LONE TREE CREEK AND POCKET ESTUARY RESTORATION: PROGRESS REPORT FOR 2004-2008 FISH MONITORING

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INTRODUCTION

The primary objective for the Lone Tree Creek and Lagoon Pocket Estuary project is to increase the size and ecological capacity of the Lone Tree pocket estuary by restoring: (1) tidal hydrology to the historic drowned channel part of the lagoon and (2) freshwater hydrology and sediment dynamics (transport and deposition) in Lone Tree Creek. The plan to restore tidal hydrology to the upper wetland of Lone Tree Lagoon was primarily to remove an undersized, perched culvert and replace it with a bridge, thus increasing the tidally influenced area of the lagoon (Figure 1). This restoration work was completed in September 2006 by the Swinomish Indian Tribal Community and its partners, creating a drowned channel estuary approximately 1246 square meters in size at mean high tide. The drowned channel estuary is shown in Figure 2 as a dark pink polygon.

In the wetland area upstream of the culvert we hypothesized the following immediate (i.e., within one year after the culvert is removed) responses to restoration:

Hypothesis 1 - Tidal prism will increase above the culvert.
Hypothesis 2 – Estuarine mixing above the culvert will increase.
Hypothesis 3 - The fish community above the culvert will change from a sparse-to-absent freshwater community into a more abundant and diverse community dominated by estuarine species.

This report describes results for monitoring sites upstream of the culvert for three years prior to the restoration project being completed in September of 2006 (pre-project) and two years of monitoring afterward (post-project).

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Figure 1. In September 2006, a culvert was replaced and a bridge was installed. The before and after restoration pictures above were taken at low tide.

Figure 2. Location of new bridge (and culvert removal site), restored drowned channel wetland, and fish monitoring and tidal water surface elevation gage sites. Numbered spots mark electrofishing reaches.

TIDAL INFLUENCE

Water surface elevation in the drowned channel area of Lone Tree Lagoon is influenced by tides flowing from Skagit Bay into Lone Tree Lagoon. We measured relative water surface elevation in the lagoon downstream of the culvert site and upstream of the culvert site at high tide on days we set fyke traps.

Removal of the culvert and road fill has increased tidal influence to the drowned channel wetland. Water surface elevation increased after removal of the culvert and road fill by approximately 20 cm at high tide (Figure 3). Prior to removal of the culvert, water in the historic drowned channel was not influenced by the tide and was primarily creek water impounded by the elevation of the culvert on the smaller high tides (<120 cm on the lagoon gage).

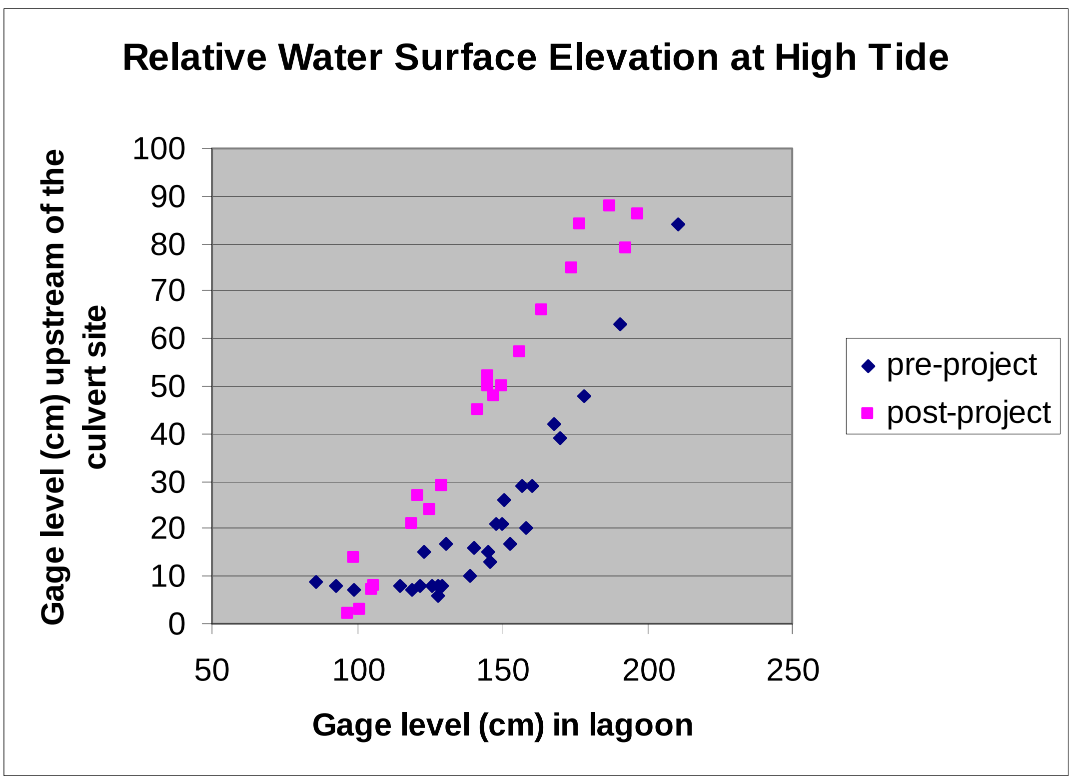

Figure 3. Relationship between high tide level downstream of the culvert (lagoon gage) and upstream of the culvert before and after restoration.

SALINITY INFLUENCE

Salinity in the drowned channel area of the lagoon is influenced by (1) tides bringing saline water into Lone Tree Lagoon from Skagit Bay and (2) freshwater flow from Lone Tree Creek directly draining into the drowned channel. Skagit Bay salinity fluctuates due to varying flow rates of the Skagit River, which empties into Skagit Bay. For this progress report we do not have the daily flow rates of Lone Tree Creek so we can not fully evaluate the effects of culvert removal on estuary mixing in the restored drowned channel wetland.

High tide within Lone Tree Lagoon alone does not correlate with salinity within the drowned channel area of the lagoon (Figure 4). We might have expected higher tides in the lagoon (and increased tidal influence post-project) to result in higher salinities within the drowned channel wetland. However, average salinity pre- and post-project were not significantly different in a T-test; Figure 4 shows no correlation with high tide level. Average salinity at high tide in the drowned channel area of the lagoon upstream of the culvert site was 18.0 ppt prior to culvert removal and 18.2 ppt after culvert removal. These results may be confounded by difference in Lone Tree Creek flow for pre- and post-project periods or sampling days within each period. The final monitoring report will include effects of Lone Tree Creek flow on estuarine mixing of the drowned channel wetland.

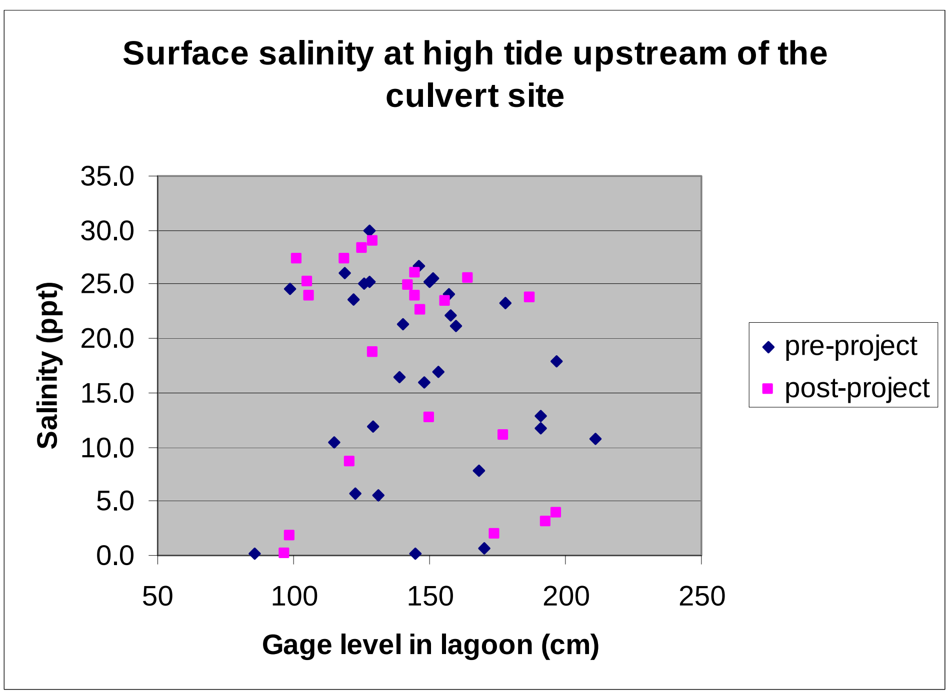

Figure 4. Relationship between high tide elevation in Lone Tree Lagoon (x-axis) and salinity at high tide upstream of the culvert site within the drowned channel (y-axis).

FISH USE IN THE DROWNED CHANNEL ESTUARY WETLAND UPSTREAM OF THE CULVERT SITE

In order to assess fish using the tidally influenced area impacted by the restoration project, we fyke trapped the area immediately downstream of the road culvert/bridge between January 2004 and October 2008. Fyke trap sampling was generally twice per month January through May, then monthly from June through October. We used standard methods described in Appendix D.I of Beamer et al. (2005). The focus of our sampling time period and frequency was to capture the juvenile salmon rearing period, which is in late winter through spring for pocket estuaries in Skagit Bay (Beamer et al. 2003).

Over the entire period (2004 through 2008), we caught 3,866 fish at the upper Lone Tree Lagoon fyke trap. Five species (Chinook salmon, chum salmon, Pacific staghorn sculpin, threespined stickleback, and shiner perch) made up 98% of the entire catch. The salmon caught were all unmarked (wild) juveniles. Figures 5 and 6 show the seasonal curves of these species for each year by month (note differing y-axis scales for some years). For this progress report we did not adjust the fish catch by trap recovery efficiency because mark and capture tests show efficiency is high and did not vary much between the pre- (75.6%) and post-project (67.9%) periods. Adjusting results for trap efficiency will slightly increase estimated fish abundance estimates for the post-project period when compared to the pre-project period.

For each of the five species except stickleback, there was a strong increase in average catch after the culvert was removed and replaced by the bridge. Juvenile Chinook salmon had a 2.4-fold increase in unadjusted catch; chum salmon a 217.9-fold increase; staghorn sculpin a 45.8-fold increase; and shiner perch a 48.2-fold increase. All four of these species are coming to the drowned channel wetland from areas downstream (either from Lone Tree Lagoon, Skagit nearshore, or – in the case of the juvenile salmon – the Skagit River), so we conclude that removing the culvert has indeed supported Hypothesis 3 (a more abundant and diverse fish community dominated by estuarine species). Stickleback are tolerant of varying habitat conditions and can live in fresh, brackish, or marine waters. It is not surprising there was not a change in stickleback results pre- and post-project.

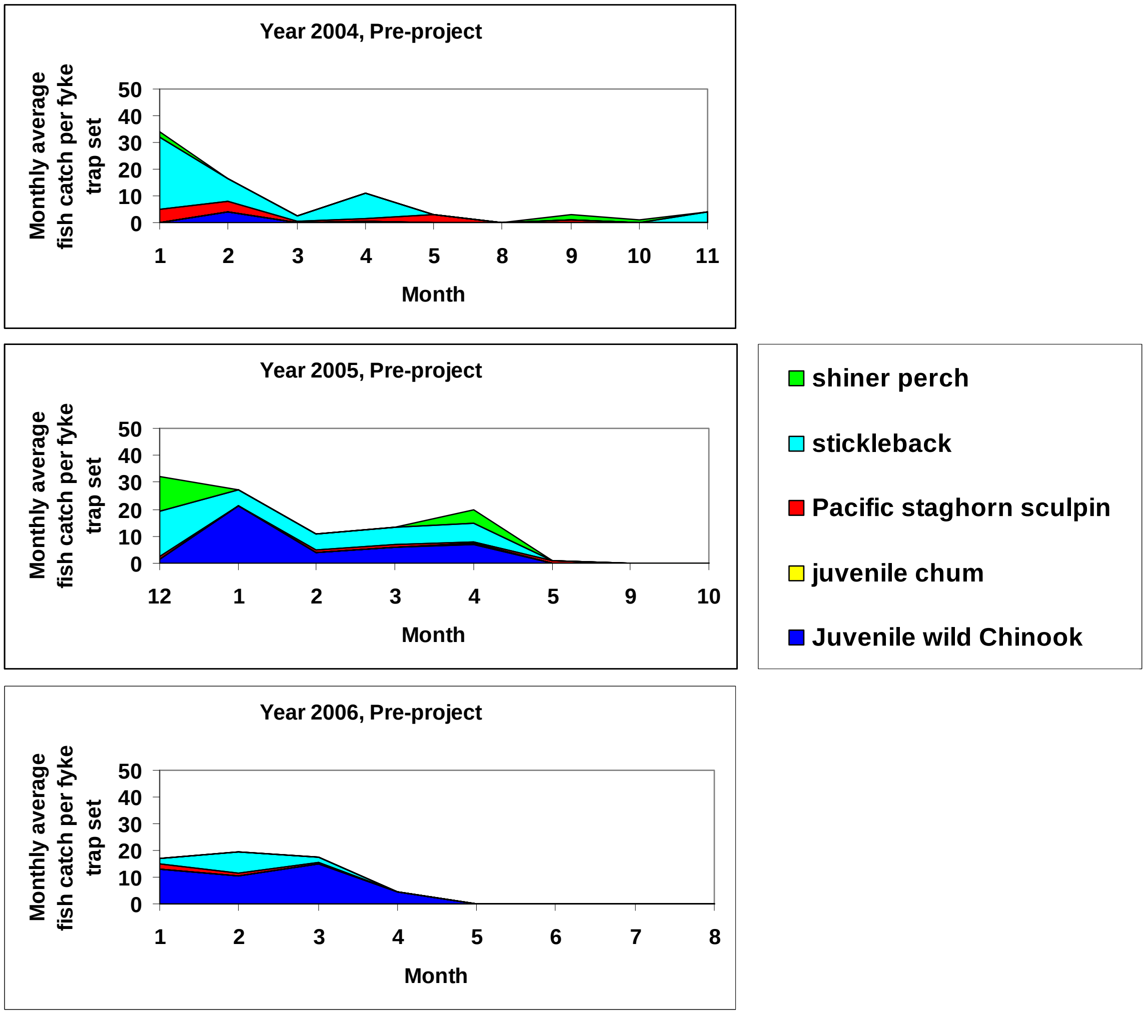

Figure 5. Annual pre-project monitoring results of the fish assemblage for the historic drowned channel lagoon area.

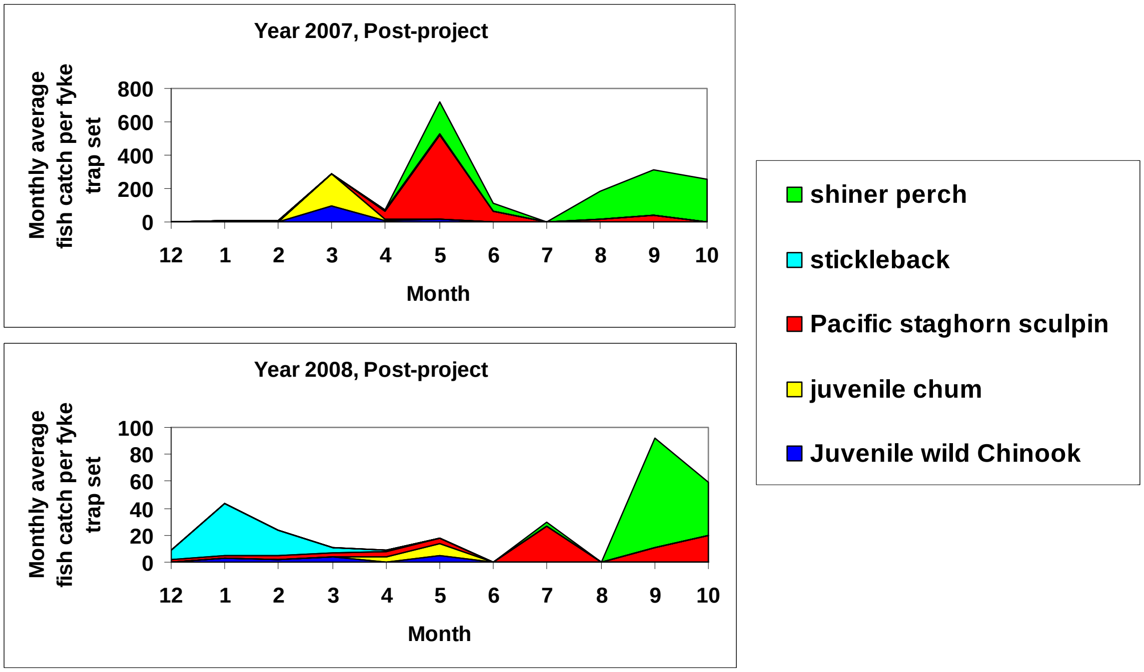

Figure 6. Annual post-project monitoring results of the fish assemblage for the restored drowned channel lagoon area.

FISH USE IN LONE TREE CREEK

Lone Tree creek flows into the drowned channel lagoon area immediately upstream of the culvert removal site. We used electrofishing methods to assess fish use of the creek pre- and post-project. The creek was divided into reaches numbered 2 through 6 (Figure 2).

We electrofished each reach in January and February of 2004 and 2006, prior to the culvert removal. We electrofished each reach monthly after culvert removal from December 2006 through May 2007 and from January through July of 2008. During this time we caught 2,826 fish. Three species (Chinook salmon, coho salmon, and threespined stickleback) made up 97% of the entire catch. We show average fish per minute results for these three species, by reach, in Figure 7.

Following removal of the culvert, we found a strong increase in the relative abundance and an extended distribution of juvenile Chinook salmon. This coincides with restoration within Lone Tree Creek itself, which was designed to improve both in-channel and riparian conditions, as well as fish passage. Prior to restoration, juvenile Chinook salmon were only found up to reach 2 of the creek (top graph, Figure 7). After restoration, juvenile Chinook were consistently present up through reach 3 of the creek (middle graph, Figure 7). The range of juvenile coho was also extended after restoration. Coho were found through reach 4 prior to restoration and afterwards they were present up to reach 6. There was no change in the range of stickleback pre- or post-restoration (bottom graph, Figure 7).

For two of these three fish species there was a strong increase in average catch (fish per minute) after restoration. Juvenile Chinook salmon had a 49.0-fold increase in relative abundance for all reaches combined. Juvenile coho salmon had a 3.6-fold increase in relative abundance for all reaches combined. Stickleback had essentially no change, with only a 1.2-fold increase in abundance after restoration.

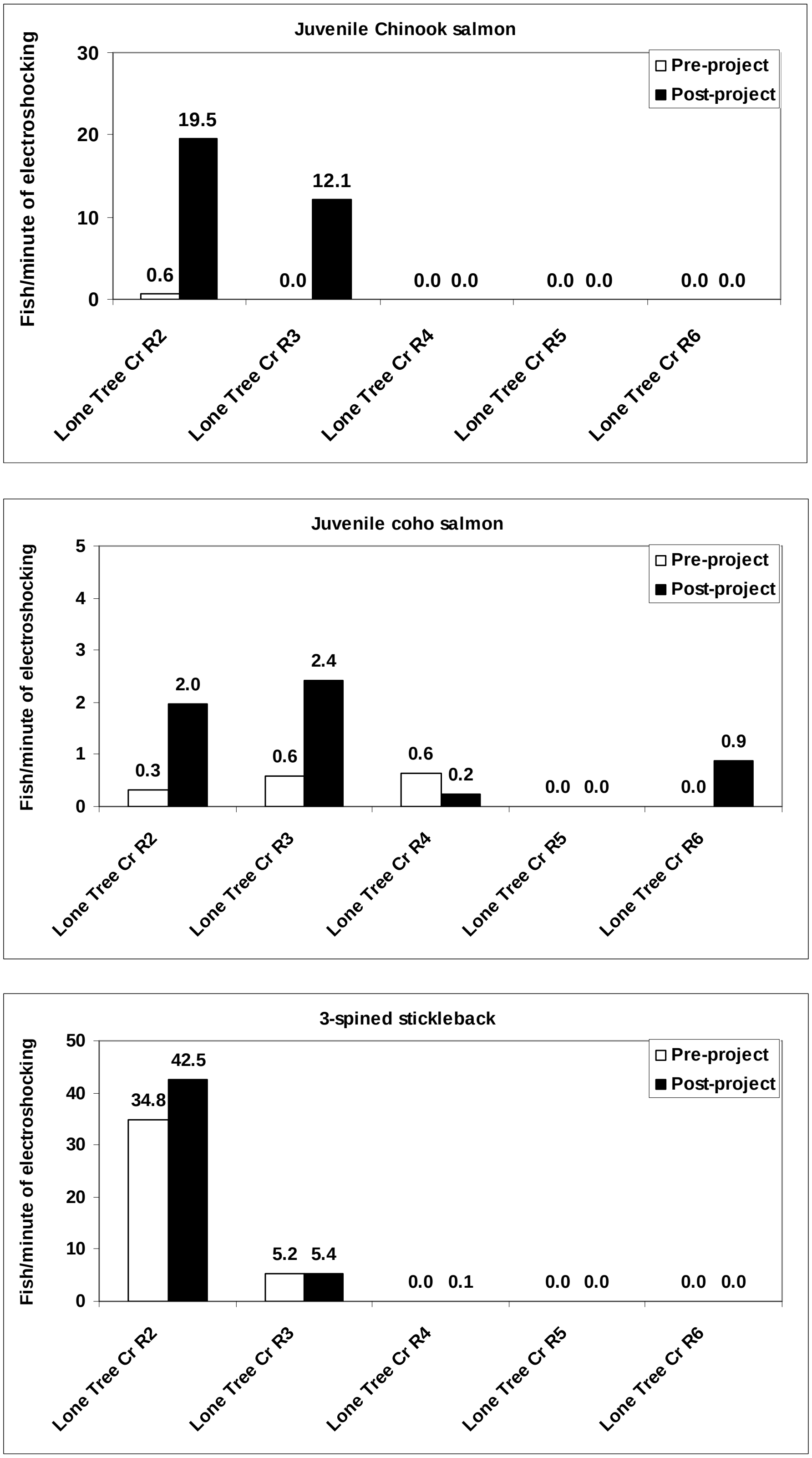

Figure 7. Average fish per minute results from electrofishing for juvenile Chinook salmon, coho salmon, and stickleback in stream reaches of Lone Tree Creek. Results are summarized by pre- and post-project years.

Fry migrant Chinook salmon and the potential of pocket estuaries providing a low salinity refuge

Juvenile Chinook salmon are over 100 times and 10 times more abundant in pocket estuary habitat around Skagit Bay than in adjacent offshore or nearshore habitat, respectively, during the period from February through May (Beamer et al. 2003). Together, the Lone Tree Lagoon and its associated drowned channel wetland comprise the Lone Tree pocket estuary. After restoration, Lone Tree Creek is well connected to the lagoon and electrofishing results show juvenile salmon access has been improved (Figure 7). All of the juvenile Chinook salmon captured in this study are fry-sized and appear to arrive within the study area early in the year (Figures 3 and 4). These fish exhibit a fry migrant life history type, and their presence could be a response to the carrying capacity of the Skagit River delta estuary being exceeded, and/or a result of premature migration to nearshore areas due to high flow events (Beamer et al 2005).

We compared sampling results between juvenile Chinook present in the restored Lone Tree Creek reaches to Chinook salmon results in the drowned channel wetland (Figures 5-7). We found that both areas had an increase in Chinook salmon abundance after restoration, but that the creek had a much higher increase than the drowned channel. The creek channel is completely freshwater (when flowing), while the drowned channel wetland has salinities varying from 0.1 to 30 ppt, depending on tides and on Lone Tree Creek flow rates (Figure 4).

These results demonstrate that fry-sized Chinook salmon, when given an opportunity, not only colonize newly available habitat of a diverse nature (e.g., drowned channel wetland, small seasonal creek), but they appear to redistribute in habitats with the lowest salinity within the entire pocket estuary complex. In the Lone Tree complex, this consists of at least three parts: lagoon, drowned channel wetland, and creek. These results suggest that pocket estuaries that include a small seasonal stream component may provide a significant function to fry migrant juvenile Chinook salmon as a low salinity refuge during their transition from fresh to saltwater residency.

REFERENCES

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