Alaska Sustainable Salmon Fund
March 2013 Completion Report

Title:	Headwater Stream Rearing Habitat - Phase 1
Number:	44507
Project Period:	5/1/2010 - 12/31/2012
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Preliminary Synopsis:
Headwater streams provide important habitat for juvenile salmon on the lower Kenai Peninsula though their importance is often overlooked. Using improved remote imaging technology, this project will develop tools to better identify important headwater streams and the landscape features that contribute to differences in headwater stream habitat. The project will also measure the ability of alder patches in the watershed to contribute nitrogen-rich nutrients that support aquatic life.

Final Synopsis:
This project modeled the effects of catchment-scale topography and wetlands geomorphic classes on stream physical habitat, chemistry, and macroinvertebrate and fish communities in headwater streams across the Kenai Lowlands. Juvenile coho salmon and Dolly Varden trout were collected in 27 and 48 of the 53 streams, and reached densities of >500 and 1300/km, respectively. Flow-weighted slope, determined through GIS analysis of LiDAR data, is an indicator of water residence time and gradient and was the best catchment-scale correlate of macroinvertebrate and fish community structure. At the reach scale, the effect was mediated by wetlands geomorphic classes and numerous water chemistry, substrate composition, and channel geomorphology variables. Juvenile salmonids were segregated among streams by both species and age classes. Predictive modeling indicated that all of the 547 km of headwater streams in the study area might serve as potential habitat for at least one species and age class of salmonids. We mapped alder cover in the 400 headwater stream watersheds across the Kenai Lowlands and modeled the effect of alder cover and other watershed physiographic variables on stream N over the growing season among 25 first-order streams from the study area. We identified a strong linkage between alder and stream N, coupled with the concurrent timing of maximum stream N from alder in the spring, to salmon fry emergence indicating the potential importance of this subsidy to headwater stream ecosystems. Our study should assist in development of catchment management tools for identifying and prioritizing conservation efforts in the region and may serve as a framework for other studies concerning biodiversity and focal species conservation in headwater streams.

Project Activities and Results:
Objective: Validate with additional field sampling and use new LiDAR data to refine the topographic-wetness index model for predicting headwater stream physical and biologic characteristics

The original model was based on a flow-weighted slope approach that incorporated GIS metrics derived from 60 meter digital elevation models and field data collected in 2006 and 2008. With the newly available LiDAR we were able, in 2010, to develop flowpath grids at a resolution of 5 meters for all of the watersheds. This data set was then used to select potential sites to sample for our validation study. In 2011, we attempted to access 44 validation sites spread across a range of model predictions. We were able to successfully sample 24 of those sites (20 sites were not sampled due to difficult access, such as logging roads decommissioned, and/or a lack of flow in the streams.) The sites that were successfully sampled represented a sufficient range of model values to permit validation of the model, which was accomplished through statistical comparison of the newly sampled sites with data from the original studies. This analysis revealed that there

was no year effect, so the data sets were pooled and the models were refit using more variables. The advantage of the new analysis using the LiDAR, is that it gave us good estimates of fine-scale reach slope, in addition to the broader context landscape slopes. Adding reach slope explained variance that flow-weighted slope didn't, and vice versa. Additionally, distance to third order streams was important for coho and dolly fry, suggesting spawning migration limitation, and distance to the ocean was important for the big pre-smolting cohos.

Objective: Quantify the relationship of alders at the landscape scale as nitrogen sources that maintain wetland and stream productivity

In 2010 and 2011, we completed work to investigate this hypothesis, including digitizing a map of all alder patches in the study area; analyzing water samples collected from 25 headwater stream watersheds, spanning a range of alder cover over a seasonal timeframe; conducting fertilization experiments of riparian vegetation and instream periphyton to understand effects of nitrogen from surrounding alder patches; and collecting flowpath data from groundwater wells to understand delivery of nitrogen from the surrounding landscape to the stream at nine headwater stream reaches. From these efforts we learned that at the larger landscape scale, stream nitrate levels appear to be primarily controlled by the amount of alder on the watershed. We interpret this relationship to be primarily driven by groundwater connectivity between upland habitats and headwater streams. Results of this study also demonstrate that the distance that alder patches are from streamside wetlands along flow paths is an important component of the productivity of the wetlands which, in turn, have been shown to be linked to foodwebs in the headwater streams including juvenile salmon. The results of our studies at differing scales demonstrate that factors at the larger landscape scale (e.g., slopes of the watersheds, amount of alder on the watershed) and the characteristics of habitats near the headwater streams (e.g., density of flow paths and the presence or absence of alder along the flow paths) are both important factors in controlling the productivity and biodiversity of headwater streams in the Kenai Lowlands.

Objective: Use the information obtained in Objectives 1-2 to attribute existing publically-available Geographic information System (GIS) databases, specifically the Kenai Lowlands Wetland Management Tool

This study has resulted in two novel GIS products that are available to the public: (1) percent alder cover in each of the 400 headwater stream watersheds of the study area, and (2) the flow-weighted slope model for predicting juvenile salmonid in headwater streams. These products are publically available, and have been uploaded onto the Kenai Lowlands Wetland Management Tool database.

Product Dissemination:
We are actively disseminating the results of this work to various decision-maker groups, including tribal corporation landowners, non profit organizations, agency land managers, and regulatory agents. So far, the results of this work have been presented at the Kenai Peninsula Borough Assembly Riparian Task Force, the American Fisheries Society Alaska Chapter meetings, to a group of 19 decision-makers at the Kenai Watershed Forum, and a Conservation Action Planning workshop for the Kenai Peninsula. Meetings are currently planned for spring of 2013 to disseminate results to the Ninilchik Tribal Council, Cook Inlet Region Incorporated, Alaska Department of Fish and Game, Alaska Department of Natural Resources, The Nature Conservancy, the Kachemak Heritage Land Trust, and other organizations and consulting firms.

Reports and Other Products:
Posters: Hiatt, D.L., P. K. Kostka, R. Doyle, C.M. Walker, D.F. Whigham, and R.S. King. 2012. Influence of catchment alder cover on periphytonenzme activity in south-central Alaska headwater streams. Poster presentation at the Society for Freshwater Sciences. Papers: Three manuscripts are being drafted for submission to peer-reviewed journals (Freshwater Science, Landscape Ecology, Wetlands). Final papers will be submitted to AKSSF when published.