Estuary Monitoring Platform: Standardized Biological Sampling across Habitat Types

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Numerous techniques are used to monitor estuary fish status and population trends. Gear selectivity and efficiency and ability to track larvae are weaknesses in current techniques. Attempts to integrate multiple abundance indices has had limited success. Although considerable collaboration has occurred, coordinated monitoring and permitting have been difficult. Processing fish and invertebrate identification and enumeration data requires extended periods of sampling downtime and is time-consuming. Additionally, association of individual species lifestages and abundances with microhabitat features and food web components would strengthen analyses (IEP MAST 2014).

The Estuary Monitoring Platform (Platform) was developed to sample fish and invertebrates and reveal habitat associations while having minimal or no "take" of sensitive species. Platform deployment expands data collection to shallow water habitat, with the capability of transitioning to deeper-open water, providing reliable sampling efficiency and CPUE estimates. To validate performance, we compared Platform fish catch and capture efficiency against three traditional methods (beach seine; electrofishing; trawling) in two different habitat types (nearshore/littoral zone; open water) on a Central Valley reservoir.

The prototype Platform sampled depths to 5 ft and operated at speeds of 0.2 ~ 4 knots. Platform image acquisition and live-trapping recorded a variety of species and estimate catch per unit effort similar to other techniques. All species captured by each technique were observed by the Platform. The Platform was able to link biological data directly to simultaneously recorded water quality parameters and geographic location.

The Platform can collect streaming images of organisms passing through the system and associate them with environmental parameters in space and time, reducing take during Estuary studies. The Platform can compliment existing Interagency Ecological Program and other fish monitoring efforts and contribute to Estuary science program efforts to inform ecosystem restoration and native species recovery actions. Specific study results and future deployment applications will be discussed.

Keywords: Prototype, fish, invertebrate, sampling gear, non-invasive, video, San Francisco Estuary

Poster Topic: Fish Biology, Ecology, & Protection

Effects of Bifenthrin on the Estrogenic and Dopaminergic Pathways in Embryos and Juveniles of Zebrafish (*Danio rerio*)

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Bifenthrin (BF) is a pyrethroid pesticide widely used in urban and agricultural applications. Previous studies in fish have shown that environmentally relevant concentrations of BF can affect the endocrine system by leading to the over production of 17b-estradiol (E2) and altering the expression of dopaminergic pathway components in the central nervous system in fish. Dopaminergic neurons regulate luteinizing hormone (LH) and follicle stimulating hormone (FSH), which control E2 biosynthesis, suggesting that BF may disrupt the hypothalamic-pituitary-gonad (HPG) axis. The hypothesis that BF impairs this pathway was tested in embryonic and one-month old juvenile zebrafish (*Danio rerio*). At 3 hours post fertilization (hpf), and one month of development, fish were exposed to 0.15 and 1.5 ppb BF for 96 hours. The relative levels of transcripts related to the dopaminergic and the HPG axis (tyrosine hydroxylase (TH), dopamine receptor 2A (DR2A), dopamine active transporter (DAT), sodium/potassium ATPase (NA/K ATPase), LHb, FSHb, and vitellogenin (VTG)) were investigated by qRT-PCR. Levels of E2 were measured by ELISA. Dopamine and its metabolites (3, 4-dihydroxyphenylacetic acid and homovanillic acid) concentrations were evaluated by LC-MS/MS. Preliminary results show significant decreases of TH, NA/K ATPase, and VTG transcripts in zebrafish embryos, and a significant increase in the expression of TH and DAT in zebrafish juveniles. Estradiol levels were significantly decreased in embryos. These results show a possible anti-estrogenic effect of BF in embryos, and estrogenicity in juveniles. Studies on dopamine concentrations are ongoing. Further analysis of differentially expressed genes coupled with endocrine responses can help assess potential toxic and sub lethal effects of BF using zebrafish as an animal model.

Keywords: Pyrethroids, endocrine disruption, dopaminergic pathway, zebrafish

Poster Topic: Fish Biology, Ecology and Protection

Examining Effects of Wastewater Effluent upon Growth Rates of Inland Silversides in San Francisco Bay Tributaries

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Wastewater runoff and other forms of human-engineered hydrology can alter ecosystems for fish species in their respective habitats. This study used otolith aging to determine growth rates of inland silversides in Alviso and Artesian Sloughs (tributaries of South San Francisco Bay) and Napa River, Petaluma River, and Sonoma Creek (tributaries of San Pablo Bay). The study expected to see higher growth rates in individuals collected from Artesian Slough compared with individuals collected from the other tributaries due to warm, nutrient-rich wastewater flowing as effluent from San José-Santa Clara Regional Wastewater Facility into Artesian Slough. This effluent should create favorable environmental conditions for inland silversides and allow the individuals to grow at an accelerated rate. Otoliths are extracted from the individuals and sanded with fine grit sandpaper in the frontal plane. Because otolith growth is directly correlated with fish length and age, widths of daily bands in the otoliths can be used as a proxy for daily growth. While the study did not find an accelerated growth rate in silversides from Artesian Slough, there was a greater catch per unit effort in Artesian Slough relative to the other sampled tributaries of South San Francisco and San Pablo Bays. This implies that growth of the inland silversides at the sampled sites may be density-dependent. Because wastewater runoff is ultimately a matter of water management, the study results show that wastewater in the estuary may be contributing to the proliferation of an invasive fish in the estuary.

Keywords: Otolith, Wastewater, Inland Silversides, Microchemistry, Growth Rate, Invasiveness

Poster Topic: Fish Biology, Ecology and Protection

Hydraulic Conditions Near a Model Louver System in a Laboratory Flume

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The San Francisco Bay Delta is heavily modified by anthropogenic factors. Man-made activities and structures, such as agricultural water diversions, pumping plants, dams, reservoirs, canals and aqueducts have dramatically altered flows within the Bay-Delta system. The flows are altered with respect to both timing and magnitude. Both the changing of flow patterns, and the physical export of flow have negatively affected biological communities. Fish species native to California are more sensitive to the effects of flow alteration than non-native species. The Delta acts as a hub for both the Central Valley Project (CVP) and the State Water Project (SWP). Timed releases of freshwater from upstream reservoirs reach the Delta, where they are drawn into CVP or SWP pumps, and exported. Determining the impact of current operational parameters at large-scale water diversion facilities on affected fish species is critical to their continued survival. This study investigates the hydraulic conditions near a model louver system simulating conditions at the John E. Skinner Delta Fish Protective Facility of the State Water Project and the Tracy Fish Collection Facility of the Central Valley Project (South Delta Fish Protective Facilities). The model louver system was developed to conduct experiments quantifying the successful bypassing of juvenile green sturgeon at a variety of experimental conditions. The results presented correspond to the first of three hydraulic variations tested in this ongoing study. Analysis of these results could provide insight into the design and operation of louver facilities in order to enhance conservation goals.

Keywords: hydraulics, fish protection, louver system, laboratory, modeling

Poster Topic: Fish Biology, Ecology and Protection

Behavior of Green Sturgeon *Acipenser medirostris* Near a Model Louver System in a Laboratory Flume

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In California's heavily-altered Bay-Delta ecosystem, anthropogenic factors coupled with drought may drastically change available habitats for many native fishes. Large water projects alter flows, expose juvenile fish to unnatural levels of larger piscivorus fish, and can cause warmer overall river temperatures. Native California fishes have been disproportionately affected by these changes compared to non-native species, and precipitous population declines have been observed for several species, some of which are listed under the Endangered Species Act, including green sturgeon. Therefore, research aimed to determine the impact of current operational parameters at large-scale water diversion facilities on sturgeon is critical to their continued survival. A model louver system simulating conditions at the John E. Skinner Delta Fish Protective Facility of the State Water Project and the Tracy Fish Collection Facility of the Central Valley Project (South Delta Fish Protective Facilities), and experiments were initiated to quantify the successful bypassing of juvenile green sturgeon at different sizes (ages), water temperatures, river sweeping flow speeds, and photoperiod (day or night). Fish were observed as they moved downstream towards the louver array where they either successfully bypassed the louver, were entrained through it, or avoided louver interactions. Several underwater cameras placed within the flume recorded fish-louver interactions and fish movement through the bypass channel. Louver contacts, impingement upon the louver, entrainment through the louver, and the timing of bypass events were recorded. Due to the overall small population size and the limited number of annual spawning adults of green sturgeon in the Bay-Delta, it is critical to understand if the current design and operation of louver facilities are cooperative with conservation goals.

Keywords: Green sturgeon, louvers, fish protection, swimming performance

Poster Topic: Fish Biology, Ecology and Protection

Developmental Toxicity of 2- and 6-Hydroxychrysene in Zebrafish Embryos

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Oil spills are one of the primary sources of polycyclic aromatic hydrocarbons (PAHs) in marine environments and are subject to biotic and abiotic weathering. PAHs can undergo photochemical oxidation, forming oxygenated photoproducts that can cause adverse ecological effects. Chrysene is one of the most persistent PAHs and is susceptible to photo-oxidation, resulting in production of oxygenated derivatives such as 2- and 6-hydroxychrysene. However, little is known about the toxicity of hydroxylated PAHs. Previously, we showed that exposure to 2- and 6-hydroxychrysene can adversely affect development of zebrafish embryos. Therefore, the goal of this study was to identify a sensitive window of embryonic development for 2- and 6-hydroxychrysene-induced toxicity. Embryos were statically exposed starting from 2, 5, 10 or 24 hours post-fertilization (hpf) to 0.5 and 5 µM of 2- or 6-hydroxychrysene for 74hrs. At 76 hpf, there was a significant decrease in survival after initiation of treatment with 5 µM 6-hydroxychrysene at 2 hpf, whereas no difference was observed following initiation of 2-hydroxychrysene treatment at any tested stage. However, the prevalence of cardiac deformities was significantly higher after treatment with 2- and 6-hydroxychrysene. These findings suggest that there is a critical time during early development when embryos show heightened sensitivity, leading to decreased survival after exposure to specific PAHs. Moreover, there was an increase in the intensity of yolk sac-localized fluorescence after treatment with either 2- or 6-hydroxychrysene. However, 2-hydroxychrysene resulted in the highest fluorescence intensity, suggesting differential uptake and/or metabolism between these two compounds. Our findings raise the need to identify mechanisms involved in the toxicity of these compounds to assess the potential risks of oil spills on fish populations. This research was made possible in part by a grant from BP/The Gulf of Mexico Research Initiative to the RECOVER Consortium, and in part by CAPES/INCT-TA and CNPq.

Keywords: Development, PAH, hydroxylated chrysene

Poster Topic: Fish Biology, Ecology and Protection

Understanding Catch Patterns of Invasive Catfish Species in the Yolo Bypass

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The San Francisco Estuary's largest floodplain, the Yolo Bypass, has historically supported a diverse fish community comprised of both native and invasive species. The adult fish catch in the perennial Toe Drain channel of the Yolo Bypass in the past decade has consistently been dominated by two non-natives: White Catfish (*Ameiurus catus*) and Channel Catfish (*Ictalurus punctatus*). Here, we examined patterns of adult White and Channel Catfish catch via analysis of both temporal and abiotic changes. Most notably, these populations of Yolo Bypass catfish are increasing over time. In combination with the lack of observable increases within any of the other migratory adult fish species caught during the same sampling effort, this increase could be cause for management concern. Catfish in other systems have notoriously been known to completely alter ecosystems for a number of reasons, including the voracity of the adult catfish diet, and their ability to tolerate a wide range of water qualities. If the catfish increase in the Yolo Bypass continues, their impact on the ecological community in this important floodplain could become more significant. We present here an investigative summary for the potential causes for this increase, and implications for future management of the Yolo Bypass.

Keywords: invasive, Yolo Bypass, catfish, community, fish ecology, adult fish

Poster Topic: Fish Biology, Ecology and Protection

Effects of Temperature on the Endocrinology of Smoltification in Juvenile Rainbow/Steelhead Trout (*Oncorhynchus mykiss*)

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The San Francisco Bay Delta is experiencing seasonally warmer waters and salt water intrusion into historically freshwater ecosystems due to climate change. Juvenile endangered Steelhead Trout (*Oncorhynchus mykiss*) inhabit this system from juvenile development through the smoltification process. It is possible that juvenile fish experience premature hypersaline acclimation due to seawater intrusion (PHA), and the effects of increased temperature and PHA on pre-smolt Steelhead are unknown. Rainbow trout (*Oncorhynchus mykiss*) were used as a genetic model for Steelhead, since they are the same species. Juvenile fry were exposed to 11^0C, 16.4^0C and 19^0C temperatures (n=12) for two weeks and then challenged for 24 hours to 32ppt seawater. Estradiol-17b (E2), cortisol, triiodothyronine (T_3), thyroxine (T_4) levels were measured in blood/plasma or whole animal homogenates using Enzyme Linked Immunnosorbent Assays. Gill Na+/K+ ATPase mRNA levels were measured using qPCR. Preliminary results show 50% survival and a lower average hepatosomatic index (HSI) of 0.89% of fish exposed at the highest temperature compared to an average HSI of 1.24% in fish exposed to the optimal temperature. Ongoing studies will explore the impacts of PHA and pesticides on smoltification and osmotic stress in multiple life stages of salmonids. This material is based upon work supported by the Delta Stewardship Council Delta Science Program.

Keywords: Steelhead trout, smoltification, climate change, temperature

Poster Topic: Fish Biology, Ecology and Protection

Migratory Behavior of Acoustically-Tagged Adult White Sturgeon and Chinook Salmon in the Yolo Bypass, 2012-2016

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The overarching aim of this project is to investigate the movement behavior of different types of migrants in the Yolo Bypass, an intensely altered seasonal floodplain in the Sacramento-San Joaquin Delta of California. Both white sturgeon (*Acipenser transmontanus*) and Chinook salmon (*Oncorhyncus tshawytscha*) navigate the floodplain during their spawning migrations, but with very different reproductive strategies. White sturgeon are iteroparous: they undergo multiple reproductive cycles (and thus multiple spawning migrations) over the course of their lifetimes. Chinook salmon are semelparous, undergoing a single spawning migration and reproducing only once before death. Like native species everywhere, both are uniquely adapted to the historical conditions of their local environment, which has since undergone extreme modification by humans. The ecological success of a migratory species may vary with life stage, migratory route, and response to passage barriers. Understanding how these animals move through their environment is a fundamental part of determining how the migratory landscape is best conserved, managed, or reconciled. This presentation synthesizes four years of data from acoustically-tagged adult migrants, and provides answers to basic questions about the route(s) taken by adult migrants, the spatiotemporal patterns of system use (i.e., the spatial extent of migrant movements as well as the timing of entry, exit, and residence in the system), the behavior around passage barriers by different migrant types, and the environmental cues they may respond to on their migratory paths in different years.

Keywords: migration, floodplain, sturgeon, salmon, behavior

Poster Topic: Fish Biology, Ecology, and Protection

Inter-population Differences in Osmoregulation of Sacramento Splittail

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The Sacramento Splittail, a minnow native to the Delta, is currently listed as a Species of Special Concern by the California Department of Fish and Wildlife. Designing conservation and management plans for this fish can be difficult due to their semi-anadromous life history as well as the existence of genetically distinct populations. Two populations are categorized as the San Pablo (SP) and Central Valley (CV) populations, which differ in their exposure to relatively high and low salinities at the juvenile stage, respectively. During wetter years, the saltwater gradient between the two populations is reduced and the more homogeneous salinity regime may allow population intermixing; however during dry years the saltwater gradient is more distinct, creating a migration barrier and possibly driving adaptive divergence. The differences in salinity between primary spawning/rearing habitats may suggest population-specific differences in salinity tolerance. To test this, a common garden experiment was performed exposing juvenile Splittail from the CV and SP populations to 14ppt or 11ppt saltwater for 24, 72, 168, or 336 hours. Expression patterns of genes specific to osmoregulation and acclimation were then analyzed to evaluate intraspecific differences. Each population showed distinct patterns of gene expression consistent with local adaptation to osmotic regimes. This finding is relevant to the development of new conservation strategies that recognize population-specific concerns. Additionally, this information sheds light on the population effects changes in salinity have on delta species, specifically those susceptible to decline.

Keywords: Sacramento Splittail, osmoregulation, gene expression, adaptive divergence

Poster Topic: Fish Biology, Ecology and Protection

Temperature and Feeding Rate Interact to Impact Growth and Survival of Larval Green Sturgeon

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Temperature and food availability are two major determinants of successful growth and survival of fishes. This study was performed to assess how temperature and food availability may impact larval green sturgeon growth and development. Fish (initial age ca. 27 days post hatch) were reared at four different water temperatures (11, 14, 17, and 20°C) and fed daily at two different food rations (100% and 25% of a laboratory-derived optimal feed rates (OFR)). Each treatment group was held at rearing conditions for six weeks, and mass, fork length (FL; cm) specific growth rate (g/day; cm/day), and condition factor ([mass/$FL^{3]}$ x 100) were assessed at 0, 3 and 6 weeks. For treatment groups fed to 100% OFR, temperature was positively correlated with the growth of larval green sturgeon; for treatment groups fed at 25% of optimal, temperature did not significantly affect the growth of larval green sturgeon. Additionally, temperature had an overall negative correlation with condition factor of the fish in both feed treatment groups. These results can help develop criteria for early life history requirements of green sturgeon and to inform management actions seeking to increase larval and juvenile recruitment success of this species of conservational concern.

Keywords: larval green sturgeon, *Acipenser medirostris*, temperature, feeding rate, growth, survival,

Poster Topic: Fish Biology, Ecology and Protection

Efforts to Conserve Pacific Lamprey

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Historically widespread along the West Coast, Pacific Lamprey (*Entosphenus tridentatus)* abundance has declined and its distribution has become restricted throughout California, Oregon, Washington, and Idaho. To assess and conserve Pacific Lamprey, a conservation initiative composed of a risk assessment, a conservation agreement, and regional implementation plans was developed. The risk assessment found a relatively high risk of extirpation in the majority of watersheds, and these results were instrumental in gaining partners' support for the Pacific Lamprey Conservation Agreement (Agreement), a voluntary commitment by the parties to collaborate on efforts that reduce or eliminate threats to Pacific Lamprey. The goal of the Agreement is to accelerate implementation of priority Pacific Lamprey protections, restorations, monitoring and evaluations, and research actions. The Agreement seeks to advance conservation through the development of Regional Implementation Plans which will evaluate information gaps, prioritize and implement conservation actions, and evaluate their effectiveness to address these gaps. There are seven California Regional Implementation Plans (RIPS); however, the Sacramento, San Joaquin, and San Francisco Bay RIPs that are currently being developed are the most relevant to Bay-Delta management and for determining ecosystem sustainability for the future.

Keywords: lamprey, conservation, Regional Implementation Plan, information gaps, collaboration, risk assessment

Poster Topic: Fish Biology, Ecology and Protection

Lots of Data without the Fishy Smell: Application of Acoustic Imaging to Evaluate Fish Behavior near Tidal Wetlands

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Major tidal wetland habitat restoration efforts are planned to benefit Delta Smelt, juvenile salmonids, and other imperiled species in the Sacramento-San-Joaquin Delta. However, successful implementation of habitat restoration is constrained by a paucity of information on the function and services that tidal wetlands provide for fishes. Our current understanding of tidal wetland service and function is constrained for several reasons. First, the rapidly changing environmental conditions and complicated physical structure of these habitats make fish sampling difficult. Moreover, empirical studies of fish in tidal wetlands are often constrained by sample size, and frequency of data collection. To address these limitations, this study used an acoustic camera to collect high frequency continuous monitoring data at the entrance of a tidal wetland. More specifically, we evaluated fish abundance and behavior in response to rapidly changing environmental conditions. Here, we report on a study aimed at understanding responses of fishes to bi-directional tidal flows and environmental factors driving movements into and out of tidal wetland habitats. Results from this work will help understand the value or detriment of different habitat features and will assist with future habitat restoration efforts.

Keywords: acoustic camera, tidal marsh wetland, Aris

Poster Topic: Fish Biology, Ecology and Protection

Occurrence of Large-Scale Loach (*Paramisgurnus dabryanus*) in the Sacramento-San Joaquin basin, CA

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Exotic species have been implicated as a major threat to native freshwater fish communities throughout the world. The San Francisco Estuary and its watershed have been recognized as the most invaded system in the world where exotics often dominate the fish community. Unfortunately, the U.S. Fish and Wildlife Service verified the occurrence of a new exotic fish species known as Large-scale Loach *Paramisgurnus dabryanus* on November 12, 2014 within the San Joaquin River in Madera County, California. A total of seven specimens were collected in isolated pool habitats using backpack electrofishing and beach seining techniques. In collaboration with the University California at Davis and Museum of Natural History of Los Angeles County, we verified that each specimen was a Large-scale Loach using DNA bar-coding and meristics (e.g., examined radiographs). We determined that this is the first known occurrence of Large-scale Loach in the United States following a review of literature and the United States Geological Survey Nonindigenous Aquatic Species Database. To elucidate the likelihood of establishment in and ecological risk to the San Joaquin River, we conducted a U.S. Fish and Wildlife Service Ecological Risk Screening Summary (ERSS). The ERSS results suggested that the likelihood of Large-scale Loach becoming established and impacting the aquatic community in the San Joaquin River is moderate based on the prevalence of degraded aquatic habitats in the river coupled with the flexible life history and habitat requirements of the Large-scale Loach. However, our ERSS results were highly uncertain because of limited peer-reviewed literature on the biology, ecology, and distribution of Large-scale Loach. Therefore, we recommend that public and private natural resource entities evaluate the ecology, distribution, and abundance of Large-scale Loach to determine their potential impact to the fish communities and related restoration projects occurring in San Francisco Estuary and watershed.

Keywords: Exotic, San Joaquin River, Large-scale Loach, Ecological Risk

Poster Topic: Fish Biology, Ecology and Protection

Reconstructing Fish Life History using Strontium Isotope Laser Ablation MC-ICP-MS Analysis of Scales, Spines, and Fin Rays as a Non-Lethal Alternative to Otolith

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Strontium isotope ratios (^{87}Sr:^{86}Sr) in otoliths are a well-established tool to determine origins and movement patterns of fish. Alternative sample tissues (scales, spines, fin rays) may also provide valuable geochemical information and are particularly useful as a non-lethal alternative for endangered fish species. Unlike otoliths that are predominantly aragonite, these tissues are comprised of biological apatite. Analyses of biological apatite using in situ laser ablation multi-collector inductively coupled plasma mass spectrometry (LA-MC-ICP-MS) is complicated by polyatomic interferences on mass 87, which can cause inaccurate ^{87}Sr:^{86}Sr measurements. To quantify this interference, we applied LA-MC-ICP-MS to three marine samples including a white seabass (*Atroctoscion nobilis)* otolith, green sturgeon (*Acipenser medirostris)* pectoral fin ray, and salmon shark (*Lamna distropis)* tooth, as well as freshwater walleye (*Sander vitreus*) otoliths, scales, and spines from Boysen Reservoir, Wyoming. These samples were selected because they originate from homogenous ^{87}Sr:^{86}Sr isotope reservoirs, allowing us to decouple potential analytical interferences from actual mobility and habitat change of the fish. Instrument conditions that maximize signal intensity resulted in elevated ^{87}Sr:^{86}Sr isotope ratios in the bioapatite samples, related to the polyatomic interference ($^{40}Ca^{31}P^{16}O$,$^{40}Ar^{31}P^{16}O$). Instrument conditions that reduce oxide levels successfully removed the effect of the polyatomic interference and resulted in consistent values across all tissue types. This provides fish ecologists with a powerful new tool to reconstruct life histories for threatened or endangered fish species where otolith extraction is not a viable option.

Keywords: Strontium isotopes, Otolith, Bioapatite, Migration

Poster Topic: Fish Biology, Ecology and Protection

The Effect of Chlorpyrifos on Salinity Acclimation of Steelhead Trout: Changes of Serum Hormone and Gene Expression in Liver, Gill and Rosette

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As a part of their unique life cycle, most salmonids undergo transition from freshwater to saltwater, requiring various adjustments in metabolism, osmotic and ion regulation. The hypersaline acclimation of salmonids can be affected by environmental pollutants such as pesticides during their downstream migration to the estuary. The present study aims to determine how toxicity of chlorpyrifos (CPF) impacts hypersaline acclimation of steelhead trout (*Oncorhynchus mikiss*). We exposed fish (52±5 g, 4 fish in each 4 replicate 20L glass tank) to 0, 20, 40, 80, 160 µg/L of CPF for 7 days, and then to hypersalinity (12ppt) for another 7 days. After 7 days of exposure, sampling was done either on serum or tissues (liver, gill and rosette). Mortality, levels of cortisol, T3 and T4 in serum, and expression of genes involved in detoxification, ion transportation and neural signal transduction were measured at the 7th day (CPF exposure) and 14th day (salinity) exposure. CPF exposure did not significantly alter cortisol levels, but fish exposed to CPF then exposed to hypersaline conditions showed higher cortisol levels than freshwater control groups. Serum thyroid hormones T3 and T4 were increased in a dose-dependent manner after CPF exposure as well as during the salinity acclimation. Hepatic mRNA of Glutathione-S-Transferse pi (GST) increased up to two folds following exposure to CPF and a similar trend was observed after hypersaline exposure. CPF downregulated around 0.5 fold the Na+/K+ATPase α1 in the gills. Transcriptional responses in neuronal signal transduction will be assessed in rosette samples. The current results indicate that chlorpyrifos could impact on the salinity acclimation of steelhead trout through inhibiting ion transportation and increasing serum thyroid hormones.

Keywords: chlorpyrifos, salinity acclimation, steelhead trout, serum hormone, gene expression

Poster Topic: Fish Biology, Ecology and Protection

Time- and Oil-Dependent Genomic and Physiological Responses to Deepwater Horizon Oil in Mahi-Mahi (*Coryphaena hippurus*) Embryos

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The Deepwater Horizon (DWH) oil spill contaminated the spawning habitats for numerous commercially and ecologically important fishes. Exposure to the water accommodated fraction (WAF) of oil from the spill has been shown to cause cardiac toxicity during early developmental stages across fishes. To better understand the molecular initiation events and explore new pathways responsible for toxicity, RNA sequencing was performed in conjunction with physiological and morphological assessments to analyze the time-course (24, 48 and 96 hour post fertilization (hpf)) of transcriptional and developmental responses in embryos/larvae of mahi-mahi exposed to WAF of weathered (slick) and source DWH oils. Slick oil exposure induced more pronounced changes in gene expression over time than did source oil exposure. Predominant transcriptomic responses included alteration of EIF2 signaling, steroid biosynthesis, ribosome biogenesis and activation of the cytochrome P450 pathway. At 96 hpf, slick oil exposure resulted in significant perturbations in in eye development and peripheral nervous system, suggesting novel targets in addition to the heart may be involved in the developmental toxicity of *DHW* oil. Comparisons of changes of cardiac genes with phenotypic responses were consistent with reduced heart rate and increased pericardial edema in larvae exposed to slick oil but not source oil.

Keywords: DWH oil spill, transcriptome, developmental toxicity, phenotypic anchoring, Mahi-mahi

Poster Topic: Fish Biology, Ecology and Protection