# THE IMPORTANCE OF STOCK IDENTIFICATION FOR MANAGEMENT OF THE PRINCE WILLIAM SOUND PINK SALMON FISHERY

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REGIONAL INFORMATION REPORT NO. 5J92-12

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December 1992

## EXECUTIVE SUMMARY

In 1992, the smallest number of even-year wild pink salmon spawned in Prince William Sound since statehood. In spite of this shortfall, fishermen harvested nearly 75 percent of the wild run. To put these numbers in perspective, managers closed the directed pink salmon fishery in 1972 and 1974 for conservation reasons -- yet in these years even more wild spawners were observed in the streams of Prince William Sound than in 1992. In 1992, the fisheries managers expected a return of over 28 million hatchery pink salmon, so closing the fishery was not an option.

The purse seine fisheries in Prince William Sound are becoming congested and compressed both spatially and temporally. The fish processing industry is calling for a higher quality product, complaining that the harvest is taken too close to the spawning areas. Since 1986 the number of wild pink salmon allowed to spawn has been below the established goal three times. Managers have faced years when spawning goals were not met for the wild fish before; but in the past -- before the hatcheries and before the bigger more effective boats -- the fishery was less complex, and the fishing took place at a slower pace. Managers had more flexibility to move boats to areas with surplus fish; in those days managers also had more room for error. In the 1990's managers may find that once the number of spawners has been allowed to fall to low levels, it will be harder and harder to correct the problem as the magnitude of the difference in size of the wild runs and hatchery runs grows larger.

The total number of spawners does not tell the whole story. Fisheries managers are facing problems with the distribution of spawners; for instance, a chronic shortage of spawners occurs in the northwestern part of the Sound. After 1992 there are no plans to collect the basic information on the number of hatchery fish in the fishery, information that managers will need to attempt to deal with these problems.

Prior to the development of coded wire tag methods for stock identification, the estimates of hatchery production were based strictly on a form of political tug-of-war between fisheries managers and hatchery operators. With no hard information to base the estimates on, the final estimates better reflected the strengths of personalities than the strengths of run sizes. Hatchery operators feared that without a sufficiently large estimate of hatchery production, their programs would not get credit for their accomplishments, and they would lose support and

funding. Fisheries managers feared excessively large estimates of hatchery production would lead to wild salmon being mistaken for hatchery fish, which would in turn lead to overharvest of wild salmon stock.

Under Alaska's system, privately operated hatcheries are to receive a specified fraction of fish the hatchery produced to fund the hatchery operation. This system can only work if an objective, credible means exists to measure the hatchery component of the returning fish. In principle, it is possible to build a hatchery that never produces a single fish, but still receive a major fraction of the harvest of wild fish that were present before the hatchery was built, based only on the wishful assumption they were hatchery fish.

In 1986 the Prince William Sound hatchery operators and the fisheries managers began experiments with coded wire tags as a means to identify hatchery pink salmon in the common property fishery. By 1989 these studies were fully operational, and in 1991 the information from these studies was used to make management decisions while the season was in progress. In 1992 only about 2½ days elapsed between the time the fish were examined in the processing plants, and when information was available to fisheries managers. The coded wire tag information played a major role in inseason management and postseason evaluation of management actions of the 1992 season.

At the current time, stock separation studies in Prince William Sound are essential. We have identified six consequences of the loss of these studies:

1. No one will know the hatchery and wild component of the pink salmon runs.

2. The frequency and severity of shortfalls in the number of spawners will increase.

3. Future experimentation with harvest strategies to improve quality of the harvest will be irresponsible, and will nearly ensure declines in the wild salmon stocks.

4. There will be no rational means to forecast the catches or monitor the productivity and performance of wild salmon stocks, as the harvest of wild salmon will not be measurable.

5. Managers will have fewer options to respond to unexpected changes in the fishery, such as in 1991 when the residence times were unusual and 1992 when the hatchery survival rates were lower than expected.

6. The public and various interest groups will be correct if they conclude that a) no one is monitoring the situation with respect to hatchery development in Prince William Sound, and b) the stocks of wild salmon are at risk from overharvest.

Currently managers are charged to allow for 30 percent of the hatchery run to go to the special harvest areas for corporate use, and 70 percent to be caught in the common property fishery. The wild fish will not be able to sustain a harvest rate of 70 percent, although the hatchery fish can. The run of wild fish must be at least 4.7 million fish if the spawning goals are to be met with the remaining 30 percent. Since 1971 the wild run has been below this level about 30 percent of the time. As the effects of the continued spawner shortfalls accumulate, the runs will fall below this level more and more often. Management in Prince William Sound now requires the highest possible management precision. If wild and hatchery stocks cannot be made distinguishable to managers now, the situation will be increasingly hard to correct in the future -- no matter what level of management resources are thrown at the problem at that time.

## INTRODUCTION

In 1992 the harvest rate on wild pink salmon in Prince William Sound was nearly 75 percent -- a harvest rate that would be acceptable for a year with an abundant run of wild fish. Yet the 1992 run was not abundant; the number of wild pink salmon that escaped the fishery to spawn in Prince William Sound was the smallest ever recorded for the even-year line. The frequency of years when fisheries managers are unable to achieve an adequate number of spawners is increasing, and in some areas of Prince William Sound managers are facing chronic shortages of spawners. Fisheries managers have been charged with protecting the wild salmon from demise through overfishing, charged with conducting orderly fisheries, and after 1989 charged with conducting the fisheries so as to provide a high quality product by harvesting bright fish far from the spawning areas. These goals are partially incompatible.

The solutions to the management problems in Prince William Sound are not so obvious. However, the most immediate problem is that the information about the abundance of wild and hatchery stocks -- the information needed to identify problems and recommend solutions -- will no longer be collected after the 1992 season.

In this document we have tried to describe the current efforts to manage the pink salmon resource in Prince William Sound, and describe the need for a means to identify the hatchery and wild components of the harvest. To make the discussion more concrete, we have reviewed the management of the 1992 fishing season and provided examples of the kind of information that was generated during the 1992 season.

Alaska has embarked on one of the most ambitious experiments in the agricultural production of fish in the world, rivaled only by the Japanese culture of chum salmon on the island of Hokkaido, and experience with chinook and coho salmon in the Pacific Northwest, including the Columbia River.

To monitor the effects of this great experiment, fisheries managers have used coded wire tags to identify hatchery-produced salmon in the Prince William Sound pink salmon fisheries since 1987. Having a means to identify various stocks of salmon is called *stock separation* by salmon biologists.

These coded wire tag stock separation studies have allowed managers to assess the effectiveness of their actions, monitor the performance of the wild stocks of fish, forecast the future production of wild pink salmon, and develop something of a strategy

for the harvest of the hatchery-produced salmon. Without coded wire tags, or some other means of identifying hatchery fish, managers will not be able to know how many wild salmon there are in Prince William Sound. Without this basic information managers will be helpless when they are called on to prevent further declines in the wild salmon stocks, and manage for improved quality in the harvest.

The need for a means to identify the number of hatchery fish in fisheries having a large hatchery influence was identified long ago; yet in Alaska we still have no mechanism to fund these studies, or agreement about responsibility for conducting them. Following pioneering development of the stock separation techniques for hatchery pink salmon made in Prince William Sound in 1987 and 1988, the Alaska Department of Fish and Game and Prince William Sound Aquaculture Corporation continue to struggle over who, if anyone, will fund these studies. After a series of meetings in 1988, Norman Cohen, then the deputy commissioner of Alaska Department of Fish and Game, struck an informal deal with Prince William Sound Aquaculture Corporation. The Alaska Department of Fish and Game would agree to support a request for money from the legislature, and if the money was denied, the hatchery operators would fund the program in 1989.

Before the legislature could consider this issue, the *Exxon Valdez* oil spill resulted in an urgent need for information on the fate of pink salmon in Prince William Sound. The existing coded wire tagging program was naturally seen as the best source of this kind of information. Money intended for oil spill research flowed into both tagging and commercial fisheries sampling to strengthen these programs in the immediate postspill period. Eventually all funding for coded wire tagging was obtained from oil spill research sources from 1989 to 1992.

Either the managers will not be able to prevent overharvest of wild fish, the commercial harvest will be of poor quality because of the need to take the harvest at the end of the migration where the different stocks have become unmixed, or hatchery fish straying into natural streams will cause the genetic loss of wild salmon stocks. Indeed, based on the recent experience, all three of these fears may be realized with or without stock separation studies. Without tools to detect the exact problems, fisheries managers will simply be helpless bystanders. Their situation will be like medical doctors examining a patient with a tumor before modern diagnostic equipment: aware of a general degenerative process, but unable to make specific recommendations.

## THE FISHERIES AND MANAGEMENT

Pink salmon management in Prince William Sound is a dynamic process that occurs while the runs are actually in progress. Management is effected by opening and closing specific times and areas to fishing on very short notice. For quite a few years, the manager's decisions have been based upon the observed performance of the natural salmon runs in their natal streams. There are over 1000 documented anadromous streams in the Sound that are distributed throughout nine management districts (see Figure 1, a map of Prince William Sound). Managers monitor the number of fish that escape the fishery and enter these streams through extensive aerial surveys while the runs are in progress. Weekly aerial surveys are flown on 203 streams that provide managers with a comparative index of the magnitude of the number of wild fish spawning. These streams were selected to be representative of the other streams based on the timing of the runs, and other physical characteristics. Weekly spawner counts, called *escapement indices*, are compared to historical data, dating back to 1960.

The Sound's natural production over the past 30 years has contributed an average harvestable surplus to the common property fisheries of 5 to 7 million pink salmon, with considerable annual variation.

Prior to the introduction of large-scale hatchery enhancement, which began in 1978, the commercial seine fishery was traditionally managed on a weekly fishing schedule of 5 days per week. The fishing season typically started in mid-July and ran through mid-August. Frequently, fishing was opened to all districts in the Sound. Districts were selectively opened or closed based on escapement trends. The fishing fleet at this time was characterized by relatively small "pocket seiners" which specialized in "round hauling" or "hooking" in the bays near the spawning areas within the Sound. For the most part, the fleet was broadly distributed throughout the Sound and there were rarely, if ever, any problems with congestion.

When the first hatcheries arrived in Prince William Sound, fishery management became more complex. The fisheries managers, the fishing industry, and the hatchery operators developed basic *management plans* to describe exactly how managers will react to protect the natural stocks, and provide for the selective harvest of surplus hatchery fish. When large areas were opened to fish on migrating salmon, the large areas are referred to as the *general waters of the Sound*. These general waters contain mixtures of stocks. The management plans describe a strategy of managing the general waters of the Sound where the various stocks are mixed, and

then fine-tuning near the ends of the spawning migrations where the stocks have separated to move into their natal streams. The authors of the plans assumed management would remain as it traditionally had been in the general waters of the Sound: based upon the strength of the run of wild salmon stocks. Hatchery operators and fisheries managers assumed that hatchery fish would be more numerous than wild fish. To provide for the harvest of hatchery stocks, special areas call *terminal harvest areas*, or *hatchery subdistricts* were established in front of the hatcheries. These areas provided a location where hatchery salmon could be taken by the common property fishermen with minimal interception of wild salmon or in years of strong wild runs, to provide a refuge for hatchery salmon.

The opening of private nonprofit hatcheries introduced a new element to management: the obligation to provide the hatchery operator with a certain portion of the hatchery run for recovery of operational costs. Thus arose an allocative split of the hatchery fish between the traditional fishermen (what is called the *common property harvest)*, and the hatchery operators (what is called the *cost recovery* harvest).

Monitoring of the strength of the wild runs based upon aerial surveys has remained unchanged. However, managers quickly found that this assessment was insufficient to manage the new, evolving fisheries containing a large hatchery component. To provide managers with methods for assessment of the hatchery returns, new tools had to be developed. Initially, managers focused on daily tracking of fish abundance in the hatchery terminal areas. Fisheries managers carefully tracked such things as the hatchery sales harvests and the numbers of fish taken in the brood collection. Because the males tend to return first, the sex ratios in the hatchery terminal areas became very important in gauging the size of the hatchery runs. Through time, sufficient data was collected to provide managers with relationships, called *run entry curves*, that show the likelihood of achieving brood stock and cost recovery objectives based on this information from the hatchery terminal areas.

In 1984 and 1985, exceptionally strong runs of wild salmon presented managers and hatchery operators with an unanticipated problem. Modernization of the seine fleet and a shift in fishing patterns to the capes and entrance areas of the Sound had resulted in a shift to fishing in the Southwestern District. These cape fisheries are *mixed stock fisheries;* that is, fisheries conducted on salmon stocks that are mixed and indistinguishable to the managers. The exceptionally strong returns of wild fish enabled managers to provide for a liberal fishing schedule of 5 to 7 days per week. Because a heavy fishing schedule was justified for the wild salmon, the hatchery fish in the mixed stock fishing areas in

the Southwestern District were subjected to the same high rate of harvest. As a consequence, the return to the hatchery was insufficient to meet cost recovery objectives. In response, Prince William Sound Aquaculture Corporation approached the Alaska Board of Fisheries requesting adoption of a regulatory management plan directing the managers to create specific areas in front of the hatcheries to assist the hatchery operator in achievement of cost recovery goals. This management plan has subsequently proven effective.

In response to the 1984 and 1985 seasons, the Prince William Sound Aquaculture Corporation and Alaska Department of Fish and Game began to plan for a stock separation study that could give managers some means of identifying hatchery fish in the fishery. The study's planners hoped that this would allow managers a means to offer protection to the weaker of the wild or hatchery component early in the season. They decided to use the half-length coded wire tag, developed at the University of Washington in the 1960's. The tag was a small sliver of stainless steel, nearly microscopic, with a code scratched on four sides. The tags were injected into the cartilage in the nose of the young fish. The fish was externally marked by the removal of the small, fleshy adipose fin on the fish's back.

In 1986, approximately 625,000 half-length coded wire tags were placed in hatchery reared juvenile pink salmon from Prince William Sound Aquaculture Corporation and Alaska Department of Fish and Game hatcheries. The tagging operations were well executed and meticulously documented. In 1987 the commercial fishery was sampled for fish with the characteristic missing adipose fin. This missing fin indicated the fish possibly contained a coded wire tag. Also in 1987, the Valdez Fisheries Development Corporation helped plan a tagging project at the fourth Prince William Sound pink salmon hatchery: the Solomon Gulch Hatchery near Valdez. In that year, 178 thousand pink salmon fry were tagged with half length coded wire tags. In these and subsequent studies about one in every 600 hatchery fish received a coded wire tag. These pilot studies were partially funded by the hatchery operators. In both the 1986 and 1987 studies, the tagging projects were judged a success although both studies identified definite problems with the coded wire technique. However, both studies showed that coded wire tags could produce reasonable estimates. The studies also showed that problems could be detected and corrected, if the studies included a well coordinated quality control procedure.

In the 1988 season, an extremely weak run of wild salmon was observed and the general waters of the Sound remained closed for conservation reasons. To harvest the returning hatchery fish, intense fishing was permitted in the hatchery terminal harvest areas. With only three areas to choose from, the seine fleet was

extremely congested in these restricted areas. Lineups of 30 to 40 boats were reported at some of the more popular fishing points.

The 1989 return was similar to 1988: a weak wild run and a large hatchery run. In 1989, management had to also contend with the *Exxon Valdez* oil spill. There were delays of up to 11 days in the harvest of fish in the hatchery terminal areas. These delays resulted in a decline in quality of the 1989 pack. Sensitized to this quality problem, the fishing industry began arguing strongly for less restrictive terminal fisheries and more fishing time in the mixed stock areas of the Southwestern District.

Hatchery runs have come to dominate the total return of pink salmon to Prince William Sound. What is more important, the proportion of the hatchery fish has varied unpredictably from year to year.

The seine fleet has become more efficient, with large "limit seiners" specializing in fishing at the capes in the entrance areas to the Sound. Due to the location of the major hatchery facilities in the western Sound, most of the fishing is concentrated in the Southwestern District and along the migratory corridors where wild and hatchery stocks are mixed. When wild salmon are abundant, managers permit fishing in the general waters of the Sound. When this happens, wild fish, particularly those bound for the northwestern areas, are subjected to higher harvest rates. These high rates simply reflect the repeated exposure to fishing along the migratory corridor.

From 1988 to 1991, coded wire tags became increasingly important to the fisheries managers in Prince William Sound. The information in these years was mainly used after the season was over to determine the effect of management actions taken during the season. The technique has been refined and the need for information became much greater as the management of the seine fisheries grew increasingly unpredictable. By 1992, the managers were able to have information available less than three days after the technicians examined the catch. In 1992 the coded wire tag played a major role in the decisions the managers made while the season was in progress.

## MANAGEMENT OF THE 1992 SEINE FISHERY

In 1992, biologists had forecast a run of 2.4 million wild pink salmon before the beginning of the season. Pink salmon return on a two-year cycle, so there are two distinct lines: the odd-year and the even-year lines. There had only been three years in which the even-year run had been observed to be that low. The expectation of

crippled runs of wild fish contrasted with a preseason forecast of 28 million hatchery fish. Based on the preseason forecast, the manager's strategy was to provide protection to the early run wild salmon and assume some risk by allowing fishing during late July and August in the Southwestern District. A salmon harvest task force, composed of various representatives of the fishing industry, was organized to develop a written plan describing the strategy. The objectives were to reduce congestion, improve quality and help prevent overloading of the processing system.

Despite the pessimistic forecast for wild returns, the fishing industry argued within the task force for aggressive fishing in general waters of the Southwestern District at the beginning of the hatchery pink salmon run. The fisheries managers were uncomfortable with this strategy but agreed to accept added risk to wild stocks to alleviate concerns about quality, and because of the need to harvest the expected large hatchery return. Managers recognized the need to test the feasibility of fishing more aggressively in the general waters in future years. The added risk was acceptable only because the coded wire tags could provide valuable insight into percentage of wild salmon in discrete areas within the Southwestern District.

As expected, the wild runs were weak. During July, aerial surveys revealed that 50 percent or less of the desired numbers of spawners had returned. The shortfall was more pronounced in the northwestern areas of the Sound, where less than 20 percent of the desired number of spawners were reaching their home streams. The task force had recommended that fishing begin on July 27. On July 27 and 30, 6-hour fishing periods were permitted in the southern half of the Southwestern District, and 12-hour periods were permitted in the hatchery subdistricts. In the hatchery subdistricts, harvests were only about 1/3 of what was expected during both periods. Based upon low numbers of wild fish escaping the fishery to spawn during July and the large hatchery forecast, managers made an important assumption: that almost all of the harvest was hatchery fish.

Fishing was concentrated in the hatchery subdistricts, and only about 25 percent of the fleet ventured into the general waters of the Southwestern District. This was presumably due to the lack of any visible signs of salmon jumping in the general waters and lost fishing time associated with running back to the subdistrict. Several vessels ventured to Cape Junken, on the Gulf of Alaska; however, after several sets they too were headed back to the subdistricts. These 6-hour openings allayed fleet jitters that the management might allow a large buildup of fish that would lead to quality declines. The openings provided management information on the abundance of fish based on catch. Surprisingly, harvest from the Unakwik Inlet terminal harvest area was nearly as great as the

Southwestern district with only 25 percent of the fishing effort. Harvest and effort in the Esther Subdistrict were dismal.

Female fish made up 10-17 percent of the hatchery sales harvest during late July; this statistic is a key indicator of how far along the hatchery run is. This low value indicated that the hatchery return was just beginning. Because of the weak performance during the first two periods the opening scheduled for August 1, which the task force recommended, was canceled. The need for the cancellation was clear to most of the fleet, although some fishermen felt that "a deal was a deal," and they wanted fishing to continue. To gather information on the dynamic entry of fish into the Sound, test fishing was conducted on August 1, in key areas of the Southwestern District. By this time, clearly the run was small.

During the next week, preliminary coded wire tag results indicated contribution of wild salmon to the total catch was higher than managers had assumed. In spite of the large shortfall in wild spawners, large numbers of wild fish had been harvested in the Southwestern District.

To see if coded wire tag information could be used to avoid wild salmon in the Southwestern District, fishing was alternately allowed on the east and west side of the migration corridor. This was the first time that management of the general waters had not been based on regulating time and area based on aerial survey indices. This procedure was used beginning on August 3. Based on the task force's recommendation, this approach continued for a total of four, 12-hour periods until August 11. The fisheries managers were clearly taking risk with this strategy: the numbers of wild salmon that had escaped the fishery was low. Yet fish quality was reported to be good, and to discontinue the corridor plan would have left management with no assessment of an alternative harvest strategy.

As the season progressed managers had to rethink their original plan. The original schedule called for fishing every other day. However, after the August 5 period, the interval between periods increased to every third day due to the weakness of both hatchery and wild runs. The Esther Subdistrict did not open during the August 8 period. For the August 11 period, the Knight Island corridor was made smaller and the fishing time was reduced. The Chenega Island shoreline was not opened and the remaining waters of Prince of Wales Passage and the Elrington subdistrict were only opened for 6 hours.

After the August 11 period, fishing was confined to the Port San Juan subdistrict, Esther Subdistrict and Unakwik Inlet Terminal Harvest Area. Fish quality had been good up to this point; but the

numbers of wild fish escaping the fishery to spawn was shaping up as the second worst on record.

As coded wire tag information on the wild fish component of the catch was received, managers adjusted the fishing area and schedule. In Unakwik Inlet a high percentage of wild fish were identified in the harvest; accordingly the southern boundary was moved north approximately one nautical mile beginning with the August 11 period.

The management plan called for 30 percent of the hatchery return to go to the special harvest areas for corporate needs, and 70 percent to be caught in the common property fishery. Based on the coded wire tag information available while the season was in progress, managers adjusted harvest rates to cause more of the Prince William Sound Aquaculture Corporation's production to be caught in the common property fishery.

In the end, the hatchery salmon were harvested, the quality remained high, and some information about the makeup of fish in the migration corridors was made available. However, the fishery was congested, and most importantly the parental stock for the salmon that will return in 1994 dropped to dangerously low levels, and the harvest rate on the wild stocks of salmon was far too high.

## PRELIMINARY 1992 CODED WIRE TAG RESULTS RELATED TO MANAGEMENT

In 1992 about 8.6 million pink salmon were harvested in the commercial fishery in Prince William Sound; this figure includes both the common property harvest and the hatchery cost recovery harvest. Preliminary estimates are that 1.8 million of these were wild pink salmon. Thus, all but about 19 percent of the harvest originated from hatcheries. This percentage varied by region. Wild fish made up 24 percent of the catch in the Eastern District, 37 percent of the catch in the Northern District, 20 percent in the Coghill District, 18 percent in the Eshamy District, and 17 percent in the Southwestern District.

The 1992 coded wire tag results showed that aggressive fishing in the general waters of the Southwestern District, before mid-August, resulted in excessive harvests of wild fish. This aggressive fishing was largely responsible for massive shortfalls in the numbers of wild spawning fish throughout the Sound. The coded wire tag information for individual fishing periods showed that the percentage of wild fish in the commercial catch was high in late July, but decreased through time. On July 27, 26 percent of the

catch was made up of wild fish, whereas on August 11, only 6 percent of the catch were wild fish. If the wild pink salmon need protection, fishing outside of hatchery subdistricts should be restricted until the second week in August. Even though delaying aggressive fishing will likely curtail interceptions of wild fish, interceptions of wild fish occurred at high levels even within the special harvest area for the Armin F. Koerning Hatchery. The fraction of wild fish in the hatchery sales harvest from that area averaged almost 20 percent for the season.

During the 1992 season, managers looked for differences in spatial distribution of hatchery and wild fish within the Southwestern District. The district was divided into an eastern and a western corridor and fishing was allowed on alternate days in these areas. When the fishery was opened on August 3, the catch in the eastern corridor contained 29 percent wild fish. The contribution of wild fish in the west corridor was 10 percent when the fishery was opened on August 5. In the following week, wild fish in both corridors were far fewer. Essentially no wild fish were caught in the eastern corridor and an estimated 6 percent were caught in the western corridor. These two estimates were considered statistically indistinguishable. Hatchery contributions in the western corridor were approximately equal portions of fish from the Wallace H. Noerenberg Hatchery and the Armin F. Koernig Hatchery. A smaller but significant contribution to the catch of fish in the western corridor came from the Cannery Creek Hatchery. The Armin F. Koernig Hatchery fish were more prevalent in the eastern corridor.

In 1992, 34 technicians sampled Prince William Sound salmon at processing plants in Cordova, Valdez, Anchorage, Whittier, Kenai, Seward and Kodiak. Three floating processors, as well as a Russian floating processor, were also sampled for coded wire tags.

A total of 6,442 pink salmon heads were recovered and shipped to the Tag Lab in Juneau for processing. Only 3,752 of these had tags in them. In all, 23 percent of the common property fishery, 31 percent of the hatchery cost recovery fishery, and 93 percent of the hatchery brood stock were *scanned*, or examined for a coded wire tag. The scan rate in 1992 was higher than in previous years due to the small size of the total return.

Sockeye, coho, chum, and chinook salmon were also sampled for coded wire tags in the Prince William Sound area. The average scanning rate for these species was 29 percent for the common property fishery, 39 percent for the cost recovery fishery, and 100 percent for the brood stock. A total of 8,983 heads were recovered of which 6,044 had tags. Tag recoveries for chum and chinook salmon were too few to draw any conclusions.

The total sockeye salmon catch in the Prince William Sound area was 611 thousand fish. An estimated 60 percent of the fish caught in the common property sockeye fishery originated from the Main Bay Hatchery.

The total coho catch in the Prince William Sound area was 128 thousand fish. An estimated 95 percent of these coho salmon originated from hatcheries.

## CONCLUSIONS

The coded wire tag information played a major role in inseason management and postseason evaluation of management actions of the 1992 season. Furthermore, at the current time, stock separation studies in Prince William Sound are essential for management of these complicated and changing fisheries. The State of Alaska has a huge investment in the development of this complex stock separation technology in Prince William Sound, and the current system is working well. In 1992 only about 2½ days elapsed between the time the fish were examined in the processing plants, and when information was available to fisheries managers.

If the current system is abandoned there will be consequences, both anticipated and unanticipated. We have identified six consequences of the loss of these studies:

1. No one will know the hatchery and wild component of the pink salmon runs.

   Without this information all aspects of the management plans calling for fractions of the hatchery harvest become meaningless. For example, the current hatchery management plans call for letting the common property fishery have 70 percent of the hatchery return. In 1992, if management would have followed their assumptions about the size of the wild run, about one million dollars of fish would have been redirected from the common property fishery to the hatchery operators.

2. The frequency and severity of shortfalls in the number of spawners will increase.

   This is simply a result of the fact that managers will have nothing at all to base inseason decisions on in

the areas where wild and hatchery stocks mix. The hatchery component can be anywhere from 20 percent to over 90 percent. Even in the hatchery terminal areas the proportion of wild fish can be as high as 30 percent.

3. Future experimentation with harvest strategies to improve quality of the harvest will be irresponsible, and will nearly ensure declines in the wild salmon stocks.

   Responsible fishery management will require more congested fisheries at the ends of spawning migrations where the stocks are relatively unmixed. This will lead to delays in harvest to attempt to assure enough wild fish escape the fishery to spawn. With no information about stock composition while fishing is in progress, the manager's only tool to measure the size of the wild run will be observed escapement.

4. There will be no rational means to forecast the catches or monitor the productivity and performance of wild salmon stocks, as the harvest of wild salmon will not be measurable.

   The forecasts are based on historical relationships between the variable being forecasted and various factors that affect the outcome. In the future, if we don't know the historical values of the variable being forecasted, we will not know how this variable is related to any other factors.

5. Managers will have fewer options to respond to unexpected changes in the fishery, such as in 1991 when the residence times were unusual and 1992 when the hatchery survival rates were lower than expected.

   This point is a reminder of why points 1 and 3 are important. The *Exxon Valdez* oil spill, and the unusual timing of the return in 1991 are examples of recent fisheries, where managers were forced to react to completely unanticipated circumstances. In an uncertain future, the stock separation information might easily have far more value than we can currently anticipate.

6. The public and various interest groups will be correct if they conclude that a) no one is monitoring the situation with respect to hatchery development in Prince William Sound, and b) the stocks of wild salmon are at risk from overharvest.

    We can already see a trend in the overharvest of the wild salmon stocks. We can surely infer the problem will be even worse once we lose sight of what the harvest rates actually are.

Currently managers are charged with managing for 30 percent of the hatchery run to go to the special harvest areas for corporate escapement, and 70 percent to be caught in the common property fishery. The wild fish will not be able to sustain a harvest rate of 70 percent, although the hatchery fish can. The run of wild fish must be at least 4.7 million fish if the spawning escapement goals are to be met with the remaining 30 percent. Since 1971 the wild run has been below this level about 30 percent of the time. As the effects of the continued escapement shortfalls accumulate, the runs will fall below this level more and more often. Management in Prince William Sound now requires the highest possible management precision. If wild and hatchery stocks cannot be made distinguishable to managers now, the situation will be increasingly hard to correct in the future -- no matter what level of management resources are thrown at the problem at that time.

## ACKNOWLEDGEMENTS

We thank Steve Fried, Karen Crandall, Tim McDaniel, Carol Peckam, David Evans, and Mark Willette for their help and advice in preparing this document.