Feature

ABL Scientists Study Glacier's Threat to Yakutat Fisheries

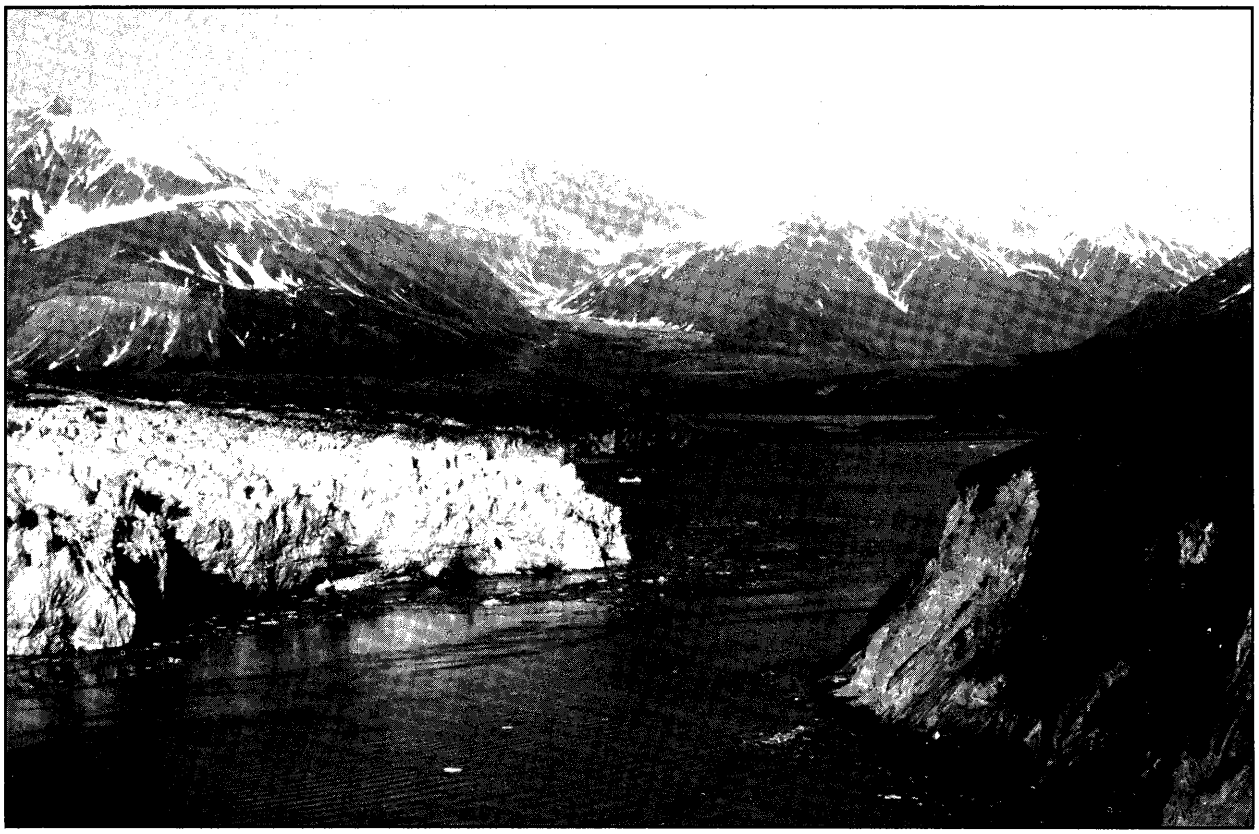

Figure 1. Hubbard Glacier at the mouth of Russell Fiord near Yakutat, Alaska.

When the "galloping" Hubbard Glacier dammed Russell Fiord near Yakutat, Alaska, (Figs. 1 and 2) in May 1986, national attention focused on the spectacular event. By the time the ice dam burst and the fiord drained in October, the trapped water had risen 25 m above sea level and covered 224 km^2. The 1-day outburst from Russell Fiord was one of the greatest water discharges to occur in North America in historic times.

Based on tidewater glacial cycles, glaciologists of the U.S. Geologic Survey predict that the ice dam will rebuild within the next decade and may persist for hundreds of years. Citizens of Yakutat and government officials are concerned about possible impacts the ice dam could have on Yakutat fisheries. Situk River's yearly salmonid production (catch and escapement) is about 180,000 pink, 115,000 sockeye, 50,000 coho, 2,000 chinook, 500 chum, and 5,000 steelhead. If the glacier blocks Russell Fiord as expected, overflow from "Russell Lake" will spill into and flood the Situk River and change it from a clear, spring-fed river to a large, unstable, glacial river laden with silt and debris. As a result, prized salmon commercial fisheries worth $2 million annually, and world-renowned salmon and steelhead sport fisheries worth $1 million annually, will be seriously jeopardized.

The Habitat Investigations Program of the Auke Bay Laboratory (ABL) recently completed a 4-year study to assess probable impacts the flooding will have on fish in the Situk River. The objective of the study was to determine distribution and use of salmonid spawning and rearing habitat in the Situk River basin in relation to the predicted flood zone.

Initial Flood is Greatest Concern

In a cycle typical of tidewater glaciers, the Hubbard and other glaciers from the St. Elias Icefields have repeatedly advanced and retreated over the past 7,000 years, alternately impounding and releasing an enormous lake in the Russell Fiord basin. The last damming of Russell Fiord and flooding of the Situk River, prior to 1986, ended in the mid-1800s. Hydrologists of the U.S. Forest Service (USFS) say that when Russell Fiord is dammed again, the Situk floodwaters will flow down the Old Situk and into the main-stem Situk Rivers (Fig. 2) following old abandoned channels carved by the last overflow.

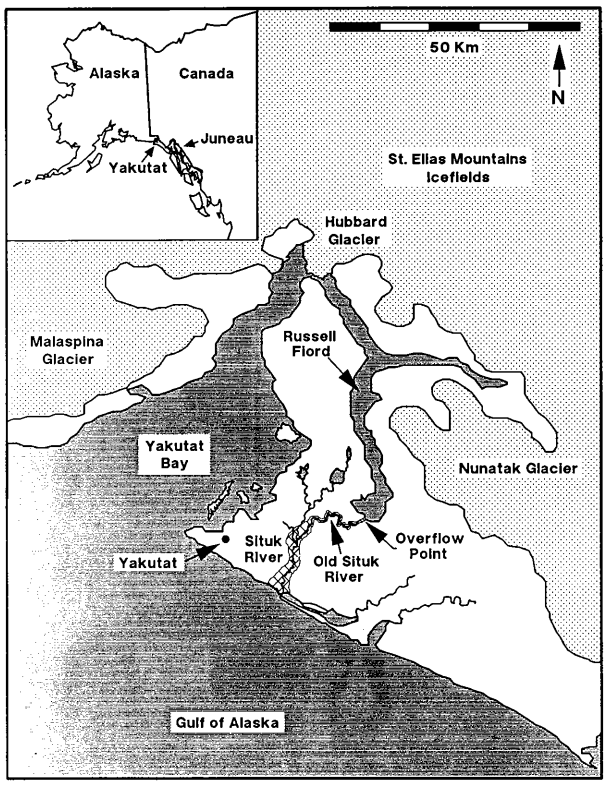

Figure 2. The area around Yakutat showing the zone of predicted flooding (hatched area) along the Situk River when Hubbard Glacier dams Russell Fiord.

The first 3-5 years of flooding from Russell Lake are expected to be the most devastating to the region's fish populations because of the destruction of fish habitat as the new Situk River reclaims its old channel. According to USFS hydrologists, the new river will be 100 times larger than it is today. Its discharge will swell from 6 m^3/s (summer average) to about 600 m^3/s during flooding, exceeding 1,400 m^3/s during peak flows. After the fiord is dammed, the river will widen from 30 m to 2,500 m. Water will be turbid with fine glacial silt and erosion by the flood will add to the river's sediment load. The spruce forest on the flood plain will be destroyed, creating giant log jams that will further intensify flooding. The ice dam may fail and rebuild several times before finally stabilizing, causing extreme oscillations in Situk River flow.

The initial years of flooding will likely devastate habitat and fish in the flood zone. Preferred habitats for rearing salmonids, such as pools with woody debris, will be washed away. Floodwaters will displace fish to river margins and off-channel areas, and sweep many to the ocean. Spawning areas will be inundated or buried in sediment. Habitats will be transient and unstable for several years as the river channel adjusts to the greatly increased flow. When the glacier dam bursts, as it has in the past, many fish will be stranded and die as the river level drops precipitously.

To determine the amount of spawning habitat in the Situk River basin jeopardized by flooding, members of the Habitat Investigations Program tagged and tracked adult salmon returning to the river in 1988. Over 4,500 sockeye and 122 chinook were tagged with Petersen disks, spaghetti tags, or radio transmitters and were tracked during migration and spawning. Results of the survey showed that only a small fraction (%) of adult chinook and sockeye spawned inside the flood zone. Additional spawning surveys showed that 20% of steelhead and 50% of pink salmon spawned inside the flood zone. (Coho and chum were not observed during surveys, but based on their typical spawning habitat, most coho probably spawn outside the flood zone and most chum spawn inside the flood zone.) Thus, spawning habitats, except those for pink and chum salmon, will be mostly spared during the initial years of flooding. Adult salmon and steelhead hold and ripen in large pools in the flood zone during their spawning migration, but adult fish should be

able to find holding areas in the river even during initial flooding.

Juvenile salmonids generally rear in the Situk basin for up to 3 years before going to sea. (Pink and chum go to sea immediately after emergence.) In order to quantify the distribution and use of rearing habitat by juvenile salmonids, Habitat Investigations staff classified the entire Situk River drainage system into stream types based on hydrologic and geomorphic features taken from aerial photographs. Fish populations were estimated in more than 50 randomly selected sites. Expanded population estimates based on total area of each stream type inside and outside the flood zone showed that, overall, about one-half of the juvenile salmonids in the Situk River basin rear in the flood zone in summer (Fig. 3). Sockeye will be the least affected by flooding. Only about 17% of the basin's sockeye rear in the flood zone; 80% rear in lakes in the river's headwaters, far from the flooding. Most (71%) coho, however, rear in the flood zone in summer. Chinook fry initially rear in the river upstream of the flood zone, but nearly all (98%) move downstream and rear inside the flood zone for about a month in summer before going to sea. Steelhead are distributed about equally inside and outside the flood zone. Thus, summer flooding could disrupt rearing for about 50% of the juvenile salmonids in the Situk River basin.

Winter habitat for juvenile salmonids is located mostly outside the flood zone. In fall, many juveniles move to wintering areas from which they migrate the next spring as smolts. Habitat Investigations staff estimated populations that wintered inside and outside the flood zone in 1990 (Fig. 4). Two "screw traps" were fished, one upstream of the flood zone and one at the river mouth. ABL scientists estimated numbers of migrant fish at both locations by mark-recapture methods. Of a total 1.3 million smolts leaving the river, only small percentages (7-19%) of sockeye, coho, and steelhead, and virtually no (1%) chinook were from inside the flood zone. Thus, most salmonids spend the winter outside the flood zone and would be spared from winter flooding.

The chinook and sockeye that rear in the flood zone in summer have unusual life histories for Alaska stocks. Both migrate to sea their first summer (referred to as "age-0" or "sea-type" stocks), whereas most Alaska stocks typically rear in fresh water at least 1 year. Early seaward migration of age-0 fish depends on rapid growth. Both species spend about a month in the lower river where abundant food and warm water produce a growth surge in the fish, enabling their early entry into the sea. Flooding with cold, turbid water could slow their growth and alter their life history.

Forecast for the Situk River

USFS scientists calculate that about 3-5 years after the Hubbard Glacier dam stabilizes, the Situk River should stabilize in the old channels of previous overflows. Once the river stabilizes, fish should begin to recover. The large volume of Russell Lake will diminish fluctuations in flow; hence, peak flows in the Situk River will be less severe than in the glacial rivers that flow into Russell Lake. Turbidity also is expected to be less than in a typical glacial river because coarse sediment will settle in Russell Lake. River temperature will be lower because of the water's glacial source. Thus, the long-term forecast for the Situk River is relatively stable, moderately turbid, colder, and about 100 times larger than today.

In many ways, the future Situk River may resemble the glacial Taku River (Fig. 5) near Juneau. Members of the Habitat Investigations Program have studied this river since 1986 to learn how salmon use habitat in large glacial rivers. Flow of the Taku

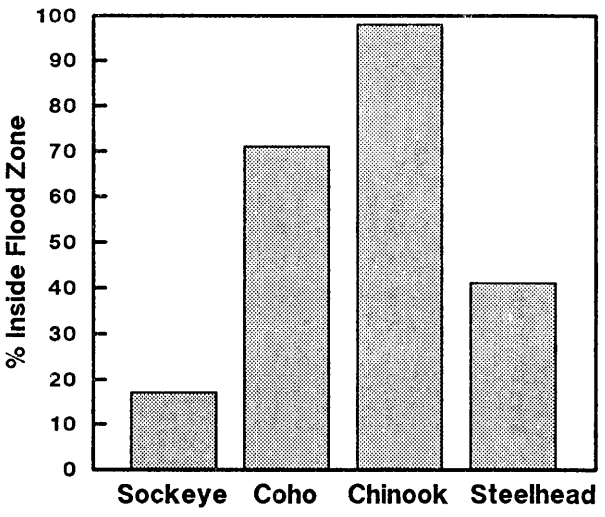

Figure 3. Percentage of the Situk River Basin's juvenile salmonids that rear in the predicted flood zone in summer.

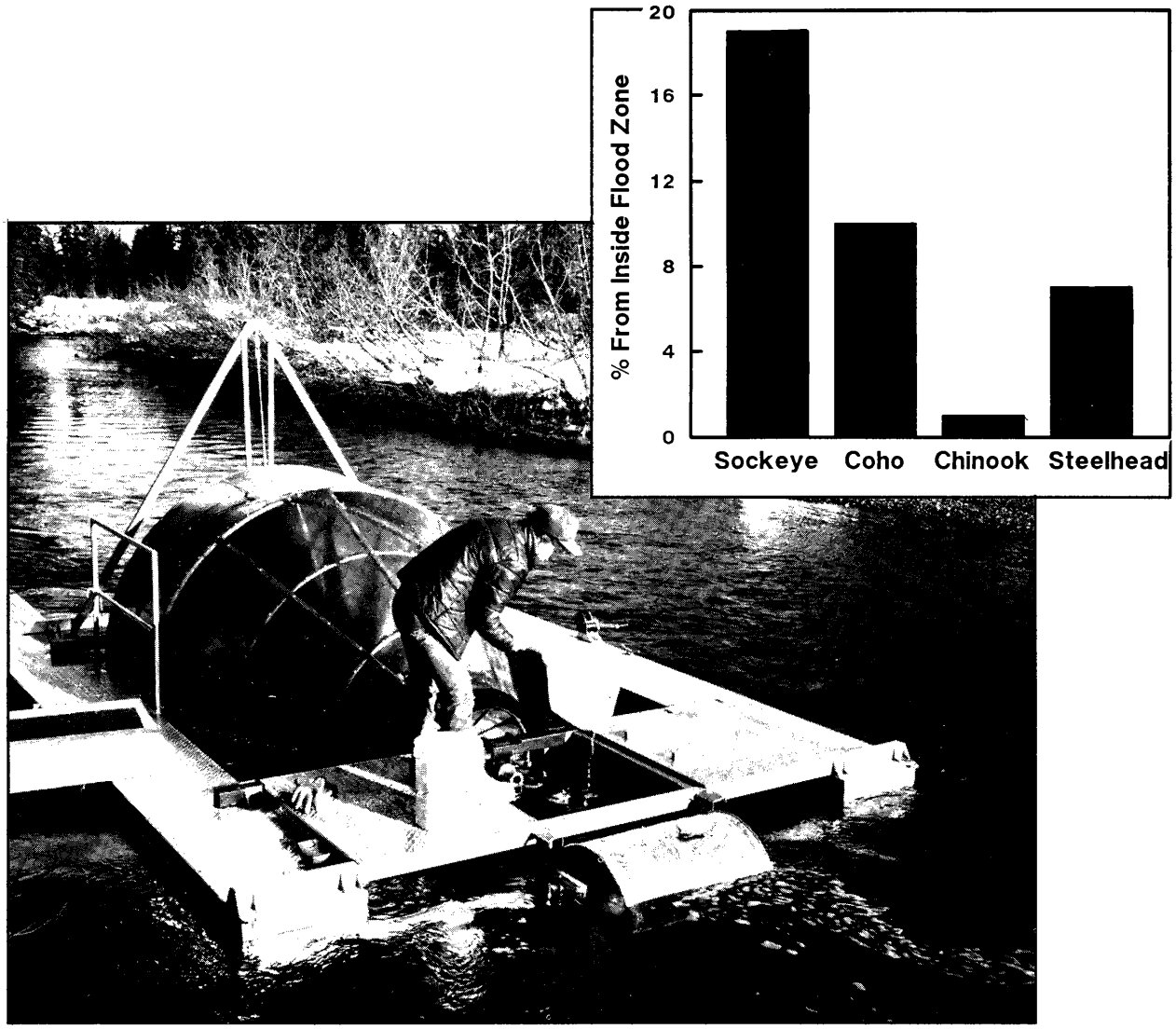

Figure 4. A screw trap used to estimate smolt populations emigrating from areas upstream of the predicted flood zone in the Situk River. The histogram shows the percentage of the Situk River Basin's smolts that emigrated from inside the flood zone.

River in summer (600-1,000 m^3/s) is about the same as the predicted flow of the future Situk River. The Situk should be similar in size to the Taku River but less turbid and more stable because of the attenuating effects of Russell Lake.

Although dominated by glacial runoff, the Taku River provides productive habitat for salmon. Adult sockeye, for example, spawn successfully in highly turbid rivers by selecting areas with upwelling groundwater. Although the main channel of the Taku River is too swift (1 m/s) for juvenile salmon, its channel edges, sloughs, and backwaters support large populations of juvenile chinook and sockeye. Coho do not rear in the turbid river; instead, they concentrate in off-channel wetlands, such as beaver ponds on the river terrace.

Once the Situk River stabilizes, the quantity of habitat will be increased, although its quality may be considerably lessened because of lower temperature and higher turbidity. The Situk River will expand and all of Russell Lake may be accessible for rearing. Lake and off-channel habitats outside the flood zone should continue to produce fish once populations recover from the initial flood. Habitat use in the new Situk River probably will be similar to that in the Taku River: areas with upwelling

Figure 5. The lower Taku River near Juneau, as a model of how the future Situk River may look after flooding from Russell Lake.

groundwater in the river will be critical for spawning; juvenile chinook and sockeye probably will occupy channel edges, backwaters, and sloughs in the river; and juvenile coho may vacate the main channel of the new river, depending on its turbidity.

The unusual life histories of the sea-type sockeye and chinook salmon in the river system may disappear. Because of lower temperature and higher turbidity, the sockeye and chinook probably will grow more slowly and take longer to become smolts. If sea-type sockeye and chinook remain in the river for a year or longer instead of 4-6 months as they do now, survival could decrease because of their longer freshwater residence.

The future of Situk River salmonids is uncertain. The environmental changes and fish population responses that will follow flooding of the Situk River are impossible to predict precisely. Research results from the Habitat Investigations studies indicate that about one-half of the fish in the Situk River basin are at risk and could be lost in the first 3-5 years after flooding. After the initial devastation, the Situk River should stabilize and fish populations should begin to recover. In the long term (possibly hundreds of years), the increased size of the river and availability of new lake habitat could result in more fish for Yakutat fishermen.

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