A Review of Population Assessment Science in the National Marine Fisheries Service Southwest Fisheries Science Center

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Executive Summary

The goals for the CIE peer review as described in its Terms of Reference were first to review population assessment methods and explore the adequacy of the available data and biological information.

Methods for most assessments of regularly exploited fish stocks build on the basic assumptions that stock dynamics, and the performance of fisheries, are regular; i.e. that there exists a relationship, albeit highly variable, between spawning stock size and the production of baby fish; that fish have regular patterns of growth in weight and length and of maturing with age; that fish have regular patterns of (often size-related) vulnerability to fishing gear and regular (usually constant) natural mortality; and that catches, or sightings, per unit of effort applied in fisheries or in surveys are an index, usually linear, of stock size. Many of the fish stock assessments that were reviewed used a standard platform, 'SS2', that fits an age-structured population trajectory to age-structured data, allowing for errors in some data types; others used other standard modelling platforms at a similar level. However, in general modelling platforms were not described in great detail. An exception was the Klamath River Chinook model, designed for a short-lived species, which estimates cohort numbers from the earliest returns to the river and makes deterministic forward projections on the basis of standard values for mortality and vulnerability to fisheries. It is associated with an ocean harvest sub-model that predicts catches from contact rates and allowed effort.

Assessments of a range of unexploited peripheral species were less detailed. Unexploited stocks present few opportunities to acquire information on stock composition and stock-dynamic parameters. Activities in U.S. coastal waters for marine turtles and white abalone were restricted to surveys. Assessments of coastal cetaceans also depended on periodic sighting surveys, takes, mostly fishery bycatch, being restricted to a very small fraction of a minimum estimate of numbers. Although there are frequent local surveys of Antarctic krill, an assessment for the Scotia Sea has depended on one major survey internationally conducted in 2000; recommendations for allowable take and its distribution should ensure that food supplies for land-based predators are secure.

Assessment models depend on series of data on catches and stock size—in both cases, preferably age- or size-specific—and also on information on biological relationships between weight, length, age, maturity, and vulnerability to fisheries. The available biological information is sometimes, but not usually, satisfactory. In many cases, assessment models run on biological data, such as size- or maturity-age relationships, that are several years out of date. The hard data on which fishery stock assessments usually depend—reliable delimitation of the assessed stock, catches, catch-effort data, length- and age-composition of stocks and catches, fishery-independent indices of the size, or recruitment to, the fishable stock—are patchy, but it is difficult to point to a single fishery among the assessments reviewed for which a complete suite of satisfactory data is available; specifically, data from foreign fisheries are often not available timely, or at all, and satisfactory fishery-independent indices of stock size are rare. There are some areas in which efforts to clear up specific data problems are overdue; examples may be the catch series for rockfish, where there has long existed a need to finalise the partitioning of unspecified historic catches among species. Standardisation of CPUE data, or agreement on standard methods for doing so, is also fairly widely required, especially for the highly migratory species.

The capacity of the SWFSC to conduct stock assessments *given the data available* is competent, perhaps above average, but not exceptional. Few platforms that are unique to the SWFSC are used, and those that are have been reviewed and documented. It appears that many assessments run on SS2, which appears to be largely exogenous. However, at least some assessments are run on platforms, apparently of similar power, that were written in this Center. The critical element is often to ensure that the treatment of the data is appropriate to the sampling used to acquire it and to its use in the model, requiring assessment scientists to have good grounding in statistical principals and good understanding of the assumptions that the modelling platform makes about the data.

Findings and Conclusions:

Population assessment methods are generally based on standard marine fish assessment techniques. Assessment modelling within the SWFSC, especially for local stocks, is dominated by SS2. In some international forums other modelling platforms are used. The Klamath River salmon stock is modelled using a unique model tailored to this stock. The modelling platforms are adapted to the available data and to the requirements of the specific management problems.

A recurring problem in stock assessment within the SWFSC, as elsewhere, is that data are often deficient. Not so much in quantity or quality, but that specific kinds of data are missing from the suite of datasets that ideally should be complete for a stock assessment to be adequately supported. Many stocks lack adequate fishery-independent stock-size indices, and for many there are deficiencies in the delivery of catch or composition data from entire segments of the fishery. For some fisheries even fishery CPU indices are doubtful owing to gear changes or imperfect collection of logbook data.

However, given the available data, and given the inevitable uncertainty associated with fish-stock assessment, the capacity of the SWFSC is in general adequate, and perhaps above average. Compared with some other forums, a very high proportion of the assessment work seems to result in full quantitative model-based assessments. A likely deficiency is that uncertainties, even when formally presented, are under-estimated; uncertainty nearly always is.

The overall state of population assessment modelling again is diverse, but most assessments have available to them advanced platforms that support stock-dynamic models as complex as the available data sets can use.

Recommendations:

The independent panel review of assessments by varying teams of specialists in fish stock assessment gives a more searching examination of the assumptions and execution and is to be recommended as a means of continually maintaining quality. Means should be sought to extend independent peer review to forums where it is not now commonly used, but assessments are reviewed within fixed groups of scientists.

Many assessment documents and STA Panel Reviews contain recommendations for filling lacunæ in the data, improving data treatment, or improving the assessment modelling. A systematic collection, collating, and review of these recommendations with a view to selectively implementing them would be recommended.

Some assessments are still using deterministic models, taking little to no account of uncertainty of knowledge or uncertainty of prediction. It will be advantageous in some cases to develop stochastic forms of deterministic models and incorporate uncertainty. A particular case is the Klamath River salmon management model, where I note however that the development of a stochastic version of the model in use already figures in future plans.

Specific suggestions for improving marine mammal assessments that are based on transect surveys could:

- repeat survey designs and methods as closely as possible;
- use systematic sampling designs and appropriate analysis methods;
- design and analyse repeated surveys as series; if the detection of change is the primary objective, use repeated designs and paired analyses;
- where methods are the same or closely similar, combine survey results weighting by effort;
- for California Current cetacean surveys, stratify the survey area and use stratified analyses to estimate trends.

Introduction

a. Background

The Southwest Fisheries Science Center of the National Marine Fisheries Service assesses the state of stocks of living marine resources on the west coast, elsewhere in the Pacific, and in the Antarctic, and provides advice on their conservation and exploitation under legislative mandates arising from the Magnuson-Stevens Fishery Conservation and Management Act (and its reauthorizations), the Marine Mammal Protection Act, the International Dolphin Conservation Program Act, and the Endangered Species Act, and participation by the U.S. in international agreements including the Convention for the Conservation of Antarctic Marine Living Resources, the Inter-American Tropical Tuna Commission, the International Convention for the Regulation of Whaling, &c. and federal-state working agreements such as the Pacific Fisheries Management Council. The Southwest Fisheries Science Center (NMFS/SWFSC) has long been associated with innovation and creativity in population assessment. However, this scientific "discipline" has never been subject to a formal scientific peer review across all Center programs. The purpose of the present review was to: (1) assess the accuracy, precision, originality, and credibility of population assessments produced by the SWFSC that are used in managing Pacific Basin fisheries, marine mammals, and other protected species and (2) improve operations of SWFSC scientific programs in order to maintain and/or achieve state of-the-art assessments. The assessments to which the Center contributes are diverse, ranging from regular assessments of commercially exploited, productive stocks of small coastal fishes through rebuilding plans for depleted stocks of long-lived, slow-growing rockfish to VPA analyses of small, endangered stocks of salmon; and from stocks considered local to the Southern California Bight to species that range from one side of the Pacific Ocean to the other.

b. Terms of Reference.

1. Review population assessment methods employed by scientists at the SWFSC. This review will include groundfish and coastal pelagic species stock assessments conducted for the Pacific Fishery Management Council, the Klamath Ocean Harvest Model (KOHM) that is used to establish salmon harvests from the Klamath River system, highly migratory species assessments conducted in International Scientific Committee (ISC) working groups, and all other relevant population assessments conducted within the SWFSC, including marine mammal population assessments and those for ESA-listed stocks (e.g., salmonids, green sturgeon, and white abalone).

2. Explore the adequacy of the available data and biological information for meeting the needs of population models and recommend improvements to both. Provide guidance as to the overall quality and quantity of data to support assessments conducted by the Center.

3. Evaluate the capacity of the SWFSC to conduct stock assessments in order to meet the demands of management for assessment products.

4. Evaluate the overall state of population assessment modeling within the SWFSC.

5. Prepare a report of findings that will include sections that detail the strengths, weaknesses, limitations, and recommendations for improving the population assessment discipline within the SWFSC.

c. Description of Review Activities

The review was carried out by a panel of scientists, mostly from NOAA Fisheries, to which were attached two external CIE reviewers. The panel Chairman was also from NOAA Fisheries.

The SWFSC initially made available, via an ftp site, a few thousand pages of assessment documents, including panel reviews of assessments, status of stocks under rebuilding plans, related technical documents, and primary publications. Somewhat before the review meeting, documents summarising the Divisions' activities, as well as suggestions that some documents might be more important to read than others, also became available. Before the review considerable time went into perusing the documents and trying to discern patterns.

Review activities on site consisted of open meetings, at which there were presentations of organisational structure, including clienteles and legal mandates, of individual assessment programmes, and, in some detail, some of the assessments themselves, by leaders of assessment teams and by assessment scientists, with some time for questioning, further explanation, and general discussion between the panel and the staff of the Center. The review panel had little opportunity to discuss, before the review meeting started, what information it wanted, or needed, from the Divisions: the agenda seemed to be largely driven by the Center itself. The review was very compressed. All presentations took place in the first two days, with the third day being reserved for panel discussion and report writing. Given the scale of the review, the meeting was rather short.

The review discussions covered all levels, from the overall organisation of the Center of the different divisions and descending at times to discussions of technical details such as dealing with errors in reading the ages of fish. Presentations were organised by Division and species group, not by conceptual level (e.g. from client/division interaction down to data acquisition and processing), and problems that were identified in presentations tended to turn around lack of specific kinds of data, inadequacy of resources, and shortage of manpower. For most of the 'standard' fish stock assessments, there was little description of the modelling platforms being used, they being largely standard. Most of the presentations were more concerned with the availability of data and its timeliness that with describing the mechanisms of assessment models or platforms; however, there was somewhat of an inverse relationship, where assessments with plenty of data were concerned about the missing bits, while some assessments that were quite poor in data, for example the ESA listing assessments, were developing new modelling approaches to suit that were described in some detail. For some conservation activities, including marine mammal conservation and the conservation of endangered salmonids, for which original models were being developed, there was more-detailed description of the modelling activities being undertaken.

Summary of Findings (in accordance with the Terms of Reference)

1. Review stock assessment methods

Population Assessment Methods, by Species Group

Groundfish (as far as the available material and presentations are concerned, mostly rockfish (*Sebastes* spp.)

Other stocks, with different problems, and to which different methods can perhaps be applied, are also assessed: methods are standard marine fish stock assessment models; i.e., age-structured population-dynamics models with recruitment related to stock size by a stock-recruitment relationship (in these assessments Beverton-Holt), length related to age by a 'growth' (length-age) curve, length related to vulnerability to fishing by selectivity ('partial recruitment') curves, and length related to weight by length-weight curves. Numbers in cohorts in consecutive years are related by a composite of natural and fishing mortality, with the latter derived from catch data apportioned to year classes according to selectivity. Such models are typically scaled by assuming that catches are absolute, and everything else is relative. Indices of biomass are usually obtained from fishery catch per unit of fishing effort.

The different assessment documents were not equally easy to read and understand. The Bocaccio document seemed well written; it classified a large set of data sources in a logical way and described them clearly, and it was helpful for understanding some of the other groundfish assessment documents.

The availability and suitability of data series, even within this closely related group of species, is quite diverse; some of these (e.g. cowcod *S. levis*) have very restricted sets of usable data.

Models are fitted on two platforms. Stock synthesis 2' (SS2) appears to be a standard platform developed within NMFS for fitting stock-assessment models; it was repeatedly referred to in the meeting. The best available description that appeared is in the assessment document for Pacific sardine, which I found quite helpful; there is also a description on a NOAA web-site. SS2 is built on AD Model Builder; however, some assessment documents referred to modelling using ADMB directly rather than SS2.

Data include series of catches, either by weight or number; length, weight and sex data from fishery sampling and from surveys, data on catch and effort from fishery logbooks, (trawl) survey data as biomass index and sex, length and age composition. Data problems associated with this species group appear to include:

- older data on commercial catches of rockfish were not reported at species level;
- older CPUE indices for commercial fisheries are unusable owing to changes both in the gear that was (allowed to be) used and in other regulation of the fishery;
- some of these species are ill suited to indexing by bottom-trawl survey because they prefer to live on untrawlable bottoms;
- regulation, including closure, of fisheries has extinguished fishery data in recent years for some species, has made CPUE series inconsistent over time, and hinders or prevents measuring the recent evolution of these stocks.

One useful thing that could be done to help Groundfish stock assessments would be to sort out the historical data on *Sebastes* catches. It was surprising to read in the Cowcod assessment that some port samples from the early 1980s had come to light since 2005, so catch data from that period had been revised. It would seem overdue to make a major, concerted effort to round up all sources of catch data and fishery sample data and to hold a coast-wide workshop to review, tabulate, and tidy up all outstanding issues on rockfish catch data, not least the coming to a universally acceptable conclusion on allocating unspecified catches to species for the whole historical series. Various problems can be foreseen if these activities are undertaken as part of the assessments for individual species.

It appears also that standardised data on the present evolution of stocks of at least some rockfishes are inadequate. Standard research trawl surveys seem to have difficulty in tracking rockfish stocks in the difficult habitat they live in, and regulatory changes bedevil the use of fishery CPUs. Sentinel fisheries using standard gear might be a method of generating a useful index of stock rebuilding.

Coastal pelagic species

An assessment of the Pacific sardine stock was presented for review. This was an assessment of a single stock ranging over the US west coast and into both Mexican and Canadian waters.

This assessment model, after a history of being fitted on other platforms, is now also fitted on the SS2 platform. (The Pacific sardine assessment document contained a helpful description of the SS2 assessment modelling platform, which was appreciated.)

Age, weight, length and maturity data is obtained from routine sampling of the commercial fisheries and, apparently, survey catch sampling as well: weight-length and length-age curves from commercial samples, and maturity-length ogives from survey samples (survey not described?). *Absit* information to the contrary, single relationships between weight, age, length and maturity were estimated for the entire stock. However, a more complex model was used for selectivity (‘partial recruitment’), which was allowed to vary between fisheries and between periods in response to (presumed) changes and differences in fishery targetting.

Two fishery-independent indices of spawning biomass were obtained from pelagic ichthyoplankton trawl survey measures of sardine egg density. It seems that survey catches, presumably from pelagic trawling, had been used to get data on stock composition. Aerial survey information, a possible index of stock size, was available, but not used. There is doubt as to whether available fishery-independent indices of stock size are wholly satisfactory: coverage of surveys capable of measuring density of eggs is less than the distribution of the stock.

A sea-surface temperature index is mentioned in the assessment document, as incorporated in the assessment model, as a modification to a Ricker spawner-recruit function. Some description of how it is built in would be appropriate. I doubt if its parameters can really be estimated to nine significant digits.

This assessment does list data and research needs; it would be advantageous to distinguish them and to be more exact about what data are needed. Some specification of the data needs to be more exact than 'better information'.

Pacific mackerel is also assessed annually. Data sources are similar, and so are problems with late or difficult access to foreign fishery data and inadequate coverage of surveys. In this case, a significant proportion of the spawning stock is thought to reside off Baja California, and this area is not adequately covered by surveys. However, a fishery-CPU index of biomass for this stock is available from recreational catch rates.

'Highly Migratory' Species

This species group includes large oceanic fishes, among them billfishes such as marlins and swordfishes, and some tunas. Some of these species migrate as they age from one side of the North Pacific to the other, and fisheries are prosecuted in international waters as well as national EE zones, so international cooperation, the pooling of information and data, and consensus on its analysis and interpretation are necessary. Assessment work is carried on in species (or species-group) Working Groups under the auspices of an 'International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean' which interacts with, without necessarily being subordinate to, various Pacific fisheries management organisations (as well as NMFS).

However, fishery management in this species group appears to be characterised by the absence of systematically and regularly collected fishery-independent data on size, age-, or sex-composition of the stocks, morphology, growth, or maturity. Assessments must therefore rely almost completely on fishery data, including fishery sampling for biological data and CPUEs as indices of stock size.

There is a large emphasis on the definition of CPUE, methods of standardising CPUE series as indices of stock size, and discussion of biases and alterations in the relationship between CPUE and stock size that may not be captured in the standardisation, because of changes in fishing practices, regulations, fleet size (with selective departure of fishing captains of different ability), and so on. For some stocks there is concern that CPU data do not adequately cover the whole area of distribution of stock and fishery. As well as analysis of catch data, there is also analysis of morphology and age data with a view to converting e.g. total catch weights to numbers of fish by age.

However, data are deficient for a number of fisheries and several species, as exemplified by statements such as 'accuracy of assessments is constrained by abundance indices' , 'insufficient data to analyse IUU impacts', 'data were limited to annual catch values and were not useful for fine-scale assessment', 'early data have problems with species identification', 'improvements [in catch statistics] from other member countries are still needed', and 'total enumeration of catch. . .a source of concern'.

In spite of the difficulties related to data, the species working groups are generally able to produce assessments that give indications of stock status, can carry out sensitivity analyses on assessments, and are able to produce conservation advice for management.

Modelling (e.g. in the Albacore Working Group) has in the past used a VPA model, but as far as US inputs are concerned, this appears now to be transferring to SS2. Contributors from other nations also run other models, and their results are presented to Working Groups and the International Scientific Committee.

Marine Mammals (Cetaceans; pinnipeds are elsewhere)

In the U.S., marine mammals receive exaggerated consideration as a result of the Marine Mammal Protection Act, which imposes on the administration a duty to ensure that their populations remain above 'optimal sustainable' level, interpreted as being the maximum net production level.

Owing to the difficulty of estimating the OS stock size for cetaceans, a rule of thumb has been included in the MMPA that limits annual takes of a cetacean species—i.e. human-caused mortalities such as fishery bycatch, ship-strike mortality, etc.—to a 'Potential Biological Removal' lying between 0.2% and 1% of a 20% lower confidence bound on stock size. (The fraction does not depend only on the stock status, but also on how accurately accidental mortality is known.)

For the purposes of this review, cetaceans were in two groups: eastern tropical Pacific dolphins, and California Current cetaceans. Dolphins in the ETP were drastically reduced in numbers by 'setting on dolphins' in the early days of the seine fishery for yellowfin tuna. Fishing practices have been improved so that observable mortality of dolphins that are trapped in tuna seines is now negligible. An intensive programme of shipboard line-transect surveys has been run for a couple of decades to monitor the recovery of the dolphin populations. The surveys have a difficult task, to estimate numbers of each of a group of related species, of somewhat similar appearance, that travel in large, and sometimes mixed, groups.

While the survey methods have been developed to a high level, with refined corrections for sighting conditions, there seems to be a persistent problem with the state of line-transect statistics. It is fairly clear that collecting sightings at distances where sightability is partial, which is what line-transect survey methods are all about, can hardly improve estimates of numbers. However, if survey methods are kept constant, and if, as in the ETP dolphin surveys, sightabilities can be corrected for sighting conditions and observer expertise, it should be possible to fit a single sighting curve to a series of surveys. In that case, the extra sightings that line-transect methods record, compared with strip-transect methods, should pay huge dividends in enabling the surveys in a series to be more sensitively compared. The SWFSC has both recently and in the past drawn attention to the difficulty of estimating trend in numbers from surveys; but considering the properties of independently analysed surveys, it has for some time been a primary goal in marine mammal surveys to get an unbiased estimate of numbers from single independent surveys. It is would therefore be in order to pay some attention to the statistical properties of survey series, and on how to design and execute surveys with the estimation of trend as the primary objective instead. It is not necessarily true that refining the corrections to single surveys regarded as independent estimates is the best way to improve estimates of trend. The number of surveys, carried out over an extended period, has generated some uncertainty over how best to combine their results to give a defensible lower confidence bound for present size; however, they have not detected that ETP dolphins are increasing.

This result is so surprising that it has motivated the development of sophisticated methods for carrying out line-transect surveys and analysing the resulting data, and these surveys now correct sightings rates for a complete spectrum of factors that could affect the likelihood that schools will be sighted. However, this has not had much effect on the observable trend in numbers. Moreover, since the tuna fishery is still setting on dolphin schools, attention has been turned to possible unobservable mortality from being chased and captured, perhaps through the separation of young calves from their mothers (for which there is some evidence) or because of other effects, such as the stress of being pursued (which while not immediately lethal could reduce productivity).

Alternatively, there could have been a shift in the ecosystem itself that has reduced its ability to support dolphins. There is little evidence for this.

For cetaceans in the California Current, stock-assessment activities appear to be limited to periodic surveys, estimation of minimum numbers and PBRs, and comparison of observed or other known takes with PBR. For all cetacean species except one, the default maximum rate of increase is assumed to apply, even though for that exception, the humpback whale, the known growth rate is twice that. There are some oddities about the methods of combining results from different surveys that are not well explained. If surveys are carried out using the same methods, effort weighting presents itself as the obvious method to be used in combining results

'Assessments' for this group of cetaceans can be provided according to the rules specified by the MMPA. These are different from most normal practices in the assessment of exploited fish stocks in that the penalties exacted on allowable takes for uncertainty of knowledge, either of the state of the stock, the dynamics of the species, or the takes themselves, are clearly spelled out.

Cetacean stock-assessment modelling is crippled by the inaccessibility of information on life history and population dynamics. The animals themselves are hard to access and to work on. Mortalities are low, and therefore difficult to estimate even on average, as are birth-rates. Protected status makes research even more difficult.

A current activity in the Protected Resources Division is concerned with defining quantitative criteria for classifying species under the ESA. In my experience, quantitative criteria are necessary for the orderly functioning of endangered species protection. The Canadian system ran for a number of years with only qualitative criteria, and gave some grounds for thinking that species 'charisma' was not unimportant in designations. Quantitative criteria were introduced in the Canadian system at about the same time as a Species at Risk Act was enacted, with legal consequences for designations, including requirements for Recovery Teams, etc. The criteria used are based on the IUCN criteria. The system functions fairly well; status reports include a technical summary that rates the species against each criterion in turn. There is disagreement about whether one set of quantitative criteria can serve for all groups of species. However, it is likely that more progress will be made by adjusting quantitative criteria for different species groups than by scrapping them.

The present activities in the Protected Resources Division seem to hinge on the notion that endangered species classification can, or should, be based on an estimated probability of extinction, over a longish period, i.e. many decades or a century. Except in trivial cases where a stock is declining so quickly that extinction is just round the corner, it is difficult to believe that such probabilities can be calculated at all, and it may not be appropriate to ascribe much weight to their absolute size. However, since they are calculated on the basis of present knowledge about stock size, dynamics, the variability of dynamics, the possibility of catastrophe, and other factors that do bear on the question of how endangered a species is, such probability calculations can be considered a form of summary or condensation of present knowledge, and therefore may not be without meaning in the context of at least ranking candidate species. They have the danger that the uninstructed might give them too much literal belief, but, while it is not always clear that the knowledge being summarised is necessarily the most relevant, PVA analyses do have the advantage of being able to condense a wide variety of different kinds of knowledge, or knowledge about many different factors affecting population dynamics, into a few critical values. A leading problem lies in separating the components of the uncertainty of population-dynamics parameters, where one can conceptually differentiate between short-term variability, longer-term variability, uncertainty of knowledge of the long-term mean, uncertainty of knowledge of the short-term mean, uncertainty of prediction of environmental factors, and uncertainty as to their effects. Generally, very long-term predictions, which can sometimes depend heavily on variances and uncertainties, are based on knowledge gained over much shorter periods, and on very defective analyses of variability and uncertainty.

There may be a parallel here with the history of the administration of the Marine Mammal Protection Act, which started with a theoretically based requirement to maintain marine mammal populations above their OSP level, but which eventually translated this into a rule of thumb that takes should not exceed some fraction of a 20% lower confidence limit on numbers, the fraction being set between 0.2% and 1% depending on another set of decision rules; i.e. the MMPA started with a somewhat theoretical concept and retreated to a simpler decision rule. It will be interesting to see how the criteria for ESA listing evolve.

Antarctic finfish

Fishery science in the Antarctic is conducted under the aegis of the Convention for the Conservation of Antarctic Marine Living Resources. Fisheries reports were presented for toothfish *Dissostichus* species and for the mackerel icefish *Champsocephalus gunnari*, respectively a large, esteemed, long-lived predatory fish with a high market value, and a fast-growing, short-lived forage fish with variable stock dynamics. Exploratory fishery reports were brief, but in some CCAMLR divisions more developed fisheries are associated with full assessments. Trawl surveys and sampling provide fishery-independent data in some areas. Assessments used CASAL, ASPM and GYM. The fitting method used in CASAL for toothfish assessments is described as ‘point estimate Bayesian’, which may be close to maximum likelihood fitting, especially since all the priors were uniform. Assessments are reviewed by a fixed group of scientists active in CCAMLR, and it was not clear that external reviews are regularly sought.

Where full assessments are carried out on toothfish, estimates of stock size and MSY are obtained and management advice is provided. For mackerel icefish, assessments are hindered by variable stock dynamics which render natural mortality difficult to estimate, even on average, and even harder to predict, and by difficulty in reading ages of individuals and therefore of separating cohorts and analysing stock structure.

Salmons

Methods for the assessment and management of two managed salmon stocks were presented: these were the Klamath River Fall Chinook and the Central Valley Chinook. The Klamath River stock is modelled by a set of deterministic models that hinges on counts of the numbers of 2-year-olds returning to the river each year. By a series of deterministic relationships, cohort sizes can be estimated, and the catch in ocean fisheries and thus the spawning escapement corresponding to different management options is forecast. The management objective is defined as a spawning escapement threshold. A recent request from the management agency for analysis of stock-recruitment relationships may indicate that this target may be reviewed. The model is deterministic and uses fixed values for some, or most, of its parameters.

The Central Valley stock is less well covered by sampling and data acquisition, having for some time met its escapement objective. However, it has just now decreased to record low levels and the lack of detailed data and well established data-acquisition networks do not facilitate accurate assessment.

The analysis of the previous year's ocean harvest data, the prediction of the coming year's fishable stock and the catches likely from various management options, and a public hearing, are all arranged in a short period in March–April of each year. The possibilities that are available in some other assessment forums for comparing and considering different tunings of a model are therefore restricted.

For the Klamath River modelling, an evolution of the models to include stochastic terms and some treatment of uncertainty has already been identified as a desirable development.

Salmon and steelhead stocks in the Central Valley have been hard hit by the damming of their spawning rivers, and in general are listed under the ESA. The modelling of the dynamics of stocks therefore mostly concerns the definition of viable population units, the estimation of their probabilities of survival, including consideration of the diverse forecast effects of global warming and the possibilities of natural catastrophes, and the evaluation of the impacts of further human disturbances such as water diversions. This has included the development of new modelling methods.

Other species

Abalone

White abalone has been severely depleted by exploitation. There is concern for its recovery. Successful spawning is thought to require an animal to be within a few metres of one of the opposite sex, and white abalones are now so sparse that this does not happen. Assessment activities are currently confined to surveys, with a view to better defining suitable habitat for the species and estimating the numbers of the remaining stock. The methods that are used include multivariate underwater remote sensing to describe the sea-bottom, and visual (camera and video records) surveys carried out by a remotely operated vehicle cruising near the bottom. Analysis of the ROV visual records and comparison with the remote-sensing record allows the habitat preferred by white abalone to be described along several dimensions and the density of abalone in its preferred habitat to be estimated, and wider-area remote sensing surveys then allow the extent of preferred habitat, and hence the stock of the species, to be estimated. ROV surveys indicate that there are few young white abalones to be found, thus tending to confirm that spawning success has for some years been poor, presumably owing to low densities and therefore unlikely to improve.

Antarctic krill

Results from an acoustic transect survey in the Scotia Sea were presented. The survey design lacked the courage to be completely systematic, and therefore ended up lacking the statistical virtues of equiprobable sampling, while not fully achieving the advantages associated with systematic sampling. Acoustic data were calibrated with known reflectors and backed up by pelagic trawling at stations distributed—again, nearly systematically—along the transects.

Assessment modelling has consisted principally of the establishment, from existing data, of probability distributions for parameters of the dynamics of an age-structured model, allowing stochastic modelling of the stock under different levels of fishing and predation. CCAMLR wishes to ensure that predators that depend on krill near their bases on land do not suffer from local depletion, and modelling has therefore also considered restrictions on the distribution of the fishery.

Marine turtles

Marine turtles fall under the remit of the Protected Species Division. Assessment activities appear to consist of population monitoring, largely by monitoring nesting activity on nesting beaches, in some cases by participation in international programmes, and also by conducting aerial surveys to monitor numbers of adults in favoured habitat.

2. Explore the adequacy of the data and biological information for meeting the needs of population models. Provide guidance as to the overall quality and quantity of data to support assessments.

'Quality' of data is difficult to assess with the available information—it is not easy even for the assessment biologists. 'Good quality' data have the characteristics that measurements are accurate, that the sampling covers the true target population, that the sampling is unbiased, and that the sampling, and the analysis of the data, properly accounts for structure in the sampled population. This last point may need some explanation; for example, in sampling from fisheries, the fish in the catch from a single set are usually not independent samples from the total catch of the fishery, and the same is probably true for the fish landed from an entire trip. The treatment of fishery-sample data should properly consider these cluster-sampling effects. In some of these analyses such treatment is described, in some it is not. Sampling design and execution are not well described, nor their effectiveness evaluated, in most of these assessments.

Sampling bias and measurement errors are inherently difficult to detect. In the collecting of data on some stocks there is systematic treatment of errors in reading the ages of fish, and the more complex modelling platforms can use such data.

‘Quantity’ of data is a misleading concept. More of the data that are already being obtained do not necessarily help, and for most of the assessments under consideration, where data are accessible, they are accessible in adequate quantities. A general exception is probably to be found in observer data, where coverage is generally inadequate, and in fishery-independent measures of stock size, where, even when these indices exist, they are generated from surveys that usually cover too small an area, too sparsely, and too seldom. Improvement in sampling designs and control of sampling might give bigger dividends.

However, in most cases, what is needed is to fill gaps with data that are largely or completely missing. Many documents already contain clear statements of data that would improve the assessments: often, these include improved or better standardised CPU indices, fishery-independent survey indices of stock size that more completely cover the range of the stock, more timely availability of catch data from certain fishery segments, or more profound analysis of historical catch series.

Some of the assessments are using biological data on, for example, size or maturity at age , that are years or decades old and should probably be updated.

Some assessments would benefit from better, regularly obtained, fishery-independent data on stock size and composition, which for many stocks is lacking.

Most assessments would benefit to some extent from improved reporting of fishery catches, more particularly with respect to information that either does not come in at all or comes in with years of delay. More intense and more accurately reported, fishery sampling would be useful in a few cases, e.g. in the highly migratory species.

All in all, the data problems are in general neither problems of ‘quality’ or of ‘quantity’; i.e. they are not necessarily to be solved by making the data now available ‘better’ or by getting more data. They are problems of completeness. The data available do not, for some or most fisheries, cover the full spectrum of what is needed to fully support a stock assessment; e.g. catch data is missing for some fisheries, fishery-independent stock-size indices are missing for some stocks, or apply only to part of the stock range, etc.

<u>3. Evaluate the capacity of the SWFSC to conduct stock assessments in order to meet the demands of management for assessment products.</u>

The capacity of the SWFSC to conduct stock assessments seems in general to be satisfactory, perhaps above average, but not exceptional. Problems often stem from the causes that bedevil fish stock assessment processes elsewhere: large, or very large, variability in the success of spawning and the survival of newly hatched fish, so that the sizes of year classes entering the fishery are difficult to predict until they arrive, unless there is good fishery-independent data from surveys that inform on the strength of year-classes not yet recruited to the fishery. There appeared to be also in many cases problems with fishery data, including fishery sampling that is either inadequate or improperly designed, the timely availability of data from some fisheries and in some cases (e.g. Highly Migratory Species, Antarctic finfish) concerns about information on IUU fishing. However, it would be difficult to support a hypothesis that the capacity of the SWFSC to conduct stock assessments has major deficiencies.

The review was presented with assessment documents and information on assessments directed mostly toward the management of exploited or, in some cases, threatened stocks. Whether this fully covers the spectrum implied by 'assessment products' is not clear. We had less, in fact almost no, information on methods and procedures for generating biological opinions and biological assessments.

4. Evaluate the overall state of population assessment modelling within the SWFSC.

Modelling *per se,* as far as the SWFSC is concerned, is dominated by SS2 as a standard platform. SS2 was neither presented nor explained, and it does not appear that a review of SS2 as a modelling platform is within the remit of this review. SS2 is by all accounts a comprehensive and fairly complex platform for specifying age-structured forward population-dynamics models for fish stock assessments and fitting them to data. Few of the assessment documents mentioned deficiencies or problems specifically with SS2. A feature of SS2 as a platform is its capacity to estimate e.g. size-age, maturity, or selectivity curves within the model. However, it appears that these estimations may interact with each other and with the stock-dynamics modelling that fundamentally constitutes the assessment in complex and little-understood ways. In some instances, data selection for assessments appeared to be based on somewhat subjective evaluations of the acceptability of such 'internal' fits of biological relationships. Other modelling platforms and structures are mentioned, and occur here and there in the documentation, but it was difficult to discern so much as a second-placed favourite, let alone any serious rival.

The cohort reconstruction used to model the Klamath River fall Chinook and its associated fisheries is *sui generis*, using data from intensive ocean fishery sampling and adequate data collection from the river fisheries. Other anadromous stocks are also covered by the ocean sampling, but collection of data on river runs and river fisheries for these stocks are generally not as complete as for the Klamath system. The modelling and analysis is designed for, and apparently suited to, these unusual—short-lived, semelparous, and yet large-sized, esteemed, and valuable—species.

We reviewed many stock-assessment reports, but there was hardly a single population-dynamics equation in any of them. There were, more often, simple equations describing, for example, the logistic function to relate maturity to length or age, or a simple power function to relate weight to length. The indications are that assessment scientists in the SWFSC tend more to develop expertise in setting up data for tuning, and manipulating the responses of standard modelling platforms, rather than developing modelling expertise. (This is not always true, as some assessment models have been independently coded.) This is a general phenomenon, not confined to SWFSC, and not surprising, given that the power of present-day computers permits fitting models of considerable complexity. This complexity which makes great demands on the builders of modelling platforms not only to have considerable understanding of algorithmic processes of model fitting, but also the ability to code their intentions correctly in all details. Furthermore, the assessment cycle is demanding, and review panels and fisheries managers prefer any change in assessment models to be documented, carefully examined and compared with the *status quo ante* before being adopted. (E.g. in the present document set, results from modelling widow rockfish on the SS2 platform were compared with those from using a model independently coded in ADMB, anticipating a transfer to SS2, and similar comparative exercises were undertaken in the Albacore Working Group of the ISC.) The prevailing practices in the use of complex compound platforms that simultaneously model the growth, maturing, and mortality of fish, the stock-dynamic processes, and the selectivity of and effort applied in fisheries militate against incremental change in modelling platforms or change that is in any way continuous; stability, with rare quantum improvements in performance, are more acceptable.

An exception to these generalisations is found in modelling undertaken for assessing stocks of marine mammals under the MMPA or in connection with the ESA and the conservation of endangered salmonids. These domains are separated from the assessments of stocks for fishery management, in some cases use rather different data, and do not have the same cycle of annual processing of quantities of fishery data, production and review of assessment, and presentation of management advice. They therefore have more time and more scope for original assessment-modelling research, and the present review showed that they take advantage of it to produce advances in modelling in these fields that are at least publishable in the primary literature.

<u>5. Conclusions and Recommendations</u>, hereunder strengths, weaknesses, limitations, and recommendations for improving the population assessment discipline within the SWFSC.

One first reservation must be whether stock assessment as we do it now is in any way a reasonable exercise. In effect, do fish stocks have such regular dynamics that mathematical models can be fitted to past data and give estimates of stock-dynamic parameters reliable enough for us to be able to forecast the results of future actions? For many stocks, year-class strength is difficult or impossible to predict, and fishery management is restricted to managing the exploitation of known strong year classes, while seeking to maintain spawning biomass at a high enough level to ensure that the favourable circumstances that might, uncertainly, occur, can generate the next one. The level of spawning biomass that can ensure that is often poorly known.

There is a difference between improving assessments and improving the assessment discipline. A major strength of the assessments carried out for the PFMC is the system of independent review by STAR Panels, with their shifting and independently selected members, and strong representation of stock-assessment and mathematical specialists. Extension of a similar system to other assessment areas is much to be recommended; internal review within standing groups, which tend to be composed not only of species specialists, but also of species specialists who think the same way about stock assessment, is not nearly so effective.

One could start by looking at the organisation of the Center with respect to the stock-assessment discipline. *Strictly* from a stock-assessment viewpoint, some of the groupings look illogical. *Dissostichus* looks more like a rockfish, while mackerel icefish looks more like a coastal pelagic; they group together because they live in the same place. Likewise, the conservation of endangered salmon species has much in common with the work of the Protected Resources

Division, and in some ways they are treading the same paths in considering definitions of viability, units to conserve, viability analyses and forecasts, and so on. So would there be advantages from a stock-assessment point of view in an organisation that reflected stock-assessment similarities, and would they compensate for the disadvantages? A matrix management scheme is defined for the SWFSC, but matrix management is not always very effective; the role of a functional leader is a difficult one, and while the management matrix was described early in the review, its presence at the desk level of the individual assessment scientist was not always obvious. It was not obvious that the stock-assessment scientists in different divisions saw themselves *primarily* as practising a common discipline in diverse contexts.

Assessments, STA Panel reviews and SSC reviews often contain recommendations for the acquisition of additional data, improved or deeper analysis of existing data, and research on the biology of the species or enhancements to assessment modelling methods. Many, or most, of them would improve the individual assessments. This is the only place that such recommendations can be put, and it would be appropriate for the improvement of the assessment discipline in the Center for them to be systematically reviewed. However, assessments are probably read as assessments and go forward to the generation of management advice. I suggest therefore that the Center management might annually collect and collate recommendations for improved assessments made in either in the assessments themselves or by STAR Panels, and produce an overview document, including statements about what it was doing to implement the suggestions made. After all, if one wants to improve the assessment discipline, one-shot suggestions from one-off reviews like this one may be useful, but a system for holding the discipline under review and *continually* considering improvements would also be helpful, and systematic use of the information scattered through the assessment documents is indicated.

A continuing process can be discerned where by assessment models progressively become more comprehensive, tending more and more to take in raw data and fit not only population-dynamics parameters but also biological relationships between, for example, weight, length and age. It may be appropriate to consider extending this to the calculation of standardised CPUE indices, by entering data on catch, effort and other independent variables such as location or vessel to the global model. A possible development also in this direction might also be to consider non-linear relationships between fishery CPUE and stock size. Most modelling considers the relationship to be linear, but in order to achieve this result, surveys have to be carefully designed and executed, and fishery effort is often quite differently distributed. However, there may arise interactions between the fitting of biological relationships simultaneously with the stock-dynamic parameters, and the question arises of when the model becomes so complex that the interactions between the different sub-models being fitted become impossible to untwine.

It can in general be assumed that there are components of uncertainty that are not included in analysis. In almost all analyses of natural-resource data with a view to generating management advice, there are components of uncertainty that are difficult or impossible to estimate, and they very often get swept under the carpet and do not contribute to a final estimate of total uncertainty. Fish stock assessments are no exception, and one improvement in general would be to ensure that components of uncertainty that are not included in final estimates are identified.

In terms of improving assessments, there were a few minor oddities in the treatment of data that I happened to notice in looking through the documents. Among them:

- Combining survey estimates for marine mammals seems to be based on a combination of adhockery and guesswork. If repeated surveys are executed with the same methods, there are fairly compelling reasons to weight their results by effort when combining them. Yet this weighting seems not even to come onto the list of the methods that are considered. This seems to arise from not thinking clearly about the statistical properties of the individual input estimates, including probable correlation between the estimate and its estimated standard error, and the statistical assumptions that they are based on, not about the statistical properties of the result. These considerations apply both to the California current cetacean surveys and to the ETP dolphin surveys.
- California current cetacean surveys look much like systematic transect surveys; there are analysis methods appropriate to analysing systematic-sample data.
- A von Bertalanffy curve fitted to a set of assessment data rejected because it gave an asymptotic length at variance with a published value; however, asymptotic lengths may often be imprecise, and the fitted curve might have been an adequate summary of the available data; this didn't seem to have been investigated.
- Antarctic krill survey dithered between systematic and equiprobable sampling, and ended up with a design that lacked the statistical virtues of equiprobable sampling, while failing fully to capture the benefits of systematic sampling.
- Weight-length relationships are simple power curves, presumably fitted by straight-line regression of logged data; a method that was well enough in the 1920s but which, while standard practice, has the obvious drawback of giving more weight to the point (0,0), which is not in the data, than to any of the points that are.

A topic of particular interest is the design and analysis of line-transect surveys for marine mammals, particularly cetaceans, and possible improvements. It should be first said that the present methods represent a high level of development of orthodox thinking on these subjects, to which most of the principal actors on this stage have contributed. However, a preoccupation with the details of specifically line-transect analysis have to some extent distracted attention from more basis topics of survey design and analysis, and the line-transect analysis methods themselves represent a high level of development in a particular direction.

Resource surveys sample a population which consists of a habitat area. Such habitat-area populations are usually spatially structured with more or less auto-correlation. In sampling from auto-correlated populations, systematic sampling should give more precise estimates of mean values of population parameters than equiprobable sampling, and the grid design of the California current cetacean surveys looks much like two systematic samples laid at right angles to each other. The conventional expression on which estimation of uncertainty is based, the sum of squares of deviations of sample members from the mean, is expected to overestimate uncertainty when a systematic sample is taken from an autocorrelated population, and can with advantage be replaced by half the sum of squares of differences between neighbouring members of the sample. Systematic sampling, with uncertainty estimation based on nearest-neighbour differences, has become the standard design method for marine mammal surveys in Canada.

A problem that frequently arises is that of taking an average of the results of several different surveys. In general, when statistical results are to be combined, it is appropriate to give each result a weight that is proportional to the effort that went into getting it. In many standard statistical problems, if the effort as such is unknown, the precision of each result can be a valid proxy for the effort. However, because this is often the case, there is a tendency to resort too automatically to inverse-variance weighting where it is not appropriate, even when effort measures are readily available.

In resource surveys, especially surveys of resources that are rare or highly clumped, the variance of a density estimate tends to be strongly correlated with the estimate itself, and combining results using inverse-variance weighting can be relied upon to give a downwardly biased overall estimate. Moreover, in transect surveys, a measure of the effort applied is almost always available, and weighting by effort when combining the results of surveys should be automatically the first resort. This is especially so when the survey methods have been the same or closely similar, so that effective transect width has changed little and the length of transect run is a very good measure of effort.

The combining survey results by using geometric means, which from the reports appears to be a frequent practice in California Current cetacean stock assessments, needs to be supported by more careful analysis of its statistical properties. All other things being equal (stock size, group-size distribution, visibility in surveys, etc.) a species with variable occurrence in the study area (e.g. because it is sensitive to year-to-year variation in oceanographic conditions) will produce a geometric mean much lower, relative to the arithmetic mean, than one that is more constantly present. Also, a species that tends to generate variable survey results because of being highly clumped or, simply, rare, will have a lower geometric mean result relative to its arithmetic mean than one that is more frequently encountered. Generating low combined results through using the geometric mean duplicates the intention of other components of the PBR rule and should not be adopted without careful thought.

An illustration here is appropriate to show the aforementioned point. A (systematic, or other) survey could quite legitimately be regarded as two sub-surveys, one consisting of the odd-numbered transects, the other of the even-numbered. These could be analysed separately. If the survey result were to be considered as a combination of the results of these two putative sub-surveys, it would be seen first that their results were combined using effort weighting, not inverse-variance or inverse-c.v., and that they had been combined using arithmetic, not geometric means. What is an automatic consequence of standard methods of analysis of a single survey should form the *starting-point* for methods of combining separate surveys. Surveys can still be regarded as independent samples from a single population, even though carried out at different times.

The statistics of line-transect surveys are complex and poorly defined. *Prima facie* a single set of observations cannot serve both to estimate a sighting curve and also to make improved estimates of density using the same sighting curve, except under some restrictive assumptions - for example about the form of the sighting curve. The more restrictive the assumptions, the more information about mean density can be extracted from sightings made at distances where sightability is partial. In reporting results of line-transect analyses, the components of uncertainty associated with the form of the sighting curve are often partly suppressed, and the complete set of assumptions with which the estimates both of density and of uncertainty are associated is not always stated.

However, even under much less restrictive assumptions—for example, only that the sighting curve has the same form, parameter values, and dependence on variables such as wind and weather, even if all these are unknown—line-transect methods should hugely improve comparisons of density over space or time, provided that the assumptions are valid. This is the principal virtue of line-transect methods, but in order fully to realise it, methods need to be as nearly as possible the same over surveys and series. If methods are similar enough, the recommended analysis would be to fit to an entire survey series a single set of parameter values defining the effects of *distance and all other extraneous variables* on sighting rate. This removes this source of uncertainty from comparisons between surveys, and improves ability to detect trends.

To ensure best possible marine mammals assessments from transect surveys, the following is recommended:

- Repeat survey designs and methods as closely as possible; i.e. with a view to analysing the survey series as a series, not as a succession of independent observations; this includes transect layouts and stratification, not just observation methods.
- Use systematic sampling designs and the analysis methods appropriate to them.
- Analyse repeated surveys as a series, fitting common sightability parameter sets to the full extent permitted by the similarity of *methods* (not results).
- Where methods are the same or closely similar, combine survey results weighting by effort or a good proxy for it, not by error variance or error c.v., and using arithmetic functions, not geometric.
- For California Current cetacean surveys, stratify the survey area for analysis. I suggest a set of coastal strata of one-third the east-west extent of the study area and an offshore set for the other two-thirds, and three or four equal-sized strata from north to south. This need not affect the layout of transects or the execution of the survey, but could improve precision.

There may be some potential for improving marine mammal assessments other than by improving survey methods. However, the information made available was overwhelmingly concerned with surveys, their methods, and the deductions to be drawn from them. The use of a blanket value of 4% as the maximum rate of population increase for ‘cetaceans’ is not completely satisfactory given their diversity, especially as data for the humpback support a rate of twice that, and it would be appropriate to revisit the question of the rates of increase that odontocete and mysticete populations may be capable. Data from grey whale population trajectories may also be illuminating in this context, and it would give evidence of more thorough thinking if odontocetes and mysticetes were dealt with separately.

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Appendix II Statement of Work for Dr. Michael Kingsley

External Independent Peer Review by the Center for Independent Experts

Review of Population Assessment Science in the NMFS/SWFSC

Project Background:

The National Marine Fisheries Service's Southwest Fisheries Science Center (NMFS/SWFSC) has long been associated with innovation and creativity in population assessment science. However, this scientific "discipline" has never been subject to a formal scientific peer review across all Center programs. The purpose of the review will be: (1) to assess the accuracy, precision, originality, and credibility of population assessments produced by the SWFSC that are used in managing Pacific Basin fisheries, marine mammals, and other protected species and (2) to improve operations of SWFSC scientific programs in order to maintain and/or achieve state-of-the-art assessments. Legislative mandates for these SWFSC population assessments fall broadly within three pieces of legislation, i.e., the Magnuson-Stevens Fishery Conservation and Management Act (and its reauthorizations), the Marine Mammal Protection Act, and the Endangered Species Act.

Overview of CIE Peer Review Process:

The NMFS Office of Science and Technology implements measures to strengthen the NMFS Science Quality Assurance Program (SQAP) to ensure the best available high quality science for fisheries management. For this reason, the NMFS Office of Science and Technology coordinates and manages a contract for obtaining external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of stock assessments and various scientific research projects. The primary objective of the CIE peer review is to provide an impartial review, evaluation, and recommendations in accordance to the Statement of Work (SoW), including the Terms of Reference (ToR) herein, to ensure the best available science is utilized for the National Marine Fisheries Service management decisions.

The NMFS Office of Science and Technology serves as the liaison with the NMFS Project Contact to establish the SoW which includes the expertise requirements, ToR, statement of tasks for the CIE reviewers, and description of deliverable milestones with dates. The CIE, comprised of a Coordination Team and Steering Committee, reviews the SoW to ensure it meets the CIE standards and selects the most qualified CIE reviewers according to the expertise requirements in the SoW. The CIE selection process also requires that CIE reviewers can conduct an impartial and unbiased peer review without the influence from government managers, the fishing industry, or any other interest group resulting in conflict of interest concerns. Each CIE reviewer is required by the CIE selection process to complete a Lack of Conflict of Interest Statement ensuring no advocacy or funding concerns exist that may adversely affect the perception of impartiality of the CIE peer review. The CIE reviewers conduct the peer review, often participating as a member in a panel review or as a desk review, in accordance with the ToR producing a CIE independent peer review report as a deliverable. At times, the ToR may require a CIE reviewer to assist with the development of a CIE summary report. The Office of Science and Technology serves as the COTR for the CIE contract with the responsibilities to review and approve the deliverables for compliance with the SoW and ToR. When the deliverables are approved by the COTR, the Office of Science and Technology has the responsibility for the distribution of the CIE reports to the Project Contact. Further details on the CIE Peer Review Process are provided at http://www.rsmas.miami.edu/groups/cie/

Requirements for CIE Reviewers:

The Population Assessment discipline review will be conducted at the SWFSC La Jolla facility in San Diego, California from 23-25 April 2008. The format of the review will be in the form of SWFSC Divisions making presentations to a panel of six outside experts over a 3 day period. The panel will be composed of people with expertise in population/stock assessment modeling, including both NMFS and non-NMFS scientists. Two of the six panel members will be CIE reviewers, who will be asked to provide an independent report based on their personal peer review of SWFSC population assessment practices. In addition, the CIE reviewer will be expected to contribute to discussions leading to a consensus panel report, which will be the responsibility of the Panel chairperson to produce in consultation with all other panelists.

The two CIE reviewers shall have a very broad understanding of contemporary methods and modeling approaches that are used to assess population status of exploited and protected resources. Furthermore, one CIE reviewer shall have experience with Bayesian statistical methods, integrated modeling using likelihood based approaches, analysis of survey data for inclusion in population models, and forecasting techniques. The other CIE reviewer should have experience in either: (1) marine mammal population assessments with some knowledge of line transect techniques or (2) population status determinations of rare and/or endangered species with knowledge of analytical methods used to project recovery of depleted populations (e.g., population viability analysis).

The two CIE reviewers shall have the requested expertise necessary to complete an independent peer review and produce the deliverables in accordance with the SoW and ToR as stated herein (refer to the ToR in Annex 1). Each CIE reviewer's tasks for reviewing pre-meeting materials, participation during the panel review meeting, and completion of an independent peer review report shall not exceed 19 days for each reviewer.

Statement of Tasks for CIE Reviewers:

The CIE reviewers shall conduct necessary preparations prior to the peer review, conduct the peer review, and complete the deliverables in accordance with the ToR and milestone dates as specified in the Schedule section.

Prior to the Peer Review: The CIE shall provide the CIE reviewers contact information (name, affiliation, address, email, and phone), including information needed for foreign travel clearance when required, to the Office of Science and Technology COTR no later than the date as specified in the SoW. The Project Contact is responsible for the completion and submission of the Foreign

National Clearance forms (typically 30 days before the peer review), and must send the pre-review documents to the CIE reviewers as indicated in the SoW.

Foreign National Clearance: The CIE reviewers shall participate in a panel review meeting requiring foreign travel, and the CIE shall provide the necessary information for each reviewer to the Project Contact who is responsible for the completion and submission of required Foreign National Clearance forms with sufficient lead-time (30 days) in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations at the Deemed Exports NAO link http://deemedexports.noaa.gov/sponsor.html

Pre-review Documents: Approximately two weeks before the peer review, the Project Contact will send the CIE reviewers the necessary documents for the peer review, including supplementary documents for background information. The CIE reviewers shall read the pre-review documents in preparation for the peer review.

Some of the documents to be considered in this review will be a series of stock assessments that have been prepared for the Pacific Fishery Management Council for groundfish, coastal pelagic species, salmon, and highly migratory species. Population status reports for marine mammals prepared by the Protected Resources Division will also be provided in advance of the review meeting. In addition, documents describing population assessments of species listed under the Endangered Species Act (e.g., salmonids and white abalone) will be distributed.

This list of pre-review documents may be updated up to two weeks before the peer review. Any delays in submission of pre-review documents for the CIE peer review will result in delays with the CIE peer review process. Furthermore, the CIE reviewers are responsible for only the pre-review documents that are delivered to them in accordance to the SoW including the scheduled deadlines specified herein.

Panel Peer Review Meeting: The CIE reviewers shall participate and conduct the peer review during a panel review meeting as specified in the dates and location of the attached Agenda and Schedule of Deliverable. The Project Contact is responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The CIE Program Manager can contact the Project Contact to confirm the facility arrangements.

The CIE reviewer will be a co-equal member of the review panel and will have input into the panel's consensus report. Currently, plans are to have three non-SWFSC NMFS scientists on the panel, one of whom will chair the meeting. One other scientist from either academia or with international experience will be seated on the panel. The CIE scientists will occupy the final seats on the panel and will be involved in all discussions, recommendations, and conclusions that the panel draws. Because this is the first review meeting of its kind there are no established guidelines for conducting the meeting, but terms of reference will be drawn up and distributed in advance. It will be the Panel chairperson's responsibility to conduct the meeting and to bring the panel to consensus in producing a report with recommendations on how to improve population assessment practices within the SWFSC.

However, the primary role of the CIE reviewer is to conduct an impartial peer review in accordance to the Terms of Reference (ToR) herein, to ensure the best available science is utilized for the National Marine Fisheries Service (NMFS) management decisions (refer to the ToR in Annex 1).

Terms of Reference: The Terms of Reference (ToR) for the CIE peer review is attached to the SoW as Annex 1. Up to two weeks before the peer review, the ToR may be updated with minor modifications as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

Independent CIE Peer Review Reports:

The primary deliverable of the SoW is each CIE reviewer shall complete and submit an independent CIE peer review report in accordance with the ToR, and this report shall be formatted as specified in the attached Annex 2.

CIE Reviewer Input for Summary Report:

Following completion of presentations, the panel will prepare a summary consensus report to be delivered to the SWFSC Science Director, which details the findings of the panel. The report is due within two weeks of the meeting and it is the responsibility of the panel chairperson to complete the report, in consultation with all panel members (including CIE representatives). Consultation and finalization of the report may be completed by panel members through email.

The primary requirement of each CIE reviewer is to provide an independent peer review according to the ToR as specified herein, and is not required to conform to a consensus. If requested in the ToR, each CIE reviewer shall provide a brief summary or consensus of agreement or disagreement for each ToR for the peer review.

The milestones and schedule are summarized in the table below. No later than June 27, 2008, the CIE panelists should submit their CIE independent peer review reports to the CIE for review[1]. These reports shall be submitted to Mr. Manoj Shivlani, CIE Lead Coordinator, via email at shivlanim@bellsouth.net, and to Dr. David Die, CIE Regional Coordinator, via email at ddie@rsmas.miami.edu.

[1] All reports will undergo an internal CIE review before they are considered final.

Schedule of Milestones and Deliverables:

4 March 2008	CIE shall provide the COTR with the CIE reviewer contact information, which will then be sent to the Project Contact
25 March 2008	The Project Contact will send the CIE Reviewers the pre-review documents
23 - 25 April 2008	Each reviewer shall participate and conduct an independent peer review during the panel review meeting
8 May 2008	Each reviewer shall submit a draft CIE independent peer review report to the CIE
22 May 2008	CIE shall submit draft CIE independent peer review reports to the COTRs
29 May 2008	CIE will submit final CIE independent peer review reports to the COTRs
5 June 2008	The COTRs will distribute the final CIE reports to the Project Contact

Acceptance of Deliverables:

Each CIE reviewer shall complete and submit an independent CIE peer review report in accordance with the ToR, which shall be formatted as specified in Annex 2. Upon review and acceptance of the CIE reports by the CIE Coordination and Steering Committees, CIE shall send via e-mail the CIE reports to the COTRs (William Michaels William.Michaels@noaa.gov and Stephen K. Brown Stephen.K.Brown@noaa.gov) at the NMFS Office of Science and Technology by the date in the Schedule of Milestones and Deliverables. The COTRs will review the CIE reports to ensure compliance with the SoW and ToR herein, and have the responsibility of approval and acceptance of the deliverables. Upon notification of acceptance, CIE shall send via e-mail the final CIE report in *.PDF format to the COTRs. The COTRs at the Office of Science and Technology have the responsibility for the distribution of the final CIE reports to the Project Contacts.

Key Personnel:

Contracting Officer's Technical Representative (COTR):

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Request for Changes:

Requests for changes shall be submitted to the Contracting Officer at least 15 working days prior to making any permanent substitutions. The Contracting Officer will notify the Contractor within 10 working days after receipt of all required information of the decision on substitutions. The contract will be modified to reflect any approved changes. The Terms of Reference (ToR) and list of pre-review documents herein may be updated without contract modification as long as the role and ability of the CIE reviewers to complete the SoW deliverable in accordance with the ToR are not adversely impacted.

ANNEX 1:

Terms of Reference

Review of Population Assessment Science in the NMFS/SWFSC

1. Review population assessment methodologies employed by scientists at the SWFSC. This review will include groundfish and coastal pelagic species stock assessments conducted for the Pacific Fishery Management Council, the Klamath Ocean Harvest Model (KOHM) that is used to establish salmon harvests from the Klamath River system, highly migratory species assessments conducted in International Scientific Committee (ISC) working groups, and all other relevant population assessments conducted within the SWFSC, including marine mammal population assessments and those for ESA-listed stocks (e.g., salmonids, green sturgeon, and white abalone).
2. Explore the adequacy of the available data and biological information for meeting the needs of population models and recommend improvements to both. Provide guidance as to the overall quality and quantity of data to support assessments conducted by the Center.
3. Evaluate the capacity of the SWFSC to conduct stock assessments in order to meet the demands of management for assessment products.
4. Evaluate the overall state of population assessment modeling within the SWFSC.
5. Prepare a report of findings that will include sections that detail the strengths, weaknesses, limitations, and recommendations for improving the population assessment discipline within the SWFSC.

ANNEX 2

Format and Contents of CIE Independent Reports

1. The report should be prefaced with a Executive Summary with concise summary of goals for the peer review, findings, conclusions, and recommendations.

2. The main body of the report should consist of an Introduction with
   a. Background
   b. Terms of Reference
   c. Panel Membership
   d. Description of Review Activities

3. Summary of Findings in accordance to the Term of Reference

4. Conclusions and Recommendations in accordance to the Term of Reference

5. Appendix for the Bibliography of Materials used prior and during the peer review.

6. Appendix for the Statement of Work

7. Appendix for the final panel review meeting agenda.

8. Appendix for other pertinent information for the CIE peer review.

Please refer to the following website for additional information on report generation:
http://www.rsmas.miami.edu/groups/cimas/Report_Standard_Format.html

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ANNEX 3

Southwest Fisheries Science Center (SWFSC) Population Assessment Review

SWFSC, 8604 La Jolla Shores Drive, La Jolla, CA 92037
23-25 April 2008

Tentative Agenda

Wednesday, April 23

8:30	Welcome	SWFSC Director
8:45	Introductions – Approve Agenda	Panel Chairman
9:00	Antarctic Ecosystem Research Division	Rennie Holt – staff
11:00	AERD Discussion	
12:00	Lunch	
1:00	Fisheries Ecology Division	Churchill Grimes – staff
4:00	FED Discussion	
5:00	Adjourn	

Thursday, April 24

8:30	Protected Resources Division	Lisa Ballance – staff
11:30	PRD Discussion	
12:30	Lunch	
1:30	Fisheries Resources Division	Roger Hewitt – staff
4:30	FRD Discussion	
5:30	Adjourn	

Friday, April 25

9:00	Follow-up on outstanding issues/questions	Panel Chairman
11:00	Panel deliberation and report writing	Panel Chairman
12:00	Lunch	
1:00	Panel deliberation and report writing (cont.)	
3:00	Adjourn	