The Copper River is the largest point-source of fresh water to the northern Gulf of Alaska, and is an important development environment for many of local pelagic fish. Salmon smolts and other juvenile fishes are known to inhabit the plume, but their feeding patterns are little studied in the region. The influence of the plume biochemistry and physical dynamics creates a non-homogeneous distribution of zooplankton and other forage material, while fluctuations in marine conditions and changes in zooplankton concentrations and fish behavior have been implicated as drivers of fish year-class strength.

We sampled fish and zooplankton across the Copper River plume, and made concurrent measurements of salinity, temperature, and turbidity with an undulating towed vehicle to develop an oceanographic description of the plume. Further description of fish diet was conducted via gut content analysis. Fish catch was highest within the plume and in the plume drift zone. Zooplankton biomass was highest in the plume edge. Fish diet did not correlate with zooplankton abundance, but prey selection was consistent within species, suggesting alternative pressures and preferences in foraging behavior beyond prey abundance. The Copper River Plume is an area of enhanced and extremely variable biological activity on multiple trophic levels, but the driving forces behind the branches of this plume ecosystem remain muddled. 

RESULTS

Station groups were defined by salinity and turbidity profiles (Fig. 4, 7). Inner plume stations had high salinity and low turbidity, while outer plume stations had turbidity levels close to zero and typical salinity levels for the river plume. Outer plume stations had levels somewhere between outer and inner plume stations. (Fig. 4)

Zooplankton samples in all location groups were dominated by small copepods, primarily Oithona spp. and Pseudocalanus spp. (Fig. 5, 6) Zooplankton commonly found in fish gut contents were grouped to display trends between years at the zooplankton forage base. (Fig 6)

Gut content analysis of some common juvenile fish revealed diet selection did not correlate with available zooplankton type or abundance. (Fig. 8) However, several of the most common prey groups (terrestrial insects, fish larva, and harpacticoid copepods) were not accurately sampled via bongo nets. Zooplankton samples may not be representative of the true forage base in each location.

Forage trends between species were distinct. Predatory selection of terrestrial insects, however, could indicate competition in territorially influenced environments. 

CONCLUSIONS

- Zooplankton population trends differ markedly from year to year. The influence of the plume is inconsistent across only two years.
- Juvenile fish make prey selections according to variables beyond basic abundance and availability.
- Fish catch was consistently higher in plume-influenced waters for all species except 2010 stickleback, indicating a plume-related benefit beyond zooplankton abundance.

METHODS

Sampling transects (Fig. 2) were conducted four times over April-July 2010 and seven times over March-August 2011.

At each station, fish were collected with a surface trawl (a 30’W x 25’H x 4’2’L midwater trawl with additional floatation), while zooplankton were sampled via 202µm bongo nets turned from 50m depth (or bottom) to the surface. Salinity, turbidity, and depth were recorded vertically through the water column in conjunction with zooplankton sampling at each station. The CTD equipment also included instruments to measure in situ chlorophyll-a (a proxy for phytoplankton) and turbidity.

Zooplankton were sub-sampled and identified to species. Gut content analysis was used to describe diet selection in a sub-sample of fish stomachs. Samples were compiled and averaged for inner plume, plume drift, and outer plume environments based on CTD profiles. We will use isotopic analysis and otolith measurements to further detail fish trophic interactions.

BACKGROUND

The Copper River drains an area in south-central Alaska that covers 7.3 million hectares. fed by glaciers and snow melt from the Wrangell and Chugach mountains (Fig. 1). As it enters the coastal ocean, the river creates a visual, physical, and bio-geochemical plume in the Gulf of Alaska ecosystem (Fig 2, 3).

The distribution and ecology of the zooplankton and fish that inhabit the region around the Copper River plume are previously undescribed. River output is significantly affected by upstream factors such as glacial melt, which has recently increased due to climate change. Studies on other plume systems have found that juvenile fish can use plumes to take advantage of concentrated zooplankton populations (Peterson and Johnston, 2006), and may use the highly turbulent water to evade predators (Lervings, 1994). Interpreting prey selection may also indicate relationships between fish foraging in the rich but spatially limited plume environment (Purcell and Shumway, 2001).