FRED Reports

FISH LADDERS IN SOUTHEAST ALASKA
THROUGH JANUARY 1986

by
Sarah A. Bibb

Number 75

Alaska Department of Fish & Game
Division of Fisheries Rehabilitation,
Enhancement and Development

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ABSTRACT

In southeast Alaska 14 fish ladders are being used to allow salmon access to spawning and rearing habitat previously underutilized because of natural barriers in the rivers or streams. Such barriers prevent or seriously delay migration of adult salmon and thus reduce the production potential of the system. The Alaska Department of Fish and Game and the U.S. Forest Service have cooperated on a variety of projects in southeast Alaska that are designed to remove or bypass migration barriers. This report describes the design of fish ladders in general and discusses both operational ladders and those that have been installed but are no longer operating.

KEY WORDS: Fish ladder, fishway, southeast Alaska, salmonid, rehabilitation.

INTRODUCTION

Commercial harvest of salmon from southeast Alaska waters began in the late 1800s; peak catches of over 60 million fish occurred in the 1930s and 1940s. Harvest levels generally declined from the 1940s; lows of about 5 million fish were reached in 1960 and again in 1975 (ADF&G 1984a). Overfishing and poor survival years for some species resulted in escapements insufficient to sustain historic harvest levels. Management agencies implemented severe fishing restrictions to reverse the decreasing population trends. Since 1975 the total catch of salmon in southeast Alaska has increased; over 42 million fish were harvested in 1983 (ADF&G 1984a). Although the harvest levels are approaching historic highs, it is the goal of management agencies and user groups to further increase the number of salmon available for harvest and escapement. There are at least two ways to accomplish this goal: (1) increase natural production, or (2) supplement natural production with hatchery production.

Enhancement, in the form of supplemental production, has a long history in southeast Alaska. Pacific salmon enhancement efforts began in this region in the late 1800s when both private and federal hatcheries were associated with large sockeye salmon producing streams. Although these early facilities document releases of many salmon, their effectiveness in rehabilitating or establishing enhanced salmon runs is not clear. As fisheries management began to emphasize harvest regulations rather than hatchery production to rebuild the stocks, all hatcheries in southeast Alaska were closed by 1935 (Roppel 1982). Enhancement activities during the next two decades were limited.

The Alaska Territorial Government established the Alaska Department of Fisheries in 1949, and in 1957 this agency became the Alaska Department of Fish and Game (ADF&G). The Division of Fisheries Rehabilitation, Enhancement and Development (FRED) was created by legislation in 1971. The mission of FRED is to plan and implement a program that ensures the perpetual and increasing production and use of Alaska's fishery resources (AS 16.05.092). The U.S. Forest Service (USFS) has long been involved in fisheries enhancement projects in this region. With the objective of increasing production from natural stocks, these agencies have independently as well as cooperatively completed fish ladders (Figure 1). These structures are intended to bypass natural stream barriers that have prevented adult salmon from using available spawning habitat or delayed migrations of spawning fish. Table 1 provides a description of operational fish ladders in southeast Alaska.

FISH LADDER DESIGN

A fish ladder is designed to allow fish to bypass barriers and continue upstream migration. In southeast Alaska, impediments are often barrier falls that are too high to negotiate or water velocities that prevent passage. Once the need for the fish

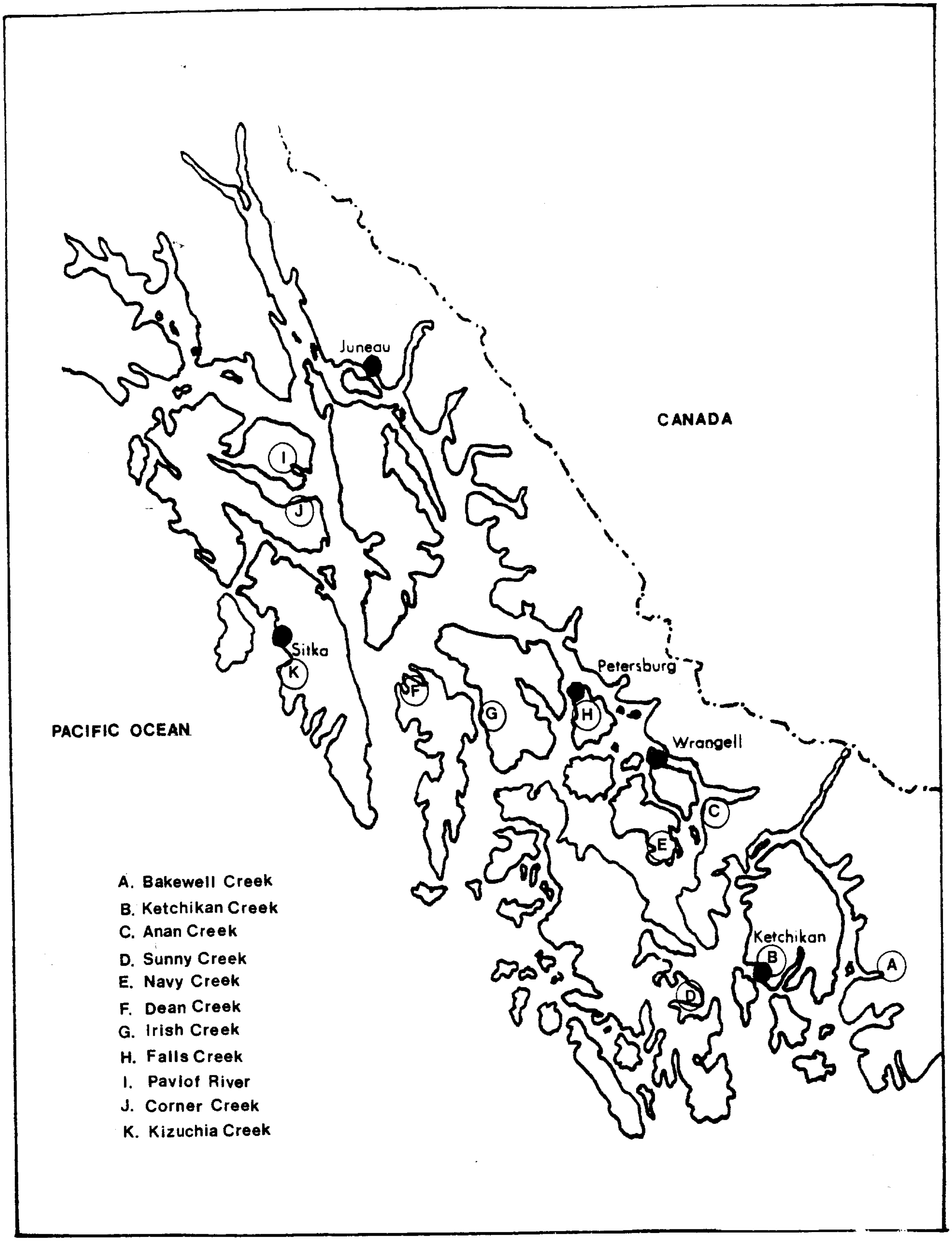

Figure 1. Location of fish ladders in southeast Alaska.

Table 1. Description of operational fish ladders in southeast Alaska

Name of ladder	Location (ADF&G Stream No.)	Species using ladder	General design
Anan Cr.	Bradfield Canal (107-60-10840)	pink, chum, coho, sockeye	1977 vertical slot
Bakewell Cr.	Behm Canal Smeaton Bay (101-55-10730)	steelhead, pink, coho, sockeye	1959-Denil, pool and weir 1984-Denil
Corner Cr.	Tenakee Inlet Chichagof Island (112-42-10160	pink, chum, coho	1981-steeppass 1983-steeppass
Dean Cr.	N. Kuiu Island (109-50-10070)	coho	1983-steeppass
Falls Cr.	Mitkof Island (106-44-10060)	steelhead, cutthroat, Dolly Varden, pink, chum, coho	1949-52, 1976 pool and weir
Irish Cr.	SW Kupreanof Is. (105-32-10120)	pink, chum, coho	1984 vertical slot lower falls 1985-steeppass upper falls
Ketchikan Cr.	City of Ketchikan (101-47-10250)	steelhead, pink, chum, coho, sockeye, chinook	1950s pool & weir 1965-steeppass-Denil modifications in 1977 and 1985
Kizhuchia Cr.	Redoubt Bay W. Baranof Island (113-41-10420)	pink, chum, coho	1981-steeppass on each of two falls
Navy Cr.	Etolin Island (106-22-10160)	pink, chum, coho	1975-steeppass
Pavlof R.	Freshwater Bay Chichagof Island	pink, chum, coho, sockeye	1935-pool & weir 1974 Denil
Sunny Cr.	Cholmondelay Sound Prince of Wales Is.	pink, chum, coho, sockeye	1984-steeppass

ladder has been identified, both the characteristics of the stream and the objectives of the ladder must be considered in choosing the location and design. The operational fish ladders in southeast Alaska can be generally classified as steeppass (Denil), vertical slot, or pool and weir. Modifications of the general design are based on conditions specific to the site.

The Stream Enhancement Guide (CDFO 1980) contains an excellent section on fish ladders. In addition to describing and illustrating various designs, the section lists information necessary to choose an appropriate site and ladder design. The following is a reproduction of part of the section on fishways.

> The principal biological and hydrological information required:
>
> - the species of salmonids in the river system, as well as the magnitude and timing of the runs;
> - the probable access route to the barrier, including areas where fish will congregate below the obstruction;
> - the extent of spawning and nursery areas and potential salmonid production from both above and below the obstruction;
> - the type and quantity of anticipated debris;
> - the frequency, duration, timing, and magnitude of various types of flows, especially extreme high and low flows; and
> - the location of other barriers in the stream system, and their possible effects on distribution of salmonids.
>
> . . .the following points must be considered in locating and designing the final structure:
>
> - . . .placement of fishway entrance is critical...the fish entrance should be located as close as possible to the areas where fish congregate below the obstruction;
> - flows in and near the fish entrance should be substantial enough to attract fish at all water levels;
> - when fish will be swimming through high velocity water, changes in direction should be minimized;
> - energy dissipation must be complete, with no carry over from pool to pool;
> - the fishway must provide adequate depth for the fish to swim;

- resting spaces must be adequate;
- flow patterns in the fishway must be stable, with no surges;
- a debris deflector should be incorporated at the water intake;
- the upstream exit should be located so fish will not readily be swept back downstream, over the obstruction; and
- the design should minimize the requirements for cleaning, regulating and repairing the fishway.

Table 2 illustrates that most of the ladders in Southeast are Alaska Steeppasses, a modified Denil design developed by ADF&G engineer Gil Ziemer. Ziemer (1962) describes the Alaska Steeppass as a sectional, prefabricated, light-weight, corrosion resistant, functional fish ladder of the Denil type. The ladder is made up of continuous, open-channel units that contain regularly spaced partition plates, or baffles, to check the flow of water through the sections. The baffles slow the velocity of the water flowing down the ladder sufficiently to allow the fish to swim upstream. These features make the Alaska Steeppass particularly desirable for use in the remote streams of southeast Alaska. Figure 2 presents illustrations of general fish ladder designs from the Canadian Department of Fisheries and Oceans (1980). The Denil fish ladder illustration includes two sections separated by a resting pool. An Alaska Steeppass section looks very similar to the Denil sections shown, but it is generally a prefabricated aluminum unit manufactured in 3.1-m-long sections.

The vertical-slot fish ladder (Figure 2) uses baffles that have a slot cut in one side. Generally, all openings for fish passage are on one side of the ladder. Water flowing through these slots is deflected so that resting areas are created between the baffles. The vertical-slot fish ladder is designed to operate under a wide range of water flows and requires little maintenance.

The pool and weir fish ladders (Figure 2) that operate in southeast Alaska have a number of different modifications. The general design uses a succession of partitions to create pools.

Table 2. General design of the operational fish ladders in southeast Alaska.

Steeppass	Denil	Vertical Slot	Pool and Weir
Corner Bay Cr.	Bakewell Lake Cr.	Anan Cr.	Falls Cr.
Dean Cr.	Ketchikan Cr.	Irish Cr. (Lower)	
Kizhuchia Cr.			
Navy Cr.			
Pavlof River			
Sunny Cr.			
Irish Cr. (Upper)			

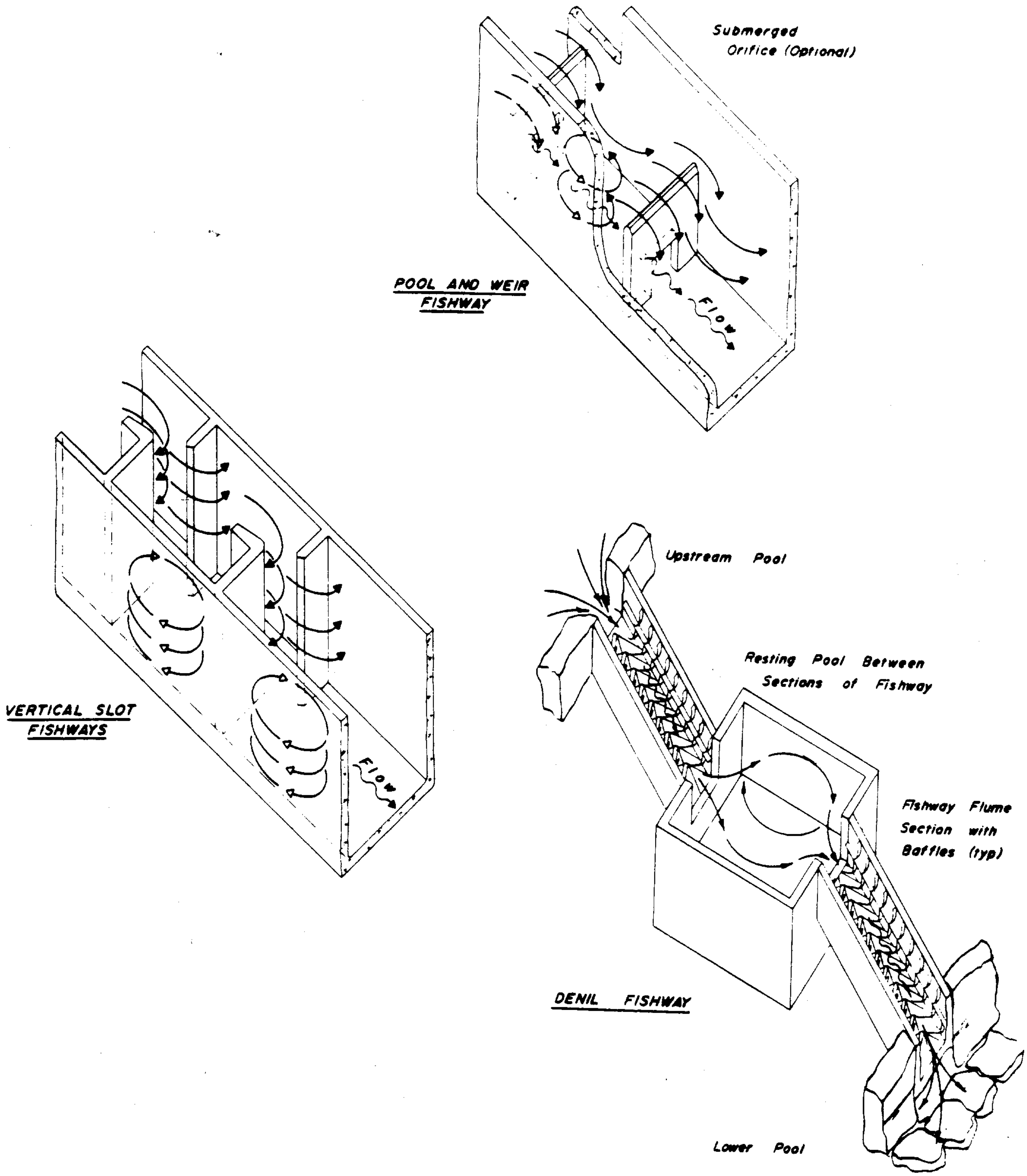

Figure 2. General fish ladder designs. (Illustration from Stream Enhancement Guide. Government of Canada, British Columbia Ministry of Environment. 1980)

Each pool is lower than the one upstream, and water flowing over the partitions or through submerged openings (orifices) attracts fish from one pool to the next.

The pool and weir design works most effectively in streams with fairly constant water flows; however, it is not the best design for streams in remote areas because the ladder cannot be monitored, cleaned, and adjusted during critical periods of fish passage.

POTENTIAL PRODUCTION

Depending on the site, the objectives of a fish ladder are to allow access to previously underutilized spawning habitat and to allow more fish to reach spawning areas during the entirety of a run. An investment in fish ladders should result in an increase in production, resulting in more fish for the common-property fishery and escapement. One of the most difficult aspects of this type of enhancement effort is in estimating the production potential of a proposed project.

In recent years, the USFS has produced habitat and environmental assessments for most proposed fish-ladder projects. These reports include estimates of the additional spawning and rearing areas and production potentials of the areas affected by the project. Although each system has unique characteristics, the USFS uses a standard set of assumptions concerning habitat capability, survival and harvest rates, and commercial value that are generally applied to all projects. Specific assumptions were developed by that agency (Table 3; Appendix A) in order to calculate the number of harvestable adult salmon that could be produced in an acre of spawning or rearing area each year (USDA n.d.b).

Table 3. Anadromous salmon habitat capability coefficients.

Species of Salmon	Annual harvestable adults/acre habitat: Stream spawning	Stream rearing	Lake rearing
Chinook, *Oncorhynchus tshawytscha*		165	
Coho, *O. kisutch*		165	
Pink, *O. gorbuscha*	6,103		
Chum, *O. keta*	4,518		
Sockeye, *O. nerka*			50

Although these assumptions are widely used in planning documents, they do not necessarily represent the achievable production levels. Once a ladder is completed, there are many factors that will influence fish production. Obviously, it is very important that it be properly designed and constructed; many have required follow-up work in order for them to successfully pass fish. Environmental conditions, such as high flows or ice, have also destroyed several of them in southeast Alaska; and once a ladder is operational, it may require several years for a stock of fish to be established. Evaluations of fish successfully using ladders to reach upstream spawning areas have been generally limited to peak-count adult escapement surveys; collecting the data necessary to estimate resulting increased production would require a significant financial commitment.

HISTORICAL PRODUCTION

Escapement, the number of adult salmon spawning in a system, is an indicator of the production of that system. Because many of the streams described in this report do not have weirs, it is difficult to get an accurate estimate of annual escapement. Surveys are not always done by the same agencies or on a continuous basis. These limitations have necessitated the use of peak-escapement estimates as indicators of the production of a system. These estimates do not reflect the total return to the streams, but are measures of the relative abundance at the time of the survey. Peak-escapement estimates for systems with operational fish ladders are listed in Appendix B.

OPERATIONAL FISH LADDERS

Anan Creek

Anan Creek flows 4 km from Anan Lake to the Bradfield Canal, southeast of Wrangell (Figure 3). Historically this system has been a high producer of pink salmon, with peak-escapement counts ranging from 60,000 to over 330,000 fish (ADF&G 1984b). The district's (ADF&G statistical area 107-40; Regulatory District 7) purse-seine fishery is often managed on the basis of pink salmon production from Anan Creek.

There are two waterfalls on Anan Creek: one is near the tidal area, and the other one is located approximately 0.4 km further upstream. The upper falls does not prevent pink salmon from moving upstream; however, the lower falls is a partial barrier to upstream migration during high-water flows. Under normal water conditions, fish are able to migrate upstream with little difficulty; but high flows are not uncommon, and the resulting problems are well documented. For example, in 1964 only 40,000 of the reported 200,000 adult pink salmon entering Anan Lagoon were able to negotiate the falls and continue upstream (Koeneman 1975).

In 1967 ADF&G installed an aluminum steeppass on the lower falls. Because the falls is a velocity barrier only during high-water flows, the ladder was supposed to allow fish passage under high-water conditions; the falls would remain available to fish during normal flows. In 1967 portions of the ladder were washed out and replaced twice. In 1972 stream surveyors reported that the ladder was operating at low flows, when the fish could ascend the fall, but was not passing fish during high flows (Koeneman 1975). The steeppass was removed after sustaining extensive damage during the winter of 1975-1976.

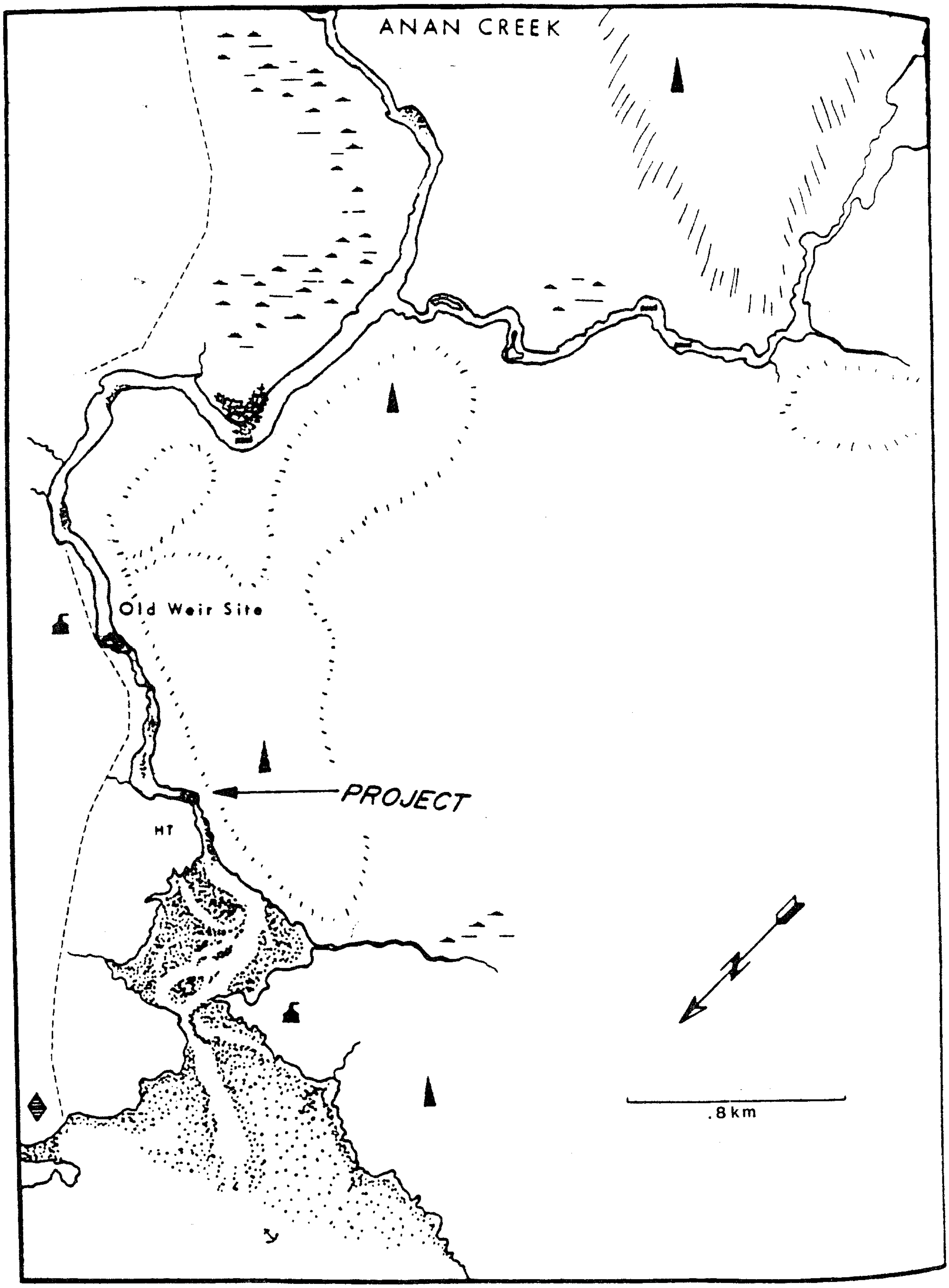

Figure 3. Location of Anan Creek Fish Ladder

In 1975 adult pink salmon were not able to negotiate the falls, and an attempt to transport them over it with a helicopter failed. In July 1976 high-water conditions resulted in the airlift of 129,000 pink salmon over the lower falls (Bergmann 1977).

In a 1977 cooperative effort, ADF&G and USFS staff constructed a second, vertical slot fish ladder (approximately 44.2 m long with a 3.4-m vertical height) that included a 33.5-m portion that is tunneled through a rock wall next to the falls (USDA n.d.a). The potential increased production due to construction of the Anan Creek fish ladder is based on the additional escapement that could be achieved, especially in years of high-water flows. The authors of USDA (n.d.a), which is an Environmental Analysis Report (EAR), assume that the ladder will allow optimal pink salmon access to Anan Creek under all water-flow regimes. It was hoped that the ladder would help to make up some of the difference between the long-term average escapement of 220,000 pink salmon and the optimal escapement of 320,000 pink salmon. The authors further assume a 1:3 spawner return ratio, with two of three returning adults harvested in the fishery. Based on this assumption, the USFS estimated that escapement and harvest could annually increase by 99,800 and 199,600 fish, respectively (USDA n.d.a).

Other than escapement surveys, there has been no formal evaluation of the effectiveness of the Anan Creek fish ladder. Fish have been observed using the ladder, and there have been no reports of fish trapped in the lagoon below the ladder. However, there are insufficient data to determine whether additional escapement or harvest has been realized.

Bakewell Lake Creek

Bakewell Lake Creek, which is approximately 64.4 km east of Ketchikan in the Misty Fiords National Monument, flows into Behm Canal (Figure 4). The stream, which drains Bakewell and Badger

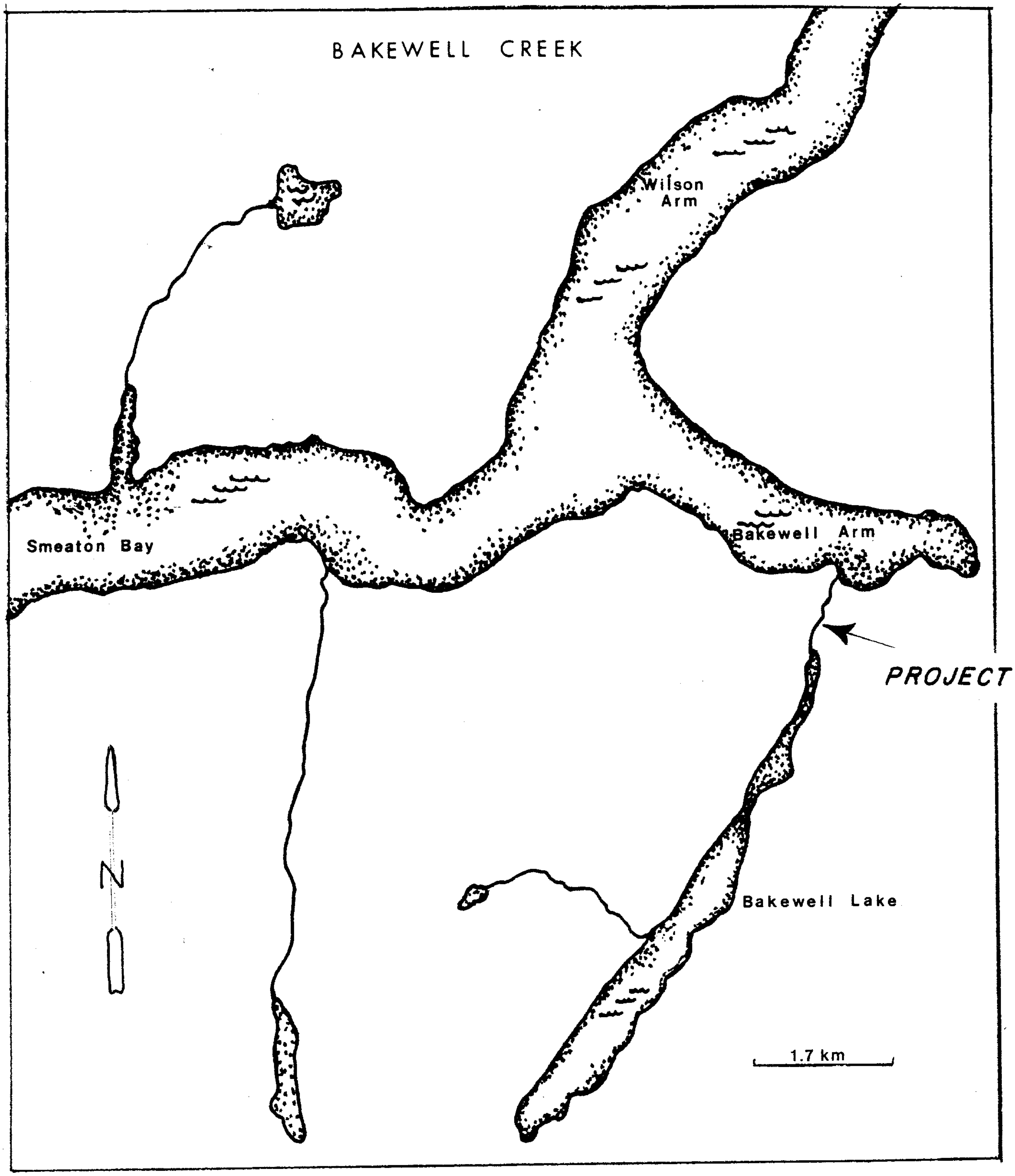

Figure 4. Location of Bakewell Lake Creek Fish Ladder

Lakes, flows into Bakewell Arm of Smeaton Bay. Bakewell and Badger are large lakes (269.1 and 205.2 ha, respectively) that are connected by a 4.8-km stream. Prior to any enhancement projects, cutthroat trout, *Salmo clarki*, Dolly Varden char, *Salvelinus malma*, and kokanee salmon, *Oncorhynchus nerka*, were the primary species in these lakes. Access by anadromous species was blocked by a 7.6- to 9.1-m falls located 0.81 km upstream from the intertidal area and 228.6 m from the lake (ADF&G 1953)[1].

USFS personnel conducted a habitat survey in 1981; this system contains an estimated 3.4 ha of salmon spawning habitat, 3.1 ha of stream-rearing habitat, and 498.2 ha of lake habitat (Pease 1981). Haddix et al. (1983) estimates the production potential of this lake system as follows:

> The rearing potential of both lakes could theoretically exceed 1,000 sockeye smolt per surface acre of lake rearing area at maximum production. This could total 1,173,000 smolt; which, with survival to adult ranging from a conservative 4% to a potential high of 10%, would be 46,920 to 117,300 total adult production or 38 to 95 adults per surface acre of rearing area... potential coho production from Bakewell should exceed 5,000.

Bakewell Lake has a long history of enhancement projects. Table 4 summarizes the Bakewell system's sockeye salmon egg and fry plants from 1955 through 1959. In 1959 a fish ladder bypassing the barrier falls was constructed by the territorial government and the U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries (ADF&G 1959). This fish ladder was a combination of the Denil and a pool and weir with submerged orifices (Pease 1982).

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[1] Publications by Alaska state and territorial fisheries management agencies are all cited under Alaska Department of Fish and Game. *See* references for agency name at time of publication.

Table 4. Sockeye salmon eggs and fry stocked into Bakewell Lake system by the Alaska Department of Fish and Game (ADF&G 1959).

Year	Green eggs	Eyed eggs	Fry
1954	100,000	200,000	
1955			49,700
1956			301,200
1957	525,000		
1958			11,500
1959			67,200

Sockeye salmon adults and fry from Hugh Smith Lake were planted in Bakewell Lake in the 1960s. Three hundred adult sockeye salmon were moved from Hugh Smith Lake in 1965, and sockeye salmon fry were planted there in 1967. In addition, 200,000 coho salmon fry and fingerlings from Deer Mountain Hatchery were introduced into the system in 1970. The largest number of fish observed below the falls was 5,000 sockeye salmon in 1977 and 1,500 coho salmon in 1975 (Haddix 1979).

Although there are records of established sockeye and coho salmon stocks, the ladder did not operate very efficiently because of original design problems and inadequate maintenance. In 1979 the USFS and ADF&G made repairs to the existing ladder; they were only temporary measures to save these established stocks. The original design problems were not solved. Estimated escapement in 1980 included less than 200 sockeye, 1,200 to 1,500 coho, and a few pink salmon. Steelhead trout, *Salmo gairdneri*, and cutthroat trout were also using the ladder (Pease 1982).

Efforts toward developing coordinated rehabilitation and enhancement of the Bakewell Lake system have continued in the 1980s. There are three components of the current project: fish ladder improvement, lake fertilization, and sockeye salmon enhancement.

Design criteria for rebuilding the fish ladder were completed in 1982. Site surveys and administration of contracts were handled by the USFS; the FRED Division Engineering Section was responsible for the drafting and design of the project. Construction of the ladder began in 1983; it was opened and operational in 1983 and completed in 1984. This new structure, constructed on the original site, is a series of aluminum Denil sections interspersed with concrete resting pools. Improvements were also made to the entrance and exit of the ladder.

With an improved fish ladder in place, additional projects to increase the salmon production of Bakewell and Badger Lakes can be justified. FRED Division and the USFS are determining the potential of this system for lake fertilization. Hugh Smith Lake is the brood source for the existing Bakewell sockeye salmon stock. To further enhance this stock, eggs were taken from the Hugh Smith Lake sockeye salmon in the fall of 1984 and 1985. These eggs were incubated at Beaver Falls Hatchery in Ketchikan. The resultant fry from 1984 spawning operations were released into Badger and Bakewell Lakes. Release of 1985 brood fry was scheduled for June 1986.

Corner Creek

Corner Creek flows about 8.6 km into Corner Bay in Tenakee Inlet, eastern Chichagof Island (Figure 5). Coho, chum, and pink salmon and Dolly Varden char spawn and rear in this system. Prior to the construction of two fish ladders, pink and chum salmon and Dolly Varden char spawning was limited to the 1.6-km area between salt water and the lower falls.

Coho salmon were the only species able to ascend the lower falls. In 1981 USFS personnel installed a 6.1-m-long Alaska Steeppass around the lower falls; they estimated that the ladder would provide pink and chum salmon and Dolly Varden char access to about 1.4 ha of spawning habitat (USDA 1981a) and that it would also provide coho salmon with an alternative route during low or moderate water flows.

In 1982 the USFS approved an Environmental Assessment for the construction of a second steeppass on the Upper Corner Creek Falls. This upper falls is about 1.6 km above the first falls. There are 0.9 ha of spawning area between the falls, and the steeppass installed on the upper falls in 1983 made an additional 3.7 km of spawning habitat available (USDA 1983a).

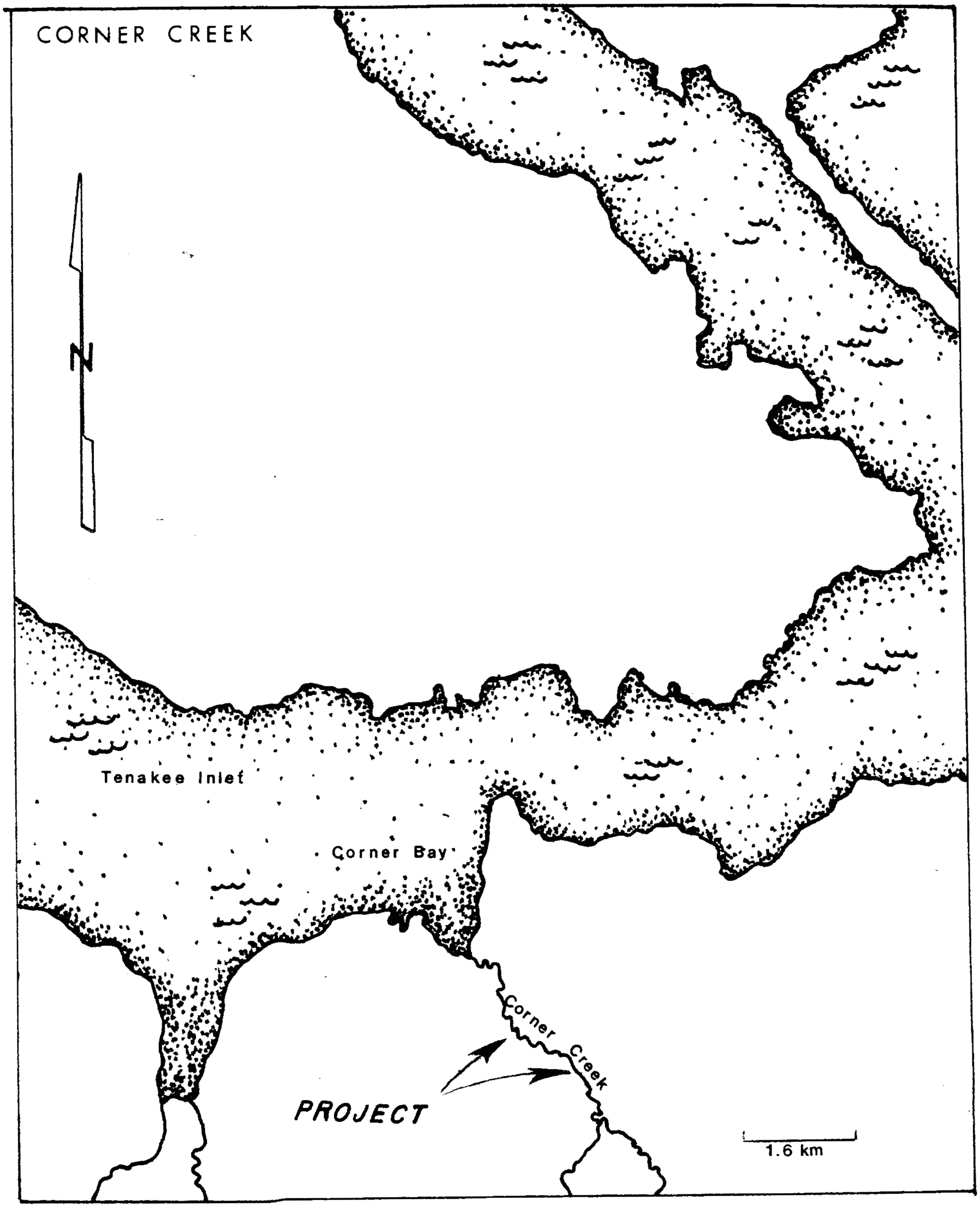

Figure 5. Location of Corner Creek Fish Ladders

USFS stream surveys conducted after the installation of both steeppasses document the use of the ladders by pink and chum salmon and Dolly Varden char. Table 5 provides a summary of these surveys.

Dean Creek

Dean Creek flows 8.9 km northwest to Frederick Sound between Security and Saginaw Bays on the northern tip of Kuiu Island (Figure 6). Recorded pink salmon escapements to Dean Creek have ranged from 50 to 2,700 fish (Appendix B). Pink salmon and a few coho salmon had access to only 0.4 km of stream below a 4.0-m waterfall. The USFS estimated 8.5 ha of available habitat above the falls. In that survey, Franzel (1977) stated that most of this habitat is best suited for rearing rather than spawning; the spawning area has few riffles and high level of fines (approximately 30%). For these reasons, Dean Creek was chosen as a site for coho salmon enhancement.

In 1983 the USFS installed a 12.2-m-long Alaska Steeppass at Dean Creek. In cooperation with ADF&G, a 3-year coho salmon enhancement project was initiated. About 3,200 coho salmon fry from nearby Security, Saginaw, and Rowan Creeks were planted above the ladder site. Coho salmon fry transfers from these neighboring streams totaled 8,235 in 1984, 10,000 in 1985, and 8,600 in 1986. Based on a USFS production estimate, each hectare of rearing habitat could produce 408 harvestable coho salmon adults.

Applying this to the 8.5 ha available at Dean Creek results in a potential production of about 3,500 harvestable coho salmon adults. However, through the present enhancement scheme, coho salmon production is not expected to reach this projected level for several cycles.

Table 5. U.S. Forest Service foot surveys of Corner Creek.

Date of survey	Species observed	Intertidal area	Intertidal to first ladder	First ladder to second falls	Above second falls	Comments
July 23, 1981	Live Pink	162	208		No Fish	Pinks were not as far up as chum.
	Dead Pink					Many Dolly Varden above ladder.
	Live Chum		110	36		
	Dead Chum		6			
July 30, 1981	Live Pink		2,066	1,162	No Fish	Many pinks congregated near base
	Dead Pink	6	10	18		of ladder. None seen near falls.
	Live Chum		37	112		
	Dead Chum		5	10		
August 7, 1981	Live Pink	797	1,331	2,783	No Fish	Very high water. No fish seen
	Dead Pink		61	44		using the ladder. Coho fry above
	Live Chum		59	48		second falls, Dolly Varden below
	Dead Chum		36	3		second falls.
August 19, 1981	Live Pink	912	1,351	1,984	No Fish	Low water conditions. Many pinks
	Dead Pink	510	770	1,44		at base of ladder, none moving up
	Live Chum			11		ladder.
	Dead Chum		45	3		
August 16, 1982	Live Pink	601	341	10	No Fish	
	Dead Pink	11	25	2		
	Live Chum		28			
September 13, 1982	Live Pink	1,300	1,900	808	No Fish	
	Dead Pink	700	659	409		
August 3, 1983	Live Pink	Not Surveyed	1,006	702	18	Second ladder installed. Two
	Dead Pink		15	11	1	salmon observed using second ladder.
	Live Chum		326	303		
	Dead Chum		4	5		

--------continued--------

Table 5. U.S. Forest Service foot surveys of Corner Creek.

Date of survey	Species observed	Intertidal area	Intertidal to first ladder	First ladder to second falls	Above second falls	Comments
August 17, 1983	Live Pink	Not Surveyed	355	212	1,425	Difficult counting because of run-off conditions.
	Dead Pink		120	212	75	
	Live Chum		22	5		
	Dead Chum		3	70		
October 29, 1984	Live Pink	1,500	1,490	589	46	A few coho and sockeye also observed. Run appears to be later than previous years.
	Dead Pink		85	55	10	
	Live Chum		1	3	4	

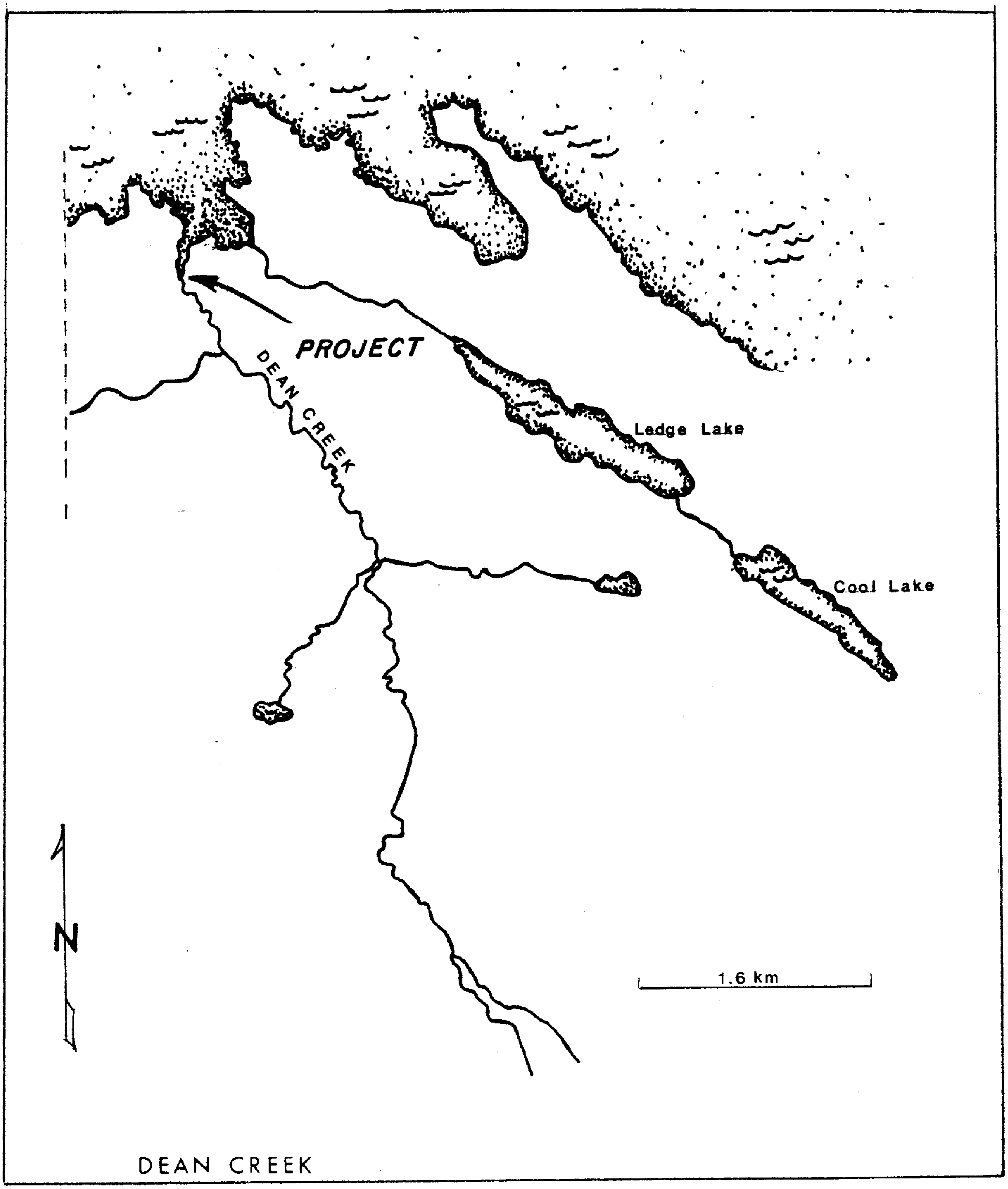

Figure 6. Location of Dean Creek Fish Ladder

Falls Creek

Construction of two fish ladders on Falls Creek, near Petersburg (Figure 7), was one of the first projects undertaken by the newly created Alaska Department of Fisheries in 1949. The barrier to upstream migration in this system is a series of falls and rapids approximately 10.4 m in height (ADF&G 1949). Cooperatively, the Alaska Department of Fisheries and the U.S. Fish and Wildlife Service completed the lower ladder in 1950 and the upper ladder in 1951; these concrete pool and weir ladders allow passage of coho, chum, and pink salmon. Steelhead trout and Dolly Varden char also use these ladders. About 1,500 to 2,000 coho salmon adults used the lower ladder in 1950. The water level in the pool between the falls was raised to allow the coho salmon to jump the upper falls. The following year, 2,280 pink salmon, 303 chum salmon, 9 sockeye salmon, and 2,467 coho salmon used the two-ladder system to reach the spawning area above the falls (ADF&G 1951).

There is little other information on the use or condition of the two ladders until the late 1960s. Ziemer (1968)[2] reported the ladder was passing fish, although there were problems in the general design. The ladder was too steep, with high steps and short pools; replacement grating was also needed to prevent debris build-up and to make the structure safer for observers. These improvements were accomplished in 1971; however, problems with debris and sediment accumulation continued. In 1976 the FRED Division and the USFS funded the installation of a trash rack and improvements to the public viewing area. Additional work may be necessary to improve fish passage through these ladders.

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[2] Unpublished notes in SE Region engineering files entitled, "Falls Creek, Petersburg" October 4, 1968. 4 pp.

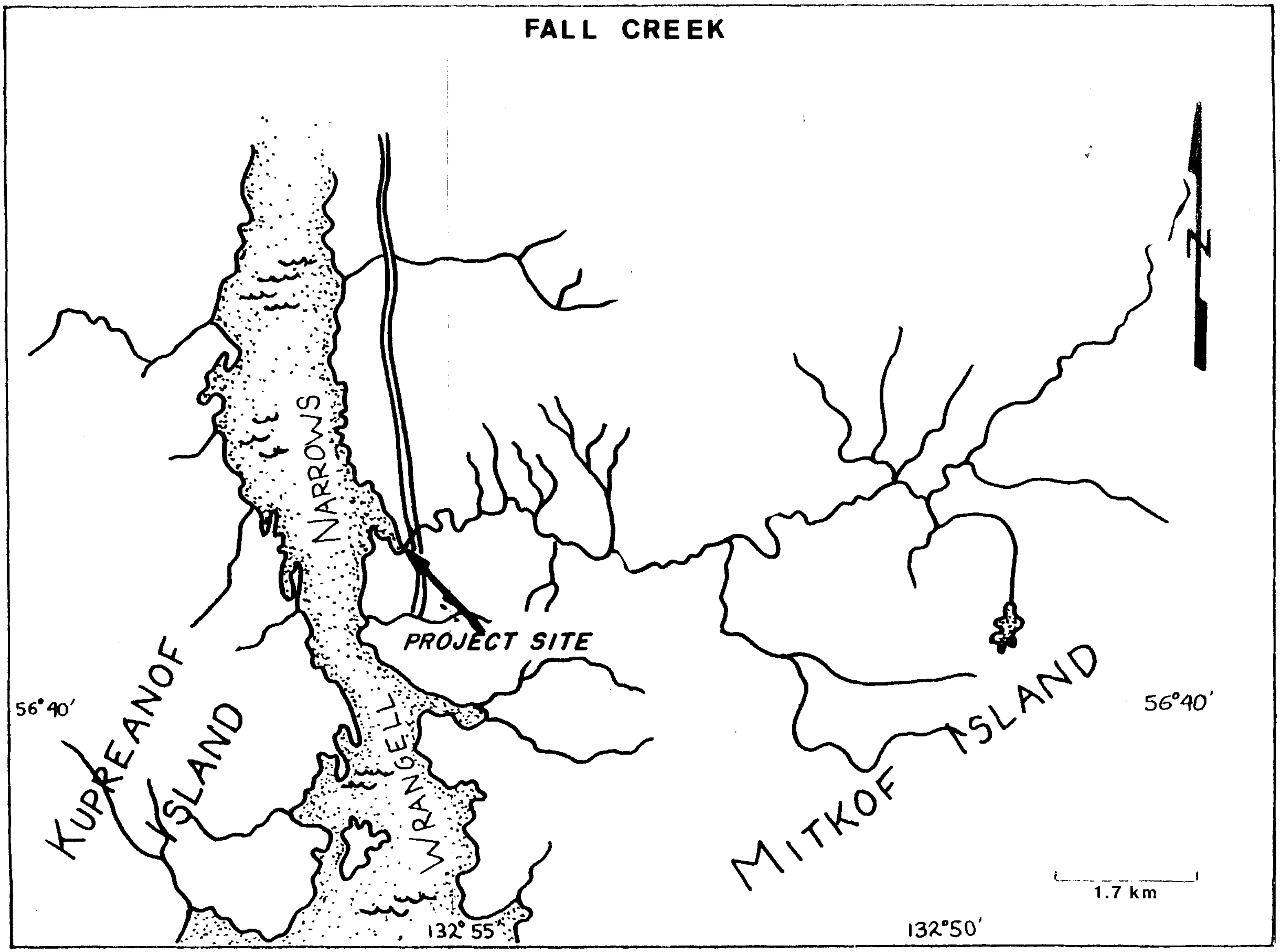

Figure 7. Location of Falls Creek Fish Ladder

Sport catches of steelhead trout and coho salmon occur above and below the falls. The creek has also been used as a steelhead trout brood source for the Crystal Lake Hatchery. Eggs were taken from 1975 through 1977 and again in 1982 and 1983, and the resulting steelhead trout were returned to the creek in 1976, 1982, and 1983.

Irish Creek

The Irish-Keku Creek system is located on Kupreanof Island and flows into Keku Strait in the Rocky Pass area (Figure 8). Keku Creek drains the two Irish lakes and flows 12.9 km to join Irish Creek. There are three barrier falls in this system: one on Irish Creek and two on Keku Creek. The first barrier, a 7.0-m falls, is located just above the tidal area on Irish Creek. This falls is a total barrier to salmon migration. The intertidal area below the falls contains limited spawning area; however, data contained in escapement-survey reports indicate several thousand pink and chum salmon spawning below the falls (Appendix B).

The USFS and ADF&G recognized the potential of the Irish-Keku stream system for increased salmon production. A USFS habitat assessment stated that there was a minimum of 2.0 ha of spawning area between the first falls on Irish Creek and the second falls on Keku Creek. Surveyors estimated that this habitat could provide 2.0 ha of pink and chum salmon spawning area and 22.6 ha of coho salmon rearing area. Applying the USFS salmon habitat capability coefficients to the available habitat results in potential production of approximately 9,200 coho, 16,000 chum, and 40,000 pink salmon harvestable adults annually (Hughes 1981).

A fish ladder at the saltwater terminus of Irish Creek was proposed in 1977. Construction of a Denil fish ladder was partially completed in 1979 but was destroyed by unanticipated

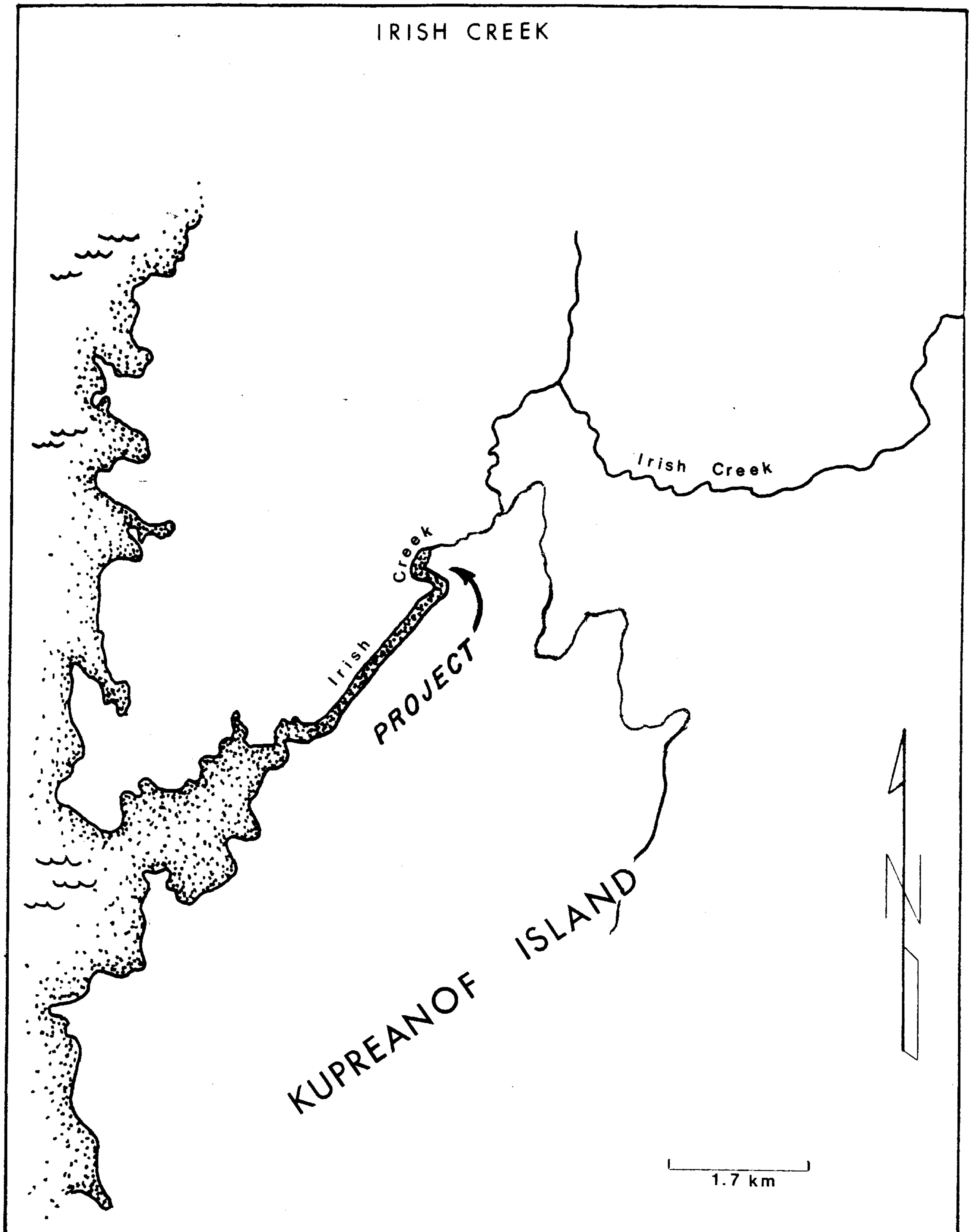

Figure 8. Location of Irish Creek Fish Ladder

high-water conditions. A vertical-slot type fish ladder was installed in the same location in 1984. The present ladder sections are covered with a concrete roof to decrease the potential for damage from the high stream flows and icing conditions. In addition to installing a ladder on the barrier falls, enhancement of Irish Creek included introducing coho salmon fry from Crystal Lake Hatchery: 1.5 million fry were released in 1983, 777,000 in 1984, and 950,000 in 1985.

Construction of a 12.2-m-long Alaska Steeppass on the second of the three falls in the Irish-Keku system was completed in the summer of 1985. This 2.8-m falls is located on Keku Creek, approximately 9.7 km upstream from the lower ladder. It is not known whether the third falls will actually be a barrier to coho salmon migration. In the fall of 1985, USFS personnel observed adult coho salmon at the base of the third falls (Bob Dewey, personal communication). For each five attempts (jumps), approximately one coho salmon negotiated this falls; however, this was a one-time observation during a high-flow event. USFS personnel have indicated that enlarging the pools at the base of the third falls will increase the rate of coho salmon passage upstream.

Ketchikan Creek

Ketchikan Creek flows through the City of Ketchikan to Thomas Basin (Figure 9). In 1902 a hatchery was constructed near Ketchikan Creek by the Fidalgo Packing Company. There were no fish released from this site, however, because the company was not satisfied with the location. From 1924 through 1927, the territorial government produced chinook, sockeye, chum, and pink salmon from the Ketchikan Creek Hatchery (Roppel 1982). Deer Mountain Hatchery was constructed in 1954, with the cooperation of the Ketchikan King Salmon Derby Committee and the Ketchikan Chamber of Commerce. Chinook, sockeye, and coho salmon were produced for lake-stocking projects and hatchery releases. In

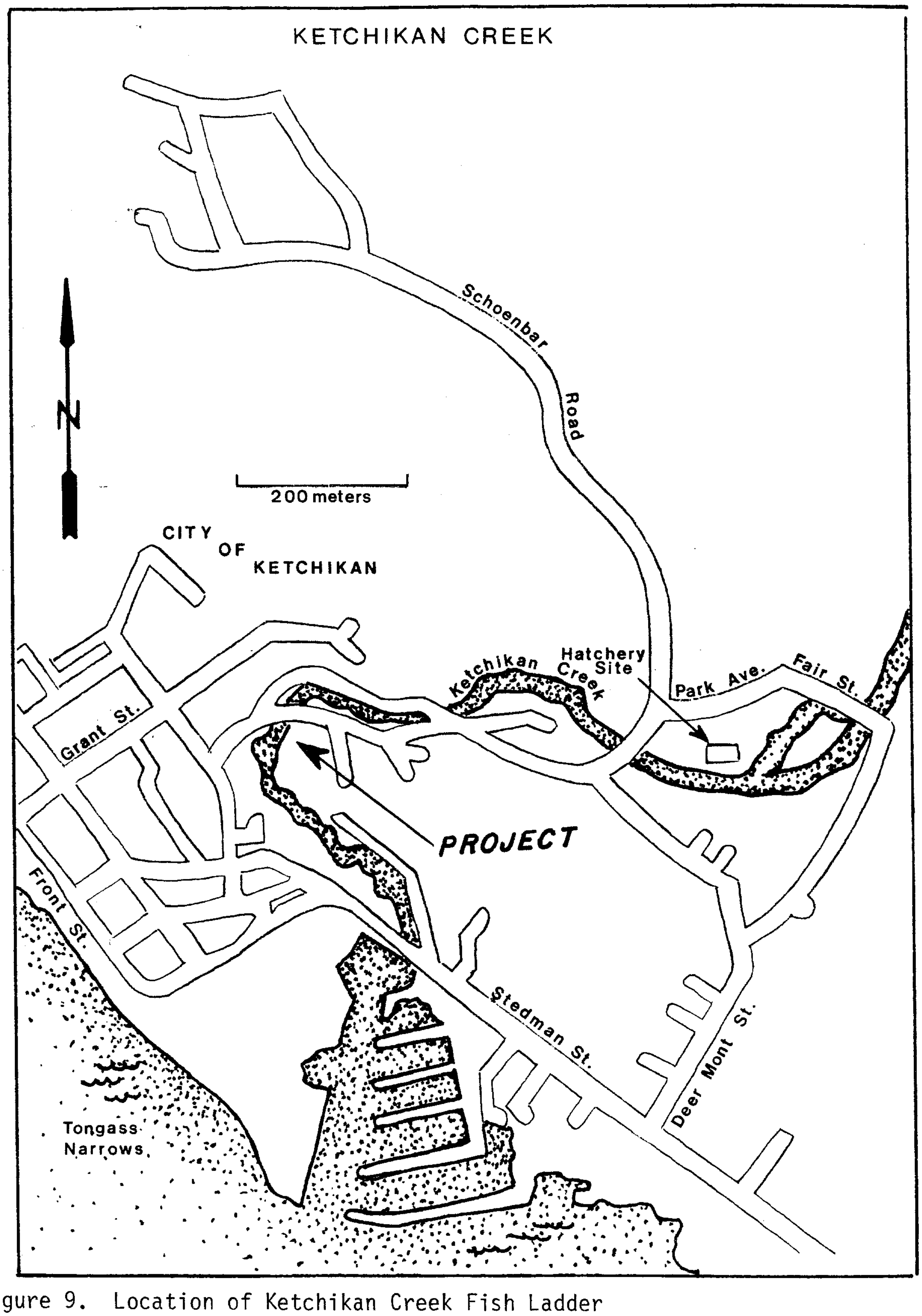

Figure 9. Location of Ketchikan Creek Fish Ladder

1957 a fish ladder was placed in Ketchikan Creek to divert returning adult salmon to a holding pond at the hatchery (ADF&G 1957).

A second fish ladder was installed in Ketchikan Creek in the 1950s to bypass a 3.1-m barrier falls. This falls is in the area of the Park Avenue Bridge, which is about 0.5 km downstream from Deer Mountain Hatchery and 30.5 m from the upper intertidal area of Thomas Basin.

The original ladder at this site was a series of concrete pools approximately 1.8 m long and from 0.6 to 0.9 m deep with a slot cut out between successive pools (Paul Novak, personal communication).

In 1965 a steeppass section was added to the existing fish ladder by ADF&G; by that time, the concrete structure had deteriorated, and there were reports that the entrance to the ladder had been placed too far downstream from the falls. Although a new section was added, it was reported that the outflow of the ladder was still not adequately attracting fish. In 1977 further modifications to the ladder were made. A Denil section was added, and to improve attraction, the bottom portion of the ladder was extended so that the entrance was closer to the falls area. Further repairs to the ladder were made in the spring of 1985. Observations made during the 1986 returns indicate an improved use of the ladder by all species.

<u>Kizhuchia Creek</u>

Kizhuchia Creek is located on Baranof Island (south of Sitka) and flows about 11.6 km into Redoubt Bay (Figure 10). Pink salmon are the major species; peak escapements ranged from 200 fish in 1963 to 34,000 fish in 1983 (Appendix B). There are also small runs of chum and coho salmon and Dolly Varden char in this system. There are two barrier falls on Kizhuchia Creek. The

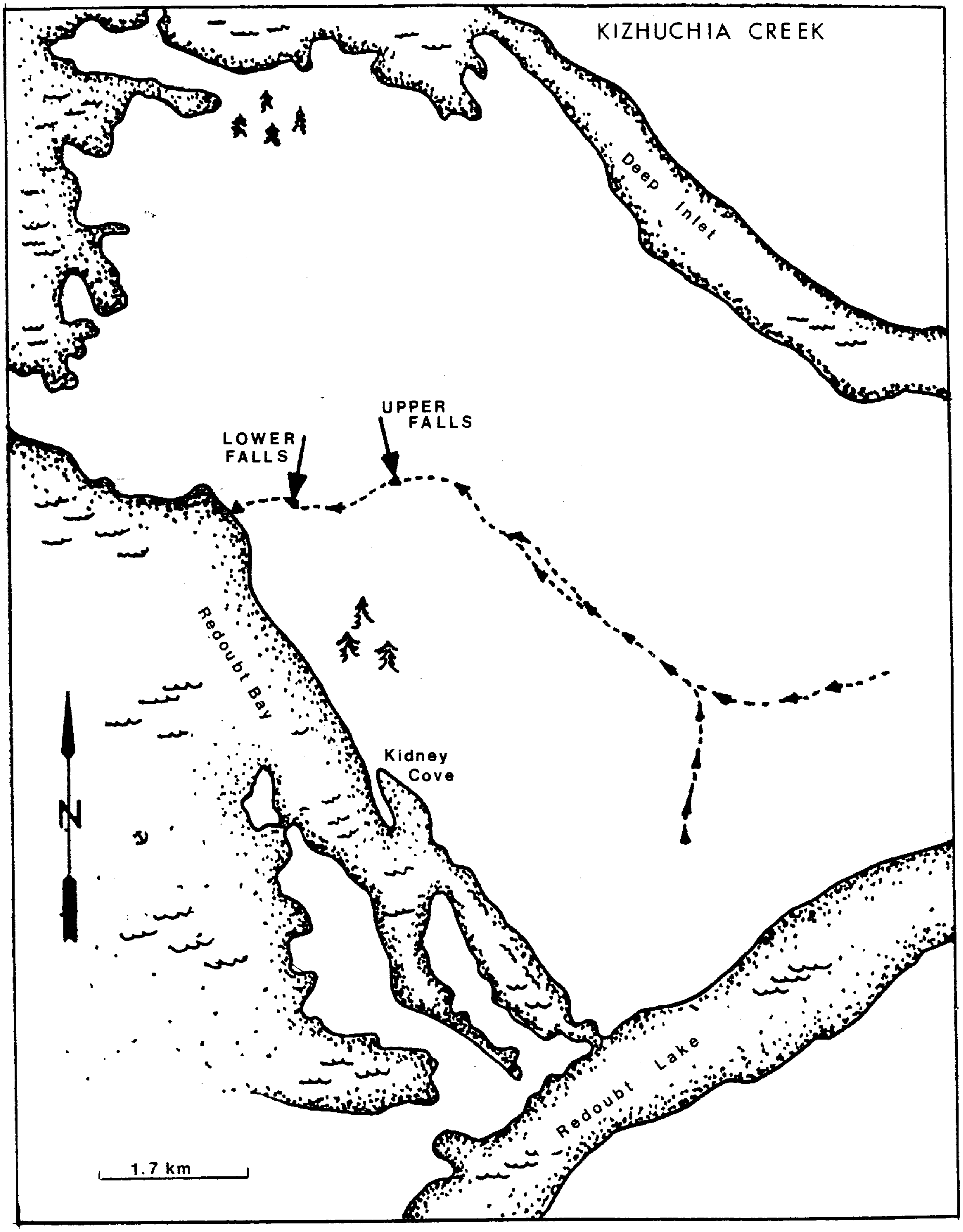

Figure 10. Location of Kizhuchia Creek Fish Ladder

first, a 4.3-m falls, is located about 1.2 km upstream from salt water and is a barrier to pink and chum salmon migration. The second falls is about 1.6 km upstream from the first.

In 1981 the USFS installed a 9.2-m aluminum steeppass on each of these falls. The steeppass units were provided by ADF&G and were designed to give pink and chum salmon access to about 4.8 ha of spawning habitat. Although some coho salmon have always been able to ascend the falls, the steeppasses should also aid the migration of this species. Table 6 presents the results of recent USFS surveys of Kizhuchia Creek.

Navy Creek

Navy Creek is located on Etolin Island (2.4 km east of Burnett Inlet) and drains Navy Lakes (Figure 11). In a 1946 biological survey, Hutchinson (1948) reported that this system had "spawning rubble unexcelled anywhere in the small streams of southeastern Alaska." Unfortunately, access to this habitat was blocked by a 2.4-m foot barrier falls at the mouth of the stream.

There are also three other barrier falls between the first falls and lower Navy Lake. It is the area between the first and second falls (884.5 m of stream) that offers exceptional spawning and rearing habitat. Only a few coho salmon were able to negotiate the first falls, and although there is little spawning area available below, chum and pink salmon spawn only 27.5 m from tidewater.

Construction of a 9.1-m-long steeppass on the first barrier falls was completed by the USFS in July 1975. During the 1984 annual inspection, one pink salmon was observed ascending the falls, and there were pink salmon spawning above the ladder site (Lynn 1984).

Table 6. U.S. Forest Service foot surveys of Kizhuchia Creek.

Date of survey	Species observed	Intertidal area	Intertidal to first ladder	Between upper and lower ladders	Above second ladder	Comments
July 29, 1981	Live Pink	1	9	943	No Fish	Two pink were observed using the first ladder, none on second ladder.
	Dead Pink			4		
August 12, 1981	Live Pink	118	1,270	1,824	1	Several pinks used the lower ladder, none used the second ladder
	Dead Pink		11	26		
	Live Coho			16		
	Live Sockeye			3		
August 27, 1981	Live Pink	Not surveyed	Not surveyed	1,824	280	Many fish attempt falls, none attempt ladder.
	Dead Pink			26	12	
	Live Coho			16	26	
	Live Sockeye			3		
September 2, 1981	Live Pink	Not surveyed	Not surveyed	Not surveyed	866	
	Dead Pink				61	
	Live Coho				128	
September 8, 1981	Live Pink	Not surveyed	Not surveyed	Not surveyed	272	Extremely high flows prohibited accurate counting. No fish were using either ladder. Both ladders were partially blocked by rocks.
	Dead Pink				1	
	Live Coho				40	
September 16, 1981	Live Pink	200	4,261	147	15	Fish were observed using first ladder, but not the second.
	Dead Pink		2,095	80	60	
	Live Coho			41	243	
July 30, 1982	Live Pink		11	No fish	No fish	
	Dead Pink		1			
	Live Coho					
	Live Chum	1				

--------continued--------

Table 6. U.S. Forest Service foot surveys of Kizhuchia Creek.

Date of survey	Species observed	Intertidal area	Intertidal to first ladder	Between upper and lower ladders	Above second ladder	Comments
August 19, 1982	Live Pink	No Fish	321	9		Peak of the run evidently occurred early in September. We missed peak counts this year.
	Dead Pinks		10	4		
	Live Chum		4	6		
	Live Coho		1		1	
September 17, 1982	Live Pink	Not surveyed	Not surveyed	14		
	Dead Pink			42		
	Live Coho			4	57	
August 29, 1983	Live Pink	Not surveyed	175	325	1,800	Flows were slightly high. Both ladders were in good condition but the upper weir needs buttressing.
	Dead Pink		12			
September 25, 1983	Live Pink	Not surveyed	Not surveyed	Not surveyed	55	
	Dead Pink				79	
September 10, 1984	Live Pink		8,450	1,370	50	Peak of run.
	Dead Pink		400	95	5	
	Live Chum		18	10	5	
	Dead Chum		11			
	Live Coho		50	30	111	
	Dead Coho			9		

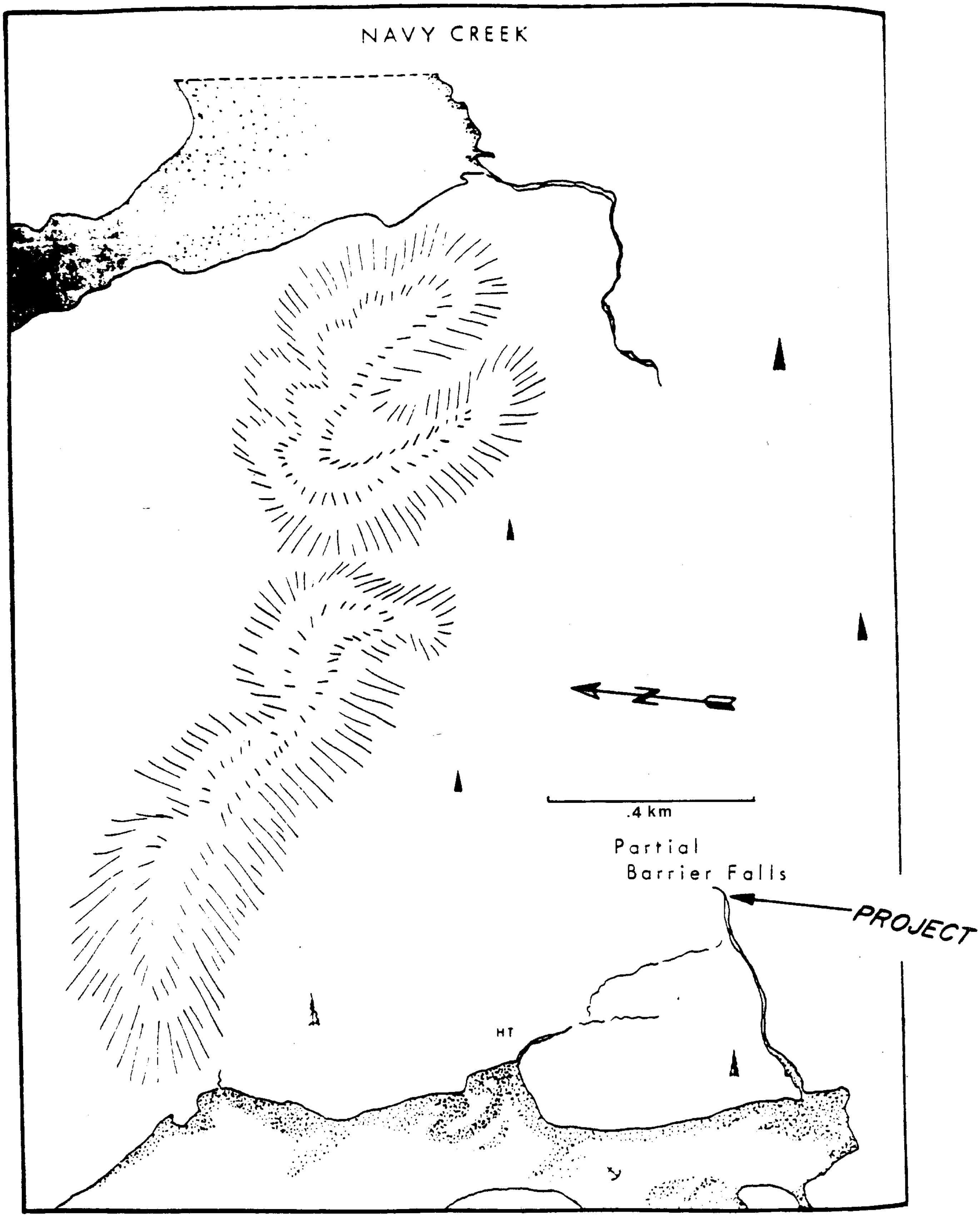

Figure 11. Location of Navy Creek Fish Ladder

Pavlof River

Pavlof River is located on the east coast of Chichagof Island, is approximately 12.9 km long, and flows through Pavlof Lake into Pavlof Harbor in Freshwater Bay (Figure 12). The outlet of the lake is about 91.4 m upstream from the tidal area. A 4.3-m falls located near the lake outlet is a partial barrier to salmon, especially during low tides. Little spawning occurs in the river between the lake and Pavlof Harbor. In 1966 stream surveyors estimated that there were about 2.5 ha of spawning area in the upper portion of the river (Huizer et al. 1970).

Sockeye, coho, and pink salmon and steelhead trout are produced in this system. In a report of a survey completed in the early 1900s, Moser (1902) said that although he did not observe fish in the river, he was told by "best authorities" that this system "will produce 50,000 redfish per season under good conditions." From 1933 through 1966, stream survey records indicate the presence of pink, chum, coho, and sockeye salmon. The surveys were done infrequently and at different times each year, so the numbers are of little use in describing escapement.

With Works Progress Administration (WPA) funding, a concrete pool and weir fish ladder were constructed in 1935 by the Bureau of Commercial Fisheries. Hutchinson (1948) describes the original structure as a series of 14 or 15 stepped pools with a 0.3-m jump height. The ladder was approximately 22.9 m in length. Problems with both the original design and the condition of the ladder were also noted in this survey. Stream surveys in the 1960s reported that, although fish were still using the ladder, its condition had deteriorated.

In August 1974 modifications (funded by the USFS and the ADF&G) were made to the existing fish ladder, and a 18.2-m aluminum Denil ladder was installed. Coho salmon were observed using the ladder soon after it was opened.

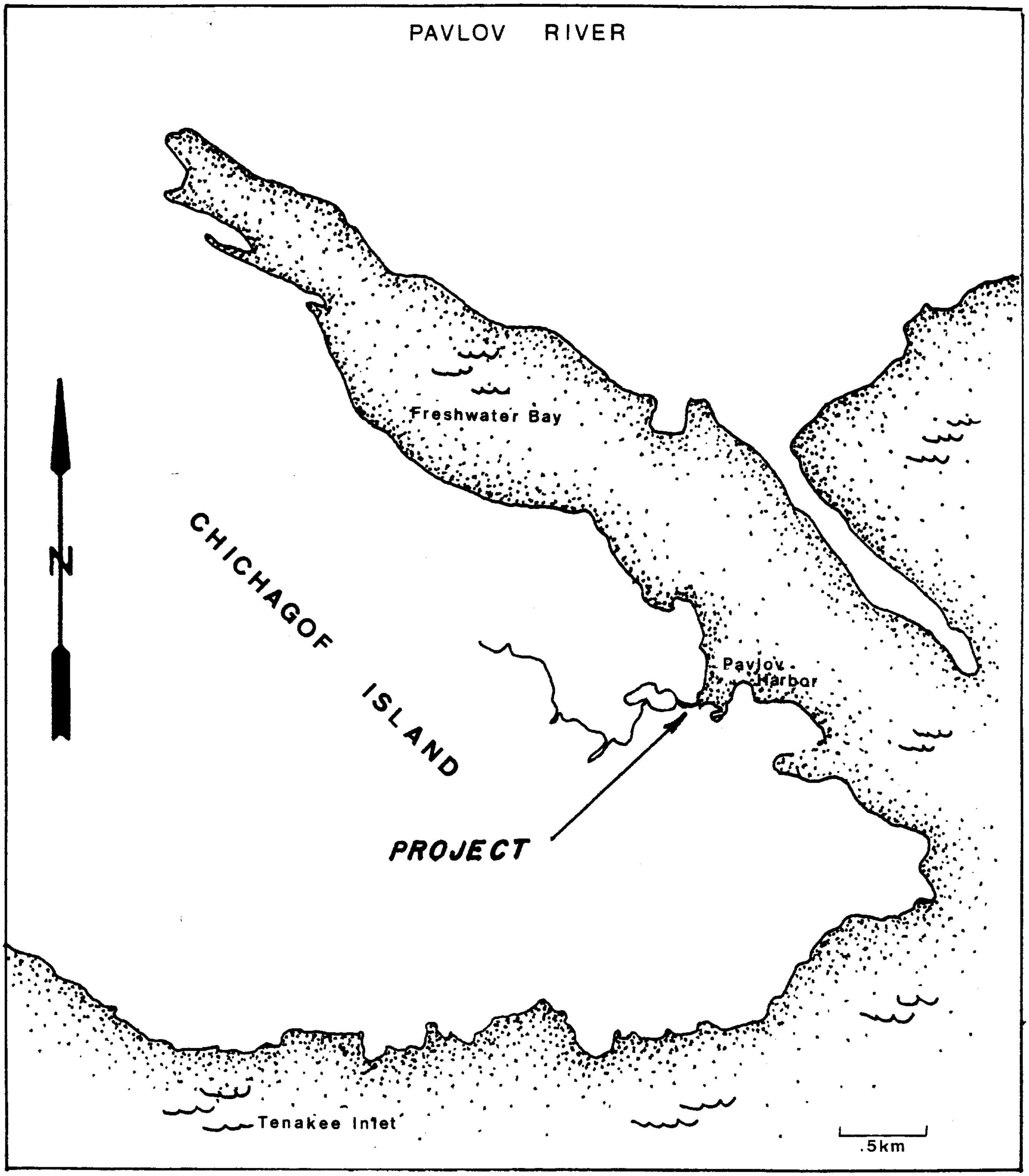

Figure 12. Location of Pavlof River Fish Ladder

In 1984 the USFS submitted a proposal to install a steeppass on a 2.8-m falls located about 2.4 km above Pavlof Lake. The falls is a total barrier to pink and chum salmon and a partial barrier to coho salmon. Constructing a ladder on this falls would provide access to almost 1.2 ha of spawning area (USDA 1984).

Sunny Creek

Sunny Creek is located on the east coast of Prince of Wales Island about 59.6 km southeast of Craig (Figure 13). The stream, which flows into Sunny Cove in Cholmondeley Sound, contains primarily pink and chum salmon but also has small runs of coho and sockeye salmon. Peak escapement counts of pink salmon have ranged from 1,400 to 95,000 fish in 1960 and 1983, respectively. Several hundred chum salmon have also been observed in some years (Appendix B).

There is a 1.8-m waterfall located approximately 0.8 km upstream from the outflow that has blocked upstream migration of most pink and chum salmon. Coho and sockeye salmon migrate beyond the falls. The USFS habitat survey estimates indicate that there are 1.5 ha of spawning habitat above the falls. In 1984 a 9.1-m-long aluminum steeppass was installed to allow pink and chum salmon to continue to upstream spawning areas (Tappel 1984). After construction was completed in 1984, an estimated 2,000 pink salmon used the ladder to reach upstream spawning areas. Applying the USFS habitat capability coefficient of 15,100 harvestable adult pink salmon per hectare to the 1.46 ha made available by the ladder results in potential production of about 22,000 pink salmon adults annually. Construction of this fish ladder was a cooperative project between the USFS and the ADF&G. The steeppass was installed by USFS personnel.

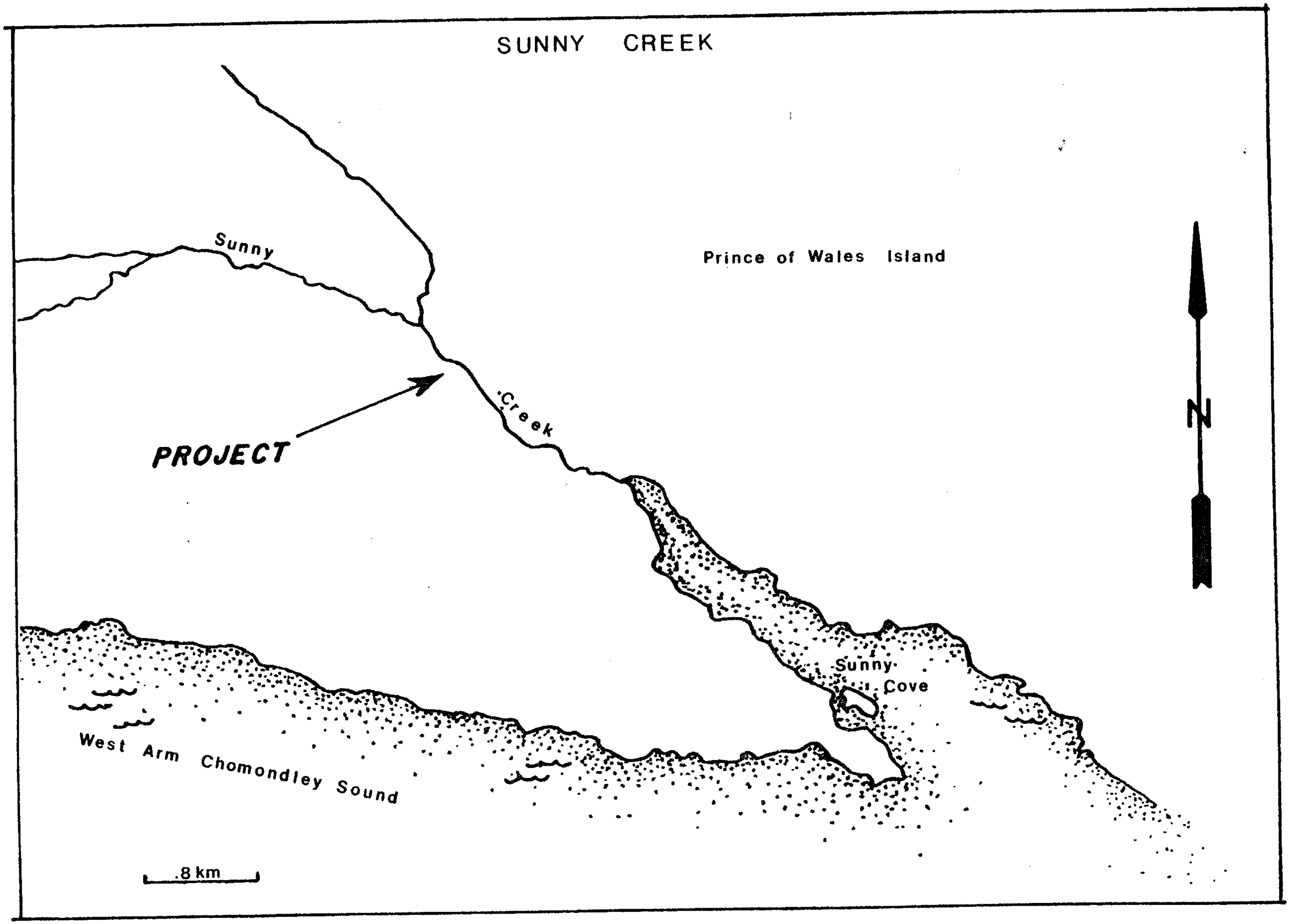

Figure 13. Location of Sunny Creek Fish Ladder

HISTORICAL FISH LADDER SITES

Several streams in southeast Alaska have been sites of unsuccessful fish ladder projects. Ladders have been installed, but in most cases, they were destroyed or washed out and are no longer operative. Among the systems that have had fish ladders installed are Dog Salmon, Kah Sheets, Kanalku, Luck, and Survey Creeks[3].

In 1966 a 9.1-m aluminum steeppass was installed by the USFS on Dog Salmon Creek to accommodate the pink, chum, sockeye, and coho salmon that were already present in the system. This stream flows into Polk Inlet on Prince of Wales Island and is about 4.8 km long. USFS habitat assessment estimates indicate that there was about 0.9 ha of spawning area between the first and second falls (USDA 1964a). The steeppass on Dog Salmon Creek washed out in 1974 and has not been replaced.

Kah Sheets Creek drains Kah Sheets Lake on southern Kupreanof Island. This stream has two falls that act as partial barriers to salmon. Some coho and sockeye salmon ascend the falls, while pink and chum salmon spawn below the falls. The USFS installed two aluminum steeppasses in 1967. Both steeppasses were later damaged by ice and removed.

An aluminum steeppass was constructed on Kanalku Creek in the early 1970s. This stream flows from Kanalku Lake to Kanalku Bay in Mitchell Bay, Admiralty Island. There is a 9.1- to 12.2-m falls about 0.8 km from tidewater that is a partial barrier to salmon migration. This stream contains small runs of sockeye, coho, pink, and chum salmon. The objective of the steeppass was to improve sockeye salmon escapement to Kanalku Lake.

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[3] This is not a complete list because there are several undocumented or poorly documented sites.

The lake is small (about 105.3 ha), and the system was not expected to be a large producer of sockeye salmon (USDA 1964b). Pink salmon would also have benefited from a steeppass, as it would provide access to approximately 0.9 ha of spawning habitat between the falls and the lake. The steeppass installed at the Kanalku Creek falls, however, was destroyed by high-water flows within a few years of construction and was not replaced.

Luck Creek flows about 11.2 km into Luck Lakes on the northeast coast of Prince of Wales Island. In 1965 the USFS blasted a series of pools along one side of a barrier falls to provide access for coho and sockeye salmon and steelhead trout. A 6.1-m-long steeppass was installed in 1972 but was washed out in the same year. (R. Uberuaga, personal communication.)

Survey Creek flows about 10 km into Survey Cove on the southwest coast of Kosciusko Island. Pink salmon and a few coho and chum salmon spawn in this system. There is a 4.9- to 6.1-m barrier falls about 3.3 km upstream from tidewater (USDA 1962a). In 1974, through a USFS and FRED Division cooperative project, a steeppass was installed on this falls. This steeppass can technically be defined as operative because the unit is in good condition; however, fish have not been observed using it to ascend the falls. USFS engineers have examined the ladder and have been unable to determine why it is not being used.

DISCUSSION

The objective of building fish ladders is to increase adult salmon and trout production by allowing access to additional spawning and rearing habitat. Including systems with more than one ladder, there are 12 streams in southeast Alaska with operational fish ladders.

Although periodic escapement surveys have confirmed that adult fish are using the ladders, we do not have precise counts. Obtaining better estimates of fish passed is desirable but not often affordable. The number of fish passed is not always directly related to fry and smolt production. To examine the benefits from fish ladder projects, it might be appropriate to divide them into two categories: (1) those that attempt to pass fish over natural barriers because the opportunity is there, and (2) those that attempt to do the same because mitigation is needed for spawning and rearing habitat lost to timber and other industries. Projects in the first category are planned and constructed based upon certain assumptions; engineering assumptions predict fish passage capabilities, and biological assumptions predict the utilization of the newly opened spawning and rearing area. The projects in the second category should be designed to produce an equal number of fry or smolts lost to industry's activities in the watersheds. Again, budgetary constraints limit our ability to precisely evaluate the benefits of each fish ladder. Perhaps a minimal requirement to demonstrate juvenile fish production equal to that lost to industrial uses of watersheds should be required for mitigation-type fish ladders.

ACKNOWLEDGMENTS

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APPENDICES

APPENDIX A

F.Y. 1984 Direction
Decision Variable 350
Fish Habitat Improvement

General Direction

Anadromous salmon habitat capability coefficients have been developed for use in the FY 1984 anadromous fish habitat improvement program. Species production coefficients and species commodity values are to be used in the evaluation and benefit - cost analysis of each proposed project. Life of project values and discount rates are specified. Forests will use the ADVENT Report 69 for benefit - cost analysis. Forests will display programs using forms enclosed.

NATURAL HABITAT - PRODUCTION COEFFICIENTS AND VALUES

SPECIES	HARVESTABLE ADULTS (Number/Acre)	WEIGHT (lbs.)	COMMODITY VALUE (Cents/lb.)
Pink	6,103	3.9	52
Chum	4,518	8.6	77
Coho	165	8.3	136
Sockeye	50	6.5	116
King	165	16.6	168

ENHANCED HABITAT - PRODUCTION COEFFICIENTS

	HARVESTABLE ADULTS PER ACRE	
	LAKE FERTILIZATION	BARREN LAKE UTILIZATION
Coho	NA	50
Sockeye	100	50
King	NA	50

BENEFIT - COST ANALYSIS CRITERIA

1. Life of Project

Stream rehabilitation, stabilization	5 yrs.
Fish passage improvement (non-structural)	25 yrs.
Fish passage improvement (structural)	
Alaska steeppass	25 yrs.
Major construction fishway	25 yrs.
Major construction fishway	50 yrs.
Lake fertilization	5 yrs.
Barren lake habitat utilization	3 yrs.

2. Discount Rates (Percent) (In addition to Standard 4% also use Alaska Region discount rate for a separate analysis.)

Alaska Region evaluation 10%

SOUTHEAST ALASKA SALMON EXVESSEL VALUES 1974-82 a/

SPECIES YEAR	CHINOOK	SOCKEYE	COHO	PINK	CHUM
		(DOLLARS	PER POUND)		
1974	0.99	0.70	0.74	0.35	0.42
1975	0.98	0.60	0.73	0.32	0.51
1976	1.50	0.80	1.15	0.35	0.60
1977	1.82	0.93	1.28	0.34	0.61
1978	1.95	1.34	1.22	0.33	0.79
1979	2.22	1.43	1.64	0.37	0.88
1980	1.89	0.79	1.01	0.38	0.70
1981	1.96	1.29	0.86	0.42	0.51
1982 b/	2.33	1.13	1.09	0.29	0.61
Ave. 1974-82	1.75	1.00	1.08	0.35	0.63
Ave. 1980-82	2.06	1.07	0.99	0.36	0.61

a/ Exvessel price data is derived from Alaska Department of Fish and Game Alaska Catch And Production Statistics Statistical Leaflet Series for the years 1974-81.

b/ The 1982 values are taken directly from State of Alaska Commercial Fisheries Entry Commission Exvessel price summaries. The 1982 prices are averages for all gear types combined without consideration as to weighting by proportion of harvest by gear type.

APPENDIX B

Appendix Table B1. Pink salmon escapement peak surveys on selected southeast Alaska streams.

Year	Anan Creek (107-60-10840)	Bakewell Cr. (101-55-10730)	Dean Creek (109-50-10070)	Falls Creek (106-44-10060)	Irish Cr. (105-32-10120)	Ketchikan Cr. (101-47-10250)	Kizhuchia Cr. (113-41-10420)	Navy Cr. (106-22-10160)	Pavlof R. (112-50-10100)	Sunny Cr. (102-40-10870)
1960	93,000	NS*	NS	NS	NS	NS	None Seen	6	None Seen	1,400
1961	60,000	None Seen	NS	NS	NS	500	NS	8,100	None Seen	11,500
1962	200,000	NS	NS	NS	NS	NS	None Seen	None Seen	None Seen	16,000
1963	258,000	None Seen	NS	NS	NS	NS	203	57,500	None Seen	18,500
1964	167,000	300	NS	NS	NS	NS	NS	200	NS	20,000
1965	95,000	1,500	NS	NS	6	NS	None Seen	21,900	31	11,100
1966	180,000	NS	NS	NS	200	NS	NS	161	None Seen	12,000
1967	82,000	NS	NS	NS	NS	NS	250	7,000	None Seen	1,800
1968	193,000	NS	500	NS	NS	NS	NS	3	500	9,700
1969	98,000	NS	NS	NS	NS	NS	NS	14,000	None Seen	40,000
1970	190,000	4,600	NS	NS	NS	NS	NS	300	None Seen	15,400
1971	210,000	None Seen	NS	NS	2,000	NS	5,000	25,100	500	73,000
1972	131,000	NS	500	NS	None Seen	NS	None Seen	40	NS	6,485
1973	222,000	7,180	NS	NS	NS	NS	2,605	46,000	None Seen	18,000
1974	86,000	4,000	NS	70	30	NS	1,000	250	NS	13,000
1975	126,300	6,000	NS	3	3	1,302	6,000	7,830	NS	43,000
1976	338,000	63,000	NS	NS	None Seen	NS	3	5,000	NS	72,000
1977	362,000	15,000	NS	303	20	6,800	20,000	28,844	None Seen	50,050
1978	193,000	3,200	800	100	1,250	1,800	1,000	2,728	NS	70,000
1979	109,000	3,275	NS	NS	2,000	16,000	4,000	48,890	None Seen	32,000
1980	91,000	8,000	50	None Seen	200	8,267	1,000	250	300	90,000
1981	71,630	15,000	NS	NS	None Seen	1,471	6,858	18,730	200	32,741
1982	159,500	9,276	NS	1,800	NS	11,479	1,003	9,006	100	35,065
1983	115,200	24,050	2,700	None Seen	NS	14,023	34,410	25,364	2,505	95,000
1984	104,690	21,000	NS	None Seen	3	13,552	10,000	9,460	500	51,000
1985	124,000	23,000	500	NS	930	1,970	82,585	9,650	1,000	80,000

* No Survey

Source: ADF&G, Commercial Fisheries Division, Region I Salmon Escapement Peak Survey, 1/8/86.

Appendix Table B2. Chum salmon escapement peak surveys on selected southeast Alaska streams.

Year	Anan Creek (107-20-001)	Bakewell Cr. (101-55-060)	Corner Creek (112-42-016)	Irish Cr. (105-32-012)	Ketchikan Cr. (101-47-025)	Kizhuchia Cr. (113-41-042)	Navy Cr. (106-22-016)	Pavlof R. (112-50-010)	Sunny Cr. (102-40-087)
1960	None Seen	NS*	None Seen	None Seen	NS	None Seen	None Seen	None Seen	None Seen
1961	None Seen	None Seen	1,500	None Seen	NS	NS	None Seen	None Seen	None Seen
1962	None Seen	NS	None Seen	NS	NS	None Seen	None Seen	None Seen	None Seen
1963	None Seen	None Seen	700	10	NS	None Seen	None Seen	None Seen	500
1964	None Seen	40	None Seen	None Seen	NS	NS	20	NS	200
1965	None Seen	None Seen	None Seen	NS	NS	None Seen	None Seen	2	50
1966	None Seen	NS	None Seen	8,500	NS	NS	None Seen	None Seen	200
1967	None Seen	NS	10	None Seen	NS	None Seen	100	None Seen	650
1968	None Seen	NS	13	None Seen	NS	NS	None Seen	None Seen	5,000
1969	None Seen	NS	25	None Seen	NS	NS	None Seen	None Seen	1,500
1970	None Seen	None Seen	None Seen	None Seen	NS	NS	None Seen	None Seen	300
1971	None Seen	None Seen	150	None Seen	NS	None Seen	None Seen	None Seen	20
1972	None Seen	NS	3,006	6	None Seen	None Seen	5	NS	108
1973	None Seen	520	None Seen	NS	NS	3	None Seen	None Seen	None Seen
1974	None Seen	None Seen	90	6,000	NS	None Seen	50	NS	None Seen
1975	None Seen	None Seen	25	3	2	None Seen	30	NS	6
1976	None Seen	None Seen	8	160	NS	None Seen	6	NS	None Seen
1977	None Seen	None Seen	20	560	None Seen	None Seen	None Seen	None Seen	None Seen
1978	None Seen	None Seen	50	550	None Seen	None Seen	42	NS	63
1979	None Seen	None Seen	500	3,000	None Seen	None Seen	2	None Seen	None Seen
1980	10	None Seen	150	1,000	None Seen	None Seen	None Seen	300	None Seen
1981	None Seen	None Seen	150	638	None Seen	None Seen	46	None Seen	721
1982	None Seen	14	28	NS	4	10	292	None Seen	233
1983	None Seen	None Seen	100	NS	1	None Seen	72	40	None Seen
1984	3	66	500	None Seen	6	44	211	None Seen	900
1985	None Seen	102	1,000	170	1	59	67	None Seen	312

* No Survey

Source: ADF&G, Commercial Fisheries Division, Region I Salmon Escapement Peak Survey, 1/8/86.