

California Recreational Fisheries Survey Methods

Pacific States Marine Fisheries Commission

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Executive Summary

A description of this program, the California Recreational Fisheries Survey (CRFS), is provided in this document includes the following:

- Integration of California's marine recreational sampling programs ;
- Reporting of catch and effort for six geographic districts, four water areas and four fishing modes monthly;
- Estimation of daylight private/rental (PR) boat mode effort at boat ramps using an on-site approach;
- Estimation of private access and night PR angler effort and beach and bank fishing effort using a telephone survey of licensed anglers;
- A Commercial Passenger Fishing Vessel (CPFV) phone survey for effort;
- Estimation of effort and catch on man-made structures using a roving access point survey;
- Sufficient sampling of boats to meet ocean salmon management data requirements, including the collection of coded wire tags.

The primary goal of the program is the timeliness and accuracy of recreational fisheries data so that they can be more effectively used for in-season monitoring, estimating take for species of concern, developing harvest guidelines, producing stock assessments, and providing other information critical to management decisions. The focus of the program is to produce timely catch estimates with reasonable confidence limits for those groundfish stocks declared overfished by National Marine Fisheries Service and for those stocks with a directed harvest.

Background

The California Recreational Fisheries Survey (CRFS) program described in this document was developed, in part, as a response to evolving management needs. In framing this program, Department and PSMFC staff drew upon their knowledge of multiple recreational sampling programs, retaining the strong points of the programs while minimizing potential shortcomings. Through this process, staff designed a closely-knit, coordinated program that includes both comprehensiveness and high frequency on-site sampling for boats. This program specifically developed the following program elements:

- Integration of California's marine recreational sampling programs
- Reporting of catch and effort at a fine geographical resolution

- Estimation of private/rental (PR) boat effort using on-site approaches
- Estimation of beach/bank (BB), private access and night angler effort using an angler license database (ALD) with the sample frame built from one out of every 20 recreational fishing licenses
- Continuation of the CPFV vessel phone survey for effort
- Comparison of CPFV phone survey with effort data collected directly from the landings and CPFV logbooks
- High levels of creel sampling for PR and CPFV vessels
- Estimation of effort and catch on man-made structures using roving angler count surveys, and creel surveys;
- Reporting of effort and catch estimates for all modes at monthly intervals
- Sufficient sampling of PR boats to meet ocean salmon management data requirements, including the collection of coded wire tags (CWTs)

Power and Authority to Collect Recreational Information in California

The Department must collect sport fish catch information to meet the conservation and management policies for California's marine living resources. The authority to collect this information is specified in the California Fish and Game Code (FGC) and California Code of Regulations (CCR), Title 14.

Goal and Objectives of CRFS Program

Goal: To produce in a timely manner, marine recreational, fishery-based data needed to sustainably manage California's marine recreational fishery resources

Objective 1: Survey California's marine recreational fisheries using the following standards and criteria:

- Sampling period – monthly
- Reporting time unit – preliminary estimates within one month of the end of the sampling period
- Geographic unit – six districts split on county lines, as described below
- Fishing area - within all marine waters (differentiating between inside and outside 3 miles and inside bays)
- Modes - all fishing modes (PR, CPFV, BB, MM)
- Species – creel information collected on all finfish species
- Data elements include, but are not limited to:
 - Date and time of sample
 - Port / landing

- Fishing location – point (latitude/longitude); if this is not available, by one nautical mile blocks
- Bottom depth
- Fishing method/gear (including spear)
- Number of anglers
- Type and number of fish kept and discarded
- Fish size
- For CPFVs only, marine mammal interaction information - presence/absence and number of interactions
- Precision – for catch estimates, strive for proportional standard errors that are ≤ 0.20 (20%).

Objective 2: Minimum 20% sampling of PRs and CPFVs targeting salmon at primary sites during the salmon season to collect CWTs. Produce the biweekly catch-effort estimates by species, fishery, and PFMC major port area needed to meet the biological and recovery goals for West Coast salmon populations.

Description of CRFS Sampling Methodology

Effort and catch information is collected for the four major recreational fishery modes in California: 1) private and rental boats (PR); 2) Commercial Passenger Fishing Vessels (CPFVs); 3) man-made structures (MM); and 4) beaches and banks (BB).

Methods Applicable to All Modes

The sampling methodology for all modes includes the following:

1. California is divided into six survey areas using county lines with two exceptions as described below:
 - a. Crescent City/Eureka Survey Area - Del Norte and Humboldt counties with the exception of Shelter Cove which is included in the Fort Bragg area;
 - b. Fort Bragg Survey Area - Mendocino and Sonoma counties; includes Shelter Cove, and Bodega Bay during closed salmon months;
 - c. San Francisco Survey Area - San Francisco Bay and San Pablo Bay counties plus Marin County south through San Mateo County on the coast; includes Bodega Bay during open salmon months;
 - d. Monterey/Morro Bay Survey Area - Santa Cruz County south through San Luis Obispo County;
 - e. Santa Barbara Survey Area – Santa Barbara and Ventura counties; and

- f. Southern Survey Area – Los Angeles County south through San Diego County.
2. Estimates of catch and effort are made monthly for each survey area for non-salmon species and biweekly by PFMC major port area for salmon. Estimates are made for each mode and will include estimates for private access and night fisheries. Each estimate of catch, effort, or catch rate (that is, CPUE: catch per unit effort) are accompanied by an estimated variance for the estimate. Except as noted below for particular modes, calculation methods and equations used for estimates and estimated variances will largely follow those presented on pages 220-222 in Chapter 15 of K. H. Pollock, C. M. Jones, and T. L. Brown. 1994. Angler and Survey Methods and Their Applications in Fisheries Management. American Fisheries Society. 371 pp. Two other sources often invoked below are: Cochran. 1963. Sampling Techniques, Second Edition. Wiley Pub. 413 pp.; and Cochran. 1977. Sampling Techniques, Third Edition. Wiley Pub. 428pp. For brevity, these sources are henceforth cited as Pollock et al. 1994, Cochran 1963 and Cochran 1977.
3. A California angler license database (ALD) is maintained and a telephone survey conducted to estimate effort for all modes. These effort estimates will include both public and private access and day and night fishing. They are used for either production estimates or for comparison to the CRFS production on-site effort estimates (for more details, see Private Access and Night PR Survey section).

Private Rental Boat Fishing Mode

Private and Rental boat fishing mode (PR) is covered using three surveys with differing sample designs. The survey method is based on three types of access points. Access points are launch ramps, marinas and docks where these boats return from fishing in marine waters. The three types of access points are;

1. Primary PR: public ramp sites with 90%+ catch of important species
2. Secondary PR: public ramp sites with <10% of the catch of important species
3. Private PR: private access, non-ramp sites and night fishing at all sites.

Primary and secondary site stratification is determined by summarizing total catch of important species by ramp site and month from the CRFS program. Knowledge of future regulation changes and past status of salmon sampling site will also be used to determine primary or secondary site status each month. A list of current private access PR sites is maintained with each site defined in terms of its location and boundaries.

Primary sites are surveyed with an access point survey for effort and catch. Secondary sites are surveyed with a roving access point survey for effort and catch. Private access sites and night fishing are surveyed with an angler license

telephone survey for effort and trip type. Private access and night fishing catch are based on catch by trip type in the primary and secondary surveys for catch.

The telephone survey for effort by trip type is used for comparison with the on-site surveys for effort. The telephone survey is also used to estimate fishing effort beginning and ending at night which is not covered at the primary and secondary PR sites. It is assumed that catch rates by trip type at night and at private access sites are the same as during the day at public access sites.

Primary PR Survey

The primary PR survey is a public launch ramp access point survey for effort and catch at high use and important species sites (primary sites) during daylight hours.

Effort

Effort in the primary PR survey is sampled by counting boats returning from fishing and trailers remaining on site at the end of the day. Angler effort is sampled by counting anglers per fishing boat.

Sample selection (frame, design, sample sizes)

All primary sites are sampled approximately eight days per month for effort and catch based on the minimum number of days required to meet salmon goals. Weekend days and weekdays are allocated based on the distribution of catch of managed species between the day types for each site and month, accounting for salmon goals. Holidays are treated as weekend days. Days by day type are chosen systematically among weeks to ensure that is spread out over the entire sample period. Particular days within weeks are chosen at random for each site without replacement. Selection without replacement may be extended to sites that are adjacent to reduce sampler travel costs. No site is sampled more often than two week days and 1 weekend/holiday per week.

Data collection (method, elements)

Samplers are issued sampling assignments for a month and site in advance. Changes to these assignments are discouraged. Samplers will arrive at a pre-determined site at a pre-determined time and remain on site for a set time when there are no trailers present. At least one sampler is present at the site during the majority of daylight hours or until all boats are sampled.

Samplers will intercept every boat that exits the water at the site, taking information on whether each boat contained anglers and if so, recording the number of anglers and the type of trip (what species groups(s) they targeted). At primary sites with nearby private access points (e.g. marinas), samplers also will separately count the number of boats that were missed (that is, the number of boats that proceeded past the primary site toward a nearby private access point). At the end of the sampling day, samplers will count the number of trailers remaining at the site.

Additional data that is collected include the assignment number, arrival and departure time, site location, license possession and date.

Data processing (data flow, validation)

Samplers will insure accurate data recording by performing self-checks on the data during slack time and at the end of the work day. Each week the sampler's supervisor will organize and check the daily forms, photocopy them, and ship them to PSMFC in Portland, OR and to the Ocean Salmon Project (OSP) in Santa Rosa, CA. During salmon season, Northern California Supervisors will ship the original forms to OSP. Weekly catch data for salmon are summarized on one form for faxing and rapid processing at OSP. In Southern California samplers will ship the original forms to their supervisor who will check and photocopy the forms before shipping them on to PSMFC (or OSP when applicable).

Key entry supervisors will perform checks on all forms received each week and provide feedback to sampler supervisors on quality. Supervisors will provide feedback to samplers and perform validation checks on samplers in the field to verify boat counts and samplers on-schedule presence at sites. Key entry programs will perform checks on all forms received and provide immediate feedback to supervisors who will inform samplers regarding data quality. OSP and PSMFC will exchange data and corrections. PSMFC will make all of the data and estimates available on the RecFIN web site for review. OSP will provide salmon estimates to salmon managers twice a month.

Estimation and analysis (equations, comparisons)

Estimates of total effort for the primary sites is calculated using the total number of boats sampled during the month, including missed fishing boats, for each type of day (weekend/weekday) and site by water area and trip type domains. Estimation of effort (as in Pollock et al. 1994) is calculated for each stratum by

$$\hat{E} = N \sum_{i=1}^n \frac{e_i}{n},$$

where N is the number of possible sample days, n is the number of actual sample days and e_i is the fishing effort (boat trips) on the i^{th} sample day. The variance is estimated by

$$\hat{V}ar(\hat{E}) = N^2 \left(1 - \frac{n}{N}\right) \frac{\sum_{i=1}^n (e_i - \bar{e})^2}{n(n-1)}.$$

This equation is given by Equation 2.19 on page 25 of Cochran 1963 and by Equation 2.21 on page 26 of Cochran 1977. Total effort estimates from selected strata are combined to produce summaries of estimated total catch for combined strata (e.g. monthly, annual, and regional estimates). Angler effort (angler days) \hat{A} is estimated as the product of the estimated number of boats (boat trips) \hat{E} and of the estimated average number \hat{a} of angler days per boat by

$$\hat{A} = \hat{a} \times \hat{E}$$

and the variance of this estimated effort by,

$$\hat{V}ar(\hat{A}) = \hat{E}^2 \hat{V}ar(\hat{a}) + \hat{a}^2 \hat{V}ar(\hat{E}) - \hat{V}ar(\hat{E})\hat{V}ar(\hat{a})$$

[Note. This equation is a corrected version of equation 15.8 on page 222 of Pollock et al 1994. Our equation here gives an unbiased estimate of the variance of \hat{A} , whereas equation 15.8 replaces our $-$ with $+$, thereby giving a positively biased estimate. Equation 15.8 was likely suggested by the fact that the analogous equation for the true (rather than estimated) variance $Var(\hat{A})$ of \hat{A} does use $+$; namely it reads: $Var(\hat{A}) = E^2 Var(\hat{a}) + a^2 Var(\hat{E}) + Var(\hat{E})Var(\hat{a})$.]

CPUE

Sample selection (frame, design, sample sizes)

The sample selection for CPUE is the same as the sample selection for effort.

Data collection (method, elements)

The sampling of the catch at primary sites is conducted in conjunction with the PR effort survey. Below are the data elements that are collected from each sampled boat and an explanation of why these data are needed (b-bookkeeping, including estimation, s-stock assessment, r-regulatory, and e-economic). Items denoted by * are required for a valid sample.

1. Date and site*—b and r
2. Time of interview for all boats, including non-fishing boats and missed boats—b
3. Sample number for fishing boats*—b
4. Number of anglers*—b, s, and r
5. Number of anglers and those with a fishing license*—b
6. Angler residence county or state of one angler per vessel—e
7. Days fished*—b and s
8. Primary and secondary target of trip (type of trip)*—b and s
9. Primary and secondary gear types—r
10. Number of fish landed by species*—b, s, and r
11. Number of fish discarded alive, taken by seals or sea lions, and reported unavailable dead by species*—b, s, and r
12. Fish lengths and weights of priority species
13. Fish length and the head removed from ad-clipped salmon *—b, s, and r
14. Harvest location within 1 square nautical mile where most fish were caught—s and r

15. Depths fished where most fish were caught (primarily nearshore and groundfish species) —s and r

Boats are sampled for the required data elements as listed above. Other data elements are collected as time permits. During extremely busy times, the sampler may shift to a sampling scheme where only required data elements are collected from most boats while detailed information (e.g., fish weights, catch locations, depths) is collected from a few boats and some boats are missed.

Residence data is collected as the California County or residence or the state or foreign country from one of the anglers in each boat (chosen at random). The county question is asked to allow for comparison with the telephone surveys. The angler license question is used to determine what proportion of PR sampled anglers is represented within the ALD.

During the salmon season, an effort is made to sample all PRs to collect required catch-effort information and to examine the catch for ad-clipped salmon. Each ad-clipped salmon is measured and its head removed. A uniquely numbered headtag is attached to each head and its number recorded next to the sample.

Data processing (data flow, validation)

The CPUE data are collected and processed together with the effort data.

Estimation and Analysis (equations, comparisons)

As with the estimation of total effort, estimates of CPUE are calculated for each trip type and water area domain within each day type (weekend or weekday), month, water area and site. For each trip-type and water area domain, catch rate (modified from Pollock et al 1994, page 221) is estimated by

$$\hat{R} = \frac{\sum_{i=1}^n c_i}{\sum_{i=1}^n m_i},$$

where c_i is the catch sampled on sampled boats, m_i is the number of boats sampled on the i^{th} sample day (missed boats are counted as un-sampled), and the summations are over all n sampled days. The estimated variance of this estimate is found as in Cochran 1964, 2.29 (and ensuing text on pages 30-31), or as in Cochran 1977, 2.39 (and ensuing text on pages 31-32). Namely, let \bar{m} be the mean of the values m_i . Then:

$$V\hat{a}r(\hat{R}) = \frac{1}{\bar{m}^2} \frac{(1 - \frac{n}{N})}{n} \frac{\sum_{i=1}^n (c_i - \hat{R}m_i)^2}{n-1}$$

Estimates of total catch are calculated for each day type (weekend/weekday), month, water area, trip type and site (as in Pollock et al. 1964, 15.3, page 220) by

$$\hat{C} = \hat{E}\hat{R}$$

The variance (as in the corrected version of Pollock et al. 1994, 15.8, page 222) is estimated by

$$\hat{V}\hat{a}r(\hat{C}) = \hat{E}^2\hat{V}\hat{a}r(\hat{R}) + \hat{R}^2\hat{V}\hat{a}r(\hat{E}) - \hat{V}\hat{a}r(\hat{E})\hat{V}\hat{a}r(\hat{R})$$

Total catch estimates from selected strata are combined to produce summaries of estimated total catch for combined strata.

Secondary PR Survey

The survey at secondary private and rental boat sites is based on a roving access point survey for effort and catch. Secondary sites are defined as sites in a particular month that fall below the top 90% of sites by total catch of important species in the Northern or Southern California sub-regions.

Effort

The secondary PR site roving survey will count boat trailers at access points for boat effort and sample complete trips for angler effort per boat. Samplers will rove among a group of sites in a geographic sub-area and perform timed start and stop counts of trailers. Between the start and stop times the sampler will monitor boats launching and returning to the access point.

Sample selection (frame, design, sample sizes)

The list of secondary PR sites is separated into geographic groups by sub-area. The number of sites in a group will vary and will depend on the travel times among sites in each geographic district and the location of samplers work stations. The number of samples per month for each group of sites will normally be three days with two on weekend days and one on a weekday.

Sampling is stratified by day type (weekend or weekday), for each site group. Days are selected systematically among weeks in a month and at random for particular days within weeks by day type. Sites within groups may be sampled with unequal probabilities in proportion to past effort patterns or to the number of anglers present at the sites after canvassing the site group. Site visit duration and number of days sampled may be adjusted for expected regulatory changes or for important site groups.

Selection of initial sites and start times within a site group is done at random. Site visit order and group sample dates for adjacent groups may be systematic. The systematic sampling component is to insure that samples taken throughout the month is temporally and geographically diverse while avoiding excessive travel time and duplicate sample dates for a sampler geographic territory.

Data collection (method, elements)

Samplers are issued sampling assignments for each month in advance for scheduling. Changes to this schedule is discouraged. Samplers will arrive at a pre-determined site at a pre-determined time and follow a pre-determined order

of site visits. Samplers may rove among sites in a group once all of the sites have been visited and initial effort levels at each of the sites have been determined.

Samplers will perform trailer counts at all start and stop time times for each site. Samplers will count trailers excluding personal watercraft, sailboat and kayak trailers. Samplers will screen all launches and boat returns and count any boats that could not be screened as missed. Samplers will also determine if boats do not have a trailer in the area where the start and stop counts were made.

Data includes the assignment number, arrival and departure time, site location, date, start time and stop time, sampler id, trailer counts and comments recorded on paper forms.

Data processing (data flow, validation)

Samplers will insure accurate data recording by performing self-checks on the data during slack time and at the end of the work day. Samplers will organize and final check the forms for shipment or delivery to their supervisor weekly.

Supervisors will perform checks on all forms received each week and provide feedback to samplers on quality. Supervisor will also perform validation checks on samplers in the field to verify trailer counts and samplers on-schedule presence at sites. Supervisors will ship the forms to PSMFC each week.

PSMFC will perform checks on all forms received each week during key entry on computers. PSMFC will provide immediate feedback to supervisors and samplers on data quality and make all of the data available on the RecFIN web site for review.

Estimation and analysis (equations, comparisons)

Effort estimation begins by multiplying the average trailer count times the length of the fishing period in hours (daylight hours) (note Pollock et al. 1964, circa page 245) to generate estimates of trailer-hours per day. Effort a_i in angler days is the product of trailer hours per day and angler trips per trailer hour, for a fishing period i , and is estimated by

$$\hat{a}_i = (\bar{I}_i T) (\overline{P_b H_t B})_i,$$

where trailer hours per day $(\bar{I}_i T)$ is the count of boat trailers for fishing period, \bar{I}_i , multiplied by the length of the fishing period T_i . In the case that only one trailer count is made during the fishing period, this term has no variance and is assumed to be measured without error. In the case that several trailer counts are made during a fishing period, then $(\bar{I}_i T)$ is estimated by

$$(\bar{I}_i T) = \frac{\sum_{l=1}^L (\bar{I}_{l,i} T_i)}{L}$$

where $l=1, \dots, L$ trailer counts are made during fishing period i . In this case, $(\bar{I}_i T)$ has the usual estimated variance

$$\hat{V}ar(\bar{I}_i T) = \frac{T_i^2 [(I_{l,i} T) - \bar{I}_i T_i]^2}{l(l-1)}$$

Angler trips per trailer hour is the mean of $(P_b H_t B)_{i,k}$, the product of fishing boats per trailer (P_b), trips per hour (H_t) and anglers per boat (B) where each of the three terms is observed for each boat interviewed ($k=1 \dots K_i$ boats) in fishing period i . Note that H_t is the inverse of hours for boat trip k . P_b is the indicator (=0, 1) of whether the boat interviewed is a fishing boat. For a non-fishing boat, this product is zero (no angler hours) while for a fishing boat this product will measure the angler trips per trailer hour for fishing boat k .

The mean angler trips per trailer hour is

$$\overline{(P_b H_t B)}_i = \frac{\sum_{k=1}^{K_i} (P_b H_t B)_{i,k}}{K_i},$$

where K_i boats are interviewed in fishing period i . Its variance is

$$\hat{V}ar(\overline{(P_b H_t B)}_i) = \frac{\sum_{k=1}^{K_i} [(P_b H_t B)_{i,k} - \overline{(P_b H_t B)}_i]^2}{K_i(K_i - 1)}.$$

Total effort for a survey period in angler hours is estimated by

$$\hat{a} = \sum_{i=1}^n (\hat{a}_i / \pi_i)$$

Here π_i is the total probability (n/N) the period i is included in the sample.

Assuming that non-fishing pleasure boats are out for about the same duration as fishing boats on average, the estimate is unbiased. If pleasure boats are out longer, then the effort estimates would be inflated. Studies aimed at measuring (and comparing) the trailer hours of fishing and non-fishing boats will measure this assumption.

The variance for angler effort is estimated by

$$\hat{V}ar(\hat{a}_i) = (\hat{I}_i T)^2 \hat{V}ar(\hat{P}_b \hat{H}_t \hat{B}) + (\hat{P}_b \hat{H}_t \hat{B})^2 \hat{V}ar(\hat{I}_i T) - \hat{V}ar(\hat{I}_i T) \hat{V}ar(\hat{P}_b \hat{H}_t \hat{B})$$

Effort estimation is concluded with the calculation of the effort for the angler reported domains of water area fished and type of species targeted in the trip (trip type). Domain classes are estimated by

$$\hat{a}_2 = \hat{a} \left(\frac{\sum_{i=1}^n a_i}{n} \right) = \hat{a}p$$

Where the sampling proportion p is estimated by percentage of anglers a in domain i among n trips in a particular stratum.

The variance for the domain is estimated by

$$\hat{V}ar(\hat{a}_2) = (p)^2 \hat{V}ar(\hat{a}) + (\hat{a})^2 \hat{V}ar(p) - \hat{V}ar(p)\hat{V}ar(\hat{a})$$

where $\hat{V}ar(p) = \frac{p(1-p)}{n}$

CPUE

The secondary PR site roving survey will collect CPUE data by interviewing anglers from fishing boats at the conclusion of their trips. Samplers will rove among a group of sites in a geographic sub-area. Samplers will remain on-site for an amount of time when trailers are present in order to screen boats and interview anglers at the conclusion of their trips before moving on to another site in the group.

Sample selection (frame, design, sample sizes)

Because the CPUE data is collected between start and stop trailer counts for effort the sample selection is the same.

Data collection (method, elements)

Samplers will interview any anglers who complete their trips while on-site and perform a creel census and ask about any unavailable fish. Data includes date and time, fishing time, location fished, type of trip, residence information, fishing license type, frequency of fishing, number of fish by species, and lengths and weights of available catch.

Data processing (data flow, validation)

Samplers will provide edit checked data to their supervisors weekly. Supervisors will perform additional checks and provide feedback and mail the forms to PSMFC weekly. PSMFC will check and enter the data and make it available for review within a week of receiving it.

The data is summarized monthly for estimation as soon as all data have been received and checked for quality. Estimates of catch and effort are available separately by site group for analysis, but are reported to the public as total catch and effort estimates for PR fishing by CRFS district, trip type and water area.

Estimation and Analysis (equations, comparisons)

Catch rate is calculated as the estimated catch divided by the estimated total number of anglers. Estimated catch rate is calculated for each stratum to include the angler reported domains of water area fished and type of species targeted in the trip (trip type). Estimation is based on summarizing the sample from angler intercepts during the roving survey. Catch rate \hat{c}_1 is calculated by summing the total catch c_i divided by the sum of the number of anglers a_i sampled in each stratum and domain i by:

$$\hat{c} = \sum_{i=1}^n c_i / \sum_{i=1}^n a_i ,$$

Total catch is estimated by

$$\hat{C} = \hat{a}_2 \times \hat{c} ,$$

where \hat{c} is the catch rate of anglers and \hat{a}_2 is the effort estimate for the corresponding domain. Variance is estimated by

$$V\hat{a}r(\hat{C}) = (\hat{c})^2 V\hat{a}r(\hat{a}_2) + (\hat{a}_2)^2 V\hat{a}r(\hat{c}) - V\hat{a}r(\hat{c})V\hat{a}r(\hat{a}_2)$$

Angler License Directory (ALD) Telephone Survey

Private access sites and night fisheries have unknown catch rates because samplers are generally unable to access these boats at the end of their trips for interviews or unable to safely and efficiently survey fishing outside of daylight hours. The private access effort is diffuse with numerous access points which are often secured to protect private property. The means to complete PR and MM catch and effort estimates is a combination of data from an angler license directory (ALD) telephone survey and information on catch rates by trip type from access point surveys. Total BB effort will come directly from the ALD.

Effort

Effort estimates are based on the mean number of trips per licensed angler from a random sampling of ALD angler contacts collected during license issue and from the proportion of unlicensed anglers sampled during angler intercepts at public sites.

Sample Selection (frame, design, sample sizes)

Anglers are asked to provide their name and phone number on the license booklet covers of annual (both resident and nonresident) and daily (10-day nonresident, 2-day nonresident, and 1-day nonresident) sport fishing license booklets. Booklets contain 5-20 licenses. Anglers purchasing their license from the booklet are asked to record their name and telephone number until the information is collected for that particular booklet. The resulting list is considered a systematic sample of all sport fishing license holders in California. The list begins again each license year. Additions to the list are made at least monthly and are available within a month after the end of each month of sale. Less than

one percent of all licenses sold are included on the contact list. Approximately 2000 licensed anglers are selected at random from the list at the end of each month for contact by telephone.

Annual license holders are included in all succeeding months of the license year after sale to determine fishing effort for the previous month. Daily license holders are contacted for two months after sale (except at the end of the license year). Daily licenses can be activated anytime after sale in the calendar year; therefore 10% of the monthly sample for daily license holders includes daily license holders in the sample frame for more than two months. This 10% sub-sample begins with the March sales and ends in January of the next calendar year.

Data Collection (method, elements)

The 5% systematic sample is stratified by annual and daily license type based on the proportion of the license types sold. The proportion for annual licenses is the cumulative number sold to date while the daily license proportion is based on the number sold in the most recent two month period (one month period for the first month in the license year). Ten percent of the daily license stratum are daily licenses sold more than two months ago (once more than two months have passed). Each stratum is sub-sampled by systematically sorting the frame geographically by area code to insure uniform spatial distribution of the sample population. Observations falling within each area code are randomized and sampled in proportion to the area code contribution and number of initial contacts wanted for dialing. The number of initial contacts is adjusted upwards by a percentage to account for no-contact rates seen in the performance of this survey. No additional sample may be added once the selection has been made. The sampling is with replacement, meaning, no license holders are exempt from re-contact between months.

Anglers are asked to provide information on all marine fishing trips made during the previous two months in the telephone survey. For each trip anglers are asked fishing mode, area of trip (ocean or inland), type of trip (target species) and access type (public or private). For PR mode, site of access for private launch ramps (name of site) is asked. For MM and PR modes, starting and ending times (duration and time of day) is asked. Trips which occur at night, with start and end times outside of daylight hours are identified for all PR and MM fishing trips.

The trip type is necessary for determining which catch rates to apply from the public access intercepts. Trip types are pre-defined. Trips not fitting into a pre-defined category are categorized later based on the target species.

The access type is needed to determine if the site is a sampled public access site. Private PR ramp sites are recorded and added to a list based on the description provided over the telephone and an investigation of the site by a sampler, if necessary.

Data Processing (data flow, validation)

Adjustments for unlicensed anglers in each mode are based on a combination of data sources. Anglers fishing from public piers are exempt from the license requirement; however anglers fishing in that mode are asked about their license status so that data collected from the ALD survey is useful in the analysis of man-made structure fishing mode. Anyone under age 16 is exempt from the license requirement; however, under-age 16 angler counts are made during sampling. The state requires that all anglers display their license on or above the waistline so that it is plainly visible when engaged in the take of any fish (i.e., fishing). However, samplers will ask anglers not displaying their license which type of license they have. These adjustments may be compared with enforcement statistics on the rate of unlicensed adult anglers cited by month, statistical area and fishing mode.

License and Revenue Branch in Sacramento will provide all anglers names and telephone numbers (angler contacts), as well as monthly license sales by license type, daily or annual, as part of their license tracking program. There is a unique bar code on each license book to assist tracking and quality control of the data. The names and phone numbers are shipped to a telephone dialing contractor in a timely manner for entry and selection of the dialing sample. The response data are collected via computer assisted dialing (CAD) telephone surveying. The license sales, angler contacts, dialing sample and response data are transmitted to PSMFC, the agency responsible for making the estimates.

The response data are merged back with the dialing sample and angler contacts by unique identifier to validate the selection of observations used in each month of dialing. No-contact and non-response rates are tracked and reported by the contractor. Complete response data are available one month after dialing begins. Up to three weeks of dialing re-attempts are allowed before a contact number is marked as a no-contact number.

Estimation and Analysis (equations, comparisons)

Effort estimates are calculated by expansion from the contacted sample of n anglers to the population of all N licensed anglers. An effort estimate is made for each stratum of angler trips defined by license type, trip type, water area (ocean or inland marine waters), mode of fishing, CRFS geographic district, access type (public-daylight or private-nighttime) each month. An adjustment for unlicensed anglers from public access sites (anglers not in the telephone survey) is made. It is assumed that for each stratum angler trip rates are the same for unlicensed and licensed anglers.

Effort in any given angler-trip stratum is estimated using this basic method:

$$\hat{E}_1 = \frac{N}{n} \sum_{i=1}^n t_i \quad ,$$

Here, for each i among the n contacted anglers, t_i is the number of trips in the stratum made by angler i . Thus, the average number of per-angler stratum trips

– the average taken for contacted licensed anglers - is multiplied by the total number N of licenses issued.

The variance of this effort estimate is estimated as

$$\hat{V}ar(\hat{E}_1) = N^2 \sum_{i=1}^n \frac{(t_i - \bar{t})^2}{n(n-1)}$$

Here, \bar{t} is the mean of the sampled values t_i .

Adjustment factors for trips not covered by the telephone survey are estimated from data collected by the boat intercept survey. In particular, the following adjustment is made for anglers not holding a fishing license. The proportion $p =$ (number unlicensed / total anglers) is estimated by $\hat{p} = U/n$, where n is the number of intercepted anglers and U is the number of those anglers without a license.

Unlicensed anglers \hat{E}_2 is estimated by

$$\hat{E}_2 = \hat{p}\hat{E}_1,$$

The variance is estimated as the variance of a product, as was first done above for the Primary PR survey. Here, the factors of the product are \hat{p} and \hat{E}_1 ,

$$\hat{V}ar(\hat{E}_2) = (\hat{p})^2 \hat{V}ar(\hat{E}_1) + (\hat{E}_1)^2 \hat{V}ar(\hat{p}) - \hat{V}ar(\hat{p})\hat{V}ar(\hat{E}_1)$$

where $\hat{V}ar(\hat{p}) = \frac{p(1-p)}{n}$

Total effort for licensed and unlicensed anglers is sum of the estimators and total variance the sum of their variances.

$$\hat{E} = \hat{E}_1 + \hat{E}_2 \text{ and}$$

$$\hat{V}ar(\hat{E}) = \hat{V}ar(\hat{E}_1) + \hat{V}ar(\hat{E}_2)$$

Effort estimates for the public access sites is available for comparison with the effort estimates from the two on-site surveys.

CPUE

Sample Selection (frame, design, sample sizes)

As noted above, there is no direct field sampling of the private access and night PR fisheries, so for these fisheries direct data are lacking not only for effort but also for CPUE. All of the CPUE and effort data obtained from sampling in the two public access site surveys are used to produce the mean CPUE for private access sites and night fishing at all sites. Trip type is stratified because it is assumed that trip type proportions may not be the same for public vs. private access, or for day vs. night trips. For example, it has been surmised that larger

and more expensive moored boats participate in pelagic fisheries more frequently than public launch boats.

Data Collection (method, elements)

Catch rate by trip type is summarized from the two public access PR surveys by major port area and month. For both surveys, collected data include the trip type.

Data Processing (data flow, validation)

Catch rate data are summarized monthly and analyzed for completeness by CRFS district and trip type. Any trip types estimated in the effort portion which were not sampled in the CPUE section will have CPUE imputed from adjacent major port areas or months so that each trip type will have CPUE data to produce an estimate of total catch.

Estimation and Analysis (equations, comparisons)

Catch and CPUE estimates are stratified by month, CRFS district, fishing mode, water area, and trip type, like the effort estimates. The CPUE is combined by stratum from the estimates of trips from the two private and rental boat intercept catch surveys (primary and secondary) to properly represent the relative size of the primary and secondary site trip populations. The estimated mean catch per boat trip \hat{c} for each district, month and trip type is estimated as

$$\hat{c} = \frac{\hat{c}}{\hat{t}} = \frac{(\hat{c}_p + \hat{c}_s)}{(\hat{t}_p + \hat{t}_s)} = \frac{(\hat{t}_p \hat{c}_p + \hat{t}_s \hat{c}_s)}{(\hat{t}_p + \hat{t}_s)}$$

where \hat{c}_p = estimated mean catch per boat trip at “primary” sites

\hat{c}_s = estimated mean catch per boat trip at “secondary” sites

\hat{t}_p = estimated number of boat trips returning to “primary” sites

\hat{t}_s = estimated number of boat trips returning to “secondary” sites

\hat{c} = estimated total catch over all sites

\hat{t} = estimated total number of boat trips over all sites

\hat{c}_p = estimated total catch by boat trips returning to “primary” sites

\hat{c}_s = estimated total catch by boat trips returning to “secondary” sites

The variance is estimated as

$$\hat{V}(\hat{c}) = \left(\frac{\hat{V}(\hat{c})}{\hat{t}^2} + \frac{\hat{c}^2 \hat{V}(\hat{t})}{\hat{t}^4} - \frac{2\hat{c}COV(\hat{c}, \hat{t})}{\hat{t}} \right)$$

where $\hat{V}(\hat{c}) = \hat{V}(\hat{c}_p) + \hat{V}(\hat{c}_s)$

$\hat{V}(\hat{t}) = \hat{V}(\hat{t}_p) + \hat{V}(\hat{t}_s)$

$\hat{V}(\hat{c}_p) = \hat{c}_p^2 \hat{V}(\hat{t}_p) + \hat{V}(\hat{c}_p) \hat{t}_p^2 - \hat{V}(\hat{t}_p) \hat{V}(\hat{c}_p)$

$$\hat{V}(\hat{c}_s) = \hat{c}_s^2 \hat{V}(\hat{t}_s) + \hat{V}(\hat{c}_s) \hat{t}_s^2 - \hat{V}(\hat{t}_s) \hat{V}(\hat{c}_s)$$

$$\text{and } COV(\hat{c}, \hat{t}) = \left[\left(\hat{c}_p - \frac{\hat{c}}{2} \right) \left(\hat{t}_p - \frac{\hat{t}}{2} \right) + \left(\hat{c}_s - \frac{\hat{c}}{2} \right) \left(\hat{t}_s - \frac{\hat{t}}{2} \right) \right] = 2 \left(\hat{c}_p - \frac{\hat{c}}{2} \right) \left(\hat{t}_p - \frac{\hat{t}}{2} \right)$$

Total catch is then estimated by

$$\hat{C} = \hat{E}_2 \times \hat{c},$$

The variance of total catch is then estimated by

$$Var(\hat{C}) = E_2^2 Var(\hat{c}) + \hat{c}^2 Var(\hat{E}_2) - Var(\hat{E}_2) Var(\hat{c})$$

Differences in effort by trip type for public and private access is analyzed and considered for designing studies to compare catch rates between private and public access sites and measure bias.

Commercial Passenger Fishing Vessel (CPFV) Mode

There are four surveys of CPFV fishing in the CRFS; 1) a specialized survey for salmon, 2) a weekly telephone survey for effort, 3) a dockside and on-board observer survey for catch, and 4) a self-reporting logbook system for effort and catch, The surveys are discussed below.

Ocean Salmon Project Survey for Catch and Effort

The Department's Ocean Salmon Project (OSP) must observe at least 20% of the salmon landed by CPFVs for the collection of CWTs. Project staff will sample dockside CPFVs targeting salmon at primary port sites north of Pt Conception. According to CPFV logs, more than 96% of CPFV Chinook salmon landings during 2000 and 2001 were made at these primary sites (the retention of Coho salmon has been prohibited since 1995). Data collected includes number of anglers (includes CPFV skipper and crew if they fished for salmon), fishing method (troll or mooch), number of salmon landed by species, the number of ad-clipped (CWT) salmon by species, number of sub-legal Chinook and Coho released and number of salmon lost to pinniped interactions. Heads from all ad-clipped salmon sampled is collected and transported to OSP's Santa Rosa laboratory for processing. These data are used to create biweekly CPFV salmon catch and effort estimates by port area and the distribution of CWTs by time and area.

Estimation of catch for CPFVs targeting salmon is based on direct dockside sampling (minimum 20% sampling level) of salmon CPFVs for catch and expanding these data based on total OSP daily boat counts by time and port. All salmon are visually checked for the collection of CWTs. These data may be adjusted postseason using information from CPFV logbooks.

CPFV Logbooks for Catch and Effort

The Department's Commercial Passenger Fishing Vessel (CPFV) logbook system collects individual fishing trip logs, or reports of no trips, monthly for each permitted CPFV. A serial numbered form with carbon copy is required to be filled out by the skipper for each separate trip and for each day of multiple day trips. Data reported include date, port, number of people intending to fish, departure and return times, target species, fishing method, bait, trip type, 100 square mile block of catch or fishing, bottom depth, surface temperature, number of fish taken, fish thrown back, fish lost to sea lions by species or taxon, and bird interactions. The current log and book containing copies of past trips must be carried aboard the vessel. All of the data are entered into a database. These data are used for comparison purposes with the CRFS.

Primary CPFV Survey

The primary CPFV survey samples boats dockside or with on-board observers for CPUE and samples vessels by telephone for effort .

Effort

CPFV effort is surveyed using a phone survey of vessels that operate in marine waters. The state requires that all vessels engaged in commercial activities have a current permit. These annual permits are updated yearly and will form the basis of the vessel list for the phone survey. Vessels not permitted but active as a CPFV are added to the list.

Sample selection (frame, design, sample sizes)

A percentage of listed vessel operators in each CRFS district are contacted weekly in advance by mail to inform them that they have been selected to report their trips. Information reported by vessel operators is validated using information from intercept surveys. The percentage selected from the vessel list ranges from ten to fifty percent, depending on the number of vessels active in a CRFS district. Weekly sampling is random with replacement from a systematically sorted list of vessels. The vessels are sorted by vessel size class to insure that vessel classes are represented. The complete methods of this survey are documented in Appendix A.

Data collection (method, elements)

Vessel operators are mailed a log a week prior to the week for which they will be reporting effort by telephone. The log is provided to assist the operator with recording the wanted data elements for a week of activity. If the operator or their representative for the survey are not going to be available during the calling periods, the form may be faxed or mailed in. The dialing period lasts for three weeks. Data includes number of trips away from the dock, type of trip, number of anglers, date and time.

Data processing (data flow, validation)

Responses to the survey, results of the attempted contacts, the sample selection, the vessel list, and checks of vessels from the intercept surveys are merged and used for calculation of mean trips per vessel adjusted for misreporting and unlisted vessels. Vessels not cooperating with the survey may be contacted through their organized association or directly by the Department.

Estimation and Analysis (equations, comparisons)

Weekly estimates by district and water area are expanded as the product of total angler trips reported by sampled vessels and the ratio of active vessels per sampled vessel. Intercepts of vessels in the CRFS field surveys are used to make an under coverage ratio to correct for participating vessels not included on the active vessel list and to make a response error ratio to correct for misreporting of vessel trips. The methods of this survey are fully documented in Appendix A.

CPFV effort information reported in the Department's CPFV logbooks are compared with the CPFV phone survey and OSP CPFV boat count data. Compliance in submitting these logbooks is variable throughout the state resulting in incomplete and delayed data. However, they provide a potential source of CPFV effort information for specific comparisons.

CPUE

A survey of passenger fishing boats operating out of CPFV ports is used to collect angler and catch data. Small vessels that operate independently of a port and typically launch from public launch ramps or private marinas are excluded from the sample list, but may be sampled when they are encountered in the CRFS surveys.

Sample selection (frame, design, sample sizes)

Ports are selected based on past effort distributions and a vessel or trip type is selected at random or systematically for multiple vessel ports. Sampling occurs at the angler level, due to the number of potential anglers and the inability of observers to monitor all of them for catch and discards during fishing. Sample selection for the CPFV catch survey sites are based on historical distributions with possible adjustments for anticipated change. Selection of vessel trips within a CPFV port are systematic and proportional to effort, trip types, and areas fished to represent the possible fisheries available at that port.

Data collection (method, elements)

Observers collect angler data from as many anglers as possible on the way out to the fishing grounds. During fishing, observers collect fishing location, species counts, discard lengths and pinniped interaction data for as many anglers as can be observed. After conclusion of fishing, the anglers who were interviewed on the way out are surveyed for creel data including lengths of retained catch, numbers of sampler examined and angler reported fish caught and retrieval of heads from ad-clipped salmon.

Data processing (data flow, validation)

Processing of CPUE data is the same as the method described in the Private Access and Night PR Survey Section on page 21.

Estimation and Analysis (equations, comparisons)

Estimation of non-salmon catch for CPFVs is based on the on-board on-site survey of catch for angler catch rates. CPUE is estimated using the method described in the Secondary PR Survey Section on page 13.

Beach and Bank (BB) Fishing Mode

Two surveys are used to get estimates of catch for BB mode: a daylight survey of public access points for catch and a telephone survey for all effort. Catch data is collected using a roving access point survey at publicly accessible beaches and banks during daylight hours. Effort is estimated using an angler license directory (ALD) telephone survey. Effort and CPUE is stratified by CRFS district, water area and trip type. Effort outside public daylight BB fishing is assumed to have the same catch rate as public daylight trips of the same stratum.

Primary BB Survey

The primary survey at beach and bank sites is based on a roving access point survey to intercept anglers for catch at public sites during daylight hours.

Effort

The ALD is used to estimate all BB effort, page 14.

CPUE

The primary BB intercept survey interviews anglers during or at the conclusion of their fishing trips. No more than 50% of trips may be incomplete trips. Samplers will rove among a cluster of access points or continuous access in a geographic sub-area and intercept anglers. Samplers are allowed to move on to another site in the cluster once sampling is unproductive at the current site.

The samplers interview any trips that complete while on-site for angler catch rate. Samplers may also intercept some incomplete angler trips. These trips must be 50% or more complete to be eligible (i.e., eligible to be included in recorded input data). An incomplete trip's recorded catch is based on catch and fishing time for the complete part of the trip and on the planned remaining fishing time.

Additional catch for remaining fishing time is imputed by sub-area and trip type or higher strata if complete trips are missing in a stratum.

Sample selection (frame, design, sample sizes)

The sample includes all public sites open to the ocean or within saltwater bays and estuaries. All natural shoreline are included in the site list with sites defined as stretches of shoreline with range boundaries. Well defined landmarks demark freshwater cutoff points. Man-made shoreline is also included where it does not

project into open water to form a structure with water on both sides (definition of MM fishing mode).

Site selection is based on once a month selection of every group of sites. Site and angler selection probability within a group of sites is non-uniform and systematically proportional to effort on the day and time of site visit. Private property shoreline and night fishing is excluded. Site clusters are groups of sites within 1 hour of travel time or less of each other within CRFS district boundaries.

Anglers are interviewed for angler and creel data while fishing or at the conclusion of fishing. At least 50% of interviews must be from anglers who have completed angling for the day. Anglers who are still fishing must have fished 50% or more of the projected total fishing time. Incomplete trips are catch rate adjusted (imputed) based on projected remaining fishing time.

Data collection (method, elements)

Samplers will interview any anglers who complete their trips while on-site and perform a creel census and ask about any unavailable catch. A random selection of anglers who have not completed their trips may be sampled when anglers do not conclude their trips when the sampler is scheduled to leave.

Data includes site, date and time, fishing time, remaining fishing time for incomplete trips, type of trip, residence information, fishing license type, frequency of fishing, number of fish by species, lengths and weights of available catch, and numbers of unavailable reported catch.

Data processing (data flow, validation)

Samplers provide edit checked data to their supervisors weekly. Supervisors perform additional checks and provide feedback and mail the forms to PSMFC weekly. PSMFC checks and enters the data and makes it available for review within a week of receiving it. Supervisors perform spot checks to see if samplers are on-schedule on assigned site-days.

The data are summarized monthly for estimation as soon as all data have been received and checked for quality. Estimates of catch and effort by public-daylight and private-night is available separately for analysis, but are reported to the public as total catch and effort estimates for all BB fishing by CRFS district, trip type and water area.

Estimation and Analysis (equations, comparisons)

Estimation of the catch rate for beaches is based on summarizing the sample from an access point survey. Some of the trips are incomplete trips, which is adjusted to complete trips by imputation of added catch by computing an adjusted catch c_i for each angler i by

$$c_i = c \frac{h + r}{h}$$

Where h is the hours fished r is added hours reported still to be fished and c is number of fish caught. Note that when the added hours r are zero, catch is unadjusted ($c_i = c$).

Catch rate \hat{c}_i is calculated by summing the total catch c_i divided by the sum of the number of anglers a_i sampled in each stratum and domain i by:

$$\hat{c} = \frac{\sum_{i=1}^n c_i}{\sum_{i=1}^n a_i} ,$$

Total catch is estimated by

$$\hat{C} = \hat{E} \times \hat{c} ,$$

where \hat{c} is the catch rate of anglers and \hat{E} is the ALD effort estimate for BB effort. Variance is estimated by

$$\hat{V}\hat{a}r(\hat{C}) = (\hat{c})^2 \hat{V}\hat{a}r(\hat{a}_2) + (\hat{a}_2)^2 \hat{V}\hat{a}r(\hat{c}) - \hat{V}\hat{a}r(\hat{c})\hat{V}\hat{a}r(\hat{a}_2)$$

Man Made Structure (MM) Fishing Mode

Two surveys are used to get estimates for MM mode: a roving survey of public access points for catch and public daylight effort, and a telephone survey for private and night effort. Catch and effort data is collected using a roving access point survey at groups of publicly accessible MM structures during daylight hours. The telephone survey uses the angler license (ALD) survey method, page 14. The ALD survey for night and private access MM effort is described on page 27. Effort is stratified by CRFS district, water area and trip type. Effort outside public daylight MM fishing is assumed to have the same catch rate as public daylight trips of the same stratum.

MM Survey

The primary survey at man made structure sites is based on a roving access point survey for effort and catch at public sites during daylight hours.

Effort

The MM site roving survey counts anglers at access points for effort. Samplers will rove among a group of sites in a geographic sub-area and perform timed start and stop counts of anglers. Between the start and stop times the sampler will monitor anglers arriving and departing the access point. Anglers will also be asked about trip duration during intercept for CPUE.

Sample selection (frame, design, sample sizes)

The list MM sites are separated into geographic groups by sub-area. The number of sites in a group will vary and will depend on the travel times among sites in each geographic district and the location of samplers work stations. The number

of samples per month for each group of sites will normally be three days with two on weekend days and one on a weekday.

Sampling is stratified by day type (weekend or weekday), for each site group. Days are selected systematically among weeks in a month and at random for particular days within weeks by day type. Sites within groups may be sampled with unequal probabilities in proportion to past effort patterns or to the number of anglers present at the sites after canvassing the site group. Site visit duration and number of days sampled may be adjusted for expected regulatory changes or for important site groups.

Selection of initial sites and start times within a site group are done at random. Site visit order and group sample dates for adjacent groups may be systematic. The systematic sampling component is to insure that samples taken throughout the month are temporally and geographically diverse while avoiding excessive travel time and duplicate sample dates for a sampler geographic territory.

Data collection (method, elements)

Samplers are issued sampling assignments for each month in advance for scheduling. Changes to this schedule is discouraged. Samplers will arrive at a pre-determined site at a pre-determined time and follow a pre-determined order of site visits. Samplers may rove among sites in a group once all of the sites have been visited and initial effort levels at each of the sites have been determined.

Samplers will perform angler counts at all start and stop time times for each site. Samplers will screen all angler arrivals and departures and count any anglers that could not be screened as missed.

Data includes the assignment number, arrival and departure time, site location, date, start time and stop time, sampler id, angler counts and comments recorded on paper forms.

Data processing (data flow, validation)

Samplers will insure accurate data recording by performing self-checks on the data during slack time and at the end of the work day. Samplers will organize and final check the forms for shipment or delivery to their supervisor weekly.

Supervisors will perform checks on all forms received each week and provide feedback to samplers on quality. Supervisor will also perform validation checks on samplers in the field to verify trailer counts and samplers on-schedule presence at sites. Supervisors will ship the forms to PSMFC each week.

PSMFC will perform checks on all forms received each week during key entry on computers. PSMFC will provide immediate feedback to supervisors and samplers on data quality and make all of the data available on the RecFIN web site for review.

Estimation and analysis (equations, comparisons)

Effort estimation for MM begins by multiplying the average angler count times the length of the fishing period in hours (daylight hours) (note Pollock et al. 1964, circa page 245).

Effort a_i in angler days is the product of angler hours per day and trips per hour, for each period i , and is estimated by

$$\hat{a}_i = (\hat{I}_i T) \hat{H}_i .$$

Angler hours per day ($\hat{I}_i T$) is the instantaneous count of anglers \hat{I}_i , multiplied by the length (in hours per day) of the fishing period T . Note that angler trips per hour (\hat{H}_i) is the inverse of hours per trip (trip duration). Total effort for a survey period in angler hours is estimated by

$$\hat{a} = \sum_{i=1}^n (\hat{a}_i / \pi_i)$$

Here π_i is the total probability n/N that the period i is included in the sample.

The variance for angler effort is estimated by

$$\hat{V}ar(\hat{a}_i) = (\hat{I}_i T)^2 \hat{V}ar(\hat{H}_i) + \hat{H}_i^2 \hat{V}ar(\hat{I}_i T) - \hat{V}ar(\hat{I}_i T) \hat{V}ar(\hat{H}_i)$$

Effort estimation is concluded with the calculation of the effort for the angler reported domains of water area fished and type of species targeted in the trip (trip type). Domain classes are estimated by

$$\hat{a}_2 = \hat{a} \left(\frac{\sum_{i=1}^n a_i}{n} \right) = \hat{a} p$$

Where the sampling proportion p is estimated by percentage of anglers a in domain i among n trips in a particular stratum.

The variance for the domain is estimated by

$$\hat{V}ar(\hat{a}_2) = (p)^2 \hat{V}ar(\hat{a}) + (\hat{a})^2 \hat{V}ar(p) - \hat{V}ar(p) \hat{V}ar(\hat{a})$$

where $\hat{V}ar(p) = \frac{p(1-p)}{n}$

CPUE

The primary MM roving survey will count anglers at access points for effort and interview anglers during or at the conclusion of their trips. No more than 50% of recorded trips may be incomplete trips.

Samplers will rove among a group of sites in a geographic sub-area and intercept anglers. Samplers will remain on-site for a pre-determined amount of time before moving on to another site in the cluster. The sampler will interview any trips that

complete while on-site for angler catch rate. Samplers may also intercept some angler trips which must be 50% or more complete to be eligible.

Effort estimation is made by multiplying the average angler count times the length of the fishing period in hours (daylight hours). Catch rate is calculated by summing the total catch divided by the sum of the trip lengths. Incomplete trips are based on catch and fishing time for the complete part of the trip. Additional effort for remaining fishing time is accounted for in the effort calculations.

Sample selection (frame, design, sample sizes)

Because the CPUE data is collected between angler counts for effort, the sample selection is the same.

Data collection (method, elements)

Samplers will interview any anglers who complete their trips while on-site and perform a creel check and ask about any unavailable fish. Data includes site, date and time, fishing time, remaining fishing time for some incomplete trips, type of trip, residence information, fishing license type, frequency of fishing, number of fish by species, lengths and weights of available catch, and numbers of unavailable reported catch.

Data processing (data flow, validation)

Samplers will provide edit checked data to their supervisors weekly. Supervisors will perform additional checks and provide feedback and mail the forms to PSMFC weekly. PSMFC will check and enter the data and make it available for review within a week of receiving it.

The data are summarized monthly for estimation as soon as all data have been received and checked for quality. Estimates of catch and effort by sub-types (trip type, access type and day-night type) are available separately for analysis, but are reported to the public as total catch and effort estimates for all MM fishing by geographic area.

Estimation and Analysis (equations, comparisons)

Estimation is based on summarizing the sample from angler intercepts during the roving survey. Some of the trips are incomplete trips, which is adjusted to complete trips by imputation of added catch by computing an adjusted catch c_i for each angler i by

$$c_i = c \frac{h+r}{h}$$

Where h is the hours fished r is added hours reported still to be fished and c is number of fish caught. Note that when the added hours r are zero, catch is unadjusted ($c_i = c$).

Catch rate \hat{c}_1 is calculated by summing the total catch c_i divided by the sum of the number of anglers a_i sampled in each stratum and domain i by:

$$\hat{c} = \frac{\sum_{i=1}^n c_i}{\sum_{i=1}^n a_i} ,$$

Total catch is estimated by

$$\hat{C} = \hat{a}_2 \times \hat{c} ,$$

where \hat{c} is the catch rate of anglers and \hat{a}_2 is the effort estimate for the corresponding domain. Variance is estimated by

$$V\hat{a}r(\hat{C}) = (\hat{c})^2 V\hat{a}r(\hat{a}_2) + (\hat{a}_2)^2 V\hat{a}r(\hat{c}) - V\hat{a}r(\hat{c})V\hat{a}r(\hat{a}_2)$$

MM effort estimates can be compared with effort estimates from the ALD survey for trips accessing public sites during the daylight hours. This analysis will include a comparison of the number of angler trips by trip type. However, this comparison is hampered by the fishing regulation that allows angling in this mode without a fishing license. Fewer reports of MM trips are expected to be found in the ALD survey because of this exception.

Private Access and Night MM Estimates

Angler fishing licenses are not required on MM structures; however, some small proportion of anglers who possess licenses may fish in MM mode. Data from the angler license telephone survey may be useful for making adjustments for missed effort. Missed effort estimates from this adjustment may be highly variable, depending on the proportion of anglers who are licensed in MM mode. Missed effort includes anglers fishing from private property and anglers fishing at night at public sites. Currently insufficient data on this fishery has been observed in the ALD with the current sample selection.

The means to make catch and effort estimates for uncovered effort in the MM roving survey would be a combination of private access and night effort data by trip type from the angler license directory (ALD) telephone survey and information on catch rates by trip type from the roving access survey as estimated by the BB survey on page 21.

NMFS Coastal Household Telephone Survey

The Coast Household Telephone Survey (CHTS) contacts households in counties adjacent to marine waters and in inland counties where a significant number of marine trips had historically been documented. Random dialing of the last few digits within blocks of residential household telephone numbers is used to determine the percentage of angler trips. Annual estimates of the total number of occupied residential households obtained from market tracking are used to estimate angler effort by fishing mode in the dialing counties. CRFS intercept surveys collect angler county of residence data to determine the proportion of

anglers not in the dialing counties as an adjustment factor. NOAA-NMFS has conducted the RDD survey since 1980 with some periodic hiatuses due to funding issues. Support for the CHTS survey has been maintained in order to form a baseline comparison for continuity with the 1979-2003 MRFSS data collection with the new methods.

Optimizing Sampling Procedures

Where possible, efforts are taken to optimize sampling allocations and procedures.

Potential Biases

Like any other monitoring program, the potential exists for bias problems in the CRFS program. As part of the process of developing this program, reviews of potential sources of bias in the CRFS program are conducted. These reviews assist Department staff in their efforts to minimize the biases within the CRFS program.

Testing Potential Biases

Potential biases exist for proposed new methods. There is an effort to account for various biases by performing studies to measure their impact. The nature of the biases can primarily be outlined by listing the assumptions used. Most of these assumptions are mentioned in their respective sections by mode and estimation of effort or catch. The common general assumptions are listed here.

Assumptions for proposed site selection methods:

- 1) Catch rates are sampled proportionally within secondary PR public access site clusters,
- 2) Effort and catch for sampled and un-sampled days are similarly distributed.
- 3) Un-sampled catches in private vs. public access sites are similarly distributed for each combination of mode and trip type.
- 4) For each given trip type, catches during un-sampled and sampled time of day (day and night fisheries) are similarly distributed.
- 5) Site catch and effort estimates for 1999-2002 are representative of initial distribution.
- 6) Single-day trip catch is representative of days within multiple-day trips.

Assumptions for proposed sampling of catch:

- 1) Catch rates and effort hours are similarly distributed for sampled and un-sampled anglers at sampled sites,
- 2) Catch rates of incomplete trips can be adjusted based on the catch up to the time of the interview.

Assumptions for proposed sampling of effort:

- 1) The rate of unlicensed anglers is the same for sampled and un-sampled angler trips.
- 2) Trip durations in hours are similarly distributed for sampled and un-sampled anglers at sampled sites.
- 3) Instantaneous counts are similarly distributed for sampled and un-sampled days
- 6) Unlicensed anglers will report that fact to samplers when asked about type of license used.

Assumptions for proposed methods of estimation:

- 1) The rate of unlicensed anglers is the same for public and private access angler trips.
- 2) Catch rates for private boats and each given trip type are similarly distributed for private and public access.
- 3) Anglers under the age of 16 don't have fishing licenses.
- 4) The proportion of unlicensed anglers at sampled sites is representative of all sites.
- 5) Instantaneous counts are proportional to total effort.
- 6) The rate of private access site usage by license holders are representative of all anglers, licensed and not.

Assumptions for proposed optimized sampling procedures:

- 1) Sampled catch within clusters of sites is representative of the aggregate.
- 2) Sampling of sites proportional to effort is representative of the aggregate.
- 3) Unlimited sampling of anglers at all sites is representative of the aggregate.
- 4) Sampling of boat catch is representative of individual angler catch.
- 5) Sub-sampling of data during high activity periods is representative of the day.

Future Changes to the CRFS Program

The CRFS program, as described above, will provide information critical for in-season management of California's finfish fisheries. However, the Department plans to continue improving the program where needed including the following:

The Department will continue its efforts to produce a saltwater angler license database system, expanding from the one built using the angler information collected from one out of every 20 licenses to a database system with angler information from all saltwater fishing licenses.

Department staff will continue their efforts to develop a better methodology for surveying private access catch. Staff will use the results of a pilot study

comparing catch from launch ramp and private access (marina) vessels to determine 1) how similar catch (number and species composition) by target species group are for private access and launch ramp boats; and 2) if using a creel survey methodology for private access vessels is financially feasible. Alternative methods will be explored including logbooks from anglers contacted through the ALD phone survey.

Given additional funding, Department staff will identify sites where invertebrates are taken by recreational fishermen and begin developing the appropriate methodologies needed to include these in the CRFS program.

Department staff will explore the possibility of increasing roving effort surveys using senior volunteers. Through a senior volunteer program developed by Department staff, over 50 senior volunteers have been trained and are now assisting Department staff with enforcement, hunter education, and office support activities (for more information, see www.dfg.ca.gov/enforcement/volunteers/).

Appendices

Appendix A – Statistical Methods for Primary CPFV Survey