Special Publication __

Run Re-constructions for the Years 1972-2001 and Recommendations Concerning Revision of the Escapement Goal for the Sockeye Salmon Stock Returning to the Italio River System of Yakutat, Alaska

By

John H. Clark

and

Gordon Woods

October, 2002

Alaska Department of Fish and Game

Southeast Region

TABLE OF CONTENTS

Page

LIST OF TABLES

Table **Page**

1.

LIST OF FIGURES

Figure **Page**

ABSTRACT

Available information on aerial surveys of spawning escapements, harvests and age compositions of sockeye salmon *Oncorhynchus nerka* returning to the Italio River system located southeast of Yakutat, Alaska, during the years 1972-2001 was collated and analyzed. This information was used to develop annual run re-constructions for the years 1972-2001 as well as a brood table of estimated escapements and age specific total returns (recruits). Two stock-recruit relationships were developed from these data; the historic relationship using brood years 1972-1981, and the recent relationship using brood years 1986-1996. Brood years 1982-1985 were not used in stock-recruit relationships because of a disruption in homing behavior that resulted from the Italio River changing channel in December of 1986 and entering the Akwe River lagoon. The historic relationship resulted in an estimate of the escapement level that produced maximum sustained fisheries in line with the goal used to manage this stock of sockeye salmon through the 2002 fishing season. However, the recent relationship demonstrated that productivity of the stock had markedly decreased since the historic period, indicating that the existing escapement objective is no longer germane. Further, productivity continued to decline across the recent period, indicating that use of the recent data to develop a revised biological escapement goal was not prudent. Therefore it is recommended that the biological escapement goal used since 1995 be rescinded and a replacement escapement goal not be defined until stock productivity stabilizes. Only insignificant fishing on the stock has taken place since 1987 and it is recommended that this pattern be continued until stock productivity stabilizes. Meanwhile, very significant information gaps pertaining to this stock exist and it is recommended that an improved stock assessment effort be undertaken. Specific stock assessment improvements are provided.

KEY WORDS: sockeye salmon, *Oncorhynchus nerka*, Italio River, brood table, escapement goal, maximum sustained yield, spawner-recruit relationship.

INTRODUCTION

The Italio River system is located southeast of Yakutat, Alaska (Figure 1). The Italio River supports a spawning population of sockeye salmon *Oncorhynchus nerka*. This area of Alaska is geologically active with rivers changing course periodically. In December of 1986, the Italio River changed course and broke through and into the Akwe River lagoon. An examination of the geography of the Yakutat area shows that all rivers in the Yakutat area to the southeast of the city of Yakutat break out into the Gulf of Alaska to the west. And many of these rivers, like the East Alsek River and the Akwe River, form lagoons with water that flows westward inside the beach for several miles before actually breaking out into the Gulf of Alaska. Prior to 1986, the Italio River entered a partially saltwater lagoon that paralleled the beach for a few miles and then subsequently entered the ocean. Since December of 1986 when the Italio River changed course, both the Akwe and Italio rivers have instead shared a significant portion of the Akwe lagoon.

Targeted commercial and subsistence set gill net fishing for both the Akwe and Italio sockeye salmon stocks takes place. In the years prior to 1987, fishermen set gill nets in the Akwe lagoon and presumably harvested predominantly the Akwe stock of sockeye salmon. And similarly, fishermen set gill nets in the Italio lagoon and presumably harvested predominantly the Italio stock of sockeye salmon. Before the fishing season in 1987, the Alaska Department of Fish and Game (ADF&G) redefined set gill net fishing boundaries in response to the Italio River changing course during the prior winter. The lower boundary of the Akwe fishing area was moved upstream above the confluence of the two rivers. And likewise, the lower boundary of the Italio fishing area was moved upstream above the confluence of the two rivers. Management intent was to continue to allow fishing, but at the same time, to preserve the management objective of only allowing fishing on target stocks to the extent practical while minimizing interception of non-target stocks.

The Akwe River is larger than the Italio River and it is glacially influenced to some extent. The Ustay River is a glacial stream that splits and subsequently feeds into both the Alsek and the Akwe Rivers. A geological change in 1985 resulted in a larger portion of the Ustay River entering the Akwe River. As a result, water clarity and the ability to observe salmon during surveys in the Akwe River since 1985 has deteriorated. Annual harvests of sockeye salmon in the Akwe fishery were as high as about 28,700 fish in 1980 and averaged about 8,000 fish during the 15-year period of 1972 to 1986. Since 1987 when the fishing boundaries were altered, annual harvests of sockeye salmon in the Akwe fishery were as high as about 21,000 fish in 2000 and have averaged about 7,000 fish in the 15-year period of 1987-2001. Thus, there has not been much difference in the Akwe fishery harvests before and after the change in the Italio River's course.

Annual harvests of sockeye salmon in the Italio fishery were as high as about 7,500 fish in 1984 and averaged about 1,800 fish during the 15-year period of 1972 to 1986. Since 1987 when the fishing boundaries were altered, annual harvests of sockeye salmon in the Italio fishery were as high as about 900 fish in 1987, but have only averaged about 70 fish in the 15-year period of 1987-2001. Thus, there is a large difference (an average of only about 4% of the historic harvest) in the before and after fishery harvests associated with the change in the Italio River's course. The since 1987 Italio fishing boundaries were defined and intended to target Italio salmon stocks. But, due to the limited geographic area available, have resulted in a fishing area that is fairly small, typical water currents causes problems and difficulties for fishing set gill nets, and only minor levels of commercial and subsistence fishing effort have been exerted in this area since 1987.

The Italio River is smaller than the Akwe River and it is a clear water stream without glacial influence. The Italio River includes a tributary with a lake that provides rearing habitat for sockeye salmon. Sockeye salmon are believed to spawn in the lake, in small tributaries to the lake, and in the Italio River itself and its other tributaries. A falls located about one half mile below the lake has historically caused some difficulty with upstream salmon migration. In the late 1970's, ADF&G and the U. S. Forest Service collaborated and made some in-stream improvements in this area to reduce water velocity and hence improve upstream migratory success for salmon. Although adult salmon can successfully migrate past this high velocity stretch of river, it is doubtful that sockeye salmon fry hatching in the river downstream of this area can successfully migrate upstream and rear in the lake. Thus offspring of sockeye salmon spawning downstream of this high velocity area would have to rear in the river itself or in the lagoon prior to entering the ocean.

The Italio River system also supports a modest population of coho salmon *Oncorhynchus kisutch.* The Italio River, since its change in course in December of 1986, has been called the New Italio River, however, in this document we simply use the term Italio River except in the following couple of paragraphs when discussing the Middle Italio River and the Old Italio River.

When the Italio River changed course in December of 1986, it left behind its original channel. That channel still flows due to upwelling at the headwaters, but with a reduced amount of water. The channel is now called the Middle Italio River because it is located between the Old Italio River and the New Italio River. The Middle Italio River annually supports a modest population of coho salmon, but does not support a population of sockeye salmon. The only recorded observation of sockeye salmon in the Middle Italio River was on July 17, 1998 when 300 sockeye salmon were observed and it is believed that these fish backed out of the system and spawned in the New Italio River.

The Old Italio River has always been completely separate from the Italio River itself ("New" or "Middle"). The Old Italio River is a small stream that exits into the Gulf of Alaska just east of the mouth of the Dangerous River. The Old Italio River annually supports a modest population of coho salmon, but does not support a population of sockeye salmon. The only recorded observation of sockeye salmon in the Old Italio River was on August 22, 1991, when 125 sockeye salmon were observed in the Old Italio River and it is believed that these fish backed out of the system and spawned elsewhere, probably in the New Italio River.

The Italio River is considered to be the most difficult stream in the Yakutat area to survey from the air. While the water is crystal clear, the river is oriented north to south, and flows through deep forest. Deep shadows often exist along extensive sections of the river. Quality of the survey counts is dependent on the skill and experience of the pilot. The river has a very convoluted course, and requires some major aerobatics to allow the observer to maintain eye contact with river. Fairly long stretches of the river are in the open, as well as several major holding pools. Italio Lake is open. The western third of the lake is a shallow bench and fish are easy to see under good lighting conditions in this area. The lake and the river are not always flown on the same survey. The lake may be open but the river in deep shadow, or the river may be open while the lake, located in the mountains, is covered with fog. Professional opinion is that under excellent conditions, the observer cannot see all the fish in the river because substantial habitat cannot be observed from the air. Professional opinion is that under excellent or under good/normal conditions, about one-half of the total number of sockeye salmon in the river system are counted.

The stock assessment program for the Italio River system sockeye salmon population consists of flying aerial surveys of the Italio River to count spawners as well as collection and tabulation of fish tickets and subsistence catch reports. Sampling of the commercial catch and the escapement for age, sex, and length information has been limited. Since 1972, only 4 of the 30 annual escapements have been sampled. While substantial harvests of Italio River system sockeye salmon have not occurred since 1987, only 6 of the 16 annual harvests from the 1972-1987 period were sampled to document age, sex, and length composition of the sockeye salmon harvested in these years.

The Italio commercial fishery is designed for active management whereas only passive management (fishery monitoring) of the subsistence fishery occurs. Intent of active management of the commercial fishery is to conduct periodic aerial surveys of spawning escapements and set variable weekly openings of the commercial fishery. The management objective is to achieve an escapement of 2,500 to 7,000 sockeye salmon in the Italio River system on an annual basis. ADF&G adopted the biological escapement goal in 1995 based on stock-recruit analysis of the 1972-1989 brood years (Clark, Burkholder, and Clark 1995). Because little fishing effort has been expended in the commercial Italio set gill net fishery since 1987, only minor effort has been required to implement the active management program.

The annual harvests of the Italio River system sockeye salmon stock have changed substantially since 1987. Escapements markedly decreased following the change in river channel. Seven years have passed since the biological escapement goal was developed. In the interim period, additional data has been collected. The objective of this technical report is to review the data available at the current time and determine if the existing ADF&G biological escapement goal for the Italio stock of sockeye salmon is still appropriate, and if not, to identify, if possible, an alternate escapement goal for future fishery management.

RUN RECONSTRUCTIONS

Escapements

Total escapement strength of sockeye salmon spawning in the Italio River system has never been directly estimated. Instead, aerial surveys of the river system provide an index of escapement strength. The index is presumably indicative of annual abundance trends. And, presumably, the index reflects a similar portion of the total escapement from year to year.

Aerial survey counts of sockeye salmon in the Italio River system since 1972 are provided in Appendix Tables 1 and 2. Peak annual aerial survey counts of sockeye salmon in the Italio River system over the 31-year period of 1972-2002 have ranged from a low count of 200 fish in 2001 to a high count of 15,000 fish in 1978 (Table 1). In most years, multiple surveys of the Italio River system to count sockeye salmon were successfully flown and the annual count used to index spawner abundance is the peak count.

Close examination of Table 1 reveals that the date of the annual peak count across the 31-year time series varied from as early as July 11th in 2001 to as late as September 3rd in 1993, a time span of about 54 days. Timing of sockeye salmon runs and time of spawning for sockeye salmon populations are typically conservative. It seems unreasonable to think that the actual peak of in-river abundance of Italio River system sockeye salmon would vary by almost two months across a 31-year time series. Therefore, we decided to spend considerable effort in the examination of

timing of the index data in an effort to adjust observed peak counts upward when they occurred outside of what appears to us to be actual peak abundance time periods.

We decided to group aerial survey count observations by time blocks for analysis. Most observations that occurred in June were in the latter part of June and hence these observations were grouped into what we termed time block 1. The months of July, August, and September were each split into three approximately equal periods (1st to the 10th; 11th to the 20th, and 21st to the 30th or 31st) and hence time blocks 2 through 10 were each defined. Observations that occurred in October were in early October and that time period was defined as time block 11.

Peak counts of sockeye salmon in each year and in each time block were arrayed (Table 2), with annual peak surveys shown in bold. Examination of these data show that peak annual surveys occurred as early as in time block 2 (July 1-10) and as late as time block 8 (September 1-10). Visual examination also shows a general trend, with peak annual surveys occurring earlier in the years after the Italio River changed course. Lastly, examination of Table 2 shows that in many of the years, there are no observations in many of the blocks, thus raising the level of uncertainty concerning whether or not observed peak surveys actually occurred during peak abundance time frames. They obviously did not occur in similar actual time frames over the 30-year time series, and are instead spread across a two-month period.

Within any given year, the peak count within a time block was divided by the annual peak count and expressed as a percent of peak value (Table 3). This allowed us to standardize the data set somewhat and examine how abundance of Italio River system sockeye salmon built up and decreased over time within and across the years. This approach also allowed us to more carefully examine what the data provided and what the data failed to provide concerning certainty with regard to timing of peak abundance.

The annual data sets were examined to determine what years fell into the following categories:

1. Level 1: In a given year, direct observations in the immediate time block before and in the next time block demonstrate conclusively that peak abundance was actually observed in that time block in that year.
2. Level 2: In a given year, direct observations within no more than two time blocks before and two time blocks after the time block of the observed peak provide an indication of the actual timing of peak abundance for that year.
3. Level 3: In a given year, direct observations both before and after the time block of the observed peak at least demonstrate that peak abundance phenomena occurred that year.
4. Level 4: The remainder of the annual data sets.

When we categorized the data in this manner, we found only 2 of the 30 annual data sets met criteria identified for Level 1. Thus, based on direct observations, we are sure that peak abundance occurred between about August 1st and 10th in both 1986 and 1988 (Table 4). Based upon simply the lack of direct observations, uncertainty concerning the actual timing of peak abundance surrounds the other 25 annual data sets examined.

Next, we went through a logic process wherein we asked ourselves, based on the annual data sets available, could the peak of abundance have occurred in another block of time and because surveys were not conducted, could the actual annual peak abundance been in a block of time not surveyed. This approach allowed us to address the likelihood that actual peak abundance occurred in various time blocks other than those with direct observations. An analysis of this type for the annual data sets identified as level 1, 2, or 3 is provided in Table 5. This analysis

indicates that peak abundance of Italio River system sockeye salmon most likely occurs in time block 5 or from August 1st through 10th.

The same approach was applied to all 27 years of data. Use of the approach identified time block 5 (August 1st through 10th) as the most likely time block when peak abundance occurred for Italio River system sockeye salmon for the full time series of 1972-2001 (Table 6). However, a difference in the years 1972-1986 versus 1987-2001 is apparent. The most likely period of time associated with peak abundance of Italio River sockeye salmon during the years 1972-1986 was time block 7 or from August 21st through August 31st (Table 6). On the other hand, the most likely period of time associated with peak abundance of Italio River sockeye salmon during the years 1987-2001 was time block 5 or from August 1st through August 10th (Table 6). Such a change in timing is to be expected, given that a different migratory corridor is involved with escapements through 1986 and from 1987 to 2001.

Based upon the analyses presented and discussed above, we decided to adjust the observed peak aerial survey counts based upon timing information. We reasoned that if the observed peak survey in a given year took place during a time block that the bulk of the data set indicated was unlikely to have been the time block when actual peak abundance occurred, the index value should be adjusted upward. In doing so we kept two things in mind. We used direct observations when we were certain, based on annual sampling data that the peak survey occurred during the relevant time block. In 1986 and 1988 for instance, direct observations demonstrated that peak abundance had to have occurred in time block 5. Second, we split the data into two periods, 1972-1986 and 1987-2001. Time block 7 (August 21st through 31st) was assumed to have been the time period when abundance actually peaked in the years 1972-1986, unless direct annual sampling observations in that time block demonstrated otherwise. Time block 5 (August 1st through 10th) was assumed to have been the time period when abundance actually peaked in the years 1987-2001, unless direct annual sampling observations in that time block demonstrated otherwise.

The values as presented in Table 3 were averaged across the full set of years and for the years 1972-1986 versus the years 1987-2001 (Table 7). Thus, for the 1972-1986 data set, the average observed count was 85% of the annual peak value during time block 7. If in a given year in the 1972-1986 data set, the observed peak survey occurred in time block 7, the peak value was not adjusted. However if the peak survey occurred in a different time block, it was adjusted based on the ratio of the average for time block 7 divided by the average for the observed time block. So for example, in 1973, the observed peak survey occurred in time block 6. In that year, there were no surveys conducted at a later date. Hence the abundance of sockeye salmon could have increased thereafter and not been monitored. And, the preponderance of data demonstrated that such a scenario was more likely than the stock having been at peak abundance on the date of the last survey. Therefore the peak abundance index of 4,200 fish counted on August 18th was adjusted upward to 4,732 fish based on an adjustment factor of 1.13. The adjustment factor of 1.13 is the result of taking the average value of 89% for time block 7 and dividing it by the average value of 79% for time block 6 when the peak observation was made. To follow through with escapement expansions, the adjusted peak count of 4,732 fish in 1973 was expanded by a factor of 2.0 to estimate total escapement. The last adjustment accounts for the assumption that peak surveys of sockeye salmon in the Italio River system likely represent one-half of the total escapement, and this assumption is based upon professional opinion of staff involved with the aerial survey program.

Although these analytic procedures may seem complex, they are actually fairly simple and in most cases, adjustments for timing only change the observed values to a minor degree. However,

in years like 1977, when the peak survey was very early (July 29th) and it was the last survey observation, the adjustment is substantial (1.56-fold) and rightfully so. It is very unlikely that the observation that has to be used as a starting value for a year like 1977 would adequately represent the annual trend nor would it be likely to represent a relatively constant proportion of the total escapement. Whether or not the magnitudes of these adjustments are fully adequate we are uncertain, while we remain certain that the index values for years like 1977 have to be adjusted upwards.

Estimated total escapements of Italio River sockeye salmon for the years 1972-1986 are provided in Table 8 with the data sets used to calculate the final estimates. The same information for the years 1987-2001 is provided in Table 9. Because no survey counts of escapement were made in 1979, we included a proxy value for that year of 17,700 which is merely the average estimated escapement for the other years in the 1972-1986 data set (Table 8). This seemed like the most appropriate methodology to use because no trend in this data set was obvious that would lead us to an alternate proxy value. No survey was completed in 1998 either and we developed a proxy value for 1998 as well. Because estimated escapements in the early years of the 1987-2001 data set were substantially higher than in the later years, we used the approximate average of the years 1997 and 1998 to define a proxy value for the escapement in 1998 (Table 9), or about 25% of the earlier period, on average.

Based on these analyses, we believe the Italio River sockeye salmon escapements have varied from under 1,000 fish to almost 35,000 fish over the 30-year period of 1972-2001. From 1972 until the Italio River changed course in 1986, we believe the sockeye salmon escapements varied from about 6,000 fish to around 35,000 fish annually and likely averaged about 18,000 fish (Table 8). After the Italio River changed course in 1986 and thus from 1987-2001, we believe the sockeye salmon escapements varied from less than 1,000 fish to about 13,000 fish annually and likely averaged about 4,500 fish (Table 9).

While we are providing numerical estimates of the escapements of the Italio River sockeye salmon stock for the years 1972-2001, we consider these as approximations only of the actual annual escapement strengths. There have been no on-the-grounds work in the Italio River system to scientifically estimate the magnitude of the annual escapement strengths of the sockeye salmon runs. And until such time as sampling based procedures are implemented, the only option available is to make conjectures, identify assumptions, and work to some how or other expand instantaneous aerial survey counts such as we have done herein. The estimates we have developed likely have large measurement errors associated with them. This is because the Italio River is difficult to survey, professional opinion is that a significant portion of the fish in the area are not visible to aerial survey observers, and available peak aerial survey observations are spread across a two month time frame. Even given these difficulties, we believe that the escapements in the years 1976-1985 were in reality substantially higher than the escapements in the years like 1994-1999. While the approach we have used is likely unable to differentiate between say escapements of 15,000-25,000 due to measurement errors, on the other hand, it is likely to be able to differentiate between escapements of say 3,000 and 10,000. Undoubtedly, the biggest uncertainty involved with efforts to develop run re-constructions and brood tables for the Italio River sockeye salmon stocks is the actual strength of the historic escapements.

Harvests

A terminal commercial fishery for Italio River system sockeye salmon has historically taken place in the lower portion of the Italio Lagoon/Italio River or the Akwe Lagoon/Italio River.

Fishing gear is limited to set gill nets. Commercial harvests of sockeye salmon in the Italio commercial fishery (commercial fishing districts 182-50) from 1972 to 2001 were summarized from fish ticket information. Fish tickets are sales receipts filled out when commercial fishermen sell fish to processors. This fishing district represents the terminal commercial harvest for the Italio stock of sockeye salmon.

Although it is likely that a few Italio River system sockeye salmon are caught elsewhere in other commercial fisheries, there is no direct evidence to support this supposition and it is likely that any interceptions are minor. The most likely commercial fishery to intercept Italio origin sockeye salmon is the Akwe fishery. Although some Italio origin sockeye may be caught in this fishery, the number intercepted must be small. This is because age composition of sockeye salmon caught in the Akwe fishery averages about 75% "zero checks" or sockeye that went to sea the year they hatched and available age composition data for the Italio escapements indicates only few "zero checks" spawn in the system[1]. Another commercial fishery likely to intercept a few Italio origin sockeye salmon is the Yakutat Bay set gill net fishery. Again, however, the preponderance of available data and professional opinion is that interception rates are minor. At the same time, some of the terminal harvest of sockeye salmon in the Italio fishery could be of non-Italio River origin. Again there is no factual basis to support or reject this possibility, but professional opinion is that if non-Italio origin fish are caught, it is a small proportion of the total catch.

As a consequence of the above arguments, the terminal commercial harvest estimates reported herein are considered to be total commercial harvests. These statistics are considered to be annual censuses without significant biases and without sampling variances, under the assumption that only Italio origin fish are caught in the Italio fishery and they are caught nowhere else. Commercial harvests over the 30-year period of 1972-2001 ranged from a low of no sockeye salmon harvested in the 11 years of 1989-1992, 1994, and 1996-2001 to a high of 7,543 sockeye salmon harvested in 1984. Commercial harvests averaged about 1,800 sockeye salmon from 1972-2001 (Table 10).

A subsistence fishery that sometimes targets Italio River system sockeye salmon periodically takes place and is located in the lower river/lagoon. For the most part, subsistence fishermen are the exact same individuals that commercial fish. They use the same gear to subsistence fish when the commercial fishery is closed or they retain some fish caught during commercial fishing periods for personal use. Subsistence fishing permits are annually issued by ADF&G to individuals that wish to participate in the subsistence fishery. At the end of the year, these individuals are required to return the permit, including a written record of the number of fish harvested. Existing subsistence catch records from these returned permits were summarized to estimate annual subsistence harvests of sockeye salmon in the Italio fishery. Annual subsistence harvests of Italio River system sockeye salmon are estimated to have never exceeded 100 fish per year since 1972 and in most years, no fish were harvested (Table 10).

Subsistence harvest estimates are judged to be reliable as far as information turned in on subsistence permits. What is unaccounted for to some extent is the number of sockeye salmon retained for personal use by commercial fishermen from their commercial catch. The ADF&G has always requested that those fish retained for personal use be reported on fish tickets, but there is no enforceable regulation to require this action and those fish may go unreported. There is not a scientific method to estimate these numbers. However, professional judgement of the local

[1] However, the Italio River sockeye salmon escapement age compositions are likely biased and the actual proportion of "zero-checks" in the escapements is likely higher than the samples indicate.

fishery manager is that it is doubtful in any given year that more than 50 fish were kept for personal use. As a result, a moderate negative bias is likely associated with the annual subsistence harvest estimates. Further, an unknown level of sampling variance is associated with these annual estimates of harvest. However, subsistence harvests are so minor in comparison to commercial harvests and escapements as to be all but inconsequential in all years (Table 10).

Annual Exploitation

Estimated total harvests and estimated total escapements of Italio River system sockeye salmon were added to obtain estimated annual total runs for the years 1972-2001 (Figure 2). Inspection of Figure 2 shows how the stock has decreased in magnitude over the last decade and a half. The magnitude of the annual runs in the early portion of the time series during the mid-1970's was about 20,000 fish, but has decreased to an average of around 4,000 fish during the last decade. A further difference is that a larger proportion of the runs in the last decade have been in the escapement. Inspection of Figure 2 also indicates that the lower magnitude runs since the mid to late 1980's was not a result of escapement shortages in their parental years, four to five years earlier, as relatively large escapements were achieved until the late 1980's.

Annual estimated exploitation rates exerted on the Italio River sockeye salmon population were calculated by divided annual estimated harvests by annual estimated total runs. Exploitation rates from 1972-2001 ranged from a low of 0% in the 13 years of 1988-1997 and 1999-2001 to a high of 35% in 1986, averaging 10% over the 30-year period (Table 10). Years since the Italio River channel change are associated with the smallest estimated exploitation rates. In most years harvests have been so small that estimated exploitation rates would remain small unless total escapements were severely over-estimated. For instance, if observed peak surveys were deemed as the total escapement, estimated exploitation rates would still be minor in almost all years and in the years 1988 to 2001, would still average less than 1%. The Italio River system sockeye salmon population has been exploited to only a very minor level in the terminal fishery over the past 30 years.

Age Composition

Approximately 300 to 400 sockeye salmon were sampled from the Italio River system escapements in the years 1982-1985 to document age composition (Table 11). The commercial set gill net harvests in the Italio fishery were sampled to document age composition from 1982-1987 with annual sample sizes ranging from about 250 to 700 fish (Table 11). These sampling programs revealed that Italio River system sockeye salmon are primarily comprised of age-4 and age-5 fish with 93% of the sampled escapement and 94% of the sampled harvest being comprised of fish within these two age classes (Table 12). The most numerous age class in escapement samples was age-5 fish (58%), while the most numerous age class in sampled harvests was age-4 fish (54%).

However, another aspect of these samples revealed a significant difference in age composition between sockeye salmon sampled from escapements and harvests; freshwater age composition was strikingly different in the two data sets. Sockeye salmon sampled from the escapements were 90% freshwater age-1, meaning these fish hatched and subsequently spent the next year in the river system before migrating to the sea (Table 13). The proportion of "zero-checks" was only 6% across the four years of sampling. On the other hand, the proportion of "zero-checks" in the

harvest samples, averaged across the six years was 54% while only 43% were freshwater age-1. (Table 13). Most of the escapement samples were 3-ocean fish (60%) while 86% of the harvest samples were 3-ocean fish (Table 14). Because the harvest samples were from a set gill net fishery, and gill nets are typically selective for larger fish, the increased proportion of 3-ocean fish in the harvest samples is not surprising. On the other hand, the large difference in the proportions of "zero-checks" between escapement and harvest samples is more difficult to explain.

It seems likely to us that progeny of sockeye salmon spawning above the falls likely rear in Italio Lake and have a typical sockeye type life history pattern, predominantly smolting after spending a year rearing in freshwater. Progeny of sockeye salmon spawning elsewhere in the system do not have access to a lake environment, and these fish may migrate as "zero-checks" or simply rear in flowing waters for a year or so. If these fish migrate as "zero-checks", the harvest age compositions may provide an approximation of the proportion of fish in the system spawning below the falls. The escapement samples themselves were collected by ADF&G staff from Italio Lake and the river below the lake, but above the falls. Escapements of sockeye spawning below the falls have never been sampled. The available data, therefore, represents age composition of only a portion of the overall escapement.

It may be that the escapement samples truly represent age composition of the overall escapement if age composition of sockeye salmon spawning above and below the falls is similar. In that case, the presence of a high proportion of "zero-checks" in the harvests is due to interception of non-Italio origin sockeye salmon in the Italio fishery. Age composition of sockeye salmon in the Akwe River system is heavily weighted toward "zero-checks" with this life history type representing about 85% of the escapements sampled (1982-1986; 5 years, over 1,100 samples in total) and about 75% of the harvests sampled (1982-2001, 19 years, over 8,500 samples in total). However, for the interception hypothesis to be correct, roughly half of the harvests in the terminal Italio fishery in the years before the river changed channel would have had to be strays. Given the geography that existed in the years 1982-1986 and the homing tendency of sockeye salmon, it seems unlikely to us that roughly half of the Italio harvest was comprised of non-Italio fish. We note however, that the 1987 harvest was comprised of 86% "zero-checks" quite a bit higher than the proportions in the prior five years (Table 13). Given the change in river channel in December of 1986, this larger proportion of "zero-checks" in 1987 likely does represent an interception of Akwe sockeye salmon in the Italio fishery.

We are left with a dilemma and several questions. Are the age compositions sampled from the Italio escapements from 1982-1985 representative of Italio escapements in general, or are they biased and representative of only a portion of the spawning population? Are the age compositions sampled from the harvests in 1982-1987 representative of the Italio River system sockeye salmon population, or are they simply representative of age composition of mixed-stock catches? Further, although age class composition samples are available for 4 of the 30 escapements and for 6 of the 30 harvests in the 1972-2001 data set, no direct information is available for the remainder of the data set (the other 26 escapements and other 15 non-zero harvests). Hence, to proceed with development of brood tables, assumptions are needed. In wrestling with this analysis problem, we noted that all the available data indicates that about 90% to 95% of the Italio sockeye salmon are 4 or 5 years in total age. Further, we noted that partitioning annual catches and escapements into age classes other than as 4's or 5's, given the likely measurement errors imbedded in the escapement database (the majority of the annual run in every year) is meaningless from a statistical viewpoint. Therefore, we decided to simply apportion annual runs into age classes 4 and 5 (total ages) and further decided to assign half of the total annual runs to each.

RECRUITMENT ESTIMATES

Estimates of total production or recruits resulting from the brood year 1972-1996 escapements were calculated by summing the age specific estimates of total runs for any given brood year as follows: *age-4's in year y+4 + age-5's in year y +5*. Total estimated number of sockeye salmon recruits from Italio River system brood years 1972-1996 ranged from a low of 1,335 fish for brood year 1996 to a high of 28,231 fish for brood year 1980 (Table 15). Estimated number of recruits per spawner for this 25-year time series ranged from a low of 0.07 for the brood year 1985 escapement to a high of 5.36 for the 1989 brood year.

The low recruit per spawner ratio value estimated for brood year 1985 is not surprising from a biological perspective. The parental brood year 1985 stock migrated upriver through the Italio lagoon, the age-0 smolt emigrated out the Italio lagoon, the age-1 smolt emigrated out the Akwe lagoon, and the adults returned through the Akwe lagoon. Several brood years involved in the series presented in Table 15 would have encountered migration difficulties and homing to their natal stream was potentially disrupted. The summary information below shows how the Italio River changing channels in December of 1986 would have disrupted the emigrating smolt's homing instinct for all or a portion of the recruits from brood years 1982 through 1985:

Brood Year	Active River Mouth	Smolt Out-Migration River		Recruit In-Migration River		Smolt Homing Disruption	
		Age 0's	Age 1's	Age 4's	Age-5s	Age 0's	Age 1's
1980	Italio	Italio	Italio	Italio	Italio	no	no
1981	Italio	Italio	Italio	Italio	Italio	no	no
1982	Italio	Italio	Italio	Italio	Akwe	**age 5's**	**age 5's**
1983	Italio	Italio	Italio	Akwe	Akwe	**both**	**both**
1984	Italio	Italio	Italio	Akwe	Akwe	**both**	**both**
1985	Italio	Italio	Akwe	Akwe	Akwe	**both**	no
1986	Italio	Akwe	Akwe	Akwe	Akwe	no	no
1987	Akwe	Akwe	Akwe	Akwe	Akwe	no	no

Earlier in this report, we documented a large change in total runs of Italio River system sockeye salmon for the early years in the series as compared to the later years in the series. We believe the channel change in 1986 likely disrupted stock dynamics by interfering with the homing instinct of smolt that emigrated out of the Italio River and lagoon but had to return via the Akwe River lagoon. Therefore, we decided to split the stock-recruit data set into two time periods; brood years 1972-1981 (the historic period) and 1986-1996 (the current period).

A plot of estimated recruits per spawner versus escapements for the three time series of brood years 1972-1982, brood years 1982-1985, and brood years 1986-1996 shows how production varied in these three periods (Figure 3). The brood year 1972-1981 data set shows a curvilinear relationship as would be expected for a salmon population with density dependence. The four brood years with potentially disrupted homing all had very low production, even though the escapements were substantial, demonstrating a trend very different than the preceding period of 1972-1981. The 11 brood years of 1986-1996 show a curvilinear relationship as one would expect, except it is located far to the left of the curvilinear relationship demonstrated for the brood

year 1972-1981 data set, showing the substantial drop in production since the Italio River channel change.

STOCK-RECRUIT RELATIONSHIPS

Two paired data sets were defined that consisted of the estimated total escapements of Italio River sockeye salmon and estimated resultant recruits from those escapements. The first paired set included brood years 1972-1981, the historic period while the second consisted of brood years 1986-1996, the recent period. Once the paired data sets were defined, spawner-recruit relationships were developed by fitting the paired data sets to the following model:

$$R_y = \alpha S_y e^{-\beta S_y} \exp(\varepsilon_y) \quad (1)$$

where: R_y = estimated total recruitment by brood y;
S_y = spawning escapement that produced brood y;
α = intrinsic rate of population increase in the absence of density-dependent limitations;
β = density-dependent parameter; and
ε_y = process error with mean 0 and variance σ_ε^2.

This model, commonly referred to as a Ricker recruitment curve (Ricker 1975), has two parameters, α and β, to estimate, given a series of spawner and resultant recruitment observations or estimates. We assumed the errors were log-normal (as is common for salmon returns), resulting in the log-transformed linear equation:

$$\ln(R_y/S_y) = \ln(\alpha) - \beta S_y + \varepsilon_y \quad (2)$$

Linear regression procedures provided estimates of the intercept ($\ln \alpha$) and the slope (β) in equation 2. Hilborn and Walters (1992:271-2) published the following empirical approximation of the estimated spawning size that produces maximum sustained yield or MSY (S_{MSY}) as a function of estimated parameters:

$$\hat{S}_{MSY} \cong \frac{\hat{\ln \alpha} + \hat{\sigma}_\varepsilon^2/2}{\hat{\beta}}[0.5 - 0.07(\hat{\ln \alpha} + \hat{\sigma}_\varepsilon^2/2)] \quad (3)$$

where: $\hat{\sigma}_\varepsilon^2$ = the mean square error from the regression.

Historic Period, Brood Years 1972-1981

Once the brood year 1972-1981 stock-recruit relationship was developed, the relationship was plotted (Figure 4, upper panel) and the residuals in the relationship were calculated (Figure 4, lower panel). Visual examination of the residual plot for the historic stock-recruit relationship revealed no pattern; residuals appeared to be randomly distributed, indicating productivity within the historic period was reasonably stable.

Analyses indicate that the replacement value for the historic stock-recruit relationship was about 23,500 total sockeye salmon. The escapement level, on average, that is predicted to have provided for maximum sustained yield fisheries during the historic period was about 9,000 total spawners (38% of replacement) or a peak survey count of about 4,500 fish. This estimate of S_{msy} is the same value as that reported by Clark, Burkholder, and Clark (1995), who used an alternate set of paired escapement and total return estimates for the 1972-1978 and 1980-1982 brood years to predict S_{msy}.

The statistical fit of the relationship between escapement and log of return per spawners was highly significant ($p = 0.00001$) as was the slope ($p = 0.000003$) and the intercept ($p = 0.00001$) of the relationship. The unadjusted Ricker alpha value from the relationship was 1.63, (CV = 8%) whereas, the Hilborn and Walters (1992) adjusted Ricker alpha value was 1.65. The estimated beta parameter was 0.0000698 (CV = 10%).

Since 1995, the biological escapement goal range for the Italio River system stock of sockeye salmon used by ADF&G is 2,500 to 7,000 fish observed during a peak aerial survey, or expressed in total escapement, is 5,000 to 14,000 total fish. This escapement goal range was based on the stock-recruit relationship developed by Clark, Burkholder, and Clark (1995) and is the range predicted to provide for 90% or more of maximum sustained yield. The historic relationship we have developed herein would provide a similar range. When Clark, Burkholder, and Clark (1995) conducted their analysis, they specifically did not include brood years after 1982. The footnote in their report states:

> *"Paired escapements and total returns for these years (BY 1983-1989) were not used for development of the spawner-recruit relationship nor estimation of the escapement goal. The Italio River broke into Akwe Lagoon in December 1986; hence BY 83 4-year olds; BY 84 3-year olds, etc. returned through Akwe Lagoon rather than Italio Lagoon and catch composition from 1987 forward differs from pre-1987 catch compositions."*

At the time of the Clark, Burkholder, and Clark (1995) analysis, insufficient information was available to ADF&G concerning how the Italio River system stock of sockeye salmon had responded from a production standpoint to the 1986 change in river channel. Further, it seemed at the time as if the most prudent action to take was a very conservative approach to the setting of the escapement goal for this stock. At that time, seven years had already passed without significant fishing taking place on this stock of sockeye salmon, but total returns were only available for two brood years with smolt that all exited and returned through the Akwe lagoon. With little fishing having had taken place and only little information to judge a change in productivity, ADF&G opted to simply use the pre-channel change fishery data to set the biological escapement goal range. Hence, the historic information was used to establish a biological escapement goal range and that biological escapement goal range was used for fishery management purposes through the 2002 fishing season. At the current time, there are eleven paired escapement-total return estimates available from the after channel change period and they can be used to determine if productivity of the stock has changed from the historic period.

Recent Period, Brood Years 1986-1996

Examination of Figure 3 clearly demonstrates that productivity associated with the brood year 1972-1981 data set is markedly different than productivity associated with the brood year 1986-1996 data set. Productivity decreased substantially following the change in the Italio River course in December of 1986. A basic tenet of using historic stock-recruit information from

salmon stocks to estimate productivity and thus to estimate the maximum sustained yield escapement goal for use in future fishery management is that the past is representative of the future. We believe that the change in course of the Italio River in winter of 1986 disrupted the homing behavior of sockeye salmon recruits from brood years 1982-1985. Other changes apparently also occurred because the productivity patterns before and after this event for brood years that did not experience a homing behavior disruption are markedly different. Thus, although we may never know all of the mechanisms associated with these changes in population dynamics of the Italio River system stock of sockeye salmon, the results of those mechanisms are in themselves clear and obvious. It is very clear that the historic period is not representative of the recent period, nor, do we believe it likely to represent the immediate future. Therefore, we believe continued use of the biological escapement goal developed from the historic period is no longer appropriate.

The recent period may be indicative of the future, if productivity has stabilized. The only information available to make a judgement concerning stabilization of productivity is the data available in the recent period.

The brood year 1986-1996 stock-recruit relationship was developed. The residuals in the recent period stock-recruit relationship were calculated. Visual examination of the residual plot for the recent stock-recruit relationship revealed an obvious trend in the data with residuals in the stock-recruit relationship decreasing over the majority of the recent time period (Figure 5). This implies that production had not yet stabilized through brood year 1996. Whether or not productivity is currently stable is unknown. However, it would not be prudent to use the recent time period to set a biological escapement goal for the Italio River system stock of sockeye salmon because analysis clearly demonstrates that productivity across this time period was unstable. Various statistics from the brood year 1986-1996 stock-recruit relationship are provided in Appendix 3, however they have little meaning from a biological perspective due to the productivity trend inherent in the data.

ESCAPEMENT GOAL REVISIONS

Productivity and likely other stock dynamics for sockeye salmon originating in the Italio River system changed dramatically following the river channel change in December of 1986. Further, productivity was not stable through the period encapsulated with data from brood years 1986-1996. And, the more recent time period cannot be used with traditional stock-recruit analysis to develop an appropriate biological escapement goal range for the current time period. The sustainable salmon fisheries policy for the State of Alaska defines a biological escapement goal as:

> *"Biological escapement goal (BEG): escapement that provides the greatest potential for maximum sustained yield. A BEG will be the primary management objective for the escapement unless an Optimal Escapement or In-River Run Goal has been adopted. A BEG will be developed from the best available biological information, and should be scientifically defensible on the basis of available biological information. A BEG will be determined by the Department of Fish and Game and will be expressed as a range based on factors such as stock productivity and data uncertainty. The department will seek to maintain escapements evenly within the bounds of a BEG."*

It is clear that the escapement goal range used by ADF&G through the 2002 fishing season is no longer appropriate for this stock of sockeye salmon. However, that range was very appropriate for fishery management purposes until ADF&G fully observed the change in Italio River system sockeye salmon productivity. In terms of determining stock health, the ADF&G adopted biological escapement goal range is very appropriate through 1986. And every escapement from 1972-1986 was either within the range or exceeded the range, demonstrating that the Italio River sockeye salmon population was very healthy across that entire time frame (Figure 6). There is no clear measure to use after 1986 to document stock health.

As Figure 2 demonstrates, very little fishing on this stock has occurred since 1987. It is appropriate to continue this pattern of allowing only very little fishing on this stock until such time as stock dynamics stabilize. At that time, data should be fully analyzed to define an appropriate biological escapement goal.

The sustainable salmon fisheries policy for the State of Alaska defines a sustained escapement threshold as:

> *"Sustained escapement threshold (SET): a threshold level of escapement below which the ability of the stock to sustain itself is jeopardized. In practice, SET can be estimated based on the lower ranges of historical escapement levels, for which the stock has consistently demonstrated the ability to sustain itself. The SET is lower than the lower bound of the BEG, and/or lower than the lower bound of the SEG. The SET is established by the Department in consultation with the Board, as needed, for stocks of management or conservation concern."*

If the ADF&G in consultation with the Board were to establish a sustained escapement threshold for this stock of sockeye salmon, we point out that the low estimated escapement in 1989 of 1,100 fish was followed by many years of higher escapements. Hence, that level (1,100 total spawners or a peak survey of 550 fish) may be in conformance with the definition of a SET as described above. However, we point out that this stock is all but unfished and productivity has been in a flux since the channel change. The definition of an escapement goal for this stock of sockeye salmon under these conditions may not have any practical use to the Department or to the Board.

We believe the stock dynamics of the sockeye salmon population in the Italio River system were in a flux initially due to the change in channel. This disruption of the migratory homing behavior has had some further effects beyond those obvious for brood years 1982-1985 and perhaps other non-fishing factors have further disrupted the stock's population dynamics. A possible mechanism hypothesis is that the velocity barrier improvements completed in the late 1970's have slowly deteriorated over the past 15 years resulting in a lesser ability of sockeye salmon to make use of Italio Lake for rearing. While the actual mechanism is not clear, it is clear that fishing on the stock is not the source of the problem (Figure 2). And therefore, we believe that ADF&G should not define an escapement goal for this stock at this time. Instead, ADF&G should invest in additional stock assessment to improve the information base available for this stock of sockeye salmon and meanwhile, ensure that any fishing on the stock is kept at minimal levels until productivity has demonstrably stabilized.

RECOMMENDATIONS

We recommend that ADF&G formally rescind the biological escapement goal range of 2,500 to 7,000 sockeye salmon counted during a peak survey. Further, we recommend that ADF&G not

adopt an alternate biological escapement goal for this stock of sockeye salmon until such time as productivity has demonstrably stabilized. We recommend the existing stock assessment program be continued, but improved. Understanding of population dynamics of Italio River system sockeye salmon is severely limited by a lack of basic knowledge. Factual information concerning where the major spawning populations are located, what portion of the stock uses Italio Lake for rearing, and whether or not a significant portion of the stock that spawns in the Italio River system produce "zero-check" smolt are issues. Whether or not the falls below Italio Lake still represents a partial migration barrier is another basic question. Factual and scientifically based information concerning the relationship between peak aerial surveys and total escapements for this stock is a critical question. Neither the escapement nor the catch for this stock of sockeye salmon has been sampled since the Italio River changed course; while we are certain the productivity changed coincident with this event, we have no information concerning current age composition of the stock. And, the factual demonstration of whether or not significant intermixing of Italio-origin and Akwe-origin fish takes place in the Akwe and Italio fishing areas is potentially an issue with significant implications. Changes and improvements in the stock assessment program we recommend include:

1. Research of the proportion of the Italio River system sockeye salmon total escapement that is counted during peak aerial surveys. With low recent exploitation rates and with low rates anticipated in the near future, the majority of the stock is in the escapement and this portion of the existing stock assessment program has the greatest uncertainty. Methodology worth consideration include implementation of a weir or tower counting program or a mark-recapture effort to estimate total escapement. In concert with this would be the successful completion of additional annual aerial surveys to better identify annual peak count time frames.

2. Collection of annual age composition samples from the escapements and ensuring that these samples are representative of the full Italio River system escapements of sockeye salmon, not just the stock that spawns above the falls.

3. Observations concerning potential migration difficulties for sockeye salmon passing over the falls located below Italio Lake are needed. This site should be visited during the sockeye salmon migration and the current effectiveness of the habitat improvements made in the late 1970's should be evaluated. If improvements are needed, appropriate methodology and budget requirements should be determined so that funding can be sought to effectuate the needed improvements.

4. If significant levels of harvest take place in the Italio fishery, the harvest of sockeye salmon should be sampled for age composition.

5. A tagging project is needed. Tagging of sockeye salmon in the Akwe Lagoon below the Italio and Akwe fisheries should take place. Recovery of tags from the Akwe and Italio fisheries will provide some information concerning exploitation rates. Recovery on the spawning grounds will provide information concerning the relative magnitude of both runs if conducted carefully and in conjunction with additional tagging in the Italio fishing area or just upstream of that area. Traditional tagging efforts have the potential to provide significant information, but, application of a reasonable number of radio tags as part of this effort will provide additional benefits if the spawning grounds are surveyed, including distribution of spawners in both systems.

Although we recognize that implementation of the suite of stock assessment activities recommended herein will be expensive, so too has been and is the lack of factual information expensive to past and present (and potentially future) users of the resource. Rationale fishery management is based upon solid stock assessment and policy. The best fishery management practices (policy) when used with poor quality stock assessment information is a potential recipe for failure.

AKNOWLEDGEMENTS

To do later

LITERATURE CITED

Chinook Technical Committee (CTC). 1999. Maximum sustained yield of biologically based escapement goals for selected chinook salmon stocks used by the Pacific Salmon Commission's Chinook Technical Committee for escapement assessment, Volume I. Pacific Salmon Commission Joint Chinook Technical Committee Report No. TCCHINOOK (99)-3, Vancouver, British Columbia, Canada.

Clark, J. H., A. Burkholder, and J.E. Clark. 1995. Biological escapement goals for five sockeye salmon stocks returning to streams in the Yakutat area of Alaska. Regional Information Report Number 1J95-16, Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development. Douglas, Alaska. 56 pp.

Hilborn, R., and C. J. Walters. 1992. Quantitative fisheries stock assessment. Chapman and Hall. New York.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bulletin of the Fisheries Research Board of Canada No. 191. 382 pp.

Table 1. Peak counts of sockeye salmon in the Italio River, 1991-2002.

Year	Peak Count	Peak Survey	Comments Concerning Water Visibility During Peak Survey, Number of Observations, and Peak Date Relative to Other Observations
1972	7,000	01-Aug	Conditions: no record, 5 observations, peak early
1973	4,200	18-Aug	Conditions: no record, 3 observations, peak last date
1974	2,800	17-Aug	Conditions: no record, 3 observations, peak last date
1975	3,500	23-Aug	Conditions: no record, 3 observations, peak last date
1976	8,000	01-Sep	Conditions: no record, 3 observations, peak last date
1977	7,800	29-Jul	Conditions: no record, 6 observations, peak last date
1978	15,000	12-Aug	Conditions: no record, 3 observations
1979	-	none	No surveys made in 1979
1980	7,000	23-Aug	Conditions: no record, 2 observations, peak last date
1981	12,000	27-Aug	Conditions: no record, 3 observations, peak middle date
1982	9,000	29-Aug	Conditions: no record, 4 observations, peak 3rd date
1983	9,000	29-Aug	Conditions: Good/Normal, 1 observation
1984	8,150	03-Aug	Conditions: Excellent, 7 observations, peak last date
1985	14,000	29-Aug	Conditions: Excellent, 6 observations, peak last date
1986	3,800	01-Aug	Conditions: Excellent, 7 observations, peak mid dates
1987	6,400	10-Aug	Conditions: Excellent, 11 observations, peak 10th date
1988	2,700	04-Aug	Conditions: no record, 15 observations, peak 12th date
1989	550	18-Jul	Conditions: Good/Normal, 13 observations, peak 11th date
1990	1,300	06-Aug	Conditions: no record, 7 observations, peak 6th date
1991	950	19-Jul	Conditions: Good/Normal, 10 observations, peak 8th date
1992	4,500	23-Jul	Conditions: Good/Normal, 12 observations, peak 11th date
1993	3,350	03-Sep	Conditions: Good/Normal, 10 observations, peak 9th date
1994	2,550	10-Aug	Conditions: Good/Normal, 8 observations, peak last date
1995	2,700	23-Aug	Conditions: Excellent, 8 observations, peak last date
1996	1,350	23-Jul	Conditions: Excellent, 8 observations, peak 6th date
1997	1,200	21-Jul	Conditions: Good/Normal, 5 observations, peak last date
1998	300	17-Jul	Conditions: Poor, fish seen in Middle Italio (wrong river)
1999	2,000	02-Aug	Conditions: Good/Normal, 7 observations, peak last date
2000	400	03-Jul	Conditions: Good/Normal, 1 observations
2001	200	11-Jul	Conditions: Good/Normal, 6 observations, peak 4th date
2002	2,200	29-Jul	----

Table 2. Survey counts of sockeye salmon in the Italio River system by time-block, 1972-2001 (annual peaks in bold).

Year	Block 1: June	Block 2: July 1-10	Block 3: July 11-20	Block 4: July 21-31	Block 5: Aug. 1-10	Block 6: Aug. 11-20	Block 7: Aug. 21-31	Block 8: Sept. 1-10	Block 9: Sept. 11-20	Block 10: Sept. 21-30	Block 11: Oct. 1-10
1972		4,000			**7,000**		5,000		3,000		
1973		2,000				**4,200**					
1974		1,000			1,200	**2,800**					
1975	500	700					**3,500**				
1976		2,000		4,000	2,000	3,700		**8,000**			
1977	1,500			**7,800**				2,000			
1978				1,000		**15,000**					
1980			4,000				**7,000**				
1981				2,000			**12,000**			10,000	
1982		1,500		8,000			**9,000**		4,000		
1983							**9,000**				
1984	300	2,500	4,500	7,000	**8,150**						
1985	400	2,300	3,200	1,500		7,000	**14,000**				
1986	2,500			**3,800**	**3,800**		2,000	2,480			
1987	500	600	1,950	1,500	**6,400**						100
1988	-	50	500	1,200	**2,700**	1,500			700	600	
1989	200	300	**550**		50	200					
1990	-	250	810		**1,300**		1,050				
1991	-	400	**950**				700				
1992	450	800	1,900	**4,500**							
1993	550	25	800					**3,350**			800
1994	550	900	2,000	1,890	**2,550**						
1995	-	750			2,410		**2,700**				
1996	-	900		**1,350**				1,000			500
1997	600	1,100	50	**1,200**							
1998			**300**			-					
1999	-		270		**2,000**						
2000		**400**									
2001	-		**200**				100				

Table 3. Proportion (percent) of each observed survey count of the annual peak survey count in each time-block, sockeye salmon in the Italio River system (annual peaks in bold).

Year	Block 1: June	Block 2: July 1-10	Block 3: July 11-20	Block 4: July 21-31	Block 5: Aug. 1-10	Block 6: Aug. 11-20	Block 7: Aug. 21-31	Block 8: Sept. 1-10	Block 9: Sept. 11-20	Block 10: Sept. 21-30	Block 11: Oct. 1-10
1972		57%			**100%**		71%		43%		
1973		48%				**100%**					
1974		36%			43%	**100%**					
1975	14%	20%					**100%**				
1976		25%		50%	25%	46%		**100%**			
1977	19%			**100%**				26%			
1978				7%		**100%**					
1980			57%				**100%**				
1981				17%			**100%**			83%	
1982		17%		89%			**100%**		44%		
1984	4%	31%	55%	86%	**100%**						
1985	3%	16%	23%	11%		50%	**100%**				
1986	66%			**100%**	**100%**		53%	65%			
1987	8%	9%	30%	23%	**100%**						2%
1988	0%	2%	19%	44%	**100%**	56%			26%	22%	
1989	36%	55%	**100%**		9%	36%					
1990	0%	19%	62%		**100%**		81%				
1991	0%	42%	**100%**				74%				
1992	10%	18%	42%	**100%**							
1993	16%	1%	24%					**100%**			24%
1994	22%	35%	78%	74%	**100%**						
1995	0%	28%			89%		**100%**				
1996	0%	67%		**100%**				74%			37%
1997	50%	92%	4%	**100%**							
1998			**100%**			0%					
1999	0%		14%		**100%**						
2001	0%		**100%**				50%				

Table 4. Uncertainty concerning block of time when peak abundance may have been present, Italio River system sockeye salmon.

Year	Peak Observed In Block	Observations Within at Least: Level 1 P-1, P+1	Level 2 P-2, P+2	Level 3 P-, P+	Level 4 Other	Surety In Peak Block	Could Peak Have Been In (y = yes; n = no): Block 4	Block 5	Block 6	Block 7	Block 8
1972	5			x			y	y	y	n	n
1973	6				x		y	y	y	y	y
1974	6				x		n	n	y	y	y
1975	7				x		y	y	y	y	y
1976	8				x		n	n	n	y	n
1977	4			x			y	y	y	y	n
1978	6				x		n	y	y	y	y
1980	7				x		y	y	y	y	y
1981	7			x			n	y	y	y	y
1982	7			x			n	y	y	y	y
1984	5				x		n	y	y	y	y
1985	7				x		n	n	n	y	y
1986	5	x				5	y	y	n	n	n
1987	5				x		n	y	y	y	y
1988	5	x				5	n	y	n	n	n
1989	3		x				y	n	n	n	n
1990	5		x				y	y	y	n	n
1991	3			x			y	y	y	n	n
1992	4				x		y	y	y	y	n
1993	8				x		n	y	y	y	n
1994	5				x		n	y	y	y	y
1995	7				x		n	n	y	y	y
1996	4			x			y	y	y	y	n
1997	4				x		y	y	y	y	n
1998	3				x		y	y	n	n	n
1999	5				x		y	y	y	y	y
2001	3			x			y	y	y	n	n

Table 5. Likelihood that peak of abundance of Italio River system sockeye salmon occurred during time blocks 3 through 8 for years when peak count had at least one observation both before and after the date of the peak count.

	For Years When Peak Counts Have Both Before and After Observations Could Peak Count Have Occurred in Block Number:					
Year	**3**	**4**	**5**	**6**	**7**	**8**
1972	yes	yes	yes	yes	no	no
1977	yes	yes	yes	yes	yes	no
1981	no	no	yes	yes	yes	yes
1982	no	no	yes	yes	yes	yes
1986	no	no	yes	no	no	no
1988	no	no	yes	no	no	no
1989	yes	yes	no	no	no	no
1990	no	yes	yes	yes	no	no
1991	yes	yes	yes	yes	no	no
1996	yes	yes	yes	yes	yes	no
2001	yes	yes	yes	yes	no	no
yes's	6	7	10	8	4	2
no's	5	4	1	3	7	9
% yes	55%	64%	**91%**	73%	36%	18%

Table 6. Likelihood that peak of abundance of Italio River system sockeye salmon occurred during time blocks 4 through 8 for all years when counts were conducted in more than one time block, summaries for BY 72-01, BY 72-86, and BY 87-01.

Year	Could Peak Have Been In Block (y = yes; n = no):				
	4	**5**	**6**	**7**	**8**
1972	y	y	y	n	n
1973	y	y	y	y	y
1974	n	n	y	y	y
1975	y	y	y	y	y
1976	n	n	n	y	n
1977	y	y	y	y	n
1978	n	y	y	y	y
1980	y	y	y	y	y
1981	n	y	y	y	y
1982	n	y	y	y	y
1984	n	y	y	y	y
1985	n	n	n	y	y
1986	y	y	n	n	n
1987	n	y	y	y	y
1988	n	y	n	n	n
1989	y	n	n	n	n
1990	y	y	y	n	n
1991	y	y	y	n	n
1992	y	y	y	y	n
1993	n	y	y	y	n
1994	n	y	y	y	y
1995	n	n	y	y	y
1996	y	y	y	y	n
1997	y	y	y	y	n
1998	y	y	n	n	n
1999	y	y	y	y	y
2001	y	y	y	n	n
72-01 yes's	15	22	21	19	13
72-01: no's	12	5	6	8	14
72-01 % yes	56%	**81%**	78%	70%	48%
72-86 yes's	6	10	10	11	9
72-86: no's	7	3	3	2	4
72-86 % yes	46%	77%	77%	**85%**	69%
87-01 yes's	9	12	11	8	4
87-01: no's	5	2	3	6	10
87-01 % yes	64%	**86%**	79%	57%	29%

Table 7. Proportions of observed survey counts of escapement expressed as average percent of the annual peak survey count by time block, for the years 1972-2001, 1972-1986,and 1987-2001, Italio River system sockeye salmon.

Time Block	Proportions of Observed Survey Counts as Average Percent of the Annual Peak Survey Count by Time Blocks		
	BY 72-01	BY 72-86	BY 87-01
Block 1: Month of June	14%	21%	11%
Block 2: July 1-10	32%	31%	33%
Block 3: July 11-20	54%	45%	56%
Block 4: July 21-31	64%	57%	74%
Block 5: August 1-10	81%	74%	**85%**
Block 6: August 11-20	61%	79%	31%
Block 7: August 21-31	84%	**89%**	76%
Block 8: September 1-10	73%	64%	*87%*[a]
Block 9: September 11-20	38%	44%	26%
Block 10: September 21-31	53%	83%	22%
Block 11: October 1-10	21%	0%	21%

[a] Note: the estimate for time block 8 for the BY 87-01 series is calculated based upon only one peak count and only one other count and therefore the estimate is not deemed reliable estimate due to the paucity of data.

Table 8. Estimated total escapements of sockeye salmon in the Italio River system from 1972-1986 based on annual peak aerial survey counts, adjusted for historic average peak timing (timing factor) and further adjusted based on the assumption that peak surveys represent 50% of the total escapement (visibility factor).

Year	Peak Count	Peak Count Date	Peak Count in Block Number	Average Percent in Peak Block	Average Percent in Block 7	Ratio of Blocks (expansion factor)	Peak Count Adjusted for Timing	Estimated Total Escapement (peak * 2.0)
1972	7,000	01-Aug	5	*74%*	*79%*	*1.07*	7,473	14,946
1973	4,200	18-Aug	6	79%	89%	1.13	4,732	9,463
1974	2,800	17-Aug	6	79%	89%	1.13	3,154	6,309
1975	3,500	23-Aug	7	89%	89%	1.00	3,500	7,000
1976	8,000	01-Sep	8	64%	89%	1.39	11,125	22,250
1977	7,800	29-Jul	4	57%	89%	1.56	12,179	24,358
1978	15,000	12-Aug	6	79%	89%	1.13	16,899	33,797
1979	unknown	none						*17,700*[a]
1980	7,000	23-Aug	7	89%	89%	1.00	7,000	14,000
1981	12,000	27-Aug	7	89%	89%	1.00	12,000	24,000
1982	9,000	29-Aug	7	89%	89%	1.00	9,000	18,000
1983	9,000	29-Aug	7	89%	89%	1.00	9,000	18,000
1984	8,150	03-Aug	5	74%	89%	1.20	9,802	19,604
1985	14,000	29-Aug	7	89%	89%	1.00	14,000	28,000
1986	3,800	01-Aug	5	74%	89%	*1.00*	3,800	7,600
Average								**17,669**

[a] No survey was completed in 1979. The approximate average of the time series of 17,700 was used as a proxy estimate.

Timing adjustment expansion notes:
In 1972, a count in block 7 was less than the observed peak in block 5, actual peak was likely in block 6, hence (79%/74%) was used.
In 1986, the peak count occurred in block 5, with observed lesser counts in blocks 4 and 6; hence, no expansion factor was used.

Table 9. Estimated total escapements of sockeye salmon in the Italio River system from 1987-2001 based on annual peak aerial survey counts, adjusted for historic average peak timing (timing factor) and further adjusted based on the assumption that peak surveys represent 50% of the total escapement (visibility factor).

Year	Peak Count	Peak Count Date	Peak Count in Block Number	Average Percent in Peak Block	Average Percent in Block 7	Ratio of Blocks (expansion factor)	Peak Count Adjusted for Timing	Estimated Total Escapement (peak * 2.0)
1987	6,400	10-Aug	5	85%	85%	1.00	6,400	12,800
1988	2,700	04-Aug	5	85%	85%	1.00	2,700	5,400
1989	550	18-Jul	3	56%	85%	*1.00*	550	1,100
1990	1,300	06-Aug	5	85%	85%	1.00	1,300	2,600
1991	950	19-Jul	3	56%	85%	1.52	1,442	2,884
1992	4,500	23-Jul	4	74%	85%	1.15	5,169	10,338
1993	3,350	03-Sep	8	85%	85%	1.00	3,350	6,700
1994	2,550	10-Aug	5	85%	85%	1.00	2,550	5,100
1995	2,700	23-Aug	7	76%	85%	*1.00*	2,700	5,400
1996	1,350	23-Jul	4	74%	85%	1.15	1,551	3,101
1997	1,200	21-Jul	4	74%	85%	1.15	1,378	2,757
1998	300	17-Jul	3	56%	85%			*3,400*[a]
1999	2,000	02-Aug	5	85%	85%	1.00	2,000	4,000
2000	400	03-Jul	2	33%	85%	2.58	1,030	2,061
2001	200	11-Jul	3	56%	85%	1.52	304	607
Average								**4,550**

[a] No survey was completed in 1998. The approximate average of 1997 and 1998 was used as a proxy estimate.

Timing adjustment expansion notes:
In 1989, a count in block 5 was less than the observed peak in block 3, run was early, actual peak was likely in block 3, no expansion was used.
In 1995, a count in block 5 was less than the observed peak in block 7, run was late, actual peak was likely in block 7, no expansion was used.

Table 10. Estimated terminal harvests, estimated total in-river runs, and estimated terminal exploitation rates of Italio River system sockeye salmon, 1972-2001.

Year	Commercial Harvests	Sub-sistence Harvests	Total Harvests	Estimated Escapement	Estimated Total Runs	Estimated Exploitation Rates
1972	0	0	0	14,946	14,946	0%
1973	1,723	0	1,723	9,463	11,186	15%
1974	99	0	99	6,309	6,408	2%
1975	365	0	365	7,000	7,365	5%
1976	1,206	0	1,206	22,250	23,456	5%
1977	1,167	0	1,167	24,358	25,525	5%
1978	1,012	0	1,012	33,797	34,809	3%
1979	2,315	0	2,315	17,700	20,015	12%
1980	302	0	302	14,000	14,302	2%
1981	1,668	0	1,668	24,000	25,668	6%
1982	2,945	0	2,945	18,000	20,945	14%
1983	1,349	0	1,349	18,000	19,349	7%
1984	7,543	0	7,543	19,604	27,147	28%
1985	1,314	0	1,314	28,000	29,314	4%
1986	4,010	0	4,010	7,600	11,610	35%
1987	932	0	932	12,800	13,732	7%
1988	5	0	5	5,400	5,405	0%
1989	0	0	0	1,100	1,100	0%
1990	0	0	0	2,600	2,600	0%
1991	0	0	0	2,884	2,884	0%
1992	0	40	40	10,338	10,378	0%
1993	1	0	1	6,700	6,701	0%
1994	0	0	0	5,100	5,100	0%
1995	24	2	26	5,400	5,426	0%
1996	0	0	0	3,101	3,101	0%
1997	0	0	0	2,757	2,757	0%
1998	0	50	50	3,400	3,450	1%
1999	0	0	0	4,000	4,000	0%
2000	0	0	0	2,061	2,061	0%
2001	0	2	2	607	609	0%
1972-1986 Averages	1,801	0	1,801	17,669	19,470	10%
1987-2001 Averages	64	19	70	4,550	4,620	1%
1972-2001 Averages	933	19	936	11,109	12,045	5%
Historic Br. Years: 1972-1981 Averages	986	0	986	17,382	18,368	5%
Current Br. Years: 1986-1996 Averages	452	14	456	5,729	6,185	4%

Table 11. Ages of sockeye salmon sampled from the spawning grounds and from the terminal harvests, Italio River system sockeye salmon, 1972-2001.

Sample Location	Year	Number Age-3	Number Age-4	Number Age-5	Number Age-6	Number Age-7	Total Sample
Escapement	1982	5	123	252	20	1	401
Escapement	1983	6	53	290	3	0	352
Escapement	1984	11	117	170	8	1	307
Escapement	1985	52	223	118	0	0	393
Harvest	1982	13	150	205	17	0	385
Harvest	1983	16	238	277	5	0	536
Harvest	1984	3	382	183	2	0	570
Harvest	1985	23	119	108	3	0	253
Harvest	1986	38	287	353	15	0	693
Harvest	1987	3	284	40	2	0	329

Table 12. Age composition of sockeye salmon sampled from the spawning grounds and from the terminal harvests, Italio River system sockeye salmon, 1972-2001.

Sample Location	Year	% Age-3	% Age-4	% Age-5	% Age-6	% Age-7	Total
Escapement	1982	1%	31%	63%	5%	0%	100%
Escapement	1983	2%	15%	82%	1%	0%	100%
Escapement	1984	4%	38%	55%	3%	0%	100%
Escapement	1985	13%	57%	30%	0%	0%	100%
Escapement	Averages	5%	35%	58%	2%	0%	100%
Harvest	1982	3%	39%	53%	4%	0%	100%
Harvest	1983	3%	44%	52%	1%	0%	100%
Harvest	1984	1%	67%	32%	0%	0%	100%
Harvest	1985	9%	47%	43%	1%	0%	100%
Harvest	1986	5%	41%	51%	2%	0%	100%
Harvest	1987	1%	86%	12%	1%	0%	100%
Harvest	Averages	4%	54%	40%	2%	0%	100%

Table 13. Freshwater age composition of sockeye salmon sampled from the spawning grounds and from the terminal harvests, Italio River system sockeye salmon, 1972-2001.

Sample Location	Year	Smolt-0's	Smolt-1's	Smolt-2's	Smolt-3's	Total
Escapement	1982	0%	91%	8%	0%	100%
Escapement	1983	2%	97%	2%	0%	100%
Escapement	1984	7%	89%	4%	0%	100%
Escapement	1985	14%	83%	3%	0%	100%
Escapement	Averages	6%	90%	4%	0%	100%
Harvest	1982	26%	68%	6%	0%	100%
Harvest	1983	44%	55%	1%	0%	100%
Harvest	1984	67%	32%	1%	0%	100%
Harvest	1985	59%	38%	3%	0%	100%
Harvest	1986	41%	56%	3%	0%	100%
Harvest	1987	86%	12%	1%	0%	100%
Harvest	Averages	54%	43%	3%	0%	100%

Table 14. Ocean age composition of sockeye salmon sampled from the spawning grounds and from the terminal harvests, Italio River system sockeye salmon, 1972-2001.

Sample Location	Year	Ocean-1's	Ocean-2's	Ocean-3's	Ocean-4's	Total
Escapement	1982	1%	34%	65%	0%	100%
Escapement	1983	1%	16%	83%	0%	100%
Escapement	1984	2%	35%	63%	0%	100%
Escapement	1985	1%	71%	28%	0%	100%
Escapement	Averages	1%	39%	60%	0%	100%
Harvest	1982	0%	22%	77%	0%	100%
Harvest	1983	0%	6%	94%	0%	100%
Harvest	1984	0%	1%	99%	0%	100%
Harvest	1985	0%	23%	62%	15%	100%
Harvest	1986	0%	13%	87%	1%	100%
Harvest	1987	0%	2%	98%	0%	100%
Harvest	Averages	0%	11%	86%	3%	100%

Table 15. Estimated recruits from Italio River sockeye salmon spawning in brood years 1972-1996, assuming total returns are 50% age-4 and 50% age-5.

Year	Estimated Escapement	Estimated Harvest	Estimated Total Run	Estimated Age-4 Recruits	Estimated Age-5 Recruits	Estimated Total Recruits	Estimated Recruits Per Spawner
1972	14,946	0	14,946	11,728	12,762	24,490	1.64
1973	9,463	1,723	11,186	12,762	17,405	30,167	3.19
1974	6,309	99	6,408	17,405	10,008	27,412	4.35
1975	7,000	365	7,365	10,008	7,151	17,159	2.45
1976	22,250	1,206	23,456	7,151	12,834	19,985	0.90
1977	24,358	1,167	25,525	12,834	10,473	23,307	0.96
1978	33,797	1,012	34,809	10,473	9,675	20,147	0.60
1979	17,700	2,315	20,015	9,675	13,574	23,248	1.31
1980	14,000	302	14,302	13,574	14,657	28,231	2.02
1981	24,000	1,668	25,668	14,657	5,805	20,462	0.85
1982	18,000	2,945	20,945	5,805	6,866	12,671	0.70
1983	18,000	1,349	19,349	6,866	2,703	9,569	0.53
1984	19,604	7,543	27,147	2,703	550	3,253	0.17
1985	28,000	1,314	29,314	550	1,300	1,850	0.07
1986	7,600	4,010	11,610	1,300	1,442	2,742	0.36
1987	12,800	932	13,732	1,442	5,189	6,631	0.52
1988	5,400	5	5,405	5,189	3,351	8,539	1.58
1989	1,100	0	1,100	3,351	2,550	5,901	5.36
1990	2,600	0	2,600	2,550	2,713	5,263	2.02
1991	2,884	0	2,884	2,713	1,551	4,264	1.48
1992	10,338	40	10,378	1,551	1,378	2,929	0.28
1993	6,700	1	6,701	1,378	1,725	3,103	0.46
1994	5,100	0	5,100	1,725	2,000	3,725	0.73
1995	5,400	26	5,426	2,000	1,030	3,030	0.56
1996	3,101	0	3,101	1,030	305	1,335	0.43
1997	2,757	0	2,757	305	Unknown		
1998	3,400	50	3,450				
1999	4,000	0	4,000				
2000	2,061	0	2,061				
2001	607	2	609				

Figure 1. Map of Italio River, etc. Gordie to prepare map showing New Italio, Middle Italio, Old Italio, Akwe, set net fishing areas for Akwe and Italio set gill nest, Akwe lagoon and old Italio lagoon, Italio Lake, and location of falls on Italio river.

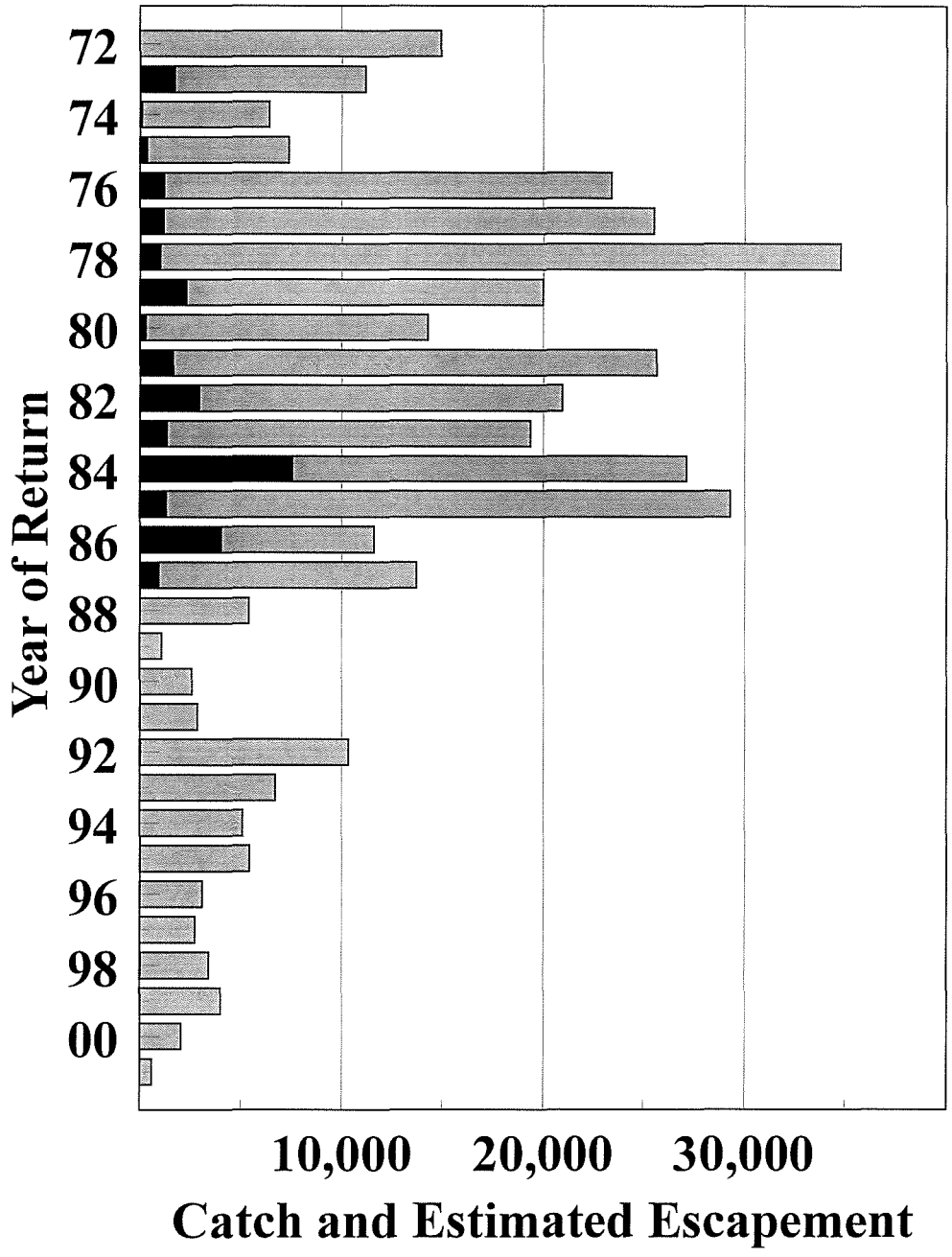

Figure 2. Catches (black bars) and estimated escapements (gray bars) of Italio River system sockeye salmon, 1972-2001.

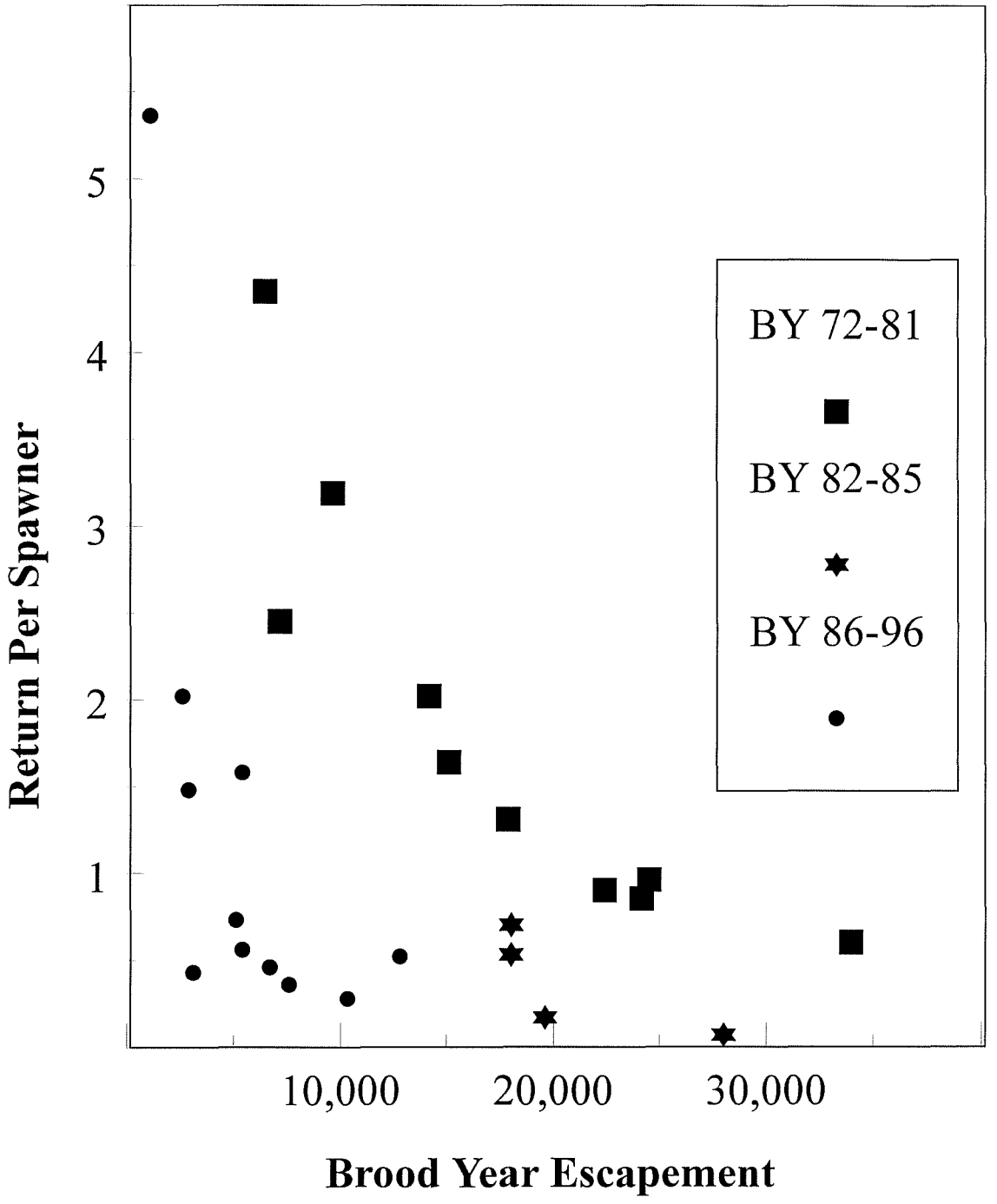

Figure 3. Estimated recruits per spawner for brood years 1972-1981, 1982-1985,and 1986-1996.

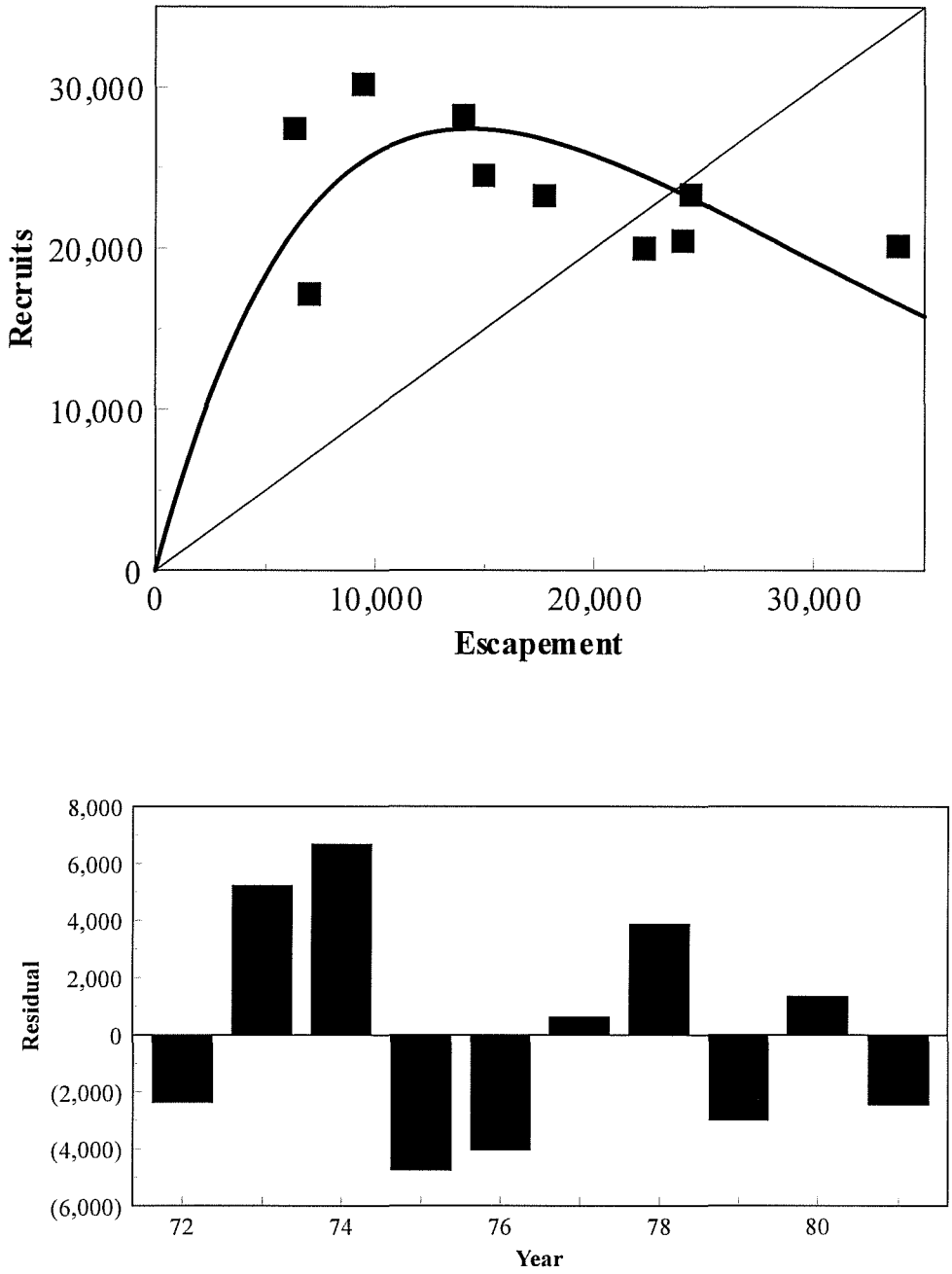

Figure 4. Stock-recruit relationship developed for brood year 1972-1981 Italio River system sockeye salmon (upper panel) and residuals in that relationship (lower panel). The historic S_{msy} escapement level is predicted to be about 9,000 total sockeye salmon or a peak aerial survey count of about 4,500 sockeye salmon in the Italio River system.

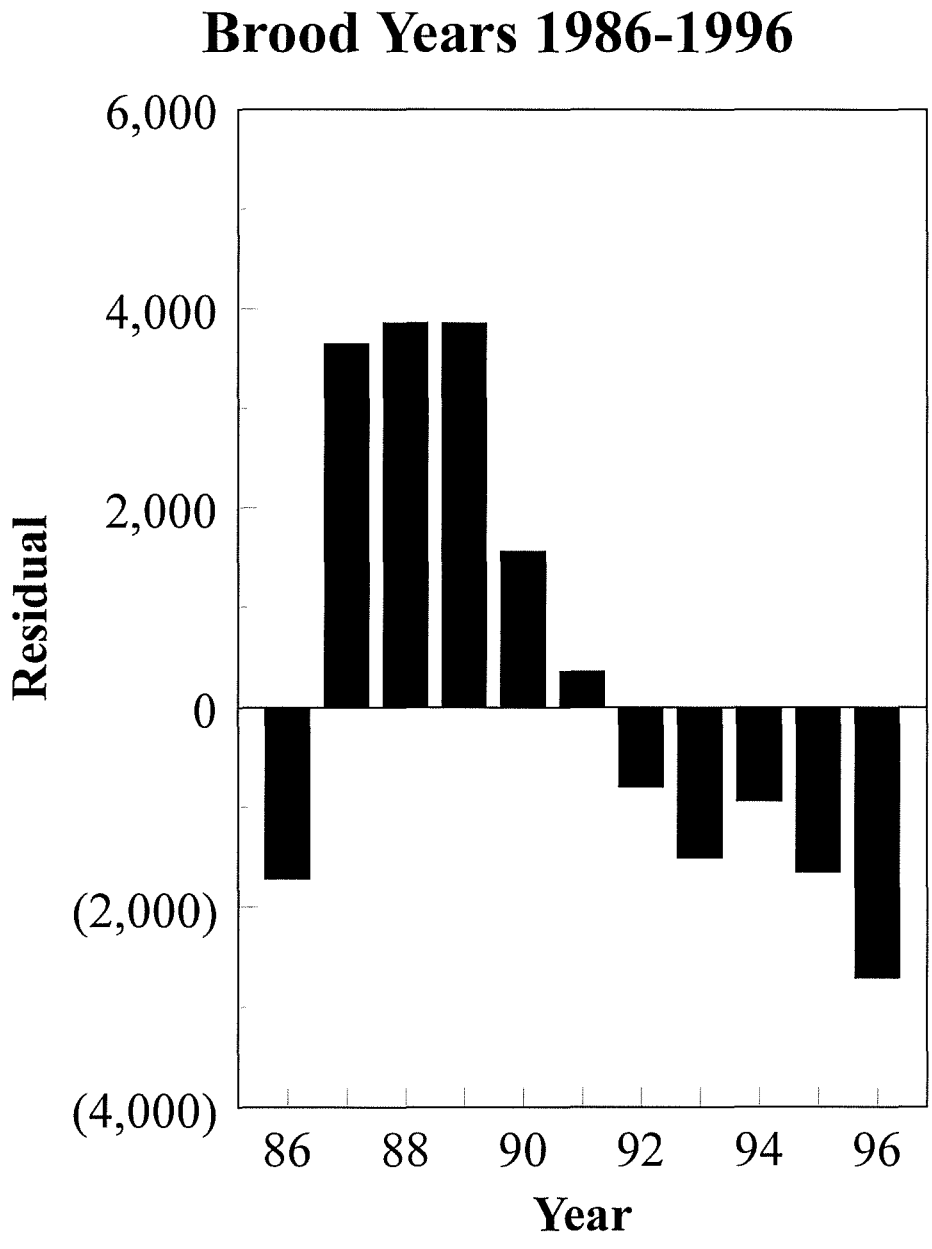

Figure 5. Residuals in the stock-recruit relationship for the Italio River system sockeye salmon population developed with data from brood years 1986-1996.

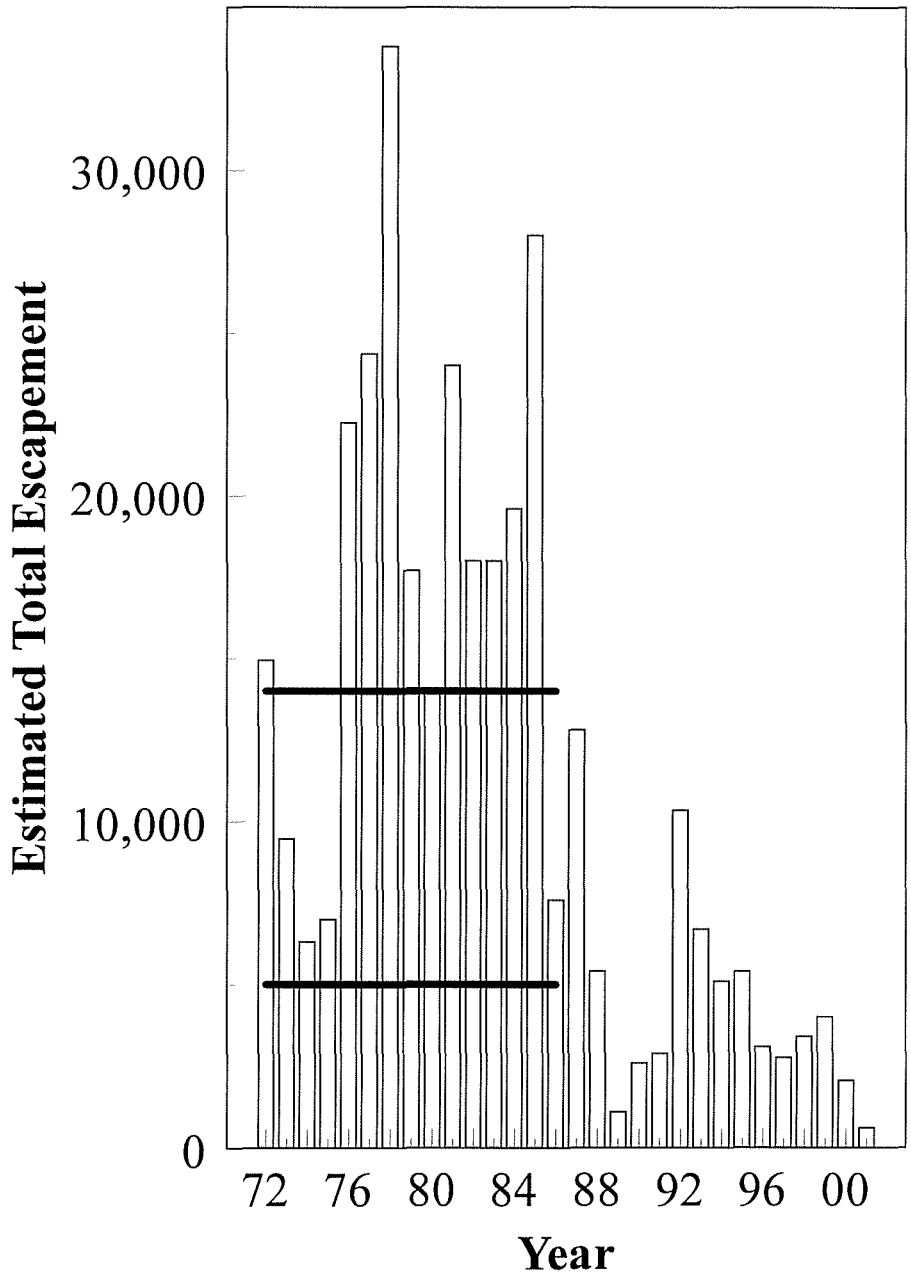

Figure 6. Stock health of Italio River system sockeye salmon. Bars are annual estimated total escapements and the horizontal lines across 1972-1986 represent the biological escapement goal range of 5,000 to 14,000 total spawners that was appropriate for this set of years.

Appendix Table 1. Counts of sockeye salmon in the Italio River, 1972-1990.

Year	Date	Count	Year	Date	Count	Year	Date	Count
1972	01-Jul	000	**1984**	21-Jun	300	**1988**	19-Jun	0
	08-Jul	000		06-Jul	2,500		26-Jun	0
	01-Aug	000		13-Jul	4,500		29-Jun	0
	29-Aug	000		21-Jul	2,000		05-Jul	0
	23-Sep	000		23-Jul	7,000		10-Jul	50
1973	04-Jul	000		31-Jul	6,500		12-Jul	500
	16-Jul	3		03-Aug	8,150		16-Jul	150
	18-Aug	4,200	**1985**	27-Jun	400		19-Jul	200
1974	09-Jul	1,000		04-Jul	2,300		21-Jul	200
	01-Aug	1,200		15-Jul	3,200		24-Jul	1,200
	17-Aug	2,800		26-Jul	1,500		28-Jul	600
1975	28-Jun	500		11-Aug	7,000		04-Aug	2,700
	10-Jul	700		29-Aug	14,000		13-Aug	1,500
	23-Aug	3,500	**1986**	30-Jun	2,500		15-Sep	700
1976	19-Jun	300		22-Jul	3,800		27-Sep	600
	04-Jul	2,000		27-Jul	1,300	**1989**	21-Jun	150
	25-Jul	4,000		29-Jul	3,800		25-Jun	100
	01-Aug	2,000		01-Aug	3,800		27-Jun	200
	11-Aug	3,700		31-Aug	2,000		28-Jun	0
	01-Sep	8,000		10-Sep	2,480		02-Jul	0
1977	24-Jun	1,500	**1987**	04-Jun	500		05-Jul	0
	29-Jul	7,800		03-Jul	200		07-Jul	225
	02-Sep	2,000		08-Jul	600		09-Jul	300
1978	28-Jul	1,000		12-Jul	1,500		12-Jul	300
	12-Aug	15,000		15-Jul	250		12-Jul	300
1979	None	-		19-Jul	1,950		18-Jul	550
1980	20-Jul	4,000		23-Jul	1,500		21-Jul	50
	23-Aug	7,000		26-Jul	1,200		15-Aug	200
1981	22-Jul	2,000		02-Aug	3,250	**1990**	24-Jun	0
	27-Aug	12,000		10-Aug	6,400		26-Jun	0
	22-Sep	10,000		09-Oct	100		01-Jul	250
1982	10-Jul	1,500					08-Jul	0
	25-Jul	8,000					18-Jul	810
	29-Aug	9,000					06-Aug	1,300
	19-Sep	4,000					22-Aug	1,050
1983	29-Aug	9,000						

Appendix Table 2. Counts of sockeye salmon in the Italio River, 1991-2002.

Year	Date	Count	Year	Date	Count	Year	Date	Count
1991	15-Jun	0	**1994**	12-Jun	0	**1999**	10-Jun	0
	19-Jun	0		26-Jun	550		14-Jun	0
	25-Jun	0		04-Jul	900		18-Jun	0
	02-Jul	0		11-Jul	0		21-Jun	0
	06-Jul	400		12-Jul	2,000		28-Jun	0
	09-Jul	0		25-Jul	1,890		16-Jul	270
	13-Jul	0		03-Aug	2,300		02-Aug	2,000
	19-Jul	950		10-Aug	2,550	**2000**	03-Jul	400
	22-Aug	20	**1995**	19-Jun	0	**2001**	03-Jun	0
	24-Aug	700		26-Jun	0		18-Jun	0
1992	09-Jun	0		01-Jul	650		25-Jun	0
	17-Jun	0		05-Jul	0		11-Jul	200
	21-Jun	0		10-Jul	750		18-Jul	0
	24-Jun	250		23-Jul	0		24-Aug	100
	29-Jun	450		02-Aug	2,410	**2002**	18-Jun	0
	07-Jul	800		23-Aug	2,700		24-Jun	0
	13-Jul	0	**1996**	09-Jun	0		29-Jul	2,200
	15-Jul	1,900		17-Jun	0			
	20-Jul	0		03-Jul	600			
	22-Jul	2,000		08-Jul	900			
	23-Jul	2,500		17-Jul	0			
	26-Jul	500		23-Jul	1,350			
1993	21-Jun	0		09-Sep	1,000			
	23-Jun	550		10-Oct	500			
	27-Jun	450	**1997**	27-Jun	600			
	29-Jun	0		03-Jul	0			
	04-Jul	25		08-Jul	1,100			
	07-Jul	0		15-Jul	50			
	12-Jul	700		21-Jul	1,200			
	16-Jul	800	**1998**	17-Jul	300			
	03-Sep	3,350		20-Jul	200			
	06-Oct	800		12-Aug	0			

Appendix Table 2. Statistics associated with the stock-recruit relationship developed for the Italio River system sockeye salmon population using brood years 1986-1996.

Stock Recruit Statistic
Brood Years Used: 1986-1996, n = 11
R^2 of the escapement versus log of return per spawner: 0.48
P value of relationship: 0.018
Unadjusted Ricker Alpha: 0.817 (S. E. = 0.408, CV = 50%, P value = 0.076)
Adjusted Ricker Alpha (Hilborn and Walters 1992): 1.049
Ricker Beta: -0.00018 (S. E. = 0.000062, CV = 34%, P value = 0.018)
Escapement level estimated to produce MSY in fisheries: about 2,500
Replacement Level: about 5,900
Residual Pattern: Decreasing trend in residuals across majority of time period