tidemarks (2000-2004), and Rennell (2000-2004), respectively. A weighted coastwide index declined by 50% over eight years. Although factors other than abundance changes probably influence the commercial CPUE index, this is considered a reasonably accurate index of population abundance. Estimation of a "three generation" change for this population based on results from short time series remains uncertain as time series of observations are short and forward projection would depend on assumptions about future fisheries management.

Limiting factors and threats

The primary threat to the population stems from overfishing a deep-water species that occupies a low-productivity environment. Since the inception of the targeted commercial fishery in 1996 off the WCVI, most indices have exhibited a substantial decline. This may be consistent with the "fishing-down" of a previously unexploited species (removal of accumulated biomass, theoretically associated with increased productivity due to reduced density), since this species was not subject to exploitation prior to this time. Recent reports from the industry suggest that the longspine thornyhead fishery has become less commercially attractive due to falling market prices for thornyheads, increasing fuel costs, and the high exchange rate for the Canadian dollar, but it is impossible to predict future conditions in the fishery.

Special significance of the species

In Canada's Pacific waters, the predominant fish species in the deep benthic waters (>800 m) include the longspine thornyhead, which likely plays a significant ecological role within this environment. Longspine thornyheads caught in Canada are exported to Japan where they are considered a delicacy.

Existing protection

Currently, fisheries management has closed the Flamingo region (west coast of Moresby Island) to all directed trawling on longspine thornyhead. Despite steep bathymetry, this region contains some potentially large areas of suitable habitat. Additionally, the management region Triangle experiences no fishing pressure due to steep and rough terrain. The fishery management plan does not include a strategy for adjusting exploitation in response to changing abundance.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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SPECIES INFORMATION

Name and classification

The genus *Sebastolobus* comprises three species in the north Pacific Ocean, including longspine thornyhead, sébastolobe à longues épines (*Sebastolobus altivelis* Gilbert 1893). The taxonomic name stems from the Greek *sebastos* (magnificent) and *lobos* (lobe – of pectoral fin), and the Latin *alutus* (high) and *velum* (sail – dorsal fin) (Hart 1973). Longspine thornyhead differs from its congener shortspine thornyhead (*S. alascanus*) by an elongated third dorsal spine, a mostly black gill chamber, and usually 15 dorsal spines (Love *et al*. 2002). Other common names for the longspine thornyhead include channel rockfish, hardhead, idiotfish (Love 1996).

Morphological description

Hart (1973) details this species' morphology. Generally, longspine thornyheads exhibit a reddish colour with some black on the fins (Figure 1). The elongate body, measuring up to 35 cm, has a terminal mouth with a large upper jaw that overhangs the lower one. The eyes appear large and oval. The strong, sharp head spines project backwards. The dorsal fin exhibits 15-16 spines, 8-9 of which are deeply and broadly notched with the 3rd being the longest. The pectoral fins have two distinct lobes. A strong spiny ridge runs along the suborbital bone. The length-weight relationship describes a typical cubic exponential curve with no difference between the sexes (Figure 2).

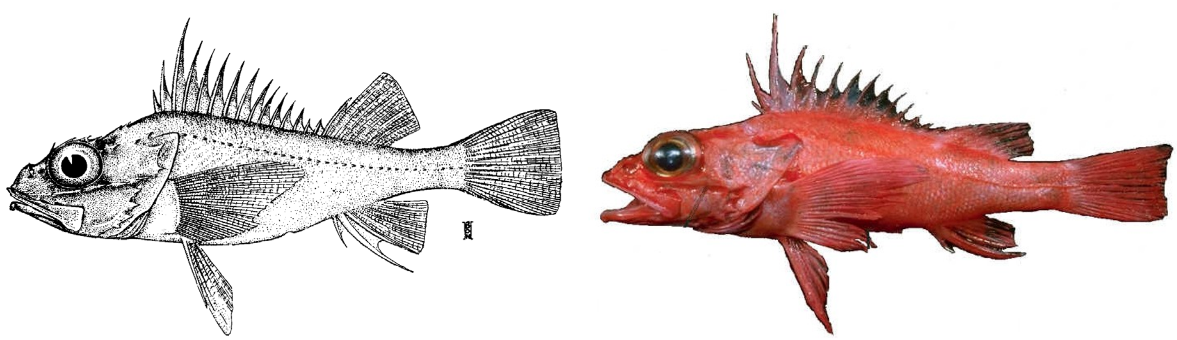

Figure 1. Longspine thornyhead *Sebastolobus altivelis* – ink drawing (Hart 1973) and photo (http://www.afsc.noaa.gov/groundfish/RockfishGuide/Rockfish_Pages/Longspine_thornyhead.htm).

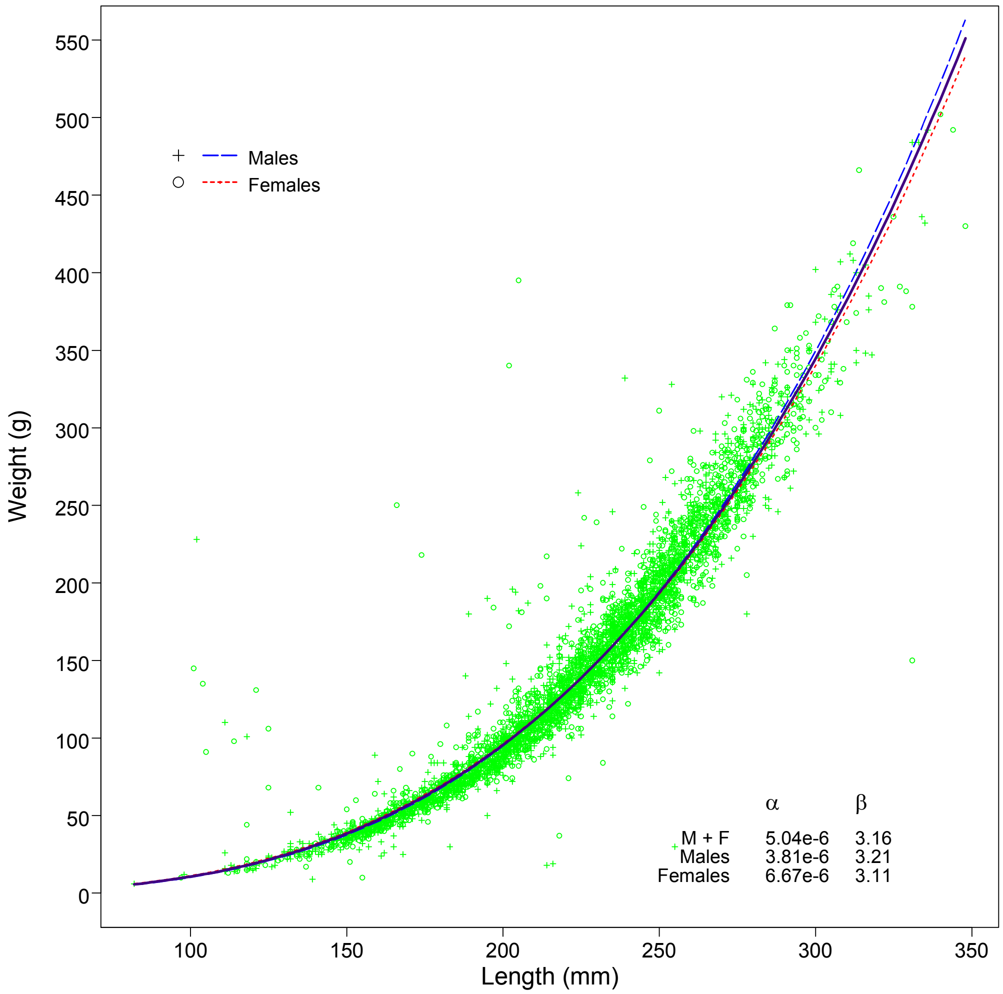

Figure 2. Longspine thornyhead weight vs. length fitted using a lognormal linear model: $\log W = \log\alpha + \beta\log L$.
Source: Haigh *et al*. (2005)

Genetic description

Currently, no genetic information on longspine thornyheads in Canada's Pacific waters exists. A mitochondrial DNA analysis by Stepien *et al*. (2000) based on 55 samples from five sites (Seward Alaska to Southern California—no Canadian sites) suggests genetic mixing of longspine thornyheads along the Pacific coast, with some evidence for genetic structuring, possibly due to larval retention caused by currents and gyres around prominent bathymetric features.

Designatable units

The species may be distributed continuously along the continental slope between 500 and 1,600 m. There are three distinct fishing areas, WCVI (west coast Vancouver Island), Tidemarks, and Rennell Sound (Figure 4). The population structure of these three areas has not been investigated due to the lack of a feasible aging protocol. For the purpose of this report, British Columbia (BC) is assumed to have one designatable unit.

DISTRIBUTION

Global range

Longspine thornyheads range from Cabo San Lucas, Baja California, to the Aleutian Islands (Figure 3) at depths recorded from 201 to 1,756 m but typically from 500 to 1,300 m (Love *et al*. 2002). They prefer soft sand or mud bottoms.

Figure 3. North American distribution of longspine thornyhead. Distribution adjacent to Asian countries is not well documented (Froese and Pauly 2005). Figure from Love *et al*. (2002). Figure reprinted with permission.

Canadian range

Longspine thornyheads occur along the continental slope of British Columbia. The most likely “extent of occurrence” lies between the 500 and 1,600 m isobaths with a flat-surface area of 17,775 km^2. Figure 4 shows the areal extent of longspine thornyheads as described by groundfish trawl fishery tows between 500 and 1,400 m from 1996 to 2004. Assuming an average trawl speed of 4.48 km h^{-1} (Schnute *et al*. 2004), tows that catch longspine thornyheads travel 31 km on average (SD=11 km, n=14,837). Often the tow path follows a horseshoe shape. Given these specifics, grid cells with dimension 5 km x 5 km reasonably summarize longspine thornyhead tow information. Using such grids, the known habitat or “area of occupancy” covers 11,700 km^2, a conservative estimate given the gear limitations of the trawl fleet. Deepwater biomass surveys (2001-2003) off the WCVI found longspine thornyheads living deeper than 1,200 m (Starr *et al*. 2002, Starr *et al*. 2004, Krishka *et al*. 2005). Commercial trawlers do not usually fish greater than 1,200 m. Table 1 offers an alternative summary of available and occupied areas using both commercial and survey tow information; however, these values are considered less accurate and are not used in the Technical Summary.

Table 1. Bathymetric determination of total available and observed occupied areas by 100-m depth interval for longspine thornyhead. Based on events from commercial fishing and surveys located in 25 km^2 grid cells. Source: Haigh *et al.* (2005).

Depth Interval (m)	Total Area (km^2)	Occupied Area (km^2)	% Occupied
501-600	1,782	1,080	60.6
601-700	1,561	1,187	76.0
701-800	1,413	1,125	79.6
801-900	1,247	955	76.6
901-1000	1,470	1,084	73.7
1001-1100	1,623	1,024	63.1
1101-1200	1,804	948	52.5
1201-1300	1,731	817	47.2
1301-1400	1,692	838	49.5
1401-1500	1,630	552	33.9
1501-1600	1,478	304	20.6
Total:	17,431	9,914	56.9

HABITAT

Habitat requirements

Adult longspine thornyheads live in deep water on soft sand or mud bottoms, often in small depressions adjacent to rocks and sponges (Love *et al*. 2002). Observations of adult longspine thornyheads always find them on the ocean floor; they presumably do not spend much time above the bottom.

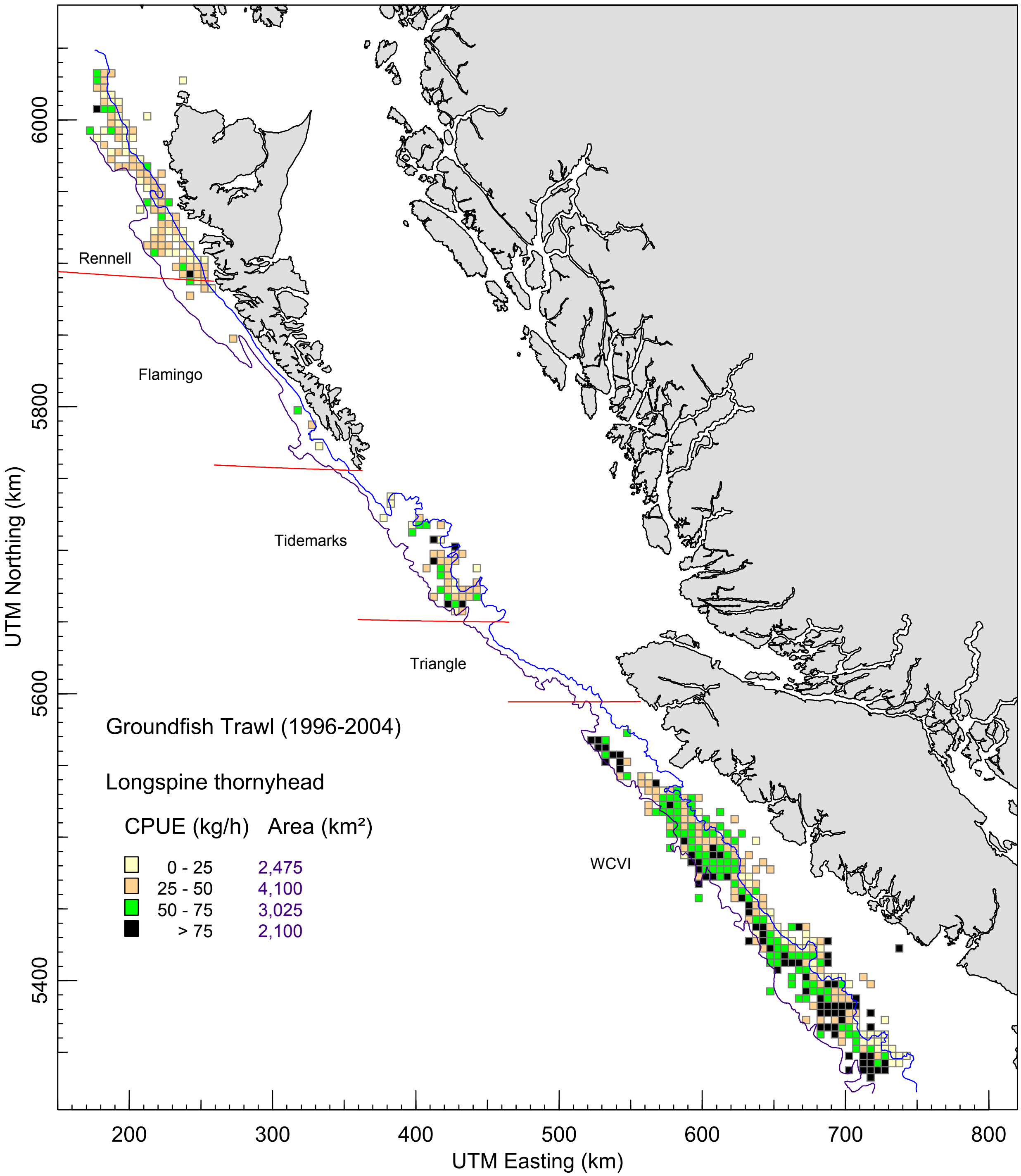

Figure 4. Mean CPUE (kg/h) of longspine thornyheads in 25 km^2 grid cells along the BC coast. The shaded cells give an approximation of the area of occupancy (11,700 km^2) as seen by groundfish trawl tows between 500 and 1400 m from 1996 to 2004. Isobaths displayed are 500 m and 1,600 m; the area between these isobaths approximates the extent of occurrence (17,775 km^2). The five DFO management regions for longspine thornyhead are delimited by horizontal red lines. Source: Haigh *et al.* (2005).

Habitat trends

No data exist on habitat trends. Trawling, by its very nature, impacts habitat; however, any effect on longspine thornyhead has not been demonstrated. Before 1996, virtually no trawling occurred in the deepwater zones. Known biogenic effects include the uprooting of deepwater corals and sponges (Ardron and Jamieson 2006).

Habitat protection/ownership

At present, Fisheries and Oceans Canada (DFO) management has closed the area known as Flamingo (51°56'N to 53°05'N) to all trawl tows targetting longspine thornyheads. Additionally, the region known as Triangle experiences no trawling activity due to the steepness and roughness of the bottom topography.

BIOLOGY

Life cycle and reproduction

Populations of longspine thornyhead off Oregon and California spawn primarily in the oxygen minimum zone between 600 and 1,000 m (Jacobson and Vetter 1996). Each female longspine thornyhead releases from 20,000 to 450,000 eggs (Wakefield 1990) in a buoyant gelatinous matrix. This oviparous characteristic contrasts with the ovoviviparous nature of *Sebastes* species. Pearcy (1962) first described the appearance of these gelatinous egg masses in surface waters off the Oregon coast. He collected specimens, incubated them *in vitro*, and described the embryonic development. Best (1964) then determined a weight-length relationship from California trawl specimens. Moser (1974) later described the larval and juvenile morphology changes in detail, and determined that spawning generally occurs from February to May with a peak in April.

Recent data from the MOCNESS[1] program in southern California suggest that longspine thornyhead larvae move away from surface waters (12% at 0-100 m, 30% at 100-150 m, 58% at 150-200 m; Bill Watson[2], pers. comm.). Juveniles remain in the water column for approximately 1 year (Moser 1974). Smith and Brown (1983) noted the highest abundance of juvenile longspine thornyheads at 600 m in the vicinity of a deep-scattering layer. They also noted that the primary prey species of juveniles were

[1]The MOCNESS (Multiple Opening/Closing Net and Environmental Sensing System) is a computer controlled net system used to collect zooplankton samples from specific depths in the water column. As the net system is towed through the water, individual nets can be opened within target depth zones. (http://swfsc.nmfs.noaa.gov/frd/CalCOFI/TT/MOCNESS.htm).

[2]Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, California 92037-1508.

omnivorous euphausiids. Thus, the chronology of the longspine thornyhead pelagic phase (18-20 months) can be generalized:

i. eggs float to the surface (Feb-May) where they hatch and develop for 3-4 weeks;
ii. larvae move away from the surface but remain in the upper 200 m for 6-7 months;
iii. juveniles remain in the mesopelagic zone (~600 m) for another year.

After the pelagic phase, longspine thornyhead juveniles (55 mm average total length, Wakefield and Smith 1990) settle directly into the benthic adult habitat between 600 and 1,200 m, where they reportedly remain (Wakefield 1990). In comparison, shortspine thornyheads settle as juveniles at 100 m (Moser 1974) and migrate deeper as they get older and, presumably, bigger (Jacobson and Vetter 1996). Consistent size gradients with depth occur along the WCVI for the two thornyhead species, where shortspine thornyhead length increases with depth while longspine thornyhead length decreases (Haigh and Schnute 2003). The two species co-occur between 600 and 1,100 m, where the median longspine thornyhead volume never exceeds one half the comparable measurement for shortspine thornyhead. The larger shortspine thornyheads commonly consume longspine thornyheads (observations cited in Jacobson and Vetter 1996). The primary food species for longspine thornyhead comprise the omnivorous brittle star[3] *Ophiophthalmus normani* (Smith and Brown 1983) and other benthic fauna (see below).

Low productivity (Vetter and Lynn 1997) and low diversity (Haigh and Schnute 2003) characterize the depths at which longspine thornyheads live. Vetter and Lynn (1997) used enzymatic analyzes to compare various slope rockfish and estimated that the time between feeding for longspine thornyhead is 130-180 days (80-90 days for shortspine thornyhead). Furthermore, Yang and Somero (1993) found similar metabolic rates of laboratory-fasted shortspine thornyhead to those for freshly collected specimens. Deep-water thornyheads have adapted to this food-limited environment by adopting a sedentary adult phase with planktonic larval and juveniles phases (Smith and Brown 1983).

The literature suggests that longspine thornyheads stop growing at a length of about 300 mm, corresponding to an estimated age of 25 to 45 years (Jacobson and Vetter 1996). Off WCVI, 99% of observed longspine thornyheads measure less than 300 mm (median length = 240 mm). Haigh and Schnute (2003) estimated the recruitment (to the fishery) length at 170 mm. Wakefield and Smith (1990) estimated the size-at-first-maturity at 150 mm. The Pacific Biological Station (PBS) has developed an ageing protocol for this species; however, its practical application remains elusive. An experimental sample thus far yields a maximum age of 71 y (mean = 23.6 y, median = 22.0 y, n = 204). In contrast, radiometric work at Moss Landing Laboratories indicates a provisional maximum age for this species of 45 years (Kline 1996). Given the paucity of the PBS data, length-at-age relationships remain poorly defined (Figure 5) for the BC population. Jacobson (1991), Kline (1996), and Fay (2006) give estimates of von Bertalanffy growth parameters for populations in Oregon/California (Table 2).

[3]Class Ophiuroidea (http://www.ucmp.berkeley.edu/echinodermata/ophiuroidea.html).

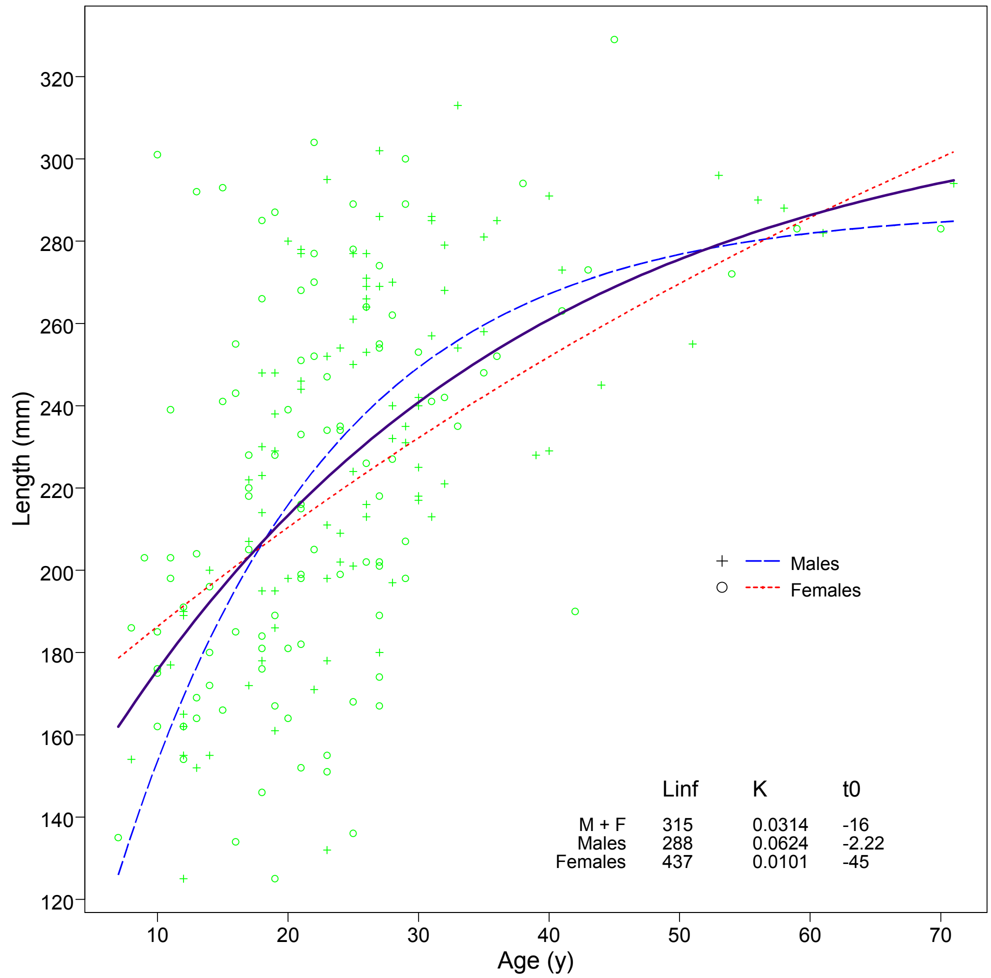

Figure 5. Length-at-age relationship for *Sebastolobus altivelis* fitted using the von Bertalanffy growth equation: $L_t = L_\infty \left(1 - e^{-K(t-t_0)}\right)$. Source: Haigh *et al*. (2005).

Table 2. Reported von Bertalanffy growth parameters for *Sebastes altivelis* along the west coast of North America.

Population	Source	n	L_∞ (mm)	K	t_0
BC	Haigh *et al*. (2005)	198	315	0.0314	-16.0
Oregon	Jacobson (1991)	192	338.6	0.0585	-0.38
California	Kline (1996)	478	300.6	0.072	-1.9
California	Fay (2005)	815	312	0.064	-2.02

The PBS data suggest an age at 50% maturity of 20 years (Haigh *et al*. 2005). The generation time using the formula $t_{gen} = k + 1/M)$, where $k = 20$ (age of 50% maturity) and $M = 0.10$ (natural mortality rate, Ianelli *et al*. 1994), is 30 years.

Interspecific interactions

The primary prey species of longspine thornyhead pelagic juveniles is probably omnivorous euphausiids, while settled adults eat the omnivorous brittle star *Ophiophthalmus normani* (Smith and Brown 1983). The adults also consume a variety of other benthic organisms including grooved tanner crabs (small specimens <30 mm carapace width, moulting adolescents <70 mm CW, and moulting sub-adults <110 mm CW), myctophids (lanternfish), and small thornyheads (Greg Workman[4], pers. comm.).

A known predator is shortspine thornyhead *S. alascanus* (observation by P. Adams, cited in Jacobsen and Vetter 1996). Other fish species are presumed to prey on *S. altivelis*, including cannibalism of newly settled juveniles by larger individuals (Love *et al*. 2002).

Physiology

Longspine thornyheads have adaptations that enable them to live in the oxygen minimum zone (600-1000 m). For instance, *Sebastolobus altivelis* has twice as many white-muscle metabolic enzymes than the shallower-living *S. alascanus*, which might reduce oxygen requirements two-fold (Siebenaller and Somero 1982). Also, enzymes in *S. altivelis* are adapted to functioning under pressure through conformational changes (Somero 1982). Unlike rockfish of the genus *Sebastes*, thornyheads do not have a swim bladder, and may be able to survive being brought to the surface.

Dispersal/migration

Information on movements once the adults settle into their territories at depth does not exist.

Interspecific interactions

Longspine thornyheads co-occur primarily with shortspine thornyheads *Sebastolobus alascanus* and sablefish *Anoplopoma fimbria* (Figure 6). The former frequently consume longspine thornyheads. As depths increase from those where the two co-occur most densely (500-800 m) to those with oxygen minima and high pressures, *S. altivelis* gains a competitive advantage through physiological adaptation to extreme conditions, and eventually predominates.

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[4]Groundfish surveys, Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, BC, V9T 6N7.

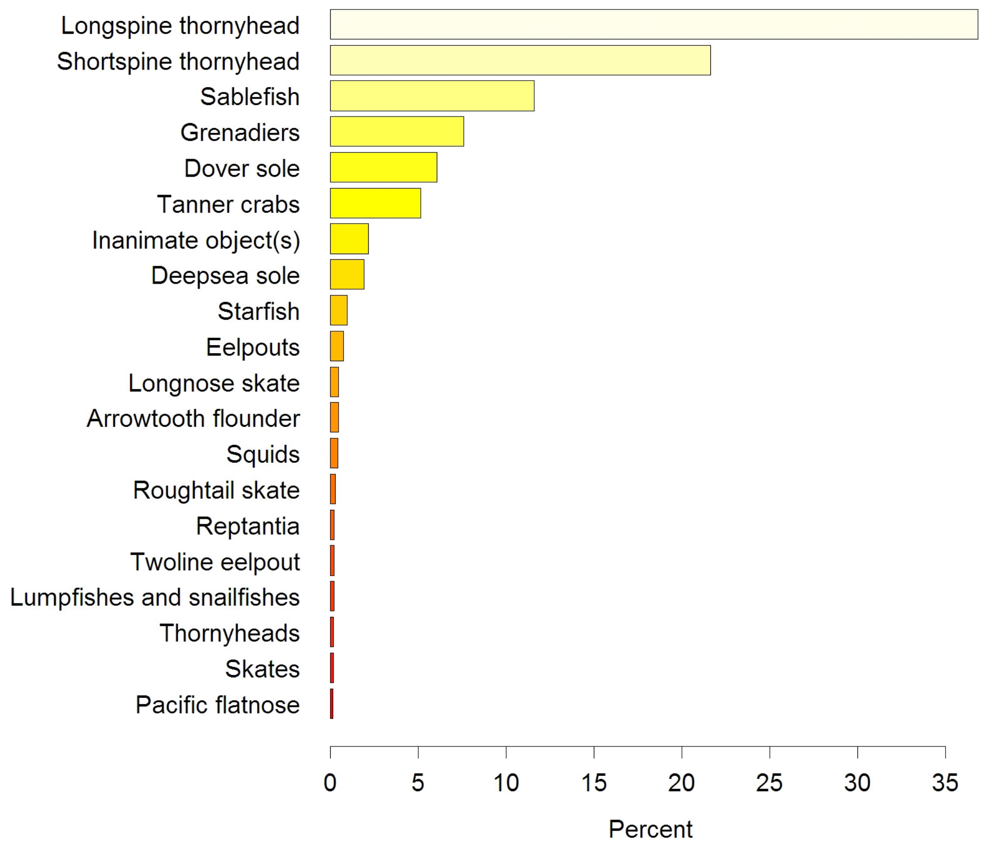

Figure 6. Concurrence of species in trawl tows (1996-2004) that captured longspine thornyhead in the preferred depth range (274-1056 m). Abundance expressed as a percent of total catch weight. Source: Haigh *et al*. (2005).

Adaptability

Longspine thornyhead are highly adapted to deep-sea environments characterized by high pressure, low oxygen and low productivity. Large-scale environmental changes to this environment, either anthropogenic or natural, would likely have detrimental effects on the species. Unlike rockfish of the genus *Sebastes*, they do not suffer obvious depressurization effects (e.g., organ extrusion) when brought to the surface. We do not know their ability to survive the temporary exposure to low pressure upon capture and release.

POPULATION SIZES AND TRENDS

Information sources

The trawl observer program archives the earliest BC records on the longspine thornyhead fishery. Trawl catch information is stored in DFO's PacHarvTrawl database.

Prior to 1996, fishermen did not target this deep-water species, and dockside agencies recorded landed specimens as “thornyheads”. The directed fishery for longspine thornyheads started off the WCVI in a region dubbed “Beginner’s Ledge”, so-called due to its ease of access by all existing trawlers. Market demand from Japan drove prices higher and management actions spurred development of the fishery northward (Figure 7). Trawl catch history by area is detailed in Table 3; the annual catch (trawl + longline) and quota history of this species is detailed in Table 4.

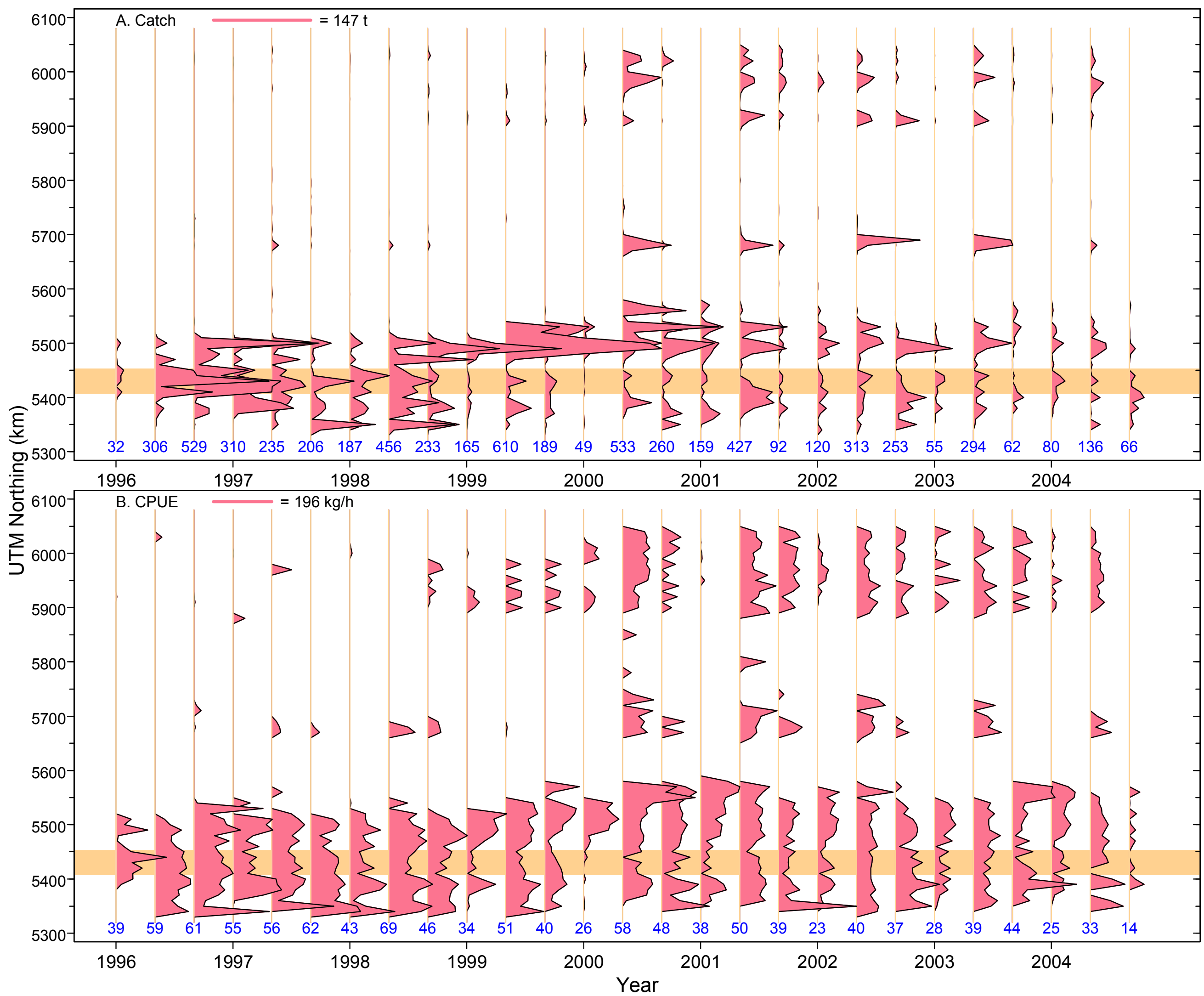

Figure 7. Spatio-temporal evolution of the longspine thornyhead fishery from its initial start on Beginner’s Ledge (horizontal band at UTM North 5400-5450) off WCVI in 1996. Total catch and mean CPUE are indicated for each 4-month interval. Source: Schnute *et al*. (2004).

Table 3. Annual (fishing year) total catch (kept + discarded) by the trawl fishery of longspine thornyhead (tonnes) in PMFC areas along the BC coast (3CD ≈ west coast of Vancouver Island, 4B ≈ Strait of Georgia, 5AB ≈ Queen Charlotte Sound, 5CD ≈ Hecate Strait, 5E ≈ west coast of the Queen Charlotte Islands, UNK =Unknown, CST = coastwide). Catches are rounded to the nearest tonne; entries marked '--' indicate no recorded catch. Data reside in PacHarvTrawl. Fishing years run from April to March, unless otherwise noted.

Year	3C	3D	4B	5A	5B	5C	5D	5E	UNK	CST
UNK	---	---	---	---	---	---	---	---	28	28
1996[1]	466	396	---	0	2	0	0	1	---	867
97[2]	185	107	---	0	0	---	---	1	---	293
1997	361	203	---	7	2	0	0	1	---	575
1998	431	392	---	6	1	0	1	8	---	839
1999	141	751	---	0	1	---	0	19	---	912
2000	163	513	---	54	31	0	0	144	---	905
2001	185	271	---	28	22	0	0	144	---	650
2002	219	249	---	48	27	1	---	116	---	660
2003	132	165	---	53	22	0	2	73	---	448
2004	137	98	---	6	6	0	1	55	---	304
2005	38	31	---	0	1	0	---	13	---	83
Total	2,458	3,176	0	203	115	2	5	576	28	6,564

[1]Feb-Dec;
[2]Jan-Mar

Table 4. Annual (fishing year) total catch (kept + discarded) by the trawl and hook and line (HL) fisheries of longspine thornyhead (tonnes) along the BC coast. Historical quotas are reported from various management plans. Values are rounded to the nearest tonne; entries marked '--' indicate no recorded catch or quota. Data reside in the PacHarvTrawl and PacHarvHL databases. Fishing years run from April to March, unless otherwise noted.

Fishing	Catch (t)				Quota (t)			
Year	Trawl	HL	Halibut	Total	Trawl	HL	Halibut	Total
1996[1]	867	---	0	867	---	654[C]	---	654
97[2]	293	---	---	293	225	---	---	225
1997[3]	575	---	---	575	860	900	---	1,760
1998	839	---	---	839	861	39	---	900
1999	912	---	---	912	855	45	---	900
2000	905	0	---	905	404[V] + 425[L]	29[C]	30[C]	889
2001	650	2	---	650	405[V] + 425[L]	27[C]	28[C]	885
2002	660	0	0	660	405[V] + 230[X]	27[C]	28[C]	690
2003	448	---	---	448	405[V] + 230[X]	26[C]	28[C]	690
2004	304	---	---	304	405[V] + 230[X]	26[C]	28[C]	690
2005	83	NA	NA	83	405[V] + 230[X]	27[C]	28[C]	690
Total	6,536	2	0	6,536	7,000	1,800	170	8,973

[1]Feb-Dec;
[2]Jan-Mar for Trawl;
[3]Jan 97 – Mar 98 for HL
[V] west coast Vancouver Island
[L]exploratory quota for fishing north of line 230° True from Lookout Island
[X]experimental quota for fishing north of 50°30'N
[C]quota for longspine and shortspine thornyheads combined

Although this directed fishery was technically new in 1996, the standards of DFO's New Emerging Fisheries Policy[5] were not well-defined at that time. One of the guiding principles of the NEFP states: "Information on the abundance, distribution, and productivity of the target species (must be) identified as the key scientific requirement for development of precautionary management strategies." Distribution of longspine thornyhead is fairly well-known given the nature of the observer program (100% coverage). Additionally, DFO management has demanded the collection of synoptic biological samples, including otoliths for ageing. While the latter are of limited use due to the lack of a feasible ageing protocol, they represent a tremendous information base once this limitation is overcome. All biological information is stored in DFO's GFBio database. At present this fishery is not profitable due to factors listed below. Consequently, pressure on the population has lessened.

Abundance

Absolute abundance remains unknown. Relative abundance estimates appear in the following sections and in Schnute *et al*. (2004). From 1996 to 2005, the commercial fleet removed approximately 6,564 t of longspine thornyhead biomass from BC coastal waters. This equals 57.6 million fish, assuming a conversion rate of 0.114 kg/fish.

Fluctuations and trends

Observed commercial trawl

Haigh *et al*. (2005) analyze longspine thornyhead catch/effort data from the DFO PacHarvTrawl database using a general linear regression model (GLM) assuming a log-normal distribution. The analysis uses data from April 1, 1996, coinciding with 100% independent observer coverage on all major trawl operators. The analysis excludes tows from depths less than 500 m due to the potential of species misidentification with shortspine thornyheads *Sebastolobus alascanus*. Three discrete fisheries for longspine thornyheads exist – the west coast of Vancouver Island called "WCVI" (PMFC regions 3C and 3D), the outer bank of Queen Charlotte Sound called "Tidemarks" (PMFC regions 5A and 5B), and the west coast of the Queen Charlotte Islands called "Rennell" (PMFC region 5E).

A GLM analysis for each fishery produced declining trends of relative CPUE (catch per unit effort) beginning from the first year of each fishery (Figure 8). Linear regression through the index points (Table 5) transformed by natural logs yields annual trend as $r = e^b - 1$, where $b =$ the fitted slope (Schnute *et al*. 2004). T he accumulated relative change over N observations is $R_N = e^{b(N-1)} - 1$. A comparison of the trends shows little difference between WCVI ($r = -0.0761$, $R_9 = -0.469$, 1996-2004) and Tidemarks ($r = -0.0900$, $R_5 = -0.314$, 2000-2004), in spite of the paucity of data for Tidemarks. The estimated CPUE decline in Rennell ($r = -0.201$, $R_5 = -0.593$, 2000-2004) greatly

[5]http://www.dfo-mpo.gc.ca/communic/fish_man/nefp_e.htm.

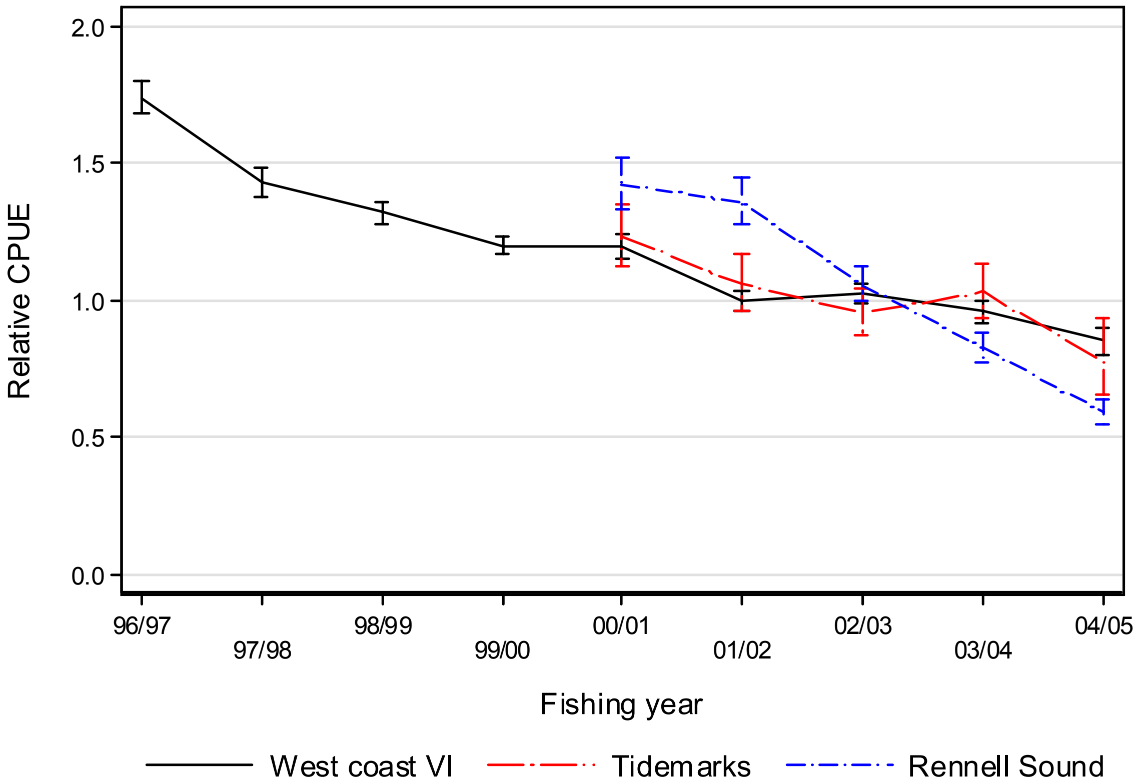

Figure 8. Comparison of CPUE indices for the three areas analyzed. Each series has been standardized relative to the geometric mean over the period 2000/01 to 2004/05. The error bars show 95% confidence limits. Source: Haigh *et al*. (2005).

exceeds the declines in the other two areas. A coastwide index comprising the regional indices weighted by bottom area between the 500 and 1,600 m isobaths (Haigh *et al*. 2005) yields an annual decline $r = -0.0825$ and an accumulated decline $R_9 = -0.498$.

WCVI longspine thornyhead survey

DFO in collaboration with the Canadian Groundfish Research and Conservation Society (CGRCS) conducted a WCVI survey targetting longspine thornyheads annually from 2001 to 2003 (Starr *et al*. 2002, Starr *et al*. 2004, Krishka *et al*. 2005). Survey depths ranged from 500 to 1,600 m, while the areal extent ranged from 48°05'N to 50°30'N. Schnute *et al*. (2004) assessed this survey and compared it with commercially available indices. Their findings indicate that during the period of the survey (2001-2003), the abundance index exhibited no significant trend.

Table 5. Annual index values from GLM analyses on commercial CPUE data from three fishing areas (Haigh *et al.* 2005), standardized to the mean of the 2000-2004 values. The coastwide index comprises the regional indices weighted by bottom area between the 500 and 1,600 m isobaths (WCVI = 8,506 km^2, Tidemarks = 2,908 km^2, Rennell = 3,162 km^2; Haigh *et al.* 2005). Calculated parameters summarize index trends: *b* = slope of linear regression line describing $\ln I = a + by$, where *I* = index value, *y* = year; *r* = annual relative growth rate = $e^b - 1$; *R* = accumulated relative change over *N*-1 periods = $e^{b(N-1)} - 1$, where *N* = number of indices *I*.

Year	WCVI	Tidemarks	Rennell	Coast
1996	1.73103	---	---	1.73103
1997	1.42119	---	---	1.42119
1998	1.31118	---	---	1.31118
1999	1.19443	---	---	1.19443
2000	1.18994	1.22008	1.35363	1.23146
2001	0.99237	1.04646	1.29210	1.06818
2002	1.01706	0.94322	1.00389	0.99947
2003	0.95420	1.01830	0.78692	0.93070
2004	0.84643	0.77194	0.56347	0.77019
Trend Parameters				
b	-0.07917	-0.09428	-0.22488	-0.08607
r	-0.07612	-0.08997	-0.20138	-0.08247
R	-0.46920	-0.31417	-0.59323	-0.49768

Trend summary

The relative survey indices from 2001-2003 appear consistent with the relative CPUE indices computed from commercial catch for this assessment and with an analysis of the CPUE information for the west coast of Vancouver Island in the most recent PSARC (Pacific Science Advisory Review Committee) assessment of longspine thornyhead (Schnute *et al*. 2004) (Figure 9). The latter analysis is based on the same data but on different analytical methods than the analysis shown in Figure 8.

Haigh *et al* (2005) showed no overall trend in proportion of commercial sets with zero catches in the three time series listed above (west coast of Vancouver Island, 1996-2004; Tidemarks 2000-2004; Rennell 2000-2004).

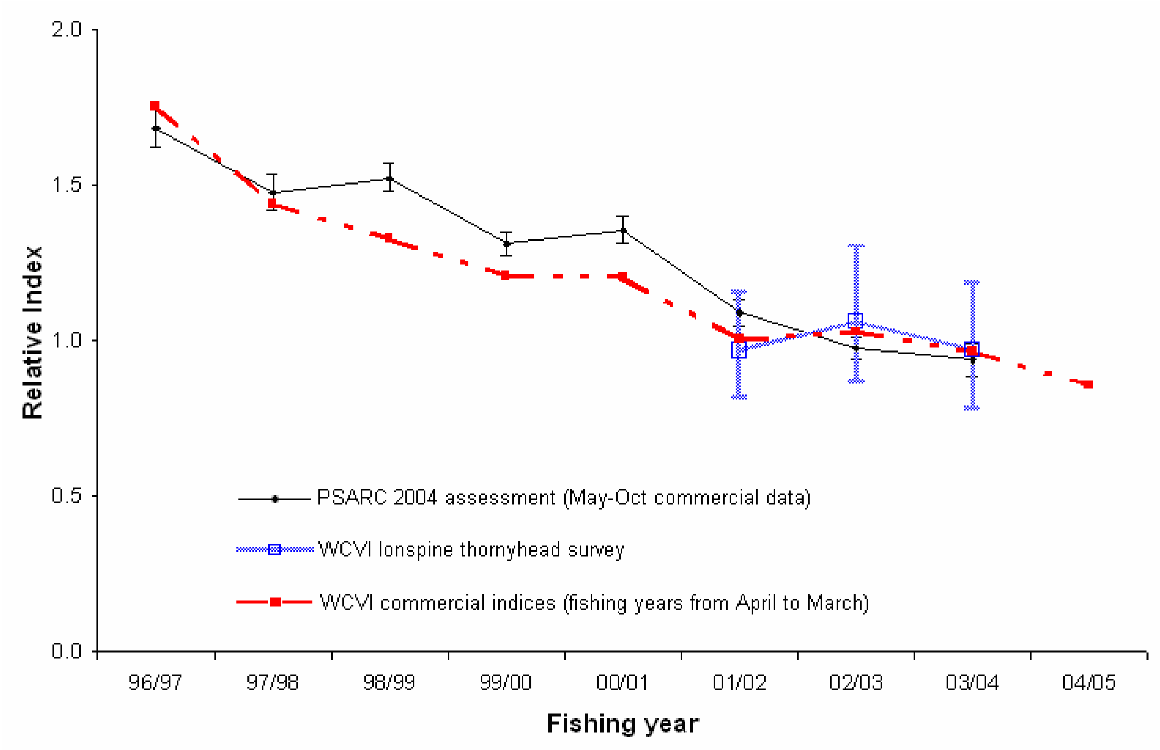

Figure 9. Comparison of WCVI CPUE indices from the most recent PSARC assessment of longspine thornyhead (Schnute *et al*. 2004), longspine survey indices (as in Fig. 8), and new indices calculated in 2005 for PMFC areas 3C+3D (as in Fig. 8). All indices have been set so that the geometric mean from 2001/02 to 2003/04 equals 1. Source: Haigh *et al*. (2005).

The three series of relative CPUE indices derived from commercial catch and effort data (Figure 8) show rates of decline of 8% per year for WCVI, 9% per year for Tidemarks, and 20% per year for Rennell. These rates expressed as total declines yield 47% over 8 years (1996-2004) for WCVI, 31% over 4 years (2000-2004) for Tidemarks, 59% over 4 years (2000-2004) for Rennell. Few other species experience directed fishing effort below 800 m, hence the CPUE index is considered suitable for tracking abundance. However, CPUE may be influenced by factors related to the fishery in addition to abundance changes. Some of these factors cited by Schnute *et al*. (2004) are:

- Fishermen have experienced a recent increase in sablefish bycatch when fishing for longspines, especially in the north. Without adequate sablefish quota, skippers must seek out fishing opportunities where tows are less productive for sablefish and, consequently, longspines (abundance of the two species is positively correlated). This behaviour depresses the index.
- In the early years of the fishery, observers did not always sample to determine the species split between shortspine and longspine thornyheads, relying instead on information from the factory. More recent samples attempt to identify the complete species composition of each tow. This change in

behaviour has possibly introduced a bias across years. The improvement in taxonomic ability would depress the index if observers in earlier years tallied shortspines as longspines.

- Fuel costs have increased substantially. The fishery on longspines ranks high in fuel consumption among all the groundfish fisheries, with tow durations in the range 4-12 h. Higher fuel costs and lower profit margins tend to discourage directed or exploratory fishing on the resource. This behaviour increases the incidence of tows where longspines are not the dominant organism, and consequently depresses the index.
- The price of thornyheads has declined substantially in the last few years, partly due to an increase in the Canadian dollar relative to the US and Japanese currencies. A reduced profit margin tends to discourage directed fishing. Again, fewer tows where longspine thornyhead is predominant depresses the index.

The three survey abundance indices obtained from 2001 to 2003 for the WCVI population of longspine thornyheads show no trend over the three years of the survey (slope=+0.1%). The trend from the WCVI survey is a more reliable abundance indicator over these three years than CPUE trends from fishery-dependent data, although it covers a much shorter time period.

The prediction of a “three generational” change for this population based on results from short time series remains highly uncertain. However, the substantial decline in survey indices over a short period, combined with the life history characteristics of this species, suggest that abundance has undergone a substantial reduction which may be difficult to reverse or manage.

Rescue effect

Bordering populations in Washington and Alaska could act as population sources given the planktonic nature of the larvae, although there is no direct evidence to support this scenario. Along the continental USA, the 2005 estimates of spawning stock and total biomass were 75,049 t and 162,642 t, respectively (Fay 2006). The ratio [spawning stock biomass]:[pristine (unfished equilibrium) biomass] was estimated at 0.71, suggesting a lightly exploited population. A fishery management regime including TACs (total allowable catches) adjusted to prevent overfishing is in place in the Washington-California area.

LIMITING FACTORS AND THREATS

The primary threat to the population stems from overfishing a deep-water species that occupies a low-productivity environment. From 1996-2005, the observer program (PacHarvTrawl database) recorded the capture of approximately 6,564 t of longspine thornyhead (57.6 million fish). Since the inception of the quota fishery in 1996, the composite coastwide index has declined by 8.25%/y for a total decline of 50% over eight years. Schnute *et al*. (2004) estimated similar declines for various models and assumptions (see their Table 9.1, p. 41). These numbers may indicate the "fishing-down" of a previously unexploited species (removal of accumulated biomass, theoretically associated with increased productivity due to reduced density). Recent reports from the industry suggest that the longspine thornyhead fishery has become increasingly less attractive commercially due to falling market prices for thornyheads, increasing fuel costs and the high exchange rate for the Canadian dollar. Indeed, the 2004-05 catches reflect this (Table 3), especially given the recent annual quotas of 635 t (Haigh *et al*. 2005). However, future conditions in the fishery cannot be predicted.

SPECIAL SIGNIFICANCE OF THE SPECIES

In Canada's Pacific waters, longspine thornyheads often predominate in deep benthic habitats (>800 m) and likely play a significant ecological role within this environment. The groundfish industry exports longspine thornyheads to Japan where people consider the fish a delicacy.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Management of longspine thornyhead in Canada is guided by a fishery management plan (DFO 2007). TACs (total allowable catches) broken down by area and fleet are in place for longspine thornyhead; although the basis for these is not given in the management plan, these are adjusted as experience with this new fishery develops (J. Rice[6], personal communication). There is 100% observer coverage of the trawl fleet, which takes most of the TAC for longspine thornyhead, and electronic monitoring of catch composition and biological characteristics on all vessels targetting groundfish which do not carry observers.

Based on evidence of declining CPUE off the WCVI, DFO management changed the management regime by spreading effort from existing areas in 2000. The WCVI quota was effectively reduced by half (Table 4), and exploration further north was encouraged (Schnute *et al*. 2004). In 2002, further measures were introduced by requiring more frequent biological sampling and by creating five longspine thornyhead management regions (Figure 4). The Flamingo area was closed to all trawl tows targetting longspine thornyhead. Despite rough bottom topography in this region, trawl records indicate that longspine thornyheads occur in Flamingo. In that sense, this area may represent a refugium; however, it is not known whether individuals in this area contribute significantly to the recruitment in other areas. Given the long planktonic phase of the larvae and juveniles, populations in Flamingo might "rescue" surrounding areas.

[6]Jake Rice, Director, Canadian Science Advisory Secretariat, DFO, Ottawa, Ontario.

The bottom topography in the area known as Triangle appears even rougher than that in Flamingo. Although Triangle has no official protection, trawl tows do not occur here. There is no information on whether longspine thornyhead populations exist in this region.

No agency has currently listed *Sebastolobus altivelis* for species-at-risk concern. However, the IUCN Red List of Threatened Species has listed its congener *S. alascanus* (shortspine thornyhead) from the US west coast with rank EN A2d, or Endangered (high risk of extinction in the wild in the near future), based on an expected population depletion of at least 50% due to exploitation within the next 10 years or 3 generations, whichever is less. On the BC coast, shortspine thornyheads appear ubiquitous and presumably abundant. Fishermen generally catch them as bycatch when targetting other species. DFO constrains this bycatch through individual vessel quotas (IVQs).

TECHNICAL SUMMARY

Sebastolobus altivelis

Longspine thornyhead — sébastolobe à longues épines

Range of Occurrence in Canada: Pacific Ocean

Extent and Area Information	
• *Extent of occurrence (EO)(km²)* Flat-surface area between isobaths 500 and 1,600 m	17,775 km²
• *Specify trend in EO*	No change
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²)* Grid of fish density (CPUE) using commercial trawl data	11,700 km²
• *Specify trend in AO*	No change
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations*	Continuous distribution
• *Specify trend in #*	N/A
• *Are there extreme fluctuations in number of locations?*	N/A
• *Specify trend in area, extent or quality of habitat*	No known change
Population Information	
• *Generation time (average age of parents in the population)*	30 years
• *Number of mature individuals*	Unknown
• *Total population trend:* • a. WCVI (8y) • b. Tidemarks (4y) • c. Rennell (4y) • d. Combined coastwide index (8y)	a. -47% b. -31% c. -59% d. -50%
• *% decline over the last/next 10 years or 3 generations.*	Unknown
• *Are there extreme fluctuations in number of mature individuals?*	Unlikely
• *Is the total population severely fragmented?*	No
• *Specify trend in number of populations*	No change
• *Are there extreme fluctuations in number of populations?*	No
• List populations with number of mature individuals in each: N/A	
Threats (actual or imminent threats to populations or habitats)	
Overfishing in low-productivity environments. Roughly 49 million fish removed coastwide from 1996-2004.	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* Continental USA: Lightly exploited	
• *Is immigration known or possible?*	Possible
• *Would immigrants be adapted to survive in Canada?*	Possibly
• *Is there sufficient habitat for immigrants in Canada?*	Probably
• *Is rescue from outside populations likely?*	Possibly
Quantitative Analysis See Haigh *et al*. (2005)	
Current Status COSEWIC: Special Concern (April 2007)	

Status and Reasons for Designation

Status: Special Concern	**Alpha-numeric code**: not applicable

Reasons for Designation:

This slow growing rockfish has adapted to survive in deep waters where oxygen concentrations are minimal and productivity is low. Since the beginning of the fishery in the mid-1990s there has been an estimated decline in commercial catch per unit effort of over 50% in 8 years. Fishing is the primary and probably sole cause of this decline. While the fishery is managed by catch limits, and there is good monitoring of fishing activities, there is no management strategy in place that assures catches will be adjusted in response to abundance changes. The substantial decline in abundance indices over a short period taken together with the very conservative life history characteristics are cause for concern, but commercial catch per unit effort may not reflect abundance changes accurately and there is potential for rescue from adjoining populations in the USA.

Applicability of Criteria (A-E)

Criterion A: May meet criterion A2b for Endangered but there is lack of confidence in the indicators used to measure decline.

Criterion B: Not met - although the extent of occurrence (17,775 km²) is less than 20,000 km² ("threatened" threshold), it is neither severely fragmented nor characterized by extreme fluctuations.

Criterion C: Not applicable.

Criterion D: Not applicable.

Criterion E: Not applicable.

ACKNOWLEDGEMENTS AND AUTHORITIES CONSULTED

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Rowan Haigh currently works for Fisheries and Oceans Canada in the Marine Ecosystems and Aquaculture Division (MEAD) at the Pacific Biological Station (PBS) in Nanaimo, BC. His professional activities include biological systems modelling, exploratory data analysis, geographic information systems management, and groundfish stock assessment. Previous experience in Oceanography at the University of British Columbia includes phytoplankton taxonomy, red tide monitoring, and coastal marine ecology.

Norm Olsen also works for Fisheries and Oceans Canada in MEAD at PBS. His expertise includes database management, geographic information systems, and exploratory data analysis.

Paul Starr works as an independent fisheries contract scientist providing advice and expertise to governments and industry. He currently contracts with the New Zealand Ministry of Fisheries and the Canadian Groundfish Research and Conservation Society. His many skills include fisheries modelling, data analysis, and strategic thinking.

Scott Wallace works as an independent contract ecology consultant. He has many years experience with species-at-risk issues. His company provides scientific expertise and education.

COLLECTIONS EXAMINED

None