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2009 Expert Review Panel Report - Review of blue cod potting survey in New Zealand

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TABLE OF CONTENTS

PLAIN LANGUAGE SUMMARY

The New Zealand Ministry of Fisheries (MFish) convened a review of New Zealand blue cod potting surveys on 16 and 17 April 2009. The review included: presentations by Expert Panel members about potting surveys; presentations by the scientists working on the New Zealand blue cod potting surveys; questions and discussion about the blue cod surveys; and conclusions from the Expert Panel. This report summarises the conclusions of the Expert Panel, relative to the Panel terms of reference.

This review occurred before the Fisheries Science Review series began, so it is being published retrospectively, to make the information (which is still relevant to blue cod science) more easily available.

EXECUTIVE SUMMARY

Stephenson, P.[1]; Sedberry, G.[2]; Haist, V.[3] (2024). Expert Review Panel Report - Review of blue cod potting survey in New Zealand.

***New Zealand Fisheries Science Review 2024/02*. 15 p.**

The New Zealand Ministry of Fisheries (MFish) convened a review of New Zealand blue cod potting surveys on 16 and 17 April 2009. The review included: presentations by Expert Panel members about potting surveys; presentations by the scientists working on the New Zealand blue cod potting surveys; questions and discussion about the blue cod surveys; and conclusions from the Expert Panel. This report summarises the conclusions of the Expert Panel, relative to the Panel terms of reference.

This review occurred before the Fisheries Science Review series began, so it is being published retrospectively, to make the information (which is still relevant to blue cod science) more easily available. It is based on a version of the report dated 14 May 2009.

[1] Division of Forestry and Wildlife
[2] National Oceanic and Atmospheric Administration
[3] Haist Consultancy

1. Management Objective

1.1 Fit for purpose

In general, the survey is adequate to address the management objective (i.e., to monitor changes in the abundance and biological characteristics of blue cod populations supporting key recreational fisheries). However, the survey estimates only reflect the survey areas and should not be extrapolated to a larger area. Given that future management measures may change the distribution of recreational fishing effort, it may be worth considering extending the range of these surveys. Estimated CVs for surveys tend to be quite small, so it may be possible to re-allocate some of the current survey effort to additional strata without significantly degrading the confidence in the abundance estimates.

The reliability of the abundance estimates is unknown. CVs are low, but environmental or population demographic effects may influence blue cod vulnerability to the pot survey. Anecdotal information suggests that small blue cod may avoid pots when there are large cod in the pot. If that is occurring, vulnerability may change with changes in fishing pressure (and hence, the size/age structure of the population). We recommend a study to investigate demographic influences on vulnerability (possibly visual survey). Z estimates are likely less affected by changes in vulnerability to the potting gear.

1.2 Informing other management objectives

We were not provided information about additional management objectives.

If a management objective were to assess the effect of a regulation change, say a reduction in daily bag limits, it may be useful to obtain annual estimates of the catch. This would allow one to ask two questions about the effect of the regulation change: 1) has it changed the catch, and 2) has it changed the population abundance or Z estimates (or other biological characteristics).

The purpose of the objective "to monitor changes in abundance of blue cod populations supporting key recreational fisheries" is unclear. If the primary purpose is to ensure positive fishing experiences then the monitoring programme is adequate to assess management measures. However, if conservation of blue cod populations is the objective, then additional information on population structure would be required.

2. Survey design

2.1 Survey areas

Some definitions needed:

Station = a site where 6 pots (with some exceptions: e.g., 9 in Marlborough) are deployed. The bigger areas are zones/areas? And zones/areas are within QMAs?

In North Canterbury (a Survey Area), there are:

3 Strata, 12 Stations with 5–6 stations picked for phase one, and each station has 6 or 9 pots.

Fishery-independent potting surveys have occurred relatively inconsistently around the country, with sampling design varying among areas. What began as a survey at fixed stations has continued as an intermittent survey of depth strata by management area. Choosing of the initial Index Stations in Marlborough Sounds is now a weak part of the survey. However, it is the longest-term sample series, so changing it would lose the time series. Randomisation would be ideal, but comparing all these zones is important. Right now we have nine pots in four zones, but it might be better to put more pots in fewer zones, since there is a single stock. Alternatively, more sites with fewer pots per site might be better. This decision might be based on pragmatic considerations (how many pots can you deploy in a day, then steam at night to next survey area?

There is some evidence that there is little adult mixing among survey areas, thus it is appropriate to report and manage at the survey level. The survey strata and the stations have been selected to cover the area of blue cod habitat based on locations reported by commercial fishermen, or from general locations reported by recreational fishermen. The biases of these user groups do not seem to be accounted for. Experience in other parts of the world indicates that reports by fishermen of fishing locations and conditions are not reliable, and often reflect the fears of fishers and their anticipation of use of the information to formulate regulations that will restrict them. In addition, fishers may be reluctant to report their best fishing areas for fear they may be fished down by the surveys or their location may be discovered by others.

The stratified random design ensures wide geographical coverage, reduces uncertainty (increases precision) and optimises the survey by increasing sample number in key areas (and presumably habitats, but these have not been mapped). The positions of pots within a station are picked usually by the entry point to the station. The next pot position is then picked at a random position with a minimum distance from the first pot. This design does not have random allocation of pots within the station and the analysis should reflect this.

The blue cod survey is two-phased. Phase 1 is a stratified (by depth and along shore habits) random survey with 6 stations chosen from about 12 in each stratum. In Phase 2, stations are selected at random within the survey area from the strata that produced the largest catch in Phase 1. The majority of the Review Panel, and the Working Group, has a desire to continue the two-Phase design. A suggested alternative is that the design be modified so that Phase 1 is an Index Station Survey, and Phase 2 can be considered a Random Station Survey. There is a problem with serial depletion of the Index Stations as a result of removal sampling. The idea of the existing two-Phase design is to reduce the impact of occasional large catches in some traps by increasing the sampling in stations where the highest abundance occurs. This is similar to what is done in post-survey analysis of the MARMAP reef fish trap survey in the southeast U.S. (to delineate the depth range of maximum abundance of each species and eliminate depths outside the range of the species). The two-Phase approach is used to guard against uncertainties of weather, mechanical problems, etc. by assuring that a minimum number of stations will be completed in Phase 1. A problem here is that the proportion of the actual population within the Phase 1 vs. Phase 2 sample areas is unknown. Also unknown is the proportion of the population attracted to the trap—effective area fished and conditions (tide, visibility, other relief besides that provided by trap; factors that affect retention and escapement) that might attract fish some distance to the trap. These variables can be analysed for, or their effects minimised, by a large number of random samples that will cover all of the variables over time.

A standardised survey, based on randomly-assigned potting locations is needed, with an adequate number of replicates to account for variations in environmental parameters. This may result in a sample size that is too large to complete with the resources available. An intense random survey may point the way to more efficient stratification.

Sufficient data do not exist to know if the survey areas are appropriate to monitor all life history stages. The survey areas seem to relate to the biological stock areas, but one was defined based on the other, with no stock identification data to support the biological stock areas. If the commercial pot fishery operates in the same way as the survey, why could not the commercial CPUE be used, at least as a check against the fishery-independent survey? An observer programme may be needed to capture this information. There seems to be no relationship between survey CPUE and fishery CPUE, or among survey CPUE sites.

Blue cod are believed to be relatively sedentary, but the current survey data indicate differences between depth zones in size and sex ratio in the protogynous species. This suggests some movement to deeper water with maturity, or for spawning. Although it is intended that the sampling takes place during the peak of spawning, there is doubt whether this occurs as it appears to come at the end of the spawning season. Reproductive seasonality has not been adequately documented, however. The extent of movements, particularly during reproduction, needs to be documented, and reproductive cycle needs to be documented with monthly histological examination of gonad samples. Based on current observations and tagging, it is thought that spawning movements are minimal and that timing of the survey around spawning is not really a relevant issue. The primary purpose is to determine relative abundance and Z estimated from age composition and so the survey may be better if timed to take advantage of resting periods when movements, length frequency, and sex ratios are likely to be less variable than during the period following peak spawning (the time currently sampled).

The periodicity of the survey (once every 4 years) does not appear to be adequate to account for the changes observed in population size and size/age distribution between sampling periods although there are clear consistencies in the level of exploitation in survey areas as indicated by the Z estimates and the shape of the age-compositions. A programme of intense annual sampling is needed to fully understand reproduction, ontogenetic migration, spawning migration, other movements and variability in catches. When the life history and movements are fully understood, a more intermittent sampling period (every 2–4 years) might be adequate. It seems with the current survey that variations in catch and size/age composition cannot be explained because of the temporal gap in sampling.

Any population structuring or stock identity that may exist is unknown. Tagging data suggest little movement, but the tagging results have not been seen. However, some species undertake extensive spawning movements, only to return to the non-spawning home range. Such movements would homogenise the stock but be undetected in traditional tagging. However, the sampling is designed as if there is much local stock structure and little adult intermingling. With at least 10 days of pelagic egg and larval duration, we suspect that there is a lot of genetic exchange among sites during the larval period (in addition to unknown levels of adult migration). It seems unlikely that the perceived stock structure fits the quota management areas. Stable isotope analysis using archived otoliths would be valuable to determine if there is little adult mixing as indicated by the tagging studies.

Catches seem to be consistently larger farther offshore in deeper water, suggesting ontogenetic movement of larger mature fish into deeper water. This fits the life history pattern of other fully (*Mycteroperca microlepis*) or partially (*Centropristis striata*) protogynous species, in which larger individuals are found deeper, or fish segregate by sex, with larger males in deep water, joined by females during spawning.

Because there is no evidence for population structuring, an intensive sampling could be done on a geographically-restricted scale for three years to further understand movements, reproduction, seasonality, fate of specific year-classes, and population structuring. The results of this survey could help point the direction for future (and more temporally and spatially spread-out) sampling that can be used to track a periodic potting index of relative abundance.

The stratification in place seems to be based on historical catch records, rather than habitat or biological data. Habitat mapping would be very important so that stations can be allocated to the appropriate depth.

There is lack of consistency of sampling methods among sites because of variability in the environment among sites (e.g., depth range). This needs to be standardised with a “standard methods” sampling manual.

2.2 Survey frequency

Appropriate survey frequency depends on the objectives for the survey, and will be dependent on resources available for doing the surveys. From the perspective of monitoring changes in recreational fishery Zs, a frequency of every 3 to 4 years should be adequate. However, if an objective of the surveys is to monitor relative year-class strength, then more frequent surveys would be required.

2.3 Stratification

The method of selection of number of strata and their boundaries is reasonable given the data available at the time of their design. Consideration has been given to both inshore and offshore habitat although there are some inconsistencies between the method of calculation of area of the stratum between inshore and offshore strata.

Because the abundance estimates relate to the area of the strata, the position of the boundaries has considerable influence on the weighting of the abundance estimates from each stratum. The strata boundaries should be revisited. Another interview process should be conducted to look again at the area of blue cod habitat, and the offshore boundaries adjusted if needed. In some cases, there are strata that appear to be disproportionately large for the number of stations in the strata. These boundaries could be adjusted and relative abundance estimates recalculated in a manner which would not interrupt the time series of the data.

2.4 Station allocation and the two phase

Within the strata, the method used to allocate stations is appropriate given the information available. A large number of stations spread across the whole of each stratum is appropriate and the size of the subset, 6–9 stations, is sufficient to get good estimates of the variation within the strata. The two-phase sampling has good theoretical basis and is commended as a good use of vessel resources that enables realistic capture of the variation.

2.5 Level of biological sampling

The level of sampling has successfully gathered information on the timing and variation in spawning and information on sex ratios and the way they vary among survey areas and strata within survey areas. The strong differences in sex ratios warrants further investigation as this may be another indicator of high exploitation.

It is difficult to say that length and age frequencies have consistency among surveys, given the time interval between them. Not too much weight should be given to the information indicating difference in size of fish between strata given the differences in growth rates and also the quite poor relationship between length and age (in Marlborough there is no difference in length between fish over 5 years old). There are clear consistencies in the degree of truncation of age-composition between surveys. In some survey areas there appears to be a fairly long history of serious over-exploitation as shown by age composition.

The current survey frequency makes it difficult to determine the consistency of the age-composition data. In addition, the survey frequency together with the method of determining age-composition is not conducive to determining recruitment variation. If recruitment variation was deemed to be important, in some survey areas, it is suggested that annual surveys would be for a period of several years and 300 – 500 otoliths collected in each survey area and the use of proxies, such as length should be investigated to ensure the current methodology will detect recruitment events. If growth rates are similar between areas and over time, the current method of sampling and analysis is satisfactory. If our knowledge suggests that the fishery is not dependent on recruitment pulses to keep the fishery at a stable level, then the added expense is not warranted.

Given that detection of recruitment variation is not a priority, the collection of small stratified age samples and a proxy sample of lengths is commended provided that the sample sizes match the spatial level of reporting. A report at a level lower than the survey area (e.g., 3 regions within the Marlborough Sounds and Tasman Bay) would require adequate samples (200–300 otoliths and 500–1000 lengths).

Although there are problems with destructive sampling in some areas, it is considered that the number of samples is small compared to the recreational catch.

If these samples sizes are not achieved, the reporting of Z estimates should be restricted to pooled areas where the number of otolith samples and length samples is sufficient to give robust estimates and this shortcoming is clearly indicated as a gap in the sampling procedure.

Consideration should be given to collecting otoliths from the recreational catch after careful consideration is given to how biased these samples are likely to be due to high grading and different selectivity of the recreational line fish to the survey trapping.

2.6 Ageing

A reference collection should be set up for blue cod with about 200 otoliths with the complete range of ages and levels of ageing difficulty. Agreed ages need to be developed for this set. This collection should be expanded each year, and a subset selected each year and read by readers to guard against drift. New or inexperienced readers need to develop a level of competency before setting out on routine ageing.

Consideration should be given to the idea of using a single reader, if the above-described reference collection and training is implemented. This would involve a structured process of training and testing. Once a new reader is trained they could be declared a blue cod competent reader and one reading used. Again, annual re-reading of the reference collection would be required each year. See QDPI fish ageing protocols.

2.7 Local variation in survey design

It is important to cover the depth and latitudinal range of maximum abundance, as is currently done in Phase 2 of the survey. This should be a standardised region-wide (country-wide) survey in which the local variation will become obvious in the results, and accounted for in interpretation of the results. Analysis of trends within a locality can serve as an Index for that locality.

2.8 Inherent assumptions in survey design

No catchability or selectivity analyses have been done, other than some qualitative video/diver observations. The assumptions are that catchability and selectivity do not vary over time or location, and if they do, are accounted for in the sample size. A larger random sample size would allow for comparison of such variability, and minimise its effects if a large sample was collected over temporal and spatial scales that included all variability.

2.9 Other strengths/weaknesses of the design

These have been covered above and below.

3. Survey gear and deployment

3.1 Sampling gear standardisation

From the presentations and documents, the gear and its deployment (ground tackle, buoy systems, soak time, trap configuration, baiting) are all standardised. There is one significant exception. Sometimes the pot entries have a finer mesh (e.g., in Marlborough Sounds). Although we have been assured this makes no difference to the selectivity, gear design should be standardised, as any change to the pot probably affects the way the traps fish, especially if blue cod or other species are partially attracted by the shelter afforded by the pot, in addition to the bait. Experience in the South East United States shows that lined pots attract (or perhaps just retain) more congrid and mureanid eels (they may be attracted to the dark shelter; alternatively, they can no longer escape through the mesh because of the liner). The presence of these eels may affect subsequent catches in the set.

Standardisation should also occur over all times and stations. The number of pots per station seems to vary (6 or 9) and this does not seem logical. The gear itself is perfectly suited to the assessment, as it is what is used in the commercial fishery, but is deployed in a standardised method. The standardised method needs to be documented in a sampling manual and used consistently at all times and locations.

There have been two types of bait used in the surveys. Paua guts were used when pilchards were not available due to herpes type virus. Trials between the two types of bait indicated that there was no significant difference among the two bait types. Bait type should be standardised to eliminate any cumulative or undetected variance caused by something that can be easily controlled.

There was no detectible effect of variation in soak time (30–60 min), but this should be standardised and traps that exceed some level of difference from a standard 60-min soak time should be eliminated. Although CPUE is calculated as fish per pot per hour, the effects of trap saturation on catchability or trap egress are unknown, so variation in soak time should be eliminated by having a standard time and eliminating from analysis any traps that are not within some tolerance ($\pm$ 15 min?).

Surveys are timed to coincide with spawning season, and this seems to the panel to introduce variance associated with variable spawning conditions. Fish spawning time and location is influenced by time, moon phase, water temperature, depth, and other conditions that we may or may not know about. A shift in appropriate temperature and/or moon phase from one year to the next may significantly affect local abundance of fish that may move to specific spawning locations. After rigorous documentation of spawning time and location (gonad histology), the survey should be done at a time that is not the spawning season to eliminate variability associated with spawning. To keep the long time series, it would be more appropriate to keep the current sampling season, but home in on one variable and keep it constant (e.g., moon phase or minimum water temperature).

3.2 Deployment procedures

Deployment procedures have not been clearly defined. It seems in some locations that the station is so small that the pots fill up the station. In other areas, the stations are large and there is flexibility and judgment/decision making by the vessel captain as to where the pots go. This seems to introduce some variance that will change from vessel to vessel and captain to captain, and this variance will be affected by the skill, experience, bias, or unknown desires of the captain that results in selection of sites that may not be typical or representative. This is where good habitat maps with random allocation of pots to sites within the correct habitat would eliminate biases and variance associated with judgments made by the captain. The ideal survey should be able to be replicated without bias by any vessel/crew, regardless of their skill, experience, or biases. A potting survey in which pot locations are chosen randomly (based on adequate habitat maps and knowledge of fish distribution) in advance of the research cruise eliminates bias caused by judgment or decision-making just prior to deployment. There may be some realities that make this impractical.

3.3 Other notes, comments and questions:

Samples are taken for age and mortality estimates from each survey area (and sometimes from each stratum) because growth models differ significantly among locations (from one sound to the next or inside the sound and outside of it). But this seems to be calculating population mortality based on local length frequency and local age/length keys. This seems unusual, especially in the absence of hard data on population structure. There may be no population structure or differences, and the local lengths and the Z based on those lengths just reflect habitat preferences of different size/age/maturity fish.

Truncated age frequency at a location may not mean high Z, but migration of large fish out of the area sampled. This is not known at this time, although the available data tell us that fishing pressure is high in these areas where truncated age frequency occurs. But fish could be moving offshore with age, giving the impression that F is lower offshore because age frequency is not truncated. It may be movement, not mortality causing the truncation; additional study is needed to determine this.

Water clarity is not measured, yet seems to be an important factor influencing catch, and is highly variable in this region and should be measured.

Survey frequency is such that year classes cannot be tracked. Perhaps some survey areas can be sampled annually to determine if fish are surviving or are all being caught, as the current survey indicates. As it is now, we cannot really determine if they are being caught or move out of the survey area as they grow, or move temporarily for spawning, since survey occurs during spawning season. Some additional annual sampling could help clarify if the absence of a year or size class is because of fishing mortality or movement. Some catch data show that fish move offshore as they grow (e.g., the year class strength in 2002 graph shows that these fish move offshore as they grow as the Age-6 peak in 2002 shows up as an Age-9 peak in 2005).

In all surveys, spawning condition was determined macroscopically during only a month or two of the year; this is not adequate as the observations miss the peak spawning and it is difficult to stage protogynous fish without histology.

4. Post Survey Analysis

The current survey design is stratified, but follows neither a strictly random nor fixed station (Index survey) design. The data are treated as if resulting from a stratified random design. Analyses are required to determine if this is appropriate. We therefore suggest an analysis of all the historical survey data to:

- determine if individual pots within a station can be treated as independent primary sampling units;
- determine if there are station effects (i.e., some stations consistently higher or lower catch rates than in others);
- determine if there are depth effects on catch rates and biological characteristics (sex ratio; length/age frequency, etc) – the issue here is if there are depth effects the distribution of depths sampled should be similar between surveys;
- results of those analysis would determine how uncertainty is calculated (CVs) and how survey abundance indices are calculated.

A bootstrap procedure for calculating uncertainty (CVs) may be the best approach as it would be consistent with the actual survey design.

3.4 Methods used to scale or weight individual station data

Methods for scaling catch and biological data are appropriate if the assumptions of stratified random sampling underpinning the analyses hold (ie. pots represent independent primary sampling units; all blue cod in each pot are sampled, no station effects; no depth effects or depth zones within strata are sampled randomly). A primary issue with the scaling is that the total blue cod habitat within each stratum is not known and the areas (or shoreline length) of each stratum used for scaling the data may be inappropriate.

There is insufficient data to develop age-length keys for each stratum so generally these have been generated at the survey area level. This is only an issue if the mean ages at length vary among the strata. A study to investigate if this is true would be useful. This could be conducted in one of the study areas where catch rates are high enough so that adequate numbers of otoliths can be collected in each stratum. Ideally this would be conducted in a survey area which has depth stratification in case there is a relationship between mean at length and depth.

3.5 Analysis of length and catch-at-age data

Recruitment indices would be useful, but surveys conducted on a triennial basis are unlikely to provide reliable indices of recruitment. It is unlikely that recruitment indices would inform management decisions, so additional survey effort to obtain better recruitment indices is likely not warranted. But, given size structure information is obtained from the potting surveys, provision of pre-recruit CPUE indices should be presented in the survey reports.

3.6 Ways to compare all survey series in space and time

The method of calculation of Z estimates (Dunn et al. 2002) has been peer-reviewed and published and the panel believes the method is sound and importantly removes the problems of zero frequencies in classical catch curve analysis.

The estimates of Z are likely the best measure for comparing stock status among the survey areas, though confidence intervals on these estimates are large. Z estimates appear to capture the essence of the relationship between age composition and level of exploitation, with truncated age distributions indicating high exploitation and long tailed distribution indicating light exploitation. The Z estimates provide good assessment of the general status of the survey areas, that is, a distinction between lightly fished and heavily fished areas. The very high Z estimates, and the associated highly truncated age compositions appear to be indicative of a very high level of exploitation in some areas.

The tables of Z values we were presented with are somewhat cumbersome, given the large number of values in them. Presentation of results should be simplified and standardised – possibly a single point estimate (i.e., selection of the 'best' assumption for fully recruited age) and a single set of confidence intervals. The simulation approach for estimating uncertainty in the Z estimate is useful, but a single set of assumptions should be agreed upon (for the simulated variance of recruitment, ageing error, etc), presented, and used to compare results among surveys.

The simulation approach used to calculate uncertainty in Z estimates could be expanded to address questions like: "given a management intervention how long would it take (or how many surveys are required) before we expect to be able to detect a population response".

The next step in using Z estimates from the blue cod surveys should be the development of reference points. These could potentially be based on spawning stock biomass per recruit (SPR) analyses. If the spawning stock measure were to be female-only based and understanding of the dynamics of sex change would be required.

3.7 Modifications to make the survey results more useful

As stated previously, assessment of the best approach for estimating abundance index CVs and habitat mapping to determine the relative amount of blue cod habitat within each stratum would improve the reliability of survey results.

3.8 Shortcomings of post-survey analysis

There are potentially a number of issues with the ANOVA analysis used to compare the time series of Marlborough Sound abundance estimates. Survey sites (zones) are treated as if randomly selected from the population (rather than from a limited number of sites) and potlifts within the sites are treated as independent primary sampling units. Given the survey design, the form of the ANOVA analysis is unlikely to be appropriate.

3.9 Could we get better estimates of changes to biomass, Z, age-at-maturity and sex ratio without using the survey?

In areas where there are commercial fisheries it may be possible to develop abundance indices and collect biological data from the commercial fishery. However, the scale at which commercial data is available relative to the scale at which the recreational fisheries operate may limit the cases where commercial data could be used.

Recreational surveys could be used to monitor the recreational blue cod populations, however they would be significantly more expensive (if collecting fine-scale catch, CPUE, and biological data) and likely less reliable than the fishery independent surveys now conducted. There may be problems with incorporation of recreational age and length samples given that the recreation catch is line caught.

4. Recommendations

4.1 Recommendations on the key aspects of potting surveys listed above

The current stratified survey design is neither strictly random nor fixed station (index survey). The data are treated as if resulting from a stratified random design. Analyses are required to determine if this is appropriate.

The blue cod potting survey design (selection of approximately 12 stations within each stratum) was adopted because of incomplete information on suitable blue cod habitat. Habitat mapping of each of the survey areas would be extremely useful - to allow appropriate scaling among strata, and more importantly determine potential sampling units in the population for potential future modifications to the surveys.

A “blue cod potting survey” manual, that describes all specifications for conducting each survey and some standard forms of analysis, would be useful to ensure consistency of surveys over time and among areas. Methods should be standardised as much as possible. We note under Objective 1 of the tender shown in the TOR for the Expert Review Panel “The previous survey should be considered and any necessary improvements implemented”. This seems to allow potentially significant variation in the conduct of surveys. Standardisation of methods is appropriate and desirable; changes to survey design should be agreed by a working group.

The sampling terms used in the documentation (survey area, stations, pots) need to be made consistent and made more recognisable in the documents by highlighting them.

A significant question that arose through the various presentations to the Expert Review Panel is “what determines the component of the blue cod stock that is vulnerable to trap gear”. Some comments made suggest the possibility that the trap-vulnerable component of the population may change in response to population characteristics (e.g., small blue cod avoid pots if large blue cod are already in the trap). Because this can have a significant effect on the CPUE indices (i.e., not proportional to stock abundance) it warrants further investigation. Visual surveys in concert with trap fishing may provide a means to address this question.

It is recommended that some examples of Z estimates determined from catch curve analysis be presented with accompanying graphs to make interpretation of the results comprehendible to a wider audience.

Given the small number of otoliths used in each area to determine Z estimates, it is imperative that ageing error be minimised and there are safeguards against drift. A previously noted, a reference collection should be established and used annually by all readers.

Stratum boundaries should be revised and, after the next survey, results re-calculated and significant changes discussed. This refinement is most unlikely to change the advice on the stock status.

4.2 Advice on alternative ways of meeting the management objective

Without significant further research it is unclear if the potting survey is providing a reliable index of abundance within the survey areas. Estimates of Z are likely more robust to survey design (assuming no depth influence on age structure), though confidence intervals on these estimates are large. Z estimates appear to provide good assessment of the general status of the survey areas, that is, a distinction between lightly fished and heavily fished areas.

The surveys in their current form give a cost effective method of determining the level of exploitation of the survey areas from Z estimates. The relative abundance estimates appear to be less useful at this stage. It may be many more years until they can be used to determine stock status especially if estimates of catch can be determined.

Commercial fishery abundance indices (and biological data) may provide alternative indices of abundance, however the number of areas where these indices could be developed is likely small. Commercial CPUE indices would likely be best used to augment results from the potting survey, rather than to replace those surveys.

4.3 Other issues or potential solutions

If the decline in relative abundance and high fishing mortality was sufficiently high as to considering closure of an area of the fishery, consideration could be given to purchase of tags entitling the fishers to catch blue cod. This could be extended to exchanging fish frames for new tags if this was practical and the data were considered useful. The price of the entitlement tag could be set very low to encourage data collection or higher to discourage fishing, preferably the former.

5. References

Dunn, A.; Francis, R.I.C.C.; Doonan, I.J. (2002). Comparison of the Chapman-Robson and regression estimators of Z from catch-curve data when non-sampling stochastic error is present. *Fisheries Research 59*: 149–159.

Appendix 1: Terms of reference

Terms of reference

The purpose of this review is to assess the following key aspects of potting surveys for blue cod, covering but not being limited by the issues listed below:

1. Management Objective

- *i. Assess whether the survey is fit for the purpose of addressing the management objective? In other words are we getting what we think we are getting i.e. a reliable index of abundance and index of changing biological trends (age, sex ratio…) in local populations?*
- *ii. What else could we do to inform other management objectives?*

2. Survey design

- *i. Are the survey areas appropriate to monitor the fishery adequately (adult and juvenile abundance) and how do the survey areas relate to biological stock areas?*
- *ii. What is the appropriate survey frequency.*
- *iii. Is the stratification used in the surveys appropriate to assess hetogeneous areas of habitat?*
- *iv. Comment on the method used to allocate stations to strata, station density, distance between stations, and the two phase design, including appropriate levels of two-phase sampling.*
- *v. Is the level of biological sampling appropriate to achieve acceptable levels of precision on estimates of sex ratios, catch-at-age, age-at-maturity? Do length and age frequencies track between surveys? Is survey frequency adequate to allow for this to be determined?*
- *vi. What aspects of the survey design are important for all surveys and how much local variation is desirable/acceptable?*
- *vii. What are the inherent assumptions in the survey design (e.g., catchability, selectivity)?*
- *viii. Comment on other strengths/weaknesses of the design if not covered in the above?*

3. Survey gear and deployment

- *i. Is the sampling gear appropriate and appropriately standardised? Is gear standardised between different surveys and is this appropriate or desirable.*
- *ii. Are the deployment procedures clear and adequate, including methodology to determine suitable ground, successful/unsuccessful stations and stop/go criteria*
- *iii. Other notes, comments and questions:*

4. Post Survey Analysis

- *i. What methods are used to scale or weight individual station catch and biological data and are they appropriate?*
- *ii. Review and comment on the analysis of length and catch-at-age data from the surveys and how they can best be used to monitor the fisheries (e.g., is development of recruitment indices possible and desirable*
- *iii. Assess ways to compare all survey series in space and time (if appropriate); e.g. are Z estimates from different surveys comparable and how may we use them to inform management?*
- *iv. What modifications to the existing analyses, or new analyses, would make the survey results more useful to address the management objectives?*
- *v. Evaluate shortcomings of post-survey analysis and evaluate the resulting estimates for consistency between stocks and conformance with international best practice?*

vi. Could we get better estimates of changes to biomass, Z, age-at-maturity and sex ratio without using the survey?

5. Recommendations

i. Formulate recommendations on the key aspects of potting surveys listed above, including identification of likely consequences of any suggested changes on time series comparability

ii. Provide advice on alternative ways of meeting the management objective if potting surveys are not providing a reliable mechanism

iii. Any other issues or potential solutions that the panel believes it should mention to the Working Group.

Appendix 2: Document list

- Blue cod potting survey review -

Document list

Document Number	Title
BCOREV-2009-01	Agenda
BCOREV-2009-02	Terms of Reference
BCOREV-2009-03	Blue cod Working Group Report
BCOREV-2009-04	Abundance and size composition of blue cod in the Marlborough Sounds and Tasman Bay, September–October 2007
BCOREV-2009-05	Relative abundance, size, and age structure of blue cod in Paterson Inlet (BCO 5), November 2006
BCOREV-2009-06	Abundance, size and age composition, and mortality of blue cod off Banks Peninsula in 2008
BCOREV-2009-07	Relative abundance, size and age structure, and mortality of blue cod off north Canterbury (BCO 3) in 2007/08
BCOREV-2009-08	Report to Southeast Finfish Management LTD: Review of the BCO 5 Fishery
BCOREV-2009-09	Age composition and derived estimates of total mortality for blue cod taken in South Island potting surveys, 2002–2005
BCOREV-2009-10	Submission to the Review of Blue Cod Potting Surveys in New Zealand 16-17th April, Wellington
BCOREV-2009-11	Response to Dr Henderson's critique of the 2007 Marlborough Sounds and Tasman Bay blue cod survey report
BCOREV-2009-12	Presentation – Vivian Haist – Canadian sablefish trap surveys
BCOREV-2009-13	Presentation – George Sedberry – Fishery-Independent Sampling for Reef Fishes off the Southeastern United States
BCOREV-2009-14	Presentation – Peter Stephenson – Fisheries dependent and independent surveys and how the data gathered relates to stock assessments: examples from Western Australia
BCOREV-2009-15	Presentation – Chris Francis – Overview of survey methods in New Zealand
BCOREV-2009-16	Presentation – Glen Carbines – Age composition and estimates of mortality of blue cod from South Island relative abundance potting surveys 2002-2005
BCOREV-2009-17	Presentation – Ron Blackwell – Marlborough Sounds Blue Cod Survey Series
BCOREV-2009-18	Presentation – Mike Beentjes – Abundance, size and age composition, and mortality of blue cod off Banks Peninsula in 2008
BCOREV-2009-19	Presentation – Glen Carbines – Abundance, size and age composition, and mortality of blue cod off north Canterbury in 2007/08
BCOREV-2009-20	Presentation – Paul Star – An alternative view on blue cod relative abundance indices: CPUE analysis
BCOREV-2009-21	Chairs note of meeting
BCOREV-2009-22	Reviewers report
BCOREV-2009-23	Document list

Appendix 3: Agenda

Blue cod potting survey review

Date: 16-17 April 2009
Location: NIWA, Allen Building Greta Point, Wellington New Zealand

Reviewers: Vivian Haist, George Sedberry, Peter Stephenson

Presenters: Glen Carbines, Mike Beentjes, Ron Blackwell, Chris Francis, Paul Starr

Agenda

Day 1
Welcome (09:30-09:35)
Introductions (09:35-09:40)
Overview (09:40-10:00)

Case studies – 30 min presentation and 15 min question time

- Fishery-Independent Sampling for Reef Fishes off the Southeastern United States – George Sedberry (10:00-10:45)
- Canadian potting surveys – Vivian Haist (10:45-11:30)
- Fisheries dependent and independent surveys and how the data gathered relates to stock assessments: examples from Western Australia – Peter Stephenson (11:30-12:15)
- Overview of survey methods in New Zealand – Chris Francis (12:15-12:45)

Blue cod

- General survey overview and age composition and mortality estimates – Glen Carbines (13:15-14:00)
- Methodological presentation for Marlborough Sounds + results – Ron Blackwell (14:00-14:45)
- Banks Peninsula – Mike Beentjes (14:45-15:30)
- North Canterbury – Glen Carbines (15:45-16:30)
- An alternative view on blue cod relative abundance indices - CPUE analysis – Paul Starr (16:30-17:15)

Discussions (17:15-17:30)

Day 2

Discussions (09:00-10:30)???

10:30-12:00

Review Panel meets independently of the Working Group to deliberate on workshop discussions and formulate conclusions and recommendations related to the Terms of Reference.

12:30-17:30

- Review Panel reports on recommendations relative to the Terms of Reference
- Moderated workshop discussion
- Review Panel finalises recommendations (preferably during the workshop, but there may be a need for a few final adjustments after adjournment of the workshop)