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EVALUATION OF PINK SALMON (Oncorhynchus gorbuscha)
FRY PLANTS AT SEAL BAY CREEK, AFOGNAK ISLAND, ALASKA

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ABSTRACT

For two consecutive brood years, 1975 and 1976, pink salmon eggs were incubated at a hatchery facility and the fry released into Seal Bay Creek. Ocean survival of fin marked groups was 0.86% and 0.06% from transplants of 778,340 and 271,650 fry, respectively. The variation in fry to adult survival was assumed to be associated primarily with the condition of fry at release. Observed straying of transplanted pink salmon to the incubation site was less than 1% of the total return for both years. Marked (transplanted) returning adults preferred spawning areas downstream from the point of release. Of the total marked return, 76.9% spawned in areas traditionally utilized by returns of naturally produced pink salmon. Results of this study indicate that pink salmon fry incubated in a separate water source and released into the parent system will successfully imprint to the stream of origin but not necessarily to a specific point of release within the stream.

Key words: salmon enhancement, salmon fry transplant, imprinting, *Oncorhynchus gorbuscha*, Seal Bay Creek.

INTRODUCTION

Methods of transplanting pink salmon (*Oncorhynchus gorbuscha*) have met varying degrees of success in establishing substantial adult returns to recipient systems. Transplant methods include the transfer of fertilized (eyed) eggs from one system to another (Walker and Lister 1971; Lear 1975), fry plants (Ellis and Noble 1959), transfer of mature adults from donor to recipient streams (McNeil, Smedley, and Ellis 1969), and the use of hybrid stock created by crossing females from a donor stock with males of the local resident stock (Bams 1976).

In 1975 the Alaska Department of Fish and Game (ADF&G) initiated a pink salmon enhancement project at Seal Bay Creek, Afognak Island. An existing run of pink salmon was to be enhanced through fry plants. This included establishment of spawning population above a previously laddered barrier falls. A second objective of the project was to test the success of imprinting. Pink salmon fry were incubated at a central incubation facility, then released into the parent system as emergent fry prior to saltwater exposure. Seal Bay brood stock was selected because genes from resident parent stock in the transplanted population would reduce straying and result in a greater return than would be expected from fry plants using exogenous stocks.

MATERIALS AND METHODS

Study Area

Seal Bay Creek is located on the northern end of Afognak Island (near Kodiak Island) at 152°13'W and 58°20'N (Figure 1). Resident anadromous fish populations include pink and coho (*Oncorhynchus kisutch*) salmon, steelhead trout (*Salmo gairdneri*), and Dolly Varden (*Salvelinus malma*). As is common in most Afognak Island streams, the Seal Bay pink salmon run is dominant during even-numbered years. Peak even-year escapement surveys indicate a high of 15,000 pink salmon in 1968 and a low of 2,059 pink salmon in 1974. Prior to 1976 only two escapement surveys were conducted on odd-numbered years. Returns of 3,323 and 1,688 pink salmon were recorded in 1971 and 1975, respectively.

Pink salmon returning to Seal Bay Creek spawn primarily in the intertidal area, with a variable number of fish moving upstream to spawn. Until 1972, upstream spawning sites were limited to a 0.68 km length of stream between the intertidal zone and a 2.4 m falls (Figure 1) which was impassable to migrating pink salmon. In 1972 the ADF&G and the U.S. Forest Service cooperated in the installation of a single 9.1 m long steep pass fishway of Denil design described by Ziemer (1962). The fishway was installed to allow passage of pink salmon to unutilized spawning areas in the upper section of the stream.

A survey of potential spawning area was conducted in 1975 to estimate optimum pink salmon escapement into Seal Bay Creek. Known spawning areas below the

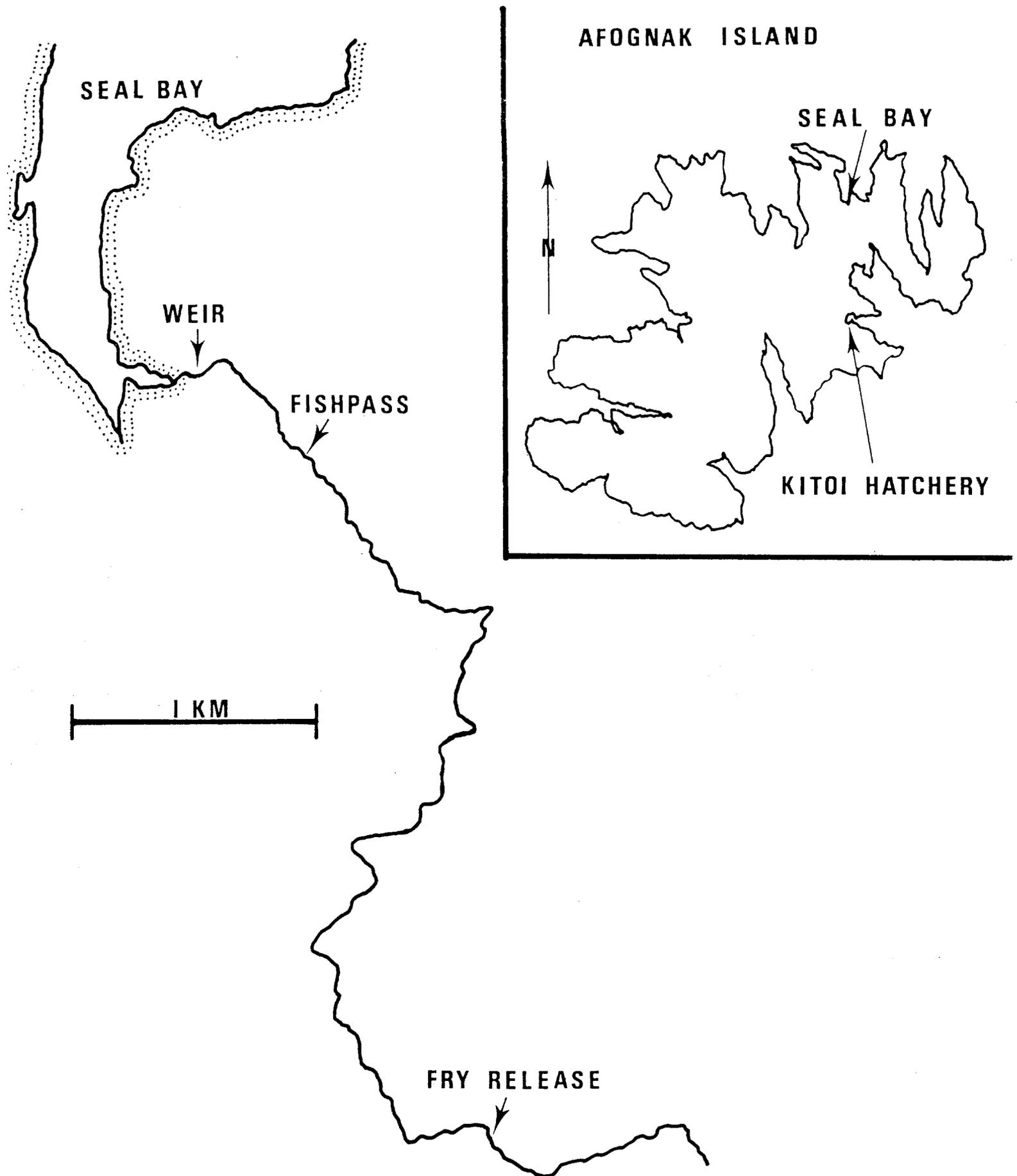


Figure 1. Seal Bay Creek and location of fry release, fishpass, weir, and the Kitoi Bay Hatchery.

barrier falls and potential spawning areas above the falls were measured and recorded. Potential upstream and downstream escapement levels were calculated from available spawning area based on a spawner density of one pair of pink salmon per square meter (McNeil 1965).

Egg Source and Treatment

Pink salmon eggs were taken at Seal Bay Creek from the 1975 and 1976 returns. Brood stock was captured in the intertidal area and spawned as the fish matured. Gamete collection coincided with natural spawning. The eggs were fertilized on site and flown to the Kitoi Bay Hatchery (Figure 1) to continue development.

After reaching the eyed stage the eggs were shocked, dead eggs removed, and the remaining live eggs enumerated. The eyed eggs were then seeded into incubation units described by Blackett (1974). Emergent fry were collected in receiving troughs, enumerated, and transferred to freshwater rearing troughs to be held for transport. A percentage of the emergent fry were marked by removal of the adipose and dorsal fins. Marking quality was monitored by taking a random sample of 20 fish per 2-hour marking period for each marker and examining the fish for completeness of fin removal. A discount was applied to a clip where 25% or more of the fin was remaining as described by Bams and Crabtree (1976). The adjusted discount was applied to the total fry marked for the time period of examination to obtain a corrected number of validly marked fry. Marked and unmarked fry were held in separate troughs to establish accurate release figures per group. All fry were fed a maintenance diet of frozen fish until 1 day prior to transport. When fry emergence from the incubation units was approximately 80% complete the fry were transported by helicopter to upper Seal Bay Creek and release approximately 5.6 km upstream from the intertidal area.

Adult Returns

In July 1977 an aluminum conduit counting fence was constructed at the mouth of Seal Bay Creek to evaluate pink salmon adult returns (Figure 1). All pink salmon returning in 1977 and 1978 were enumerated and examined for fin marks. Approximately 25% of the returning marked fish were tagged with plastic streamer tags and released above the weir. The distribution of marked and unmarked pink salmon was monitored during weekly foot surveys of the stream in order to determine the distribution of spawning fish. No attempts were made to evaluate the contribution of transplanted fish to the commercial fishery. All pink salmon returning to the Kitoi Bay Hatchery were examined for the adipose-dorsal mark to determine the incidence of straying of transplanted fish back to the incubation source.

RESULTS

Evaluation of Potential Spawning Area

Estimated optimum pink salmon escapement for Seal Bay Creek was calculated from survey estimates of known and potential spawning area. A total of

20,400 m² of potential spawning habitat was identified; 5,700 m² below the falls and 14,700 m² above the falls. Based on a spawning density of one pair of pink salmon per square meter, Seal Bay Creek could theoretically support an escapement of 40,800 pink salmon, 29,400 above the falls and 11,400 below the falls. This analysis does not take into account quality of spawning habitat and considerable variability may exist within the system.

Fry Release and Adult Return

A total of 1.05 million pink salmon fry was released into Seal Bay Creek from the 1975 and 1976 broods. Fry releases, adult returns, and ocean survival estimates are presented in Table 1.

Ocean survival data are based on the rate of return of marked adults to the creek as a percentage of the number of marked fry released. These estimates are assumed to be low because of differential mortality between marked and unmarked fry, and because commercially harvested fish were not enumerated. Ocean survival data were used to estimate returns from transplanted fry. The remainder of the run was assumed to be from natural production.

In 1977, 14,314 pink salmon returned to Seal Bay Creek between 26 July and 19 September, of which 508 (3.5%) were marked. Projecting from the ratio of marked-to-unmarked fry released the run was comprised of 6,538 (46%) hatchery incubated fish and 7,776 stream produced fish. Fry to adult survival of hatchery produced pink salmon was 0.84%.

A total of 13,129 pink salmon entered the system between 31 July and 11 September 1978. Twenty-five marked fish were recovered at the weir for a projected hatchery contribution of 163 pink salmon or 1.24% of the run. It is estimated that 98.76% of the pink salmon returning from the 1976 brood were the result of stream production. Fry to adult survival of hatchery produced pink salmon was 0.06%.

Poor ocean survival was anticipated for the 1976 brood because of logistical problems involved with fry transport and release. Emergent fry had to be retained at the hatchery for a period of 30 days until a helicopter was available for transport. Near the end of the holding period the fry began rejecting food and were in a stressed condition prior to transport and release. It is suspected that heavy fry mortality occurred during downstream migration and early estuarine residence.

Some straying of transplanted fry occurred from both brood year releases. In 1977, two adipose-dorsal marked fish were recovered at the Kitoi Bay Hatchery. In 1978, one adipose-dorsal marked fish was recovered at the facility. Straying was not restricted to the transplanted stock. Three marked fish of Kitoi Hatchery stock origin were recovered from the 1977 Seal Bay return. These fish were marked with adipose-ventral combinations as part of the hatchery evaluation of incubation density/substrate tests. No hatchery released fish were recovered in the 1978 Seal Bay return.

Table 1. Fry release, adult returns, and ocean survival estimates for 1975 and 1976 brood year pink salmon fry released into Seal Bay Creek.

Brood year	No. unmarked release	No. marked release	Marked return	Total projected return	% ocean survival
1975	718,191	60,149	508 (1977)	6,538	0.84%
1976	232,865	38,785	25 (1978)	163	0.06%

Spawner Distribution

Surveys conducted to evaluate the distribution of transplanted fish on the spawning grounds indicated that marked adults did not show a preference for spawning habitat near the point of release. In 1977, tagged transplanted fish were observed from the intertidal area to approximately 3.4 km upstream. The concentration of marked fish was high in spawning areas below the fish ladder. The distribution of marked and unmarked pink salmon in Seal Bay Creek are presented below for the 1977 and 1978 returns in Table 2.

Overall, 69.5% of the spawning population utilized spawning areas below the falls while the remaining 30.5% migrated upstream above the falls into areas historically unutilized. Of the total number of tagged (marked) fish observed on the surveys, 76.9% were observed in the downstream area below the falls while 23.1% were observed in areas above the falls.

The 1976 brood release produced few returning adults and consequently only 25 marked fish were recovered at the weir. The distribution of tagged fish was difficult to monitor because of the low density of marked fish within the study area. Over the entire study period only two tagged fish were observed below the falls. Of the total 1976 brood return, 78.5% spawned in the downstream area and 21.% spawned above the fish ladder.

DISCUSSION

The homing of marked adult fish to Seal Bay Creek from the 1975 and 1976 brood transplants suggests that emergent pink salmon fry successfully imprinted to the system. The low number of transplanted fish returning to the incubation water source is probably within the natural limits of straying for the species, though no quantitative data are available on the incidence of straying of local natural stocks. The possibility of transplanted fish returning to streams near Seal Bay Creek was investigated. Two small streams adjacent to Seal Bay Creek were surveyed periodically, but no marked fish were observed.

The ocean survival (0.86%) of transplanted fry from the 1975 brood release was similar to the ocean survival of two marked groups of pink salmon fry incubated in gravel incubators at the Kitoi Bay Hatchery (0.79% and 1.27%) and wild fry marked and released from Big Kitoi Creek (0.91%) for the same brood year. The low ocean survival of marked transplanted fry from the 1976 brood release is much lower than estimated ocean survivals of hatchery-produced or wild pink salmon fry for four consecutive years of fry to adult survival studies conducted at the Kitoi Bay facility.

Parker, Black, and Larkin (1963) have discussed differential mortality rates of marked and unmarked pink salmon in relation to stress and predation. The effects of extended freshwater rearing of the 1976 brood fry may have significantly increased the mortality rate of marked fry after release, resulting in the low return of marked adults.

Table 2. Distribution of marked and unmarked pink salmon in Seal Bay Creek, 1977 and 1978.

Year of return	Downstream of fish ladder		Upstream of fish ladder	
	Total fish observed	Tagged fish observed	Total fish observed	Tagged fish observed
1977	13,653	100	5,979	30
1978	6,151	2	1,688	4

The variation in ocean survival between brood years demonstrates the importance of conducting salmon fry transplants that parallel the early life history of the particular stock involved. Important factors in producing substantial adult returns from fry transplants are timing and condition of fry at release.

The distribution of adult pink salmon within Seal Bay Creek did not indicate a preference by marked fish for spawning areas close to the point of release. This information suggests that pink salmon are not site specific in returning to spawn near natal areas. Upstream migration to unutilized spawning areas was probably a density dependent factor. The higher-than-average density of salmon in the creek as a result of fry plants may have contributed to the use of upstream spawning areas not utilized by previous returns.

Adult returns from transplants of fry supports the concept of a central incubation facility as a tool for rehabilitating or enhancing pink salmon runs of depressed or underutilized streams but the cost and physical restrictions of transporting large numbers of fry, particularly in Alaska, should be carefully considered in project planning phases.

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