Appendix K. Revised Protocols for Fishery-Dependent Monitoring and Fishery-Independent Assessment.

Revised Protocols for Fishery-Dependent Monitoring

Currently, fishery-dependent data collection is characterized by inefficient monitoring and sampling efforts, which hamper the assessment and conservation of marine resources on an ecosystem level as mandated by the Marine Life Management Act of 1998 (section 7050(b)(1)). For example, fishery-dependent sampling of nearshore finfish species surveys mostly market-sized fish, providing an inherently biased sample of the population. Reliance on this constricted approach has unfortunately left a legacy of marine resource depletion. For example, when used alone, fishery-dependent data has performed poorly in predicting stock decline, especially for residential species (National Research Council 2000). Imprecise recording of fish landings for combined species, as often documented by fishery-dependent data, can actually hide precipitous declines in fished populations (Karpov et al. 2000). Vigorous and refined ecosystem-based sampling and revised fishery-dependant monitoring protocols are needed to help adequately address the complex issues now faced by fishery managers.

Fishery-Dependent Sampling

California's pool of fishery-dependent samplers represents a heterogenous mixture of state and federally-funded, part- and full-time employees that sample specific fish or groups of fish during certain times of the year. There is presently much room for improvement and consolidation of sampling effort that could be realized by implementing a new, cooperative sampling regime which focuses on multiple species within an ecosystem (i.e. considers bycatch) and gradually moves away from the current single fishery/species-based sampling.

Landing Receipts and Logbooks

Commercial landing receipts do not provide specific information on the species of fishes landed, and species of rockfish are only occasionally reported in sport CPFV logbooks. Market categories not only confound identification of species landed, they can lead to miscalculation of the numbers of boats and fishermen participating in the fisheries. Inadequate information from logbooks, combined with low sample frequency (both recreational and commercial) have prevented accurate predictions of abundance trends and assessments of fish populations.

Landing receipt and logbook data can be improved through implementing a species-specific recording protocol. Prior to this effort, however, fishermen and fish buyers must be taught to identify the different species of fish, which can be accomplished through outreach/educational efforts and distribution of fish identification materials.

Another problem with landing receipt and logbook data is the often inaccurate and generalized recording of fishing locations. CPFV logbook and commercial fishing location is identified by Department fishing block (a 10 by 10 nautical mile area). This area is far too large to allow for identification of locations and/or populations of often very territorial fishes. Lack of precise catch location undermines CPUE data, and may allow localized depletion (or serial depletion) to go unnoticed.

Greater resolution can be obtained in a number of ways. For example, refined

logbooks could require commercial fishermen and CPFV operators to record such information as Geographic Positioning System (GPS) coordinates, or "microblock" fished (a smaller segment of the larger fishing block), and gear set times. This would provide accurate spatial and temporal information about when and where fishing occurred. GPS-based 'logbooks' kept by fishery participants would also provide excellent fishing location information, and could be periodically downloaded by fishermen (NWFSC Electronic Fish Catch Logbook Project 2001).

Unreported Landings

Unreported landings, especially of nearshore species, seriously impairs the ability to estimate basic fishery information. Requiring all landing receipts to be filled out dockside, perhaps at certified landing stations, and during specific time periods, would help to eliminate the incidence of unreported landings. In this way, transportation receipts could be eliminated, and a much more complete record of landings established. Requiring nearshore fishery participants to land and record their catch at certified stations would also facilitate sampling and may streamline issues related to enforcement of regulations. Being able to directly correlate a sampled landing to its specific landing receipt would greatly improve catch data.

Frequency of Sampling

In addition to changes and improvements in sampling, fisheries need to be sampled more frequently, especially for the nineteen species of concern. At a minimum, sampling should occur frequently enough to allow for distinguishing between trends in year classes (modal progressions), impacts from fishing activities and environmental fluctuations. Without a sufficient number of samples, scientists are poorly equipped to estimate basic parameters for management.

Nearshore Fish Sampling

The nearshore live-fish fishery should be a primary target of increased sampling to remedy the paucity of information on the nearshore species complex. For example, sub-samples of live fish on the market should sampled for age, sex, and so on; and methods need to be developed to sample these fish for age and growth information in a manner that does not harm the fish (e.g. snipping fin spines, or taking scale samples).

The Department also recommends that a robust CPFV and commercial nearshore observer program be developed. Onboard observers can provide critical information about species composition, mortality rates, discard rates, and CPUE, while providing assistance and/or corroborating information regarding species identification and logbook data. It is critical that the mortality rates, amounts, and species composition by gear type and depth associated with discards of unwanted species or individuals be examined.

Implementing Recommendations for Revised Fishery-Dependent Monitoring Protocols

As mandated by the MLMA, these recommendations work toward providing needed EFI, and bring the Department closer to an ecosystem approach to management of fisheries. The following suggested actions would greatly improve the Department's ability to monitor and assess the nearshore fishery (Tables K-1 and K-2):

Table K-1. Commercial landings databases/sampling programs with weaknesses and suggested improvements.

CFIS - CMASTR (Commercial Fisheries Information System - commercial landings database)

Weaknesses	Improvements
Recorded landings by "market categories" and not by actual species (though, in many cases market category designations and species are synonymous - therefore a major point of confusion and need for caution in interpreting data)	Landings to be documented by recording actual species landed and discontinue use of market category designations
Catch location and landing location may be a source of confusion	Mandatory log books for all fisheries
Missing or incorrect information	Increase enforcement of Fish and Game Code sections §8010 and §8043 and better education of dealers. Also, need to develop an error checking method for submitted receipts
Mobile dealers and landing receipts not completed at the place and time of landing	Establish fixed designated landing sites and eliminate transportation receipts
No method to document effort	Mandatory log books for all fisheries

CALCOM (California Cooperative Survey - commercial landings sampling program)

Weaknesses	Improvements
Major target: groundfish (but not all groundfish)	Revamp program to give equal importance to all rockfishes, gears used, and areas fished
In certain ports logistics of sampling is very difficult	Increased funding to hire additional samplers and fixed landing sites
Not enough samples and/or sampling due to personnel constraints	Same as above
Sampling concentrated in northern and central portions of the state with less data from southern portion	Same as above Also, establish a statewide designated nearshore fisheries sampling coordinator who would work with the statewide groundfish coordinator

SFRA (Sports Fish Restoration Act - hook-and-line gears and traps sampling program)

Weaknesses	Improvements
Sampling protocols/methods not consistent from port complex to port complex Short-term database (only from 1993) Trap gear sampling not included until 1998	This program has been discontinued, therefore the data exit as-is.

PacFIN (Pacific Fisheries Information Network - commercial landings database)

Weaknesses	Improvements
Dependent upon states' databases	Improvements will result from those applied to the CMASTR database (see above)
Not all species accounted for	Immediate change in program to include all species
Not actual landings but estimates (in many cases)	Landings documented by species rather than by market category

Table 1.4-2. Recreational Improvements/Enhancements	
MRFSS (Marine Recreational Fisheries Statistics Survey- recreational landings by fishing mode)	
Weaknesses	**Improvements/Enhancements**
Cost associated with two sampling efforts (field and phone surveys) higher than logbooks	
Low % sampling rate of angler trips	The Department has assigned staff sampling time to increase the sample size of MRFSS trips in Southern California
Effort derived from randomized digit phone survey, non-coastal effort estimated	Establishing a license base which randomly samples anglers
In large sampling regions, difficult to sample fishing sites proportional to effort; this sometimes leads to rural areas having too few samples	Add more samples for rural areas
Allocation of field samples based upon past fishing information; recently new closed seasons are considered when allocating samples	
Phone survey not designed to estimate effort for small geographic regions and depends on two-month angler recollection of number of trips	NMFS will examine further stratification of catch estimates by smaller geographic areas to reduce the coefficient of variation
Estimates of catch and effort only available by 2-month periods in Southern or Northern California	
Sampling of party/charter vessels limited to cooperative vessels	The Department will establish a better relationship with CPFV owners and operators by writing a letter asking for greater cooperation with onboard observer programs
For some sampled trips, discarded and filleted catch information depends on angler recollection	
The importance of a rare event catch (such as a marlin) is magnified in the estimates	
Commerical Passenger Fishing Vessel Logbook **(CPFV)** (Logbook trip information)	
Weaknesses	**Improvements/Enhancements**
Taxa not always at species level	The Department has already revised logbooks to include more specificity for catches of species that require closer tracking.
Catch data not recorded by professional samplers	
Accuracy varies by species and CPFV operator	
No biological data (lengths or weights) recorded	
Location recorded on a gross scale (10-by-10 nm)	The Department will initiate focused outreach with CPFV vessels and work with enforcement to improve the accuracy of the logs
Logbook reporting varies between ports and years and usually is less than 100% (17-100%)	

Infrastructure

Develop communication and logistical support, among existing sampling programs;

Standardize data collection methods, preliminary analysis, and reporting;

Combine, where applicable, federal and state programs to increase resolution of EFI.

Commercial/Recreational Landings

Enhance recreational sampling of banks, beaches, private skiffs, and CPFVs (MRFSS sampling).

Require commercial landing receipts to be filled out dockside and eliminate the use of transportation receipts.

Require commercial landings to occur at certified landing stations during specific landing periods, to allow for sampling.
Require species-specific recordings of landings.
Generate real-time reporting of commercial landings .

Commercial/Recreational Fishing Operations

Require compliance with requests to board observers
Require that logbooks record microblock, GPS coordinates, set times,
Increase penalties and/or enforcement for non-compliance with regulations.

Socioeconomic Studies

Determine the value of the sport fishery.
Include a socioeconomic component to creel surveys.
Gather cost information on commercial fishing operations.

Outreach/Education

Develop and disperse multi-language logbooks and I.D. sheets.

Revised Protocols for Fishery-Independent Assessment

Currently, fishery-independent data collection is characterized by inefficient monitoring and sampling efforts, which hamper the assessment and conservation of marine resources on an ecosystem level as mandated by the Marine Life Management Act of 1998 (§ 7050(b)(1)). The following sections propose to build on and expand existing information by developing a framework that will not only incorporate past data but ensure that future data are collected toward achieving a common goal. This framework will establish standard protocols for data collection and analysis, involve constituents, and allow for robust management decisions. Such a collaboration will allow a more comprehensive and holistic approach to monitoring and assessment of the fishery and the resource.

The long-term monitoring and assessment of the California nearshore will consist of surveys that will capture geographic, temporal, and ecological dimensions of the nearshore system. Interactions between habitat and organisms will be explored through habitat mapping. ROV, SCUBA, and experimental fisheries studies will be used to estimate fish abundance, distribution, and recruitment. Life-history , tagging, and genetics studies will investigate reproductive characteristics, population structure, size, demographics, and movement. The study of diet, stable isotopes, community structure and function, and behavior will elucidate ecological relationships. The integration of information from these various approaches enables the development of powerful and predictive dynamic models of the nearshore system. These models will be used to aid future management actions.

Important considerations for this approach include the need for cooperative partnerships and coordinated ecosystem assessments. A cooperative pooling of state, federal, academic, and volunteer efforts and resources will be required to minimize cost and fully staff and support studies. For example, shared use of patrol vessels and research boats from academic, state, and federal sources would cut costs. In addition, state coordination of sampling is needed to ensure that common methodologies are employed in data collection and analysis. Finally, an ecosystem approach is vital for a

viable program. Concomitant assessments of invertebrate species and algae would enlarge the pool of basic resources available for reef fish assessment and allow an integrated, ecosystem-based assessment strategy.

Study Area Selection

As mentioned in Chapter 4, the Department will follow three sets of criteria to rank potential areas for study. In order of importance:

For all areas:
1) Area contains an appropriate array of habitat, and is subject to representative oceanographic conditions for the region.
2) Area has not been the target of unique or abnormal human-caused disturbance.
3) Area is of appropriate size and shape and depth range.
4) Area is readily accessible by SCUBA and boat.
5) Area has been subject of previous long-term research.
6) Area has recently been selected as a subject for long-term research.
7) Area is suitable for use in the assessment/management process for both invertebrates and finfish of management importance.

For open areas:
1) Area is subject to fishing pressure that is representative of regional trends and proximity to port.
2) Productivity of area is representative of regional trends.

For closed areas:
1) Area currently obtains some protection by the state or federal government.
2) Area currently represents a Marine Protected Area in the state of California.

<u>Closed Area potential study sites</u>:

Humboldt County -
Kings Range MRPA Ecological Reserve (Punta Gorda)

Los Angeles County -
Abalone Cove Ecological Reserve
Catalina Marine Science Center Marine Life Refuge
Lovers Cove Reserve, Santa Catalina Island

Marin County -
Point Reyes Headlands Reserve

Mendocino County -
Point Cabrillo Reserve

Monterey County -
Big Creek MRPA Ecological Reserve
Hopkins Marine Life Refuge

Pacific Grove Marine Gardens Fish Refuge
Point Lobos Ecological Reserve

San Diego County -
Cabrillo National Monument
San Diego-La Jolla Ecological Reserve

Santa Barbara County -
San Miguel Island Ecological Reserve
Vandenberg MRPA Ecological Reserve

Sonoma County -
Bodega Marine Life Refuge
Del Mar Landing Ecological Refuge
Gerstle Cove Reserve

Ventura County -
Anacapa Island Ecological Reserve
Big Sycamore Canyon MRPA Ecological Reserve

Open Area potential study sites:

Del Norte County -
St. George Reef
Point St. George/Pebble Beach

Humboldt County -
Cape Mendocino
Delgada Canyon
Patrick's Point
Redding Rock
Shelter Cove
Trinidad Head

Marin County -
Cordell Bank

Mendocino County -
Abalone Point
Caspar Urchin Closure
Elk Creek
Elk (Cuffy Cove)
Laguna Point
Point Arena Rock
Point Arena
Point Cabrillo

Russian Gulch
Saunders Reef
Tolo Banks
Van Damme State Park

San Francisco County-
Farallon Islands

San Luis Obispo County-
Diablo Canyon
Pt. Buchon
Cambria

Sonoma County -
Bodega Head
Bodega Marine Life Refuge
Fort Ross Reef
Gualala Point
Salt Point

Standardized Method of SCUBA-Based Ecosystem Study

Methods for visual survey by SCUBA have been established for the nearshore system, and must simply be modified and adopted for the proposed system of study sites (Bodkin 1986; Davis et al. 1997; Paddack and Estes 1996; VenTresca et al. 1996). Subtidal community structure surveys will quantify substrate type and relief, benthic cover, abundance of major groups of macroalgae and invertebrates, and abundance and size of fishes. Spatial allocation of sampling is designed to measure year-to-year, and site-wide variability in community structure and the spatial scales at which such variation occurs. The scuba-based sampling techniques proposed to assess the nearshore ecosystem include:

- Swath Sampling: The purpose of the swath sampling is to estimate the density of conspicuous, solitary and mobile invertebrates as well as specific macroalgae on fixed-length transects.
- Uniform Point Contact Benthos Sampling: This sampling protocol records three types of information beneath the transect line: substrate type, physical relief, and percent cover of space occupying organisms.
- Quadrat Sampling: The purpose of quadrat sampling is to determine the abundance of a) small invertebrate species, b) recruit invertebrate and macroalgal species, c) cryptic or small benthic fishes, and d) species that are too abundant to count on swaths.
- Fish Sampling: The purpose of fish sampling is to estimate fish density, size, gender (if obviously sexually dimorphic) and vertical distribution in the water column. Within each study site, replicate transects are sampled at various depths.

Methods other than fixed-area transect-sampling have been used to estimate the

abundance of organisms and may be considered. These include: timed estimators, distance or 'plotless' estimators, and variable-area estimators.

Submersibles and Remotely Operated Vehicles (ROVs)

Like scuba-based surveys, ROVs will be used to quantify substrate type and relief, benthic cover, abundance of major groups of macroalgae and invertebrates, and abundance and size of fishes. ROV work is essential to assessing the nearshore environment since SCUBA operations have a limited depth range. In addition, ROVs can be used to collect information on a wide variety of concurrent physical parameters, and ROV work can often be undertaken when SCUBA work is impractical or hazardous. Mapping of study areas using geo-referenced multi-beam sonar is preferable before conducting ROV and SCUBA surveys. ROV surveys can be guided by a GIS-based navigation feature using the high-resolution bathymetric maps. Thus, habitat type and relief as determined from multi-beam bathymetry maps can be ground-truthed.

Depending on the site to be surveyed, it is possible to conduct both lengthy, linear transects (approx 2 km) and repetitive shorter transects (< 300m). All survey events are captured on video and are geo-referenced. Parallel lasers mounted on the camera allow measurement of the field of view and objects such as fishes, invertebrates, algae and habitat features. Recorded images from the ROV also include information on depth, heading and ambient temperature. Orientation relative to currents, swell direction, habitat relief, or other environmental factors can also be measured. Various other sensors such as light or conductivity meters can be integrated into ROV data collection as necessary. ROVs can also be configured with various devices that allow collection or manipulation of organisms.

During processing of video, substrates are identified using criteria similar to those proposed by Greene et al. (1999). Invertebrates, fishes and algae are enumerated and verified by redundant viewing of the video tape. This geo-referenced video record allows re-sampling of specific areas to assess temporal changes in abundance of organisms and habitat features with greater precision (Trush 1994). Fish and invertebrate counts and habitat classification from the ROV can be compared to and may be standardized against counts by divers. Comparison of survey results between ROV and scuba techniques may reveal biases associated with each method and guide the complimentary application of each technique.

Tagging Studies

Two types of tagging studies can contribute essential fishery information. . The first, which requires capturing, tagging, and releasing large numbers of rockfish, employs passive numbered or coded tags. This form of tagging will yield data on fish movements, population structure, population size, gear selectivity, growth, and survivorship.

The second type of tagging involves in the implantation of an ultrasonic tag and temperature/bathymetric tag in a relatively few individuals. Tracking these individuals will reveal the extent of their daily and seasonal movements. This approach should be conducted as a brief, intensive effort for each nearshore species at one or more representative localities. Both forms of tagging studies can be conducted during experimental fishery studies and fisheries-independent surveys (see details below).

Life History Work

Several types of research will yield information on life history characteristics of nearshore finfish, as required by the MLMA. Samples of fishes and fish tissues for life history analyses can be collected during SCUBA surveys, from experimental fishery studies, and from commercial and recreational catch. Brief descriptions follow:

Age and growth

Scales, otoliths, and bone can be used to determine the age and rate of growth for all nearshore species using standard techniques for analysis (Brothers et al. 1976;Neilson and Green 1980; Hettler 1984;Campana and Neilson 1985; Richter and McDermott 1990). The most serious inadequacy of the age and growth data is the lack of a time series of age data and a consolidated ageing program for any of the 19 nearshore species. Age validation studies are needed for nine species and ageing techniques should be applied to other species in order to verify results of earlier studies (Francis 1995; McFarlane and Beamish 1995). In addition, the Fulton condition factor should be calculated for all fish as an estimate of general fish health (Anderson and Gutreuter 1983).

Analysis of chemical structure

Otolith microchemistry (stable isotope analysis) will be used to validate the nature and magnitude of trophic interactions (Lajtha and Michener 1994), and to make inferences of movement patterns. High resolution otolith analysis will be used to collect stable isotope samples from various regions of the otolith, and estimates of residence time in various habitats will be estimated (Schwarcz et al. 1998; Weidman and Millner 2000). If preliminary studies reveal the presence of site-specific elemental signatures in nearshore fish otoliths, then this can be used as a proxy for estimates of movement patterns of individuals. Samples for this kind of analysis can be drawn from material collected for age and growth analysis, and supplemented as necessary by additional one-time collections directed toward answering specific questions.

Diet analysis and food web

An initial major effort shall be directed toward understanding the food and feeding relationships of the major nearshore commercial fishery species to each other and to other organisms with which they share their ecosystem. This should be accomplished by combining and comparing the results of gut content analysis and stable isotope analysis, to establish the relationship between the taxonomic composition of prey, and the effective trophic level of a predator. Once the behavior of the system is more thoroughly understood, stable isotope analysis of tissues alone may suffice as a means of monitoring shifts in food web structure at any given locality, and for comparing food web structure and function among observatory areas.

Stomach analysis for the entire community must be conducted on all fish and non-fish samples collected. Percent occurrence, numerical, volumetric, gravimetric, and subjective methods of stomach analysis should all be employed to give a complete picture of trophic interactions (Hyslop 1980). Substantial information from existing fish, seabird and marine mammal diet studies will also be brought to bear on diet analyses.

Fecundity

A gonadosomatic index should be calculated for each specimen collected (DeVlaming et al. 1982). This value provides a relative index of fecundity for species and sizes of fishes. In addition, the mean number of eggs per female can be determined for some sub-sample of the catch.

Genetics

DNA samples of all fishes can be archived for future use by the Department or collaborating organizations. Sub-samples of the catch can be used to estimate the interrelatedness of individuals, the effective size of populations, and the delineation of sub-stocks.

Modeling

Numerical populations models have been used with varying success in fisheries management. Fishery-independent data, such as that proposed in this plan, make it possible to estimate the stocks size and fishing effort, thereby allowing more sophisticated modeling. Together with conventional population models, evaluations of energy flow within systems can increase the resolution of fishery models. These types of studies will be used to do the following:

1) Estimate fishing and natural mortality.
2) Describe variances in and the biological importance of growth patterns.
3) Estimate and investigate the importance of ecological interactions.
4) Approximate the relationship between environmental variables, ecological interactions, reproductive characteristics, and recruitment.
5) Visualize the causes and consequences of movement patterns and the distribution of populations.
6) Estimate the effects of fishing mortality.
7) Predict, describe, and assess the consequences of management actions.
8) Estimate the consequences of environmental variances in relation to current human and animal trajectories.
9) Synthesize the above efforts to assess the sustainability of current practices and estimate action needed to correct for human-fish-environment interactions.

Most important is the assessment of current management actions, and the analysis of potential future management.

We cannot ignore the utility of unorthodox sampling methods (Love et al. 1998). There is almost no end to the number and kind of collaborative possibilities, and any reasonable suggestions for work which might facilitate the NFMP process should be entertained.