

# Using Rice Fields as Managed Floodplains to Help Recover Fish Populations

**Project No.:** STEWCROP14

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## A. Summary

There is growing recognition that availability of floodplain habitats during crucial periods might be key for juvenile salmon in California. In 2020, we collaborated with River Garden Farms to successfully study 9000 juvenile salmon out-planted to experimental rice fields. Receiving fields were prepared in a variety of ways. Preliminary results suggest overall survivorship of salmon in the agricultural fields was high (~80% on average). No differences were observed in growth or survivorship among field preparation methods; thus preparations by growers for salmon can be relatively simple and highly effective. Rice-reared fish grew substantially faster than lab-reared fish. Tracking studies indicated that, following release into the river, close to 5% of rice-reared salmon survived to the Pacific Ocean. In contrast, <1% of our control (lab-reared fish) reached ocean entry, consistent with previous work on juvenile salmon during drought conditions. These results provide the first empirical evidence that rearing salmon on agricultural fields has the potential to boost populations in California. Further work is needed to study the same dynamics across more farms, through time, and to scale the conservation practice more generally.

## B. Objectives

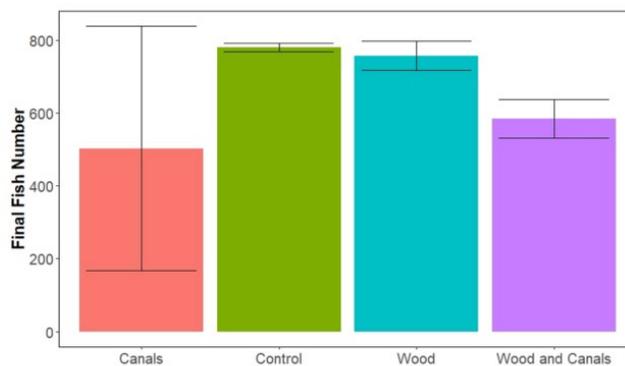
1. Receive, grow, and implant 450 juvenile Chinook salmon with JSAT tags in a rice field. Subsequently track outmigration routes and survival (2019 and 2020).  
**>UC Davis successfully led and completed this objective. A manuscript for a PhD dissertation is being developed with these data.**
2. Bench test methods for growing, marking, and volitionally releasing salmon in rice fields (2019-2021).  
**>UC Davis successfully led and completed this objective. A separate manuscript (independent from 1) is being developed with these data.**
3. Develop partnerships and technical advisory groups with fish managements agencies, agricultural interests, NGOs, and other resource management groups (2019-2021).  
**>Project partner Paul Buttner with the California Rice Commission led this objective. We assembled a technical working group for this project and met**

annually in 2019 and 2020. In addition, we participated in at least 10 meetings with the California Department of Fish and Wildlife provided their staff regular updates on our work. Finally, we met regularly with various agricultural groups, companies and project sponsors.

4. Train a graduate student at UC Davis on this work.  
>**Rachelle Tallman completed two years of PhD training on this project and will be using data from this grant for 2/3 of her dissertation chapters. Rachelle continues to make outstanding progress towards her degree at UC Davis.**

### C. Annual Results and Discussion

Final results from this year's work are pending; however preliminary analysis revealed survival of salmon in rice fields was quite high (>80%) and did not vary substantially by treatment type. One field on the edge of our plot matrix had substantially higher mortality, presumably from a set of resident egrets that were captured on field cameras.



Plots 1-8  
F Value: 0.618  
P-Value: 0.639

*Fig. 1. Average survival trends for juvenile salmon stocked into each of four replicate field preparation treatments. Statistical analysis revealed no significant differences in survival across the treatment types.*

Salmon reared in rice fields grew exceptionally fast, reaching taggable size in only 3-4 weeks. Preliminary tracking results are also encouraging with ~5% of tagged rice fish reaching ocean entry; expectation for survival in water years like 2020 (i.e., drought years) is 0-3%. This study posted high survival numbers compared to >10 other concurrent telemetry projects in the region. Additional tracking analytics available here: <https://bit.ly/30O1Aw3>

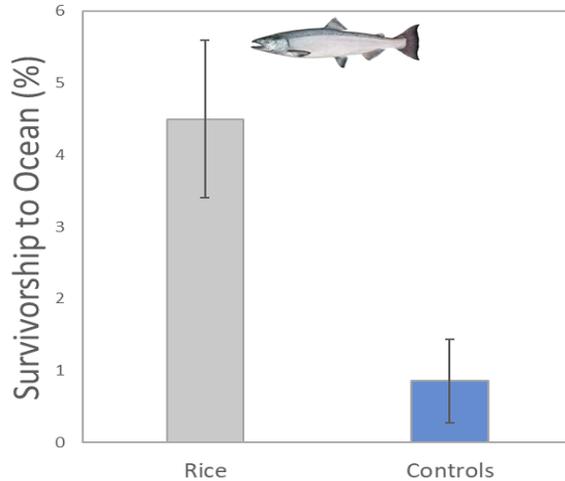


Fig. 2. Patterns in outmigration survival for juvenile Chinook salmon reared in rice fields relative to fish reared under laboratory conditions. Error bars represent the mean of confidence intervals from a point Bayesian survival model as reported in the tracking analytics webpage above.

Based on this work, we have developed a new NRCS practice standard to encourage growers in the Sacramento to engage in salmon conservation activities using their winter-flooded fields. This document is available upon request, and has been provisionally submitted to NRCS for consideration. We are currently seeking a new block of funding from NRCS to “practice the practice standard” during 2022-2026. Part of this work will involve attempting to replicate promising telemetry results reported in Fig. 2.

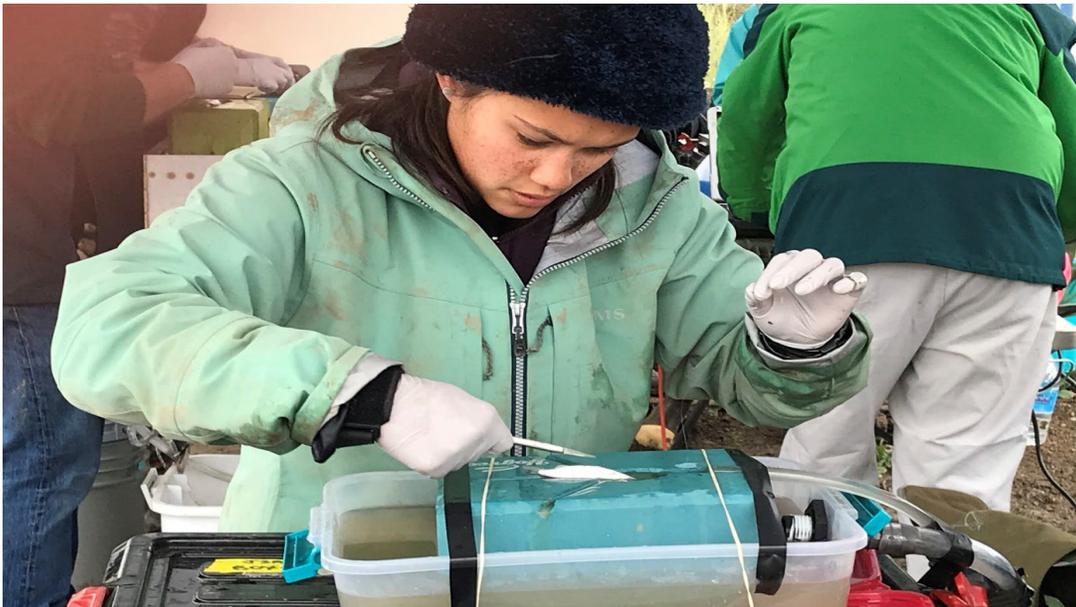


Fig. 3. Rachelle Tallman performing fish surgeries to install JSAT telemetry tags into rice-reared fish at River Garden Farms, March 2019.

Finally, we are currently planning to leverage preliminary (and future) telemetry results from Fig. 2 as input into an existing population model for Chinook salmon in the Central Valley. This activity will focus on asking: Assuming survival results are generalizable,

how much acreage and fish enrolled in the NRCS program would it take to turn the Central Valley salmon population from a declining to a growing population?

## D. Outreach Activities

This work is being conducted in close collaboration with the California Rice Commission as part of a grant from USDA NRCS. Our data has already been used to develop a draft practice standard for growers to help raise salmon in agricultural fields in the Central Valley. Growers are directly involved in our project, specifically to test and refine field management and provide salmon the ability to exit fields naturally.

Project partner Paul Buttner with the California Rice Commission has led and executed a large amount of outreach activities. We assembled and held a technical working group for this project (composed of ~25 representatives from resource management agencies, NGOs, farm partners and universities) and met annually in 2019 (in Sacramento) and 2020 (virtual). In addition, we participated in at least 10 meetings with the California Department of Fish and Wildlife (at CDFW offices or the Cal Rice office) and provided their staff regular updates on our work. Finally, we met regularly with various agricultural groups, companies and project sponsors on an as needed basis.

## E. Materials and Methods

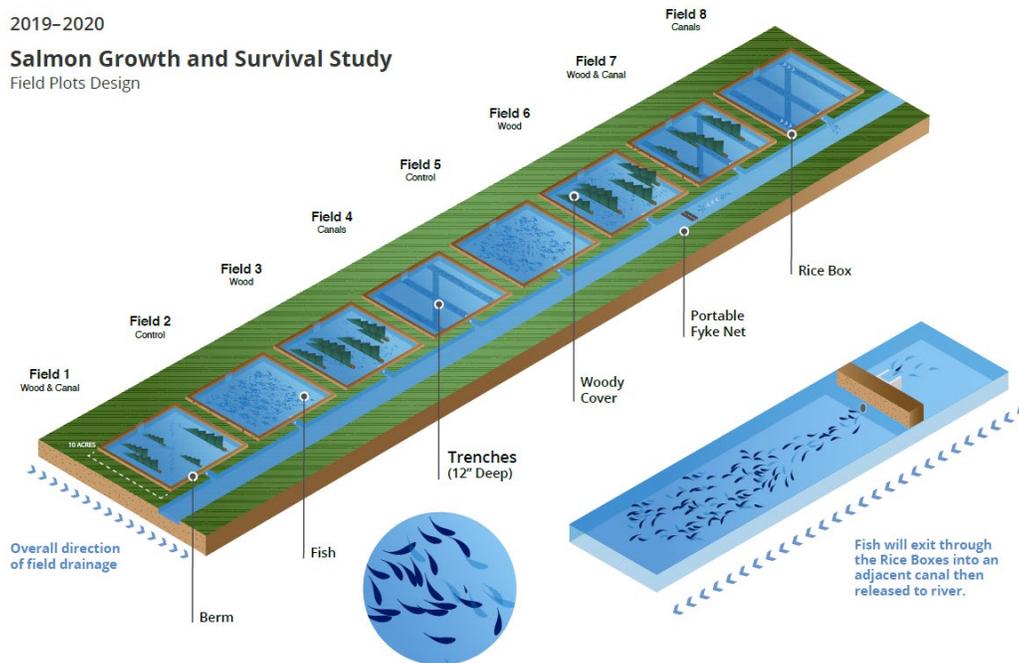




Fig. 4. Schematic design (top) and aerial photo (bottom) of experimental fields built and used at River Garden Farms, 2019-2020.

We developed a study aimed at understanding how preparation of rice fields by California growers could contribute to survival and local production of juvenile salmon. 9000 juvenile salmon were stocked into eight replicate 0.5-acre fields prepared with in the following ways (installation of ditches, installation of wood, installation of ditches + wood, and control plots, see Figs. 1 and 4). We monitored survival of salmon over a 3-4 week rearing period using mark-recapture techniques involving PIT tags. Fields were drained in mid-March and PIT tags used to examine volitional egress of salmon through rice boxes. In addition, we performed surgeries on 450 rice-reared salmon using JSATS tags and released these fish into the Sacramento River. An additional 450 lab-reared fish were tagged and released as controls in early June upon reaching taggable size.

#### **F. Publications that emerged from this work**

Holmes, E.J., P. Saffarinia, A.L. Rypel, M.N. Bell-Tilcock, J.V. Katz, and C.A. Jeffres. 2020. Reconciling fish and farms: Methods for managing California rice fields as salmon habitat. In Revision at PLoS One. BioRxiv Preprint available at <https://doi.org/10.1101/2020.08.03.234062>