OVERVIEW

A major goal of restoration in the Situk River watershed after flooding should be to replace or sustain fish stocks and habitat that existed before flooding. Restoration would not have to occur, however, at the same site where fish or habitat was impaired. For example, Canon Beach Creek in the Tawah Creek drainage could be improved to produce more salmon, thus replacing losses in Old Situk River. Restoration strategies are difficult to prioritize because of the magnitude of the potential habitat change from flooding, coupled with the resiliency and adaptability of salmonids. Because of the extensive habitat loss predicted from flooding, large-scale restoration efforts should be directed toward specific stocks or habitats at risk.

The restoration strategies we have identified for replacing fish and habitat in the Situk River assume total loss of all fish inside the flood zone. Undoubtedly, not all juveniles or adults will be lost; some will be displaced to other areas of the river and would still contribute to total production. Because the Situk River will be larger after flooding, more rearing habitat would be available on river margins and secondary flood plain channels. In addition, the creation of Russell Lake would potentially provide a major new rearing and wintering area for juveniles. Thus, creation of new habitat after flooding will partially restore some losses from flooding.

Several "enhancement" projects have been attempted in the Yakutat area since the early 1970s and may serve as guides for restoration. The effectiveness of these projects, however, was never fully evaluated. These projects were reviewed in the Yakutat Comprehensive Salmon Plan (ADF&G 1984) and included conversion of gravel pits to rearing ponds, relocation of stranded fish, enhancement of spawning areas, and woody debris manipulation. Mattson (1976) surveyed potential salmon enhancement sites (e.g., hatcheries) near Yakutat for the Yak-Tat Kwaan Corporation—Roosevelt Creek near Knight Island was the only possible site with sufficient water for a conventional salmon hatchery.

The greatest potential for restoration in the Yakutat area is the development of groundwater sources for spawning channels, rearing ponds, and egg-incubation facilities (e.g., egg boxes). Groundwater channels are inexpensive to construct, can be built with minimal disturbance, and are productive. Successful groundwater spawning channels have been developed in Southeast Alaska near Haines (Bachen 1984) and Hyder (Rickel 1984) for chum and coho salmon. In British Columbia, spawning channels 300-1,000 m long and 5-6 m wide have produced escapements of nearly 250 coho within 3 years; in subsequent years, escapements increased 2- to 8-fold (Sheng et al. 1990). These same channels also provide important winter habitat for coho and have produced 300 coho smolts/100 m^2. In Alaska's Gulkana River, groundwater-fed incubation boxes have been successful in enhancing sockeye production (Roberson and Holder 1987). Areas in the Situk River and neighboring watersheds with sufficient groundwater for spawning and rearing channels (or ponds) include Cannon Beach Creek, Milk Creek, ponds on Tawah Creek drainage near Yakutat airport, and Bean Belly Creek and Greens Pond in the upper watershed between Situk River and Old Situk River (Table R.1; Fig. R.1). Four gravel-pit rearing ponds near Yakutat are currently utilized by juvenile coho (Bryant 1988).

Several criteria were used to rank Situk River salmonids in order of potential risk to damage from flooding and need for restoration. These criteria included their current status (run strength), life stage(s) of the stocks affected, amount of critical habitat lost, uniqueness of the stock, importance to fisheries (i.e., subsistence, recreational, commercial), and feasibility of restoration. Species in order of highest risk are steelhead (spring and fall stocks), chinook (ocean type), sockeye (ocean type), and coho (Table R.2). Fish losses and possible restoration strategies for each species are discussed below. Other species would also be affected by flooding, but restoration should be lower priority because they are of little commercial importance, and either their run size is small (chum salmon) or they are widely distributed throughout the Situk River watershed (pink salmon, Dolly Varden).

Table R.1—Summary of possible restoration strategies for adult and juvenile salmonids in the Situk River and neighboring watersheds. Specific restoration sites are shown in Figure R.1.

Restoration activity and site	Stock*
Egg incubation facility:	
Ophir Creek	sockeye, coho, chinook
Milk Creek	chinook
Cannon Beach Creek	chinook, sockeye
Bean Belly Creek	chinook
Egg incubation boxes:	
Russell Lake	sockeye, coho
Outside flood zone	steelhead
Fry stocking:	
Russell Lake	sockeye, coho
Tawah Creek	sockeye, coho
Spawning/Rearing channels:	
Cannon Beach Creek	sockeye, coho
Milk Creek	chinook, steelhead, coho, sockeye
Tawah Creek	sockeye, coho
Bean Belly Creek	steelhead, chinook, coho, sockeye
Rearing Ponds:	
Greens Pond	sockeye, coho
Airport Ponds	sockeye, coho
Lake fertilization:	
Situk Lake	sockeye
Mountain Lake	sockeye
Redfield Lake	sockeye
Enhancement/Restoration:	
West Fork Situk River	steelhead

* Sockeye and chinook are ocean type, steelhead are spring run.

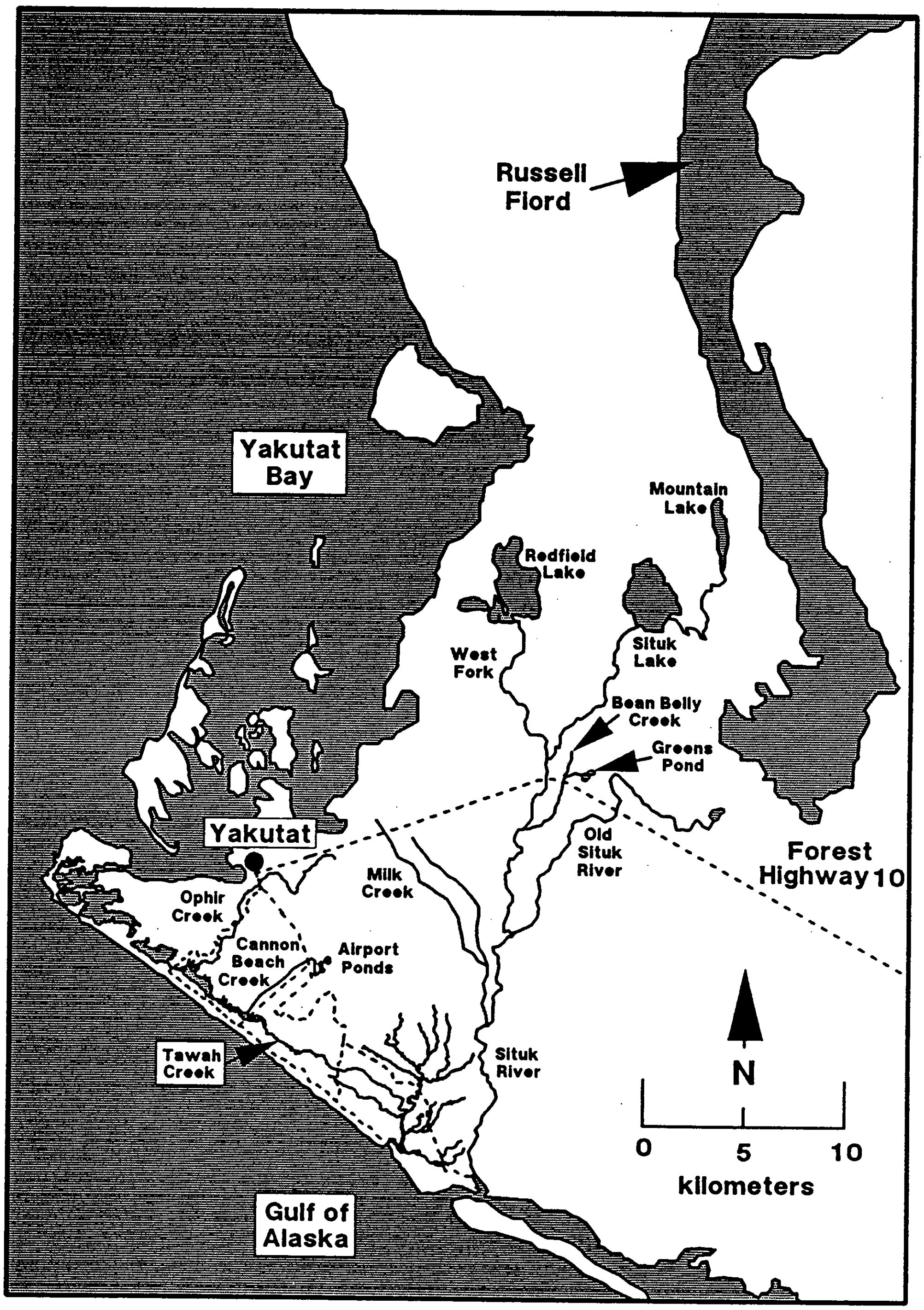

Figure R.1—Location of possible restoration sites in the Situk River and adjacent watersheds.

SPECIES RESTORATION STRATEGIES

Steelhead Trout (Spring and Fall Stocks)

Steelhead are at highest risk to potential impacts from flooding because of their uniqueness (i.e., spring and fall stocks), high value as a sport fish, the amount of critical spawning and rearing habitat affected, and the current depressed status of both stocks. In 1991 and 1992, the Situk River was closed to the taking of steelhead, and only "catch and release" angling was allowed. The estimated total run of both stocks is currently only about 3,000 fish.[24]

Adult spring steelhead are more at risk from flooding than fall steelhead, whereas juveniles of both stocks will probably be equally impacted. Spawning habitat for about 1,000 spring steelhead (2,000 m^2) is inside the flood zone (Study 1) and may need to be replaced by restoration (Table R.2); most fall steelhead spawn in the upper river outside the flood zone. About 50% (62,000) of all juvenile steelhead rear within the flood zone (Table R.2). Based on the average of the highest three rearing densities observed in the Situk River (Study 2), about 62,000 m^2 of rearing habitat would be needed to offset the potential total loss of juvenile steelhead in the flood zone (Table R.2).

The best restoration option for steelhead may be to rebuild the run size prior to flooding. At present, prohibiting log jam and woody debris removal in the stream for boat navigation would help protect spawning and rearing habitat. Requiring only artificial lures and continuing "catch and release" regulations on steelhead should help rebuild the run. Incidental catch of "dropout" or spent steelhead in the set-net fishery should be monitored to determine its effect on repeat spawners. After flooding, construction of groundwater channels in Milk Creek and Bean Belly Creek (Fig. R.1) could provide limited spawning and rearing habitat for steelhead.

[24]Mike Bethers, Alaska Dep. Fish and Game, Div. Sport Fish, Southeast Region, 802 Third St., Douglas, AK 99824. Pers. commun., Feb. 1992.

Table R.2—Salmonid habitat requirements, predicted maximum loss in flood zone, and restoration needs in the Situk River, Alaska.

	Habitat requirements			Predicted maximum loss				Restoration
		Rearing						
Species	Spawning[a] (m^2/♀)	Average[b] (m^2/fish)	Optimum[c] (m^2/fish)	No. Adults[d]	Spawning[e] habitat (m^2)	No. Juveniles[f]	Rearing[g] habitat (m^2)	Juvenile habitat[h] (m^2)
Steelhead	4	3.7	1.0	1,000[i]	2,000	62,000[j]	229,000	62,000
Chinook	20	4.2	1.2	100	1,000	67,000	281,000	80,000
Sockeye[k]	4	9.1	1.2	5,000	10,000	85,000	774,000	102,000
Coho	4	0.3	0.1	10,000	20,000	2,800,000	840,000	280,000
Pink	1	NA	NA	60,000	30,000	NA	NA	NA
Chum	2	NA	NA	200	200	NA	NA	NA
Dolly Varden	0.5	2.2	0.3	3,000	750	586,000	1,289,000	176,000

[a]Based on ♀ redd requirements from Study 1.
[b]Habitat requirements = area/average rearing density weighted by channel type from Study 2.
[c]Habitat requirements = area/mean of 3 highest rearing densities from Study 2.
[d]Predicted loss from Study 1.
[e]Assume sex ratio of 50:50 and specific redd requirement for ♀.
[f]Predicted loss from Study 2.
[g]Predicted loss based on average rearing density from Study 2.
[h]Habitat restoration needs based on optimum density expected from restoration activity; adult habitat restoration needs = predicted loss.
[i]Spring stock.
[j]Spring and fall stocks.
[k]Ocean type.

Chinook Salmon

Chinook salmon in the Situk River are ranked at high risk because of their uniqueness (only the second documented ocean-type stock in Alaska), importance to Yakutat fisheries, and potential habitat loss. The ocean-type life history may disappear because of decreases in water temperature and food abundance; fish may rear in the river a year or more before migrating to sea instead of the present 4-6 months.

Adult chinook may be less impacted from flooding than juveniles. Most adults spawn in the upper river outside the flood zone. About 100 chinook, however, spawn in the flood zone and if none could spawn there after flooding, about 1,000 m^2 of new spawning habitat would need to be replaced (Study 1; Table R.2). About 67,000 juvenile chinook rear inside the flood zone; therefore, about 80,000 m^2 of new rearing habitat would be needed to offset a total loss of this habitat (Table R.2).

To restore some of the lost spawning and rearing habitat for chinook, groundwater channels in Milk and Bean Belly Creeks could be developed. To supplement natural production, egg-incubation facilities could be constructed in Milk, Bean Belly, Cannon Beach, or Ophir Creeks, and chinook fry could be released into the upper Situk River until the river stabilizes.

Sockeye Salmon (Ocean Type)

Ocean-type sockeye, which predominately use Old Situk River, would be the sockeye stock most severely impacted by flooding. This stock was ranked at high risk because of its uncommon life history and because both its spawning and rearing habitats in Old Situk River are located in the flood zone and will be severely impacted.

About 5,000 sockeye spawners, predominately ocean type, would be impacted by flooding; approximately 10,000 m^2 of new spawning habitat would be required to maintain the spawning population (Study 1; Table R.2). Construction of groundwater channels at Milk or Bean Belly Creeks, or in some other tributary in the upper Situk River could replace some of the lost spawning and rearing habitat. New rearing habitat for about 85,000 juvenile sockeye (102,000 m^2) would be necessary to replace that impacted by flooding (Table R.2). To sustain the ocean-type life history, such habitat must contain relatively stable water temperature and abundant food.

Off-site restoration or enhancement could be developed to utilize the extensive rearing habitat in the Tawah Creek drainage (Fig. R.1). Egg-incubation facilities in Cannon Beach or Ophir Creeks could supply sockeye fry for introduction into off-channel areas of Old Situk River or Tawah Creek, or for rearing in saltwater pens, as is being done by Southeast Regional Aquaculture Association in Ketchikan and NMFS[25] in Auke Bay, Alaska. The ocean-type life history could provide an excellent opportunity for a private non-profit hatchery venture in the Yakutat area. A hatchery could also provide fry for stocking the upper Situk River and Russell Lake.

Coho Salmon

In terms of numbers of fish displaced or amount of habitat lost, coho would suffer the greatest overall impact from flooding. Coho were not ranked as high a risk as other species, however, because they are abundant, widely distributed throughout the watershed, and do not exhibit any known unique life history. Initially, coho production will probably decrease because the amount and quality of habitat will be reduced in the flood zone. Flooding would impact most coho life stages and their habitats except winter habitat in lakes and sloughs. Coho, however, were considered the most feasible species for habitat restoration and they would probably benefit from efforts to restore other species.

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[25]Jerry Taylor, National Marine Fisheries Service, Auke Bay Fisheries Lab., 11305 Glacier Hwy., Juneau, AK 99801. Pers. commun.

Both adult and juvenile coho would be affected by flooding. Approximately 10,000 adult coho spawn in the flood zone; thus, after flooding, to replace a total loss of spawning habitat, about 20,000 m^2 of spawning habitat would need to be developed. (Study 1; Table R.2). Nearly 3 million juvenile coho rear in the flood zone in summer. To replace a total loss of coho rearing habitat after flooding, about 280,000 m^2 of habitat (Table R.2) would be needed. Obviously, it would not be feasible to create enough new habitat to totally compensate for the potential habitat loss.

Development of groundwater channels would help restore some of the lost coho habitat. Construction of channels in Milk and Bean Belly Creeks could provide about 20,000 m^2 of spawning and rearing habitat. Development of groundwater in Cannon Beach Creek, which is already utilized by coho, could provide about 15,000 m^2 of spawning and rearing habitat. Improvement of the existing 14 man-made ponds in the Yakutat area (ADF&G 1984) and construction of new rearing ponds could provide additional rearing habitat.

OTHER RESTORATION STRATEGIES

Habitat enhancement of other river systems in the Yakutat forelands (e.g., Ahrnklin, Italio, Akwe, Dome, and East Rivers) could provide increased harvest levels to assist fishermen displaced from the Situk River. ADF&G's program to evaluate lake productivity in the Situk River watershed (i.e., Redfield, Mountain, and Situk Lakes) should be actively pursued. If fertilization would be beneficial, salmonid stocks could be enhanced prior to flooding to ensure that runs are at a high level of abundance and able to withstand flooding impacts. The "new" Russell Lake may support rearing sockeye.

Fishery management could also be used to reduce some of the impacts of flooding on fisheries. Management of pink salmon escapement may be necessary to alleviate competition with other species on the spawning grounds and prevent redd superimposition. Perhaps, a special seine or gill-net fishery could be implemented to harvest pinks before they enter the Situk River.

A floodwater-diversion structure and floodplain clearing are possible restoration projects suggested by other agencies. Construction of a dam in the headwaters of Old Situk River and a canal to divert flood waters away from the main-stem Situk River is not warranted because of cost ($48 million) and unknown impacts to other areas of the Yakutat Forelands (Paul 1988; Clark and Paustian 1989). Removal of trees and brush from inside the flood zone could speed the development of a stable channel and control the path of flood waters. This would be detrimental to salmonids, however, because riparian vegetation and instream woody debris are important components of their habitat (Murphy et al. 1987). Removal of riparian vegetation would reduce cover, food supply, streambank stability, and pool formation for many years and, thus, should not be done.

In summary, resource managers would have some lead time to implement appropriate restoration strategies because Russell Lake would take up to 14 months to fill. Timing and duration of flooding would determine what species or stocks warrant restoration. Restoration efforts should concentrate on species or stocks with high commercial or sport value (sockeye, coho, steelhead) or those with uncommon life histories (ocean-type sockeye and chinook). Possible restoration strategies include groundwater spawning and rearing channels, fry stocking, and off-site egg-incubation facilities. Egg-incubation facilities and fry planting must rely solely on Situk River and Lost River stocks instead of other stocks to prevent the introduction of disease and maintain genetic integrity. Costly restoration efforts should be limited within the initial years of flooding to evaluate how fish populations and habitat recover naturally.

FUTURE RESEARCH

Before flooding, pilot studies should be done to evaluate the effectiveness of the identified restoration strategies. One of the suggested groundwater sites (e.g., Milk Creek) could be developed before flooding to evaluate the potential capacity to replace damaged habitat. Therefore, the proper area and design of spawning and rearing channels needed for restoration would be known. Groundwater sources should be evaluated to determine areas in the Situk River watershed where flow is sufficient to provide year-round water to spawning and rearing channels. Carrying capacity should be determined for Tawah Creek, Ophir Creek, upper Situk River, Redfield Lake, and West Fork to identify areas that could accommodate more spawning and rearing fish. To better predict the effects of increased adult salmon spawning outside the flood zone, the effects of stock interaction should be studied. Smolt yield should be determined again to establish a baseline for smolt yield and to quantify smolt predation and identify its source. The contribution of rearing ponds to smolt production should be evaluated before any ponds are enhanced or new ones created. Although restoration in Russell Lake will be difficult because of its wilderness classification, Russell Lake should be studied after flooding for the feasibility of rearing sockeye. Fish populations and habitat should be monitored at established baseline sites (Study 10) for several years before and after flooding to evaluate restoration effectiveness.