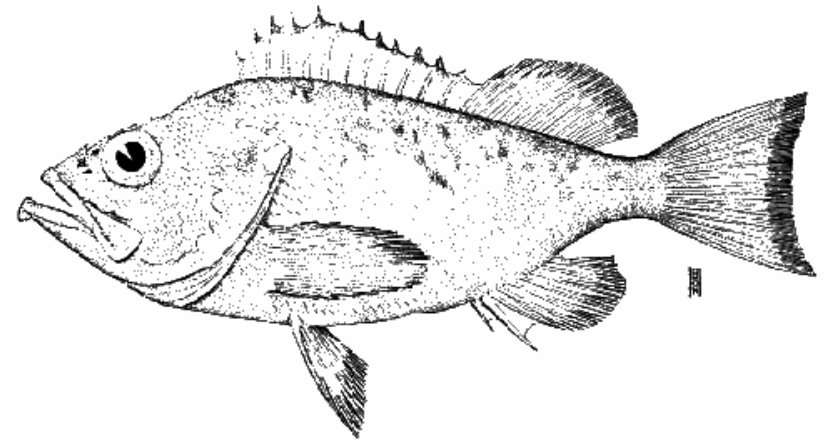
# COSEWIC
# Assessment and Status Report

on the

# rougheye rockfish
*Sebastes* sp.

*Sebastes* sp. type I
*Sebastes* sp. type II

**in Canada**



***Sebastes* sp. type I – SPECIAL CONCERN**
***Sebastes* sp. type II – 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:

COSEWIC 2007. COSEWIC assessment and status report on the rougheye rockfish *Sebastes* sp. type I and *Sebastes* sp. type II in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 36 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Production note:

COSEWIC would like to acknowledge Rowan Haigh, Norm Olsen, Paul Starr and Scott Wallace for writing the status report on the rougheye rockfish *Sebastes* sp. type I and *Sebastes* sp. type II in Canada, prepared under contract with Environment Canada. This report was overseen and edited by Howard Powles, Co-chair, COSEWIC Marine Fishes Species Specialist Subcommittee, and Chris Taggart, member, Marine Fishes Specialist Subcommittee.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le sébaste à œil épineux *Sebastes* sp. (*Sebastes* sp. type I et *Sebastes* sp. type II) au Canada.

Cover illustration:
Rougheye Rockfish — (Hart 1973).


Catalogue No. CW69-14/526-2007E-PDF
ISBN 978-0-662-46006-0

# COSEWIC
# Assessment Summary

**Assessment Summary – April 2007**

**Common name**
Rougheye Rockfish - type I

**Scientific name**
*Sebastes* sp. type I

**Status**
Special Concern

**Reason for designation**
This species is a relatively large (reaching 90 cm length) rockfish species and among the longest-lived, estimated to approach 200 years. It is one of two sympatric species which have been identified within the described species *Sebastes aleutianus*. It ranges from northern Japan to southern California in depths 200 to 800+ m along the shelf break. In Canadian waters abundance information is derived from surveys and from the commercial fishery that has maintained a relatively constant reported catch of between 1000 and 2000 tonnes annually over the last 2 decades. Abundance indices and biomass estimates are uncertain, compromised by short time series and survey techniques not always appropriate for the species. No strong abundance trends are observed in the available indices. There is evidence of truncation of the age distribution over the last decade, suggesting that mortality from all sources may have doubled (4.5% $y^{-1}$ to 9.1% $y^{-1}$). Long-lived, low-fecundity *Sebastes* species are particularly susceptible to population collapse, and recovery may be compromised when the age- and size-distribution is truncated (i.e. when the number of spawners declines) through fishing. Difficulty in separating the two species increases the risk of potential impacts on one of the species going unnoticed.

**Occurrence**
Pacific Ocean

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

**Assessment Summary – April 2007**

**Common name**
Rougheye Rockfish - type II

**Scientific name**
*Sebastes* sp. type II

**Status**
Special Concern

**Reason for designation**
This species is a relatively large (reaching 90 cm length) rockfish species and among the longest-lived, estimated to approach 200 years. It is one of two sympatric species which have been identified within the described species *Sebastes aleutianus*. It ranges from northern Japan to southern California in depths 200 to 800+ m along the shelf break. In Canadian waters abundance information is derived from surveys and from the commercial fishery that has maintained a relatively constant reported catch of between 1000 and 2000 tonnes annually over the last 2 decades. Abundance indices and biomass estimates are uncertain, compromised by short time series and survey techniques not always appropriate for the species. No strong abundance trends are observed in the available indices. There is evidence of truncation of the age distribution over the last decade, suggesting that mortality from all sources may have doubled (4.5% $y^{-1}$ to 9.1% $y^{-1}$). Long-lived, low-fecundity *Sebastes* species are particularly susceptible to population collapse, and recovery may be compromised when the age- and size-distribution is truncated (i.e. when the number of spawners declines) through fishing. Difficulty in separating the two species increases the risk of potential impacts on one of the species going unnoticed.

**Occurrence**
Pacific Ocean

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

# COSEWIC
# Executive Summary

## rougheye rockfish
*Sebastes sp.*

*Sebastes* sp. type I
*Sebastes* sp. type II

### Species information

Rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) (sébaste à oeil épineux) belongs to the family Scorpaenidae. The name “rougheye” refers to a series of suborbital spines (along the lower rim of the eyes).

The described species includes two recently-discovered sympatric species, separable on the basis of allozymes and microsatellite and mitochondrial DNA. Morphologically, the two species may be distinguishable by gillraker number and length and relative body depth, but they are difficult to separate under field conditions. There is no detailed information on relative abundance, distribution, or impact of fisheries for the two species in Canadian waters. Accordingly it is assumed that available information on rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) applies equally to each of the two new species.

To recognize the existence of two species without prejudging results of a future taxonomic revision that will formally name them, this report refers to *Sebastes* sp. type I (rougheye rockfish type I) and *Sebastes* sp. type II (rougheye rockfish type II), consistent with recent publications. Reference to information which does not distinguish the two species uses the term “species pair” or refers to the entity formally described: rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898).

### Distribution

Rougheye rockfishes of this species pair occur in the Pacific Ocean north of Japan from the Kamchatka Peninsula to the Bering Sea, the Aleutian Islands, Gulf of Alaska, and the west coast of North America from British Columbia to southern California. In British Columbia (BC), they occur along the continental slope, and are typically captured at depths between 170 and 660 m. The estimated extent of occurrence in BC covers approximately 37,000 $km^2$. The relative distribution and abundance of the two newly-identified species in Canadian waters is unknown.

## Habitat

Highest densities of rougheye rockfishes occur on bottoms with soft substrates, in areas with frequent boulders, and on slopes greater than 20° (observed via manned submersibles). The association with soft substrates coincides with the availability of preferred prey items (pandalid shrimps). Boulders may act as territorial markers, current deflectors, or structures to enhance prey capture. This species pair apparently avoids flat bottoms.

## Biology

The biology of the two species in the rougheye rockfish species pair remains poorly known. Longevity exceeds that for most other *Sebastes* species, with a maximum age recorded anywhere of 205 years for a specimen from southern Alaska. Adults reach a maximum length of approximately 90 cm. Females are 20 years old at 50% maturity. Like all viviparous *Sebastes* species, fertilized eggs remain within the ovary until larval extrusion. Planktonic larvae and juveniles occur near the surface and at midwater depths. The calculation for generation time appropriate for this species pair yields 48 years, assuming an age at 50% maturity of 20 years and a natural mortality rate of 0.035.

## Population sizes and trends

Commercial catch per unit effort (CPUE) indices computed over the years 1996-2005 for the rougheye rockfish species pair show little trend. Survey index trends are generally without trend or increasing; however, these series cover periods substantially less than the generation time of rougheye rockfishes. In addition, most of the longer time series were designed with other species in mind and do not cover suitable depth ranges. The large error bars associated with index points reflect the limitations of these surveys and indicate highly uncertain trends. Indices from the Queen Charlotte Sound synoptic groundfish survey (2003-2005) will describe abundance trends with reliable measures of error once the survey series covers longer time periods.

## Limiting factors and threats

The primary threat to the BC population stems from overfishing a long-lived species that inhabits the continental shelf and upper slope. The observed decline of older age classes (50+) in the 2003 data compared to 1996 may reflect the effect of fishing pressure, and catch curve analysis indicates that the mean total mortality over these eight years has doubled from 0.045 to 0.091. However, non-representative catch sampling from the commercial fishery may account for some of the perceived difference in proportion-at-age data.

The lack of information on relative abundance, distribution and threats for the two recently-identified species within the species pair constitutes a threat, since the existence of cryptic species of this sort increases the risk of loss of unrecognized biological diversity.

## Special significance of the species

Rougheye rockfishes are possibly among the longest lived fish species on earth. In Alaska, scientists aged one specimen to 205 years. Early Aboriginal fisheries probably captured rougheye rockfishes with halibut and sablefish, but no records exist to verify this. The existence of two cryptic species within the complex recognized as rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) is of considerable scientific interest with respect to speciation mechanisms.

## Existing protection

Fisheries management controls removals of this species pair through coastwide quotas that are administered through an individual-vessel-quota system. The preferred bottom types of rougheye rockfishes – steep-slope, boulder habitats – may act as potential deterrents to fishing, at least from bottom trawling. Longline gear can presumably access these sites. The depth preference of this species pair limits its exposure to recreational harvest. There is no official habitat protection for this species pair.

## 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.

# COSEWIC Status Report

on the

# rougheye rockfish
*Sebastes* sp.

*Sebastes* sp. type I
*Sebastes* sp. type II

**in Canada**

2007

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## SPECIES INFORMATION

### Name and classification

Rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) (sébaste à oeil épineux) has been considered one of 102 known species of the rockfish genus *Sebastes*, 96 of which live in the north Pacific Ocean. The taxonomic names stem from the Greek *sebastos* (magnificent) and *aleutianus* (Aleutian Islands where the species was first reported; Love *et al*. 2002). The name "rougheye" refers to a series of spines (numbering 2 to 10) along the lower rim of the eyes (Love *et al*. 2002). In Canada's Pacific waters, 36 species of rockfish have been captured.

During preparation of this status report, two sympatric but genetically distinct species within what was considered rougheye rockfish were identified (Gharrett *et al*. 2005, Hawkins *et al*. 2005). As well as differences in allozymes, mitochondrial DNA and microsatellite DNA, differences in frequencies of two parasites (Hawkins *et al*. 2005), colouration (Gharrett *et al*. 2006, Hawkins 2005) and meristic and morphological characteristics (Gharrett *et al*. 2006) have been described.

The two genetically distinct species have been named differently by two research teams: type I and type II (Gharrett *et al*. 2005, 2006), and *Sebastes aleutianus* and *Sebastes* sp. cf *aleutianus* (Hawkins *et al*. 2005). Based on differences in colouration described in the two papers, type I of Gharrett *et al*. (2005, 2006) appears to correspond with *Sebastes* sp. cf. *aleutianus* of Hawkins *et al*. (2005).

In order to recognize the existence of two species, but to not prejudge results of a future taxonomic revision that will formally name them, this report will refer to *Sebastes* sp. type I, rougheye rockfish type I, corresponding to the type I of Gharrett *et al*. (2005, 2006), and *Sebastes* sp. type II, rougheye rockfish type II, corresponding to the type II of Gharrett *et al*. (2005, 2006). Where reference to the described species rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) is necessary, this report will refer to the rougheye rockfish species pair or will refer to the entity by its full common and Latin name.

### Morphological description

Rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) are relatively large rockfish with a maximum length typically in the 80 to 100 cm range (Love *et al*. 2002). This species pair appears red (Figure 1) with dark or dusky blotches of pigment in the dorsal region (Mecklenburg *et al*. 2002). A light red lateral line is conspicuous as it contrasts with the otherwise dark red body. All but the pectoral fins are usually marked with black margins.

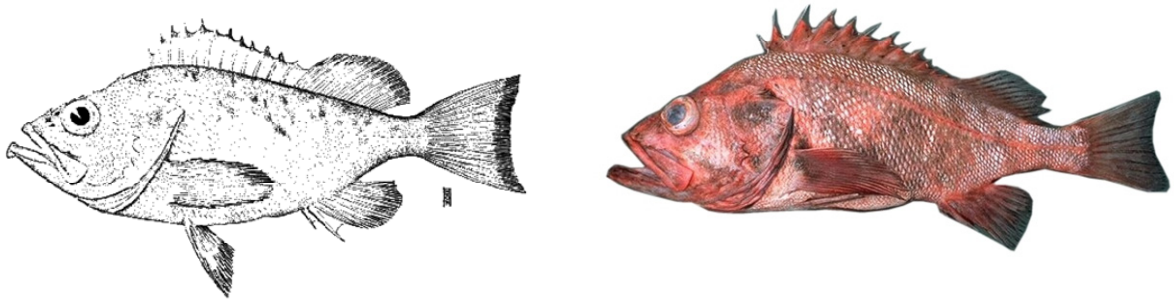

Figure 1. Rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898), ink (Hart 1973) and photo (http://pacpbsgfiis/gfimages/photos/0235_IMG0099.JPG).

Phenotypic differences in colouration and presence or absence of suborbital spines were reported to exist between the two genetically distinct species (Hawkins *et al*. 2005). Gharrett *et al*. (2006) reported that the two genotypes could be distinguished by gill raker length and number and body depth; type II have slightly fewer and shorter gill rakers and deeper bodies than type I. Discriminant analysis of morphological characteristics accurately delineated the two species in >94% of cases (Gharrett *et al*. 2006). Colouration may not be a reliable guide for separating the genotypes; most type II fish have light colouration, but type fish I may be either light or dark coloured, and the proportion of each colour form changes geographically (Gharrett *et al*. 2006).

Types I and II of Gharrett *et al*. (2005, 2006), although sympatric, exhibit different spatial preferences, at least according to the proportions of the two types captured in trawl hauls (Gharrett *et al*. 2005). While both types occur throughout the north Pacific, type I predominates in the northeast Pacific and in deeper water (A.J. Gharrett[1], pers. comm.). Hawkins *et al*. (2005) also observed that their *Sebastes* sp cf *aleutianus* predominated in deeper water.

Rougheye weight increases as a near cubic function of length (Figure 2) with little difference between males ( $\beta = 2.93$ ) and females ( $\beta = 2.88$ ). Parameter estimates for the pooled sexes ( $\alpha = 2.81 \times 10^{-5}$ ; $\beta = 2.90$ ) suffice for this species.

## Genetic description

Researchers cannot use conventional tagging studies to assess population structure as rougheye rockfish do not survive the barotrauma (i.e., physiological damage associated with change in pressure) when brought from depth to the surface.

[1]Fisheries Division, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1120 Glacier Highway, Juneau, AK 99801

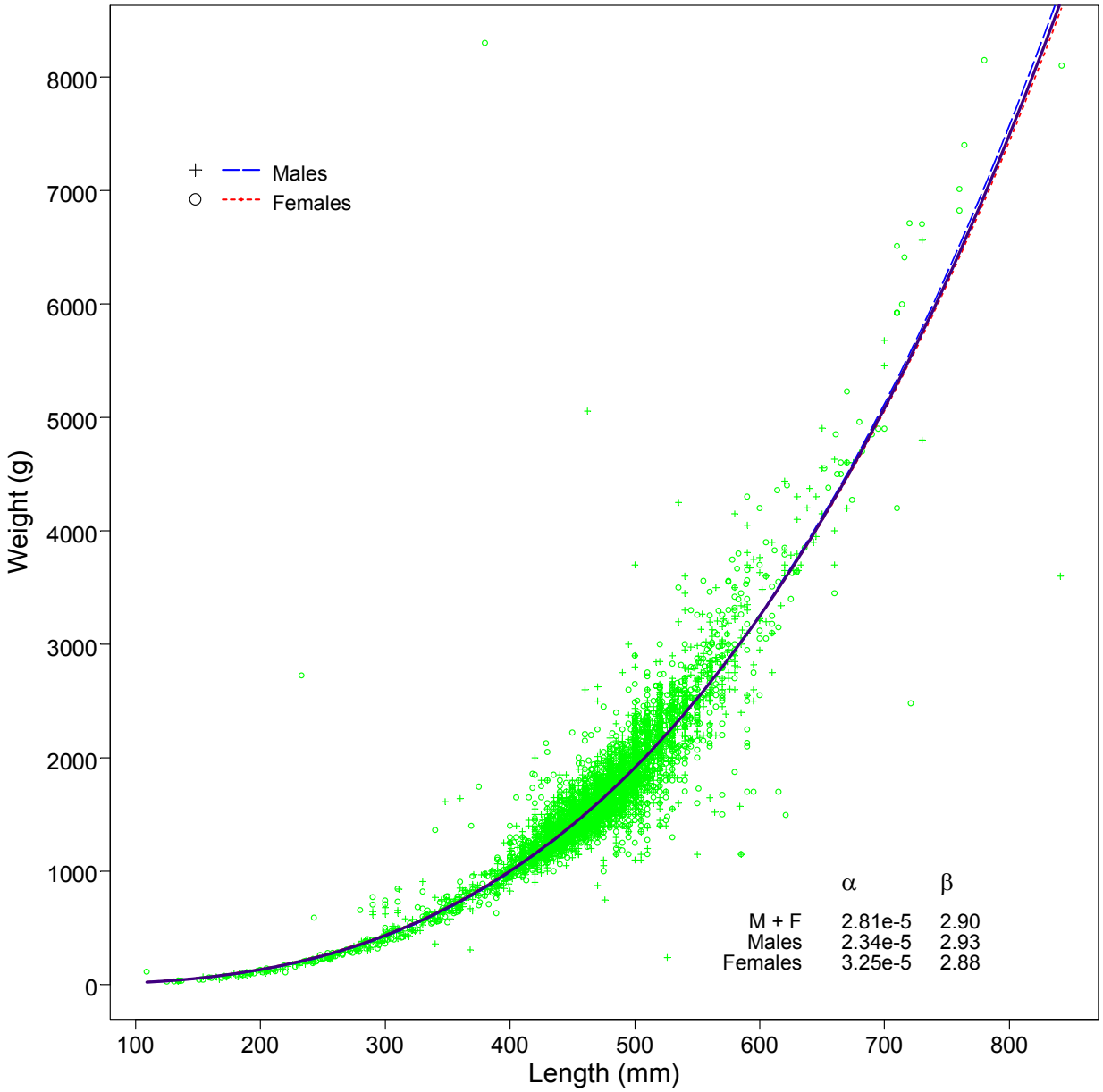


Figure 2. Rougheye rockfish species pair, weight vs. length using a lognormal linear model: $\log W = \log\alpha + \beta \log L$. Source: Haigh *et al*. (2005).

Early studies (Tsuyuki *et al*. 1968; Seeb 1986; Hawkins *et al*. 1997) reported two phenotypes and inferred genetic differences. Recent studies of rougheye in the Gulf of Alaska provide evidence of genetic differentiation among co-occurring (sympatric) rougheye rockfish, based on microsatellite and mitochondrial DNA markers and distributions of allozyme allele frequencies (Gharrett *et al*. 2005, Hawkins *et al*. 2005). Gharrett *et al*. (2005) confirmed these differences in 698 rougheye rockfish specimens sampled along the Pacific Rim from the Oregon coast to the Aleutian Islands and Bering

Sea. All three types of genetic marker revealed strong and concordant evidence that rougheye rockfish comprise two sympatric species.

### Designatable units

The two genetically distinct species identified by Gharrett *et al*. (2005, 2006) and Hawkins *et al* (2005) have been identified and characterized primarily on the basis of samples from the USA. Rougheye rockfish type I and rougheye rockfish type II both occur in Canadian waters, although type I reportedly predominates. The relatively few Canadian samples (n=39) were all collected just south of the Queen Charlotte Islands, and all consist of type I from deep water (Figure 3, Gharrett *et al*. 2005), but this could simply reflect the small sample size. Considerably more sampling will be required to determine the prevalence and distribution of types I and II in Canadian waters.

In Pacific waters under Canadian jurisdiction, fisheries management and all previous studies have assumed a single panmictic stock of rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898). Because the two recently identified rougheye rockfish species have not been separated in past studies or in fisheries, for the purposes of this report it is assumed that rougheye rockfish type I and rougheye rockfish type II are covered equally well by the available information collected on the basis of a single species. A single designatable unit for each of rougheye rockfish type I and rougheye rockfish type II is assumed in Canadian waters, in the absence of information to the contrary.

Cryptic species of this kind increase the risk of loss of unrecognized genetic diversity, but there is no current information on status of each of the two putative species. Accordingly a single status report is considered to include the information for the two species.

## DISTRIBUTION

### Global range

Rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann 1898) are reported to range from north of Japan, through to the Kamchatka Peninsula, the Bering Sea, the Aleutian Islands, the Gulf of Alaska, and the west coast of North America from British Columbia (BC) to southern California (Figure 4). Although range extends into Asian waters, records from the northwestern Pacific are poorly documented (Froese and Pauly 2005).

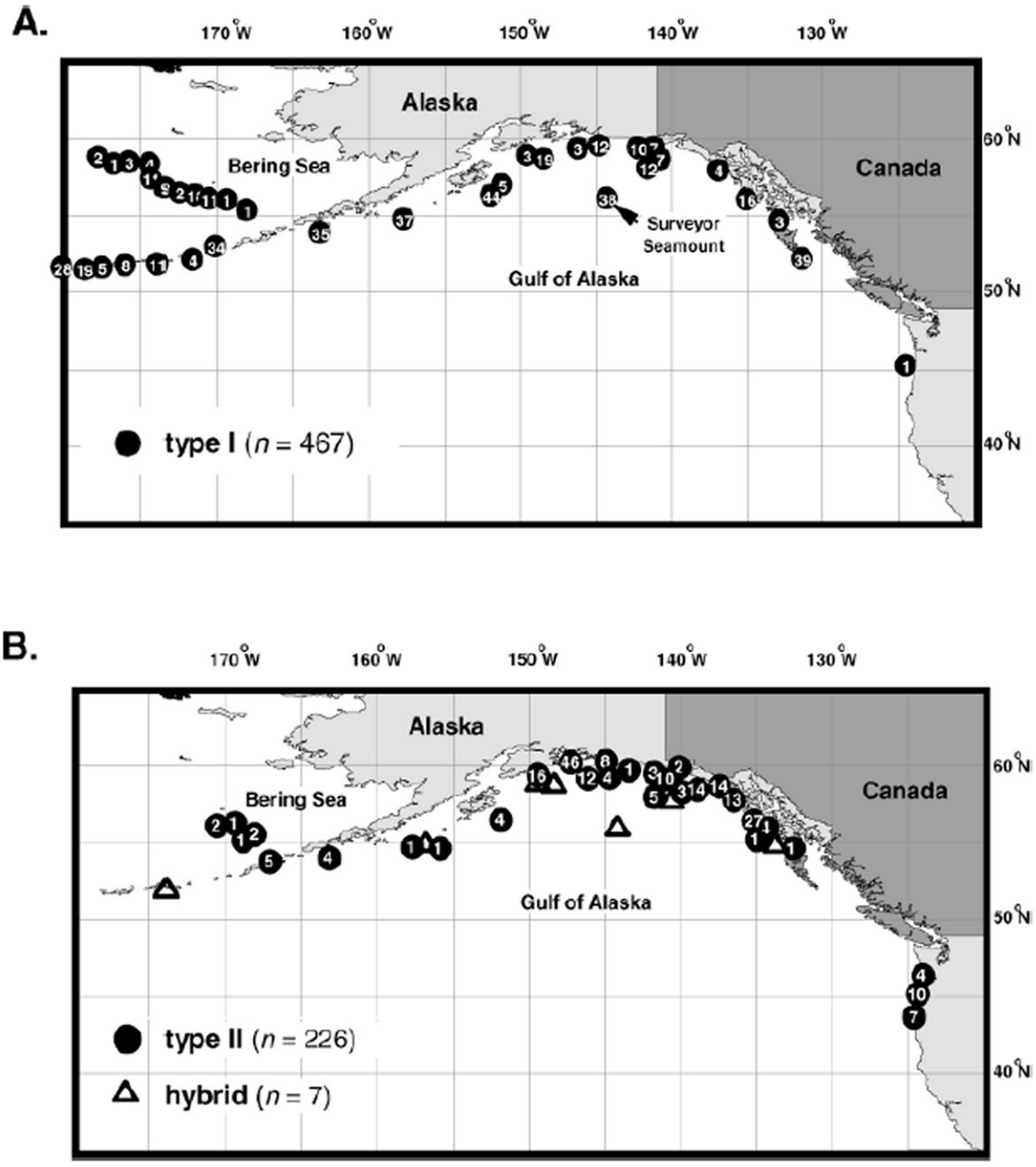


Figure 3. Locations of rougheye rockfishes surveyed for mitochondrial DNA and microsatellite variation. Chart (A) shows the locations of type-I fish and (B) the locations of type-II fish (circles) and presumed hybrids (triangles). The numbers within the circles are the sample sizes from each location; each triangle represents a single fish. Locations represent all collections within a 50 km radius. Adapted from Gharrett *et al*. 2005.


Figure 4. North American distribution of rougheye rockfish species pair. Distribution adjacent to Asian countries is not well documented (Froese and Pauly 2005).

## Canadian range

Figure 5 shows the areal extent of rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann 1898) as inferred from commercial groundfish trawl and longline catch rates for fisheries that target this entity at depths ranging from 0 to 800 m over the period 1996 through 2004. Choice of grid cell size influences the estimation of occupied

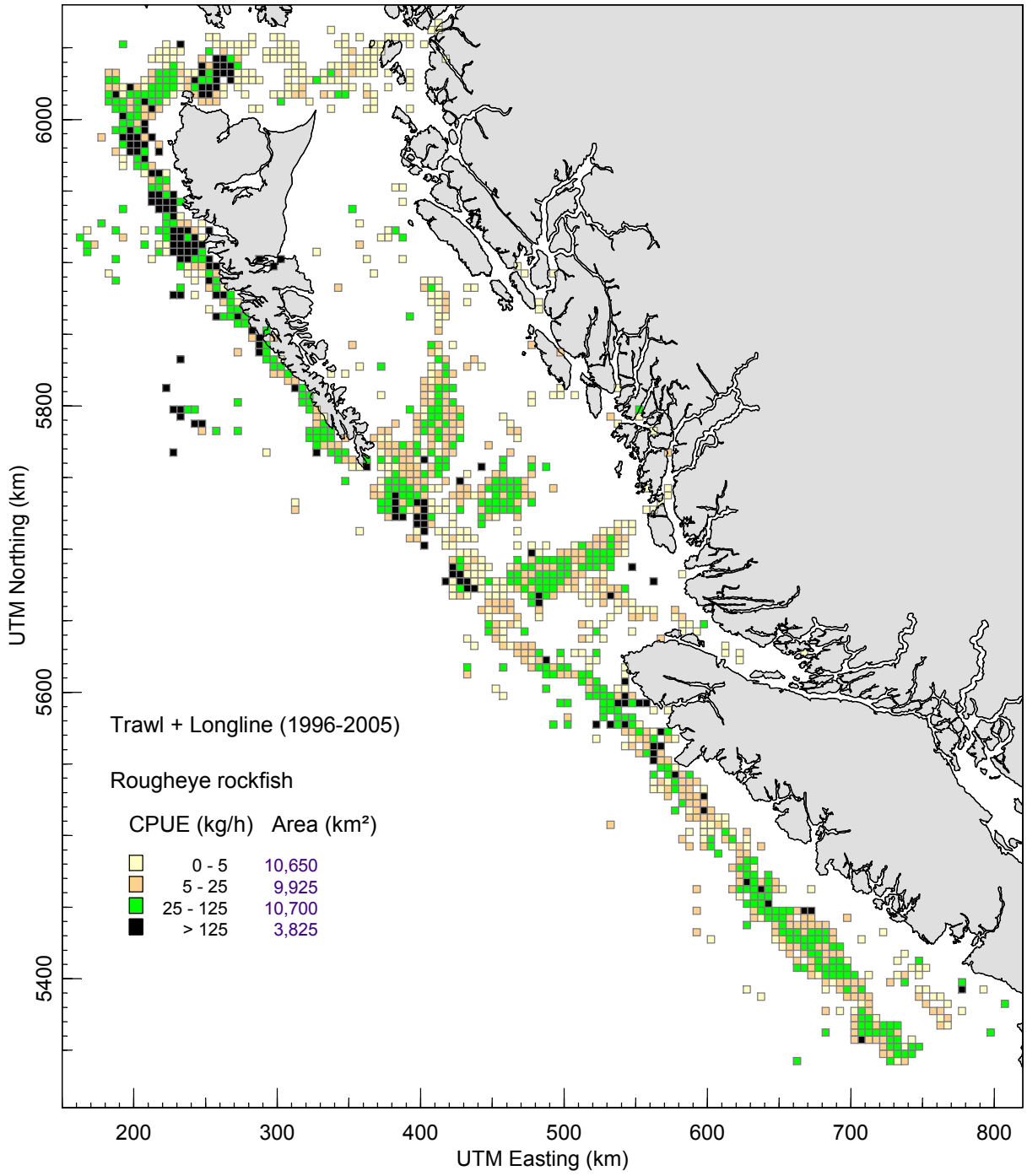


Figure 5. Mean CPUE (kg/h) of rougheye rockfish species pair in 25 km$^2$ grid cells along the BC coast. The shaded cells give an approximation of the area of occupancy (35,100 km$^2$) as determined using groundfish trawl tow and longline set data collected between 0 and 800 m from 1996 to 2005 inclusive. Source: Haigh *et al*. (2005).

area – cell size often shows a positive correlation with inferred area of occurrence. This effect is aggravated by sparse and infrequent tow locations represented by a single point. In reality, fishing events (trawl tows and longline sets) traverse tens of kilometres, often following contours and looping back on themselves. Given this scenario, a 5 km $\times$ 5 km cell gives a reasonable approximation of a typical fishing event. At this grid cell size, the known habitat or "area of occupancy" covers at least 35,000 km$^2$. Table 1 offers a similar summary from commercial and survey logs from the trawl fishery where the estimated area of occupancy covers approximately 30,000 km$^2$ between 0 and 800 m. Due to the extent of trawl and longline sets mentioned above, the former estimate is preferred. Depth distributions from commercial data indicate that 95% of rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) caught occurred between 170 and 650 m (Figure 6). Figure 7 shows all available bathymetry bounded by these depths (blue shading), giving a rough estimate of the "extent of occurrence" of 37,000 km$^2$.

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

| Depth Interval (m) | Total Area (km$^2$) | Occupied Area (km$^2$) | Percent Occupied |
|---|---|---|---|
| 1-100 | 46,089 | 2,908 | 6.3 |
| 101-200 | 36,432 | 8,905 | 24.4 |
| 201-300 | 16,468 | 7,836 | 47.6 |
| 301-400 | 7,276 | 3,905 | 53.7 |
| 401-500 | 2,766 | 1,951 | 70.5 |
| 501-600 | 1,782 | 1,332 | 74.7 |
| 601-700 | 1,561 | 1,305 | 83.6 |
| 701-800 | 1,413 | 1,167 | 82.6 |
| Total: | 115,034 | 30,232 | 26.3 |

## HABITAT

### Habitat requirements

Krieger and Ito (1999) used manned submersibles to determine the habitat preferences of rougheye rockfishes and shortraker rockfish (*S. borealis*). Their observations revealed that greatest densities occurred on bottoms with soft substrates, in areas with frequent boulders, and on slopes greater than 20°. The association with soft substrate may be attributable to preferred prey items like pandalid shrimps (stomach content analyses, Yang and Nelson 2000). Krieger and Ito (1999) speculated that boulders might act as territorial markers, current deflectors, or structures to enhance prey capture. Their data also indicated that rougheye rockfishes avoid flat bottoms. Regardless of speculation on why this species pair adopts these habitat preferences, the observations suggest that rougheye rockfish habitat may be relatively unfavourable for trawling methods.

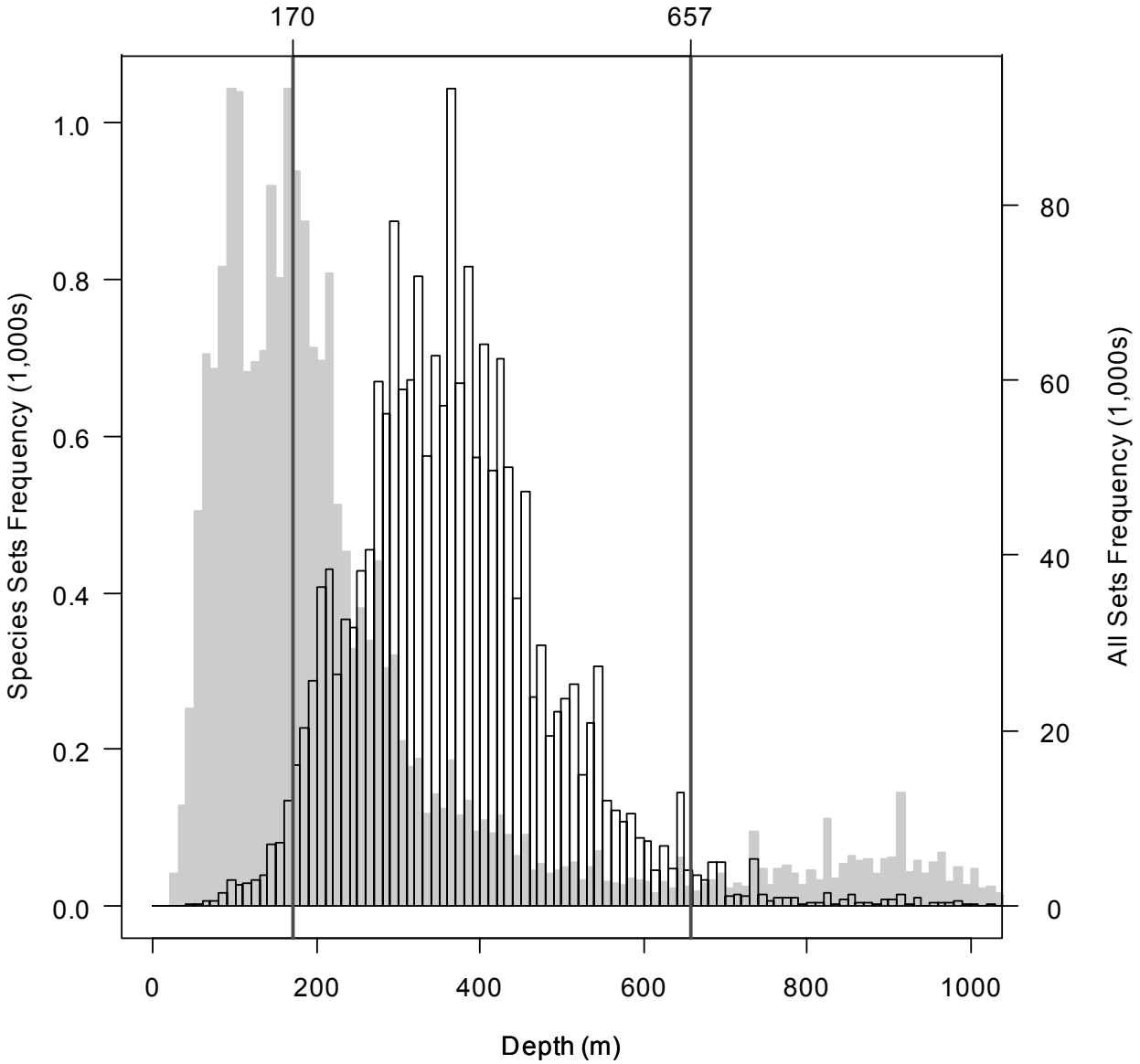


Figure 6. Histogram of depth-of-capture for rougheye rockfish species pair as reported in commercial trawl log books (1996-2005). The vertical lines denote the 2.5% and 97.5% quantiles that are used to infer the preferred depth range for the species pair and to determine the maximum potential shelf-wide habitat range and distribution (see Figure 7). The distribution of all trawl sets is shown in light grey bars

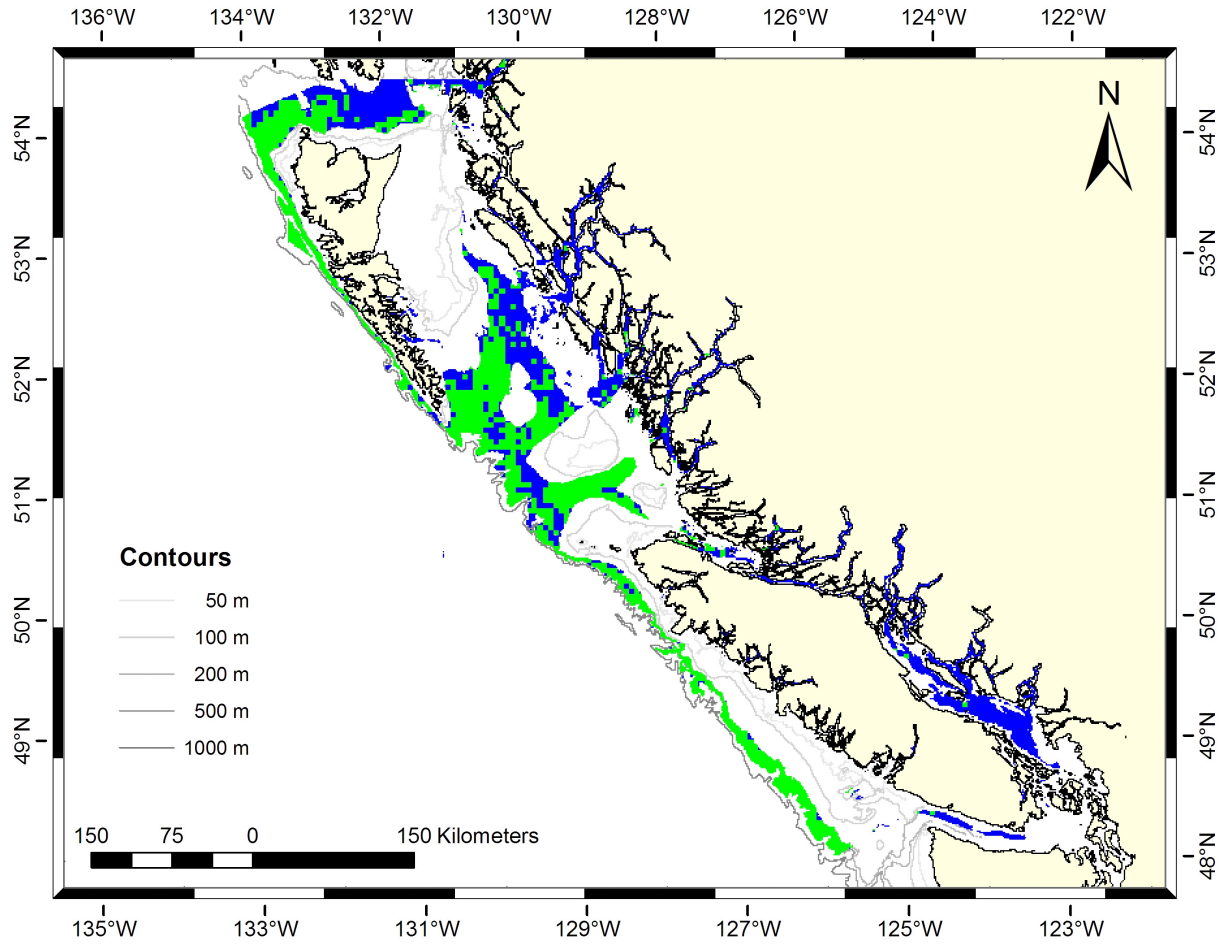


Figure 7. Estimated range and distribution of habitat of rougheye rockfish species pair in Canadian waters, based on preferred depth distribution of 170 m to 657 m (see Figure 6). The maximum potential habitat based on depth preference is 37,145 $km^2$ (blue shading). The estimated occupied habitat based on trawl logs only (5x5 km grid) is 18,530 $km^2$ (green shading), or 49.9% of the potential habitat. Source: Haigh *et al*. (2005).

## Habitat trends

Not applicable.

## Habitat protection/ownership

Although no official habitat protection exists, fisheries management controls removals of this species pair through coastwide quotas that are administered through an individual-vessel-quota system. The preferred bottom types of rougheye rockfishes – steep-slope, boulder habitats (Krieger and Ito 1999) – act as potential deterrents to fishing, at least from bottom trawling. Longline gear can presumably access these sites. The depth preference of this species limits its exposure to recreational harvest.

## BIOLOGY

### Life cycle and reproduction

The biology of the rougheye rockfish species pair remains poorly known. The longevity of species in the pair exceeds that for most other *Sebastes* species, with a maximum age recorded anywhere of 205 years for a specimen from southern Alaska (Munk 2001). Adults reach a maximum length of approximately 90 cm. Length-at-age boxplots (Figure 8) reveal similar size-at-age for males and females. Length-at-age data show considerable variability around fitted von Bertalanffy models, and there is a dearth of information for the younger age classes (Figure 9). Although large natural variations occur in lengths-at-age, age readings of otoliths are generally precise, as are length measurements.

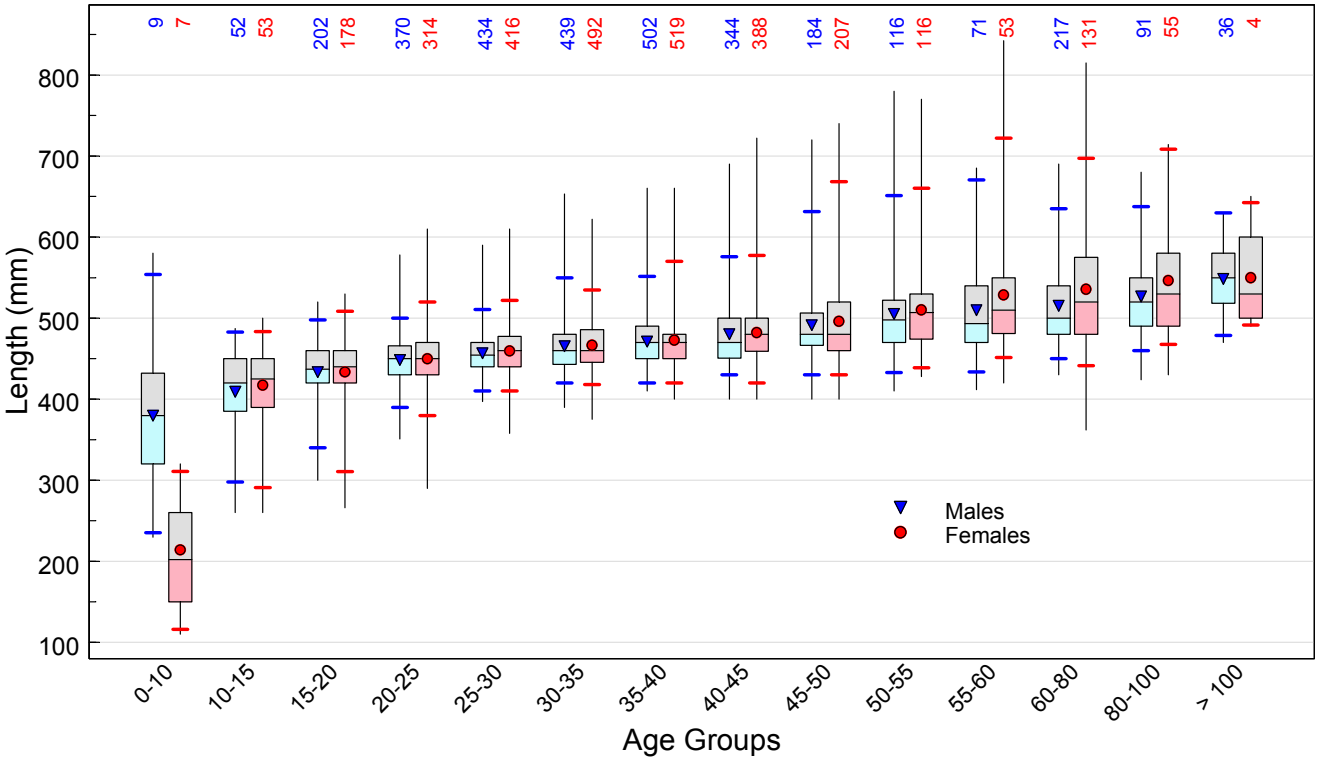


Figure 8. Boxplots of length-at-age by sex for rougheye rockfish species pair. Symbols indicate mean age, horizontal marks indicate the 2.5% and 97.5% quantiles, and whiskers show the extent of the data. Number of observations per box are indicated along the top. Source: Haigh *et al.* (2005).

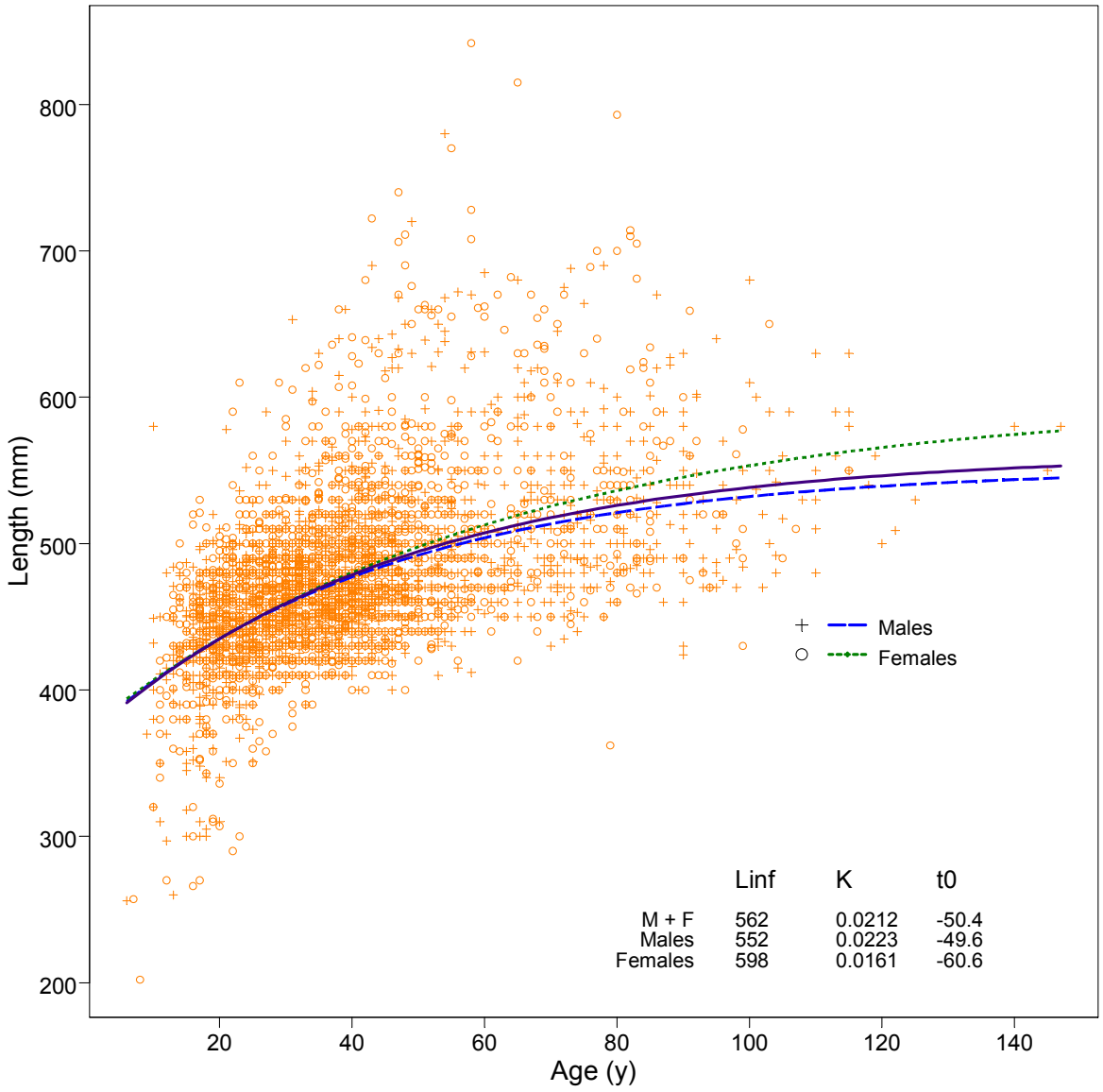


Figure 9. Length-at-age relationship for rougheye rockfish species pair fitted using von Bertalanffy growth equation: $L_i = L_\infty \left(1 - e^{-K(t_i - t_0)}\right)$. Source: Haigh *et al*. (2005).

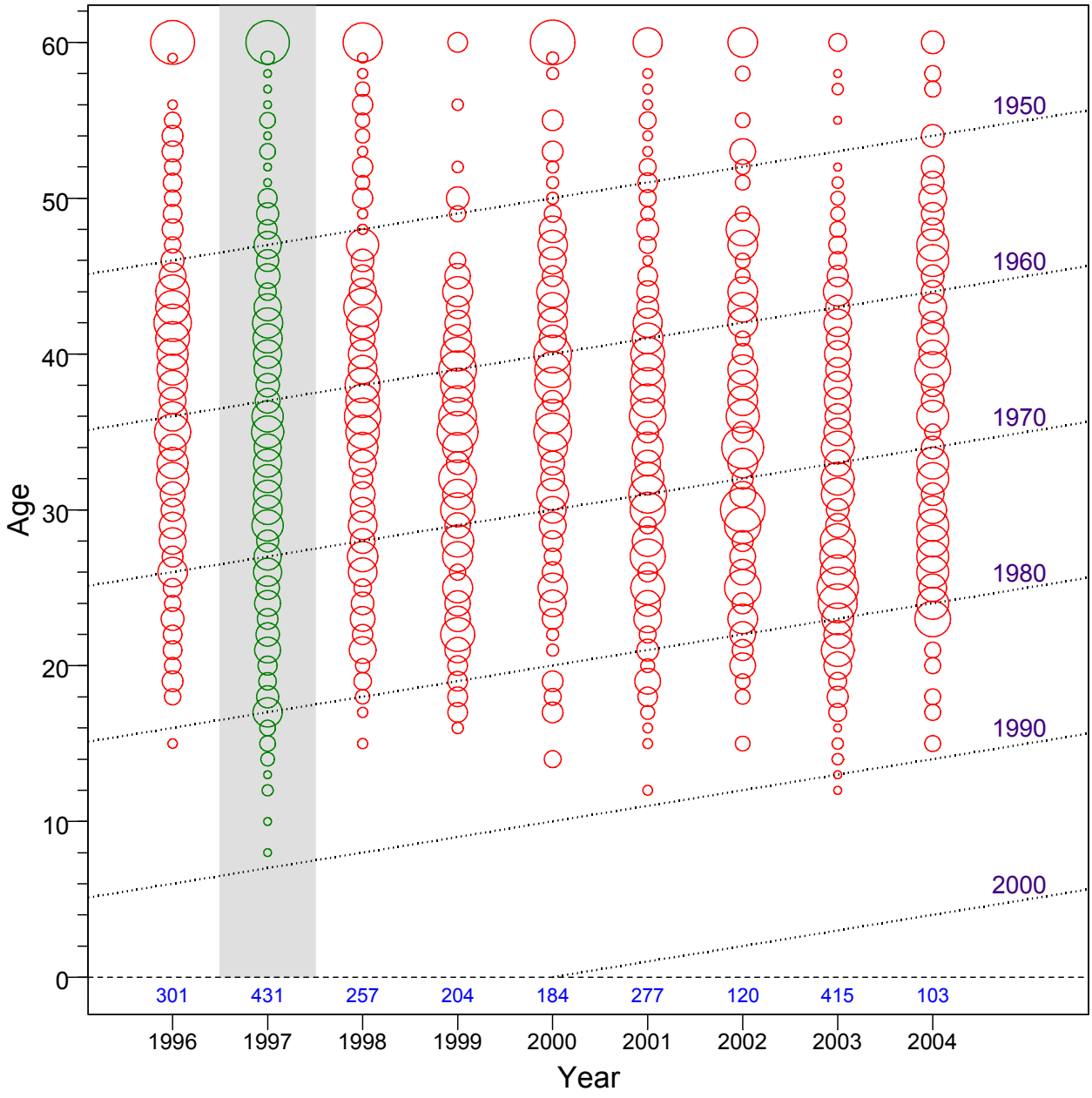


Figure 10. Bubble plot representing observed age proportions in various years for rougheye rockfish species pair in PMFC 5E (WQCI). Background shading indicates the one year where data come from research surveys, and the remainder come from the commercial fishery. Diagonal lines give reference years for cohort progression. Numbers below the horizontal line at age 0 show the number of fish aged each year. Age 60 represents a plus-class. Source: Haigh *et al*. (2005).

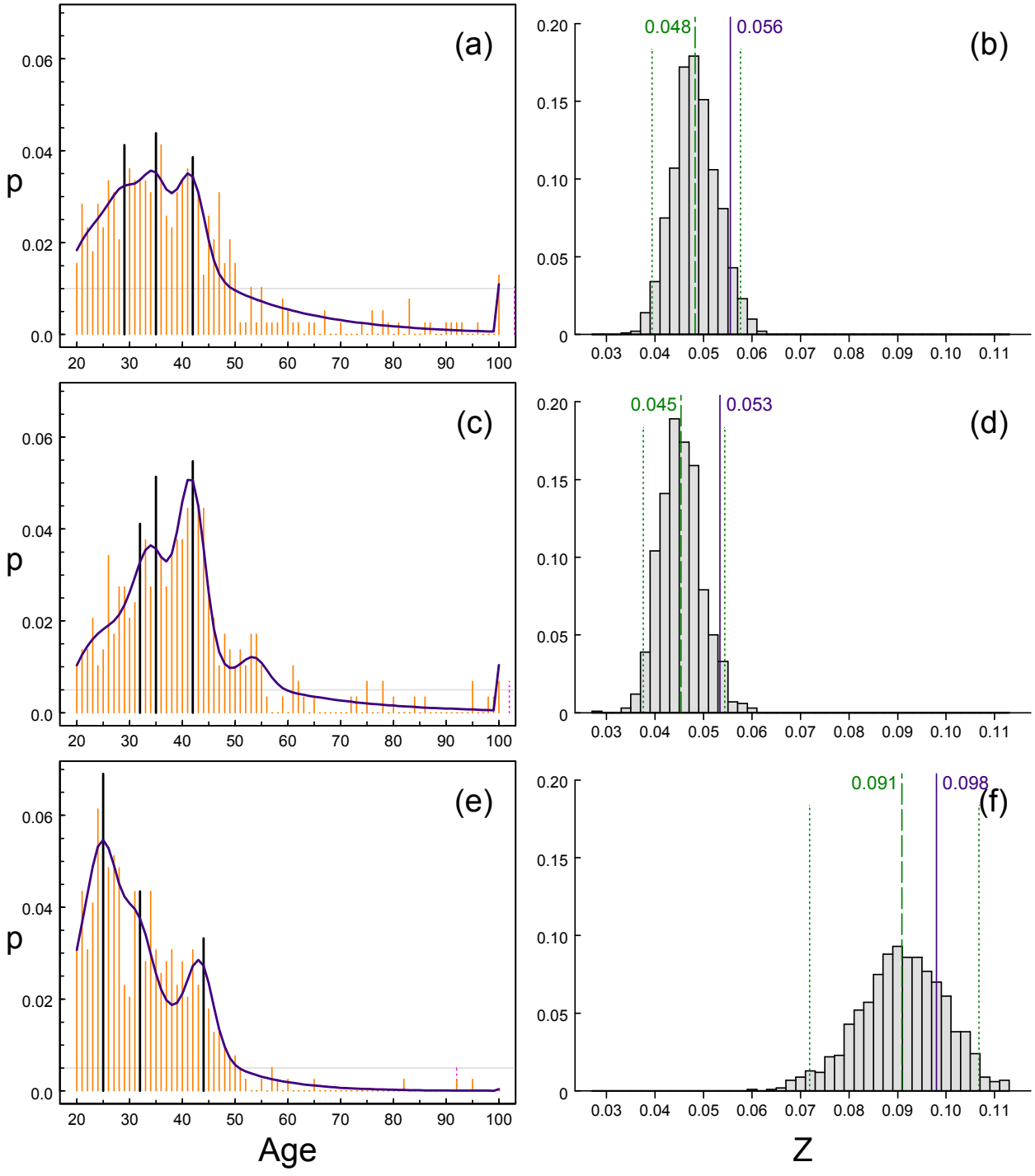


Figure 11. Catch-curve analysis to estimate total mortality (Z) for (a-b) 1997 survey data (n = 431), (c-d) 1996 commercial data (n = 301), and (e-f) 2003 commercial data (n = 415). (a,c,e) p = proportions-at-age, both observed (vertical bars) and predicted (solid curves) from Schnute and Haigh's (2006) catch-curve model. The recruitment anomalies assumed are highlighted as dark vertical bars. Full selectivity is assumed by age 40. (b,d,f) Posterior samples of Z as histograms. Solid vertical lines indicate the mode from the model fits. Dashed vertical lines indicate the mean Z-values, dotted vertical lines indicate the 2.5% and 97.5% quantiles. Source: Haigh *et al*. (2005).

Approximately half of all males are mature at 400-450 mm, females at close to 470 mm. Females are approximately 20 years old at 50% maturity (McDermott 1994). The principal spawning period off BC is in April. Like all viviparous *Sebastes* species, fertilized eggs remain within the ovary until larval extrusion and may obtain at least some of their nutrition from the female parent during development (DFO 1999). *Sebastes* larvae occur near the surface where they feed opportunistically on invertebrate eggs, copepods, and euphausiids; juveniles occur at midwater depths where they feed on larger prey items (Moser and Boehlert 1991). Planktonic larvae of *Sebastes* can be found up to 500 km offshore from the BC coast, far from adult habitat; however, their midwater residency (200-250 m) as juveniles subjects them to shoreward geostrophic advection (Moser and Boehlert 1991). Currently, there is no evidence to show that larvae and juveniles of rougheye rockfishes follow patterns different from those of other *Sebastes* species.

The generation time using the formula $t_{gen} = k + 1/M$, where $k = 20$ (age at 50% maturity) and $M = 0.035$ (natural mortality rate, McDermott 1994), is 48 years.

**Predation**

In the Gulf of Alaska, rougheye rockfishes consume primarily shrimp (*Pandalus borealis*, *P. montagui tridens*, hippolytids, and crangonids), composing roughly 45-60% by weight of total stomach contents (Yang and Nelson 2000). They also consume fish species, including walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasi*), eulachon (*Thaleichthys pacificus*), Pacific sand lance (*Ammodytes hexapterus*), myctophids, zoarcids, cottids, snailfish, and flatfish. In the Gulf of Alaska, fish make up roughly 15-20% of total stomach contents (Yang and Nelson 2000). Additional food items include Tanner crab (*Chionoecetes bairdi*), cephalopods, amphipods, mysids, euphausiids, cumaceans, isopods, and polychaetes. While all size-classes of rougheye rockfishes primarily consume shrimp, fish less than 30 cm have a higher proportion of amphipods in their diet whereas fish larger than 30 cm consume more fish. Krieger and Ito (1999) note that rougheye rockfishes will leave the bottom to capture various prey species.

**Interspecific interactions**

Rougheye rockfishes co-occur with numerous commercially harvested species (Figure 12), including arrowtooth flounder *Atheresthes stomias* and Pacific ocean perch *Sebastes alutus*. Other than competition for food resources with these species, there is no current information on interactions that might limit the survival of rougheye rockfishes.

**Physiology**

Unknown

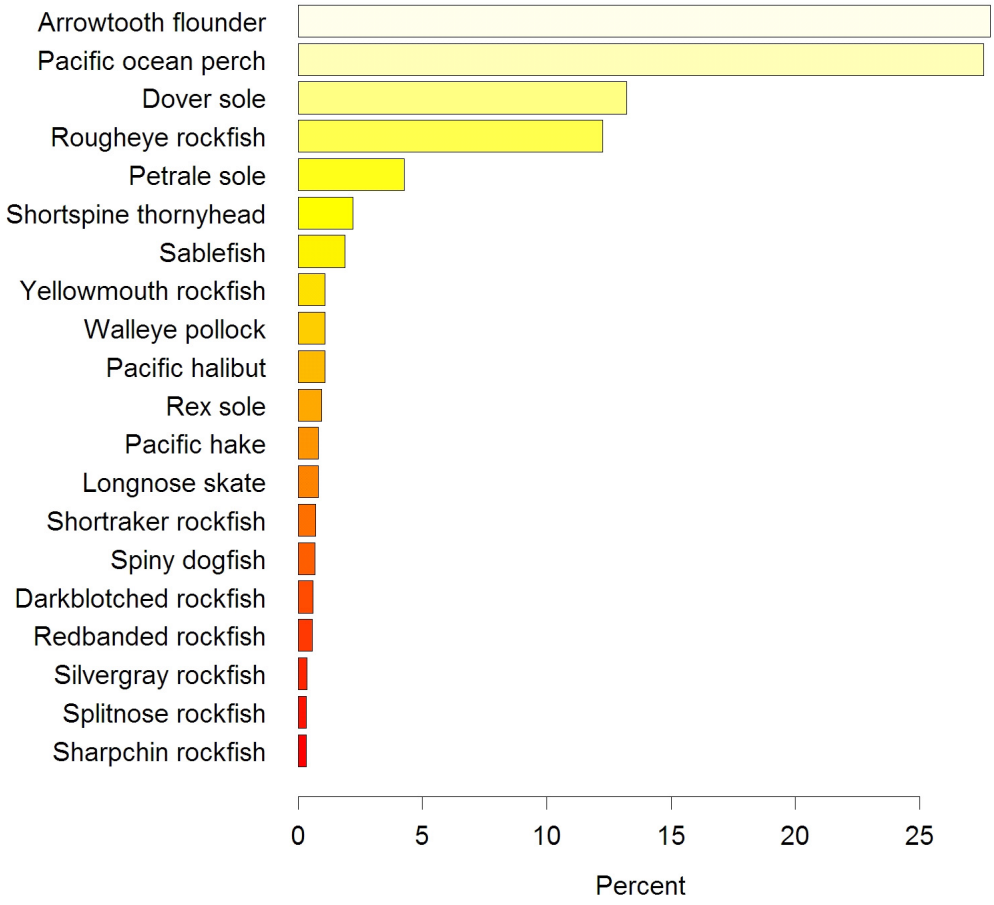


Figure 12. Abundance of the top 20 species in trawl tows (1996-2004) that captured at least one rougheye rockfish in the preferred depth range (170-650 m). Abundance is expressed as a percent of total weight of all species caught in the tows. Source: Haigh *et al*. (2005).

## Dispersal/migration

No information exists for this species pair on the dispersal patterns during the planktonic phase or on the migration patterns of the adults. Like other *Sebastes* species, dispersal of planktonic larvae is probably influenced by ocean circulation patterns. Gharrett *et al*. (2005) infer that spatial movement is limited based on the apparent genetic heterogeneity among various geographic populations.

## Adaptability

Unknown. Susceptible to barotrauma.

## POPULATION SIZES AND TRENDS

### Fishery history

The frequent occurrence of rougheye rockfishes in the Canadian bottom trawl fishery (Figure 5) indicates a widely distributed species pair (and possibly relatively large biomass) compared to other rockfish. Table 2 gives the annual catch and quota history of this species pair along the BC coast. In 1989, DFO separated rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) out from a managed aggregate (Pacific ocean perch, yellowmouth rockfish, rougheye rockfish) and set specific quotas for the Western Queen Charlotte Islands (PMFC 5E) where the species pair is primarily targetted. Quota levels reached a peak in 1996, the year that 100% observer coverage was implemented for the trawl fleet. In 1997, an individual-vessel quota (IVQ) system was started, and since 1998 the quotas have remained constant (coastwide = 950 t).

### Abundance

No estimates of absolute abundance exist. From 1971 to 2005, the combined trawl and longline fleets removed 25,590 t of biomass of the rougheye rockfish species pair from BC coastal waters. This is equivalent to 16.2 million fish, assuming a conversion rate of 1.585 kg/fish (Haigh *et al*. 2005).

### Fluctuations and trends

Research surveys cover large areas of the BC continental shelf and slope, but do not currently provide comprehensive spatial sampling (Figure 13). Commercial fisheries catch-per-unit-effort (CPUE) data are also available to support status assessment.

Hecate Strait assemblage survey

The Hecate Strait (HS) bottom trawl survey, initiated in 1984, was designed to collect data on species interactions (Fargo and Tyler 1991), and continued on a roughly biennial basis until 2003. Prior to 2003, the survey focused on determining abundance indices for flatfish with the consequence that the habitats surveyed do not appear to be appropriate habitat for rougheye rockfishes; 3 out of 1,048 trawl collections provided rockfish specimens. An extended survey area, ranging from Dixon Entrance in the north to Queen Charlotte Sound in the south, initiated in 2005 should improve the utility of the HS survey for many species. However, the depth ranges of the revised survey do not yield large areas of depth preferred by rougheye rockfishes (Greg Workman[2], pers. comm.), and consequently, this survey will not yield useful results for this species.

[2]Marine Ecosystems and Aquaculture Division, Fisheries and Oceans Canada: Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, BC, V9T 6N7

**Table 2. Annual (fishing year) catch (kept + discarded; tonnes) of rougheye rockfishes coastwide by various BC fisheries. Catches are rounded to the nearest tonne; entries marked '---' indicate no recorded catch or quota. Trawl data from 1971 to 1995 are stored in the GFCatch database; data from 1996 on reside in PacHarvTrawl. Hook and line data from the Zn, Schedule II, and halibut fisheries reside in PacHarvHL. From 1971 to 1996, fishing year = calendar year; thereafter, fishing year spans Apr to Mar. Source: Haigh *et al.* (2005). Total allowable catches (TACs) can be found in various fisheries management plans at: http://www-ops2.pac.dfo-mpo.gc.ca/xnet/content/MPLANS/MPlans.htm?lang=en**

| | Catch (t) | | | | | | TAC (t) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Trawl | Zn HL | Shed II | Halibut | SB Trap | Total | Trawl | HL | Halibut | Total |
| 1971 | 9 | --- | --- | --- | --- | 9 | --- | --- | --- | --- |
| 1972 | 8 | --- | --- | --- | --- | 8 | --- | --- | --- | --- |
| 1973 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1974 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1975 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1976 | 14 | --- | --- | --- | --- | 14 | --- | --- | --- | --- |
| 1977 | 77 | --- | --- | --- | --- | 77 | --- | --- | --- | --- |
| 1978 | 140 | --- | --- | --- | --- | 140 | --- | --- | --- | --- |
| 1979 | 220 | --- | --- | --- | --- | 220 | --- | --- | --- | --- |
| 1980 | 88 | --- | --- | --- | --- | 88 | --- | --- | --- | --- |
| 1981 | 119 | --- | --- | --- | --- | 119 | --- | --- | --- | --- |
| 1982 | 386 | --- | --- | --- | --- | 386 | [5E]250 | --- | --- | 250 |
| 1983 | 214 | --- | --- | --- | --- | 214 | agg | --- | --- | --- |
| 1984 | 347 | --- | --- | --- | --- | 347 | agg | --- | --- | --- |
| 1985 | 618 | --- | --- | --- | --- | 618 | agg | --- | --- | --- |
| 1986 | 758 | --- | --- | --- | --- | 758 | agg | --- | --- | --- |
| 1987 | 491 | 0 | --- | --- | --- | 491 | agg | --- | --- | --- |
| 1988 | 1,097 | 3 | --- | --- | --- | 1,099 | agg | --- | --- | --- |
| 1989 | 1,039 | 2 | --- | --- | --- | 1,040 | [5E]200 | --- | --- | 200 |
| 1990 | 1,197 | 19 | --- | --- | --- | 1,216 | [5E]250 | --- | --- | 250 |
| 1991 | 1,015 | 33 | --- | --- | --- | 1,048 | --- | --- | --- | --- |
| 1992 | 1,649 | 29 | --- | --- | --- | 1,678 | --- | --- | --- | --- |
| 1993 | 1,891 | 23 | --- | --- | --- | 1,915 | --- | --- | --- | --- |
| 1994 | 1,353 | 122 | --- | --- | --- | 1,476 | 796 | --- | --- | 796 |
| 1995 | 1,152 | 677 | --- | 1 | 3 | 1,834 | 735 | --- | --- | 735 |
| 1996 | 980 | 440 | 1 | 3 | 3 | 1,427 | [RS]1,311 | 700 | --- | 2,011 |
| [A]97 | 140 | --- | --- | --- | --- | 140 | 242 | --- | --- | 242 |
| [B]1997 | 420 | 719 | 0 | 4 | 5 | 1,147 | 380 | 805 | --- | 1,185 |
| 1998 | 530 | 567 | 7 | 14 | 3 | 1,121 | 549 | 401 | --- | 950 |
| 1999 | 432 | 928 | 7 | 21 | 8 | 1,395 | 433 | 517 | --- | 950 |
| 2000 | 407 | 639 | --- | 68 | 27 | 1,140 | 431 | 474 | 35 | 940 |
| 2001 | 436 | 713 | 0 | 101 | 3 | 1,254 | 530 | 391 | 29 | 950 |
| 2002 | 548 | 492 | 0 | 83 | 9 | 1,132 | 530 | 391 | 29 | 950 |
| 2003 | 472 | 283 | 0 | 102 | 22 | 879 | 530 | 391 | 29 | 950 |
| 2004 | 503 | 209 | 0 | 143 | 28 | 883 | 530 | 391 | 29 | 950 |
| [C]2005 | 263 | NA | NA | NA | 8 | 271 | 530 | 391 | 29 | 950 |
| UNK | 123 | --- | --- | --- | --- | 123 | | | | |
| Total | 19,137 | 5,898 | 16 | 539 | 119 | 25,709 | | | | |

[A]Jan-Mar for Trawl; [B]Jan 97 – Mar 98 for HL; [C]Apr-Dec (incomplete catch records)
agg = aggregate trawl quota for Pacific ocean perch, yellowmouth rockfish, and rougheye rockfishes
[5E]PMFC area 5E only; [RS]Rougheye rockfishes and shortraker rockfish combined

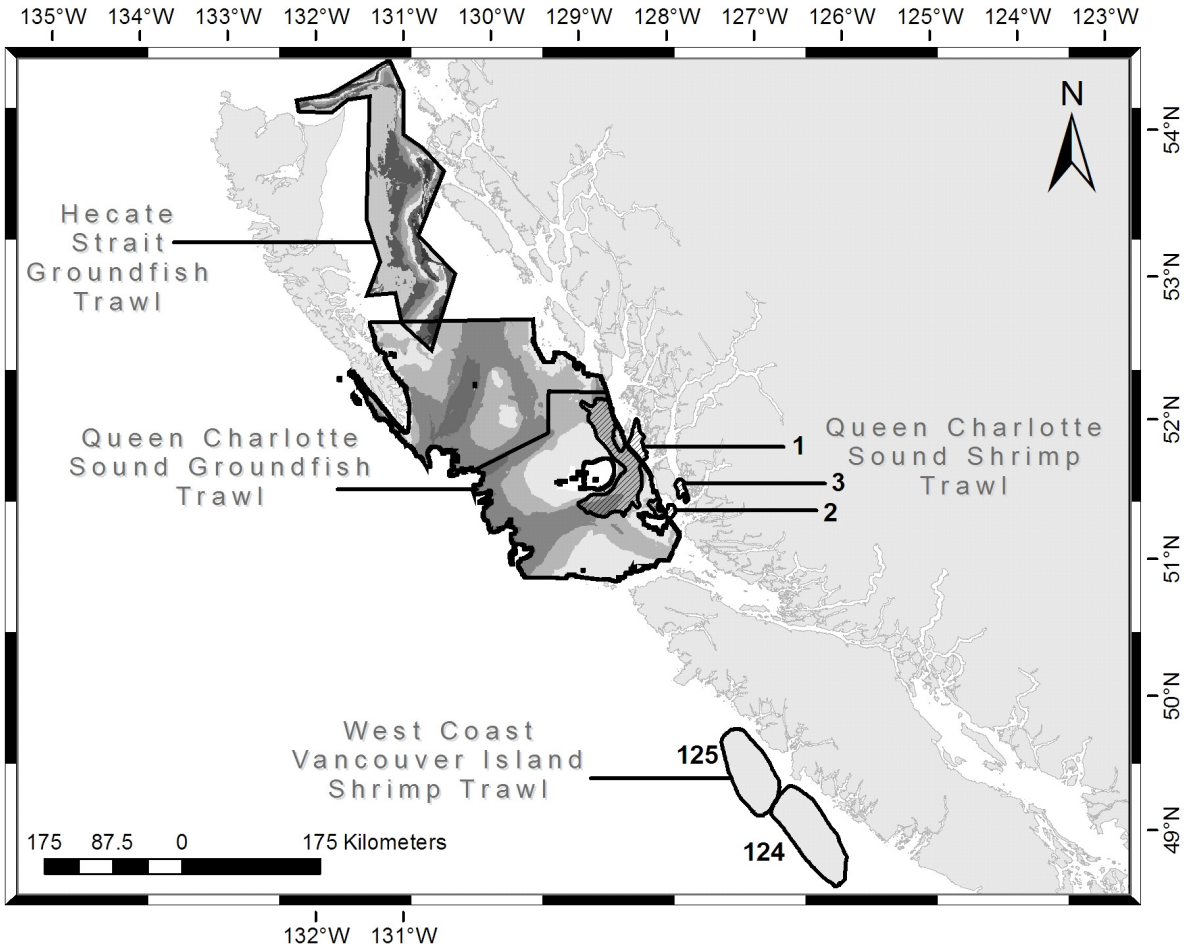


Figure 13. Overview of surveys used as abundance indices for rougheye rockfishes. Depth strata (specific to surveys) are represented by various shades. Source: Haigh *et al*. (2005).

## Queen Charlotte Sound synoptic survey

The Queen Charlotte Sound (QCS) bottom trawl survey was initiated in 2003 to meet multispecies survey requirements for ecosystem-based management (Stanley *et al*. 2004). The survey area covers the region north of Vancouver Island to southern Hecate Strait and depths of 50 to 500 m. The survey is designed to capture all groundfish species using a tow allocation budget that minimizes the CPUE-estimate CVs for stocks representing a variety of concerns and interests. Rougheye rockfishes were included, but as a “species” whose preferred habitat is in depths too great to be well sampled by the survey. At present, the time series spans only three years (Figure 14), a period too short to detect abundance changes for any species.

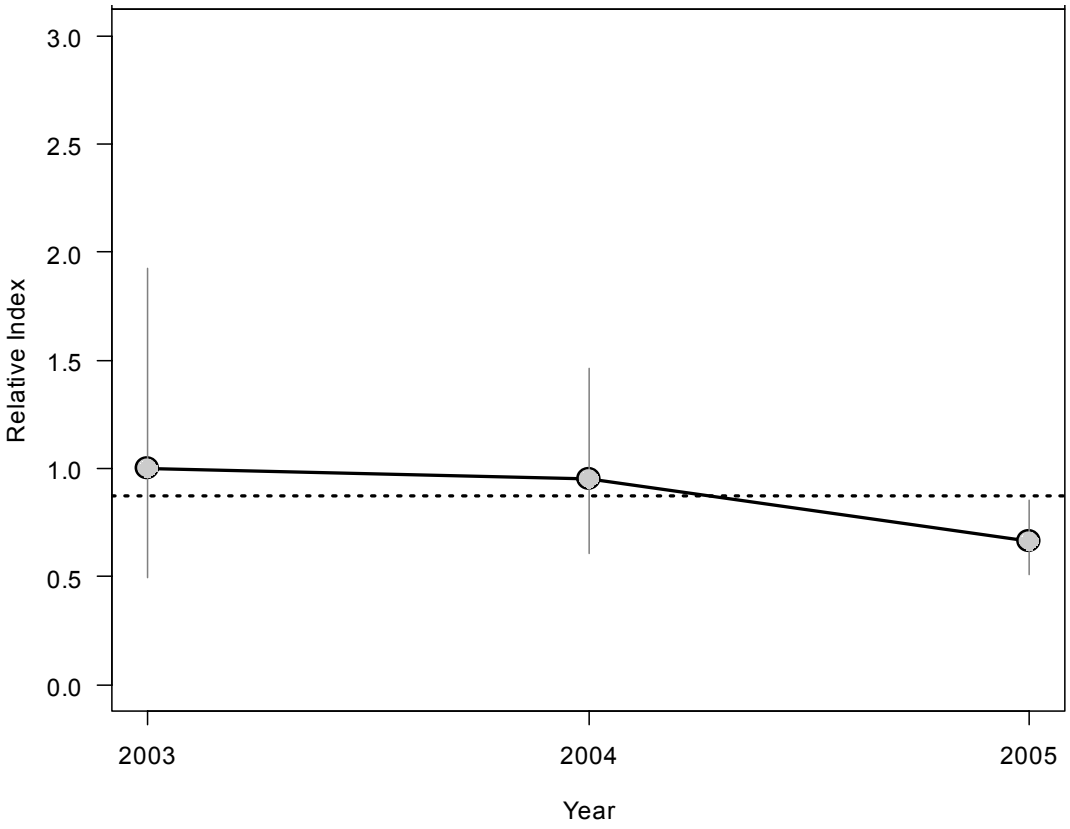


Figure 14. Abundance index from trawl survey for rougheye rockfish species pair in Queen Charlotte Sound. Index is standardized to 2003. Vertical bars indicate 90% confidence intervals from 1,000 simulated index estimates. Source: Haigh *et al*. (2005).

## Shrimp trawl surveys

Sinclair *et al* (2001) describe, in detail, the shrimp trawl survey off the west coast of Vancouver Island (WCVI). For some species of rockfish, relative abundance indices from the shrimp trawl survey show coherence with those from surveys targetting groundfish. In the case of the rougheye rockfish species pair few tows caught this species, which renders this index series useless (Figure 15, left panel). As seen above for the HS assemblage survey, the WCVI shrimp survey consistently covers depths too shallow (80 m to 175 m) to provide a reliable index for this species.

Boutillier and Olsen (2000) describe the Queen Charlotte Sound (QCS) shrimp trawl survey. Unlike the WCVI shrimp survey, 50-60% of the tows capture rougheye rockfishes. The trend analysis excludes the years 1998, 1999, and 2005 as the tows cover the survey region inconsistently. Overall, the index shows no trend from 2000 to 2004 (Figure 15, right panel). However, the 2004 index confidence interval does not overlap that for 2000. This survey, if continued, might prove useful for tracking populations of rougheye rockfishes in the region of QCS that it covers.

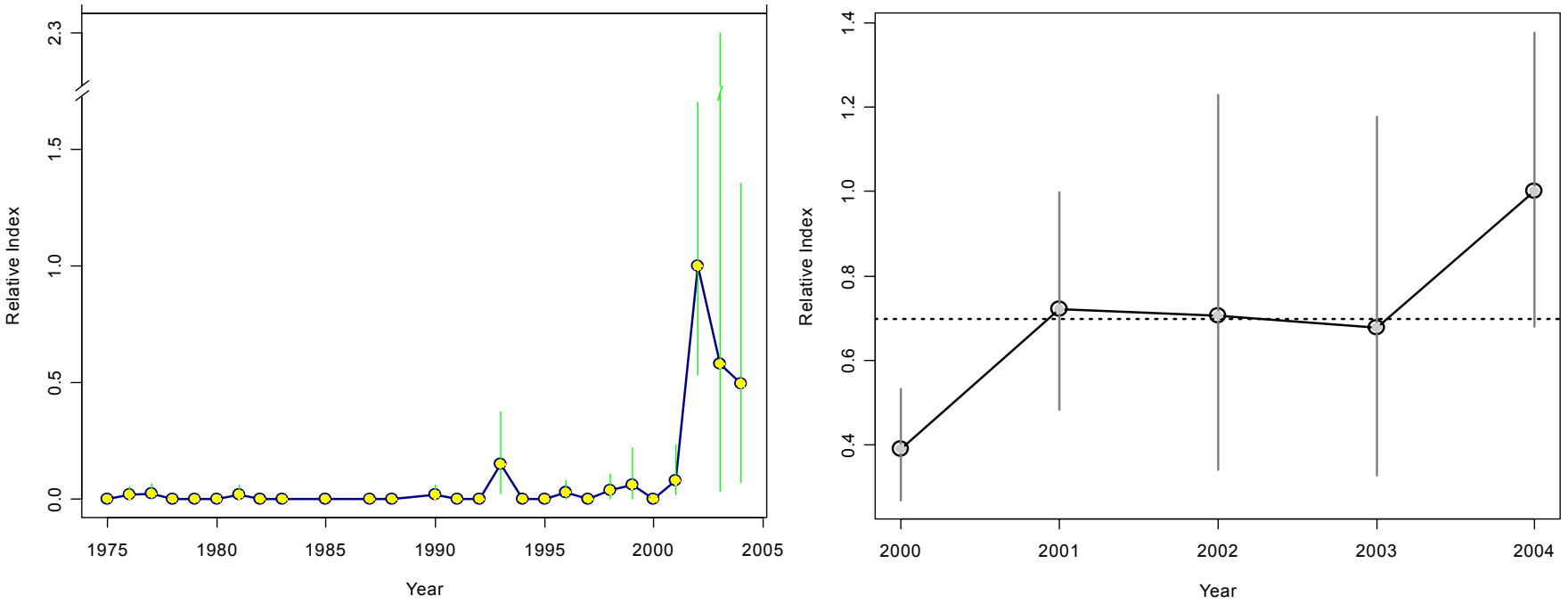


Figure 15. Relative abundance index for rougheye rockfish species pair from shrimp trawl surveys in waters off the WCVI (left) and Queen Charlotte Sound (right). Vertical bars indicate 90% confidence intervals from 1,000 simulated estimates. Source: Haigh *et al*. (2005).

NMFS triennial trawl survey

The US National Marine Fisheries Service (NMFS) conducted triennial groundfish trawl surveys at depths 55-500 m along the US Pacific coast and the WCVI from 1977-2001 (Weinberg *et al*. 2002), using statistical areas set up by the International North Pacific Fisheries Commission (INPFC). Mark Wilkins[3] provided tow data from a trans-boundary INPFC region named "Vancouver" for the seven years that surveyed Canadian waters. NMFS assigned these tows to depth strata, but the size and definition of these strata changed over the life of the survey. In particular, NMFS added deep strata (367-500 m) in the final years.

Haigh *et al*. (2005) assessed and analyzed these data (excluding deep strata) for rougheye rockfishes for the entire Vancouver region and for the Canadian and US sub-regions (Figure 16). The relative biomass estimates show no significant trend for the Vancouver region, nor for the two sub-regions. The trend for the total Vancouver region reflects that in the Canadian sub-region. The relative biomass estimates are more precise in the US sub-region than in the Canadian sub-region due to the reasonably consistent catches of rougheye rockfishes in US waters. In Canadian waters, the surveys captured almost no rougheye rockfishes in 1980, 1983 and 1989; whereas the 1995 survey had one tow with a large catch of this species pair.

Observed commercial trawl CPUE

Haigh *et al*. (2005) analyze commercial catch data for rougheye rockfishes from the DFO PacHarvTrawl database using two general linear regression models (GLM): one assuming a log-normal distribution based on non-zero catches of rougheye rockfishes, and the other assuming a binomial distribution based on the presence/absence of this species pair in the catch. The CPUE analysis uses only data starting April 1, 1996 when 100% observer coverage on the trawl fleet began. The analysis also restricts tows to depths where rougheye rockfishes were captured and to vessels that participated in the fishery for at least three years with at least five trips per year. The analysis considers three fisheries for rougheye rockfishes: the west coast of Vancouver Island (WCVI: PMFC areas 3C and 3D), the combined Queen Charlotte Sound and Hecate Strait (QCS: PMFC areas 5A, 5B, 5C and 5D), and the west coast of the Queen Charlotte Islands (WQCI: PMFC area 5E).

[3]Alaska Fisheries Science Center, Department of Commerce, National Oceanic and Atmospheric Administration: National Marine Fisheries Service, 7600 Sand Point Way N.E., Bin C15700, Building 4, Seattle, Washington 98115-0070

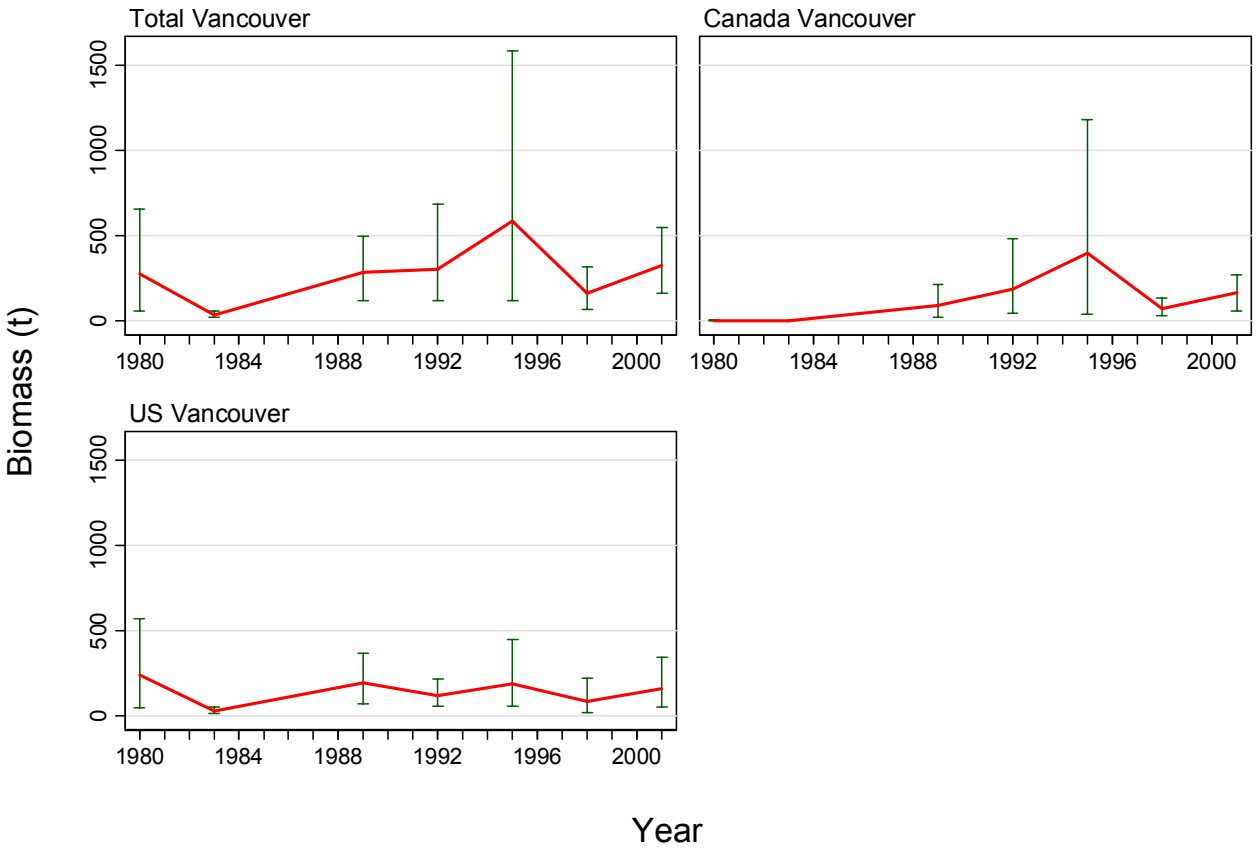


Figure 16. Three relative biomass indices for rougheye rockfish species pair from US National Marine Fisheries Service (NMFS) triennial groundfish survey off the west coast of Vancouver Island (total region, Canadian waters only and US waters only) with 95% bias corrected error bars estimated from 5,000 bootstraps. Source: Haigh *et al*. (2005).

A comparison of the three areas for each type of GLM analysis shows similarities between series across areas (Figure 17). Although regression analysis of the six series reveals increasing trends ranging from 2% to 11% per year (depending on the area and regression model used), the three binomial series exhibit little long-term trend although the most recent one or two fishing years show higher values than earlier. The three lognormal series overlay each other with no strong trend, even though maxima and minima are not synchronized. The WQCI lognormal series peaks in both 1998/99 and 2003/04, inconsistent with the other two areas. This could be due to a strong directed fishery for rougheye rockfishes in WQCI while the other two areas only catch this species incidentally. These relative indices should be interpreted with caution, however, as they come from fishery-dependent data that reflect between-year effects originating from sources other than fish abundance (primarily fishermen behaviour – compliance with quotas and regulations, bycatch avoidance, minimization of fuel costs, etc.).

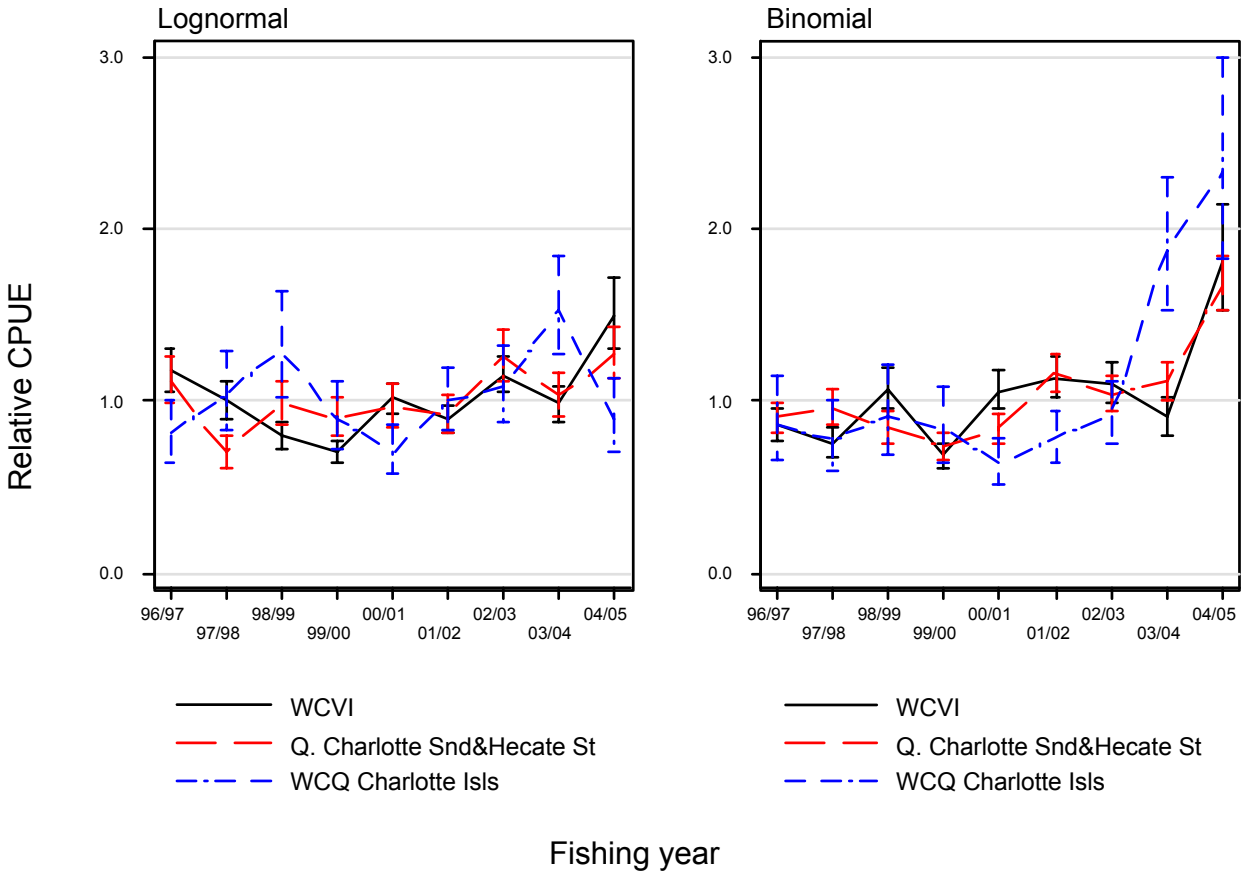


Figure 17. Comparison of two sets of CPUE indices each based on different regression model assumptions for each of three areas. Each series has been standardized relative to the geometric mean of the period 1996/97 to 2004/05. The error bars show ± 95% confidence bounds. Source: Haigh *et al*. (2005).

## Trend summary

The available survey index trends are generally flat to increasing, but available surveys either do not cover the distribution of rougheye rockfishes well or are of short duration. The two shrimp trawl surveys – one off WCVI and the other in QCS (Figure) – suffer from restricted spatial (depth and area) ranges. The US NMFS triennial survey (Figure 15) shows no significant trend, although there is some tendency for increase in the latter part of the time series. However, this survey covers depth ranges too shallow for rougheye rockfishes. While surveys usually give the most reliable index for monitoring demersal marine species, the large error bars from these surveys mean that any estimated trends would be highly uncertain. Indices from the more appropriate groundfish synoptic surveys initiated in 2003 should describe abundance trends more reliably once the survey series cover longer time periods.

All six sets of CPUE abundance series (two models: lognormal and binomial for each of three areas outlined above) show little overall trend, although higher values in the last 1-2 years are seen in some (Figure 17). These indices may be influenced by factors other than abundance of rougheye rockfishes.

### Changes in age composition and mortality

Age-proportion data from 1996 to 2004 off the west coast of the Queen Charlotte Islands (WQCI, PMFC[4] area 5E; Figure 10) suggest a decline in older ages (plus class), and a shift to younger fish (Figure 11). Catch-curve analysis using the method of Schnute and Haigh (2006) suggest that total mortality (natural + fishing) has doubled from 1996 to 2003 (Figure11). The model comprises three components – survival, selectivity, recruitment anomalies – and assumes full selectivity by age 40. Posterior model estimates of total mortality rate $Z$ for the survey year 1997 have mean 0.048 with 95% limits of (0.039, 0.058). Commercial age proportions in 1996 yield essentially the same estimate of $Z$ with mean 0.045 and 95% limits (0.038, 0.054). In 2003, the shift in age classes yields a posterior distribution of $Z$ with mean 0.091 and 95% limits (0.072, 0.107). While the increase suggests that fishing mortality has escalated, non-representative catch sampling may account for some of the perceived difference in proportion-at-age data. A survey in PMFC 5E would be advisable to clarify the situation.

### Rescue effect

Bordering populations in Washington and Alaska could act as population sources though there are no data suitable to test this hypothesis. Population trends in the Gulf of Alaska, from both bottom trawl indices and sablefish longline survey indices, are stable (Shotwell *et al*. 2005). In Washington, the INPFC does not assess rougheye rockfishes, but most *Sebastes* stocks have been in decline. The US Vancouver region NMFS survey index shows no trend (Fig 16).

## LIMITING FACTORS AND THREATS

The primary threat to the population stems from overfishing long-lived species that inhabit the upper continental slope. Given the benthic nature of the rougheye rockfish species pair, both trawl and hook and line fleets affect this species. An apparent reduction in older age classes (Figure 10) from 1996 to 2003 may indicate a significant fishing pressure, and catch curve analysis based on proportions at age suggests that the mean $Z$ doubled during this period, but these changes may be due to non-representative sampling. The apparent doubling of total mortality is not consistent with the apparent stability or increase in CPUE indices in the same period.

[4]Pacific Marine Fisheries Commission, Portland OR.

The recently discovered existence of two species within what was formerly known as rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898), and the lack of knowledge of distribution and threats for the two species, constitutes a threat in itself. Cryptic species of this kind increase the risk of loss of unrecognized genetic diversity. Considerable additional scientific work will be required to describe the relative abundance of the two species in Canadian waters, their distribution, and the impacts of fisheries (and potentially other threats) on each.

Overall, this species pair remains poorly understood from either a biological or population perspective. Recently initiated synoptic groundfish surveys should help to improve the information base on trends in this species pair within a few years.

## SPECIAL SIGNIFICANCE OF THE SPECIES

Rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) is possibly one of the longest lived fish species on earth (Love *et al*. 2002). In Alaska, scientists aged one specimen to 205 years (Munk 2001). Early Aboriginal fisheries probably captured rougheye rockfishes with Pacific halibut *Hippoglossus stenolepis* and sablefish *Anoplopoma fimbria*, but no records exist to verify this.

The existence of two cryptic species within the complex recognized as rougheye rockfish, *Sebastes aleutianus* (Jordan and Evermann, 1898) is of considerable scientific interest with respect to speciation mechanisms.

## EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Fisheries for this species pair are managed through a fisheries management plan (DFO 2007). Under this plan, quotas are set for coastwide removals of rougheye rockfishes that are administered through an individual-vessel-quota system. Currently, 55.8% of the 950 t coastwide quota is allocated to the trawl fleet and 44.2% is allocated to the hook and line sector (halibut and rockfish licences). Industry plays an active role in fishery management through scientific collaboration, including significant funding towards research surveys, observer coverage, and electronic monitoring of vessels which do not cover observers.

The preferred bottom types of rougheye rockfishes – steep-slope, boulder habitats (Krieger and Ito 1999) – may act as potential deterrents to fishing, at least from bottom trawling. Longline gear can presumably access these sites. The depth preference of this species pair limits its exposure to recreational harvest.

No official habitat protection exists for this species pair.

# TECHNICAL SUMMARY

***Sebastes* sp. type I**
Rougheye rockfish type I Sébaste à oeil épineux dutype I
Range of Occurrence in Canada: Pacific Ocean (BC continental shelf/slope between 170 and 650 m)

| **Extent and Area Information** | |
|---|---|
| • *Extent of occurrence (EO)(km²)*<br>**Flat-surface area between isobaths 500 and 1,600 m** | 37,000 km² |
| • *Specify trend in EO* | No change |
| • *Are there extreme fluctuations in EO?* | No |
| • *Area of occupancy (AO) (km²)*<br>**Grid of fish density (CPUE) using commercial trawl data** | 35,000 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 #* | Not applicable |
| • *Are there extreme fluctuations in number of locations?* | Not applicable |
| • *Specify trend in area, extent or quality of habitat* | No change |

| **Population Information** | |
|---|---|
| • *Generation time (average age of parents in the population)* | 48 years |
| • *Number of mature individuals* | Unknown |
| • *Total population trend:* | No trend observed |
| • *% decline over the last/next 10 years or 3 generations.*<br>Catch per unit effort in commercial fisheries: stable or increasing since 1996 | No trend observed |
| • *Are there extreme fluctuations in number of mature individuals?* | No |
| • *Is the total population severely fragmented?* | No |
| • *Specify trend in number of populations* | A single population assumed |
| • *Are there extreme fluctuations in number of populations?* | No |
| • List populations with number of mature individuals in each | Not applicable |
| **Threats (actual or imminent threats to populations or habitats)** | |
| Fishing mortality on a long-lived species; lack of knowledge of distribution, abundance and threats for one of a recently discovered cryptic species pair | |
| **Rescue Effect (immigration from an outside source)** | |
| • *Status of outside population(s)?*<br>**USA: Declining (?) based on other rockfish species** | |
| • *Is immigration known or possible?* | Unknown, but possible |
| • *Would immigrants be adapted to survive in Canada?* | Probably |
| • *Is there sufficient habitat for immigrants in Canada?* | Unknown, probably |
| • *Is rescue from outside populations likely?* | Possible |
| **Quantitative Analysis**<br>See Haigh *et al*. (2005) | |
| **Current Status**<br>COSEWIC: Special Concern (2007) | |

**Status and Reasons for Designation**

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

**Reasons for Designation**:

This species is a relatively large (reaching 90 cm length) rockfish species and among the longest-lived, estimated to approach 200 years. It is one of two sympatric species which have been identified within the described species *Sebastes aleutianus*. It ranges from northern Japan to southern California in depths 200 to 800+ m along the shelf break. In Canadian waters abundance information is derived from surveys and from the commercial fishery that has maintained a relatively constant reported catch of between 1000 and 2000 tonnes annually over the last 2 decades. Abundance indices and biomass estimates are uncertain, compromised by short time series and survey techniques not always appropriate for the species. No strong abundance trends are observed in the available indices. There is evidence of truncation of the age distribution over the last decade, suggesting that mortality from all sources may have doubled (4.5% $y^{-1}$ to 9.1% $y^{-1}$). Long-lived, low-fecundity *Sebastes* species are particularly susceptible to population collapse and recovery may be compromised when the age- and size-distribution is truncated (i.e. when the number of spawners declines) through fishing. Difficulty in separating the two species increases the risk of potential impacts on one of the species going unnoticed.

**Applicability of Criteria**

**Criterion A**: (Declining Total Population): Not met - no indications of decline in available abundance indices.

**Criterion B**: (Small Distribution, and Decline or Fluctuation): Not met - extent of occurrence and area of occupancy larger than thresholds.

**Criterion C**: (Small Total Population Size and Decline): Not met - population size estimate not available but certainly larger than threshold.

**Criterion D**: (Very Small Population or Restricted Distribution): Not met.

**Criterion E**: (Quantitative Analysis): Not undertaken.

# TECHNICAL SUMMARY

***Sebastes* sp. type II**
Rougheye rockfish type II Sébaste à oeil épineux du type II
Range of Occurrence in Canada: Pacific Ocean (BC continental shelf/slope between 170 and 650 m)

| | |
|---|---|
| **Extent and Area Information** | |
| • *Extent of occurrence (EO)(km²)*<br>**Flat-surface area between isobaths 500 and 1,600 m** | 37,000 km² |
| • *Specify trend in EO* | No change |
| • *Are there extreme fluctuations in EO?* | No |
| • *Area of occupancy (AO) (km²)*<br>**Grid of fish density (CPUE) using commercial trawl data** | 35,000 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 #* | Not applicable |
| • *Are there extreme fluctuations in number of locations?* | Not applicable |
| • *Specify trend in area, extent or quality of habitat* | No change |
| **Population Information** | |
| • *Generation time (average age of parents in the population)* | 48 years |
| • *Number of mature individuals* | Unknown |
| • *Total population trend:* | No trend observed |
| • *% decline over the last/next 10 years or 3 generations.*<br>Catch per unit effort in commercial fisheries: stable or increasing since 1996 | No trend observed |
| • *Are there extreme fluctuations in number of mature individuals?* | No |
| • *Is the total population severely fragmented?* | No |
| • *Specify trend in number of populations* | A single population assumed |
| • *Are there extreme fluctuations in number of populations?* | No |
| • List populations with number of mature individuals in each | Not applicable |
| **Threats (actual or imminent threats to populations or habitats)** | |
| Fishing mortality on a long-lived species; lack of knowledge of distribution, abundance and threats for one of a recently discovered cryptic species pair | |
| **Rescue Effect (immigration from an outside source)** | |
| • *Status of outside population(s)?*<br>**USA: Declining (?) based on other rockfish species** | |
| • *Is immigration known or possible?* | Unknown, but possible |
| • *Would immigrants be adapted to survive in Canada?* | Probably |
| • *Is there sufficient habitat for immigrants in Canada?* | Unknown, probably |
| • *Is rescue from outside populations likely?* | Possible |
| **Quantitative Analysis**<br>See Haigh *et al*. (2005) | |
| **Current Status**<br>COSEWIC: Special Concern (2007) | |

**Status and Reasons for Designation**

| **Status**: Special Concern | **Alpha-numeric code**: not applicable |
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**Reasons for Designation**:

This species is a relatively large (reaching 90 cm length) rockfish species and among the longest-lived, estimated to approach 200 years. It is one of two sympatric species which have been identified within the described species *Sebastes aleutianus*. It ranges from northern Japan to southern California in depths 200 to 800+ m along the shelf break. In Canadian waters abundance information is derived from surveys and from the commercial fishery that has maintained a relatively constant reported catch of between 1000 and 2000 tonnes annually over the last 2 decades. Abundance indices and biomass estimates are uncertain, compromised by short time series and survey techniques not always appropriate for the species. No strong abundance trends are observed in the available indices. There is evidence of truncation of the age distribution over the last decade, suggesting that mortality from all sources may have doubled (4.5% $y^{-1}$ to 9.1% $y^{-1}$). Long-lived, low-fecundity *Sebastes* species are particularly susceptible to population collapse and recovery may be compromised when the age- and size-distribution is truncated (i.e. when the number of spawners declines) through fishing. Difficulty in separating the two species increases the risk of potential impacts on one of the species going unnoticed.

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**Criterion D**: (Very Small Population or Restricted Distribution): Not met.

**Criterion E**: (Quantitative Analysis): Not undertaken.

## ACKNOWLEDGEMENTS AND AUTHORITIES CONSULTED

We thank the Canadian Groundfish Research and Conservation Society for their ongoing support of survey work. Chris Grandin, Lisa Lacko, and Jon Schnute provided additional assistance. Paul Bentzen provided assistance with interpreting published information on the sympatric species and establishing the designatable unit.

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Rowan Haigh (principal author) 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