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Scientific advice for input to the Allowable Harm Assessment for Bocaccio

Avis scientifiques pour l'évaluation des dommages acceptables concernant le bocaccio

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Abstract

The B.C. population of bocaccio (*Sebastes paucispinis*) may be listed as "Threatened" under Canada's Species at Risk Act. If this occurs, Fisheries and Oceans, Canada will follow the SARA Permitting Framework and develop an Allowable Harm Analysis (AHA) for management of this population. In anticipation of this requirement, we have summarized the available scientific information on the bocaccio population as it relates to development of the AHA.

The organization of this document follows from the technical guidelines recommended for the National Assessment Process meeting that was conducted October 25-29, 2004 in Halifax. This summary is largely derived from analyses presented in two previous CSAS Research Documents on bocaccio. Analysis of the current status of bocaccio is limited to information on trends in relative abundance and distribution. The available data indicate that bocaccio continue to be widespread over their habitat and stable in abundance since the mid-1990's. Over the longer term, the population may have declined to about 25-100% of the abundance observed in the latter half of the 1970's, the earliest point in the available time series. Rebuilding from the current status depends on maintaining sufficient spawning biomass to take advantage of positive recruitment conditions.

The principal current threat to the population is catch from commercial fishing with most (90%) of the current annual catches of 300-330 t coming from the bottom trawl fishery. The remaining 10% comes from midwater trawling and the hook-and-line sector. Possible precautionary approaches could consider, as a first step, the capping of catches at the current levels of 300-330 t. If a more aggressive strategy is deemed appropriate, catches could be reduced through use of disincentives such as placing caps on the individual vessel/license quotas (IVQ's) and/or introducing fleet wide TAC's for bocaccio. Trawl fishers have already demonstrated the capacity to significantly reduce bycatch of this minor species in response to voluntary regulatory changes, including surrendering any catch of bocaccio at dockside.

While it is reasonable to argue that a reduction in catch may increase the likelihood or speed of the return to population levels of the 1970's, there are insufficient data to provide an analytic basis for predicting how much a given catch reduction will influence the likelihood or rate.

RÉSUMÉ

Il se peut que la population de bocaccio (*Sebastes paucispinis*) retrouvée dans les eaux de la Colombie-Britannique soit désignée comme menacée en vertu de la *Loi sur les espèces en péril* (LEP). Si cela est le cas, Pêches et Océans Canada suivra le cadre régissant la délivrance des permis en vertu de la LEP et fera une évaluation des dommages acceptables pour sa gestion. En prévision de cette exigence, nous résumons les données scientifiques disponibles sur cette population de bocaccio à cette fin.

L'organisation du document découle des lignes directrices techniques recommandées lors de la réunion du processus national d'évaluation, qui a eu lieu du 25 au 29 octobre 2004 à Halifax. Ce résumé repose en grande partie sur les analyses présentées dans deux documents de recherche du SCCS précédents portant sur le bocaccio. L'évaluation de l'état actuel de cette population se limite à de l'information sur les tendances dans l'abondance relative et la répartition. Les données disponibles indiquent que le bocaccio continue d'être répandu dans son habitat et que son abondance est stable depuis le milieu des années 1990. Il se peut que la population ait connu un déclin de 25 à 100 % par le passé par rapport à l'abondance observée vers la fin des années 1970, le point de départ de la série chronologique disponible. Le rétablissement de la population dépend du maintien d'une biomasse suffisante de reproducteurs afin de profiter des bonnes conditions de recrutement.

La principale menace qui pèse sur cette population à l'heure actuelle est la pêche commerciale; la plus grande partie des prises annuelles (90 %) de 300 à 330 t proviennent de la pêche au chalut de fond, l'autre 10 % étant récoltées au chalut méso-pélagique et à la ligne et hameçon. Comme première mesure de précaution, on pourrait imposer un plafond sur les prises, pour les limiter aux niveaux actuels de 300 à 330 t. Si une stratégie plus musclée est considérée comme appropriée, le niveau des prises pourrait être réduit par le biais d'éléments dissuasifs, comme l'imposition de plafonds sur les quotas individuels de bateau (QIB) et/ou l'introduction de TAC pour l'ensemble de la flottille. Les pêcheurs au chalut ont déjà démontré leur capacité de réduire nettement les prises accessoires de cette espèce de moindre intérêt en réponse à des modifications réglementaires, y compris la remise des prises de bocaccio à quai.

Bien qu'il soit raisonnable de soutenir qu'une réduction des prises pourrait mener à une augmentation de la probabilité ou du taux de retour aux niveaux d'abondance des années 1970, les données sont insuffisantes pour faire une analyse des prévisions de la mesure dans laquelle une réduction donnée des prises influera sur cette probabilité ou ce taux.

Introduction

The British Columbia (B.C.) population of bocaccio (*Sebastes paucispinis*) may be listed as "Threatened" under Canada's Species at Risk Act (SARA). If this occurs, Fisheries and Oceans, Canada (FOC) will follow the SARA Permitting Framework and develop an Allowable Harm Analysis (AHA) for management of this population. In anticipation of this requirement, we have developed the attached summary of scientific advice on the bocaccio population in B.C. waters.

The organization of this document follows from the technical guidelines recommended for the National Assessment Process (NAP) meeting conducted October 25-29, 2004 in Halifax (see Appendix 1). Unless otherwise noted, this summary is derived from the analyses presented in the two previous CSAS assessments on bocaccio (Stanley *et al*., 2001; Stanley *et al*., 2004), which are not repeated in this draft. The 2001 CSAS document provided the basis for the bocaccio status report published by the Committee on the Status of Wildlife in Canada (COSEWIC, 2002).

Phase 1 – Recovery Potential

1. Present/recent species trajectory

Commercial bottom trawl catch data are not reliable prior to 1996 and therefore cannot be used to track abundance. However, with the introduction of 100% observer coverage in 1996, the data collected since then are considered reliable and comparable. Bocaccio commercial catch rates appear stable since that date. The interpretation of recent trends in the available survey data is difficult due to the high level of uncertainty inherent in the relative biomass estimates for this species. Possible interpretations of the current data range from no detectable change since 1990 to the suggestion that indices since 2000 are stable but less than half the level observed in the 1990`s. Commercial and research catches by trawl and hook-and-line gear indicate that the distribution continues to be widespread over the continental shelf. These same activities also demonstrate a continued presence in enclosed waters and inlets.

2. Present/recent species status

The absolute abundance of bocaccio in B.C. waters is unknown, nor is there a time series of age or size composition. Current catches are about 300-330 t/y, which translates to a catch of about 70-80,000 specimens a year. Most of these specimens are mature or near mature, thus it can be assumed that many hundreds of thousands of late juvenile or adult specimens are present in B.C. waters, perhaps more than a million. Given the recent stability in abundance and the widespread distribution, extirpation does not appear to be an immediate concern.

Analysis of relative abundance over the longer term is limited to examining trends in spatial occupancy and the catch rates from two imprecise bottom trawl surveys for the south coast and one from Hecate Strait in the north coast. In the COSEWIC assessment, they recommended a "Threatened" status for the B.C. population, based primarily on the observed decline in the catch rates in the two surveys off the southwest coast of Vancouver Island (COSEWIC, 2002). The U.S. National Marine Fisheries Service (NMFS) triennial trawl survey conducted off the south and central west coast of Vancouver Island (WCVI) indicated a nominal decline of up to 98% from 1980 to 2001. An annual FOC shrimp trawl survey, operating also of the west coast of Vancouver Island, was interpreted as indicating a decline of about 67% from 1975 to 2001. Similar trends were observed in surveys of U.S. waters from the B.C./Washington State border to central California. The decline was attributed to a sustained period of poor recruitment and to overfishing, although a causal link with overfishing has not been demonstrated for B.C. waters.

The survey data were examined more closely in Stanley *et al*. (2004). With respect to the NMFS survey, it was noted that the high 1980's survey points were strongly leveraged by the catches in 1 or 2 tows in each year. The leverage was illustrated in the analysis by comparing the index in Canadian waters with an index calculated from the same survey in adjacent Washington State waters. The highest index value in this second series was 1989, attributable to a single tow. This value was two orders of magnitude larger than the index values that preceded or followed it. This disparity in the observed trends between adjacent areas illustrates the high level of uncertainty that is evident in the relative biomass estimates for this species.

More importantly, the re-analysis of the WCVI shrimp survey in Stanley *et al*. (2004) provided a very different view of the population history since the mid-1970`s than was emphasized in earlier documents. The different view is supported by three changes in the treatment and presentation of the data. First, Stanley *et al*. (2004) used a simple stratified estimator instead of the spatial analysis estimator presented in Stanley *et al*. (2001). The spatial analysis is appropriate for the analysis of shrimp catch rates, which tend to be continuously distributed, but Stanley *et al*. (2004) argued that a stratified area-weighted estimator was more appropriate for bocaccio, given its more patchy distribution. This change in methodology, however, produced only minor changes (Figure 1).

Second, Stanley *et al*. (2004) were not able to reconstruct the identical spatial index provided in Stanley *et al*. (2001). The difference related mainly to the estimate for 1979, which was about one order of magnitude lower in the re-analysis (Figure 1). The difference appeared to be caused by a data input error during the first analysis.

Third, Stanley *et al.* (2004) presented the WCVI shrimp survey with the points connected rather than as a scatter plot with a regression line drawn through the data points (compare Figs. 1 and 2). The 2004 graphical presentation emphasized the structure in the time series and demonstrated that there had been a period of lower abundance prior to the 1980's (aided by the lower 1979 value). The scatter-plot presentation used in earlier document (Figure 2) de-emphasized the structure in the time series.

These changes did not provide a substantially different overall interpretation from that presented earlier for the period from 1980 to the present. This is because the WCVI shrimp survey corroborates the NMFS survey in showing a major decrease in relative abundance of bocaccio since the early 1980's (Figure 3). However, with respect to defining a recovery target for this population, the apparent temporal structure in the WCVI shrimp survey index becomes more important. Aided, but not dependent on the re-analysis, the shrimp index indicates a clearly defined period of lower abundance prior to 1980, the period lacking from the NMFS survey. It was probably incorrect to ignore this structure as was done implicitly in (Figure 2) (see Figs. 18 and 19 from COSEWIC, 2002 and Stanley *et al*., 2001, respectively). The WCVI shrimp survey provides a different view of the earliest abundance for bocaccio and implies that the relative abundance observed in the early 1980's may have been the peak abundance over the nearly 30 years of available record.

Since it is not possible to determine the current status of the bocaccio population in absolute abundance, we suggest there are five distinct hypotheses on the present relative status of the population. The first hypothesis, which causes the greatest concern, is that the NMFS triennial survey can be interpreted as showing a decline of greater than 98% since 1980. While the estimate of the size of the decrease may vary, a similar trend over an equivalent period is reflected in the shrimp trawl survey and even from the Hecate Strait Assemblage bottom trawl survey (Figure 3). While each of these surveys is imprecise and highly influenced by a few tows, they indicate an agreement over this period, and are similar to the trends seen in various indices taken from U.S. waters to the south. It is this hypothesis that is emphasized in the COSEWIC Status report (COSEWIC, 2002).

The emphasis on a decline beginning from 1980 relies implicitly on the assumption that the abundance observed in the early 1980's represented a "beginning", "normal" or "healthy" level of abundance. This hypothesis arises because it is derived from the earliest data available from the NMFS survey. The WCVI shrimp survey, however, provides insight into an earlier period. This viewpoint was not well developed in the initial reports on this species.

The WCVI shrimp survey indicates that the early 1980's are more likely to be a peak period of abundance, given the available data spanning 28 years (1975-2003). Therefore, it is incorrect to view the apparent high abundance of the early 1980's as a reasonable recovery target.

The second hypothesis, noted in Stanley *et al.* (2001) and in COSEWIC (2002), indicated that the abundance had declined by approximately 70% over a 27-

year period. This estimate is derived from fitting a linear regression to the WCVI shrimp survey points. This is a more plausible view, in that it uses the longer time series, but it leads to an indefensible means for reconstructing the earliest relative abundance, and ignores the obvious structure in the longer time series. It is reasonable to argue for a return to abundance levels of the earliest period, but we do not view the endpoints of a linear regression as the best means for characterizing the size of the decline or defining the rebuilding target.

The third through fifth hypotheses treat the time series as representing levels or "steps". Mean index values for each of three surveys (NMFS[1], WCVI Shrimp, Hecate Strait Assemblage) were computed over a range of years and blocked into periods. This approach assumes that the average index over a block of years is a better indicator of the relative level of bocaccio biomass than fitting a model to the data. A number of different year block definitions were applied to the WCVI shrimp survey while only two blocks were applied to the NMFS and Hecate Strait Assemblage surveys (Table 1, Figs. 4-12). In every case, it was assumed that the period 1980-1989 represented a different level of biomass than the periods which preceded or followed that decade.

Simple averages were computed for each block of years except for the shrimp trawl survey for which we also applied an inverse variance weighting scheme in recognition that surveys in some years were more precise than others. The 2000 survey index was undefined for this weighting scheme because there had been no bocaccio observations and hence had a CV of zero. Two alternatives were used to fill in the missing CV value: one used the minimum CV observed for the series and the other used the mean CV value for the series. The substitution of the average CV for all surveys is probably preferable given that there is no trend in the observed CV's (Figure 11).

The third hypothesis treats each survey series as two steps (Table 1, Figs 4-8). This was achieved by dividing each of the available series into two periods between 1989 and 1990, calculating a mean index for each period relative to the mean of the entire survey series, and comparing the mean for the second or last period to the mean of the first period. All five series show a change in the mean relative index from the first to the second period, ranging from –34% for the WCVI shrimp survey to –98% for the NMFS-Vancouver survey.

The fourth hypothesis is based on the observation that the shrimp time series provides insight into an earlier stage by dividing the entire period of 1975-2003 into three stages (Table 1, Figure 9). Various stage definitions were tried, but all had similar outcomes. The stages presented herein have breakpoints between 1979 and

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[1] Note: data from the NMFS survey were treated as three surveys: 1) U.S.-Vancouver included only the data from northern Washington; 2) U.S.-Canada included only the data from north of the U.S. border and 3) U.S.-Vancouver combined the data from both sub-regions.

1980, and 1989 and 1990 (1975-1979, 1980-1989, 1990-2003). Mean stage indices relative to the entire series mean were calculated and the mean for stages 2 and 3 were compared with the mean for stage 1. This viewpoint indicates virtually no decline (2%) from the first to third stage.

The fifth and final hypothesis uses four steps in emphasizing that abundance in the most recent period from 2000-2003 may be lower than the abundance observed in the 1990's (Table 1, Figure 10). This approach, depending on the weighting, indicates a decline of 57-74% or about 65% from the first stage, or a decline of about 26% from mean abundance. The values varied only modestly with small changes in the breakpoints. The effect of inverse variance weighting depended on whether we used the minimum or mean CV for the 2000 index value (Table 1, Figs. 11 and 12).

In summary, if one uses the longer time series of the WCVI shrimp survey, and view the series as two, three or four stages, then current abundance relative to: 1) earliest abundance, or (2) mean abundance, can be expressed as the following proportions:

	1) Recent abundance relative to overall mean abundance	2) Recent abundance relative to earliest abundance in earliest period
2-step	0.80	0.66
3-step	0.80	1.06
4-step	0.26	0.35
4-step*	0.18	0.26
4-step**	0.27	0.43

*Inverse variance weighted - $CV_{2000} = \min\left(CV_{1975\Rightarrow1999}, CV_{2001\Rightarrow2003}\right)$

**Inverse variance weighted $CV_{2000} = \text{mean}\left(CV_{1975\Rightarrow1999}, CV_{2001\Rightarrow2003}\right)$

These views place estimates of current abundance at 18% to 80% of the long term mean, or 26% to 106% of the earliest period in the series. As mentioned earlier, the COSEWIC decision was primarily based on the observed decline in the NMFS survey. This corresponded to an "Endangered" classification; however, COSEWIC relaxed this classification by one level because the available indices represented only a limited portion of the coast.

3. Expected order of magnitude/target for recovery

Measuring sticks

Prior to defining a recovery target, we must identify the options for "measuring sticks" which are available to define a target. Since estimating absolute abundance for bocaccio will not be possible for the foreseeable future, and bocaccio already appear to fully occupy their available habitat, we are restricted to tracking abundance by following relative abundance over time. While commercial trawl catch rates have been used to track relative bocaccio abundance, it is likely that management measures imposed to mitigate the impact of this fishery on this species will also affect the catch rates by increasing avoidance and thus limit the utility of this monitoring tool. Therefore, we emphasize that the only available measuring stick for this species will be survey catch rates.

The NMFS survey has discontinued working in Canadian waters. This is unfortunate because it would be better to track rebuilding in terms of the same measuring sticks (including the same biases) that were used to monitor the decline. However, the annual WCVI shrimp survey is still continuing and the Science Branch of FOC in conjunction with the fishing industry has initiated a comprehensive research survey plan for B.C. waters. This will not only replace the coverage of the Southwest Coast of Vancouver Island, but will include surveys over virtually the entire trawlable bottom in B.C. waters (Stanley *et al*., in prep). We expect that at least five of these new surveys will provide usable tracking of relative bocaccio abundance. Catch rate information for bocaccio is now also being collected from the annual International Pacific Halibut Commission longline survey and will be collected in other hook-and-line surveys that are being initiated (Stanley *et al*., in prep). The recovery target can be defined in terms of an increase in the catch rates from these existing or planned surveys. This target can be altered to make the strategy more or less precautionary.

Recovery target

By using the reverse logic that a population is "Not at Risk" (NAR) if it is at least 70% of 1) the earliest recorded abundance, or 2) at the average abundance over the time series (COSEWIC, 2003), we have a basis for determining a recovery target. From the discussion above this indicates that the bocaccio population in B.C. is, at best, NAR, and at worst, requires a three-fold increase from current relative abundance levels.

	1) Recent abundance relative to overall mean abundance	2) Recent abundance relative to abundance in earliest period
2-step	Not at Risk	0.66 ? 0.70 = 6% increase from the present
3-step	Not at Risk	Not at Risk
4-step**	0.27 ? 0.70 = 159% increase from the present	0.43 ? 0.70 = 63% increase from the present

**Inverse variance weighted $CV_{2000} = \text{mean}\left(CV_{1975 \Rightarrow 1999}, CV_{2001 \Rightarrow 2003}\right)$

A review of all survey evidence suggested that the bocaccio population in B.C. may be at lower risk than assessed by COSEWIC but a more precautionary approach may be warranted given that:

- bocaccio abundance is at the lowest point in the time series;
- there is evidence for a pronounced decline since 1980 from California to northern B.C.;
- the poor recruitment for most groundfish species during the 1990's provides a mechanism for a decline.

It therefore is reasonable to propose that some rebuilding of this stock is justified, probably on the order of a doubling or tripling of the current levels. However, a policy that targets a return of the bocaccio population to the levels observed in the early 1980's does not seem appropriate.

4. Time frame for recovery to the target.

Recovery of the bocaccio population appears feasible. The only demonstrated anthropogenic threat to bocaccio is fishing mortality, which can be reduced, although no causality between fishing mortality and a decline in abundance has been established in Canadian waters. The U.S. assessments of bocaccio indicate that U.S. harvests may have had an impact on this population, but the level of harvest in the U.S. has also been significantly reduced.

A reasonable policy would be to wait for good recruitment while ensuring that spawning biomass is not radically different from the biomass levels observed in the 1970's which led to the peak biomass levels observed in the early 1980's. The population is widespread in B.C. so it is not reliant on a positive recruitment environment in a specific locale. There are also some signs that the oceanographic environment may have changed at the end of the 1990's from conditions that led to poor recruitment from the 1980's to mid-1990's (McFarlane, 2003). There are presently signs of improved recruitment for many groundfish species in B.C. and U.S. waters. U.S. assessments have suggested that the 1999 year-class of bocaccio appears to be strong which helps to provide a positive prognosis for recovery in U.S. waters even with a significant commercial fishery (MacCall 2003a, b).

We suggest that recovery is highly probable in the long run, but that the time frame is unpredictable. It could happen suddenly in response to 1-2 large year classes, but we cannot predict when or how often these year classes will appear. Large year classes are infrequent and unpredictable for bocaccio and rockfish in general, with an expected frequency of about once in a decade.

Phase 2A – Acceptable limits of harm

5. What is the maximum human-induced mortality which the species can sustain and not jeopardize survival or recovery of the species.

Current human induced mortality appears to be confined to fishery mortality. Since we can assume that virtually all fish will die following capture, human-induced mortality is equivalent to the total catch from all fisheries. Current catch levels appear associated with a stable population, albeit not rebuilding. The large number of specimens indicates that extirpation is not an issue at this time.

Strictly speaking, the maximum human-induced mortality consistent with survival or recovery would be realized by capping current catches**.** This assumes that current mortality is not leading to further decline and that there is sufficient spawning biomass to take advantage of any improvement in the recruitment environment and notes that the recovery targets do not reflect a large increase from current levels. Thus, it can be argued that capping current levels of catch would be a precautionary approach over the short term provided there are no further indications of decline.

A more precautionary approach would be to reduce catches because it is also reasonable to argue that reducing catches would increase the likelihood of a significant increase in abundance and, possibly, the rate of the increase. These potential benefits could be realized by:

- increasing the likelihood that the spawning biomass does not decline further;
- increasing the likelihood that spawning biomass will increase even if the period of below average recruitment continues;
- providing a buffer to account for measurement error in the estimation of catches;
- providing some insurance if the relative decline since the 1970's is greater than inferred from the indices.

Unfortunately, data are too limited to derive the relationships between the effect of a given catch reduction on the likelihood or rate of recovery, let alone estimating the uncertainty around such a prediction.

6a. Potential sources of mortality or harm in Canada?

The only demonstrated significant source of human-induced mortality in Canadian waters is fishing.

6b. What are the major potential sources of mortality outside Canada?

The major source of human-induced mortality outside of Canada is fishing in U.S. waters to the south. However, catches of bocaccio have been severely reduced in recent years owing to closures to trawling of large portions of the U.S. continental shelf. The relationship of the Canadian bocaccio population to stocks outside of Canadian waters is unknown.

Phase 2B – Quantify Harm

7. For those factors not dismissed (in 2A-Question 6), quantify to the extent possible the amount of mortality or harm caused by each activity.

Current coastwide catches are about 300-330 t/y. The groundfish trawl fishery catches about 240-300 t (90%), which is usually retained for sale. The remaining 30 t of catch is generated largely in the hook-and-line fisheries. This catch is incidental and usually discarded. Negligible amounts are caught during recreational and First Nations fisheries. This species is not usually considered desirable.

8. Aggregate total mortality/harm attributable to all human causes and contrast with that determined in Question 5.

See answers to Questions 5, 6 and 7.

Phase 3 – Options

9. Consider alternatives to the activity that would reduce the impact on the stock/population.

- **Develop an inventory of all reasonable alternatives to the activities in #7, but with potential for less impact. (e.g. different gear, different mode of shipping)**
- **Document expected mortality/harm rates of alternate activities**
- **Document nature and extent of major ecosystem effects caused by the alternate activities (e.g. habitat impacts, impacts on dependent predators, etc.)**

- **Document expected costs and benefits of options which could be adopted, at least when options may look promising**

Other than exploring the means for reducing catch within existing fisheries, we know of no alternative opportunities for mitigative action.

10. Consider feasible measures to be taken to minimize the impact of the activity on the stock/population or its critical habitat or the residences of its individuals

- **Develop an inventory of all feasible measures to minimise the impacts of activities in #7**
- **Document the expected effectiveness of the mitigation measures for permitted activities**
- **Document the expected costs and benefit of options which could be applied, at least when options may look promising**

We are not aware of "a completely different way" to conduct the activities of fishing for the wide array of demersal species. However, we suggest that through use of fisher knowledge about the areas and times most prone to bocaccio capture, there is a significant potential to reduce catches of bocaccio without unduly affecting the catch of target species. This capacity is augmented by the real-time communication about catch composition that now takes place on the fishing ground. This potential can be realized given the current 100% observer coverage in conjunction with catch disincentives imposed by management. We leave it to managers to specify feasible disincentives. These might include, by example, caps on the IVQ's for bocaccio or a collective fleet TAC as is done for Pacific halibut. An additional tool might be imposing time/area closures on known bocaccio hotspots. These measures would be best determined in consultation with fishers.

Similar principles could be applied to the hook-and-line fisheries, although the less than 100% observer coverage in this fleet makes it more difficult to be confident that such mitigation measures would be effective. Fortunately, this fishery only accounts for about 10% of the total B.C. bocaccio catch, so it may be sufficient to simply stop catches from increasing in the hook and line fisheries. It should also be noted that this sector is planning to significantly increase the level of monitoring.

We cannot provide advice on the degree of catch reduction that such initiatives would generate but analyses of B.C. trawl fishery data indicate that trawlers have demonstrated considerable ability to modify incidental catch rates of other non-target species in response to changes in trawl quotas for yelloweye rockfish (*S. ruberrimus*), shortraker rockfish (*S. borealis*) and rougheye rockfish (*S. aleutianus*) (Branch and Hilborn, in prep). We note that, since abundance has recently been stable, managers have time to evaluate the effects of initial measures.

Trawl fishermen have already implemented voluntary measures in the current fishing year to reduce the catch of bocaccio in the coastwide demersal fishery (B. Turris, pers. comm[2].). These measures include the voluntary surrender of bocaccio at dockside and the avoidance of known areas of higher bocaccio abundance. The effectiveness of these measures is measurable because of the current policy of 100% observer monitoring in this fishery. Preliminary analysis of the partial catch of bocaccio to date (1 April 2004 to 19 October 2004) indicates that the total trawl catch of bocaccio, including discards, is likely to be significantly less than recent trawl catches (A. MacDonald, pers. comm.[3]). This represents a significant reduction from the previous catch levels in this fishery between 240-300 t/y and is indicative of the potential benefits available from the management measures which can be implemented in this fishery.

11. Consider activities that will not jeopardize the survival or recovery of the stock/population and document:

- **The expected mortality or harm for various scenarios carried over from #9 and/or #10 are below that determined in #5 and;**
- **The projected population trajectory under the various scenarios indicates that survival or recovery is not in jeopardy, considering cumulative sources of impact.**

The expected mortality/harm will be equal to the total catch. This in turn can be controlled or reduced through the imposition of catch limits, whether they are a fleet IVQ or "bycatch" limit. With respect to the expected population trajectory, see answer to Question 5.

<u>If a reduction in catch is considered warranted, then the choice of the target level of catch will be arbitrary. The available information is too limited to provide an analytic basis for choosing a specific harvest related to a target level of abundance.</u> We advise that, since there does not appear to be an urgent need for a severe response, catch reductions can be increased incrementally if the population does not appear to be responding.

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12. Options and recommendations regarding permits (for fishing research, aquaculture, other activities), including rationales, relevant conditions to ensure (9), (10), and (11) are covered, and performance measures

These options and recommendations await a decision on the magnitude of the response.

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Table 1. Relative mean values for three surveys that have indexed bocaccio over the period 1975-2003, using the indicated period definitions. An inverse weighting scheme based on the square of the survey CVs was applied to the four-step WCVI shrimp survey averages to account for differences in survey reliability. Two options for filling in the CV for the 2000 index (where CV=0) were tried: one with the minimum CV of the series and the other with the mean CV of the series.

Survey	**Step function type**	**Index period**	**Recent index value relative to mean of all survey indices**	**Recent index value relative to 1st period index value**
Canada-Vancouver	2-step	1980-1989	2.14	1.00
		1990-2001	0.14	0.07
US-Vancouver	2-step	1980-1989	2.28	1.00
		1990-2001	0.04	0.02
Total-Vancouver	2-step	1980-1989	2.21	1.00
		1990-2001	0.09	0.04
WCVI shrimp	2-step	1975-1989	1.21	1.00
		1990-2003	0.80	0.66
Hecate St. Assemblage	2-step	1984-1989	2.89	1.00
		1990-2003	0.29	0.10
WCVI shrimp	3-step	1975-1979	0.76	1.00
		1980-1989	1.50	1.99
		1990-2003	0.80	1.06
WCVI shrimp (no weights)	4-step	1975-1979	0.76	1.00
		1980-1989	1.50	1.99
		1990-1999	1.02	1.35
		2000-2003	0.26	0.35
WCVI shrimp	4-step*	1975-1979	0.69	1.00
Inverse CV^2 weights and		1980-1989	1.52	2.20
$CV_{2000} = \min(CV_{1975 \Rightarrow 1999}, CV_{2001 \Rightarrow 2003})$		1990-1999	1.43	2.07
		2000-2003	0.18	0.26
WCVI shrimp	4-step**	1975-1979	0.63	1.00
Inverse CV^2 weights and &		1980-1989	1.39	2.20
$CV_{2000} = \text{mean}(CV_{1975 \Rightarrow 1999}, CV_{2001 \Rightarrow 2003})$		1990-1999	1.31	2.07
		2000-2003	0.27	0.43

*Inverse variance weighted - $CV_{2000} = \min(CV_{1975 \Rightarrow 1999}, CV_{2001 \Rightarrow 2003})$

**Inverse variance weighted $CV_{2000} = \text{mean}(CV_{1975 \Rightarrow 1999}, CV_{2001 \Rightarrow 2003})$

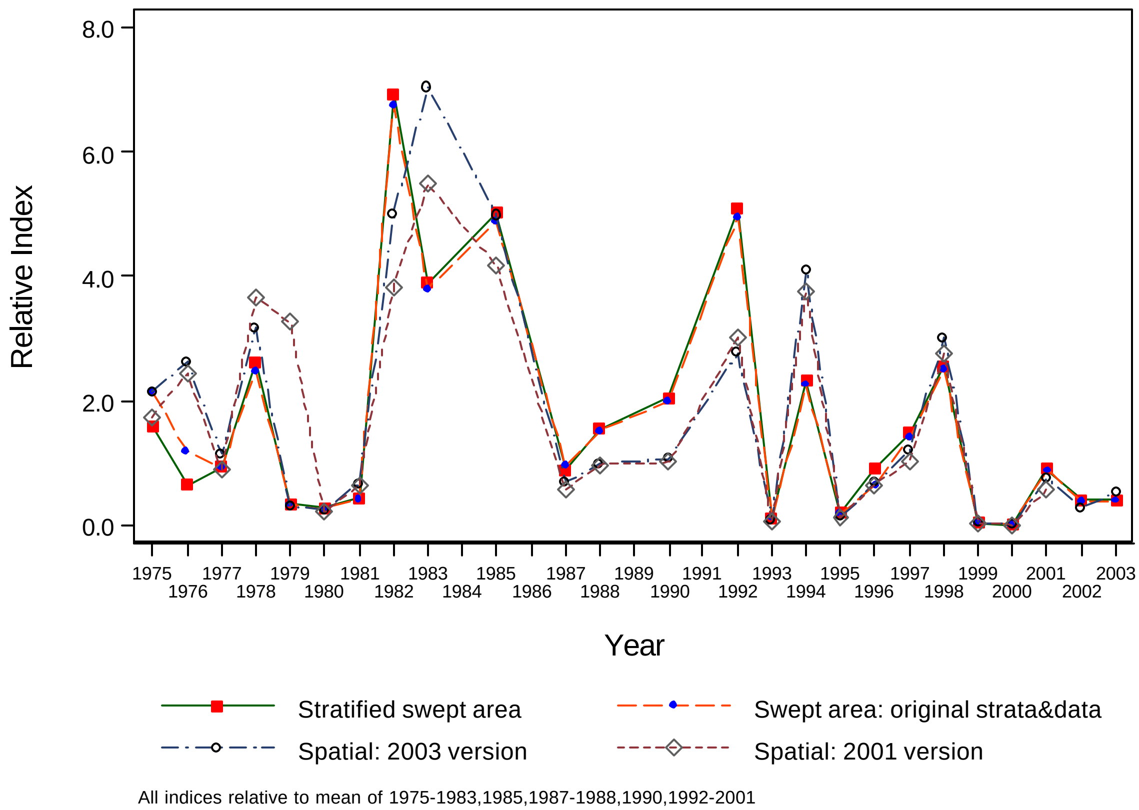

Figure 1. Comparison of a range of biomass indices using the WCVI shrimp trawl survey data: a) swept area using the stratification that was adopted by Starr *et al.*, 2002; b) swept area using the original survey stratification and without dropping any tows; c) a recalculated spatial shrimp index and d) the original spatial index used in 2001 (from Stanley *et al.*, 2004).

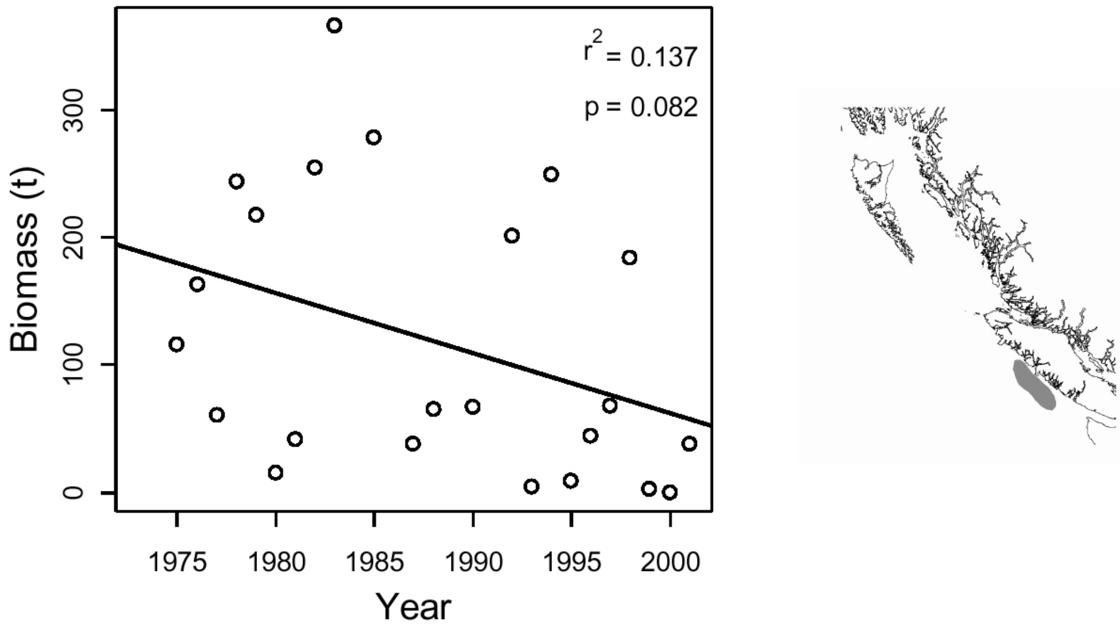

Figure 2 Bocaccio biomass estimates from the WCVI shrimp survey. The shaded region on the inset chart indicates the area that was surveyed (from Stanley *et al* 2001 and COSEWIC 2002).

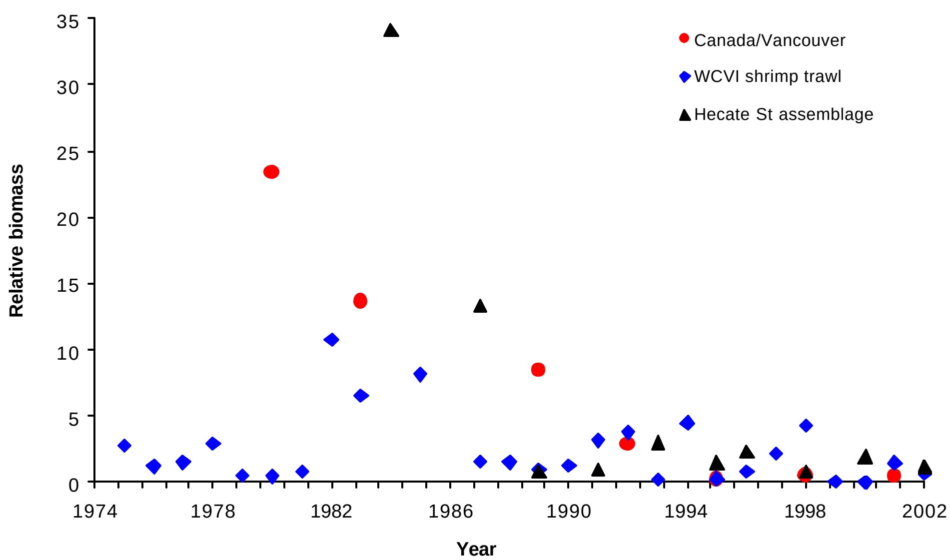

Figure 3 Comparison of the three available sets of trawl survey data for bocaccio in Canadian waters: a) NMFS survey for the Canada/Vancouver region; b) WCVI shrimp trawl survey; c) Hecate St. Assemblage bottom trawl survey. All survey indices have been standardized relative to the geometric mean of the 1989, 1995 and 1998 indices, the only years of overlap in these surveys (from Stanley *et al.*, 2004).

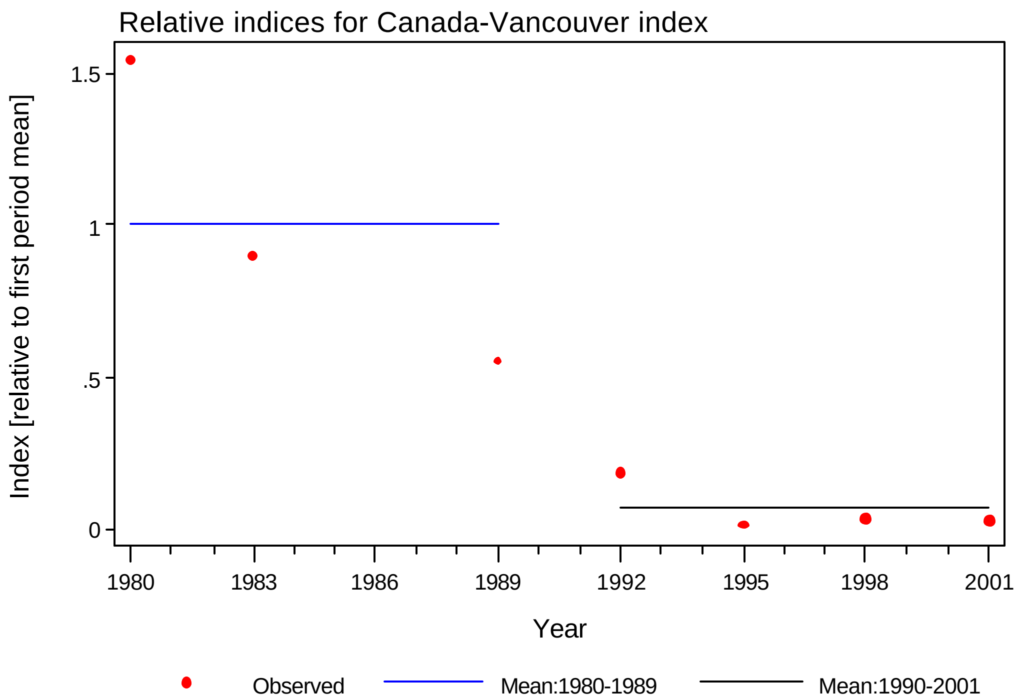

Figure 4. Two step function for the NMFS Canada-Vancouver survey index, plotted relative to the mean 1980-89 survey estimates.

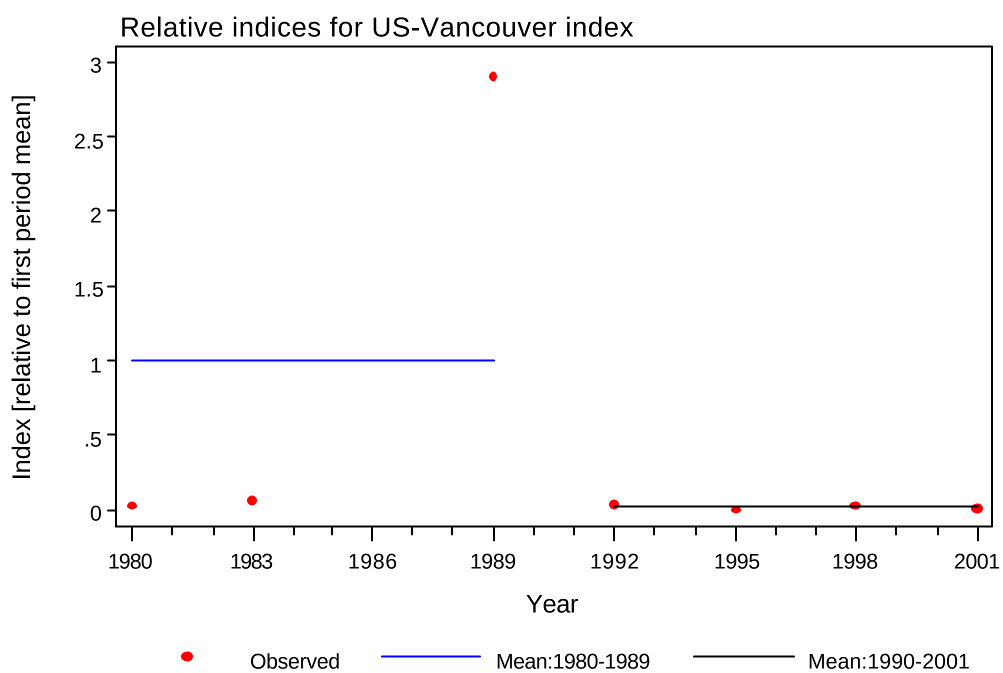

Figure 5. Two step function for the NMFS Canada-Vancouver survey index, plotted relative to the mean 1980-89 survey estimates.

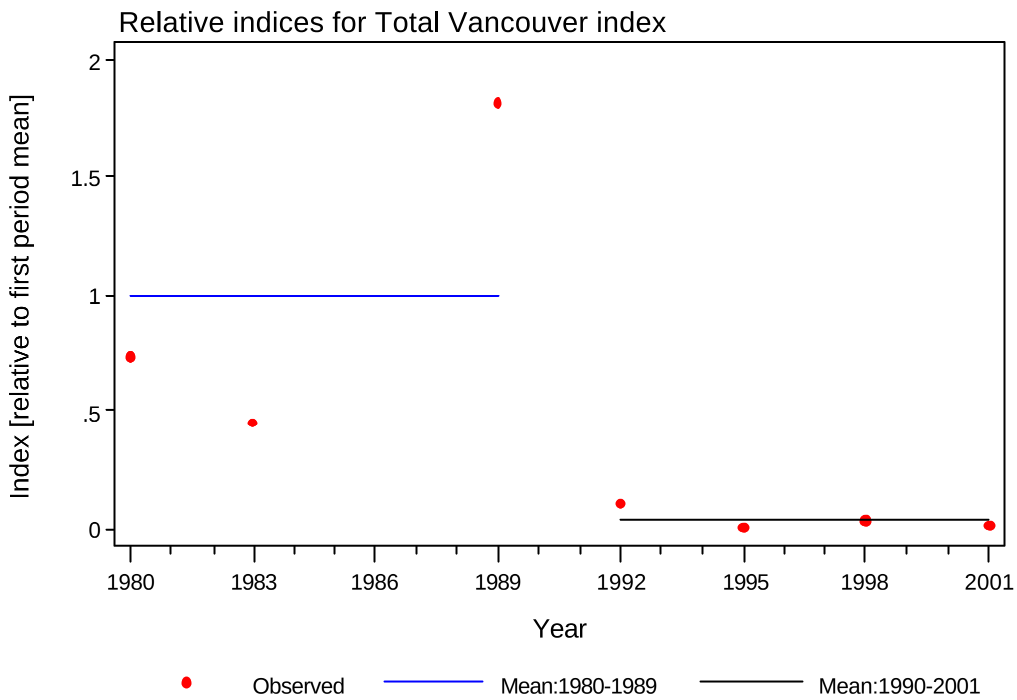

Figure 6. Two step function for the NMFS Total-Vancouver survey index, plotted relative to the mean 1980-89 survey estimates.

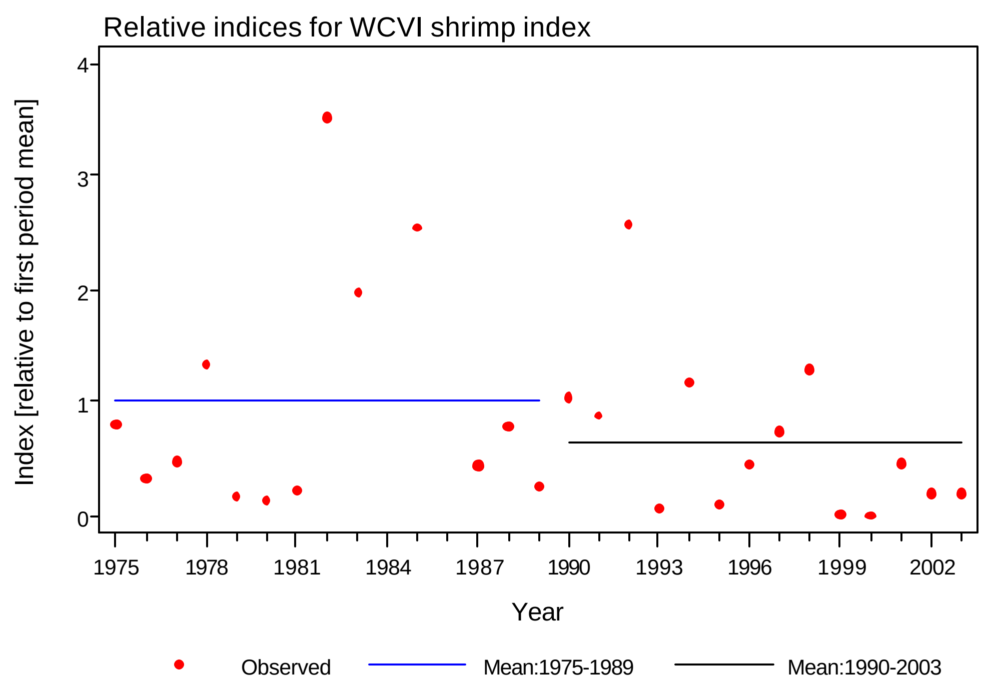

Figure 7. Two step function for the WCVI shrimp survey index, plotted relative to the mean 1975-89 survey estimates.

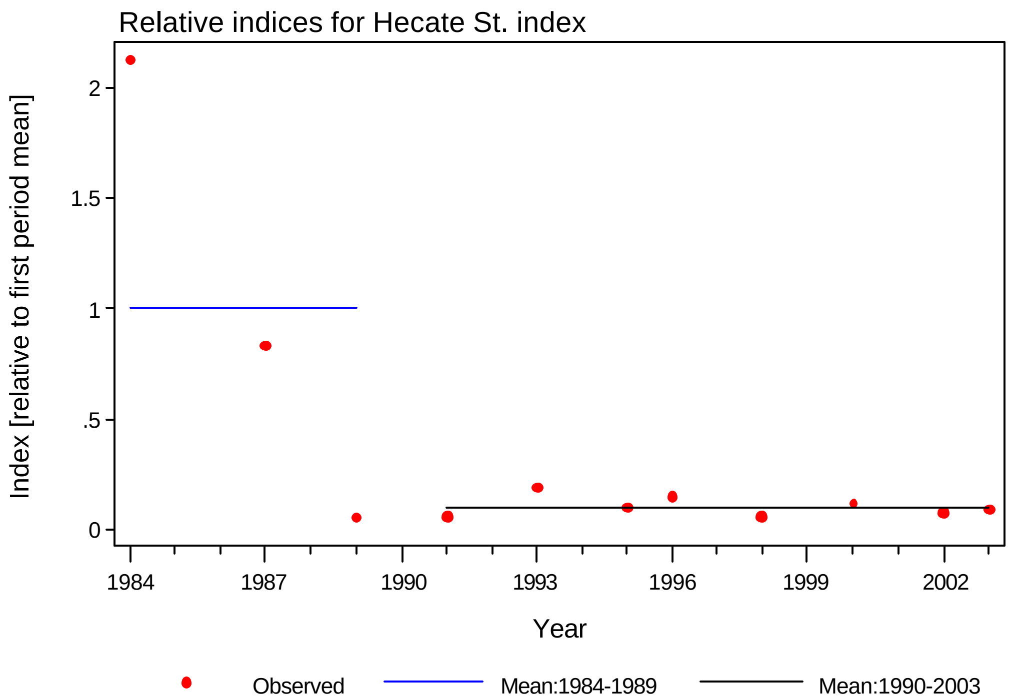

Figure 8. Two step function for the Hecate St. Assemblage survey index, plotted relative to the mean 1984-89 survey estimates.

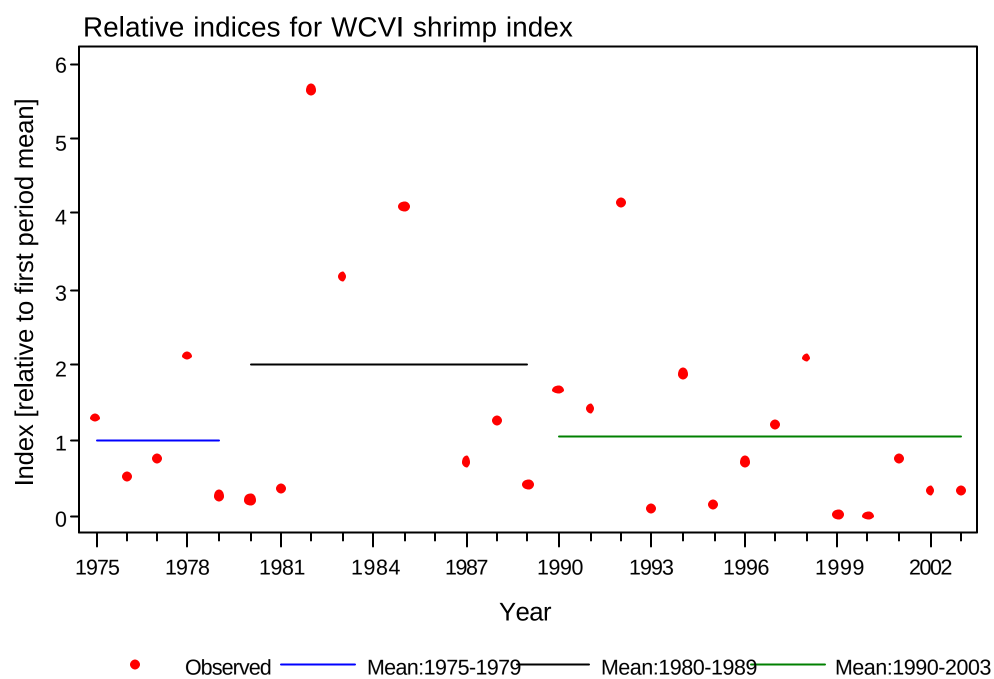

Figure 9. Three step function for the WCVI shrimp survey index, plotted relative to the mean 1975-79 survey estimates.

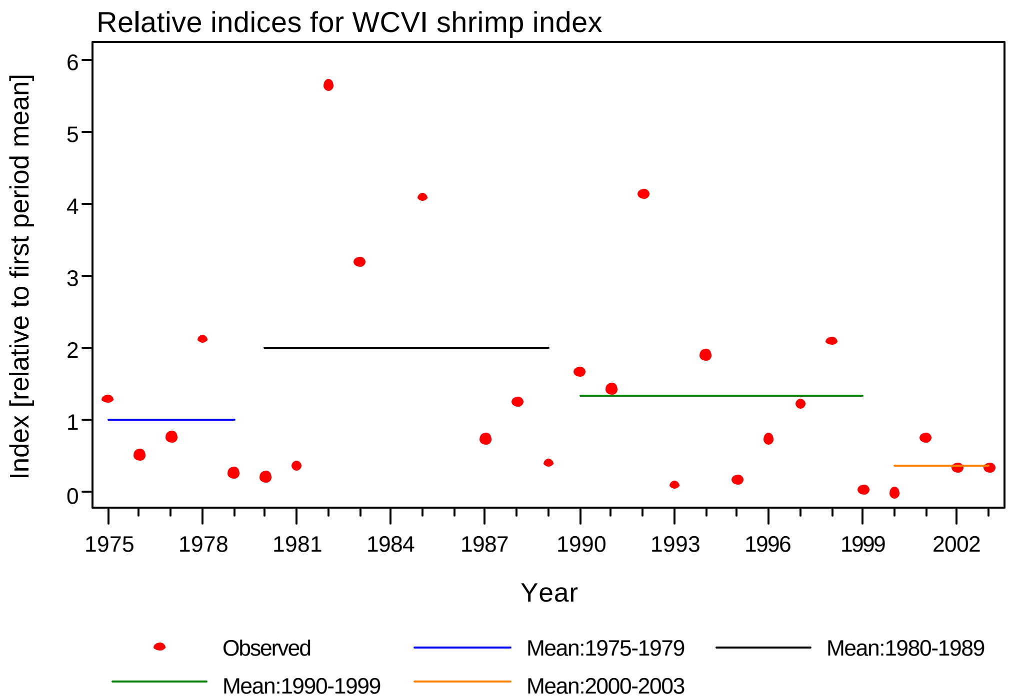

Figure 10. Four step function for the WCVI shrimp survey index, plotted relative to the mean 1975-79 survey estimates, un-weighted by variance.

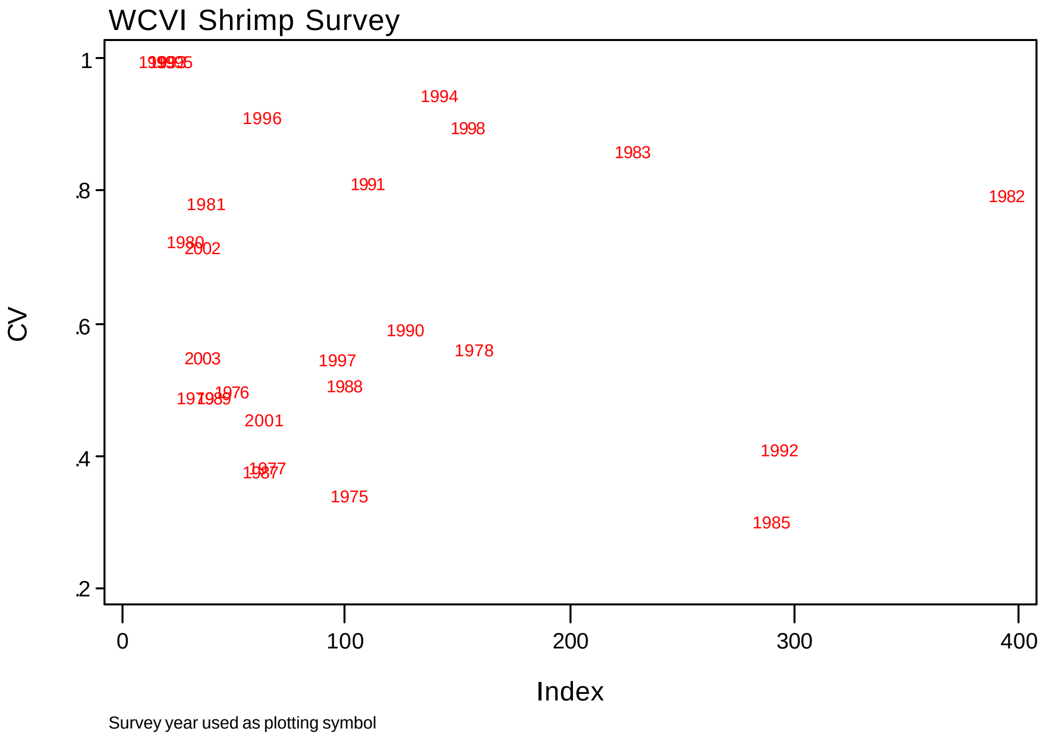

Figure 11. Mean survey values are unweighted. Plot of the bocaccio index against the CV for all the WCVI shrimp survey. indices.

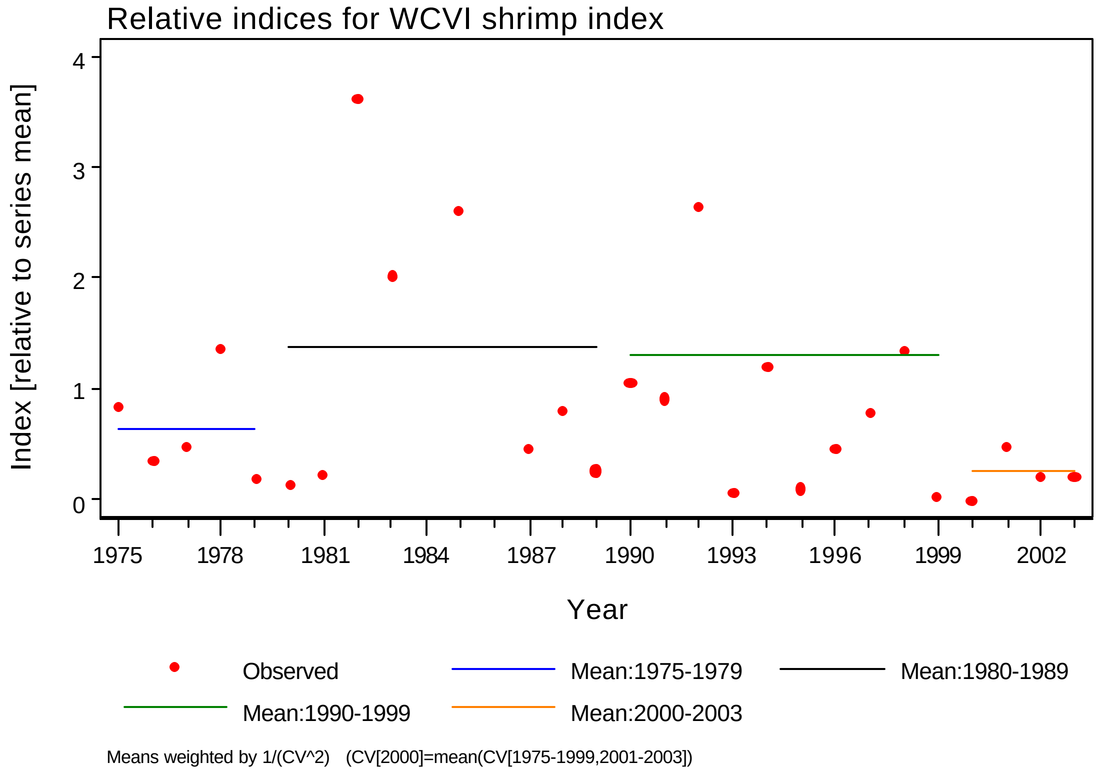

Figure 12. Four step function for the WCVI shrimp survey index, plotted relative to the mean 1975-79 survey estimates, weighted by the inverse of the CV^2 for each survey. The mean CV for the entire series (0.653) was used for the 2000 index because CV_{2000}=0.

Appendix 1: Terms of Reference, National Assessment Process (NAP) Meeting, Determination of Allowable Harm under SARA – Finfish, October 25-29, 2004, Lord Nelson Hotel, Halifax, NS

COSEWIC has recommended that four finfish stocks/populations be listed under Canada's Species at Risk Act (SARA). The four are:

1. Atlantic cod - Newfoundland and Labrador population (2GH, 2J3KL, 3NO) – Endangered;
2. Atlantic cod – Laurentian North population (3Ps, 3Pn4RS) – Threatened;
3. Cusk – Threatened;
4. Bocaccio – Threatened.

Background

SARA authorizes competent ministers (the Minister of the Environment and the Minister of Fisheries and Oceans) to enter into an agreement or issue a permit authorizing otherwise prohibited activities affecting a listed wildlife species, any part of its critical habitat, or the residences of its individuals. Sections 73-78 of the Act set out the conditions under which an agreement may be entered into or a permit issued, as well as the nature of the terms and conditions that may be included in such permits and agreements.

What activities may be authorized?

Under section 73(2) of SARA, authorizations may only be issued for one or more of the following purposes:

(a) the activity is scientific research relating to the conservation of the species and conducted by qualified persons;
(b) the activity benefits the species or is required to enhance its chance of survival in the wild; or
(c) affecting the species is incidental to the carrying out of the activity

Under what circumstances are activities authorized?

Section 73(3) establishes that authorizations may be issued only if the competent minister is of the opinion that all three of the following pre-conditions are met:

(a) all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;
(b) all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and
(c) the activity will not jeopardize the survival or recovery of the species.

Meeting Objective

The objective of the meeting will be to determine, for each stock/population,
a) whether or not allowable harm can be permitted without jeopardizing the survival or recovery of the population and, if so,
b) what alternatives to the activity would best reduce the impact?
c) what feasible measures would need to be implemented to mitigate any adverse effects of the best alternatives; and
d) what levels of those activities could be undertaken without jeopardizing the survival or recovery of the population.

The results of this meeting will be used to inform the Minister's decision on whether to add the species in question to the legal list (Schedule 1) of SARA.

Meeting Framework

The meeting is structured around the **Framework for DFO to Address Permitting Requirements Under Section 73 of SARA.** This framework is designed to describe conditions that would allow human activities to occur without jeopardizing survival or recovery of the species. The framework outlined below divides logically into three phases. Steps 1-4 (Phase 1) are an initial scoping of whether recovery of the species would be feasible, if human activities which affect the species were to continue. Steps 5-8 (Phase 2) then scope out the important human activities which affect the species. If Phase 1 determines that there is scope for some human-induced impact, then Phase 2 identifies the activity-specific boundary conditions within which they would have to operate to not jeopardize survival or recovery. If Phase 1 determines that there is no scope for human-induced impact, then Phase 2 identifies those human activities which would have to be curtailed or modified to cause negligible impacts, were the species to be listed. Steps 9-12 (Phase 3) then develop the specific options for those activities, consistent with the provisions of Section 73. Many of the steps (particularly 1-5, 8 and 11) require science-based inputs, which must be subjected to inclusive but thorough quality control/peer review. This does not mean that the framework will only be applied to species where we are data and knowledge rich. Sometimes the best information available will be qualitative or even descriptive. However, as long as it is the "best" information available, it meets the needs of the process, and warrants quality checking. **The implementation of the steps in the framework will be aided by a set of Technical Guidelines**.

Phase 1 - Recovery Potential (must document the degree and nature of uncertainties)

1. Present/recent species trajectory
2. Present/recent species status
3. Expected order of magnitude / target for recovery
4. Time frame for recovery to the target

Phase 2A - Acceptable limits of Harm

5. Maximum human-induced mortality which the species can sustain and not jeopardize survival or recovery of the species?

6. Potential sources of mortality/harm. Consider:

    - Directed fishing (with or without a quota) for a listed species
    - Bycatch in fisheries directed at other species
    - Detrimental impacts on habitats by fishing activities
    - Direct mortality by permitted habitat alterations
    - Detrimental alteration of habitats by permitted activities
    - Ecotourism & recreation
    - Shipping & transport & noise
    - Fisheries on food supplies
    - Aquaculture; Introductions & Transfers
    - Scientific research
    - Military activities

Phase 2B - Quantify Harm

7. For those factors (in B above) not dismissed, quantify to the extent possible the amount of mortality or harm caused by each activity.

8. Aggregate total mortality/harm attributable to all human causes and contrast with that determined in Question # 5.

Phase 3 – Options (to be developed by Fisheries & Aquaculture Management in consultation with Science, academics, NGOs & industry.)

9. Consider alternatives to the activity that would reduce the impact on the stock/population.
    - Develop an inventory of all reasonable alternatives to the activities in #7, but with potential for less impact. (e.g. different gear, different mode of shipping)
    - Document expected mortality/harm rates of alternate activities
    - Document nature and extent of major ecosystem effects caused by the alternate activities (e.g. habitat impacts, impacts on dependent predators, etc.)
    - Document expected costs and benefits of options which could be adopted, at least when options may look promising

10. Consider feasible measures to be taken to minimize the impact of the activity on the stock/population or its critical habitat or the residences of its individuals
    - Develop an inventory of all feasible measures to minimize the impacts of activities in # 7
    - Document the expected effectiveness of the mitigation measures for permitted activities
    - Document the expected costs and benefit of options which could be applied, at least when options may look promising

11. Consider activities that will not jeopardize the survival or recovery of the stock/population and document:
    - The expected mortality or harm for various scenarios carried over from #9 and/or #10 are below that determined in #5 and;
    - The projected population trajectory under the various scenarios indicates that survival or recovery is not in jeopardy, considering cumulative sources of impact.

12. Options and recommendations regarding permits (for fishing research, aquaculture, other activities), including rationales, relevant conditions to ensure 9, 10, and 11 are covered, and performance measures.

E) Output

- Summary results of the framework, which will go on the CSAS website as An Allowable Harm Status Report for each stock/population.
- Any Research Documents and the Proceedings for each stock/population will also go on the CSAS website.
- Any directive, conclusions or advice to FAM with regard to the meeting objectives.