INFORMATION ITEM

Lead Scientist's Report

Summary: Over the next few months, the article spotlights in the Lead Scientist's Report will feature previous recipients of the Delta Science Fellowship to report on the findings of their work. These spotlights will be thematically clustered. In this month's article spotlight, we highlight results from three Delta Science fellows who are investigating how characteristics of the physical environment (e.g., temperature and oxygen levels) impact the growth rate, size, and survival of three native fish species of concern: the Longfin smelt, Delta smelt, and Chinook salmon. Their findings will help inform methods used in sustaining captive populations and help anticipate how wild populations will likely respond to warming (so that water and hatchery operations may be optimized to help enhance their resilience). These studies are broadly responsive to action area 4 of the 2017-2021 Science Action Agenda (Improve understanding of interactions between stressors and managed species and their communities) and specifically responsive to action 4A-A (Better understand salmonid temperature tolerances in streams).

LONGFIN SMELT: EFFECTS OF TEMPERATURE ON HATCHING AND GROWTH PERFORMANCE OF EMBRYOS AND YOLK-SAC LARVAE OF A THREATENED ESTUARINE FISH: LONGFIN SMELT. YANAGITSURU ET AL., AQUACULTURE, 2021.

Longfin smelt, one of the native fish species in the San Francisco Estuary, is listed as a threatened species under the California Endangered Species Act. Historically, it was one of the most abundant fish species in California. The San Francisco Estuary population was the largest self-sustaining population of longfin smelt along the Pacific coast of the United States. However, populations are now less than one percent of their pre-1980s numbers, with the most precipitous decline happening over the past 20 years. In 2015, the population nearly collapsed, as evidenced by the low catch of just three individuals during their peak spawning period. In response, the Fish Conservation and Culture Laboratory at the University of California, Davis, initiated a captive culture program for longfin smelt. However, researchers found that the culture methods used for Delta smelt do not apply to longfin smelt, which experienced complete mortality.

Yuzo Yanagitsuru and their team conducted a study to help develop improved methods for growing longfin smelt in captivity. They observed that, in the field,

longfin smelt spawn when the water is at lower temperatures than when Delta smelt spawn, and developed a hypothesis that longfin smelt larvae require lower temperatures than Delta smelt in the period just after hatching. They proposed that temperature affects the larvae's growth rate and swimming speed—two factors that contribute to successful feeding once the yolk and oil from the smelt's egg have been consumed.

After conducting experiments in which they incubated longfin smelt larvae at different temperatures, the team found that longfin smelt embryos reared at lower temperatures than used in previous attempts, resulting in a higher hatch success rate and larger size overall. However, they also observed high variability in these results. The researchers also pointed out that unknown factors other than starvation may be the dominant cause of mortality in cultured longfin smelt, as all test groups in this study still experienced mass mortality before the yolk and oil had been fully observed.

DELTA SMELT: OTOLITH-BASED APPROACHES INDICATE STRONG EFFECTS OF ENVIRONMENTAL VARIATION ON GROWTH OF A CRITICALLY ENDANGERED ESTUARINE FISH. LEWIS ET AL., MARINE ECOLOGY PROGRESS SERIES, 2021.

Delta smelt are another native Estuary fish species listed as critically endangered and vulnerable to stressors such as habitat disruption. Their populations have been drastically declining since the 1980s, inspiring many studies to understand the factors behind their decline. These studies have not revealed any specific "smoking gun," and it is generally understood that many factors underlie the Delta smelt's decline, including changing temperatures, water clarity and salinity, and diminished access to food resources and habitat. However, with a wild population heading toward extinction, it has been difficult to conduct studies that conclusively identify the effects of stressors on Delta smelt. With the extremely low population numbers, it cannot be assumed that the rare individuals caught in the wild are in optimal locations for their survival, and the results of studies conducted on individuals in captivity do not always transfer to the wild populations.

A method newly applied in the Delta by former Delta Science Fellow Levi Lewis overcame some of the previous methods' difficulties. The method can precisely quantify the growth rate of individual fishes—a parameter that correlates strongly with success in avoiding predation at critical times in the fish's development. It does so through analysis of otoliths—bones in the inner ears of fish that form tree ring-like structures indicative of the fish's growth rate over time. By compiling data on the growth rate of archived specimens of Delta smelt for the 14 days prior to

capture and pairing it with data on the physical environment collected at the time the fish were caught, Lewis' team could model the precise influence of different environmental factors on Delta Smelt growth rate. They found that growth rate declines precipitously at temperatures greater than 20°C (68°F) and as water clarity increases (a recent phenomenon attributed to the filter-feeding of the invasive overbite clam and decreasing sediment inputs from the watershed). This confirms previous assumptions based on less robust studies. They also found that high salinities depress growth rates, though there was no specific association between growth rate and the current salinity standard. In general, their findings supported the ongoing use of flow management actions designed to enhance downstream dispersal and the extent and quality of low-salinity habitats in the late summer to early fall. The results also illustrated how drought could imperil the species via critically high-water temperatures.

CHINOOK SALMON: DIFFERENTIAL SENSITIVITY TO WARMING AND HYPOXIA DURING DEVELOPMENT AND LONG-TERM EFFECTS OF DEVELOPMENTAL EXPOSURE IN EARLY LIFE STAGE CHINOOK SALMON. DEL RIO ET AL., CONSERVATION PHYSIOLOGY, 2021.

Temperature management for Chinook salmon is typically based on lethal effects, but sublethal effects also contribute to population decline via reduced feeding success, increased predation, and reproductive impacts. These effects, however, have been poorly studied. Annelise Del Rio and colleagues worked to fill this knowledge gap by examining individual and combined impacts of common environmental stressors (high temperature and low oxygen, or hypoxia) on Chinook salmon embryos during development after hatching. After exposing the embryos to warm water temperature, hypoxia, or both stressors, the team measured the embryos' routine metabolic rate (RMR) at two stages as a stressor exposure marker. Their results found that, in general, salmon embryos reared under warm water temperature with and without hypoxia conditions experienced the greatest impact on RMR during exposure and in later life stages. Further, the hatch rate decreased for embryos incubated with warm water and hypoxia. Overall, the team concluded that the observed sublethal impacts could have substantial detrimental impacts on adult Chinook salmon populations.

DELTA SCIENCE PROGRAM ACTIVITIES

Draft 2022-2026 Science Action Agenda

The Delta Science Program circulated the draft 2022-2026 Science Action Agenda (SAA) for public review in mid-November. In addition to sharing the draft via public

listservs, staff carried out targeted outreach to collaborative venues and sought feedback from the Delta Independent Science Board (Delta ISB). Staff is in the process of reviewing input from the public review period, which closed on January 21, 2022. Input from the review period will be considered when revising the final SAA, anticipated by Spring 2022.

Delta Interagency Invasive Species Coordination (DIISC) Symposium

The public, biennial Delta Interagency Invasive Species Coordination (DIISC) Team Symposium was held on December 15, 2021. In 2013 the DIISC team was formed to foster communication and collaboration among California state agencies that detect, prevent, and manage invasive species and restore invaded habitats in the Sacramento-San Joaquin Delta. Participants in DIISC include state agency program managers and scientists (including Council staff), research and conservation groups, federal agencies, and other stakeholders. As outlined in the Invasive Species Coordination Framework, the goals of the DIISC team are to establish a framework for strategic planning, coordinated implementation, education and outreach, data management, research needs, and funding.

To meet their goals, the DIISC team holds a public, biennial symposium. This year the symposium focused on the challenge of early detection and rapid response (EDRR) to species invasions. EDRR is a second line of defense for the Delta once prevention measures have failed. Eradication at early stages, before the species has had a chance to get established and spread, is both the most cost-effective and efficient way to protect the Delta from the ongoing threat of invasive species. Sessions focused on lessons learned from EDRR efforts in other systems, successes and setbacks in EDRR efforts in the Delta, and emerging EDRR tools and challenges. The Council was well represented at the meeting through speakers, session and panel moderators, and members of the meeting planning committee. In addition, Delta ISB Chair Steve Brandt gave a plenary talk on the findings of the Delta ISB's invasive species review. The symposium launched the development of a framework for systematically implementing EDRR in the Delta. This framework will advance Action 3D of the 2022-2026 Science Action Agenda, which is "to synthesize existing knowledge and conduct applied, interdisciplinary research to evaluate the costs and benefits of different strategies for minimizing introduction and spread of invasive species, and to inform early detection and rapid response strategies."

A recording of the symposium can be found at https://www.youtube.com/watch?v=ryxcdCX4Nuo.

Adapting Restoration for a Changing Climate

Adapting Restoration for a Changing Climate is a two-day symposium taking place on February 2-3, 2022, which will explore how restoration projects are currently integrating immediate and long-term climate change considerations into their planning and implementation in the San Francisco Bay-Delta and beyond. Sessions will focus on implementation and science at the project level and the social and political dimensions that shape projects. Talks, panels, and interactive discussions will explore the planning, implementation, funding, permitting, collaboration, and communication strategies for climate-adaptive restoration and will emphasize the importance of long-term resilience in the face of uncertainty. Registration is now open at https://us06web.zoom.us/webinar/register/WN_Z--e2DgOT7W5EvLOQTDuLA.

Delta Science Tracker Update

The Delta Science Tracker is a tool under development by Delta Science Program staff that is envisioned to improve coordination and collaboration within the Delta science community by gathering, organizing, and categorizing critical information about science activities in a way that is valuable to scientists, decision-makers, and managers in the Delta. Science activities included in the Tracker include recent research and monitoring efforts being implemented by a myriad of state, federal, and private research groups. The pilot website is currently under review, and a public release is tentatively expected in April 2022.

Social Science Community of Practice Meeting

The social science integration efforts at the Council continue to grow. There is a new social science webpage (https://deltacouncil.ca.gov/social-science) on the Council website that highlights ongoing efforts, including our work to build a Bay-Delta Social Science Community of Practice (CoP). Check out the CoP webpage to see active members and the community's objectives (https://deltacouncil.ca.gov/bay-delta-social-science-community-of-practice).

The CoP includes social science researchers, agency scientists, and practitioners interested in building knowledge on the social, political, and cultural dynamics of the Delta as a social-ecological system. We hosted the steering committee meeting for the community on January 18, 2022, in which we met with the U.S. Department of Interior (DOI) to learn about their effort to build a Social-Behavioral-Economic science community of practice of their own to connect social scientists across federal agencies within the DOI and discuss collaboration opportunities. The

Steering Committee also set goals for convening the network in 2022 and data synthesis or new research efforts the community members may initiate in the upcoming year.

Delta Lead Scientist "Ask-Me-Anything" (AMA) Series

On December 20, the Science Program's Senior Environmental Scientist Rachael Klopfenstein co-hosted the Delta Lead Scientist AMA session. The discussion focused on the need for and role of the Science Action Agenda, the process involved in developing the 2022-2026 edition, and the science priorities contained therein. Archives of the December and previous AMA sessions can be found on the @deltastewardshipcouncil Instagram account.

The next AMA will take place on Instagram Live on January 31 at noon. Co-hosted by the Science Program's Dr. Sam Bashevkin, senior environmental scientist, and Pascale Goertler, senior environmental specialist, the session will focus on recent and ongoing science synthesis activities. Synthesis is an approach to unlocking a big-picture understanding of the Delta hidden among many types of data. It requires bringing together different datasets and performing analyses that reveal how different components of the Delta both control and respond to many, simultaneously changing factors. Often overlooked and underfunded, synthesis activities have the potential to address some of the most critical science gaps underlying management needs in the Delta. Join the session with Dr. Bashevkin and Dr. Larsen to ask your pressing questions about this core function of the Delta Science Program.

ON YOUR RADAR

Delta Science Fellows

The Delta Science Program and California Sea Grant are releasing a request for applications for the 2022 class of Delta Science Fellows at the end of January 2022. Delta Science Fellowship awards provide Masters and Ph.D. students, along with postdoctoral researchers, with up to two years of research funding. This program pairs the next generation of Delta scientists with academic and community mentors to conduct critical science investigations targeting high-priority Delta issues identified in the 2022-2026 Science Action Agenda (SAA). New this year is an increased emphasis on recruiting social science applicants, supported by separate review panels for social science and biophysical science applications. Applications

are due in April 2022, awards will be announced in June, and fellows will begin work in August/September 2022.

BY THE NUMBERS

Delta Science Program staff will provide a summary of current numbers related to Delta water and environmental management. The summary (Attachment 1) will inform the Council of recent counts, measurements, and monitoring figures driving water and environmental management issues.

LIST OF ATTACHMENTS

Attachment 1: By the Numbers Summary (provided at the Council Meeting)

Attachment 2: Visual Abstract of Article Summary 1

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