Central Valley versus Petaluma/Napa: A Nutritional Examination of Sacramento Splittail

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Sacramento splittail, *Pogonichthys macrolepidotus*, is a native cyprinid of the San Francisco Estuary (SFE) and is a species of special concern by the US Fish and Wildlife Service and the California Department of Fish and Game. Genetic analysis has identified two distinct populations of splittail, the Petaluma/Napa and Central Valley populations. Splittail were examined at the end of fall 2010 and 2011 to examine the differences between these two populations. Splittail was sampled from 6 regions, Petaluma River, Napa River, Carquinez Strait, Suisun Bay, Honker Bay and the Confluence during the migratory period to assess their health and nutritional status before spawning. No splittail were collected in Carquinez Strait suggesting there was no interchange between the two populations. Preliminary results showed that the Petaluma/Napa splittail were in poorer condition and nutritional status than Central Valley splittail for both 2010 and 2011. In particular, splittail collected in the Petaluma River exhibited significantly lower health and nutrition indices than even splittail from Napa River suggesting poorer habitat quality in the Petaluma River.

Relevance: Information presented in this study supports the management of splittail as two distinct populations in the San Francisco Estuary.

Keywords: Sacramento splittail, nutrition, proximate analysis

Poster Topic: Fish Biology, Ecology and Protection

Effects of Flow, Habitat, and Water Quality on Hitch (*Lavinia exilicauda*) Abundance and Distribution within the Sacramento-San Joaquin River Delta

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The Sacramento-San Joaquin Delta is a dynamic ecosystem that is heavily influenced by anthropogenic factors. Native fish abundance can be affected by the alteration of river flows which can impact required habitat, food availability, and water quality.

Beginning in 1976, the U.S Fish and Wildlife Service's Delta Juvenile Fish Monitoring Program (DJFMP) has performed long-term juvenile fish surveys throughout the Sacramento-San Joaquin Delta. The objective of DJFMP is to estimate and monitor the movement, abundance, distribution and timing of fish inhabiting the Bay-Delta estuary and the lower Sacramento and San Joaquin Rivers. In this analysis we used the historical data set (2000-present) and multivariate analyses to model the relative abundance of the native hitch, *Lavinia exilicauda,* in relation to flow stage, physical habitat, and water quality parameters.

Although hitch abundance is low throughout the whole delta system (less than 2% of our catches between the lower Sacramento River and north delta regions), we showed increased relative abundance during high flow events. In terms of spatial and temporal patterns, we demonstrated that hitch use specific portions of the river depending on their life history stage. Just spawned individuals are typically found in the north and central delta regions, downstream of their spawning grounds. Larger individuals are primarily found in warm, slow moving waterways within the lower Sacramento River. Results may help inform water managers to coordinate and minimize the impact of water transfers on native fish populations.

Keywords: Hitch, Sacramento River, river flow, abundance, presence

Poster Topic: Fish Biology, Ecology and Protection

New Genetic Tools and Their Research Applications for Central Valley Chinook Salmon

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Central Valley Chinook salmon have experienced dramatic declines in recent years. Increased scientific understanding of population dynamics and factors contributing to survival and fitness is needed to aid in restoration and recovery efforts. We are developing new genetic resources for Chinook salmon and applying them to a number of studies focused on understanding the biology and ecology of Chinook in the Bay-Delta system. We are identifying thousands of new single nucleotide polymorphism (SNP) markers using next generation RAD-sequencing technology and positioning these SNPs onto a Chinook genetic map. These markers will be used to identify the different runs of Chinook salmon in the Central Valley and their natal origin. These markers will also be used to conduct association studies related to phenotypic traits of conservation importance. In addition to genetic diversity, we are examining epigenetic diversity (DNA methylation) within and among Chinook runs. As temperature is predicted to be an increasing stressor for Chinook in the Central Valley, we are also examining the gene expression profiles of fall run Chinook at increasing temperatures and evaluating thermal tolerances via RNA-sequencing. These new tools will be applied to studies that address pressing research needs for Chinook salmon management in the Bay-Delta system, including identifying run and spawning origin in state and federal fish collection salvage facilities and determining habitat use by juvenile Chinook salmon in the mainstem Sacramento River and Yolo bypass.

Keywords: Chinook salmon, RAD-sequencing, genetic resources, gene expression, SNPs, population structure

Poster Topic: Fish Biology, Ecology and Protection

Spatial Perspective for Delta Smelt: A Summary of Contemporary Survey Data

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We utilized recently available data from the 20-mm Tow-Net and Spring Kodiak Trawl, together with other Interagency Ecological Program and regional monitoring programs to provide a comprehensive description of the range and temporal and geographic distribution of delta smelt (*Hypomesus transpacificus*) by life stage within the San Francisco Estuary, California. Within 21 sampled regions we identified 289,401 survey events at 624monitoring stations. Delta smelt were observed at 430 stations (69%) in an area from northern San Francisco Bay in the west, to the confluence of the Sacramento and Feather rivers in the north, and to the disjunction of Old and San Joaquin rivers in the south, an area of approximately 51,800 hectares. Delta smelt were observed more frequently and at higher densities (at all life stages) near the center of their range, from Suisun Marsh down through Grizzly Bay and east Suisun Bay through the Confluence to the Lower Sacramento region, and into the Cache Slough region. Delta smelt larvae were observed in the San Francisco Estuary from March through July, sub-juveniles in April through August, juveniles in May through December, sub-adults in September through December, and pre-spawning and spawning adults in January through May. This comprehensive data review provides managers and scientists an improved depiction of the spatial and temporal extent of the delta smelt throughout its range and lends itself to future analysis of delta smelt population assessment and restoration planning.

Keywords: Delta smelt distribution, spatial analysis, life stage, observed presence

Poster Topic: Fish Biology, Ecology and Protection

Using Underwater High Definition Video as a Fish Sampling Tool

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To minimize impacts on endangered or rare species, fish scientists are increasingly searching for sampling tools that minimize fish contact, while still collecting meaningful biological data on fish populations (e.g. infrared scanning, sonar imagery, video). Recent advancements in video technology have led to the availability of relatively cheap, high resolution (1080p) waterproof cameras than can easily be adapted to act as fish sampling devices. Here we present an example application in the Yuba River, California, where fixed position cameras were used to observe entrainment risk of juvenile Chinook salmon along a porous dike, and video transects were conducted using cameras suspended from a kayak to index salmon predator densities in a diversion side channel. Video cameras were also paired with underwater lighting to examine diel influences on the behavior of juvenile salmon and their predators. Where high visibility conditions occur, similar methods could be applied in other river systems or for other fish species to examine fish behavior (e.g. spawning, habitat usage), estimate abundance, or index fish community structure.

Keywords: underwater video, fish sampling, methods, juvenile salmon, Yuba River

Poster Topic: Fish Biology, Ecology and Protection

Evaluating Downstream Movement and In-river Survival of Naturally Produced Juvenile Chinook Salmon in the Lower Mokelumne River using Visible Implant Elastomer Tags

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Juvenile Chinook salmon *Oncorhynchus tshawytscha* face numerous sources of mortality prior to emigration from their natal streams. In the California Central Valley, survival of naturally produced juvenile Chinook salmon within Bay-Delta tributaries is an important component of population fitness. A pilot study was conducted in 2011 to determine if Visible Implant Elastomer (VIE) tags were suitable for evaluating in-river survival of juvenile Chinook salmon in the lower Mokelumne River. Results indicated that there were no significant differences in growth and survival between groups of tagged and untagged juvenile Chinook salmon, and the two groups of VIE tagged salmon had tag retention rates of 93% and 95% over a 104-day study period. During the 2012 juvenile Chinook salmon emigration period, the study proceeded as 4,300 naturally produced fall-run Chinook salmon fry were tagged with VIE between January and March at the upstream rotary screw trap on the lower Mokelumne River. Study results will include the timing of downstream movement and recapture rates of VIE tagged salmon, as well as an in-river survival estimate for juvenile Chinook salmon between upstream and downstream trapping locations on the lower Mokelumne River. In addition, the results will be compared with upstream and downstream juvenile Chinook salmon abundance estimates and migration timing, and relationships with environmental variables will be examined. These data will reflect one season of a long-term study examining downstream movement and in-river survival of juvenile Chinook salmon under a variety of environmental conditions.

Keywords: Chinook salmon, survival, juvenile, downstream, emigration, lower Mokelumne River

Poster Topic: Fish Biology, Ecology and Protection

Comparison of Race Compositions Using Length-at-Date Criteria and Genetics for Catch of Juvenile Chinook Salmon at Sacramento and Chipps Island in 2007-2011

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A key component to estimating juvenile abundance of listed races of Chinook salmon in the Delta is to correctly identify the race of juvenile Chinook caught. Length-at-date criteria have been used to classify race in the field; however, this approach is inaccurate. To better estimate the juvenile abundance of listed winter- and spring-run Chinook salmon, fin tissue was collected from juveniles captured in trawl sampling conducted at Sacramento and Chipps Island between 2007 and 2011. Tissues were analyzed using 21 microsatellites to determine race of individuals in the catch. While also not without error, simulations and blind tests indicate that these microsatellites have 98% and 84% respective success rate across all races. The numbers of catch by race were compared using length-at-date criteria and genetic analysis. Results indicate that there is considerable overlap in the juvenile length distributions of the four different races, and hence, the length-at-date criteria do not accurately discriminate between races. As a result, the catch of winter and spring run are likely overestimated using length-at-date criteria, whereas fall and late-fall are underestimated. The results of the analyses will be used to better quantify catch and absolute abundance of winter and spring run at Chipps Island and Sacramento. Improved accuracy for estimating juvenile abundance of these listed species entering and leaving the Delta is fundamental to understanding population status and how to improve survival through the Delta for ecosystem sustainability.

Keywords: Juvenile salmon, race differentiation, genetics, length-at- date criteria

Poster Topic: Fish Biology, Ecology and Protection

Integrating Hydrodynamic Data, Acoustic Telemetry and Simulation Models to Assess and Describe Juvenile Salmonid Migration Behavior and Survival in the Delta

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The relative influence of tides, river inflows, and South Delta exports on flow patterns in California's Sacramento-San Joaquin Delta continues to be a source of confusion and uncertainty for resource managers. A particle tracking model (PTM) has been used to characterize Delta flow patterns and to evaluate entrainment risks for larval fishes and, for the first time in the 2009 National Marine Fisheries Service OCAP Biological Opinion, to evaluate hydrodynamic effects on juvenile salmonids. While PTM results appear sensitive to net water movements over longer time periods (>days), recent findings from acoustic telemetry studies suggest migrating juvenile salmonids respond to instantaneous hydrodynamics conditions; not to daily average flows. Hydrodynamic mechanisms observed in the analysis of existing acoustic telemetry data indicate that the proportion of time flows enter a particular route may be important drivers of juvenile salmonid survival and route selection. The hydrodynamic variables of interest are readily available and provided by the "Delta Simulation Model 2 HYDRO" model with considerable spatial-temporal resolution (every 15 minutes for 500+channel locations). Our analysis indicates that commonly prescribed management actions may not yield desired and expected benefits because actual hydrodynamic conditions differ from conditions which are assumed to exist. For example, we observed little evidence that river inflows or South Delta exports, within the range typically controlled by managers, could substantially alter hydrodynamic conditions likely to cause juvenile salmonids to enter the interior Delta from the mainstem San Joaquin River. Additional acoustic telemetry studies may be necessary to more thoroughly test the relative importance of hypothesized hydrodynamic mechanisms. However, our analysis suggests available hydrodynamic data can be used to model and plan management actions with the greatest potential to enhance juvenile salmonid survival in the Sacramento-San Joaquin Delta.

Keywords: Salmon, Delta, hydrodynamics, routing, exports, inflows, OMR, modeling

Poster Topic: Fish Biology, Ecology and Protection

Thermal Preference of Two Populations of Splittail, *Pogonichthys macrolepidotus*

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Variable water flows through the San Francisco Bay Delta (SFBD) watershed have been linked to fluctuations in the abundance of Sacramento splittail (Cyprinidae). Seasonal air temperatures and the reduction of freshwater inflow into the SFBD correspond with changes in water temperatures. This, coupled with dams and diversions restricting access to spawning and foraging sites, has earned this endemic fish species its current listing as a California Species of Special Concern and former listing as threatened under the US Endangered Species Act. Although recent evidence has established the existence of two genetically distinct splittail populations (a Central Valley population and a Petaluma/Napa Rivers population) there have not yet been any comparative studies to evaluate divergence in physiological traits between populations. Understanding whether these two fish populations have distinct physiological or life-history traits may reveal critical environmental factors(s) important to effectively manage and preserve each population. We measured and compared the thermal preferences of both splittail populations acclimated to 18C, using an annular preference chamber. A fish's preferred temperature often corresponds closely to the optimal thermal range for growth and metabolism, and can help define suitable or unsuitable habitats used by a species at each stage of its life cycle. Preliminary results indicate that the selection behavior of splittail in a horizontal temperature gradient of 13-28C is affected by the presence of another fish in the chamber. Whereas individual splittail in our preference experiments swam through the entire gradient almost continuously, an unusual observation for these types of studies, experiments with multiple fish of the same cohort exhibited less active behavior. Research funding provided by the Delta Science Program.

Keywords: splittail, temperature preference, conservation, ecology, San Francisco Bay Delta, physiology

Poster Topic: Fish Biology, Ecology and Protection

Comparative Laboratory Critical Swimming Performance of Larval and Juvenile Green and White Sturgeon; with a Note on Exercise Conditioning

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Determining the swimming abilities of Sacramento River sturgeon juveniles at specific lengths or ages will be valuable in developing risk models for wild sturgeon in this watershed. Sturgeon swimming performance measures, including larval versus juvenile fish and between species comparisons are poorly represented in the literature (e.g., dueto small sample sizes and swimming chamber limitations). We conducted critical swimming velocity (Ucrit) experiments on green (*Acipenser medirostris*) and white (*A.transmontanus*) sturgeon (range 3.7 cm to 50.0 cm Fork length (FL)), using modified recirculating-flow, Brett-style swimming chambers of various sizes. These sturgeons generally increased their Ucrit with increasing FL, except green sturgeon showed a performance plateau near 25 cm FL. Also, exercise-conditioned fish may simulate, more closely, wild specimens compared with non-exercised fish, and their use as proxies for wild fish in laboratory or field experiments was considered. We found that exercise-conditioned (i.e., maintained at ca. 10cm/s velocity) sturgeon did not swim better than non-exercise-conditioned fish, but varied in mass. Future swimming performance research on green and white sturgeon larvae and juveniles will investigate California sturgeons' potential negative interactions with fish-protection screens and louvers. These data will be valuable to Bay-Delta fisheries and water managers in minimizing these fishes' entrainment and impingement risks (e.g., regarding flow criteria, approach velocities) at water-extraction facilities. Research supported by the U.S. Bureau of Reclamation.

Keywords: Ucrit, Swimming performance, *Acipenser medirostris*, *A. transmontanus*

Poster Topic: Fish Biology, Ecology and Protection

Challenges Confronting Juvenile Sacramento River Chinook upon Entering the California Current Ecosystem: Results from NOAA SWFSC Juvenile Salmon Trawls and Acoustic Surveys

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Changing food availability in the California Current Ecosystem is one of several factors that determine Sacramento River salmon abundance, but its relative contribution to recent high variability in returns and fisheries catch is not well understood. In a geographic information system (GIS) framework, we used simultaneous ship-based recordings of continuous krill distributions and direct measures of species richness and abundance to investigate the spatial associations between prey patches (krill "hotspots" of abundance) and the distribution and abundance of genetically identified Sacramento River juvenile Chinook salmon.

Data from three juvenile salmon trawl surveys in July 2010, July 2011 and September 2011 were used for this study. Each survey spanned two weeks and ranged over 52 stations across the continental shelf between San Francisco, California and Newport, Oregon. Echo sounders sampled multiple frequencies and dB differencing was used to identify krill from acoustic backscattering (*Sv*) within a 10 m buffer below the surface and 5 m above the seafloor. Acoustic data were vertically integrated throughout the water column and horizontally integrated in one nautical mile (nmi) bins using Nautical Area Scattering Coefficient (NASC). In GIS, NASC values were averaged and gridded into 25 km^2 cells to control for survey effort. Gridded data was smoothed with a kernel density procedure and reclassified into utilization distributions at 10%intervals. By comparing catch richness and abundance with underlying krill hotspots, a spatial regression model revealed that krill hotspots explain little variation in catch richness and abundance, with highest residual variance just outside San Francisco Bay, off Point Reyes and Montara, California. Visual inspection suggests these patterns may be partly attributed to a lag that places krill north and up-current of high catch values. Resolving such patterns will contribute to understanding inter-annual variation in migration routes and survival of Sacramento River Chinook salmon.

Keywords: Sacramento River, Chinook salmon, California Current, Ecosystem, Krill

Poster Topic: Fish Biology, Ecology and Protection

Movement, Survival and Life History of Wild Mokelumne River Steelhead

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Anthropogenic alterations have removed or altered a majority of anadromous habitat of California's central valley. Furthermore, alterations may select against movement and therefore anadromy in steelhead. Here I investigated the movement and related survival patterns of 130 acoustically tagged wild steelhead in 2007 and 2008 using standardized transects along the lower Mokelumne River (LMR). Transects were nested within a larger network of stationary acoustic receivers throughout the LMR and Bay-Delta in collaboration with the East Bay Municipal Utilities District and the California Fish Tracking Consortium. I observed a wide range of movement from no movement over the 218 day study period to successful emigration to the Pacific Ocean. I observed a low degree of anadromy (8%) in tagged individuals. All anadromous emigration occurred in the spring, and was highly correlated with peak streamflows. Resident movement was highest in spring and summer relative to fall and winter. A significant interaction between fork length and home reach in 2007 may be explained by larger fish exploring the habitat variability of upper reaches to maximize growth during spring and summer. Like anadromous emigrants, smaller residents moved more in the spring and summer of 2008 perhaps due to a history of adaptation to a natural snow fed hydrograph. Fish that were observed to move more were more likely to suffer mortality. Thus, with the high instream growth rates of the LMR, benefits of oceanic growth potential may no longer outweigh the demonstrated instream mortality risks and risks of navigating the delta. Mitigating anthropogenic alteration and non-native predator related increased mortality throughout the delta and lower river reaches may help to return the cost-benefit-comparison to select for anadromy. Results here imply the importance streamflow peaks and variability to successful anadromous migrations and the maintenance of life history diversity in this imperiled population.

Keywords: acoustic telemetry, migration, anadromy, *Oncorhynchus mykiss*, salmon, mortality, mobile tracking

Poster Topic: Fish Biology, Ecology and Protection

Steps toward Evaluating Salmonid Predation in the Sacramento River Delta

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Low salmon smolt survival continues to be a problem in the Sacramento River Delta despite efforts to reverse these trends. Predation has been identified as one of the causes of this decline. Acoustic telemetry is commonly used to track the downstream migration of juvenile salmonids and has recently been used to identify predatory behavior in other species.
Over the past decade, fine-scale fish tracks have illustrated migration behavior and survival in river systems throughout California and elsewhere around the world. In recent years as more data has become available from various species via fine-scale 2D and 3D telemetry, new questions have emerged. One of the principal questions of great importance in the Bay-Delta region is: Can we determine whether or not an acoustically-tagged fish has been eaten by a predator? A critical assumption of survival estimation for acoustically tagged migrating species is that the detected tag signals are from distinctly unconsumed and freely migrating fish. Protocols for determining predatory-like movement has been objectively defined for use in analyzing telemetry data.
In this presentation, we will discuss fine-scale acoustic tag development and current methods for determining predation events. Fish tracks are presented as two-dimensional fish densities superimposed over GPS geo-referenced river environments. Various results will be presented including recent examples of predatory behaviors [e.g., tagged predatory species] and a review of recent advances in data analysis techniques.

Keywords: Predation, acoustic telemetry, behavior

Poster Topic: Fish Biology, Ecology and Protection

Effects of Temperature Acclimation on a Native Minnow; Standard Metabolic Rate and Thermal Limits of Adult and Juvenile Hardhead, *Mylopharodon conocephalus*, Acclimated to 4 Seasonal Temperatures

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The majority of rivers feeding the Sacramento-San Joaquin Delta have been dammed or altered in some way. As a result, the frequency and timing of temperature and flow changes may not reflect historic conditions to which native fishes have adapted. Cold water releases in late summer, when fish are acclimatized to higher temperatures, may impact native fishes in ways that are not fully understood. We conducted a series of laboratory experiments in order to determine the effect of temperature acclimation on the standard metabolic rate (SMR) and the upper and lower thermal tolerance limits (i.e. critical thermal maxima (CTmax) and minima (CTmin) respectively) of adult (N = 80, mean wet weight = 709 g) and juvenile (N = 77, mean wet weight = 4.67 g) hardhead, *Mylopharodon conocephalus* (CDFG and US Forest Service Species of Special Concern), from the American and Feather Rivers, acclimated for 30 days or longer, to 11, 16, 21 and 25°C. SMR and CTmax/min increased with acclimation temperature similarly for both juveniles and adults. These data can be used to develop effective conservation strategies and inform management decision concerning thermal regimes of rivers inhabited by hardhead.
Research funded by California Energy Commission Public Interest Energy Research (PIER) Program.

Keywords: Hardhead, Metabolic rate, Thermal Limits, Cyprinidae, Temperature Acclimation

Poster Topic: Fish Biology, Ecology and Protection

Straying of Late-Fall-Run Chinook Salmon from the Coleman National Fish Hatchery into the Lower American River, California

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Anadromous salmon Pacific salmon (*Oncorhynchus* spp.) generally home to their natal streams to spawn. Straying is a natural behavior and can impart adaptive advantages for a fraction of individuals from a population or even for the species. Straying can also occur as a result human intervention. In the winter of 2008/2009, at the end of the Department of Fish and Game lower American River escapement survey for fall-run Chinook salmon, a new pulse of fish began spawning in the river. These fish turned out to be primarily 2006 brood year late-fall-run Chinook salmon strays, from the Coleman National Fish Hatchery, that were part of a Delta survival study using downstream release groups. The American River has not generally supported a late-fall-run and understanding the reason for this unusual behavior is the basis for this project.

This study was based on the hypothesis that salmon released in close proximity to the American River are more likely to stray into the river than fish released farther from the river's mouth. Coded-wire tag release and inland return data for the 2006 brood year were used for this study.

Results indicate that straying increased with proximity of release to the American River and with respect to downstream releases in general. No salmon released in the vicinity of the natal hatchery were recovered in the lower American River. This study indicates that release location should be carefully evaluated if future downstream releases of hatchery salmon are conducted within the watershed. Results of this project can help fisheries managers and researchers make decisions about down-stream release location placement with respect to river tributaries while trying to improve salmon survival in the watershed and through the Delta.

Keywords: straying, homing, salmon hatchery

Poster Topic: Fish Biology, Ecology and Protection

Effects of Nutritional Status on the Temperature Tolerance of Green Sturgeon (*Acipenser medirostris*) Fingerlings

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Effects of global climate change relevant to the San Francisco Bay Delta (SFBD) include increasing water temperature and increasing salinity as a result of sea level rise and seawater intrusion into the SFBD, changes in precipitation patterns, and a smaller snowpack, contributing to a lower spring freshwater runoff. Recent evidence also suggests that the food webs in the SFBD system are changing and that sturgeon diets can shift to reflect availability and abundance of prey items. Because early life stages of green sturgeon spend part of their lives in the SFBD, they may be exposed to fluctuations in environmental temperature, salinity, and experience low nutritional status due to the low quality and quantity of prey organisms. Therefore, the purpose of this study was to address whether green sturgeon fingerlings with lower nutritional status possess the physiological capacity needed to survive and thrive when faced with temperature stress. Sixteen tanks with 30 green sturgeon fingerlings per tank were randomly assigned to one of four feeding rates: 0.25, 0.5, 1.0 and 2.0% BW.d-1. After the 2-week growth trial, the groups receiving more restricted feeding showed a significant reduction ($p < 0.05$) in growth indices (SGR, feed efficiency, proximate composition) and lower plasma protein, glucose, and triacylglycerol levels compared to the non restricted-feeding group. However, swimming performance (Ucrit) tests showed no significant ($p > 0.05$) difference among the treatment groups. Fish from each treatment were used in the determination of critical thermal maximum (CTMax) as an index of whole-organism thermal tolerance. There was no significant difference ($p> 0.05$) in CTMax among the treatments. Fish from each treatment were also sampled for the analysis of liver and muscle RNA/DNA ratios, glycogen, lipid and the levels of heat shock proteins (Hsp 90, 70 and 60).

Keywords: Green sturgeon, climate change, nutritional status, heat stress

Poster Topic: Fish Biology, Ecology and Protection

Environmental Water Management for Lake Curry and Suisun Creek

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Lake Curry is a 10,000 acre-foot municipal water supply reservoir owned by the City of Vallejo and located on upper Suisun Creek in Napa County. The Suisun Creek watershed, with an area of approximately 55 square miles, is one of the least disturbed systems in the San Francisco Bay area and contains no major urban areas. Lake Curry and Suisun Creek, due to their relatively small size, offer the potential for experimentation with reservoir releases and the possibilities for either improvement or harm to creek aquatic habitats for salmonids. The Suisun Creek watershed has been the subject of extensive monitoring and study since 2001 to determine the limiting factors for steelhead trout in the watershed. While these factors vary for each major tributary, high water temperatures limit aquatic habitat values for salmonids throughout the system. In summer 2006, California Land Stewardship Institute staff worked with the City of Vallejo to alter the Lake Curry release regime in order to examine the effects of different release rates on water temperatures at 17 monitoring stations downstream. In addition, water temperatures in the lake were monitored and a model created to determine the volume of cold water available for release under various climatic conditions and at different release rates. The results of this model and the real time experiment will be presented along with the next set of proposed experimental releases and recommendations for future management of Lake Curry for the benefit of salmonid habitat.

Keywords: dam, reservoir, Suisun, steelhead, temperatures

Poster Topic: Fish Biology, Ecology and Protection

Effects of Water Year Type on Juvenile Chinook Salmon Size at Emigration in the San Joaquin River Basin

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Most Central Valley rivers are regulated by large dams and are highly channelized, reducing the frequency of flooding events. Consequently, the amount and accessibility of floodplain habitat may vary considerably across water year types. Annual discharge in the Merced and Tuolumne rivers are based on the Water Year Type (WYT) designation for the San Joaquin Basin. Studies have shown that floodplain habitat is important rearing habitat for juvenile Chinook salmon *Oncorhynchus tshawytscha*. Floodplains provide food resources, which contribute to faster growth rates when compared to fish rearing in the main river channel. This gives these fish obvious advantages in survival and predator avoidance. Significant differences in daily mean sizes of juvenile Chinook salmon exist across WYT ($P \leq 0.01$) in fish sampled in the Merced, Tuolumne, and San Joaquin rivers. Wet years tend to produce the largest juveniles while Dry years produced the smallest fish on average. Increasing the amount of floodplain habitat available to juvenile salmon in these rivers at a variety of flow conditions could increase the overall size of juveniles and lead to higher survival.

Keywords: anadromous, restoration, Chinook salmon, water year, floodplain habitat, San Joaquin

Poster Topic: Fish Biology, Ecology and Protection

Fire, Floodplains and Fish: An Ethnographic Study on *Lavinia exilicauda chi* in Clear Lake California

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For thousands of years, the California landscape has been tended and its resources sustainably harvested. Prior to Euro-American settlement, California Native Americans manipulated the natural environment, particularly plant resources, to meet long-term cultural needs (Stevens 1999). In fact, indigenous people all over the world have been found to be key factors in influencing biodiversity, sustainability, and optimum resource utilization. Historical ecology focuses on this reciprocal interface between humans and the environment in order to further the understanding of landscape transformations over time (Grossinger et al. 2006). It is this fundamental understanding that promotes educated changes and implementations to policy and overall environmental awareness. Our presence within local environs needs to be understood both holistically and scientifically in order for there to be progression towards sustainability. The field of historical ecology does not typically incorporate both archaeological data and ethnoecology into an assessment of historic ecosystems. Archaeological records contain not only demographic information not found in most historical texts, but also environmental information in the form of material culture, paleobotanical, and faunal remains. This study will explore archaeological fish faunal remains, ethnographic data, and traditional knowledge sounding *Lavinia exilicauda chi* and the Pomo Native American people in order to reconstruct the landscape of the lower Clear lake basin and it's watershed prior to Euro-American settlement and alteration. The historical reconstruction proposed will illustrate, within the limitations of the data, how past indigenous traditional management practices influenced both vegetation patterns and probable fish distributions in the Clear Lake area.

Keywords: hitch clear lake Pomo species wetlands river lake sustainable natural

Poster Topic: Fish Biology, Ecology and Protection

Delta Smelt Captive Refugial Population Update and Relevancy, 2012

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The captive refugial delta smelt (*Hypomesus transpacificus*) population, held at the Fish Culture Conservation Lab (FCCL) - University of California, Davis (UCD), was initiated in 2008 with wild-caught captive 2 year-old delta smelt after alarmingly low abundance estimates were reported for the species over several years. Declines in species abundances have been attributed to the highly altered nature (i.e. diking and draining for agriculture, increased water exports, invasive species) of the San Francisco Bay – Delta. The delta smelt is endemic to the upper Bay – Delta, and has been listed as endangered in the State of California. Genetic management of the refugial population, in collaboration with the UCD Genomic Variation Laboratory, is employed to maintain genetic diversity and minimize mean kinship through parentage analysis. The recent spawning season, ending late May 2012, produced the 5th generation. In total, 282 pair crosses were made, through manual expression of gametes and in vitro fertilization, which compares favorably to the target of 250 pair crosses per year. In 2012, 48 wild fish were successfully spawned to supplement genetic diversity and minimize genetic drift in the refugial population. Through the F3 generation, genetic analyses have shown no significant differentiation or loss of genetic diversity between the captive refugial population and the wild population of delta smelt. The captive refugial population of delta smelt is an important safeguard against further species-jeopardy, but stocked fish could perish along with wild fish, and so continued attention to effective Bay - Delta habitat remediation is imperative. The captive refugial population is relevant to Bay – Delta management by demonstrating a successful preservation technique of a native species, which, together with other protected natives, will ultimately contribute to the overall health and sustainability of the ecosystem.

Keywords: Delta Smelt, endangered, captive population, genetic management

Poster Topic: Fish Biology, Ecology and Protection

The Effect of Dietary Methylmercury on Na+, K- ATPase Activity and Growth in Central Valley Fall-run Chinook Salmon (*O. tshawytscha*)

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A manipulative experiment was conducted to determine whether methylmercury had the potential to disrupt the physiological processes associated with smoltification in juvenile Chinook salmon. Hatchery salmon from California's Central Valley were fed for 62 days (Apr-Jun) on fish pellets mixed with methylmercury hydroxide concentrations of 0, 1, 3, or 5 $\mu g \cdot g^{-1}$. Weight, fork length, condition factor, and Na+, K- ATPase measurements were collected every two weeks and a 96 hr seawater challenge was conducted at the conclusion of the experiment. Results from two-way ANOVA indicated no significant differences among treatments for weight ($F_{3, 32} = 1.38$; p=0.280), length ($F_{3, 32} = 0.986$; p=0.412), condition factor ($F_{3,32} = 0.239$; p=0.869), or mortality. Post-hoc analysis of ATPase activity indicated the 3 and 5 $\mu g \cdot g^{-1}$ dietary groups were significantly elevated in early May as compared to the control. The results from the 96 hr seawater challenge indicated weight influenced survival the strongest in the transition from freshwater to seawater. Results from this study indicate methylmercury, a known neurotoxin, can disrupt normal ATPase activity patterns in fall-run Chinook causing potentially undesirable effects in smolt timing. One possible mechanism for this disruption is via the stress induced hormone cortisol.

Keywords: chinook, salmon, methylmercury, ATPase, physiology, smoltification, mercury,

Poster Topic: Fish Biology, Ecology and Protection

Movements, Survival, and Residence Times of Three Native Fish Species in the Yolo Bypass in a Dry Year

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Although the Yolo Bypass floodplain has been demonstrated to benefit a suite of native fishes, particularly in flood years, little is known about how the movement patterns, survival, and residence time of native fishes in the Yolo Bypass. In cooperation with the Department of Water Resources (DWR), we implanted 68 white sturgeon caught in the DWR fyke net, located just below Lisbon Weir in the Toe Drain (the perennial channel that runs along the eastern side of the Yolo Bypass). The sturgeon were implanted with VEMCO V16 coded tags. Separately, twenty-five juvenile chinook salmon (100-125mm FL) and twenty-five juvenile steelhead trout were implanted with VEMCO V5 and V7 coded tags, respectively. The smolts were released 91 river kilometers upstream from the base of the Cache Slough Complex, and monitored with seven VEMCO VR2W 180-kHz monitors within the Toe Drain (a total reach of 38.45 river kilometers). The white sturgeon were monitored within and throughout the Toe Drain and into the San Francisco Bay using an array of VEMCO VR2W 69kHz monitors, including those maintained by the California Fish Tracking Consortium. We calculated residence time in the Toe Drain for the smolts and the sturgeon, as well as rates of survival for the smolts. Variables of consideration for behavioral movement analysis of white sturgeon included sex and fork length.

Keywords: Yolo Bypass, white sturgeon, salmonids, outmigration, telemetry, animal movement, floodplain

Poster Topic: Fish Biology, Ecology and Protection

Juvenile Salmon Response to Levee Repair on the Sacramento River

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California Department of Water Resources (DWR) and the United States Army Corps of Engineers (USACE) are engaged in levee repair focused on preventing levee erosion and flooding. The repairs also include features to improve the fish habitat including shallow water benches and instream woody material. However, there remains uncertainty about how fish respond to these features. In addition, questions regarding which enhancement provides the most benefit to fish also remain. To address these questions, we investigated fish movement using acoustic tags at river mile 85.6. Approximately 100 detailed 2D fish movement tracks were collected in the vicinity of the repair site. We also collected detailed bathymetric and hydraulic data and developed a 3D computational fluid dynamics (CFD) model of the levee repair site. We then developed a fish movement model using the Eulerian-Lagrangian-Agent Method (ELAM) and used the fish movement data from the 2D acoustic tag tracks for calibration of modeled fish movement. The fish movement model matched observed travel times and spatial distribution accurately. The fish movement model suggests that the levee repair has a strong effect on fish movement at small spatial scales. Modeled fish move faster when in proximity to the levee and alter their spatial distribution by shifting their position in the river and moving away from the repair site. Before fish arrive in the Bay-Delta they must move through hundreds of miles of river where levees impact the habitat. Thus fish may arrive in the Bay-Delta in poor condition and be subject higher mortality. Given the prevalence of levees on the Sacramento system and it is important that we consider how fish habitat considerations be integrated to repair projects. More broadly, we are developing a management tool that will allow for scenario analysis at small (10 m) and large (100 km) of river.

Keywords: levee, ELAM, fish movement, fish tracking

Poster Topic: Fish Biology, Ecology and Protection

When to Bolt: Fry or Smolt? Estimating Survivorship of Juvenile Salmon Migratory Life Histories Using Otolith Strontium Isotopes

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The maintenance of life history diversity is critical for the persistence of salmonid populations and is central to recovery efforts. Juvenile salmon leave their natal rivers at different sizes, ages, and times of the year and it is thought that this life history variation contributes to population sustainability. Preserving and restoring diversity of life history traits depends in part on the environmental factors affecting their expression. Rotary-screw traps (RST) at Caswell have indicated that during years when spring flows are high, large numbers of fry size Chinook salmon emigrate from the Stanislaus River, presumably rearing downstream in the San Joaquin, delta and/or estuary. In drier years fewer fry sized Chinook are collected at the Caswell trap. It remains unclear whether fry (<55mm), parr (56-75mm) or smolt (>76mm) outmigrants contribute disproportionately to the adult spawning population and whether this is influenced by hydrologic regime.

This study utilizes Sr isotopes ($^{87}Sr/^{86}Sr$) in adult Chinook salmon otoliths (earbones) to bridge the information gap between how river conditions influence juvenile outmigration patterns and survivorship of life history strategies in different years. A total of 200 paired otolith and scale samples were used to reconstruct and compare size-specific out-migration patterns of juvenile salmon in an 'Above Normal' (2000) and a 'Below Normal' (2003) water year type. For each returning adult, the size that it had emigrated from the Stanislaus River was reconstructed by coupling otolith $^{87}Sr/^{86}Sr$ with otolith radius measurements. To determine the relative success of the fry, parr and smolt-sized outmigrants, we compared their proportions within the juvenile RST samples with those reconstructed in the adult returns from the same cohort.

Keywords: Salmon, Otolith

Poster Topic: Fish Biology, Ecology and Protection

Central Valley Steelhead Draft DRERIP Conceptual Model

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The draft Central Valley steelhead conceptual model describes, in both text and figures, the major stressors on the steelhead populations in the Central Valley of California. Following the DRERIP format, the model ranks the importance of each population stressor, our relative understanding of the relationship between each stressor and the success of a population, and the certainty that a particular stressor is important to this species.

The conceptual model reviews the literature on the ecology, life-history, historic and current distribution, management, and current status of this distinct population segment (DPS) of steelhead. The model covers the key stressors impacting survival and growth at each life-stage, including egg and alevin, parr, smolt, post-smolt, adult, and kelt. Specific ecological issues addressed include historic and current distribution, the question of residency vs. anadromy in Central Valley *O. mykiss*, and life-history variation within and among populations including age at smolting, age at maturity, repeat spawning, and the poorly understood "half-pounder" strategy. Management questions addressed include the role of hatchery supplementation, migration barriers, and water temperature regulation. The goal of the model is to create a common, agreed-upon, qualitative model of the life-history of Central Valley steelhead, which can be used to help guide future analyses, monitoring, and research.

Keywords: steelhead, biology, model, management, life-history, stressors

Poster Topic: Fish Biology, Ecology and Protection

Advances in Longfin Smelt Culture Development

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Following the population decline of longfin smelt and listing as threatened in the San Francisco Bay Estuary, the Fish Conservation and Culture Lab (FCCL) has been developing methods to rear longfin smelt through all life stages for research purposes. Using culture methods based on those developed for delta smelt in our laboratory, longfin smelt are reared in intensive culture (recirculating and biofiltered systems with temperature control). Over the last 3 years the FCCL has received a few mature broodfish (US Fish and Wildlife Service) annually and, using in vitro fertilization, produced eggs, larvae, and juveniles. Survival has improved from nearly zero at 40 days post hatch to some individuals reaching the 1-year mark. However, longfin are difficult to obtain and are dissimilar enough from delta smelt to present some problems in culture. Two current fish husbandry problems are the low number of gravid longfin broodfish received each year and the fact that these mature fish and the older juveniles are not weaning to a dry commercial diet. In the 2012 season only two gravid females were successfully spawned. The dependence on live prey species, which is poor in nutrients and difficult to maintain over winter, results in inefficient fish production and poor fish condition. A demand for research animals currently exists, and FCCL hopes to meet the demand in a few years. The FCCL has tested eggs and larvae under several saline-exposure conditions and expects to continue this line of inquiry. Animals are requested by collaborators and researchers at University of California - Davis to address bioenergetics, behavior, salinity-exposure, and tagging studies. Results from this suite of research studies will help delineate migratory patterns, areas of favorable environmental conditions, and energy expenditures for wild fish – all highly relevant to Bay-Delta management.

Keywords: Longfin Smelt, fish culture, captive rearing

Poster Topic: Fish Biology, Ecology and Protection