CANADA
British Columbia Groundfish Fisheries and Their Investigations in 2004

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REVIEW OF AGENCY GROUNDFISH RESEARCH, STOCK ASSESSMENT, AND MANAGEMENT

A. Agency overview

Fisheries and Oceans Canada (DFO), Science Branch, operates three principal facilities in the Pacific Region: the Pacific Biological Station (PBS), the Institute of Ocean Sciences (IOS), and the West Vancouver Laboratory (WVL). These facilities are located in Nanaimo, Sidney and West Vancouver, BC, respectively. Dr. Laura Richards is the Regional Director of Science. Pacific Region Science is undergoing restructuring and the proposed Divisions and Sections are as follows:

Division Heads in Science Branch reporting to Dr. Richards are:

Canadian Hydrographic Service	Dr. Denis D'Amour
Ocean science	Mr. Robin Brown
Salmon & Freshwater	Dr. Brian Riddell
Marine Ecosystems & Aquaculture	Mr. Ted Perry

Section Heads within the Marine Ecosystems & Aquaculture Division are:

Groundfish	Mr. Jeff Fargo
Shellfish	Mr. Jim Boutillier
Pelagics	Mr. Jake Schweigert
Conservation Biology	Mr. Jim Boutillier
Applied Technologies	Mr. Ken Cooke
Fish Health and Parasitology	Dr. Susan Bower
Aquaculture and Environmental Research	(West Van Lab)

Groundfish research and stock assessments are conducted primarily in the Groundfish Section and groundfish ageing and acoustics work is conducted in the Applied Technology Section. The Canadian Coast Guard operates DFO research vessels. These vessels include the *W.E. Ricker*, *J.P. Tully* and *Neocaligus.*

The Pacific Region Headquarters of Fisheries and Oceans Canada is located at 401 Burrard Street (Vancouver BC, V6C 3S4). Management of groundfish resources is the responsibility of the Pacific Region Groundfish Coordinator (Ms. Diana Trager) within the Fisheries Management Branch in Vancouver, BC. Fishery Managers receive assessment advice from StAD through the Pacific Scientific Advice Review Committee (PSARC). The Chair of PSARC (Mr. Al Cass) advises the Regional Management Committee on stock status and biological consequences of fisheries management actions and works in consultation with the Canadian Stock Assessment Secretariat (CSAS) in Ottawa. Research documents can be viewed on the website http://www.pac.dfo-mpo.gc.ca/sci/psarc/ResDocs/res_docs_e.htm

Trawl, sablefish (trap and hook-and-line), and halibut (hook-and-line) fisheries continue to be managed with Individual Vessel Quotas (IVQ). IVQ's can be for specific areas or coastwide. Within the general IVQ context, managers also use a suite of management tactics including time and area specific closures and bycatch limits. Specific management issues are addressed below when appropriate. Management plans can be viewed on the website http://www-ops2.pac.dfo-mpo.gc.ca/xnet/content/MPLANS/MPlans.htm

Managers are currently engaging industry in discussions to address issues associated with groundfish conservation and management of the commercial fishery. In particular, DFO and the various fishery sectors (geartypes) are working towards an integrated fishery plan.

B. Multispecies or ecosystem models

No update is currently available

C. By species

1. Pacific cod

i. Stock Assessment

The available commercial fishery and research survey data for Pacific cod stocks in Hecate Strait (5CD) and Queen Charlotte Sound (5AB) were assembled and reviewed in a stock assessment presented in January, 2005. Results from a 3-year survey designed specifically to monitor Pacific cod abundance in Hecate Strait during a period of stock recovery were included. A delay-difference stock production model was used to synthesize these data. There are clear indications that the Hecate Strait population has increased in abundance and biomass since an historic low in 2001. The reduction in TAC for this stock which was introduced in the 2001/02 fishing year resulted in a decrease in exploitation rate which has contributed to the increase in stock size. However, the population has not yet recovered to the long term average biomass and continued increases may be desirable. A candidate stock biomass limit reference point is proposed based on the previous minimum biomass from which the stock had recovered. This was the stock biomass in 1971. Catch forecasts were calculated for a wide range of TAC in 2005/06. The results are

presented as probabilities of specific performance measures being met or exceeded. Attention is drawn to the probability of biomass increase and the probability of the biomass being greater than the biomass in 1971. We were unable to produce an analytical assessment of the Queen Charlotte Sound population.

2a. Rockfish – offshore

i. Research programs

No survey targetting slope rockfish occurred in 2004.

ii. Stock assessment

We prepared a major stock assessment document on longspine thornyhead *Sebastolobus altivelis* in 2004 (Schnute et al. 2004). The report presents an analysis of the biomass survey, conducted annually in 2001-2003 off the west coast of Vancouver Island (WCVI), in the context of a coastwide longspine thornyhead fishery that began in 1996 and extended northward from WCVI into two northern regions, Tidemarks and Rennell (Fig. 1).

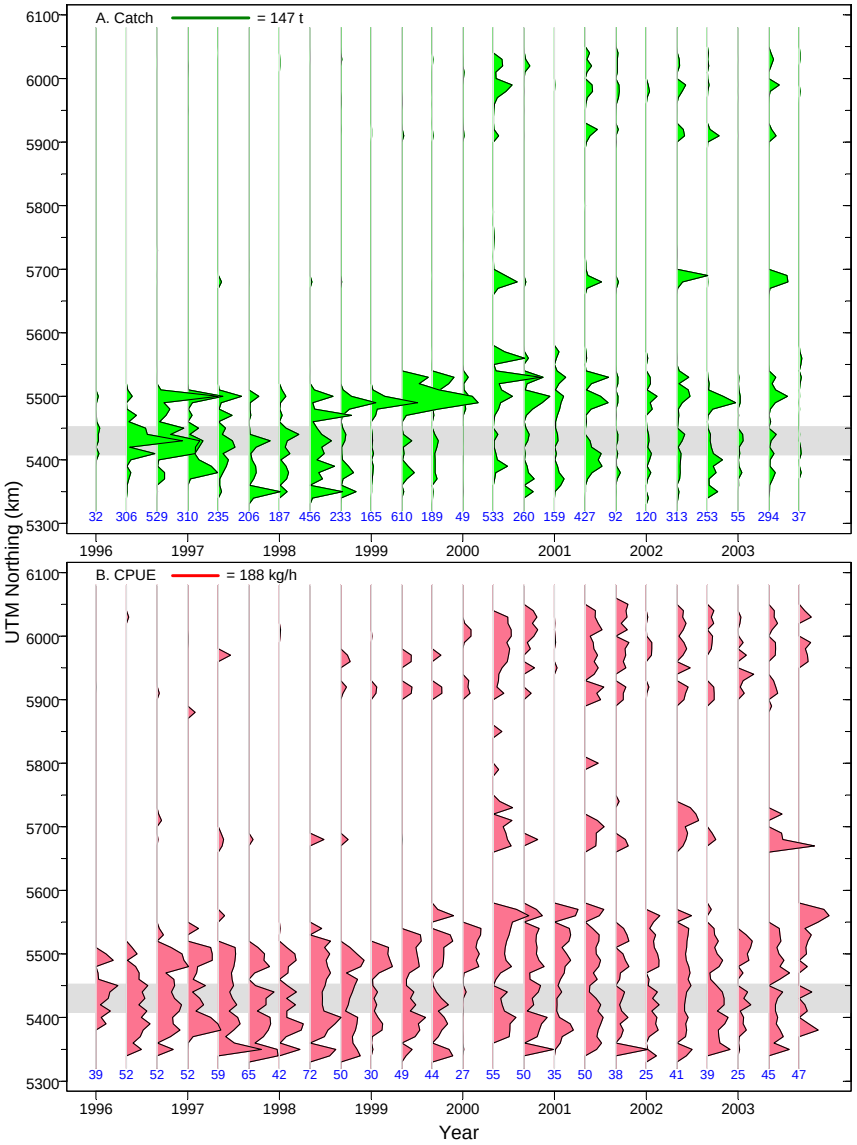

Figure 1. Latitudinal spread of catch and CPUE over time along the BC coast using 10-km UTM northing intervals and 4-month periods. All tows catching longspine thornyhead are used to summarize catch. CPUE is calculated using bottom trawl tows deeper than 500 m by vessels with an onboard observer. Total catch and mean CPUE are indicated for each 4-month period. The genesis of the fishery started in an area off WCVI known locally as "Beginner's Ledge" (grey band).

In the WCVI region, the survey appears to index longspine thornyhead biomass well, achieves coefficients of variation near 10%, and indicates no significant biomass change in the period 2001-2003 (Fig. 2). Because the survey has limited coverage in space and time, we compare this analysis with similar analyses of commercial catch per unit effort (CPUE) data in WCVI (Fig. 2) and the two northern regions, where no surveys exist.

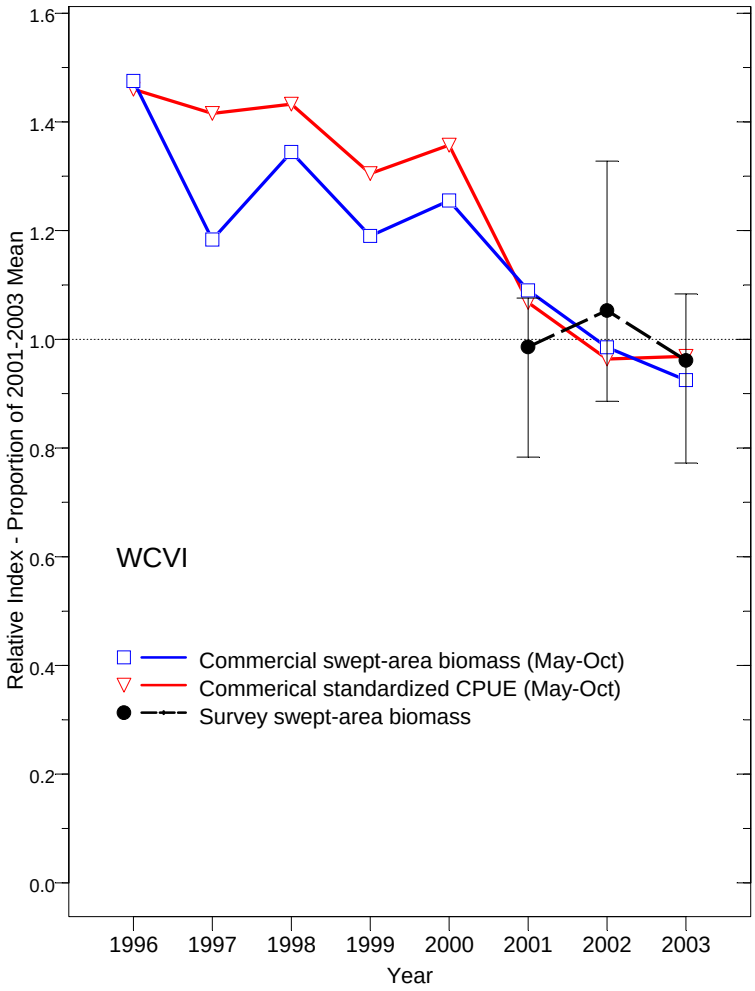

Figure 2. Comparison of annual abundance indices for the WCVI region: commercial vs. survey indices, each standardized to its 2001-2003 mean. Survey indices show bootstrapped 95% confidence intervals.

We present an integrated framework of three mathematical models for making these comparisons: (i) swept-area biomass estimates, (ii) standardized catch rates with fixed effects for various factors (Fig. 3), and (iii) swept-area biomass estimates with standardized vessel effects. All commercial indices for the three regions show downward trends since the inception of the fishery, with the largest decline in the Rennell Sound area. The magnitude of decline depends on the model chosen for analysis. If these trends in the commercial data reflect real declines in population biomass, current removals of longspine thornyhead may not be sustainable. We conclude with recommendations for planning future surveys, integrating data from surveys and commercial fisheries, planning future reductions in the commercial fishery, and improving the basic biological information available for this species.

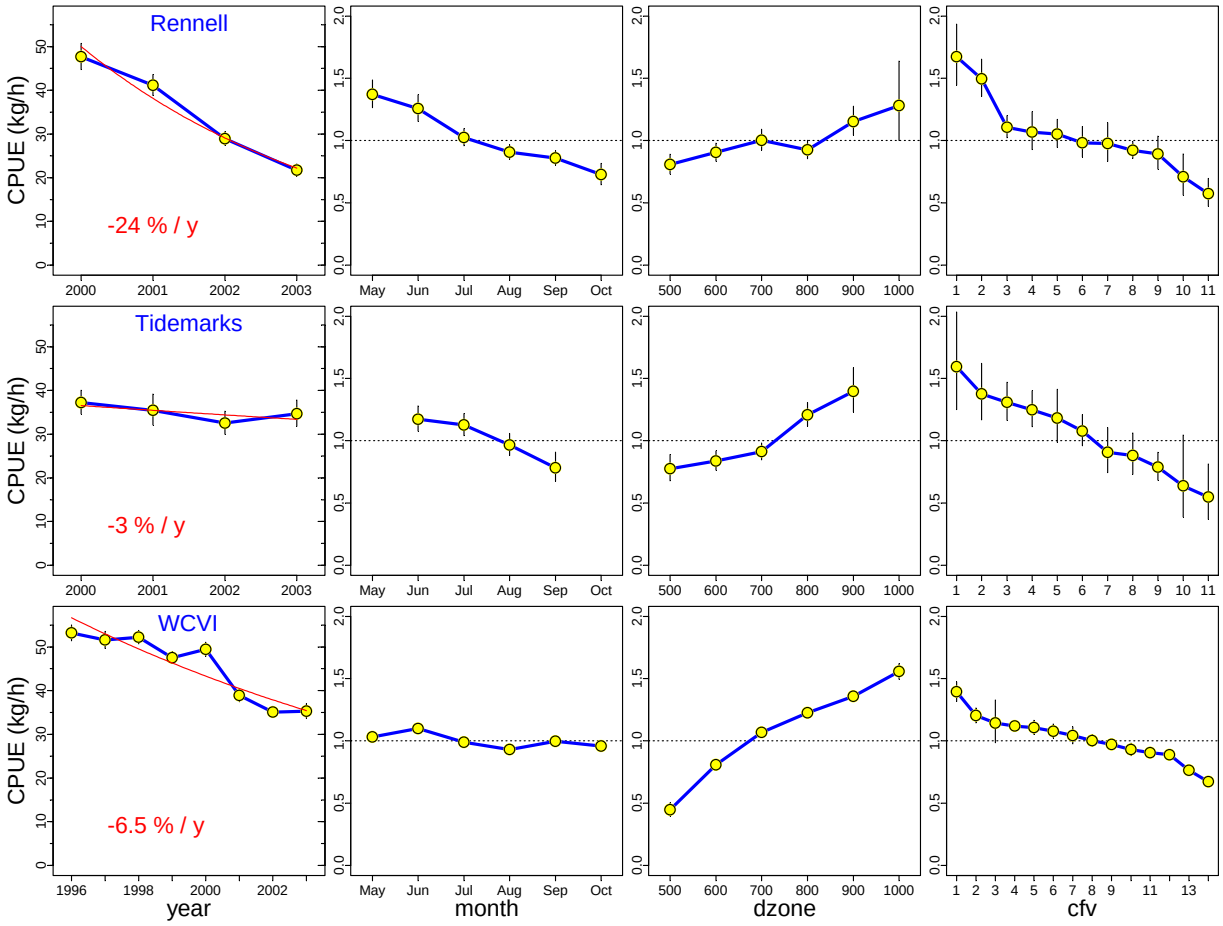

Figure 3. . Commercial longspine thornyhead CPUE U (kg h^{-1}) as $\log_2 U$ in three management regions (Rennell, Tidemarks, WCVI) along the BC coast – year as $2^{\mu+\alpha_i}$, month as 2^{β_j}, depth zone (100-m intervals) as 2^{γ_k}, and vessel (cfv) as 2^{δ_l}. Vertical error bars indicate 95% confidence limits. Red lines in column 1 show the back-transformed linear fit through α_i; implies an annual loss of 24, 3, and 6.5 % $\cdot y^{-1}$ in each of the three regions, respectively.

iii Research activities for 2005

There is a proposed 2005 survey for the west coast of Vancouver Island that will include the slope community (to depths of 1,500 m). Additionally, an ongoing Tanner crab survey will provide an opportunity to collect biological samples of deepwater fish such as longspine thornyhead *Sebastolobus altivelis*.

The third year of the Queen Charlotte Sound synoptic survey will continue in 2005, targetting the 5AB (central BC coast) region between 50 and 500 m. This includes a fair amount of slope rockfish habitat, especially that of Pacific ocean perch *Sebastes alutus*.

2b. Rockfish – shelf

i. Research Programs in 2004

There was no new directed work on any shelf rockfish species in 2004. Staff efforts were directed at the multiple species bottom trawl surveys (see below). Work continues on yellowtail genetics study with Washington Department of Fish and Wildlife and a paper (Stanley and Kronlund 2005) on the biology of silvergray rockfish. Staff also played a consultative role in a U.S. widow rockfish acoustic project being conducted by the NWFSC and the U.S. trawl fishery.

ii. Stock assessments in 2004

Staff developed an Allowable Harm Assessment (AHA) for bocaccio (*Sebastes paucispinis*) in B.C. waters (Stanley and Starr 2004). If a species is listed in Canada, then an AHA is required as background for developing a permit basis for harvesting, should harvesting be allowed. A decision on the proposed designation is expected by mid-2005.

The current status and recovery definition for bocaccio is ambiguous as shown in Figure 1. A shrimp trawl research index conducted off the west of Vancouver Island since 1975 is consistent with other information to indicate that abundance is currently low in comparison with the early 1980's. The early 1970's information, which is only available in this one time series, tends to indicate an earlier low period of abundance. Thus the current status of bocaccio can be viewed either relative to an averaged abundance or relative to the earliest period in the available time series. The same ambiguity affects any recovery strategy which has to define a recovery target.

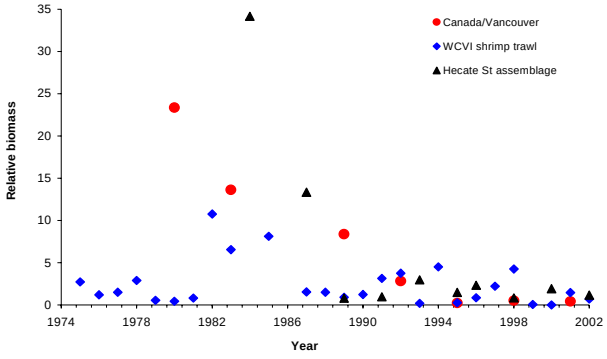

Figure 1 Comparison of the three available sets of trawl survey data for bocaccio in Canadian waters: a) NMFS survey for the Canada/Vancouver region; b) WCVI shrimp trawl survey; c) Hecate St. Assemblage bottom trawl survey. All survey indices have been standardized relative to the geometric mean of the 1989, 1995 and 1998 indices, the only years of overlap in these surveys.

The AHA proposed that the time series be viewed as having various stages; one example is provided in Fig 2.

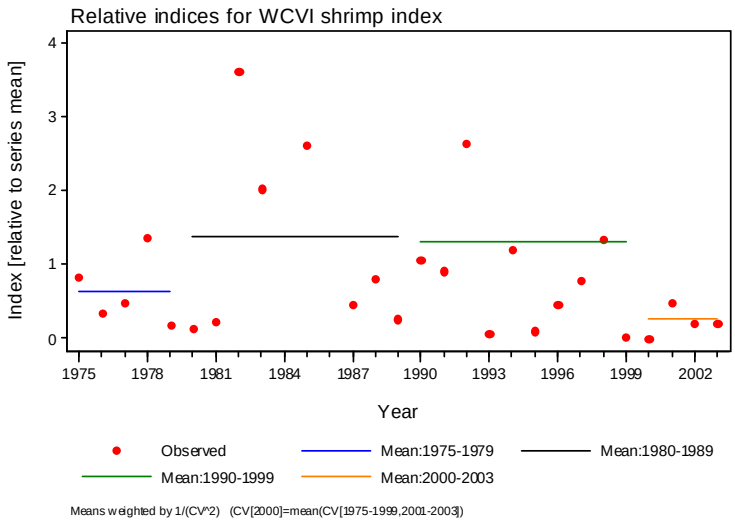

Figure 2. Four step function for the WCVI shrimp survey index, plotted relative to the mean 1975-79 survey estimates, weighted by the inverse of the CV^2 for each survey. The mean CV for the entire series (0.653) was used for the 2000 index because $CV_{2000}=0$.

iii. Research activities planned for 2005

Staff will continue participate in the conduct and analysis of bottom trawl surveys. There are no plans for directed research work on shelf rockfish for 2005.

iv. Stock assessment activities for 2005

Staff will be preparing a Status Report in 2005 on canary rockfish for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

2c. Rockfish – inshore

i. Research programs in 2004

Funded jointly by the Pacific Halibut Management Association (PHMA) and the Canadian Sablefish Association (CSA), an observer was deployed to collect biological samples and hook-by-hook catch data, during the International Pacific Halibut Commission (IPHC) Area 2B setline survey conducted from May to August 2004. Redbanded (*S. babcocki*) and yelloweye rockfishes were the dominant rockfish species taken on the survey. Preliminary simulation results from 2003 indicate that if an annual catch rate index is collected, it will be useful to track abundance trends for yelloweye rockfish by 2009. The PHMA and CSA also funded a technician in the Pacific Biological Station's Ageing lab, for 6 months, to assist in ageing the backlog of yelloweye rockfish ageing samples.

A repeat of the depth stratified (41 – 70 m and 71 – 100 m) random design survey conducted in 2003 was conducted in the Strait of Georgia (PFMC 4B), Statistical Areas 12 and 13 during August and September 2004. Fourteen species of rockfishes were encountered on the survey. Quillback and yelloweye rockfishes were again the dominant rockfish in the catch. Other commercial species caught included spiny dogfish, pacific cod, sablefish, pacific halibut and lingcod. A total of 4176 fish were sampled on the survey, including 658 rockfish. A strong 1985 year class is evident in the quillback age frequency data from both 2003 and 2004..

Jig research surveys were conducted in Statistical Area 12 (PFMC 4B) during June 2004. One hundred and one fishing sets were completed in 10 index sites. Preliminary data show continued declines in quillback rockfish catch per unit of effort from 1986-88 and 1992. A strong 1985 year class of quillback rockfish contributed 25% to the catch in 1992 (7 yr) and accounts for 11% of the catch in 2004 (19 yr.)

In collaboration with Dr. Sean Cox from Simon Fraser University, research on a genetic tagging experiment is continuing in a Rockfish Conservation Area (RCA) in the Strait of Georgia (PFMC 4B). Habitat maps have been developed by the Pacific GeoScience Centre (PGC) of Natural Resources Canada (NRCAN) and genetic tags were deployed in 5 study sites. Estimates of population size within the study sites are then extrapolated using the habitat maps.

ii. Stock assessment

No stock assessments were conducted in 2004. A stock assessment framework document was prepared for PSARC in May 2004 which summarizes all research activity conducted on inshore rockfish.

iii. Management actions for 2004

During 2003 the rockfish sustainability team worked with stakeholders through various advisory processes, publicly held workshops and the Department's consultation website to modify and improve 89 Rockfish Conservation Areas (RCAs). These 89 RCAs were then implemented for the 2004 fishing year. RCAs are used as a management tool to protect rockfish and fishing activities that are likely to catch rockfish are prohibited.
http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/fisheriesmgmt/rockfish/default_e.htm

iv. Research activities planned for 2005

Further development of a rockfish conservation areas (RCAs) strategy is planned and will involve the investigation of a spatial model based on multibeam bathymetric and backscatter data to identify habitat areas. Rockfish habitat areas, identified through the model, will be overlain with all available fishery data to assess the potential of using these to site additional RCAs.

A submersible survey using visual methods to assess rockfish abundance is planned for May 9 to 24, 2005 in the Queen Charlotte Islands. This survey is designed to develop habitat assessment methodology and assess stock status for inshore rockfish. Rockfish density estimates by habitat type may be expanded using habitat maps to a biomass estimate over an area much larger than that surveyed by submersible. Habitat maps are being developed with the PGC using multibeam

backscatter, bottom grab and seismic data. The submersible project is a joint project with the Washington Department of Fish and Game.

DFO will continue to coordinate and compile the hook-by-hook catch composition and rockfish biological sample collection on the IPHC setline survey in 2005. The cost of the contracted observer and additional vessel costs are borne by the halibut industry.

The longline survey in the Strait of Georgia (PFMC 4B) is planned for August 10th to September 6th, 2005 and will be conducted Statistical Areas 14 to 20 within the Strait of Georgia Management Region 4B.

3. Sablefish

No report available.

4. Flatfish

No program in 2004.

5. Pacific hake

On March 10, 2005 the US Pacific Fishery Management Council met to set the US total allowable catch (TAC) for the 2005 Pacific hake fishery based on analysis of data including the 2004 fishery. Although Canada and the US adopted a new treaty for the joint management of this shared resource in 2003, the treaty has not yet entered-into-force as the US has yet to be ratified by the U.S. Congress. to seek to have the catch-sharing provisions of the treaty informally applied in 2005, as they were in 2004.

In advance of the Council meeting, a new stock assessment had been prepared jointly by Canadian and US scientists. The new stock assessment was an update of the 2004 assessment that included additional data for catch, catch-at-age and juvenile pre-recruit abundance in 2004 but otherwise used the same model configuration as in 2004. As was the case last year, the major source of uncertainty was the value of the catchability coefficient (q) for the acoustic survey. Both the 2004 assessment and the 2005 update provided two scenarios for the stock size and catch projections based on two alternative models (q=1.0 and q=0.6). Both were identified as equally likely, and decision tables were generated for both models. The Council then adopted a TAC which corresponded to the US's treaty share of a coast-wide TAC derived from the q=1.0 model.

6. Elasmobranchs

i. Research programs in 2004

An examination of potential age determination methods for big skate was completed (*Raja binoculata*) and submitted for publication. Vertebral centra sectioned longitudinally, immersed in ethanol, stained with crystal violet and enhanced with a thin layer of mineral oil produced the

best results. Age compositions were produced and growth curves estimated. The method appears appropriate for age determination of big skate and the production of growth rates and productivity for input into ecosystem models. The method was also utilized on centra of longnose skate with good results.

A tag/recapture program to examine stock discreteness of Big skate was initiated in 2003.This program was continued in 2004. Approximately 4300 big skate were tagged and released, bringing the total number of skates tagged and released to 7800 fish. As of November 2004 452 skates were recaptured.

In November 2004 a longline survey for spiny dogfish was conducted in the Strait of Georgia. The objectives of the survey were: 1) compare catch rates of spiny dogfish between 'J' hook and circle hook gear; 2) collect biological data at 7 sites, 4 depths including age structures; and 3) compare catch rates of dogfish to previous surveys.

ii. Stock assessment in 2004.

No assessments were conducted on BC elasmobranches. COSEWIC status reports on blue sharks, shortfin mako, and basking sharks were prepared and will be submitted in early 2005.

iii. Management

There are no directed fisheries allowed for sharks (excluding spiny dogfish, *Squalus acanthias*) in BC waters; therefore sharks are bycatch only. There is no immediate concern regarding the bycatch of sharks in BC fisheries, therefore no specific recommendations are made. However, the bycatch should be monitored by species and area in order to ensure that future productivity of BC sharks is not compromised.

Recent increases in directed catch of skate prompted management to examine options for the 2002/2003 and subsequent fishing years. This resulted in a catch "cap" of 850 t on Hecate Strait big skate in 2002/03, which was continued in 2004/05.

iv. Research activities planned for 2005.

1. Continue tagging program for big skate.
2. Conduct longline survey for spiny dogfish in Strait of Georgia.
3. Refine age determination methodology for spiny dogfish.
4. Prepare COSEWIC reports on spiny dogfish, big skate, longnose skate, sandpaper skate, six-gill shark, brown cat shark, soupfin shark.

7. Lingcod

i. Research programs in 2004

Lingcod abundance surveys were initiated in the Strait of Georgia in 2004: hook and line for juveniles and adults, bottom trawl for young of year, and dive survey for juvenile and adults.

Community dive surveys for lingcod and rockfish densities, coupled with egg mass surveys sponsored by DFO were initiated.

ii. Stock assessment

Offshore

No assessment was conducted on offshore lingcod stocks in 2003.

Inshore

No assessment was conducted on Strait of Georgia lingcod stocks in 2004. A Management Framework was developed for the Strait of Georgia lingcod population which identified rebuilding targets and timeframes for this severely depressed stock. It is likely that recreational fishing will resume in 2005.

iii. Research activities planned for 2005

Lingcod abundance surveys will be continued in the Strait of Georgia in 2005. A new survey on larval fish distribution throughout the Strait of Georgia will take place in April. This research is in collaboration with oceanographers at the Institute of Ocean Sciences and its objective are to investigate the distribution of larval fishes (including lingcod) in relation to circulation patterns; and to link those distribution patterns to subsequent area recruitment. Research will focus on integrating lingcod abundance surveys to ROV research conducted by the inshore rockfish program with the objective of developing biomass estimates for the Strait of Georgia lingcod population.

D. Other related studies

1. Statistics and Sampling

i. Database work in 2004

Principal Statistics and Sampling activities in 2004 included the ongoing population of the groundfish biological database (GFBio). This database now includes about 6,500,000 specimens. Data entry activities continue to concentrate on input of current port sampling and observer biological data and recent research cruises. When time is available, the database is backfilled with research cruise data collected before 1997. This past year involved a considerable effort in the entry of historic port samples, with backfilling complete to 1954.

Approximately 10% of a person year is involved with data uploads of the trawl observer data and providing catch data summaries. The groundfish trawl fishery continues to be covered by 100% dockside and virtually 100% observer coverage. These observers also provided 502 length/sex/age samples and 314 length samples in 2004. Port samplers provided an additional 189 samples, 168 samples with ageing structures (length/sex/age/weight) and 21 without structures (length/sex/weight).

Hook-and-line and sablefish trap landings have 100% dockside validation. Observer coverage in the hook-and-line fishery was initiated in 2000 and continues to provide about 5-15% coverage.

Staff also prepared a draft report on a General Groundfish Survey Strategy for groundfish (under revisions) as well as began work on a draft report on a General Groundfish Sampling Strategy. They also assisted in an analysis of the potential benefits of introducing Individual Quotas in the west coast U.S. trawl fishery (Branch et al., in press).

ii. Field work in 2004

Staff participated on various bottom trawl surveys as well as operating as port samplers (1.8 person-years) in the Vancouver and Prince Rupert areas

iii. Proposed field work for 2005

Port sampling will continue in 2005, as will staff participation in the bottom trawl surveys, a submarine survey of inshore rockfish, and the coastwide acoustic survey of hake.

iv. Proposed catch monitoring research and development in 2005

Staff will be participating in research pertaining to designing the Electronic monitoring system in the hook and line fisheries. Specific studies will examine the capability to measure fish from video footage, and the sample size needed during dockside monitoring to estimate mean size in landed species. An accurate estimate of mean size is required to estimate piece count from the larger unloadings. Part of the audit tracking of accurate monitoring will depend on a comparison of piece count in the fisher logbooks with piece count in the unloading.

The proposed use of EM is part of a large information system that will be developed in 2005. This system is required to support the information and data flow requirements of the Integrated Groundfish Fishery plan. The 2005 pilot is designed to develop and beta-test a catch monitoring system that will be fully implemented for April 1 of 2007. The key elements of the system are:

1) full accountability for all catches (retained and discarded);
2) updates of individual fishers' catch histories within 24-hours of unloading;
3) the ability of the system to collate data from multiple providers (multiple contractors) at the same time.

Staff from the Statistics section of groundfish are providing the Stock assessment and research advice during design and implementation of the system.

APPENDIX 1. REVIEW OF CANADIAN GROUNDFISH FISHERIES

1. Commercial fisheries

All catch figures for 2004 are preliminary. Canadian domestic trawl landings of groundfish (excluding halibut) in 2004 were 104,750 t, a decrease of 5% from the 2003 catch. This decrease was mainly accounted for by the decrease in landings of Pacific hake. The major species in the trawl landings were Pacific hake (62%), Pacific ocean perch (6%), turbot (5%), yellowtail rockfish (4%). Principal areas of trawl production were 3C (58%), 4B (11%), 5B (9%) and 3D (6%).

Canadian landings of groundfish caught by gear other than trawl in 2004 totalled 8,816 t. Landings by trap and longline gear accounted for 2,682 t, approximately 83% by trap gear and 17% by longline gear. Sablefish accounted for more than 99% of the landed amount. Landings of species other than sablefish by longline, handline and troll gear accounted for 6,134 t (72% dogfish, 13% rockfish and 12% lingcod).

2. Recreational fisheries

Each year, Fisheries Management Branch of DFO conducts creel surveys of the recreational angling fishery in the Strait of Georgia. Principal target species are chinook and coho salmon. In 2004 these surveys covered the months of May to October. Provisional estimates of 2004 catches, landings and discards, for this 6-month period were 18,207 fish for lingcod, 28,363 fish for all rockfish species, 1,899 fish for halibut, 10,930 fish for flatfish, 26,303 fish for dogfish, 4,551 fish for greenlings and 421 fish for cabezon.

3. Joint-venture fisheries

In 2004, 38 Canadian catcher vessels delivered Pacific hake and incidental species to 11 processing vessels in co-operative fishing arrangements. This fishery took place off the southwest coast of Vancouver Island (Area 3C). A total of 58,892 t of Pacific hake was processed by 11 Russian vessels. The quotas and catches are outlined below:

Nation	Species	Quota (t)	Catch (t)
Poland	Hake	50,000	58,892
	Pollock	incidental	44
	Rockfish	incidental	89
	Other	incidental	757

4. Foreign fisheries

There were no national or supplemental fisheries for Pacific hake off southwest Vancouver Island (Area 3C) in 2004.

APPENDIX 2. GROUNDFISH RELATED REPORTS PUBLISHED BY IN 2004/05.

1. Primary Publications

Beamish, R.J., Schnute, J.T., Cass, A.J., Neville, C.M., and Sweeting, R.M. 2004. The influence of climate on the stock and recruitment of pink and sockeye salmon in British Columbia, Canada. Transactions of the American Fisheries Society 133: 1396–1412.

Branch, T. A, K. Rutherford, and R. Hilborn. 2005. Replacing trip limits with individual transferable quotas: implications for discarding. Marine Policy. (in press).

Haigh, R. and J. T. Schnute. 2003. The longspine thornyhead fishery along the west coast of Vancouver Island, British Columbia, Canada: portrait of a developing fishery. North American Journal of Fisheries Management. 23: 120-140.

McFarlane, G. A., J. R. King. 2003. Migration dynamics of Spiny dogfish (*Squalus acanthias).* In the North Pacific Ocean. Fish. Bull. 101: 358-367.

King, J. R., and G. A. McFarlane. 2003. Marine fish life history strategies: applications to fishery management. Fish. Man. and Ecology 10:249-264.

King, J.R. and R.E. Withler. 2005. Male nest site fidelity and female serial polyandry in lingcod (*Ophiodon elongatus*, Hexagrammidae). Mol. Ecol. 14(2): 653-660.

Schnute, J. T. 2003. Designing fishery models: a personal adventure. Natural Resource Modeling 16: 393-413.

Schnute, J. T. and R. Haigh. 2003. A simulation model for designing groundfish trawl surveys. Canadian Journal of Fisheries and Aquatic Sciences. 60: 640-656.

Sinclair, A.F., and Crawford, W.R. 2005. Incorporating an environmental stock-recruitment relationship in the assessment of Pacific cod (Gadus macrocephalus). Fish. Ocean. 41: 138-150.

Withler, R.E., King, J.R., Marliave, J.B. Beaith, B., Li, S., Supernault, K.J. and K.M. Miller. 2004. Polygamous mating and high levels of genetic variation in lingcod, *Ophiodon elongatus*, of the Strait of Georgia, British Columbia. Env. Bio. Fish. 69: 345-357.

2. Other publications

Boers, N.M., Haigh, R., and Schnute, J.T. 2004. PBS Mapping 2: developer's guide. Canadian Technical Report of Fisheries and Aquatic Sciences 2550, 38 p.

Choromanski, E.M., J. Fargo, G.D. Workman, and K.Mathias. 2004. Multispecies trawl survey of Hecate Strait, *F/V Viking Storm*, June 10 – 28, 2002. Can Data Rep. Fish. Aquat.Sci. 1124:81p.

Haggarty, D.R. and J.R. King. 2005. Hook and Line Survey of Lingcod (Ophiodon elongatus) and Rockfish (Sebastes spp.) in Northern Strait of Georgia (Statistical Areas 13, 14, 15 and 16) June 14-July 9, 2004. Can. Tech. Rep. Fish. Aquat. Sci. *In press.*

Haggarty, D.R., King, J.R., Surry, A.M. and K.M. Mathias. 2005. Bottom Trawl Survey of Young-of-the-Year Lingcod (Ophiodon elongates) in the Strait of Georgia by the R/V Neocaligus, July 12 – 23, 2004. Can. Tech. Rep. Fish. Aquat. Sci. *In press.*

Haggarty, D.R. and J.R. King. 2004. Hook and Line Survey of Lingcod (*Ophiodon elongatus*) and Rockfish (*Sebastes* spp.) Stocks in Southern Strait of Georgia (Statistical Areas 17, 18, 19) October 2003. Can. Tech. Rep. Fish. Aquat. Sci. 2533.

Haist, V, A. R. Kronlund, and M. R. Wyeth. 2004. Sablefish (*Anoplopoma fimbria*) in British Columbia, Canada: Stock Assessment for 2003 and Advice to Managers for 2004. PSARC Working Paper G2004-01.

King, J.R. and D.R. Haggarty. 2004. Lingcod Egg Mass and Reef Fish Density SCUBA Survey in the Strait of Georgia, February 17 - March 3, 2004. Can. Data Rep. Fish. Aquat. Sci. 1147.

King, J.R. and D.R. Haggarty. 2004. An Examination of Recapture Rates of Lingcod as a Potential Source of Bias in Recreational Catch Per Unit Effort (CPUE) Indices. Can. Man. Rep. Fish. Aquat. Sci. 2670.

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APPENDIX 3. GROUNDFISH STAFF IN 2004

S. Acheson	Groundfish port sampling
W. Andrews	Elasmobranchs
K. Castle	Groundfish port sampling
E. Choromanski	General stock assessment and biology, flatfish, field technician
K. Cooke	Database technician
J. Fargo	Section Head, stock assessment and biology, flatfish
C. Grandin	Biologist, GIS, programmer, inshore rockfish
R. Haigh	Statistical and exploratory data analysis, thornyhead and slope rockfish
D. Haggerty	Lingcod
V. Hodes	Lingcod and elasmobranchs
G. Jewsbury	Seconded to salmon group
K. Castle	Groundfish port sampling
J. King	Lingcod, climate studies
B. Krishka	Biological data control and analysis, thornyhead and slope rockfish
R. Kronlund	Sablefish, analytical programs
L. Lacko	Hook and line database manager, GIS specialist, inshore rockfish
J. Lochead	Inshore rockfish stock assessment and biology
G. A. McFarlane	Groundfish population dynamics and biology, fish/ocean interaction, elasmobranchs
J. Martin	Inshore rockfish stock assessment and biology
W. Mitton	Sablefish
N. Olsen	Biologist/programmer/GIS, Shelf rockfish
K. Rutherford	Biologist/database manager, Shelf rockfish
J. Schnute	Stock assessment; mathematical analysis, mentoring, thornyhead and slope rockfish
A. Sinclair	Pacific cod assessment and ecosystem research
R. Stanley	Shelf rockfish stock assessment and biology, groundfish statistics.
M. Surry	Lingcod
G. Workman	Port sampling, Pacific Cod, Survey design
M. Wyeth	Sablefish stock assessment and biology
L. Yamanaka	Inshore rockfish stock assessment and biology