Interagency Ecological Program for the Sacramento-San Joaquin Estuary

Newsletter

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For information on the Interagency Ecological Program, visit our home page on the World Wide Web (*www.iep.water.ca.gov*).

Readers are encouraged to submit brief articles or ideas for articles. Correspondence, including requests for changes in the mailing list, should be addressed to Randy Brown, California Department of Water Resources, 3251 S Street, Sacramento, CA 95816-7017.

Interagency Program Quarterly Highlights

These Quarterly Highlights summarize significant activities and findings of the Interagency Program during the past 3 months.

Water Quality

Harlan Proctor

After a strong spring runoff with outflows pushing the north delta outflow index to nearly 100,000 cfs in May, decreasing summer outflow through July and August averaged about 10,000 cfs and by late September were down to 4,000-5,000 cfs. Corresponding salinity at Chipps Island increased from <1 to 10 mS/cm. Chlorophyll concentrations remained near background levels throughout the study area, with slight increases to 18 μg/L in the southern delta and a moderate bloom in the eastern channels near Stockton, peaking at 26 μg/L in July. The phytoplankton assemblages responsible for these minor events were mixed, but dominated by the filamentous diatoms *Thalassiosira eccentrica* and *Skeletonema potamos*. Expansion of the benthic monitoring network has added to the diversity of organisms in samples taken during 1996. New upstream freshwater sites have been yielding numerous midge and other insect larvae. The special dissolved oxygen runs in the Stockton Ship Channel to track dissolved oxygen levels during the fall salmon migration began in August. Minimum levels in late September were 4-5 μg/L.

Delta Flow Measurement

Rick Oltmann

Numerous ADCP flow measurements have been made at the San Joaquin River at Jersey Point UVM site during the last several months for use in developing a new velocity rating for the UVM. The measurements show that two velocity ratings will be needed during each tidal cycle to calculate tidal flows because the velocity rating is different depending on whether the flow is changing from ebb to flood or from flood to ebb. More than 200 measurements were made and used to define the initial velocity rating for calculating flows for this site before the transducer piles were destroyed during April 1995. Those 200 measurements

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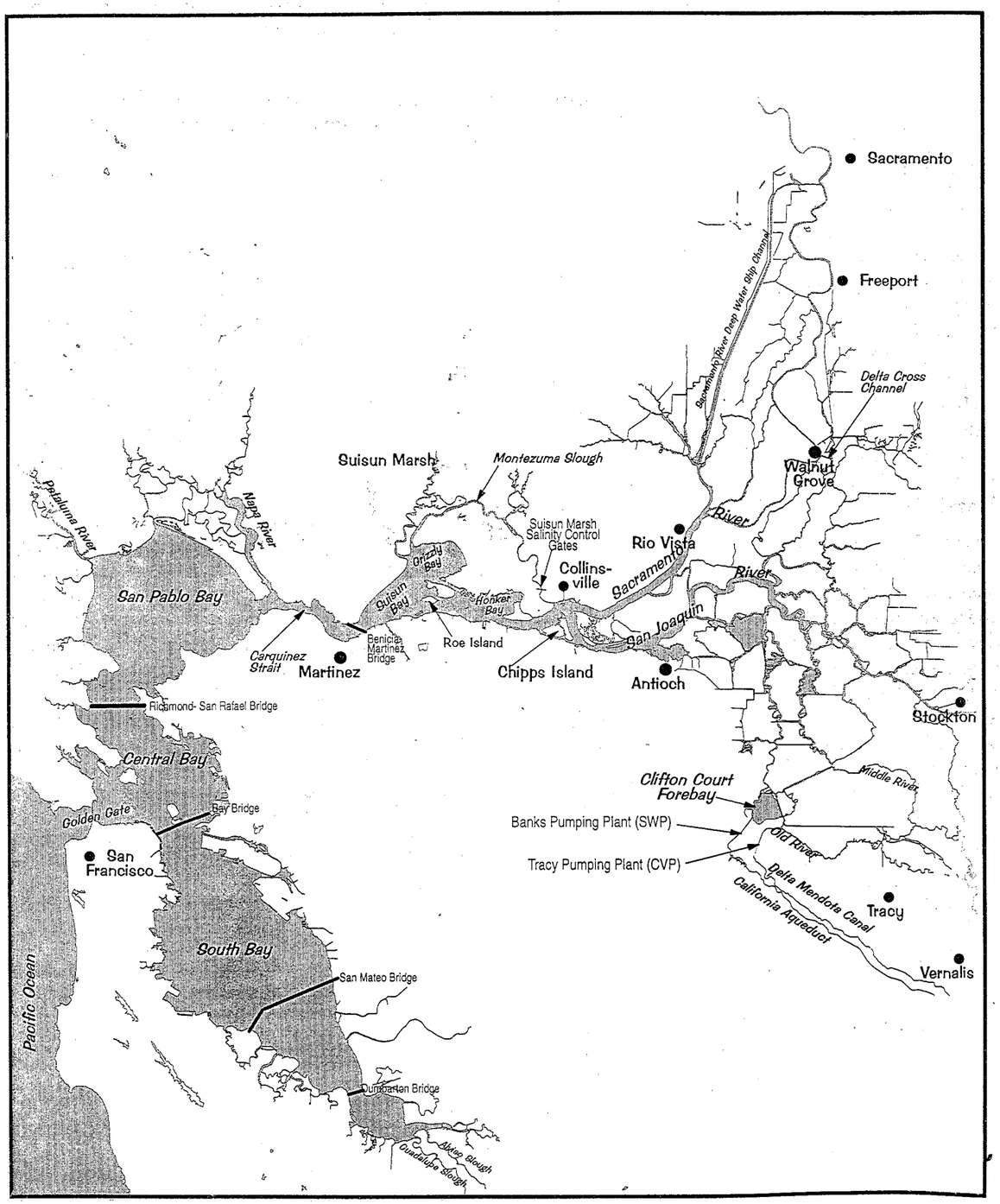
SACRAMENTO-SAN JOAQUIN DELTA AND SAN FRANCISCO BAY ESTUARY



where not adequate to define the atypical double rating condition we now know exists. Therefore, the flows that were initially calculated for May 1994 to April 1995 are incorrect, because only the ebb-to-flood flow velocity rating was used to compute flows. The error introduced has not yet been determined. The development of the two ratings and how they will be used to compute flows has not yet been finalized.

Velocity ratings have been established for the San Joaquin River at Stockton and Dutch Slough at Jersey Island sites. Flow data have been computed from August 1995 to present for the Stockton site and from February 1996 to present for the Dutch Slough site. Preliminary analysis of the Dutch Slough data indicates that net flow through Dutch Slough is highly related to SWP and CVP export rate and San Joaquin River flow at Vernalis.

Several sets of ADCP flow measurements have been made at the Sacramento River at Rio Vista UVM sites, and preliminary ratings have been developed. Initial results indicate no atypical velocity rating problems for this site. During September 19-20, 1996, a flow measurement dataset was collected at Rio Vista, which should provide enough data to finalize the Rio Vista velocity ratings. The ratings will then be used to back-calculate flows starting from April 1995.

The remaining UVM sites provided usable data throughout the quarter, except for Middle River at Bacon Island, which experienced periodic power supply problems resulting in lost record.

San Francisco Bay 3-Dimensional Hydrodynamic Model

Pete Smith

Documentation of the computational algorithm and testing for the new 3-D model is getting close to completion. Most of the past quarter was spent generating the final figures describing the numerical experiments made to test the stability and convergence of the model. Results of the testing look good. Next quarter, work will begin on configuring the model to the bay and western delta. The landward boundary for the model on the Sacramento River will be at the USGS flow monitoring station at Rio Vista. On the San Joaquin River, the boundary will be at Jersey Point. Other boundary flows will be defined at Threemile and Dutch sloughs. The intention is to run the model using measured delta outflow from the USGS UVM stations as input to the model. The seaward boundary at the Golden Gate will use tide height and salinity measurements for the forcing. A 250-meter numerical bathymetric grid has already been defined for the bay portion of the estuary from Chipps Island to the Golden Gate. A bathymetric grid for the western delta will be developed that is consistent with bathymetric data being used for the new delta 1-D model (DSM2).

Delta 1-Dimensional Model

Kamyar Guivetchi and Rick Oltmann

The Delta Model project work team finished preparing bathymetry data and irregular cross sections for Suisun Marsh and began retrieving and preparing bathymetry data for San Francisco Bay. UTM coordinates were determined for all bathymetric data and model grid nodes, enabling entry into a GIS. Participants installed the Delta Simulation Model 2 (DSM2) code on their computers and conducted test runs. DWR's Delta Modeling Section prepared a subroutine that will use irregular cross sections prepared from the Bathymetry Data Viewer Program. The IEP File Server staff compiled extensive datasets needed to calibrate and verify the DSM2 on the file server and are providing the data in HECDSS (Data Storage System) format for direct use by the model.

In the next quarter, the team will complete the cross section data file and begin stage and flow calibration of the DSM2 hydrodynamics model. We are also coordinating and working with the USACE Hydrologic Engineering Center in Davis to prepare a user-friendly graphical user interface for the DSM2.

Phytoplankton Monitoring

Peggy Lehman

Chlorophyll *a* concentrations were below 3 µg/L for most of the estuary in June, with higher concentrations in the southern delta at Vernalis (25 µg/L) and Stockton (9 µg/L). Concentrations were similar in July: at or below 5 µg/L for Suisun and San Pablo bays and at 6-18 µg/L in the southern delta. July differed from June, however, in the increase of chlorophyll *a* concentration to 26 µg/L in the eastern delta (station MD10). Higher chlorophyll *a* concentrations for both months and locations were associated with a mixed phytoplankton assemblage dominated by the filamentous diatoms *Thalassiosira eccentrica* and *Skeletonema potamos*.

Neomysis/Zooplankton Study

Jim Orsi

Neomysis abundance was very low in July and August, the last months for which samples have been processed. In August the species was taken only at station 64 near Decker Island, in the Sacramento River, and only 12 individuals were caught. *Acanthomysis* abundance reached its annual peak in July, when the highest station abundance was 167/m^3 in Suisun Slough. This is more than twice as high as its 1995 peak of 82/m^3 in western Suisun Bay. Relative to historical *Neomysis* abundance, *Acanthomysis* abundance is low, indicating that it may be food limited.

Zooplankton abundance was typical for summers since the arrival of *Potamocorbula*. *Acartia* abundance was very low, and it was found only at Martinez. *Eurytemora* was absent at all stations. *Acartiella* and *Pseudodiaptomus forbesi* were the most abundant calanoid copepods. *Pseudo*diaptomus forbesi was the only copepod to be found at all stations. *Sino*calanus abundance was very low, and it was caught at only two stations. The cyclopoid *Limnoithona tetraspina* had the highest station abundance of any copepod, 42,260/ m^3 at Chipps Island. A *Bosmina* bloom occurred in the San Joaquin River at Stockton in August, when abundance reached 12,626/m^3. The abundance of the entrapment zone rotifer *Synchaeta bicornis* was the highest in several years, reaching a high of 81,395/m^3 in Suisun Bay in August.

Estuarine Ecology Team

Wim Kimmerer

The Estuarine Ecology Team has been actively engaged in preparing a report, "Assessing Evidence on the Importance of Various Limiting Factors on Selected Ecological Features of the San Francisco Estuary". This report was originally intended to provide CALFED with the team's collective opinions about how various factors might affect fish and other biota. However, in the glare of attention the early drafts received, we decided to give it several rounds of review and revision before submitting it to CALFED through the Interagency Program. As a result, it is a much more well-rounded and complete document than it otherwise would have been. In particular, the contributions of members of the Contaminants project work team were invaluable in improving the discussion of toxic effects. The final version of the report has been submitted to CALFED.

The Estuarine Ecology Team also completed work on a document that formed much of the basis for the CALFED report: An Assessment of the Likely Mechanisms Underlying the "Fish-X2" Relationships. This report, now being published as an Interagency Technical Report, discusses probable modes by which various fish and invertebrate species and groups in the estuary respond to freshwater flow and its correlates. The document was intended to provide direction for future special studies.

The draft final report of the 1994 entrapment zone studies has been reviewed and is now under revision for submission as an Interagency Technical Report. Portions of that report will also be submitted to technical journals.

Delta Smelt

Dale Sweetnam

The delta smelt 20mm sampling program completed its eighth and final survey on July 27. This year's production of young-of-the-year delta smelt appeared to be good, with more individuals collected than in 1995. Delta smelt collected in the final two surveys are being used for otolith analysis to determine if fish collected in different locations in the estuary are growing differently. Diet and liver condition will also be evaluated. Distribution was widespread from the Napa River and San Pablo Bay to the delta, but by the end of July numbers declined in the Napa River. In fact, additional sampling in the Napa River using 20mm gear as well as beach seines failed to catch any delta smelt in August. One wakasagi was captured in a beach seine 3 miles above the city of Napa.

The summer tow-net survey was completed on July 26. The 1996 tow-net abundance index for delta smelt is 11.1. This year's index was based on the second and third surveys, because the first survey was terminated prior to completion due to boat breakdowns. The index of 11.1 is the average of the second and third survey indices, 5.4 and 16.8. The abundance index is up from the 1995 index of 3.2 and is similar to the 1994 index of 13.0. Geographic distribution from the tow-net survey ranged from San Pablo Bay to the lower Sacramento River in early July (Survey 2), with the highest concentration in Suisun and Honker bays (56% of the catch). By the end of July (Survey 3), the downstream extent of the distribution had shifted to Suisun Bay, with the highest concentrations in Suisun and Honker bays (32%), Chipps Island to the confluence (30%), and the lower Sacramento River (26%).

The September sampling of the fall midwater trawl survey was completed September 12. Only 17 delta smelt were collected, resulting in a September index of 20.6. Distribution was centered near Chipps Island, with a few stragglers in Suisun Bay. One smelt identified as a delta smelt was collected in San Pablo Bay at a specific conductance of 33,200 mS/cm. However, the fish was not correctly preserved and could not be verified. Results of the September survey are disturbing, because the delta smelt population had done well in the spring. and summer Possible causes of the apparent drop in the population are being studied.

Collection of live delta smelt began in September for treadmill studies at UC-Davis. Results of these studies will be used to determine appropriate fish screen approach velocities for delta diversions. So far, about 150 live delta smelt have been collected.

Splittail

Randall Baxter

Budget preparation and planning for the next field season occupied much of the late spring and summer. Plans to capture and tag adult splittail in the late fall were devised. We hope to implement a regular schedule of fyke trapping starting in December and continuing through at least March, with fyke traps located somewhere between Rio Vista and Isleton. Radio tags, slightly smaller than those used in 1996, will be attached to some of the splittail captured, then the fish will be tracked using fixed site (Greenes Landing near Courtland), boat-based, and aerial receivers. By following fish during their migration, we hope to identify additional spawning areas. This work is being considered for the 1997-98 spawning season.

Last quarter we reported that radio-tagged splittail in the Sutter Bypass emigrated downstream from the area coincident with a dropping hydrograph in late March. We were concerned that this behavior may have been a response to tagging and not reflective of the behavior of untagged fish. Data from another source indicate that this was about normal emigration timing. Two screw traps and a fyke trap were fished on Butte Creek during the winter and spring of 1996 (Kathy Hill, DFG Region II, pers. comm.). Butte Creek enters the Sutter Bypass at its upper (northern) end. The downstream screw-trap was at the southwestern edge of Sutter National Wildlife Refuge (the upstream end of the Sutter Bypass). This trap was fished from January through June. The capture of significant numbers (>2/day) of adult splittail in this trap began March 21 and 22, with 26 and 14 fish, respectively; only four adult splittail had been collected by the trap before March 21. Similarly, tagged fish emigrating from the Sutter Bypass (n=15) were detected at Greenes Landing (fixed-site receiver, n=13) between March 19 and 28, with three fish passing March 21 and four fish passing March 22.

The Butte Creek screw trap data are being entered on dBASE at the DFG Bay-Delta Division (thanks to K. Hill for providing copies of data sheets). Preliminary summaries, based on incomplete data entry for the downstream trap (January 17 through June 6; trapping ended in early July), show the following native minnows were captured: 235 adult splittail, 28 age-1 splittail, 149 young-of-year splittail, 180 hitch, 728 squawfish, and 4 Sacramento blackfish. Since it is unlikely that age-1 splittail migrated into the creek with the adults, these data suggest that a fraction of the 1995 year class spent their entire first year in Butte Creek. Data have yet to be entered from the upstream screw trap, located a few miles east of Highway 99. A quick review of data sheets from this screw trap failed to find any splittail, but hardhead, California roach, hitch, and squawfish were common.

Two other projects associated with these splittail investigations are winding down and should be complete by early 1997. The first re-addressed the issues of fecundity and egg size among splittail and compared estimates and measurements from fish collected in 1996 to those of previous studies (Caywood 1974, Daniels and Moyle 1983). The second project evaluated several hard structures (otolith, operculum, fin rays) in relation to scales for precision and accuracy in aging splittail.

Juvenile Salmon

Mark Pierce

Midwater trawling at Sacramento was conducted 3 days/week for the quarter, and beach seining in the lower Sacramento River and delta continued weekly. Catches of salmon have been sporadic and minimal. An intense monitoring effort is scheduled at Sacramento to detect winter run and tributary spring run entering the delta during the fall, when make-up pumping will be occurring in the southern delta.

Winter-run-sized fish have not been detected in the delta to date, but a 38mm winter run was seen at Glenn-Colusa Irrigation District on August 8.

Trawling at Chipps Island was severely curtailed over the last quarter due to high numbers of delta smelt. Only a few tows per week were permitted until Aug 13, when FWS reached its take limit and stopped sampling. Consultation with Ecological Services has resulted in an amendment to the program's delta smelt take permit.

Limited trawling is expected to resume in October. Since delta smelt will likely be a concern in the long term, moving the Chipps Island trawling site will be evaluated.

As a pilot study for 1996, kodiak trawling at Mossdale began September 4 on a 3 day/week basis to determine if any San Joaquin basin yearling chinook are coming into the delta in the fall and winter months. The effort is planned through March 15, when DFG Region 4 will resume monitoring for the annual index. No chinook had been captured through the end of September.

Contra Costa Canal Intake Entrainment

Jerry Morinaka

We used a sieve-net to sample fish entrainment every fourth day at the Contra Costa Canal (on the discharge side of Pumping Plant 1) during July, then switched to once a week in August. The predominant fish species captured in July and August was juvenile American shad (mean fork length = 25). Chinook salmon, delta smelt, longfin smelt, and splittail were not captured in the sieve-net during any of the sampling efforts. Although August marked the end of the initial 3-year sampling program, sieve-net sampling will resume in November and continue until the diversion is screened (projected to be October 1998).

In July, we monitored in the intake channel of the Mallard Slough Pumping Plant and outside the channel in Suisun Bay, using tows with an egg and larval net and a modified tow-net. The egg and larval net sampling captured delta smelt in Suisun Bay (0.0387 smelt/m^3), but delta smelt were not captured in the intake channel. Longfin smelt were captured in Suisun Bay with both the egg and larval net (0.0097 smelt/m^3) and the modified tow-net (0.0104 smelt/m^3), but not in the intake channel. Salmon and splittail were not captured in either gear type. Monitoring was discontinued after July because the diversion was no longer being used by Contra Costa Water District.

Sport Fish Project

Dave Kohlhorst

We completed two of three scheduled monthly juvenile sturgeon surveys between Sherman Island and San Pablo Bay. This survey, using baited set-lines, is designed to sample 40-116cm sturgeon with the aim of estimating year-class strength. A fin ray, used to age sturgeon, is removed from a subsample of the catch for age determination and development of an age-length key. The length-frequency distribution is distinctly multimodal, with an obvious group of fish at 44-52cm, a wider mode at 66-82cm, and a large number mostly >100 cm. No 54-64cm sturgeon were caught. Although no fin rays have been sectioned for aging, past age-length data suggest that the smallest mode represents the 1995 year class. The second, intermediate-sized group probably consists of year classes from the early 1990s, and broad grouping >100 cm encompasses year classes from the 1980s, including cohorts from the strong 1982 and 1983 year classes.

Fish Treadmill Studies

Darryl Hayes

The long-awaited operation of the large fish stamina testing device is finally a reality. Initial hydraulic tests indicate the device is able to operate within the expected hydraulic criteria. The 1:2.5 scale model was well worth the effort because of design insights and modifications during the study that led to the prototype design. The complex free and forced vortex actions in the circular flumed facility can be well controlled and easily replicated for the proposed experiments. The laboratory is being equipped with the necessary water quality control features and fish holding facilities.

A meeting with agency technical representatives is expected to result in testing priorities; testing protocols; and an outline of responsibilities for the first year of testing, scheduled to begin this fall or as soon as the holding facilities are completed.

CALFED Fish Facilities Development

Darryl Hayes

During the Phase II process of the CALFED Bay/Delta Program, fish facilities planning will be an important consideration in defining components of the preferred alternative. A focused project work team, jointly led by DFG and DWR, will study feasibility, operations, and fishery issues associated with the remaining alternatives. Conceptualized facilities, fish screen criteria, and protection goals will be established and included in the proposed program EIR/EIS.

New information on fish facilities development will be limited within the next year, so Phase II alternatives and criteria will be based on past efforts, existing criteria, and judgment of fish facility experts. Limited information will be available on fish pump feasibility from the Red Bluff Research Pumping Plant studies and on appropriate velocity criteria for delta fish species from the "fish treadmill" studies. System simulation and hydraulic modeling studies of alternatives and establishment of pre-project fish monitoring will also be emphasized. Agency and consulting experts will assist in the new project work team's effort on selection of proposed facility options.

The Question of Run Identity for the Winter Run Take in 1996: Some Genetic Perspectives

Michael A. Banks, Marco J. Calavetta, Sheila Greene, Vanessa Rashbrook, and Dennis Hedgecock

Correctly identifying the origins of juvenile chinook salmon taken at the state and federal water projects is necessary to comply with legal protections afforded threatened or endangered stocks. For example, water projects must consult with the National Marine Fisheries Service if take of winter run at the salvage operations has reached 1% of the estimated outmigrating population of smolts (NMFS 1993, 1995), with the limit being 2%. (If the take reaches the 2% level, the agencies reinitiate consultation to determine appropriate action.) This 2% "red light" condition was reached in April 1996 (Anon. 1996). Researchers and managers also need positive run identification techniques to help determine which stocks are being harvested, to determine timing of outmigration, and even to identify the run of salmon taken by poachers. Traditionally, the length distribution of juvenile fish, given the time and locality where captured, has been used to determine run identity (Fisher 1992). Today, however, methods of molecular biology and population genetics promise to resolve run identity with much greater accuracy and precision.

This article provides a brief overview of these methods and an example of their application to estimate the composition of two samples of juvenile chinook in the winter-run length. The first sample of juveniles (RBDD'95) was collected by rotary screw trap at the Red Bluff Diversion Dam between August 4 and December 5, 1995; all juveniles were within the winter-run length criteria. The second sample (SWP'96) was collected at the SWP facility between January 9 and April 3, 1996; this sample comprises 17% spring run, 14% late-fall run, and 69% winter run according to length criteria.

DNA analyses used to identify the races of fish in these samples consist of:

- A genetic profiling of baseline populations of known run identity, *ie,* collections of either spawning adults, post-spawn carcasses, or young juveniles collected on spawning grounds.
- A statistical test to determine if each of the two samples of juveniles consists of single populations or are mixtures from more than one run.
- An allocation of juvenile samples to their likely run origins.

These analyses are preliminary. They are included to illustrate the process and demonstrate its potential.

Molecular Techniques for Discrimination of Chinook Salmon Runs

Protein variation has been used since the early 1970s to understand the genetic affinity of Pacific salmon species and populations. More recently, variation in the DNA sequence of the mitochondrial genome (mtDNA) has been applied to the task. Variation among chinook salmon stocks of the Central Valley for either of these classes of molecules is insufficient to accomplish the run discrimination needed in the delta and elsewhere. Therefore, we have isolated and characterized some nuclear DNA markers, known as microsatellites, that undergo evolutionary structural changes three to five times as fast as the rate of change for proteins or mtDNA (Edwards *et al* 1991; Hearne *et al* 1992; Weissenbach *et al* 1992; Queller *et al* 1993). This class of DNA markers ought, therefore, to reveal differences among the recently evolved and closely related chinook runs of the Central Valley. Of 41 available microsatellites isolated from Pacific salmon, 5 show strong potential for run discrimination in the Central Valley river system. The first such diagnostic marker to be isolated, a microsatellite we have named *Ots-2*, is transmitted from generation to generation according to the laws of inheritance first discovered by Gregor Mendel in his pea studies (**Box A**; Banks *et al* 1996). Population data for this microsatellite are now extensive enough to provide an example of run determination and mixed stock analysis. Current research is actively accumulating data for the other four microsatellite loci that show potential for increasing the power for run discrimination and mixed stock analysis.

We now step through a method for analysis of data derived using these techniques. The RBDD'95 and SWP'96 juvenile chinook samples will be the working examples of unknown populations that we will test for mixture and for which we will perform mixed stock analysis.

Step 1 Genetic Profiling of Baseline Populations

Representative populations of the four major runs of chinook salmon spawning in the upper Sacramento River basin have been characterized for *Ots-2* variation (Table 1). Although we have examined all winter-run brood stock collected for the captive propagation and hatchery supplementation programs, the winter run is represented here by a sample of post-spawn carcasses collected on the Sacramento river near Redding from June