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CVPIA Comprehensive Assessment and Monitoring Program
Standard Protocol for Rotary Screw Trap Sampling

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BACKGROUND

The CAMP Implementation Plan (March, 1997) recommended the use of rotary screw trapping for assessing the relative effectiveness of action categories by indexing the number of juvenile salmonids outmigrating each year from selected Central Valley watersheds. Target races selected for inclusion in the program are fall, spring, and winter-run chinook salmon. Selected watersheds include the American River, Battle Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Merced River, Mill Creek, Mokelumne River, Sacramento River (upper mainstem), Stanislaus River, Tuolumne River, and the Yuba River.

To ensure that comparable data are collected throughout the Central Valley for the CAMP program, standardized methods need to be developed for juvenile outmigrant sampling. The following methods are suggested for use in the CAMP program. Existing programs may need to be modified to conform with the standardized program.

STANDARD PROTOCOL

Gear Type

Standard rotary screw traps (E. G. Solutions®, Corvallis, Oregon) will be used for sampling. Rotary screw traps consist of a funnel shaped core screened throughout with 3-mm diameter perforated plate and suspended between two aluminum pontoons. The cone acts as a sieve separating fish from water sampled. Water flowing into the funnel transfers rotational energy to the internal screw core, causing the funnel to rotate. As the cone turns, entrained fish are trapped in pockets of water and guided into an attached livebox at the rear of the trap.

To reduce fish losses from the livebox, fish refuge devices and debris separators will be installed within the livebox to dissipate water velocities and reduce predation.

A single five or eight foot diameter trap will be fished on each stream, depending on stream size. If existing sampling uses more than one trap at a site (i.e. two traps fished side-by-side), multiple traps will continue to be used for consistency with past data collection.

If standard rotary screw traps are not appropriate for sampling at a particular site, the use of other gear types will be evaluated.

Trap Placement

If feasible, sampling sites will be selected as close as possible to the mouth of each tributary stream in order to sample the population of juveniles outmigrating from the stream. The site will be selected based on the suitability of hydraulic conditions for sampling and accessibility to install and monitor the traps. If possible, water velocities should be a minimum of 2 ft/sec at the trap site at the lowest flow to be sampled. If a site with suitable hydraulic conditions and access cannot be located near the tributary mouth, the trap may be located further upstream, but downstream of spawning areas. Once a suitable trap site has been found, the location will remain fixed throughout the monitoring period unless changes in channel configuration or hydraulic conditions warrant adjustments.

Traps will be held in place securely with 1/4 inch or thicker cable fastened to large trees, deadmen, or permanent structures on the bank. If possible, overhead cables will be used to secure traps. Each trap will be positioned in the current so that a significant proportion of the flow enters the mouth. A safety cable will be attached to the rear of the trap, such that the trap will swing to shore if the front cables fail.

In some locations at the mouths of tributary streams, trap efficiencies may be low because of low stream gradients and water velocities at the mouths of the traps. Under these conditions, fish may be able to avoid capture and a low proportion of the total flow may be sampled by the trap. In these locations, channel modifications to divert more flow into the trap mouth may be needed to increase trap efficiency. Depending on the stream size and channel configuration, sandbag walls, gabion walls, fyke-net guidance panels, or hardwire fence panels could be used. Channel modifications will need to be considered on a site-specific basis. Some modifications may require additional permit conditions for installation. Channel modifications may also increase predation on juvenile fish.

Sampling Duration

The following are general guidelines for sampling period, based on typical outmigration periods for each race of juvenile chinook salmon. Due to individual differences in run timing, these periods will differ on some tributaries. Sampling may be varied from year to year, based on anticipated variations in outmigration timing due to factors such as flow or turbidity.

- In streams where only fall-run chinook salmon occur, sampling will occur from January 1 through June 30 of each year.
- In streams with fall and spring-run chinook, monitoring will occur from September 1 through June 30.
- In the upper Sacramento River, where fall, spring, and winter-run chinook occur, sampling will occur year-round.

If the trap cannot be operated over the entire period of outmigration, data will be used to make partial estimates of abundance.

Trap Monitoring/Data Collection

QA/QC procedures will be established for data collection. Standard procedures will be followed for training new personnel in data collection methods.

Traps will be fished continuously for a minimum of five days per week for the duration of the sampling period. During periods of high abundance of target species/races, traps will be fished seven days a week. Traps will be checked a minimum of twice per day (morning and evening) to remove debris and process catches. If debris loading and fish numbers are low, traps may be checked only once per day. When flows or debris loading are high, or during trap efficiency tests, the trap will be checked several times per day, up to every two hours, if needed, to avoid fish mortality. On a monthly basis, traps will be checked every two hours over a 24-hour period to determine diel variation in catch. Frequent trap checks may be conducted on a more regular basis, if detailed information on migration timing is needed. The length of time each trap was fished and debris type and amount will be recorded during each trap check.

During each trap check, the contents of the livebox will be emptied completely. Fish will be carefully sorted from debris, looking closely for small fish. Debris will be discarded and fish placed in buckets of fresh water for processing.

During processing, fish will be anaesthetized using MS-222 or CO_2. Dosage will be adjusted to avoid fish mortality. All fish will be identified to species, counted, and recorded by standard USFWS species codes. Voucher specimens will be collected periodically in a manner that complies with scientific collection permits. Special handling procedures for listed species will be followed.

All salmonids will be counted and fork lengths measured to the nearest 1.0 mm. When large (>100) numbers of subyearling salmonids are captured, they will be sorted according to general size class (30-50 mm, 51-100 mm, etc.) and a random sample of approximately 50 fish of each target species/race in each size class will be measured. When trap checks are made on an hourly or every other hour basis, a random sample of approximately 20 fish in each size class will be measured. For non-salmonid fish captured, a random subsample of up to 20 fish of each species will be measured and the remainder counted. All yearling salmonids will be measured.

In areas where more than one race of chinook salmon occur, race will be determined from daily length tables, where possible, using stream-specific length criteria. On some streams, length criteria is not adequate for separating runs. In these cases, the use of genetic monitoring may be considered for stock differentiation.

In areas where hatchery releases of smolts are made upstream from the sampling location, adipose fin-clipped fish will be noted when captured in the trap. Currently, only a small proportion of hatchery releases is marked. Natural fish production in each stream will be estimated based on the assumption that the ratio of adipose-clipped to non-adipose clipped hatchery-origin fish in the sample is the same as the ratio at time of release.

The external appearance of smolting characteristics will be recorded for each juvenile salmonid measured, according to smolt appearance ratings. Smolting appearance will be rated on a scale of 1 to 3, with 1 an obvious parr and 3 an obvious smolt. Smolt characteristics to be evaluated include silveriness, easily shed scales, and the presence or absence of a dark band at the margin of the tail and dorsal fins. The relationship between smolt index values and length will be evaluated. Since rating external smolting characteristics is subjective, if possible, the same personnel will conduct the ratings throughout the sampling period.

All biological and environmental data will be recorded on standard USFWS sampling forms.

Following processing, fish will be released far enough downstream of the trap that they are not likely to re-enter the trap (preferably at least 1/4 mile). Environmental data will be measured following the release of fish, according to methods in the following section.

After fish are processed and environmental data are measured, debris accumulated inside and against the funnel walls will be cleared. A boat hook, gaff, and/or long handled dip net will be used to clear large debris within the cone. Debris against the funnel walls will be cleared using brushes and/or spraying with a hose. Most traps have doors on the side of the cone that can be opened to aid in removing debris. At no time will personnel climb or reach into the trap cone to clear debris. Mud and debris will be swept off pontoons and all equipment removed from the trap platform at the end of each trap check.

Monitoring of Environmental Factors

Daily stream flow data will be obtained from the nearest USGS or DWR gauge. A staff gauge will also be installed near the trap site and daily water surface levels recorded. Depth-velocity profiles across the channel at the trap site will be measured at the beginning of the trapping season, and again if significant changes in channel morphology occur. In larger streams where direct measurement of depth-velocity profiles is not practical, acoustic doppler technology may be used, if appropriate. Changes in flow or channel morphology at the trap site may affect trap efficiencies.

Water velocities entering the mouth of the trap will be measured on a daily basis at the center of the mouth, six inches below the water surface, using a flow meter. In addition, an average trap rotation speed will be estimated on a daily basis, before raising or cleaning the trap and again after cleaning. The change in rotation rate will serve as an indicator of the degree of clogging in the trap cone. Trap rotation rate will be estimated by measuring the time, in seconds, with a stopwatch for three revolutions of the trap and dividing by three. A mechanical revolution counter will be installed to measure the total daily trap rotations. The counter will be recorded and reset each morning, and when the trap is jammed or specific tests are being conducted.

If possible, flow meters will be mounted at the trap mouth to monitor flow through the trap. However, high debris loading may preclude use of flow meters.

Water temperatures at the trap site will be measured daily with a hand-held thermometer. A recording thermograph will also be installed at the trap site to monitor hourly water

temperatures. Daily average, minimum, and maximum water temperatures will be calculated from the hourly measurements. Thermographs will be calibrated on an annual basis with a standard calibration device.

Turbidity will be measured daily with a turbidity meter (in NTUs). A light intensity meter could also be installed near the trap mouth, as trap efficiency may be more highly correlated with light intensity than with turbidity.

Appropriate DWR gage sites may also be a source of physical/chemical monitoring data for comparison with trap site data.

Trap Efficiency Tests

To estimate the number of juveniles outmigrating from each tributary, trap efficiency tests will be conducted to convert raw catch data to indices of abundance. Trap efficiency tests will be conducted frequently during a sampling season, particularly when changes in fish size, flows, turbidity, or other factors occur which can significantly affect trap efficiency. Tests will be designed to evaluate the effect of important variables on trap efficiency. Efficiency tests will be conducted with each target species.

Trap efficiency test releases will be made during daylight and darkness to assess the effect of light on trap efficiency. If significant numbers of fish are not recaptured from daylight releases, these may be discontinued. Tests will not be conducted when water temperature or other conditions may result in high mortality.

If trap catches are high enough (the desired number of fish can be collected within 3 to 4 days), wild fish captured in the traps will be used to conduct efficiency tests. Daily catches will be held in net pens or continuous flow tanks until a sufficient number have been collected for testing. On streams where hatchery fish are available, hatchery fish may be used in efficiency tests. Close coordination with hatcheries will be needed to obtain appropriate numbers of fish and arrange for suitable time and place of delivery. Where hatchery fish are used, if possible, comparative tests should be made using hatchery and wild fish. Limited data are available on behavioral differences which may influence the results of efficiency tests.

The number of fish needed in each release group will depend on trap efficiency. The release group will be large enough so that a minimum of 20 fish from each group are recaptured in the trap (a minimum of approximately 1,000 fish in each release group). Replicate groups will be released when the availability of fish and marking procedures allow. Replicate groups should be released on different days with similar environmental conditions. Ideally, 3 - 5 replicate groups should be released at each of a variety of environmental conditions.

Marking strategies used in trap efficiency tests will be coordinated with CDFG and other USFWS programs to ensure that marks do not interfere with those used in other studies. Marking and tagging logs will be used to track fish marked for trap efficiency tests.

One to four days prior to release, fish will be marked by cold brand or dye inoculation. Fry too small to be inoculated with dye will be marked with a cold brand. Larger fish will be marked by dye inoculation into the fins; each release group will have a distinct mark.

Once marked, fish will be held in free-standing net pens located at the release location, where they will be allowed to recover at least 24 hours prior to release. Flow refuge will be provided within the pens. Net pens will be enclosed in a locked cyclone fence enclosure, such as a dog kennel, to prevent vandalism. Fish marked with dye inoculation will be held a minimum of one to two days; fish marked with cold brands will be held longer (3 - 4 days) to allow brands to darken. The release location will be approximately 1/4 - 1/2 mile upstream from the trap site.

Prior to release, fifty fish from the marked group will be measured at random and checked for mark clarity. The number of fish released will be adjusted by the proportion of fish with mark loss. Fish will be released in small groups from the holding pens, approximately ten to twenty fish at a time, one to two minutes apart. By protracting the releases, fish will be prevented from behaving as a single school and will be dispersed in time and space as natural migrants would be.

Traps will be checked frequently following release of marked fish (approximately every two hours), to monitor the timing of recapture and ensure that a trap stoppage does not invalidate a mark-recapture test. Frequent trap checks will be continued until the catch of marked fish is low. Catch data from day and night will be analyzed separately to evaluate the difference in trap efficiency in daylight/darkness.

Over the course of the sampling season, the duration of dye marks and the effects of marking and handling on mortality will be tested. Small groups of fish will be marked and held in net pens for up to 3 weeks. A matched group of unmarked fish will be held as a control group. Loss of marks and delayed mortality will be recorded for each group.

As part of standard trap efficiency tests, efficiency tests will be conducted to estimate fish retention in the live box. Small fish may be lost from the live box through the trash wheel at the rear of the box (in older traps), through faulty seals, by predation in the box, or by crushing in accumulated debris. Efficiency tests will be conducted by releasing marked groups of fish of various sizes into the live box and monitoring recoveries in subsequent trap checks. The efficiency of the live box in retaining fish will be used along with trap efficiencies to adjust raw catch data to abundance indices.

Potential biases in efficiency data at specific sites will be identified and taken into account in data analysis.

Data Analysis

Trap Efficiency

Trap efficiency estimates derived for marked fish will be assumed to be equivalent to efficiency rates for unmarked fish stocks. Trap efficiencies will be calculated according to the following ratio:

Trap efficiency = Number of recaptures / Number of marked fish released upstream

To extrapolate trap efficiency rates to days when tests are not conducted, trap efficiencies will be related to a predictor variable that will be measured on each day the traps are operating. The relationship of efficiency to streamflow, turbidity, average water velocity, and length of fish will be evaluated. Results of the trap efficiency tests will be extrapolated to other time periods based on the best of these relationships.

The precision of trap efficiencies will be estimated using two methods: one using the coefficients and their associated variances describing the relationship between trap efficiency and the environmental factors, and the other estimating the variance of trap efficiencies of replicate release groups.

Estimates of Relative Abundance

On days when multiple trap checks are performed, catch data will be summarized into one daily report. Data will be summarized from 12:01 PM to 12:00 PM on the following day.

The number of fish of each target species/race migrating from each stream will be estimated based on the weekly catch and the results of applicable trap efficiency tests, according to the following expression:

Estimated outmigration = Catch / Estimated trap efficiency

To evaluate the precision of the estimated indices of abundance, confidence intervals will be calculated for trap efficiencies and for the annual abundance index for each target species/race.

Length data will be compiled for each species/race to estimate the frequency distribution of estimated outmigrant abundance in 10 mm. size intervals. Mean lengths on each sampling date will be plotted to evaluate the relationship between size and timing of outmigration. The smolt appearance index will also be plotted by date to evaluate the change in stage of smoltification over time.

To determine the size selectivity of the trap, the mean size of fish prior to release and at recapture will be compared for each efficiency test release group.

If juvenile salmonids are monitored with other rotary screw traps or by other methods in the watershed, indices of abundance may be compared. Survival between sampling points may be estimated. However, abundance indices may be too imprecise to evaluate survival between sites.

Environmental Factors

To evaluate the effect of flow on the timing of outmigration, estimated daily outmigration will be plotted with mean daily flow values. To evaluate the effects of water temperature and turbidity on outmigration, adjusted daily trap catches will be plotted with daily

temperature and turbidity measurements. Mean daily temperatures will be calculated from hourly recording thermograph data.

Diel movement patterns will be analyzed by comparing relative abundance of salmonids between diurnal and nocturnal periods. Nocturnal movement will be monitored by morning trap checks; daylight movement will be monitored by evening trap checks.

Safety Measures

In many cases, sampling sites will be located in areas that receive heavy recreational use for swimming, angling, and boating (canoes, rafts, inner-tubes, and float tubes). Since water velocities around and under the traps are high, there is a potential drowning hazard if people were to get caught on the sides or under the trap platforms, between the traps and the platforms, or on the cables upstream. If someone were to fall into the trap mouth, drowning or crushing could result from the force of the screw mechanism. The following measures will be included at each sampling site to minimize risks to sampling personnel and the public:

1) Life jackets will be worn at all times by personnel working on the trap platforms. A minimum of two people will always be present and within visual contact while working on the trap platform.

2) Personnel will wear footgear with non-skid soles while working on the trap platform. Personnel will not cross the trap in front of the mouth while it is fishing, except when necessary to raise or lower the cone, or take measurements of environmental data. If a person should fall into the trap mouth, the cone will be immediately raised to stop it from rotating. Worm gear will be installed on the cone winch to prevent it from free-wheeling.

3) Before getting on the trap platform, personnel will check visually for mechanical problems, such as loose or broken cables or debris blocking the cone. If needed, debris will be cleared or the trap re-secured before getting on the platform. Personnel will check all welds, cable attachments, and moving parts for excessive wear on a daily basis.

4) For crew safety, a catwalk and hand rails will be installed across the front of the trap. A metal grate/trash rack will also be installed in front of the trap mouth to prevent large objects from entering the trap (including swimmers, animals, rafts, inner-tubes, etc.).

5) Personnel will use a net to lift catch and debris out of the livebox. Personnel will not reach into the live box with their hands or wade in the live box. (Hypodermic needles and rattlesnakes have been found in liveboxes.)

6) Every effort will be made to keep the public out of the immediate trap area. To warn boaters moving downstream of the potential hazard, at least one large sign will be suspended above the river upstream from the trap site warning boaters of the trap location and the potential hazard (typical wording: "DANGER AHEAD, Instream Obstacle, Stay Left ⇐ (or right ⇒)").

7) Signs will be posted on the shoreline immediately adjacent to the traps warning of the drowning hazard. Signs will be both in English and Spanish. If needed and practical, the shoreline adjacent to the traps will be fenced to keep the public from wading or swimming to the trap platforms from the shore.

8) Battery-operated orange strobe lights (similar to ones used at road construction sites) will be placed on the traps for increased trap visibility at night.

9) All cables at the water surface will be marked with bright colored buoys along their length to make them visible to anyone floating in the water.

10) Traps will be moored such that they can be quickly retrieved in case of high water. Emergency procedures will be developed for retrieving traps; appropriate crew training and frequent monitoring of conditions when high flows are imminent will be emphasized. Crew safety will always be the first priority; however, following standard emergency procedures may reduce loss of equipment.

Permitting

Appropriate permits will be obtained for installing and operating trapping facilities. Additional conditions may be required when channel modifications are planned. Required permits may include State Reclamation Board, U.S. Army Corps of Engineers, and SWRCB permits, CDFG Streambed Alteration Agreements, and State Lands Commission land leases. Permits will be required to collect listed species. Appropriate scientific collection permits will also be required.