Exxon Valdez Oil Spill
Restoration Project Annual Report

Coded Wire Tag Recoveries from Pink Salmon in Prince William Sound Salmon Fisheries, 1996

Restoration Project 96186
Annual Report

This annual report has been prepared for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have not been addressed in this annual report.

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David G. Evans

Alaska Department of Fish and Game
Division of Commercial Fisheries Management and Development
401 Railroad Avenue
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Study History: The coded wire tag program in Prince William Sound was initiated in 1986 to partition returns of pink salmon into wild and hatchery stocks, and to determine the size of hatchery returns. After the *Exxon Valdez* oil spill, the program was incorporated into Natural Resource Damage Assessment Fish/Shellfish Study Number 3 (F/S 3), to document effects of the spill on wild pink salmon by comparing returns to oiled and unoiled streams, as well as to estimate size of hatchery and wild stock returns. The project effort was continued under Restoration Study Number 60A (Coded wire tag studies on Prince William Sound salmon, 1992), Restoration Project 93067 (Coded wire tag recoveries from pink salmon in Prince William Sound salmon fisheries, 1993), Restoration Project 94320B (Coded wire tag recoveries from pink salmon in Prince William Sound salmon fisheries, 1994) and Restoration Project 95320B (Coded wire tag recoveries from pink salmon in Prince William Sound salmon fisheries, 1995).

Abstract: During 1995, about 0.6 billion pink salmon fry were released into Prince William Sound from A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch hatcheries; 1,017,782 were tagged with half-length coded wire tags. During 1996, tags from the 1995 releases were recovered in the commercial catch, and preliminary estimates based upon detected tags were given to the management biologists. Postseason analysis of the 27.26 million pink salmon taken for commercial fisheries and brood stock indicated that A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch hatcheries, contributed 1.98 million, 5.73 million, 4.70 million, 7.24 million pink salmon, respectively, and that wild stocks contributed 7.62 million pink salmon. The 1996 Cannery Creek hatchery contribution may have been underestimated, as a result of tag loss. An historical adjustment factor of 1.87 was used to compensate for differential mortality and tag loss for tagged salmon from all hatcheries, and was calculated as the average of adjustment factors for W.H. Noerenberg hatchery from 1989 to 1996. The overall survival rates for pink salmon released from A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch hatcheries were 1.82%, 3.29%, 3.6% and 3.51%, respectively.

Key Words: Coded wire tag, commercial harvest, hatchery, *Oncorhynchus gorbuscha*, pink salmon, Prince William Sound, wild stock.

Project Data: The collected data are stored in 2 RbaseTM database tables. One table contains data about the samples, while the other contains data about the individual salmon heads which were collected. The sample table fields include: sample identity number, number of heads collected, number of heads which contained tags, species, harvest type, harvest location, week, processor, date sold, number of salmon sampled, gear type, tender name, port, and percentage of catch coming from the separate Prince William Sound districts. The table with information on

individual salmon heads contains the following fields: sample identity number, head number, harvest type, district, week, date sold, processor, tag code (or reason for lack thereof), hatchery of origin, length of salmon, quality of adipose finclip, and stream number (as catalogued by the Alaska Department of Fish and Game). In addition to the sample and head tables, data taken from fish tickets, daily brood stock information, processor codes, hatchery codes, species codes, and statistical week designations are also included in the RbaseTM database. A separate RBase TM database exists for each year. The data are available in database format, or as ASCII files.

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EXECUTIVE SUMMARY

This report documents Restoration Study 96186, one of the projects designed to restore the pink salmon *Oncorhynchus gorbuscha* resource of Prince William Sound to its pre-spill status. Coded wire tags applied in 1995 at four hatcheries in Prince William Sound, the W.H. Noerenberg, Cannery Creek, A. F. Koernig, and Solomon Gulch facilities, were recovered in the commercial catch of 1996 and used to provide inseason estimates of hatchery contributions. These estimates were used by fishery managers to target numerically superior hatchery returns, and thus to reduce pressure placed upon oil-damaged wild stocks. Inseason estimates were made in two stages. Preliminary estimates were based solely on detected tags (not extracted) in collected salmon heads and were made available to managers upon completion of sampling. These estimates were updated approximately three days later with coded information obtained from extracted tags.

Postseason analysis revealed that from a commercial catch of 27.26 million pink salmon, approximately 7.62 million salmon were estimated to be of wild origin. Of the hatchery component (estimated at 13.51 million pink salmon), 1.98 million, 5.73 million, 4.70 million, and 7.24 million originated from the A.F. Koernig, W.H. Noerenberg, Cannery Creek and the Solomon Gulch hatcheries, respectively. Overall adult survival rates of hatchery reared pink salmon were 1.82%, 3.29%, 3.6%, and 3.51%, for the A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch facilities, respectively.

INTRODUCTION

Between 1961 and 1976, prior to the establishment of hatcheries in Prince William Sound, the commercial seine harvest averaged about 3.4 million pink salmon *Oncorhynchus gorbuscha*. In the early 1970's, run failures led to an aggressive enhancement program which included construction of hatcheries. By 1986, five hatcheries were operating (Figure 1): the Solomon Gulch hatchery, which produced pink salmon, and later also chum salmon *O. keta*, and coho salmon *O. kisutch*: the A. F. Koernig hatchery, which produced pink salmon: the W.H. Noerenberg hatchery, which produced pink salmon, and later also chum coho and chinook salmon *O. tschawytscha*: the Cannery Creek hatchery, which produced pink salmon: and, the Main Bay hatchery, which originally produced chum and presently raises sockeye salmon *O. nerka*.

Supplemental hatchery salmon production complicated management of commercial salmon fisheries in Prince William Sound. Hatchery salmon stocks can tolerate much higher harvest rates than wild salmon stocks. Ideally, different management strategies would be applied to them, which requires that hatchery and wild stocks be separated in time or space.

In order to collect information about the actual spatial and temporal distributions of hatchery and wild salmon, a coded wire tagging program was initiated in 1986 for hatchery releases of pink salmon, with recovery of tagged returning adults in commercial and cost recovery fisheries beginning in 1987. Tag recovery data enabled managers to estimate hatchery and wild contributions to catches from strata within the fishery.

The March 24, 1989, *Exxon Valdez* oil spill exacerbated the many problems faced in managing this complex fishery. The spill contaminated intertidal portions of streams where most wild salmon stocks in western Prince William Sound spawn as well as the marine waters traversed by juvenile salmon on their migration seaward through the Sound. Decisions made by fishery managers suddenly became more complicated insofar as they affected wild populations injured by the oil spill. The coded wire tagging program was expanded to include tagging of wild salmon, in order to examine survival rates of wild salmon in oiled versus unoiled streams, under the Natural Resource Damage Assessment study F/S 3 (Sharr et al, 1995a), and Restoration Study R60A (Sharr et al, 1995c). In recent years, the emphasis of the program has been to provide management biologists with timely data on the relative abundance of wild and hatchery stocks, so that they could target fishing effort on hatchery stocks and protect recovering wild stocks. For 1996, the program was supported by R96186, along with matching funds from the Prince William Sound Aquaculture Corporation (PWSAC), Valdez Fisheries Development Association (VFDA), and the State of Alaska.

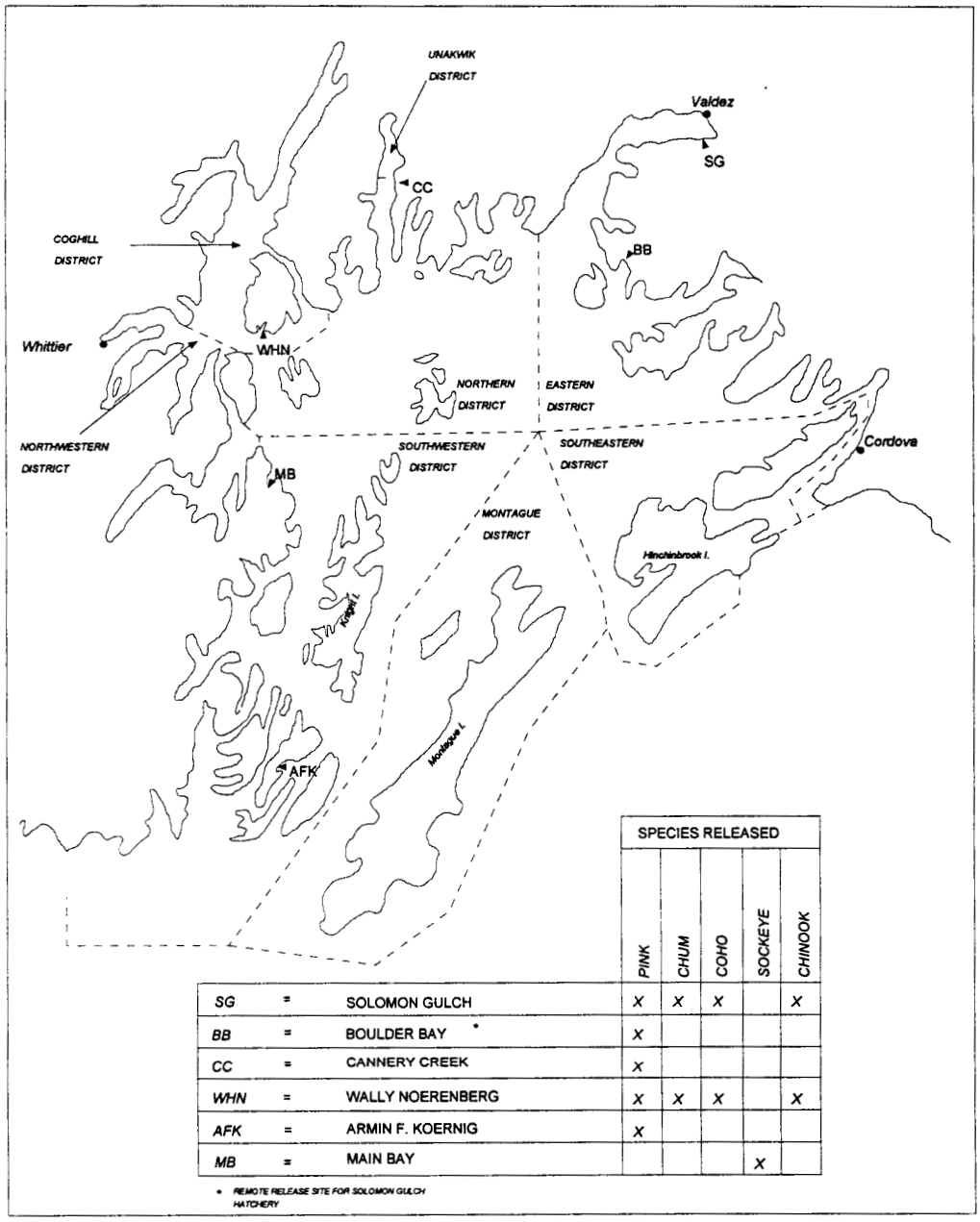

Figure 1. Fishing districts and hatcheries of Prince William Sound, Alaska

This report documents the activities and results of the coded wire tag program for the 1996 recovery year. It focuses primarily upon hatchery contributions to the different fisheries, survival rates of different hatchery release groups, and inseason estimation of contributions. Aggregated data are presented in the main body of the document, while more specific data are placed in the appendix.

OBJECTIVES

1. To provide estimates of wild and hatchery components of the pink salmon commercial fisheries of 1996 to fishery managers on an inseason basis, so that fishing effort could be directed towards hatchery stocks.

2. To estimate marine survival rates for each uniquely coded hatchery release group returning in 1996.

3. To evaluate the method selected in 1993 for inseason analysis of coded wire tag data, whereby an historical adjustment factor and numbers of detected (undecoded) tags are used to estimate the hatchery and wild contributions.

METHODS

Tagging

Technicians hired by the aquaculture associations tagged pink salmon fry at the three PWSAC facilities (W.H. Noerenberg, Cannery Creek, and A. F. Koernig hatcheries) and at the VFDA facility (Solomon Gulch hatchery). Tagging rates and recovery efforts were selected that would yield contribution estimates of sufficient precision to allow fishery managers to make meaningful inseason decisions. Assuming a potential sampling rate of approximately 20% for commercial and cost recovery harvests, and following an analysis of the performance of previous tagging studies (Peltz and Miller 1990; Peltz and Geiger 1990; Geiger and Sharr 1990), an overall tagging rate of approximately 1 coded wire tag per 600 salmon (0.001667) was chosen. A different tag code was given to each release group, which represented a batch of salmon subjected to a certain feeding regimen (early feeding, late feeding or no feeding), and release timing. During 1995, four lots of salmon were part of a continuing Sound Ecosystem Assessment (SEA) experiment to ascertain whether juveniles above 60 mm in length had greater survival rates than smaller juveniles. In contrast to 1994 tagging, these salmon were not tagged at a different rate than other release groups.

Pink salmon fry to be tagged were randomly selected as they emerged from incubators. Fry were anesthetized in a 1 ppm solution of MS-222 prior to removal of adipose fins and application of tags. Half-length coded wire tags were applied with a Northwest Marine Technology tag injector (model MKIV). Adipose finclipped and tagged salmon were passed through an electronic quality control device to test for tag retention. Rejected salmon were held and retested later. If rejected a second time, they were killed to minimize the number of untagged clipped salmon in the release. Fry which retained tags were held overnight at PWSAC and for 72 hours at VFDA, to determine short-term mortality and tag loss. Hatchery personnel determined mortality rates by counting the number of salmon floating on the surface (floaters) after the holding period. The tag loss rate was estimated by randomly selecting 200 salmon and testing them with the quality control device before release into saltwater rearing pens. Tag placement was checked periodically, but not quantified.

At PWSAC hatcheries, after the overnight holding period and prior to release, all tagged fry were introduced into small saltwater pens within larger pens holding their unmarked cohorts. This additional separation allowed determination of short-term saltwater mortalities through enumeration of floaters. At the VFDA Solomon Gulch hatchery, tagged fry were transferred to the saltwater net pen holding their unmarked cohorts following a 72 hr. mortality check in freshwater; no saltwater mortality estimate was made on tagged salmon. The number of fry released with tags of tag code *t*, Tr_t, was estimated for each release group by deducting both short-term tagging and saltwater rearing mortalities (for PWSAC facilities) from the number of fry initially tagged and accounting for tag loss :

$$\hat{Tr}_t = (T_t - Mo_t - Msw_t)(1 - \hat{Lo}_t), \qquad (1)$$

where

T_t = total number of tagged (*t*) salmon
Mo_t = number of deaths during holding period among tagged (*t*) salmon
Msw_t = number of deaths during saltwater rearing period among tagged (*t*) salmon (PWSAC only); and,
Lo_t = proportion of tagged (*t*) salmon which lost their tags during the holding period.

At PWSAC hatcheries, unmarked fry entering the large saltwater rearing pens were enumerated with electronic fry counters. Fry mortalities were estimated visually immediately prior to releaseand were applied equally to tagged and untagged salmon to obtain final release estimates.

With the exception of experimental release groups, fry releases were timed to coincide with peak plankton abundance near the hatcheries. The VFDA hatchery estimated the number of salmon entering the large saltwater pens by estimating the number of fry that emerged from the incubators supplying salmon to the pens.

Tag Recovery

Commercial and Cost Recovery Harvests

Recoveries were stratified by district, week, and processor. This stratification was chosen as a result of the findings of Peltz and Geiger (1990), who detected significant differences between the proportions of some tag codes among such strata. These differences indicated that processors tend to receive catches from only certain parts of a district and is believed to be the result of traditional tendering patterns.

Recoveries of pink salmon tags from commercial and cost recovery harvests were made after each fishery opening, as salmon were pumped from tenders onto conveyor belts at land based processors located in Cordova, Valdez, Seward, and aboard two floating processors in PWS. Technicians sampled salmon that were moving down the conveyer belt, and subjected each sampled salmon to a visual and tactile examination for a missing adipose fin.

Data recorded for each tender included harvest type (i.e. commercial or cost recovery catch), fishing district(s) from which the catch was taken, catch date, processor, and the number of salmon examined. Catch data were later verified from fish tickets.

Technicians excised the heads of salmon marked with an adipose finclip, identified them with a uniquely numbered cinch strap and placedthem in plastic bags. Once sampling was finished, individual heads were passed through a Northwest Marine field sampling tag detector. The detector produced an audible signal upon detection of a metal tag in the head. This procedure yielded actual numbers of tags in the sample.

All heads were then frozen and, together with sample data, were shipped twice weekly from each site to the Alaska Department of Fish and Game Coded Wire Tag Processing Laboratory in Juneau (Tag Lab). Tag Lab staff located and removed tags from heads, decoded extracted tags, and entered tag code and sample data into a database accessible to biologists in Cordova.

Brood Stock Harvests

Hatchery brood stocks were scanned for tags in order to estimate adjustment factors which could be used to account for loss of tags from the population. Three assumptions inherent in the use of the brood stock for this purpose are: a) the brood stock consists only of salmon reared at the hatchery, b) the tendency for a tagged salmon to lose a tag or to die is similar for all salmon marked at the same hatchery, and c) for a specific tag code, the marking rate in the commercial fishery is the same as that in the brood stock. Work by Sharr et al. (1995c) indicates that the first of these assumptions is violated at all facilities except the W.H. Noerenberg hatchery. Consequently, only the adjustment factor calculated from the brood stock at W.H. Noerenberg hatchery used as the basis of adjustments for tag loss and differential mortality at all hatcheries. Historical average W.H. Noerenberg adjustment factors were used for both inseason (1989-1995) and postseason (1989-1996) estimations.

The adjustment factor for hatchery h, a_h, was estimated as the ratio of sampled salmon in the brood stock to the expanded number of salmon based on tags found in the sample :

$$\hat{a}_h = \frac{s_h}{\sum_i^T \frac{x_i}{p_i}} \qquad (2)$$

where

T	=	number of tag codes released from hatchery h,
p_i	=	tagging rate at release for the ith tag code (defined as number of tagged salmon released with the ith code divided by the total number of salmon in release group i),
x_i	=	number of tags of the ith code found in s_h and,
s_h	=	number of brood stock salmon examined in hatchery h.

The W.H. Noerenberg historical average adjustment factor was then used to adjust contribution estimates (Equation 3), if it was significantly greater than 1.0 at the 90% level. An appropriate test of the hypothesis : $Ho : a_h \leq 1.0$ is given in Sharr *et al.* (1995a).

Estimation of Contributions and Survival Rates

Postseason Hatchery Contributions and Survival Rates

The contribution of release group t to the sampled common property, cost recovery, brood stock and special harvests, as well as the escapement, C_t , was estimated as:

$$\hat{C}_t = \sum_{i=1}^{L} x_{it}\left(\frac{N_i \hat{a}}{s_i p_t}\right), \tag{3}$$

where

x_{it}	=	number of group t tags recovered in the ith stratum,
N_i	=	total number of salmon in the ith stratum,
s_i	=	number of salmon sampled from the ith stratum,
p_t	=	proportion of group t tagged,
a	=	historical adjustment factor associated with W.H. Noerenberg facility,
L	=	number of recovery strata associated with common property, cost-recovery, brood stock, special harvests and escapement in which tag code t was found.

The contribution of release group t to unsampled strata, Cu_t, was estimated from contribution rates associated with strata which were sampled from the same district-week openings as the unsampled strata:

$$\hat{C}u_t = \sum_{i=1}^{U}\left[N_i * \left(\frac{\sum_{j=1}^{S}\hat{C}_{tj}}{\sum_{j=1}^{S}N_j}\right)\right], \tag{4}$$

where

U	=	number of unsampled strata,
N_i	=	number of salmon in ith unsampled stratum
S	=	number of strata sampled in the period in which the unsampled stratum resides,
C_{tj}	=	contribution of release coded with tag t to the sampled stratum j, and
N_j	=	number of salmon in jth sampled stratum.

When a district-week opening was not sampled at all (an infrequent occurrence), the catch from that opening was treated as unsampled catch from the subsequent opening in the same district.

An estimate of the contribution of tag group t to the total Prince William Sound return for 1996 was obtained through summation of contribution estimates for sampled and unsampled strata.

An estimate of the total hatchery contribution to the Prince William Sound return was calculated through summation of contributions over all release groups.

A variance approximation for $\hat{C}_t$, derived by Clark and Bernard (1987) and simplified by Geiger (1990) was used:

$$\hat{V}(\hat{C}_t) = \sum_{i=1}^{L} x_{it} * \left[\frac{N_i \hat{a}}{s_i p_t}\right]\left[\frac{N_i \hat{a}}{s_i p_t} - 1\right]. \qquad (5)$$

Assuming that covariances between contributions of different release groups to a stratum could be ignored, summation of variance components over all tag codes provided an estimate of the variance of the total hatchery contribution. Inspection of the formula given by Clark and Bernard (1987) for the aforementioned covariances shows them to be negligible for large N and s, and to be consistently negative, so that when ignored, conservative estimates of variance are obtained. Variances associated with unsampled strata are believed to be small (Sharr et al,1995b).

The survival rate of the release group coded with tag t (S_t), was estimated as:

$$\hat{S}_t = \frac{\hat{C}_t + \hat{C}u_t}{R_t}, \qquad (6)$$

where,

C_t	=	contribution of release group coded with tag t to sampled strata,
Cu_t	=	contribution of release group coded with tag t to unsampled strata,
R_t	=	total number of salmon in release group coded with tag t released from hatchery.

Assuming the total release of salmon associated with a tag code is known with negligible error, and that the cumulative variance contributions associated with the unsampled strata are small, a suitable variance estimate for S_t is given by:

$$\hat{V}(\hat{S}_t) = \frac{\sum_{i=1}^{L} x_{it} * \left[\frac{N_i \hat{a}}{s_i p_t}\right]\left[\frac{N_i \hat{a}}{s_i p_t} - 1\right]}{R_t^2}. \qquad (7)$$

Inseason Hatchery Contributions

Two inseason estimates of hatchery contributions of pink salmon were generated for each opening. The first and more timely estimate was made using the method suggested by Sharr et al. (1995b). This method depended on the number of (undecoded) tags detected in heads of sampled adipose clipped salmon by a Northwest Marine field tag detector. Estimates using undecoded tags required that assumptions be made about adjustment (a) and expansion ($1/p_t$) factors (see Equation 3). For all inseason estimation, an adjustment factor of 1.77 was used, which is the historical average adjustment factor (1989-1995) associated with the W.H. Noerenberg facility. For fishery openings in the western and northern portions of Prince William Sound, late run hatchery returns to PWSAC facilities were assumed to be the only hatchery contributors. For openings in the Southwestern district, an expansion factor of 599 was used; this is a weighted average of all expansion factors associated with tags released at the A.F. Koernig (599), W.H. Noerenberg (599) and Cannery Creek (600) hatcheries in 1995. The weighting scheme depended upon historical contributions of hatcheries to the Southwestern district. Using a similar weighting scheme for the Coghill and Northern districts, expansion factors of 599 and 600 were calculated. For openings in the Eastern district, the early run hatchery returns to Solomon Gulch were assumed to be the only hatchery contributors, and an expansion factor of 608 was used. This is the average of all expansion factors associated with releases from the VFDA facility in 1995. The second method, which used fully decoded data, was used less frequently during the season. Fully decoded data were usually available about 1 week after heads were collected, and results were not as useful in making management decisions. Under most circumstances, results from decoded tags agreed very closely to results based on number of detected tags. Calculations of inseason contributions were consistent with those used to generate postseason results (Equation 3). Postseason estimation is a more thorough, but less timely method which uses data from extracted and fully decoded tags, and which allowed tag specific expansion factors to be used.

RESULTS

Tagging

Over 613 million pink salmon fry were released from the A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch hatcheries in 1995 (Table 1). Solomon Gulch hatchery released the most pink salmon fry, while A.F. Koernig released the least. The number of separate release groups ranged from 8 for Solomon Gulch to 17 for A.F. Koernig. In contrast to the 1994 release, the desired tagging rate (0.001667) for 1995 was the same for all release groups.

Tag Recoveries

Sampling Rates

Approximately 19% of the pink salmon captured in the common property and 24% of those captured in the cost recovery harvests were sampled during 1996. These sampling rates were functions of the size of the catch, the number of samplers and the short time period the salmon were accessible to samplers. Additionaly, about 80% of the pink salmon brood stock was sampled.

Estimates of Contributions

Tags from hatchery produced pink salmon were recovered in the common property, cost recovery, and brood stock harvests(Table 2 and Appendix B). Wild stocks comprised the largest proportion of salmon in the total catch (28%), followed closely by Solomon Gulch hatchery salmon (26.6%). W.H. Noerenberg and Cannery Creek hatcheries contributed 21% and 17% of the total catch, respectively. A.F. Koernig pink salmon contributed only 7.2% of the catch.

In past years, agreement between inseason and postseason contribution estimates was greatest for the Eastern district common property fishery, and least for the Southwestern district common property fishery. In 1996, as in previous years, inseason and postseason estimates for the Eastern district common property fishery agreed very closely (Figure 2). Inseason and postseason estimates in the 1996 Southwestern district common property fishery also agreed favorably in 11 of 13 fishing periods (Figure 3). Northern district inseason estimates were not used because there was strong evidence that hatchery contributions were being underestimated. Coghill district inseason estimates were not calculated because there was little fishing effort in that district.

Table 1. Pink salmon tagging data for fry released into Prince William Sound in 1995 which returned as adults in 1996.

Hatchery	Fry Released (millions)	No. Tag Codes	Fry Tagged	No. Tags per Fry	Range of Tagging Rates for Release Groups
A. F. Koernig	108.85	17	181,100	0.001668	0.001667 - 0.001684
W.H. Noerenberg	168.86	16	281,300	0.001666	0.001634 - 0.001726
Cannery Creek	130.34	14	217,600	0.001669	0.001646 - 0.001675
Solomon Gulch	205.37	8	337,800	0.001645	0.001589 - 0.001678
Totals	613.42	55	1,017,800		

Table 2. Postseason estimates of hatchery and wild stock contributions to the Prince William Sound catch of 1996 (millions of salmon).

Contributor	Common Property	Cost Recovery	Brood Stock[a]	Total Contribution	95% Bounds	Percent of Total Catch
A. F. Koernig	1.97	0.004	0	1.98	1.73 - 2.22	7.23
W.H. Noerenberg	2.99	2.26	0.48	5.73	5.26 - 6.21	21.02
Cannery Creek	3.68	0.85	0.17	4.70	4.29 - 5.11	17.24
Solomon Gulch	4.87	2.02	0.35	7.24	6.83 - 7.64	26.56
Hatchery Total	13.51	5.14	0.99	19.64	18.96 - 20.33	72.05
Wild Stocks	4.20	3.14	0.28	7.62		27.95
Grand Total	17.71	8.28	1.27	27.26		100.00

[a] Brood stock numbers include salmon used for roe recovery.

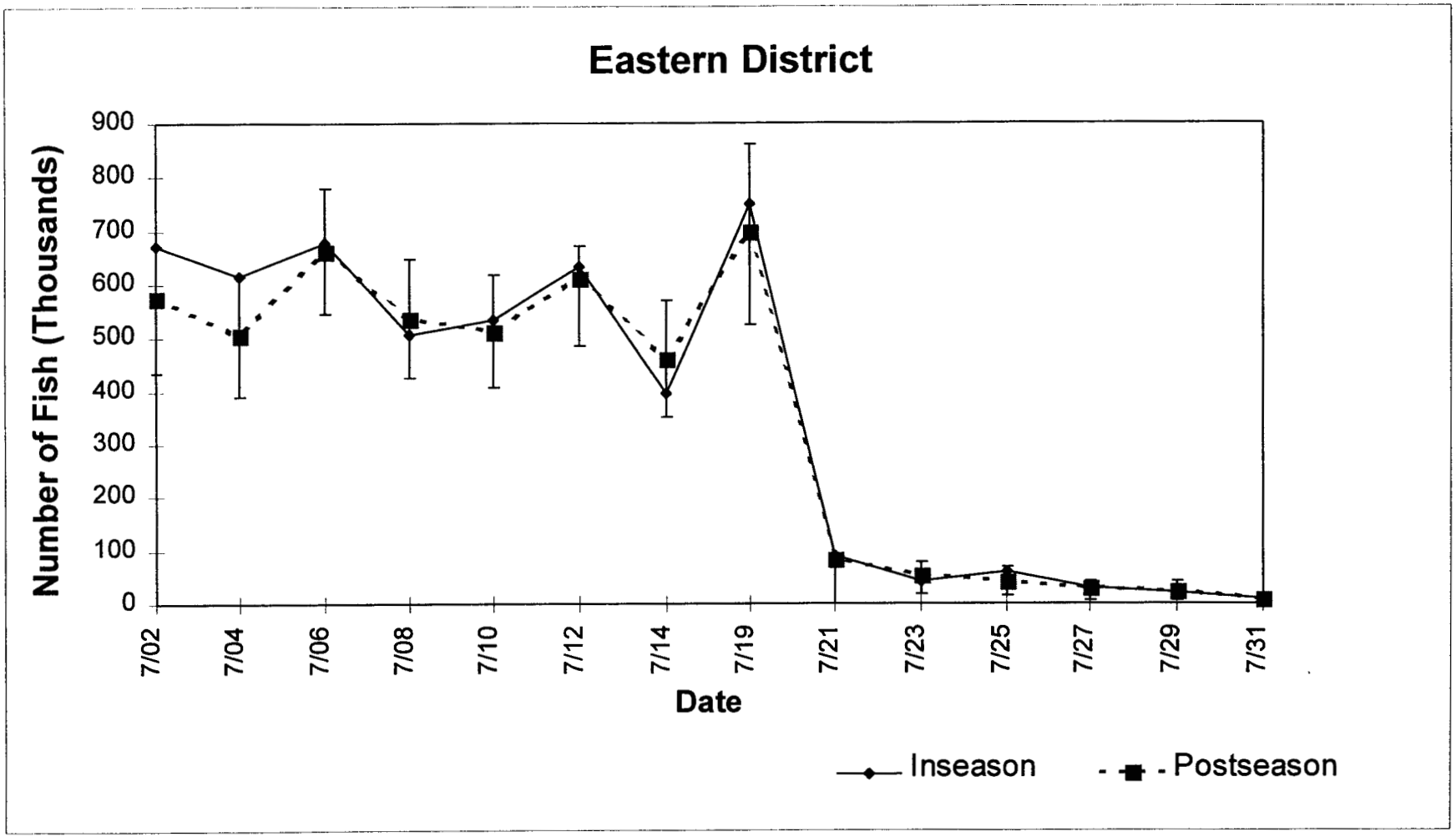

Figure 2. **Comparison of inseason and postseason estimates of hatchery contributions to the Eastern district common property fishery in Prince William Sound during 1996.**

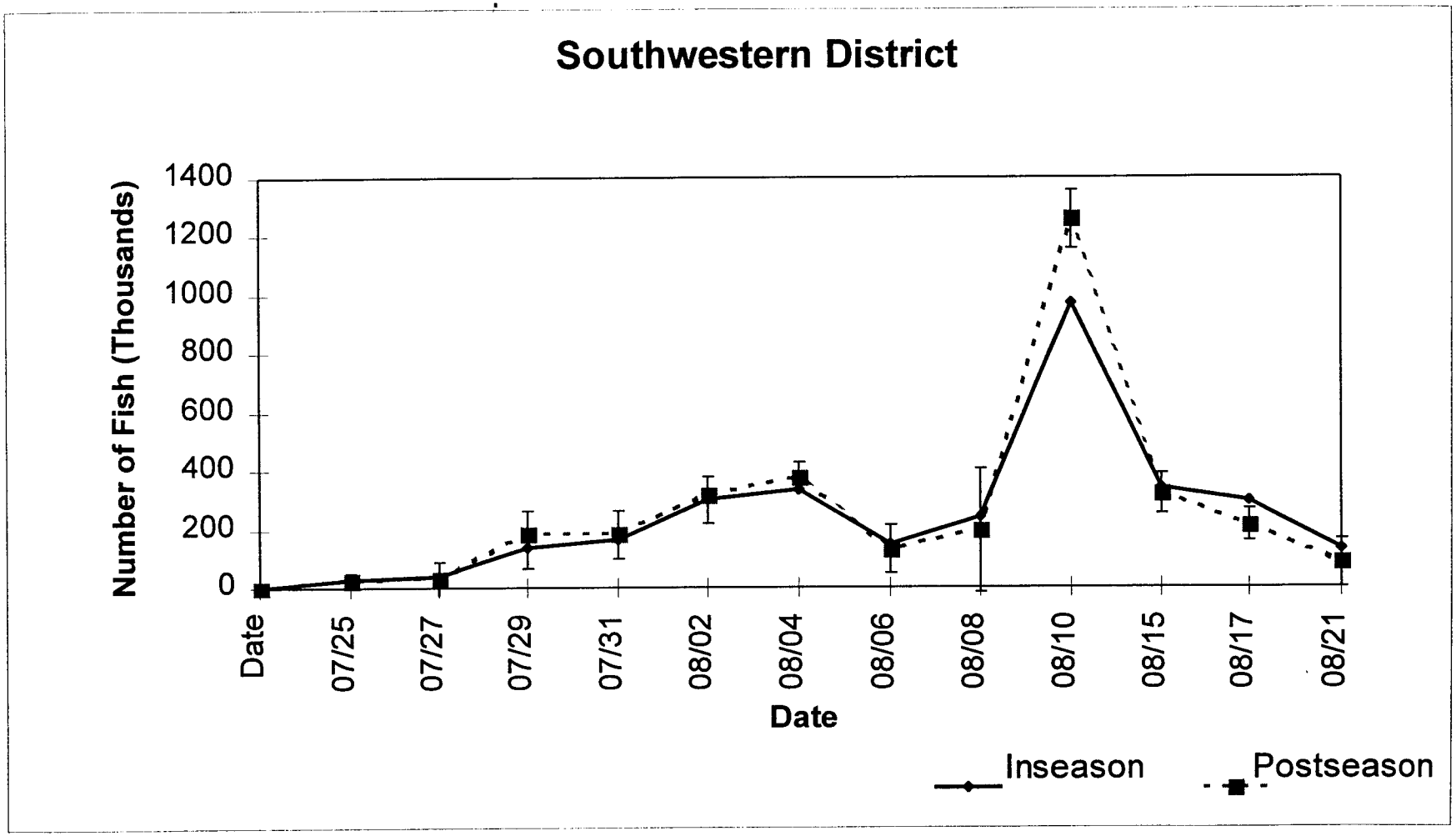

Figure 3. **Comparison of inseason and postseason estimates of hatchery contributions to the Southwestern district common property fishery in Prince William Sound during 1996**

Test Fishery Catches

Usually, ADF&G conducts a test fishery in the Southwestern District so that the general fishery opening is scheduled to focus most commercial harvest effort on later returning hatchery salmon. Coded wire tagging data is used to ascertain the percentage of wild and hatchery salmon in the test fishery catch. General fishery openings are scheduled based upon decreasing percentages of wild salmon in test fishery catches. The test fishery was not conducted in 1996, because most fishing effort was concentrated around the hatcheries, which reduced pressure on wild stocks, and few fishers wished to participate in the test fishery.

Common Property Catches

In the 1996 common property fishery, about 17.71 million pink salmon were harvested. Solomon Gulch salmon comprised the largest proportion of the common property catch, contibuting 4.87 million pink salmon, or 27.5% of the harvest (Table 2, Appendix A.1). Wild stocks contributed 23.7% of the catch, followed by Cannery Creek with 20.8%, W.H. Noerenberg with 16.9%, and A. F. Koernig with 11.1%.

The Eastern district harvest accounted for 6.06 million pink salmon, of which 4.8 million salmon originated from Solomon Gulch hatchery. Mostof the harvest occurred during July 6 through July 20 (Figure 4). Between July 21 and September 7, 0.42 million salmon were harvested, of which 64% were estimated to be of hatchery origin.

The Northern district common property harvest was 5.04 million salmon (Appendix A.1). The peak weekly harvest occurred from August 4 to 10 (Statistical Week 32), when 1.72 million salmon were caught (Figure 5). Northern District catch contribution estimates may have greatly underestimated the actual number of hatchery salmon. In Northern district, high percentages of scanned salmon with missing adipose fins (marked salmon) did not contain tags, which suggested a high tag loss. In the 1996 Cannery Creek brood stock, the percentage of marked salmon that did not have tags was 57%, coinciding with the median percentage seen in Cannery Creek brood stock from 1989 to 1996. In Northern District common property fishery samples, 34.9% of marked salmon had no tags. For management purposes, some marked salmon with no tags were treated as tagged salmon, to produce a more realistic estimate of hatchery contributions (Joyce and Riffe 1997). Those estimates are not included in this report, because they were derived using an *ad-hoc* procedure which provided no way to properly analyze the estimate or calculate a variance.

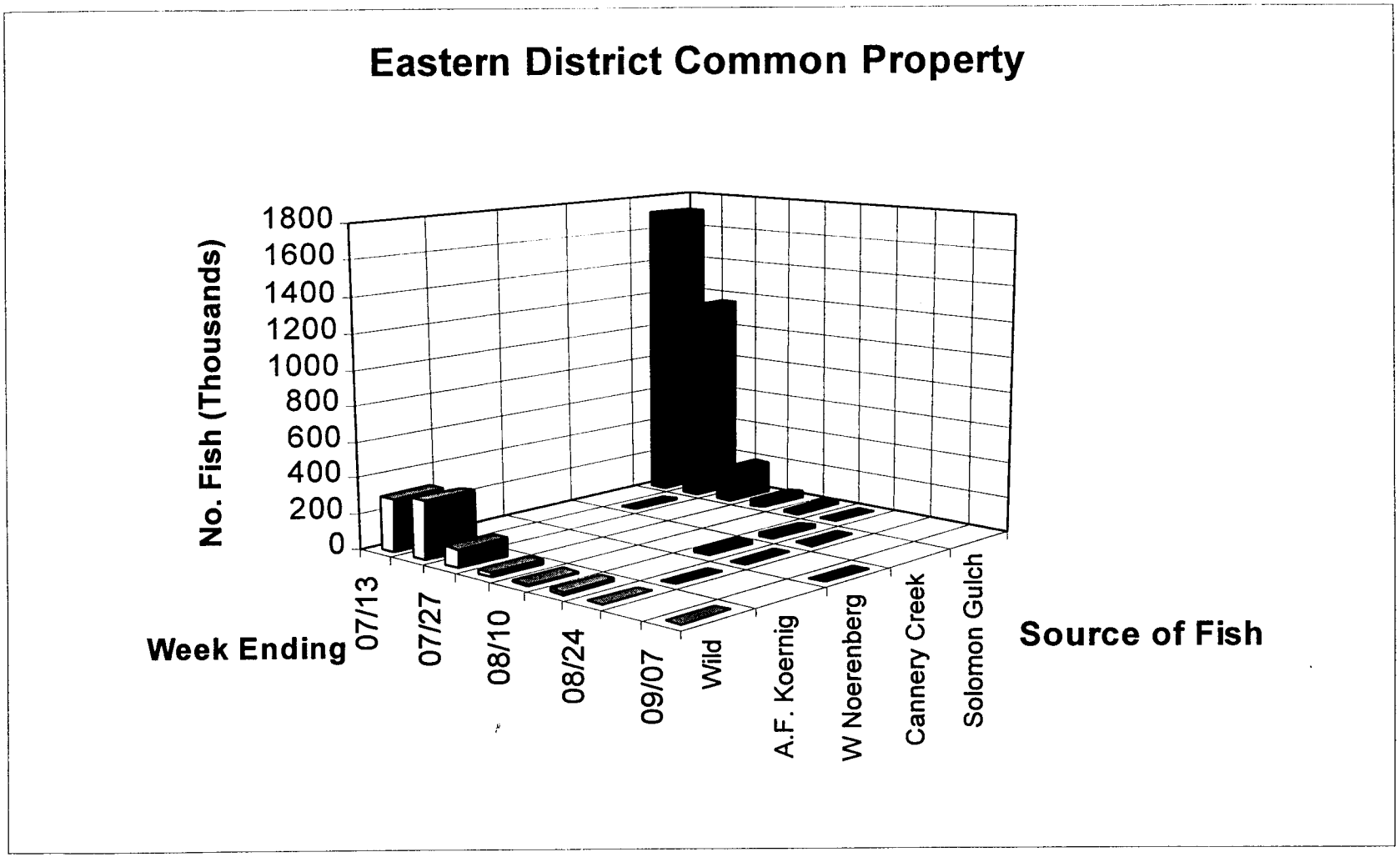

Figure 4. **Hatchery and wild stock contributions to the Eastern district common property fishery catches by week in Prince William Sound during 1996.**

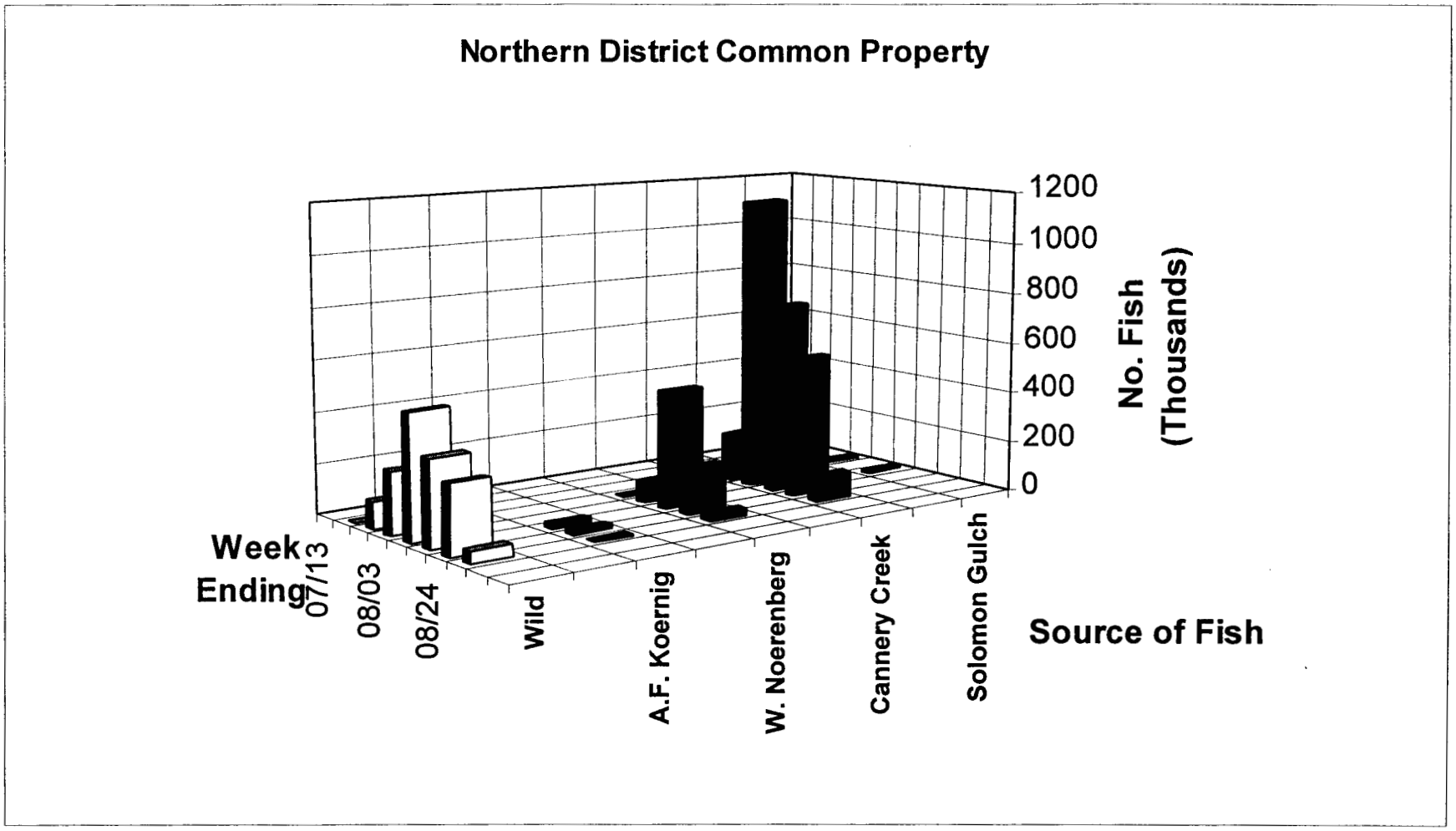

Figure 5. **Hatchery and wild stock contributions to the Northern district common property fishery catches by week in Prince William Sound during 1996.**

The 1996 Coghill District common property pink salmon harvest was 1.54 million salmon, of which 1.18 million originated from W.H. Noerenberg hatchery (Figure 6, Appendix A.1). The Coghill District purse seine fishery began the week of July 27 (Statistical Week 30), with 659 pink salmon harvested.. Prior to August 4 (Statistical Week 32), most pink salmon were harvested incidentally in the drift gillnet fishery targeting sockeye salmon. Peak harvest weeks were those ending August 10 and August 17 (Statistical Weeks 32 and 33), with 783,626 and 641,480 pink salmon being caught, respectively.

Eshamy District had the smallest common property pink salmon harvest, with 19,043 pink salmon caught (Appendix A.1). Eshamy District pink salmon were not sampled because it was difficult to obtain samples of salmon which were not mixed with salmon from other districts. Coghill District catch compositions from the following week were used to allocate salmon caught in Eshamy district for the weeks ending on August 3 and August 10.

The Southwestern District common property catch was 5.05 million pink salmon. Since a cost recovery fishery was not conducted in the Southwestern District during 1996, all pink salmon were taken in the common property fishery. About 75% of the catch consisted of hatchery salmon, with A.F. Koernig pink salmon being the largest component and contributing 1.97 million salmon (Figure 7, Appendix A.1). Wild stocks comprised the second largest component of the harvest, contributing 1.27 million pink salmon. About 1.08 million W.H. Noerenberg salmon and 0.72 million Cannery Creek salmon were caught in this district, while only 50,000 Solomon Gulch salmon were caught.

Cost Recovery Catches

The total 1996 cost recovery harvest was 8.28 million salmon. Nearly 50% of the overall harvest was taken in Coghill District, where 4.11 million salmon were caught (Appendix A.2). The increased harvest in Coghill District occurred because PWSAC ceased cost recovery operations in Southwestern District and concentrated its effort on Coghill District. Wild stocks comprised the largest portion of the pink salmon cost recovery catch, contributing 3.14 million salmon, followed by W.H. Noerenberg hatchery with 2.26 million salmon, Solomon Gulch with 2.02 million salmon, Cannery Creek with 0.87 million salmon, and A.F. Koernig with 0.004 million salmon.

The cost recovery fishery for the Eastern District began during the week ending June 22 (Statistical Week 25), and peaked during the week of July 13 (Statistical Week 28) when 0.669 million pink salmon were caught (Figure 8, Appendix A.2). Wild stocks comprised about 15% of the total catch. The greatest percentage of wild salmon harvested occurred during the last week of the cost recovery harvest when 35% of the catch, or 0.151 million salmon were taken. Samples indicated that the hatchery component was exclusively comprised of Solomon Gulch hatchery pink salmon. Cost recovery was completed the week ending July 20 (Statistical Week 29).

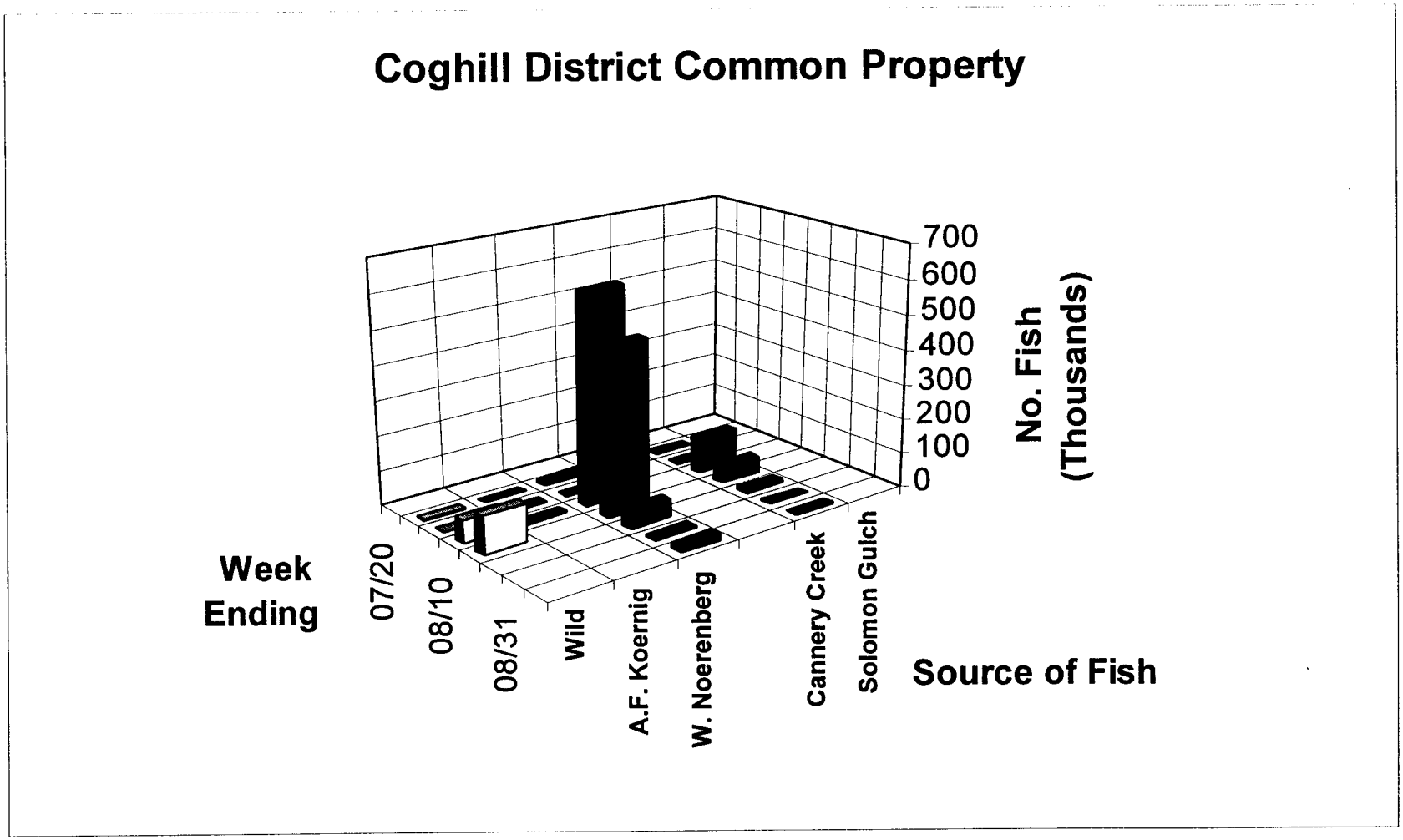

Figure 6. **Hatchery and wild stock contributions to the Coghill district common property fishery catches by week in in Prince William Sound during 1996.**

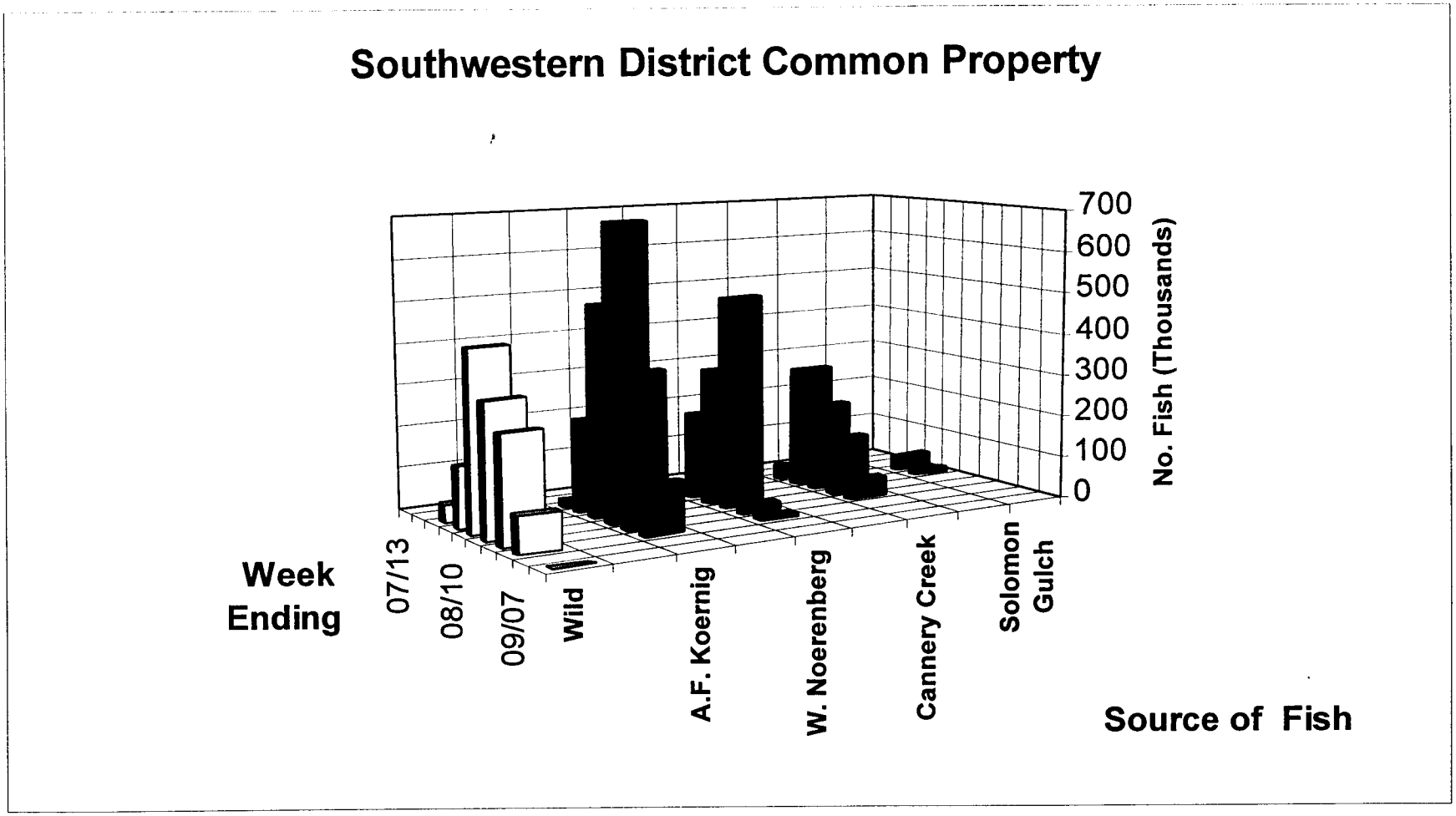

Figure 7. **Hatchery and wild stock contributions to the Southwestern district common property catches by week in Prince William Sound during 1996.**

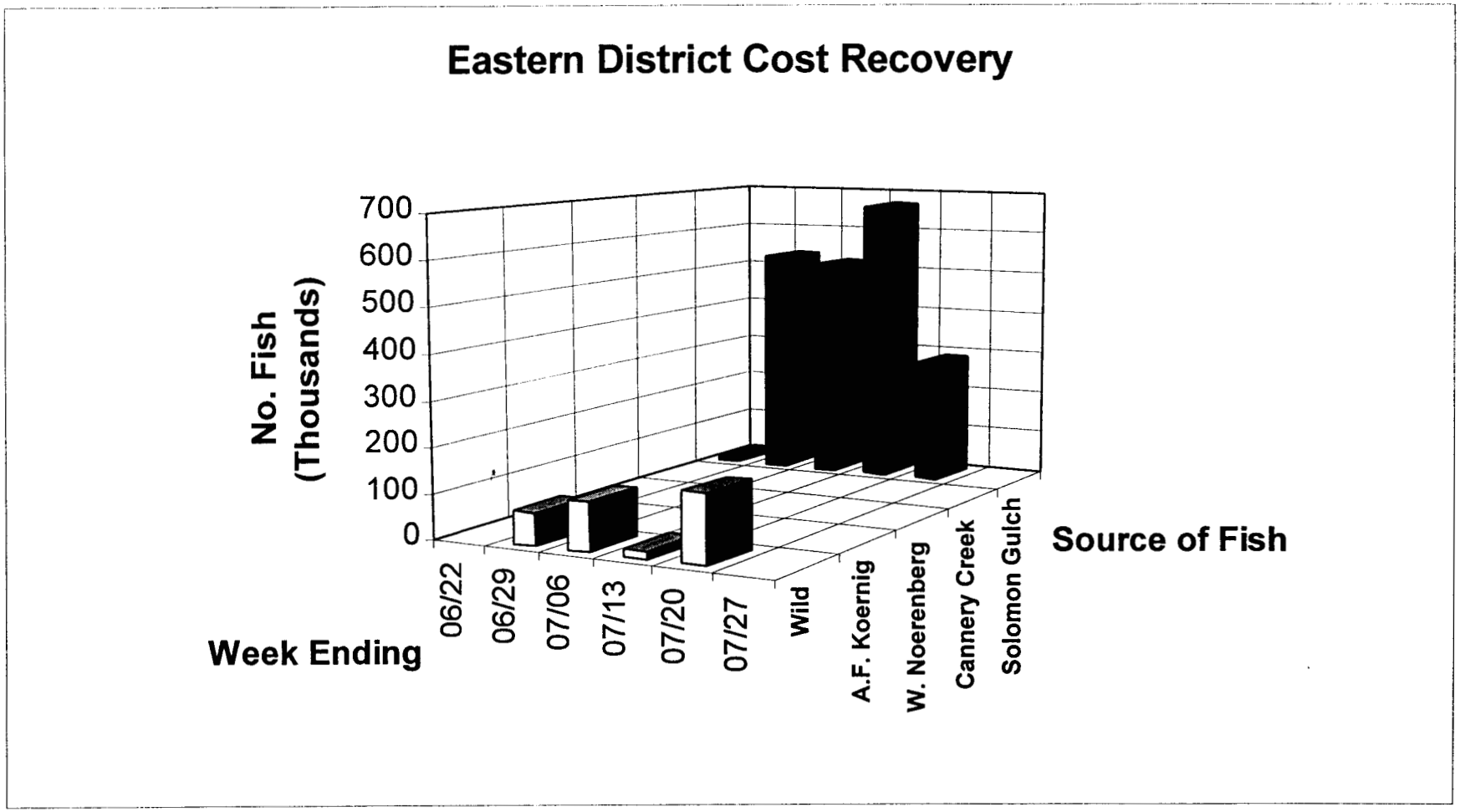

Figure 8. **Hatchery and wild stock contributions to the Eastern district cost recovery fishery catches by week in Prince William Sound during 1996.**

Over 60% of the Northern District cost recovery harvest was estimated to be comprised of wild stocks, with Cannery Creek hatchery pink salmon comprising the rest (Figure 9). However, hatchery contribution estimates may be too low since the principal contributor of hatchery salmon, Cannery Creek, has a high apparent tag loss rate. Cost recovery began during the week ending July 27 (Statistical Week 30), and ended the week of August 31 (Statistical Week 35). A total of 1.11 million salmon were harvested, with a peak harvest of 0.211 million salmon during the week of August 17 (Statistical Week 33).

In Coghill District, the cost recovery harvest began during the week of August 3, and ended the week of September 14 (Figure 10). A total of 4.11 million pink salmon were caught, of which 2.26 million originated from W.H. Noerenberg hatchery. The second largest component consisted of wild stocks, which contributed 1.68 million salmon to the harvest. Approximately 0.15 million Cannery Creek salmon were caught, as well as 4,100 pink salmon (0.004 million) from A. F. Koernig hatchery.

A total of 6,039 pink salmon or 0.006 million were caught in the Eshamy District cost recovery fishery. Since none of the Eshamy district pink salmon catches was sampled and the harvest was small, no hatchery contribution estimates were made.

Survival Rates

Survival rates (over all tag codes) of adult hatchery pink salmon were 3.6% for Cannery Creek, 3.51% for Solomon Gulch, 3.29% for W.H. Noerenberg, and 1.82% for A.F. Koernig (Table 3). Significant differences (α=0.05) in survival rates of hatchery reared salmon were detected between A.F. Koernig hatchery and all others. These tests assume zero-covariance between hatchery survival rates, and that variability associated with unsampled strata is minimal. Since evidence exists that Cannery Creek hatchery returns are being underestimated, comparisons of survival rates between Cannery Creek and W.H. Noerenberg or Solomon Gulch are likely not valid. There was no significant difference between survival rates of Solomon Gulch and W.H. Noerenberg pink salmon. The SEA project release groups originating from A.F. Koernig and W.H. Noerenberg hatcheries had the highest survival rates of all release groups from their respective hatcheries, roughly twice the overall hatchery survival rate (Figure 11, Appendix B). The overall hatchery survival rates for A.F. Koernig and W.H. Noerenberg have increased from 1995, while that of Cannery Creek hatchery appears to be the same, and that of Solomon Gulch hatchery has declined (Riffe et al 1996).

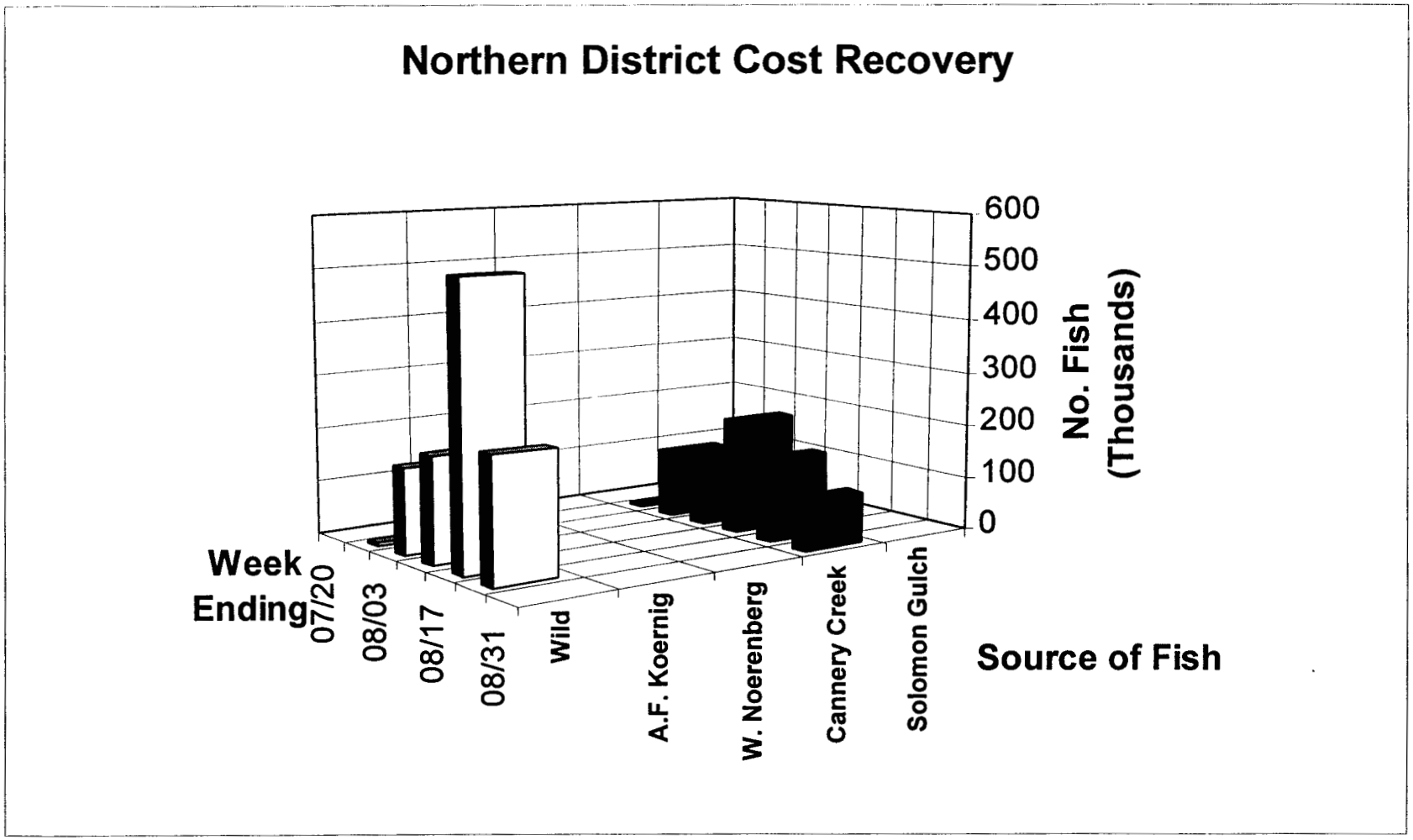

Figure 9. **Hatchery and wild stock contributions to the Eastern district cost recovery fishery catches by week in Prince William Sound during 1996.**

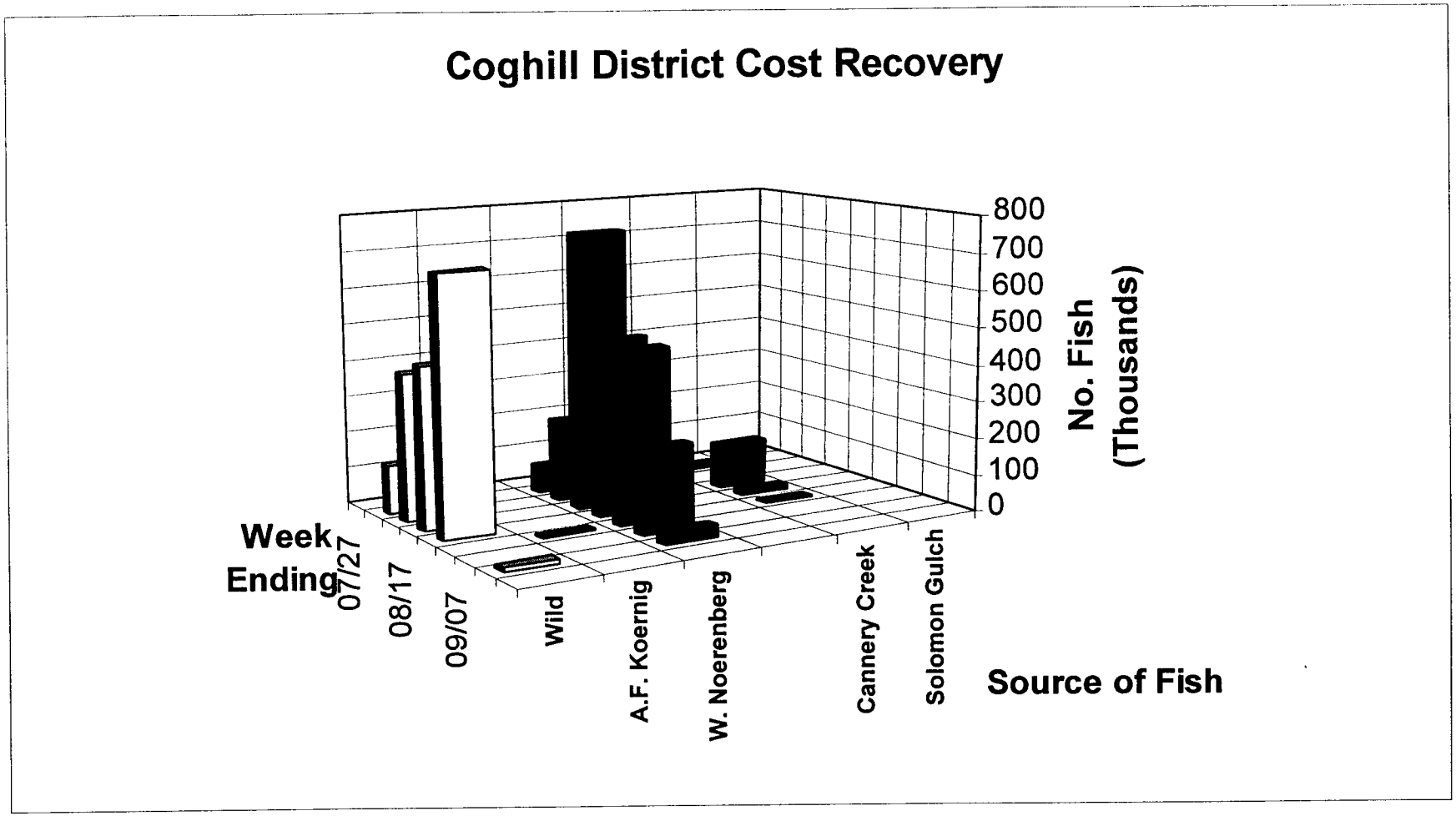

Figure 10. **Hatchery and wild stock contributions to the Coghill district cost recovery fishery catches by week in Prince William Sound during 1996.**

Table 3. Overall survival rates by hatchery of tagged pink salmon returning to Prince William Sound in 1996.

Hatchery	Survival Rate (%)	95% Bounds
A.F. Koernig	1.820	1.596 - 2.043
Wally Noerenberg	3.291	3.010 - 3.572
Cannery Creek	3.603	3.284 - 3.922
Solomon Gulch	3.507	3.331 - 3.707

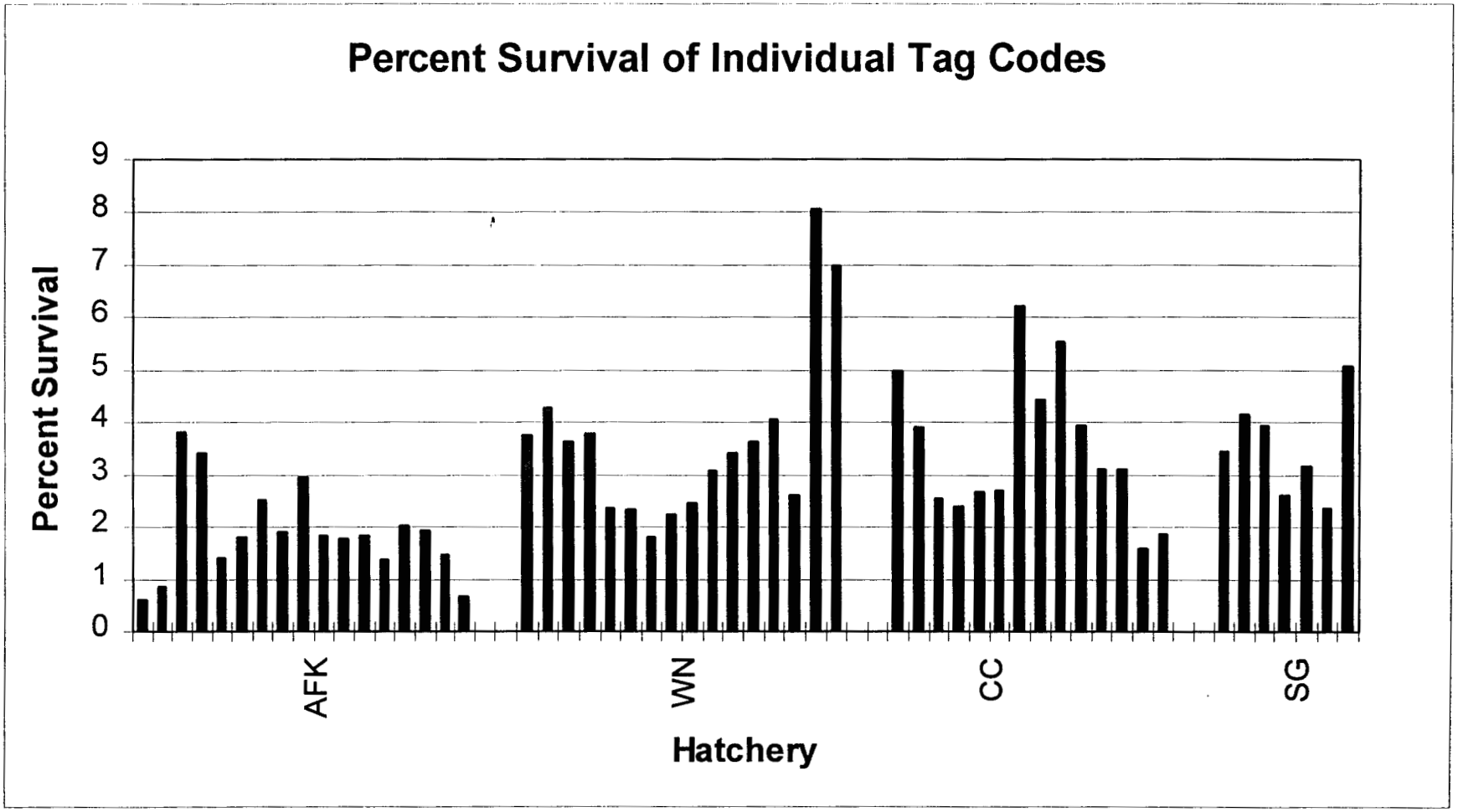

Figure 11. **Percent survival rates for individual tag codes delineated by hatchery for tagged pink salmon returning to Prince William Sound in 1996.**

Adjustment Factors

Adjustment factors were estimated from pink salmon brood stocks (Table 4). The smallest brood stock adjustment factor was for Solomon Gulch, at 2.30. Cost recovery adjustment factors for the Solomon Gulch and Cannery Creek hatcheries were 2.19 and 4.62, respectively. The brood adjustment factor for W.H. Noerenberg was 2.60, which was comparable to that of Solomon Gulch. The W.H. Noerenberg historical (1989-1996) adjustment factor of 1.87 was found to be significantly greater than 1.0, and was used for all postseason contribution estimates. The 1996 adjustment factors for all of the hatcheries are the largest or second largest calculated over the history of the project (Table 5).

Table 4. Adjustment factors by hatchery, estimated from the 1996 brood stock harvests.

Hatchery	Adjustment Factor		P Value for Ho: A. Factor ≤ 1.0
	Estimate	SE	
W.H. Noerenberg	2.60	0.145	0
Cannery Creek	4.01	0.371	0
Solomon Gulch	2.30	0.145	0
Historical Average	1.87	0.107	0

Table 5. Adjustment Factors estimated from brood and cost recovery harvests by facility for pink salmon from 1989 through 1996.

	Brood				Cost-Recovery	
Year	WHN[a]	AFK[b]	VFDA[c]	CC[d]	VFDA[c]	CC[d]
1989	1.73	1.36	1.13	2.12	1.11	1.81
1990	1.28	1.58	1.82	1.96	1.23	1.71
1991	1.82	1.45	1.94	2.28	1.55	1.97
1992	1.63	1.43	2.55	2.74	1.25	1.58
1993	1.78	2.06	3.82	2.91	2.41	2.36
1994	2.05	1.75	3.15	2.38	1.89	2.64
1995	1.96	2.13	1.45	3.21	1.89	5.55
1996	2.60		2.30	4.01	2.19	4.62

[a] W.H. Noerenberg
[b] A.F. Koernig
[c] Solomon Gulch
[d] Cannery Creek

DISCUSSION

Contributions of Hatchery Salmon to the Commercial Catch

The primary function of the Prince William Sound Coded Wire Tag project is to provide accurate and timely information on hatchery and wild components of the catch to management biologists. The information is used to facilitate management decisions which protect injured pink salmon populations. During 1996, the demand for this information was not as great as in previous years. A reduction in the active fishing fleet during 1996 eased fishing pressure in common property fisheries. In addition, the fleet clustered around the hatcheries, which further reduced pressure on stocks moving through migration corridors. Outcomes of decreased fishing pressure included increased wild escapement counts from aerial surveys in all districts except Southwestern. While the aerial survey counts did not reach escapement goals in the Coghill and Northwestern districts, they were the highest seen in those districts in 15 years. Such reduced fishing pressure is not expected to continue, and the value of catch composition data will increase as fishing pressure increases.

Two methods were used to calculate catch contributions. In contrast to 1995, the 1996 preliminary estimates based on detected tags approximated postseason estimates using decoded tags. The agreement between preliminary and postseason estimates for Eastern District underscores the utility of the coded wire tag program as a management tool in situations where tag loss or differential mortality of tagged salmon are not problematic. Agreement between preliminary and postseason estimates in Eastern District may also be enhanced due to the preponderance of hatchery salmon in the catch, and the single source of those hatchery salmon.

Since the percentage of marked salmon without tags in samples from the Northern District remains high, the proportion of Cannery Creek hatchery salmon in catches from this district are likely underestimated and that of wild salmon overestimated. Despite use of different tagging machines and different tagging personnel, the number of marked salmon without tags in the Cannery Creek brood stock has hovered around 56% since 1989. One hypothesis is that electronic interference affects the Quality Control Device (QCD) which checks for the presence of a tag in newly marked salmon. The hypothesis is supported by anecdotal evidence from Cannery Creek hatchery personnel. The QCD apparently malfunctions when the radiotelephone is used. Electronic interference may also affect the tagging machine. The high percentage of marked salmon with no tags was ignored by the coded wire tag recovery project until 1995, primarily because Cannery Creek hatchery returns were overshadowed by returns to other hatcheries. Recoveries of otolith marks and coded wire tags in 1997 should answer questions about the origin of the marked salmon that do not contain tags and the percentage of wild pink salmon in the brood stock.

Survival Rates of Hatchery Salmon

In comparison to 1995, overall marine survival rates for 1996 returns remained relatively constant for Cannery Creek hatchery, rose for A.F. Koernig and W. H. Noerenberg hatcheries, and dropped for Solomon Gulch hatchery. Survival rates for Cannery Creek hatchery are likely being underestimated, because of apparent problems with tag retention. The A.F. Koernig hatchery survival rate, though not as low as in 1995, was much lower than the rate realized at other hatcheries. Interestingly, aerial survey counts of wild salmon in Southwestern District were also poor, suggesting that factors which reduced survival of A.F. Koernig salmon had also affected wild stocks in the area.

In contrast to PWSAC hatcheries, the decrease in Solomon Gulch hatchery survival rates from 1995 to 1996 may be the result of hatchery practices rather than changes in the marine environment. At Solomon Gulch hatchery, personnel often do not pond the fry upon emergence. This causes fry to become emaciated prior to being fed, thereby reducing their fitness. Rearing at hatcheries is generally not considered when examining marine survival rates because rearing practices tend to be consistent and to maximize survival within the scope of the program. In this case, marine environmental effects are confounded by hatchery rearing effects. Another factor obscuring marine environmental effects is violation of the assumption that tagged salmon are representative of untagged salmon. During 1995, Solomon Gulch hatchery personnel returned tagged salmon to incubators, and did not feed them for weeks (T. Joyce, ADF&G, Cordova, personal communication). Fortunately, additional salmon were tagged to compensate for mortalities of these earlier tagged salmon. If such remedial tagging had not been done, estimated survival rates would have been less than actual survival rates, since survival rates for tagged salmon would have been lower than those for untagged salmon. Since this problem was recognized and counteracted, the drop in survival rates from 1995 to 1996 is probably not an artifact of improper tagging practices. However, there is no way to determine the degree to which rearing practicesaffected estimated survival rates at this facility.

Adjustment Factors

Adjustment factors were developed to address violations of underlying assumptions in the analysis: i.e. salmon do not lose tags, and mortality rates are the same for tagged and untagged salmon. However, adjustment factors are not an optimum solution, due to their own underlying assumptions: e.g. all pink salmon in the brood originate from the hatchery in question. Data are not available to properly test for and quantify deviations from the assumptions governing use of adjustment factors.

A standardized adjustment factor (historical mean adjustment factor from W.H. Noerenberg hatchery) has been used for all hatcheries. This was done because brood stocks at Cannery Creek, Solomon Gulch and A.F. Koernig hatcheries included wild salmon and salmon from other hatcheries which would inflate calculated adjustment factors for these facilities. If wild salmon were absent from Cannery Creek hatchery brood stock, the adjustment factor associated with Cannery Creek could be used to compensate for tag loss. However, anecdotal evidence strongly suggests that Cannery Creek brood stock includes wild salmon from a stream adjacent to the hatchery. Since tag loss is likely confounded by inclusion of wild salmon in the brood stock, Cannery Creek adjustment factors cannot properly quantify tag loss associated with that hatchery. Since Solomon Gulch and A.F. Koernig hatcheries are believed to have similar problems, an adjustment factor from the hatchery least likely to be affected by wild stock contamination, W.H. Noerenberg, was used on all tagged salmon.

Proper investigation of adjustment factors is going to require additional information, which we expect toobtain when salmon with both otolith marks and coded wire tags return in 1997. Comparisons between stock composition based on otolith marking and stock composition based on calculations of adjustment factors should allow a proper evaluation of adjustment factors.

In addition to providing an independent assessment of numbers of wild salmon in the various brood stocks, otolith marking combined with coded wire tags should allow the investigation of tag retention rates, and possibly, rates of naturally missing adipose fins in Prince William Sound pink salmon. Head samples collected for coded wire tags will have otoliths extracted and examined. A small number of otoliths will be extracted from heads with tags for use in blind tests to ensure that the hatchery of origin can be properly identified. A percentage of heads without tags that are collected will have the otoliths removed to determine probable origin. The classification of marked salmon with no coded wire tags by otolith marks should quantify tag loss for coded wire tags, thereby allowing a more complete investigation of tag loss and contributions of wild salmon to hatchery brood stocks.

CONCLUSIONS

The major objective of this study was to provide fishery managers with time and location specific data relating to the occurrence of wild stocks in the commercial fishery. These data were to be provided in a timely fashion using a technique based upon detected (undecoded) tags. It was found that inseason estimates of hatchery contributions generally agreed with postseason estimates. Hatchery survival rates, as well as survival rates by release group, increased for A.F. Koernig and W.H. Noerenberg salmon from 1995 to 1996 and decreased slightly for Solomon Gulch salmon. A continuing apparent tag retention problem at Cannery Creek hatchery were also identified, which suggests consistent underestimation of Cannery Creek pink salmon production over the history of the coded wire tag program. The degree to which the Cannery Creek pink salmon production has been underestimated will require further information, which the thermal otolith marking program may provide.

ACKNOWLEDGMENTS

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LITERATURE CITED

Clark, J.E. and D.R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing microwire tag recovery from commercial salmon catches in southeast Alaska. Information Leaflet 261. Alaska Department of Fish and Game, Juneau.

Geiger, H.J. 1990. Parametric bootstrap confidence intervals for estimating contributions to fisheries from marked salmon populations. American Fisheries Society Symposium 7:667-676.

Geiger, H.J. and S. Sharr. 1990. The 1988 Tag Study of Pink Salmon from the Solomon Gulch Hatchery in Prince William Sound, Alaska. *In* Pilot Studies in Tagging Prince William Sound Hatchery Pink Salmon with Coded Wire Tags. Fishery Research Bulletin No. 90-02.

Joyce, T. and R. Riffe. 1997. A Summary of Pacific Salmon Coded-Wire Tag Application and Recovery, Prince William Sound, 1996. Regional Information Report No. xxxxxxx. Alaska Department of Fish and Game, Cordova.

Peltz, L. and H.J. Geiger. 1990. A Tagging Study of the Effects of Hatcheries on the 1987 Pink Salmon Fishery in Prince William Sound, Alaska, *In* Pilot Studies in Tagging Prince William Sound Hatchery Pink Salmon with Coded Wire Tags. Fishery Research Bulletin No. 90-02.

Peltz, L. and J. Miller. 1990. Performance of half-length coded wire tags in a pink salmon hatchery marking program. American Fisheries Society Symposium 7:244-252.

Riffe, R., S. Gehlbach, D.G. Evans, and B.G. Bue. 1996. Coded Wire Tag Recoveries from pink salmon in Prince William Sound Fisheries, 1995. Restoration Project 95320B, Alaska Department of Fish and Game, Cordova.

Sharr, S., T.M. Willette, C.J. Peckham, D.G. Sharp, J.L. Smith, D.G. Evans, and B.G. Bue. 1995a. Coded Wire Tag Studies on Prince William Sound Salmon. Natural Resource Damage Assessment Fish/Shellfish Study Number 3, Alaska Department of Fish and Game, Cordova.

Sharr, S., C.J. Peckham, D.G. Sharp, J.L. Smith, D.G. Evans, and B.G. Bue. 1995b. Coded Wire Tag Studies on Prince William Sound Salmon. Natural Resource Damage Assessment Restoration Study R60A, Alaska Department of Fish and Game, Cordova.

LITERATURE CITED (continued)

Sharr, S., C.J. Peckham, D.G. Sharp, J.L. Smith, D.G. Evans, and B.G. Bue. 1995c. Stock Identification of Chum, Sockeye, Coho and Chinook Salmon in Prince William Sound. Natural Resource Damage Assessment Restoration Study 93068, Alaska Department of Fish and Game, Cordova.

Sharr, S., R.R. Riffe, S. Gehlbach, D.E. Evans, and B.G. Bue. 1995d. Coded Wire Tag Recoveries from Pink Salmon in Prince William Sound Salmon Fisheries, 1994. Restoration Study 94320B, Alaska Department of Fish and Game, Cordova.

Willette, T.M. and G. Carpenter. 1994. Early marine salmon injury assessment in Prince William Sound. Natural Resource Damage Assessment Fish/Shellfish Study Number 4, Alaska Department of Fish and Game, Cordova.

Appendix A: Pink Salmon Hatchery and Wild Stock Contributions to Prince William Sound Test Fisheries by Period and Week for 1996.

Appendix B.1. Pink salmon hatchery and wild stock contributions to Prince William Sound common property fisheries by district and week during 1996.

Eastern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/06	27							1,700,412	1.23E+10	1,700,412	1.23E+10	445,823	2,146,235	295
7/13	28							1,711,825	1.04E+10	1,711,825	1.04E+10	295,818	2,007,643	392
7/20	29					3,733	1.39E+07	1,153,736	1.08E+10	1,157,469	1.08E+10	324,667	1,482,136	225
7/27	30							183,796	1.26E+09	183,796	1.26E+09	102,595	286,391	30
8/03	31							37,550	1.41E+08	37,550	1.41E+08	25,600	63,150	13
8/10	32 1/							12,848	1.65E+07	12,848	1.65E+07	8,760	21,608	0
8/17	33			22,163	2.46E+08	11,087	1.23E+08			33,250	3.69E+08	17,116	50,366	3
8/24	34 2/			659	216,974	330	108,586			989	325,560	508	1,497	0
8/31	35												0	
9/07	36											37	37	0
Subtotals		0		22,822	2.46E+08	15,150	1.37E+08	4,800,167	3.49E+10	4,838,139	3.53E+10	1,220,924	6,059,063	958

1/ Proportions from week 31 were used to allocate the catch.

2/ Proportions from week 33 were used to allocate the catch.

Northern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/20	29 1/					708	149,489			708	149,489	2,501	3,209	0
7/27	30					30,562	2.78E+08			30,562	2.78E+08	107,867	138,429	4
8/03	31			3,744	1.4E+07	187,971	3.96E+09	7,318	2.68E+07	199,033	4.0E+09	244,405	443,438	39
8/10	32			83,802	9.14E+08	1,154,894	1.21E+10			1,238,696	1.3E+10	485,945	1,724,642	185
8/17	33	19,902	1.65E+08	460,841	6.66E+09	747,092	6.43E+09	10,994	1.32E+08	1,238,829	1.34E+10	337,811	1,576,640	196
8/24	34	19,105	7.75E+07	134,587	8.95E+08	552,056	6.44E+09			705,748	7.41E+09	270,288	976,036	137
8/31	35 2/	3,476	2,564,135	24,535	2.96E+07	100,439	2.13E+08			128,450	2.45E+08	49,127	177,577	0
Subtotals		42,483	2.45E+08	707,509	8.52E+09	2,773,722	2.94E+10	18,312	1.59E+08	3,542,026	3.84E+10	1,497,945	5,039,971	561

1/ Proportions from week 30 were used to allocate the catch.

2/ Proportions from week 34 were used to allocate the catch.

Coghill District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
6/15	24													
6/22	25											13	13	0
6/29	26 1/											556	556	0
7/06	27 1/											1,120	1,120	0
7/13	28 1/											2,176	2,176	0
7/20	29 1/											10,152	10,152	0
7/27	30 2/	96	9,141	10,579	1,549,221	1,837	216,485			12,512	1,774,847	1,129	13,641	0
8/03	31 2/	13	182	1,491	30,788	259	4,302			1,763	35,272	160	1,923	0
8/10	32	5,492	3.02E+07	607,728	5.11E+09	105,547	7.14E+08			718,767	5.86E+09	64,859	783,626	138
8/17	33			483,554	7.51E+09	48,327	7.79E+08			531,881	8.29E+09	109,599	641,480	38
8/24	34			51,971	9.83E+08	10,364	1.95E+08			62,335	1.18E+09	0	62,335	6
8/31	35 3/			5,441	1.07E+07	1,085	2,141,731			6,526	1.29E+07	0	6,526	0
9/07	36 3/			16,120	9.45E+07	3,215	1.88E+07			19,335	1.13E+08	0	19,335	0
9/14	37											986	986	0
Subtotals		5,601	3.02E+07	1,176,884	1.37E+10	170,634	1.71E+09	0		1,353,119	1.54E+10	190,750	1,543,869	182

1/ Proportions from week 25 were used to allocate the catch.
2/ Proportions from week 32 were used to allocate the catch.
3/ Proportions from week 34 were used to allocate the catch.

Eshamy District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/06	27											4,578	4,578	0
7/13	28											2,943	2,943	0
7/20	29											4,521	4,521	0
7/27	30											1,429	1,429	0
8/03	31 1/	31	943	3,398	159,869	590	22,340			4,019	183,152	363	4,382	0
8/10	32 2/			897	25,833	90	2,679			987	28,512	203	1,190	0
Subtotals		31	943	4,295	185,702	680	25,019	0		5,006	211,664	14,037	19,043	0

1/ Proportions from week 32 of the Coghill district common property catch were used to allocate the catch.
2/ Proportions from week 33 of the Coghill district common property catch were used to allocate the catch.

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Southwestern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	No. Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/27	30	15,415	5.94E+07	17,589	9.78E+07	32,658	1.51E+08			65,662	3.08E+08	42,230	107,892	16
8/03	31	222,406	9.36E+08	205,405	2.32E+09	289,467	3.45E+09	37,374	2.08E+08	754,652	6.91E+09	145,737	900,389	156
8/10	32	501,678	3.55E+09	324,486	2.37E+09	210,736	1.64E+08	12,788	1.64E+08	1,049,688	7.63E+09	428,304	1,477,992	187
8/17	33	698,391	7.68E+09	503,628	7.39E+09	138,826	2.19E+09			1,340,845	1.73E+10	316,970	1,657,815	174
8/24	34	364,367	2.32E+09	20,342	1.04E+08	47,240	2.98E+08			431,949	2.72E+09	255,483	687,432	74
8/31	35	121,080	4.73E+08	7,789	3.03E+07					128,869	5.03E+08	86,530	215,399	33
Subtotals		1,923,337	1.5E+10	1,079,239	1.23E+10	718,927	7.64E+09	50,162	3.71E+08	3,771,665	3.53E+10	1,275,254	5,046,919	640
Grand Totals		1,971,452	1.53E+10	2,990,749	3.48E+10	3,679,113	3.89E+10	4,868,641	3.51E+10	13,509,955	1.24E+11	4,198,910	17,708,865	2,341

Appendix B.2. Pink salmon hatchery and wild stock contributions to Prince William Sound cost recovery fisheries by district and week during 1996.

Eastern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
6/22	25							10,688	5.37E+07	10,688	5.37E+07	0	10,688	5
6/29	26							533,839	1.89E+09	533,839	1.89E+09	72,041	605,880	151
7/06	27							518,848	1.53E+09	518,848	1.53E+09	107,481	626,329	176
7/13	28							668,909	2.87E+09	668,909	2.87E+09	17,504	686,413	156
7/20	29							284,643	1.17E+07	284,643	1.17E+07	151,078	435,721	68
Subtotals		0		0		0		2,016,927	1.17E+09	2,016,927	1.17E+09	348,104	2,365,031	556

Northern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/27	30 1/					4,843	808,935			4,843	808,935	6,177	11,020	0
8/03	31					124,767	5.37E+08			124,767	5.37E+08	159,110	283,877	29
8/10	32					111,872	3.21E+08			111,872	3.21E+08	196,568	308,440	39
8/17	33					210,604	9.86E+08			210,604	9.86E+08	516,440	727,044	45
8/24	34					153,751	6.71E+08			153,751	6.71E+08	226,924	380,675	51
8/31	35					94,103	3.11E+08			94,103	3.11E+08	0	94,103	30
Subtotals		0		0		699,940	2.83E+09	0		699,940	2.83E+09	1,105,219	1,805,159	194

1/ Proportions from week 31 were used to allocate the catch.

Coghill District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/03	31			73,816	1.09E+09	14,694	2.16E+08			88,510	1.31E+09	134,501	223,011	6
8/10	32			224,318	1.03E+09					224,318	1.03E+09	402,605	626,923	54
8/17	33			754,679	1.09E+10	123,322	8.0E+08			878,001	1.17E+10	441,588	1,319,589	114
8/24	34			479,438	5.75E+09	11,979	1.44E+08			491,417	5.89E+09	694,875	1,186,292	41
8/31	35	4,127	2.52E+07	469,686	2.87E+09	4,136	2.53E+07			477,949	2.92E+09	0	477,949	116
9/07	36			227,097	1.8E+09					227,097	1.8E+09	0	227,097	57
9/14	37			34,987	1.75E+08					34,987	1.75E+08	11,301	46,288	7
Subtotals		4,127	2.52E+07	2,264,021	2.36E+10	154,131	1.19E+09			2,422,279	2.48E+10	1,684,870	4,107,149	395

Eshamy District 1/

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/06	27											4	4	0
7/13	28													
7/20	29													
7/27	30											329	329	0
8/03	31											184	184	0
8/10	32													
8/17	33											5,472	5,472	0
8/24	34													
8/31	35													
9/07	36													
9/14	37											20	20	0
Subtotals		0		0		0		0		0		6,039	6,039	0
Grand Totals		4,127	2.52E+07	2,264,021	2.36E+10	874,071	4.01E+09	2,016927	3.52E+10	5,139,146	3.52E+10	3,144,232	8,283,378	1,145

1/ Catches were not allocated to hatcheries due to lack of samples taken in Eshamy district.

Appendix B.3. Pink salmon hatchery and wild stock contributions to Prince William Sound hatchery brood stock by district and week during 1996.

Eastern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/27	30							91,415	1.25E+08	91,415	1.25E+08	6,778	98,193	67
8/03	31							87,363	1.29E+08	87,363	1.29E+08	28,513	115,876	59
8/10	32							73,770	1.11E+08	73,770	1.11E+08	13,642	87,412	49
8/17	33							52,144	6.63E+07	52,144	6.63E+07	19,528	71,672	41
8/24	34							26,976	3.31E+07	26,976	3.31E+07	17,072	44,048	22
8/31	35							17,229	3.95E+07	17,229	3.95E+07	0	17,229	14
Subtotals		0		0		0		348,897	5.04E+08	348,897	5.04E+08	85,533	434,430	252

Northern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/31	35			1,515	2,296,316	32,772	4.88E+07			34,287	5.11E+07	32,334	66,621	23
9/07	36					37,866	5.31E+07			37,866	5.31E+07	50,849	88,715	27
9/14	37			3,346	5,598,521	66,569	1.11E+08			69,915	1.16E+08	49,182	119,097	42
9/21	38					28,534	5.43E+07			28,534	5.43E+07	57,933	86,467	15
Subtotals				4,861	7,894,837	165,741	2.67E+08			170,602	2.75E+08	190,298	360,900	107

Coghill District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/24	34			14,268						14,268		0	14,268	22
8/31	35			67,564						67,564		0	67,564	57
9/07	36			107,754						107,754		0	107,754	71
9/14	37			108,101						108,101		0	108,101	74
9/21	38			130,136						130,136		0	130,136	47
9/28	39			44,256						44,256		0	44,256	10
Subtotals		0		472,079		0		0		472,079		0	472,079	281
Grand Totals		0		476,940	7.89E+06	165,741	2.67E+08	348,897	5.04E+08	991,578	7.79E+08	275,831	1,267,409	640

Appendix B: Percent Survival by Tag Code of Pink Salmon Returning to Prince William Sound in 1996.

Appendix B.1. Percent survival by tag code of pink salmon returning to Prince William Sound in 1996.

Origin	Tag Code	# Tagged	# Released	Estimated Percent Survival	Standard Error	Lower 95% Confidence Interval	Upper 95% Confidence Interval
A. F. Koernig	1301030112	10,805	6,482,867	0.6273	0.2274	0.1815	1.0731
	1301030208	5,484	3,290,381	0.8551	0.3639	0.1418	1.5684
	1301030611	4,949	2,961,191	3.8069	0.8506	2.1340	5.4741
	1301030612	5,056	3,024,130	3.4228	0.8582	1.7408	5.1049
	1301030613	12,844	7,706,875	1.4195	0.4634	0.5112	2.3278
	1301030614	13,227	7,935,957	1.8131	0.4983	0.8365	2.7898
	1301030615	13,150	7,890,002	2.5186	0.5286	1.4825	3.5547
	1301030701	13,267	7,959,660	1.8989	0.4217	1.0724	2.7254
	1301030702	11,523	6,914,076	2.9554	0.5969	1.7854	4.1253
	1301030703	11,489	6,896,169	1.8450	0.3621	1.1353	2.5547
	1301030704	11,568	6,940,882	1.7759	0.4081	0.9761	2.5757
	1301030705	11,971	7,182,752	1.8385	0.5290	0.8017	2.8753
	1301030706	11,497	6,898,064	1.3965	0.3246	0.7604	2.0326
	1301030707	11,596	6,884,266	2.0239	0.3855	1.2683	2.7794
	1301030708	10,712	6,427,763	1.9541	0.5675	0.8419	3.0663
	1301030709	10,362	6,217,053	1.4790	0.3808	0.7326	2.2253
	1301030710	11,624	6,974,024	0.6808	0.2419	0.2067	1.1549
W. H. Noerenberg	1301030412	18,306	11,204,511	3.7630	0.6002	2.5866	4.9393
	1301030413	19,685	11,784,356	4.2798	0.6263	3.0522	5.5074
	1301030414	19,554	11,835,217	3.6413	0.6085	2.4487	4.8339
	1301030415	19,626	11,858,128	3.8029	0.5899	2.6466	4.9592
	1301030501	19,655	11,965,054	2.3725	0.4245	1.5405	3.2044
	1301030502	19,615	11,910,616	2.3392	0.4835	1.3916	3.2868
	1301030503	21,607	12,939,147	1.8215	0.3846	1.0678	2.5753
	1301030504	20,170	12,045,477	2.2398	0.4491	1.3596	3.1199
	1301030505	20,192	12,055,098	2.4580	0.4506	1.5748	3.3412
	1301030506	20,258	12,094,688	3.0890	0.5150	2.0796	4.0985
	1301030507	19,983	12,032,630	3.4294	0.5377	2.3755	4.4833
	1301030508	20,160	12,041,789	3.6520	0.5534	2.5673	4.7366
	1301030509	20,152	12,058,282	4.0573	0.6107	2.8603	5.2544
	1301030510	11,518	6,723,354	2.6206	0.5475	1.5475	3.6936
	1301030511	5,443	3,153,255	8.0870	1.7299	4.6964	11.4777
	1301030512	5,346	3,162,934	6.9855	1.4687	4.1069	9.8641

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Origin	Tag Code	# Tagged	# Released	Estimated Percent Survival	Standard Error	Lower 95% Confidence. Interval	Upper 95% Confidence. Interval
Cannery Creek	1301030903	15,972	9,557,693	4.9891	0.9055	3.2144	6.7638
	1301030904	16,382	9,791,611	3.9179	0.6266	2.6898	5.1460
	1301030905	16,244	9,699,256	2.5472	0.5084	1.5508	3.5436
	1301030906	16,740	10,028,649	2.4096	0.4786	1.4715	3.3476
	1301030907	16,366	9,833,723	2.6805	0.5191	1.6630	3.6980
	1301030908	16,661	9,865,363	2.7152	0.4314	1.8696	3.5607
	1301030909	16,345	9,827,507	6.2311	0.7479	4.7652	7.6971
	1301030910	16,785	10,026,368	4.4486	0.5800	3.3118	5.5853
	1301030911	16,480	9,864,051	5.5536	0.7644	4.0553	7.0519
	1301030912	16,394	9,831,138	3.9557	0.5473	2.8830	5.0284
	1301030913	16,668	10,101,033	3.1075	0.5214	2.0856	4.1294
	1301030914	16,247	9,765,141	3.1258	0.5488	2.0501	4.2016
	1301030915	16,094	9,610,718	1.5995	0.3718	0.8708	2.3282
	1301031001	4,176	2,537,200	1.8674	0.7923	0.3145	3.4202
Solomon Gulch	1301030602	38,238	24,064,548	3.4483	0.3090	2.8426	4.0540
	1301030603	41,773	25,360,456	4.1628	0.2939	3.5867	4.7389
	1301030604	42,204	25,937,816	3.9351	0.3346	3.2792	4.5909
	1301030605	44,606	26,999,046	2.6309	0.2227	2.1945	3.0674
	1301030606	45,160	27,148,395	3.1727	0.2822	2.6197	3.7258
	1301030607	40,824	24,333,581	2.3821	0.2613	1.8699	2.8943
	1301030608	52,218	31,917,113	5.0820	0.3011	4.4918	5.6722
	1301030609	32,811	19,610,175	2.6692	0.2591	2.1613	3.1771