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History of Lower Cook Inlet Pink, Sockeye, and Chum Salmon Escapement Goals

by

Henry J. Yuen

State of Alaska | Walter J. Hickel, Governor

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ABSTRACT

The history of Lower Cook Inlet pink, sockeye, and chum salmon escapement goals was reviewed with an emphasis on the methods used to establish the goals. Discrepancies among various annual reports were resolved. Optimum escapement estimates were calculated for 11 pink, 2 sockeye, and 2 chum salmon streams from escapement and return data presented in the Annual Management Reports and Ricker's dome-shaped, stock-recruitment curve. These were compared with the existing escapement goals with the intent of highlighting research needs.

KEY WORDS: escapement goals, Lower Cook Inlet, salmon.

INTRODUCTION

The Department of Fish and Game is currently establishing an escapement goal policy. One objective of that policy is to provide uniform criteria for the establishment and revision of escapement goals. Before existing goals can be revised, however, it helps to know how they were derived and what information was considered. The purpose of this report is to describe the past and present escapement goals for Lower Cook Inlet pink, sockeye, and chum salmon.

This report compares the existing goals with optimum escapement estimates derived from a fit of Ricker's curve (Ricker 1975) to the most readily available data, those published in the 1989 Annual Management Report (Schroeder and Morrison 1990). The Ricker optimum escapement estimates in this report, however, were not used to revise any existing goal. Instead, they were intended to highlight areas where additional research was required. The reader should keep in mind that (1) Ricker curve was only used because the model is a widely employed (it may not necessarily be suitable as an optimum escapement model) and (2) the entire Lower Cook Inlet escapement data base is presently being reviewed for accuracy and consistency in methods.

The Lower Cook Inlet (LCI) salmon management area is comprised of the Gulf of Alaska west of the longitude of Cape Fairfield and Cook Inlet between the latitude of Cape Douglas and the latitude of Anchor Point (Figure 1). Although all five species of Pacific salmon are harvested within this area, escapement goals were established only for three of the more abundant species: pink (Oncorhynchus gorbuscha), sockeye (O. nerka), and chum (O. keta) salmon.

METHODS

History of Lower Cook Inlet Salmon Escapement Goals

The historical review of LCI escapement goals was based on interviews with three of the former LCI area management biologist (J. Rearden, L. Flagg, and T. Schroeder) plus information presented in the LCI Annual Management Reports (AMR) and the annual reports to the Board of Fisheries (BOF). Both report series began in 1968. The reader should be aware that some AMRs were published years after the fishery and summarized escapement goals in effect at the time of publication, not those in place during the report year. Where the AMR and BOF reports disagree, the BOF was presumed to be correct because it was usually published during the year of the fishery. However, there were no BOF reports in 1987 and 1989 because the Board of Fisheries began to address Lower Cook Inlet salmon issues on an alternate year basis.

Prior to publication year 1982, both the AMR and BOF reports presented a table titled "Estimated pink salmon escapements in thousands of fish for the nine index streams in Southern and Outer Districts of Lower Cook Inlet". This report will refer to them as "index stream" tables. In publication year 1982, the AMR introduced a second table titled "Escapement goal, averaged observed, (year) escapements of pink salmon". This report will refer to them as the "escapement goal" tables. In 1982 the BOF report replaced the "index stream" with the "escapement goal" table. Unfortunately, the numbers and footnotes listed in the two types of tables within a report did not always agree. Again, the BOF tables were presumed to be correct as they were almost always published during the year of the fishery.

Resolving Discrepancies in the Literature

1975 AMR

The escapement goal ranges summarized in the 1975 AMR most likely refer to those in effect during 1981. The 1975 AMR (ADF&G 1981b) did not have a year of publication and was probably published during or after 1981 (Schroeder, retired ADF&G, Homer, personal communication) because it referenced a report published in 1981.

1982 Publications

The "escapement goal" tables found in the 1980 and 1981 AMR (ADF&G 1982b and 1982c) refer to 1982, the year of publication. The correct year can be determined by comparing the AMR tables with similar tables in the 1980, 1981, and 1982 BOF reports (ADF&G 1980, 1981a, and 1982a). Pink salmon escapement goals for the Eastern District were published once in the 1976 BOF report (ADF&G 1976) and were never mentioned again until 1982 in the "escapement goal" table of the 1982 BOF report (ADF&G 1982a).

Pink Salmon

Report year	Publication year	"Escapement goal" table	Escapement goal year	"Index stream" table	Escapement goal year
80 AMR	82	Table 2	82	Table 7	80
81 AMR	82	Table 4	82	Table 9	81

chum salmon

Report year	Publication year	"Escapement goal" table	Escapement goal year	"Index stream" table	Escapement goal year
80 AMR	82	Table 3	82	Table 8	80
81 AMR	82	Table 5	82	Table 10	81

"Index Stream" Tables After 1981

The "escapement goal" tables in the AMR after report year 1981 (ADF&G 1983, 1985c, 1985d, 1985e, 1987a, and 1987b; Schroeder and Morrison 1989, 1990) list the escapement goals in effect during the report year. However, the "index stream" tables in the AMR for report years after 1981 continued to present the 1981 pink and chum salmon escapement goals by mistake, i.e., Tables 8 and 9 of the 1982 AMR (ADF&G 1983), Tables 8 and 9 of the 1983 AMR (ADF&G 1985c), Tables 8 and 9 of the 1984 AMR (ADF&G 1985d), Appendix Tables 8 and 9 of the 1985 AMR (ADF&G 1985e), Appendix Table 6 of the 1986 AMR (ADF&G 1987a), and Appendix Table 6 of the 1987 AMR (ADF&G 1987b). The AMR "index stream" tables for pink salmon ceased to offer escapement goals for the nine original "index" streams beginning with the 1986 AMR. The chum salmon escapement goals in the AMR "index stream" tables were brought up to date in the 1988 AMR (Schroeder and Morrison 1989).

1985 Publications

Six reports were published in 1985: the 1976-77, 1978-79, 1983, 1984, and 1985 AMRs plus the 1985 BOF report (ADF&G 1985a, 1985b, 1985c, 1985d, 1985e, and 1985f). The "escapement goal" tables in all these reports presented the 1985 escapement goals with one exception. The 1985 AMR and 1985 BOF tables correctly reported the Thumb Cove escapement goal as increased from 1,000 to 4,000 in 1985 while the other four AMRs published in 1985 presented the older escapement goal of 1,000 in effect between 1982 and 1984.

1986 and 1987 Publications

Escapement goals for James Lagoon, Desire Lake, and Aialik were added in 1986. They are in the "escapement goal" tables of the 1986 AMR (ADF&G 1987a) and BOF reports (Schroeder and Morrison 1986) as well as the 1985 AMR (ADF&G 1985e). The cover page of the 1985 AMR list the date of publication as "March, 1985". The year should have been "1986" because the report was written after the fishery. Likewise, the cover page of the 1987 AMR (ADF&G 1987b) lists the date of publication as "March, 1987". Accordingly, the year should have been "1988".

Comparison of Existing Goals with Estimated Optimum Escapement

Ricker curves were used to estimate optimum escapement from stock-specific return by brood year escapement data where return was catch plus escapement. For pink salmon, the data was easily obtained because the returning adults all mature and return to spawn at age-2. Lower Cook Inlet sockeye salmon, on the other hand, return between the ages of 4 and 6, whereas chum salmon mature between the ages of 3 and 6. Continuous age composition data for 3 - 4 years period is required to discern total return for a given brood year escapement. Age composition data can be found in reports by Schroeder (1984, 1985, 1986), Morrison (1987), and Yuen et al. (1989, 1990). Only four sockeye and chum salmon systems were examined because the limited availability of the needed consecutive years of age composition data.

Escapement Data

The stock-specific escapement estimates used in this report were from Schroeder and Morrison (1990). Data for pink, sockeye, and chum salmon began in 1960, 1959, and 1964, respectively. The pink and chum salmon escapement estimates were probably total annual escapements, as opposed to an index of escapement such as peak aerial survey counts. These were derived from the area under the stream survey curve divided by a 17.5-d stream life factor (the number of days spawning pink or chum salmon are alive in the stream). (Davis and Valentine 1970). The following equation was used to convert periodic survey counts to estimates of fish gained or lost in the stream since the last survey. It considers the number of days elapsed since the last survey as well as stream life:

$$\hat{c}_i = \frac{(d_i - d_{i-1})x_i - \frac{(d_i - d_{i-1})(x_i - x_{i-1})}{2}}{s} \quad , \qquad (1)$$

where
$\hat{c}_i$ = estimated number of pink or chum salmon that entered the study stream between survey i-1 and survey i;
d_i = Julian calendar day of survey i ($1 < d < 365$);
x_i = number of live pink or chum salmon observed in the study stream during survey i;
s = stream life for pink or chum salmon (17.5 days).

Total annual escapement was then calculated as

$$\hat{E} = \hat{c}_a + \sum_{i=1}^{n} \hat{c}_i \quad , \qquad (2)$$

where
$\hat{E}$ = total estimated number of pink or chum salmon that entered the study stream to spawn during the season;
n = number of surveys made during the season;
$\hat{c}_a$ = estimated number of live pink or chum salmon that entered the study stream between the last (n^{th}) survey and 15 September (an arbitrarily selected date when stream survey count was expected to be zero):

$$\hat{c}_a = \frac{\frac{(258 - d_n)x_n}{2}}{s} \quad . \qquad (3)$$

Return Data

Both mixed and discrete-stock catch estimates of pink, sockeye, and chum salmon dating back to 1959 used in this report were taken from Schroeder and Morrison (1990). The only exception was the South Nuka catches, obtained from the fish ticket data system (Statistical Areas 232-15 and 232-21). These catches reflect returns to nine other streams besides South Nuka Island Creek. The nine other stream produce sporadically and therefore escapement data is collected in South Nuka only. The exception was 1981 when catches were reported in Mikes Bay on Nuka Island and in Tonsina Bay to the west of Nuka Island (T. Schroeder, ADF&G, Homer, personal communication).

Definition of a Stock

Most of the pink salmon spawner-return data were for systems with discrete stock catches, but the catch assigned to (1) Windy Left and Windy Right in Windy Bay, (2) Port Dick and Island Creek in Port Dick Bay, (3) Desire Lake Creek and James Lagoon in East Nuka Bay, and (4) Sunday Creek and Browns Peak Creek in the Ursus and Rocky area. These were simply assumed to be proportional to the spawning escapement; there was no data available to test this assumption. The catches in Resurrection Bay were not assigned a stream of origin. Instead, the seven streams in Resurrection Bay were treated as a single stock.

Systems where hatchery returns were mixed with wild stocks were not included in this study. For pink salmon, 12 harvest areas and 24 corresponding spawning streams are covered in this report. Six streams with existing escapement goals were ignored because either no means were available to estimate discrete stock harvests or because hatchery returns were present (Table 1).

For some systems, all streams flowing into a common bay were considered a single stock. Of the 10 sockeye salmon harvest areas, there were sufficient age composition data to examine only two. Of the eight systems not analyzed, two contained hatchery fish, three were primarily interception fisheries, three had insufficient data, and one had no age composition data (Table 2). Of the 14 chum salmon harvest areas, 12 were not analyzed because of either insufficient age composition data, no age composition data, or no escapement data. Those without escapement data also had no existing escapement goal (Table 3).

Definition of Peak-Year

The predominance of intertidal or upstream spawning by pink salmon is related in part to the size of the escapement. Typically, the intertidal areas are used every year. However, during years of large escapements (i.e., peak-years) spawning also occurs in the upstream areas. Some existing escapement goals are presented as a range. For pink salmon, the upper end of the escapement goal range was usually a management target only after fish were observed using upstream spawning areas. There is evidence that intertidal spawners are more successful than upstream spawners (Hanavan and Skud 1954). Therefore, three separate Ricker curves were calculated for each pink salmon spawning stream: (1) all-years-combined, (2) peak-year only, and (3) off-cycle-year only. This would allow for differences in spawning success attributed to differences in spawning areas.

An odd- or even-year cycle was defined as a pattern of large escapements and returns during odd- or even-numbered years. Good examples of a dominant year cycle can be found in a few streams: Seldovia, Windy Creeks, and Rocky River. Unfortunately, Lower Cook Inlet pink salmon stocks have switched from one dominant year pattern to the other and back again, making the odd-even year definition confusing. Therefore, escapements were classified either as peak- or off-cycle year allowing odd- and even-year data to be lumped according to escapement and return size. The ranges within the peak- and off-cycle-year escapements were later used to classify other escapements.

When a cycle shifts pattern, there may be a few years during the transition when the size of the return shows no relationship to the size of the escapement. Examples of this can be found in Port Graham, Port Chatham, Port Dick, Island

Creek, James Lagoon, Desire Lake Creek, Brown's Peak Creek and Sunday Creek. In some systems, there may be a long period when no obvious dominant year pattern can be determined. All were assigned a classification depending on whether the escapment was within the peak- and off-cycle-year escapements ranges.

There were two systems, Humpy Creek (in Kachemak Bay) and Bruin Bay where the upstream section of the total spawning area was not used unless escapements were very large. For these two systems, a minimum threshold escapement for upstream spawning to occur was estimated. Escapements above this estimate were classified as peak-year escapements.

Finally, there is one system, Resurrection Bay, where spawning alternates between geographical areas. During the even-numbered years upstream spawning predominates in the inner bay, whereas during the odd-numbered year intertidal spawning occurs in the outer bay. The odd-even year classification was used for convenience.

Optimum Escapement Estimate From Ricker Curve

A Ricker dome-shaped stock-recruitment curve (Ricker 1975) was fitted through the data (Appendix B) such that

$$R=Ee^{\alpha(1-\frac{E}{E_r})}, \qquad (4)$$

where R = total return (catch plus escapement)
E = escapement
E_r = unfished equilibrium stock size
α = coefficient

Optimum escapement was approximated (Hilbourn 1985):

$$e_{opt}=(0.5-0.07\alpha)E_r \qquad (5)$$

This estimate of optimum escapement corresponds to the greatest return above the replacement line (Figure 2). This is also defined as Maximum Sustained Yield or MSY. This estimate was declared "not meaningful" whenever a dome-shaped curve could not be fitted through the data. In this situation, the "optimum escapement estimate" was frequently greater than the largest observed escapement.

Outliers were not removed from the data sets unless specifically stated otherwise, e.g., Bruin Bay. Variability for some data sets were problematic, but if outliers were removed, sample sizes would have been reduced to unacceptable levels.

Age-specific returns, as opposed to total returns, for sockeye and chum salmon were estimated from escapement data because there were insufficient data to estimate total returns by brood year. Consequently, all of the various age-specific estimates of optimum escapements were weighted by their corresponding age-specific mean return-per-spawner ratio to derive an age-independent escapement goal.

RESULTS

History of Lower Cook Inlet Salmon Escapement Goals

Pink Salmon

Prior to statehood the Bureau of Commercial Fisheries and the U.S. Fish and Wildlife Service had the responsibility of estimating numbers of spawning salmon in Lower Cook Inlet. These estimates were indices most likely based on peak aerial survey counts. Lacking any other data, the Department of Fish and Game used these counts as an informal escapement goal until their own research could be completed (Rearden, ADF&G, Homer, personal communication, Appendix A.1).

The earliest reference to pink salmon escapement goals that I found was in the 1968 AMR where Davis (1968) stated "the escapement needs for the district vary with the return distribution. Approximately 200,000 pinks are needed for spawning purposes if all streams receive adequate numbers of fish". However, there was no discussion on how the 200,000 figure was derived, how the total escapement goal was distributed by stream, or when the goals were put into use. Rearden (ADF&G, Homer, personal communication; Appendix A.1) and Barrett (ADF&G, Kodiak, personal communication) felt that the estimate may have been based on historical aerial surveys adjusted for spawner distribution, winter water flow, and size of spawning stream.

The first published Lower Cook Inlet pink salmon escapement goals that I found were in Table 6 of Davis and Valentine (1970), which presented the desired escapement ranges for nine streams: Humpy, Tutka, Seldovia, and Port Graham in the Southern District and Windy Left, Windy Right, Rocky, Port Dick, and Island in the Outer District (see Table 6 of this report). These goals were based on 1.5-2.0 spawners/m^2 (McNeil 1962) and a measurement of the preferred upstream and intertidal spawning areas. Altogether, the total range was 183,000-244,000 pink salmon. That, however, did not agree with their text, which stated "approximately 225,000 pinks are needed for spawning purposes if all streams receive adequate numbers of fish". Nevertheless, both numbers were close to the 200,000 figure mentioned in the 1968 AMR. There were neither an explanation for the difference in Davis and Valentine's report or with the 1968 AMR nor any indication if these escapement goals were used prior to the year of publication.

Beginning in 1975 some of the nine original pink salmon escapement goals were revised upwards based upon subsequent observations on the extent of upstream spawning area being used (Schroeder, ADF&G, Homer, personal communication). Thus, in the next publication of pink salmon escapement goals, i.e., Table 1 of the 1975 BOF report (ADF&G 1975), the goal for Tutka was revised upwards by 1,000. No explanation for the revision was found in the text.

Table 1 of the 1975 BOF report also included escapement goals for five streams in the Kamishak District (McNeil-Amakdedori, Bruin Bay, Ursus Cove, Sunday Creek, and Cottonwood-Iniskin). Unfortunately, species was not indicated in the table, but species could be inferred from the stream names. All of the streams are major pink salmon streams except for McNeil-Amakdedori, Ursus Cove, and Cottonwood-Iniskin, which were chum salmon spawning streams (Schroeder, ADF&G, Homer, personal communication). Escapement goal ranges were not presented in the 1975 BOF report. Nevertheless, the single published figure matched the upper range published in 1970 with the exception of Tutka.

The text of the 1975 BOF report explained that "after examination of the spawning streams, it was felt that some of the escapement goals for particular streams were high, when compared to Southern district streams, and management decisions were based accordingly". That referred to a downward revision of the pink salmon escapement goal from 50,000 to 30,000 in Sunday (and Brown's Peak) Creek (Schroeder, retired ADF&G, Homer, personal communication), suggesting that escapement goals for the Kamishak District were in use prior to their publication in 1975. The original 50,000 escapement goal in Sunday (and Brown's Peak) Creek was never published in an AMR or BOF report.

Two years later, the 1977 BOF report (ADF&G 1977) provided some insight on the evolution of the Port Dick escapement goals. It stated that "measurement of available spawning area did not take into account three minor side spring spawning tributaries, one major tributary or the area above a large meadow. In 1975, due to strong upstream migration past the intertidal spawning area, an escapement of over 60,000 pink salmon was allowed. Although there was undoubtedly an environmentally caused survival factor from the fry to adult stages, it was quite evident from the phenomenal return to this stream that a substantial increase in the escapement goal was necessary. A decision was made to try and achieve an upstream escapement of 60-70,000 plus an additional 20,000 intertidal spawners for an overall escapement of 80-90,000". However, the escapement goal published in the 1977 BOF report for Port Dick continued to be listed as 22,000-30,000. Escapement goals were not published in the 1978 BOF.

Alternative goals of 25,000-35,000 for Windy Left and 70,000-100,000 for Port Dick were finally published in the 1979 BOF report (ADF&G 1979) as a footnote to the "index stream" tables. The footnote states "in years where large numbers of upstream spawners return". The rationale for the revised alternative range in Port Dick was published later in 1981.

The 1975 AMR (ADF&G 1981b) published in 1981 stated that "a major adjustment was made for the odd-year escapement goals to the Port Dick and Windy Left spawning streams. The Windy Left pink salmon escapement goal was increased from 7,500-10,000 to 25-35,000 and the Port Dick pink salmon escapement from 22,500-30,000 to 70-100,000. The escapement goal for Windy Left was increased after it was observed that pink salmon were readily moving into the extensive upstream spawning area". The Port Dick "odd-year pink salmon escapement goal was increased to allow additional spawning salmon into the extensive upstream spawning area". Both revisions continue to appear only as a footnote to the "index stream" tables that began in 1979. There was no mention of the alternative ranges in the "escapement goal" tables.

The 1976 BOF report (ADF&G 1976) explained the Resurrection Bay pink salmon goals were based on "estimated spawning capacity" according to a column heading in Table 9 of that report (Appendix A.2). There were also two creeks, Airport and Grouse, that were listed once in the 1976 BOF report but never again in any AMR or BOF reports. During 1986, escapement goals for another three pink salmon streams were established: James Lagoon, Desire Lake, and Aialik. They were based on the manager's aerial survey experience, his estimate of spawning area potential, and perceptions on ideal spawner densities (Schroeder, retired ADF&G, Homer, personal communication).

Sockeye Salmon

The earliest publication of sockeye salmon escapement goals was found in the 1982 BOF report (ADF&G 1982a). Goals were published for 7 streams: English Bay in the Kamishak District; Desire Lake, Delight Lake, and Anderson Beach in the Outer District; Aialik Lake in the Eastern District; and Mikfik and Chenik Lakes in the Kamishak District (see Table 7 of this report).

In the 1984 AMR (1985d) and BOF reports (ADF&G 1984b) were discussions on the Bear Lake sockeye run and escapement goal. According to the BOF report, "the sockeye return to Bear Lake in Seward was fished for the first time since 1971". The AMR indicated that "sockeye escapement had been previously limited to a minimum of 500 fish of either sex in order to maximize coho salmon production from the lake for the recreational fishery in Resurrection Bay. Last minute adjustments lowered the allowable escapement to only 250 sockeye of either sex".

During 1988, the escapement goal for Mikfik was increased by the Mikfik Creek-McNeil Lagoon Salmon Management Plan from 5,000 to 5,000-7,000 (Appendix 1 of the 88 AMR (Schroeder and Morrison 1989)). Tom Schroeder (retired ADF&G, Homer, personal communication) in a memo wrote, "The escapement goal for sockeye salmon in Mikfik Lake has always been 5,000 fish. While this figure is somewhat arbitrary, it is based on looking at escapement goals for other Lower Cook Inlet sockeye producing systems. Based on observation of the total returns to Mikfik it appears that this system in 1985, which totalled 87,000 sockeye was from 1980 and 1981 escapements of 6,500 and 5,300, respectively. Recent strong returns are definitely due primarily to environmental conditions rather than escapement levels as this trend has been an area-wide phenomenon. Total returns from the large 1982 spawning population of 35,000 fish were estimated to be 20,600 in 1986 (4 year old) and 10,500 in 1987 (5 years old) for a total of 31,100 fish. This represents only a 0.89 return per spawner, whereas, lower escapements in Mikfik and other systems in Cook Inlet generally produce R/S ratios of 3 or 5 to 1" (see Appendix A.3 of this report). However, the escapement goals printed in the 1988 BOF (Schroeder and Morrison 1988), 1988 AMR (Schroeder and Morrison 1989), and the 1989 AMR (Schroeder and Morrison 1990) remain 5,000.

Chum Salmon

Table 1 in the 1975 BOF report (ADF&G 1975) may have presented chum salmon escapement goals for three major chum salmon spawning streams in the Kamishak District: McNeil-Amakdedori, Ursus Cove, and Cottonwood-Iniskin. Unfortunately, species was not indentified in the table. The Cottonwood-Iniskin goals appear to be the sum of the Cottonwood and Iniskin Bay goals but the goals for the other two streams did not match with either chum or pink salmon goals reported elsewhere.

The earliest publication of known chum salmon escapement goals was found in the 1979 BOF report (ADF&G 1979). Goals were published for 12 streams: Port Graham, Dogfish Lagoon, Rocky River, Port Dick (Headend) Creek, Island Creek, Big

Kamishak, Little Kamishak, McNeil River, Bruin Bay, Ursus Cove, Cottonwood Creek, and Iniskin Bay (see Table 8 of this report). The text of the 1979 BOF did not explain how those goals were derived.

During 1982, the BOF report (ADF&G 1982a) presented revisions for all 12 goals. Two new goals (Petrof and Kamishak Main Left) were also added during 1982. They were summarized in the "escapement goal" table of the 1982 BOF. The BOF reports also stopped presenting the "index stream" table. Meanwhile, the 1982 AMR (ADF&G 1983) published both an "index stream" and an "escapement goal" table. Although the 1982 AMR and BOF "escapement goal" tables both agree, the AMR "index stream" table continued to print the original chum salmon escapement goals through 1987.

Also published during 1982 were the 1980 and 1981 AMR (ADF&G 1982b, 1982c). They both had an "escapement goal" table, which agreed with those published in the 1982 AMR and BOF reports with one exception. The 1980 and 1981 AMR "escapement goal" tables printed the goal for Bruin River as 5,000-10,000 chum salmon. According to the BOF report it should have been revised as simply 5,000 chum salmon.

Comparison of Existing Goals with Estimated Optimum Escapement

An inventory of Lower Cook Inlet salmon escapement goals, catch and escapement data, and whether optimum escapement was estimated with a Ricker curve is presented by harvest area in Tables 1-3. The definition and classification of peak- and off-cycle years for 11 pink salmon harvest areas are presented in Table 4. Comments on preferred spawning area and definitions of peak escapement are also presented. A history of escapement size and percentage of intertidal spawning are presented in Table 5. None of the correlations between size of escapement and percentage of intertidal spawning were statistically significant (α =.05). Nevertheless, there was a trend in most of the streams suggesting a smaller proportion of intertidal spawners, i.e., a greater use of the upstream spawning areas with larger escapements. Port Graham and Island Creek were the only exceptions (Figures 3-9).

The results of fitting Ricker's curve to 11 pink salmon harvest areas are presented in Table 9. Mean annual returns and return per spawner ratios from all-years, peak-years, and off-cycle-years are also presented. Results from the fitting of Ricker's curve to two sockeye and two chum salmon harvest areas are presented in Table 10.

Humpy Creek Pink Salmon

The Ricker curve based on escapements below 40,000 produced an optimum escapement estimate of 18,500, less than the lower end of the existing range of 25,000-50,000 (Figure 10). The Ricker curve based on escapements greater than 40,000 was not dome-shaped (Figure 11). The Ricker curve based on the entire data set produced an optimum escapement of 51,900, very close to the existing upper range (Figure 12).

The rationale for an escapement range in Humpy Creek was based on large escapements pushing spawners into the upstream areas, specifically the right fork

(Figure 3). Escapements above 40,000 resulted in significant numbers of spawners above the right fork (Schroeder, retired ADF&G, Homer, personal communication).

Seldovia Pink Salmon

The Ricker curve optimum escapement estimate of 26,500 for peak-years (Figure 13), 29,700 for off-cycle years (Figure 14), and 33,600 for all years combined (Figure 15) were all within the existing range of 25,000-35,000. The spawner-return data exhibited no clear relationship between size of escapement and dominant year (Appendix B.2).

The intertidal spawning areas in this stream has shifted during the last 7 or 8 years due to channel changes with considerable loss of intertidal spawning area (Schroeder, retired ADF&G, Homer, personal communication). Ricker curves based on only the most recent data may produce different optimum escapement estimates.

Port Graham Pink Salmon

The peak-years and all-years-combined Ricker curves had optimum escapement estimates of 16,800 and 13,900, both less than the existing goal (Figures 16 and 17). A dome-shaped Ricker curve could not be calculated from the data for the existing off-cycle-year (Figure 18).

This stream has had a history of downward revisions in its escapement goal. The original goal of 45,000-60,000 was designed to allow for extensive upstream spawning. The upstream spawning areas, however, were subsequently lost because of changes in the stream channels and profile. Consequently, the goals were revised downwards to 20,000-40,000 in 1977. The upper end of the existing goal (40,000) was intended to "push" fish upstream with a large escapement should the opportunity occur (Schroeder, retired ADF&G, Homer, personal communication). Port Graham was one stream where the proportion of intertidal spawning did not drop with increasing escapement (Figure 5). Port Graham stream channels are still in transition at this time with additional losses in spawning area where sections of the stream have become deep pools, unattractive to spawning pink salmon (Schroeder, retired ADF&G, Homer, Personal Communication).

Port Chatham Pink Salmon

The Ricker curve optimum escapement estimate for peak-years (13,500) is within the range of the existing escapement goal of 10,000-15,000 (Figure 19). There was an insufficient number of off-cycle-year data sets to form a curve and the results from the all-years-combined data were not meaningful (Figure 20).

Windy Left Pink Salmon

Both the Windy Left all-years-combined (38,200) and peak-years-only (30,400) Ricker curve results were within the existing range (30,000-50,000) (Figures 21 and 22). The off-cycle-year result (2,000) was considerably below the existing range (Figure 23).

The stream requires additional research because the peak-year results were less than the results for all years combined and because the peak-year and off-cycle-year results were contrary to the recent upward revision of the original goal (10,000), which was made to account for additional spawning area above the forks.

Windy Right Pink Salmon

Only the off-cycle-year Ricker curve was dome-shaped (Figure 24). However, the off-cycle-year Ricker curve result (1,000) was considerably below the existing goal of 10,000. Neither the all-years-combined nor the peak-years Ricker curve were meaningful (Figures 25 and 26).

Considerable loss of spawning area has occurred in this stream due to logging (Schroeder, retired ADF&G, Homer, personal communication) but this was not the reason for the low Ricker curve estimate of optimum escapement. Instead, the results may be due to a combination of most of the data points being on the low end of the escapement range (hence the concave all-years-combined curve) and errors in the manner of estimating a stream of origin for the catch. Combining Windy Left and Windy Right into a single Windy Bay stock led to an optimum escapement estimate of 60,200, which is at the upper end of the combined existing range.

Rocky River Pink Salmon

The Ricker curve estimates for all years combined (11,400), peak years (32,000), and off-cycle years (3,300) were all well below the existing goal of 50,000 (Figures 27, 28, 29).

The existing escapement goal was intended for both intertidal and upstream spawning whereas the data used in the Ricker curve may be reflecting intertidal spawning only. The main stem of this river has changed significantly because of flooding related to logging that began in this area in 1965. The data used in the analysis were brood years 1967-1986. The main stem is no longer used for upstream spawning and most spawning is intertidal (Schroeder, retired ADF&G, Homer, personal communication). However, a reduction in the escapement goal would preclude an opportunity to see if upstream spawning might return in the future.

Port Dick Pink Salmon

The Ricker peak-year estimate (112,700) was close to, albeit greater than, the upper end of the existing goal of 100,000 (Figure 30). The Ricker off-cycle-year estimate of 20,400 agreed very well with the lower end of the existing goal of 20,000 (Figure 31). The Ricker all-years-combined curve, however, was not meaningful (Figure 32).

The definition of a peak-year escapement in this stream was not precise. There was an overlap between the off-cycle year (1,500 - 56,100) and peak year (26,400 - 116,000) escapement ranges.

Island Creek Pink Salmon

The Ricker peak-year optimum escapement estimate of 12,400 was within the existing range of 12,000-18,000 (Figure 33). The all-years-combined Ricker curve estimate of optimum escapement, 11,000 was slightly below the lower end of the current escapement goal range (Figure 34). However, the Ricker off-cycle-year estimate of 800 was considerably lower than the lower end of the existing goal (Figure 35).

The data set for Island Creek was inconsistent. Between 1960 and 1970, there was a clearly discernable even-year pattern where the dominant year escapements were an order of magnitude greater than those of the off-cycle-years. Between 1971 and 1985, however, all of the escapements were considered small, i.e., less than 2,000, accompanied by equally small returns, except brood years 1979 and 1980. Relatively small escapements of 600 and 2,200 during those two brood years produced unexpectedly large returns of 242,729 and 33,911. Between 1981 and 1986, the situation reversed. All of the escapements were considered large, greater than 15,000, but the returns from brood years 1985 and 1986 were surprisingly small, 165 and 9,413. Removing the most obvious outlier, brood year 1985, from the peak-years-only data set did not improve the results.

South Nuka Island Pink Salmon

The all-years-combined and the odd-years-only Ricker curve results were not meaningful (Figures 36 and 37). Interestingly, their Ricker curve estimates were 14,600 and 10,900, both very close to the existing goal of 10,000. Nevertheless, these curve were rejected because they were not dome-shaped. There was insufficient data to estimate an even-year Ricker curve.

Desire Lake Pink Salmon

The all-years-combined Ricker curve estimate of optimum escapement (12,100) was within the existing range of 10,000-20,000 (Figure 38). There were not enough observations to form a Ricker curve for the peak and off-cycle years.

The commercial catch from the East Arm of Nuka Bay (McCarty Fiord) attributed to Desire Lake was based on the ratio of escapements to Desire Lake and James Lagoon. Paired Desire Lake and James Lagoon escapement data, however, were not available prior to 1980.

No dominant year pattern could be found between brood years 1980 and 1987. The lack of a dominant year pattern should be verified when more data become available in the future.

James Lagoon Pink Salmon

The Ricker curve estimate of optimum escapement for all years combined (3,100) was below the existing goal of 10,000 (Figure 39). There were not enough observations to form a Ricker curve for the peak and off-cycle years.

The ratio of escapements to Desire Lake and James Lagoon may not have been the appropriate method of estimating stream of origin for the East Nuka Bay commercial catch. That, in turn, would have influenced the Ricker curve results.

Resurrection Bay Pink Salmon

The Ricker curve estimate of 17,600 for all years combined and 19,800 for even years were both below the existing goal of 30,000 (Figures 40 and 41). There were not enough observations to form a Ricker curve for the odd years.

Resurrection Bay is made up of many small streams, each with a unique reason for reduced productivity. Tonsina Creek was physically changed in 1987 when the sea berm was pushed into the creek creating a dam. A chicken farm on Bear Creek resulted in chicken manure and feathers being deposited in the stream between 1982 and 1987. New housing construction is also affecting Salmon and Bear Creeks (Schroeder, retired ADF&G, Homer, personal communication). It remains to be decided whether to lower escapement goals to reflect degradation of the streams, or to retain the existing goals with the idea of rebuilding the runs.

Bruin Bay Pink Salmon

With the 1986 data point removed, the all-years-combined Ricker curve estimate (47,100) was within the existing range of 25,000-50,000 (Figure 42). The peak-years Ricker curve optimum escapement estimate was less that the escapements used to build the model (Figure 43). The Ricker curve off-cycle estimate of 15,800 was well below the existing range (Figure 44).

The 1986 brood year escapement of 1,206,000 was removed from the data set because it was three times greater than the next largest escapement (403,800). If the 1986 data point was included in the data analysis, the Ricker curve results would have been very different. First, the Ricker curve estimates for peak-year escapements would have fallen to 17,800. Second, the all-years-combined estimate of 67,800 would have exceeded 50,000. Schroeder (retired ADF&G, Homer, personnal communication) felt that escapements in excess of 50,000 would lead to spawners moving into upstream areas that are prone to overwinter freezing.

Sunday Creek Pink Salmon

The all-years-combined and peak-year Ricker curve estimates were similar, 17,600 and 17,900, and within the existing range of 10,000-20,000 (Figures 45, 46). The off-cycle-year curve estimate was 1,600, below the existing goal (Figure 47).

Brown's Peak Creek Pink Salmon

Both the all-years-combined and peak-year Ricker curve estimates, 8,400 and 7,700, were below the existing goal of 10,000-20,000 (Figures 48 and 49). The off-cycle-year Ricker curve estimate was not meaningful (Figure 50). The low optimum escapement estimates may be due to problems in estimating the stream of origin in the Ursus-Rocky Cove complex.

Aialik Sockeye Salmon

Only the age-1.2 and -1.3 age-specific Ricker curves were meaningful. There was some agreement between the Ricker estimate for these two ages, 5,400 and 6,200, and the upper end of the existing range, 5,000 (Figures 51 and 52). Likewise, the weighted average of the two age-specific estimates of optimum escapement, 5,800, was close to the upper end of the existing range.

On the other hand, the Ricker estimates for ages 2.2 and 2.3 were both approximately 600, well below the range of data used to build the model and therefore were considered not meaningful (Figures 53 and 54). The age-2. returns are usually in the thousands, and the Ricker estimates for the 2.2 and 2.3 returns should not be given as much weight as the age-1. returns. Age-1.2 and --1.2 returns are typically in the tens of thousands.

Nuka Sockeye Salmon

There was a substantial difference between the Ricker estimates for age-1.2 and --1.3, 3,900 and 5,300, and the existing goal of 20,000 (Figures 55, 56). These age groups are a sizable component of the runs. The Ricker curve for age-2.2 was not dome-shaped (Figure 57) while the Ricker estimate for age-2.3, 1,600, was well below the range of data used to build the model (Figure 58).

McNeil Chum Salmon

The age-0.3 curve has an optimum escapement estimate of 10,200, below the existing range (Figure 59). The age-0.4 curve was not meaningful (Figure 60). There was insufficient data to build Ricker curves for ages 0.2 and 0.5.

Presently, the lower end of the goal, 20,000, is used if spawning above the falls is minimal. If large numbers of spawners move above the falls, then the upper end of the range, 40,000, is used.

Cottonwood-Iniskin Chum Salmon

The age-0.2 Ricker curve was not meaningful (Figure 61). The age-0.3 Ricker curve has an optimum escapement estimate of 9,900, well below the existing goal of 20,000 (Figure 62). The age 0.4 Ricker estimate, 6,700, was also considerable less than the existing goal (Figure 63).

DISCUSSION

Ricker Curve Optimum Escapement Estimates

The suitability of Ricker curves to estimate optimum escapement have not been demonstrated for Lower Cook Inlet salmon stocks. Indeed, the Ricker model performance as a predictor of pink salmon returns was inferior when compared to a noncompensatory (linear) model (Yuen 1989). However, the procedure of estimating an optimum escapement simply from spawner-return data has been well documented for the Ricker curve. On the other hand, linear models with only one independent variable, such as the one presently used to forecast returns, cannot be optimized because the model does not produce an inflection point beyond which rate of return is diminished.

This study did not consider other variables that may influence optimum escapement such as the environment (e.g., cold winter temperatures, warm summer temperatures, freshwater discharge); interaction between brood years (e.g., spawning activity of large escapements washing the gravel of silt, which in turn would enhance the production of subsequent runs or two large outmigrations competing with each other in the estuary); spawning ground behavior (e.g., upstream versus intertidal spawning given certain conditions); economics (e.g., different ex-vessel values for different species where two species overlap, change in market prices due to supply and demand); tradeoffs between stocks (e.g., where two stock of disparate absolute abundances overlap); and risk aversion (of run failure). The Ricker curves were presented only to show where there was some support for the existing goals and where additional research was required.

Escapement Data

The data used in this report were from a readily available publication, the Annual Management Report series. The reader should be aware that the entire Lower Cook Inlet salmon escapement data base is presently being reviewed and the Ricker curves in this report may change as a consequence.

Periodic stream surveys were employed in Lower Cook Inlet to obtain the data to estimate total escapement. The pink and chum salmon escapement estimates used in this study were assumed to be estimates of total annual escapement. If they were later found to be indices, e.g., peak survey counts, then the corresponding Ricker curves would have to be recalculated. Peak escapement is a fraction of total escapement. Total returns (i.e., catch plus escapement) cannot be related to indices of escapement, because there is no common unit of measure.

Stream of Origin

Mixed stock catches cannot be avoided in many harvest areas. In this report, escapement ratios were used to estimate streams of origin so stock-specific spawner-return data could be obtained. Other means of estimating stock composition may be appropriate but have not been tested. Some examples of other means are differences in body size reported on the fish tickets and area specific harvest records. Applicable mixed stock harvest areas for sockeye are Delight-Desire Lakes (separate by Statistical Areas 232-23 and 232-26) and like-wise chum Douglas River-Silver Beach (separate by differences in body size) Ursus-Rocky Cove (separate by Statistical Area 249-80 and 249-73) Cottonwood-Iniskin Bay separate by Statistical Area 249-83 and 249-85).

Catch Sampling Priorities

If sockeye and chum salmon escapement goals are to be evaluated on the basis of spawner-return relationships, then the collection of sockeye and chum AWL samples should be maintained annually because it takes at least 3 consecutive years of data to estimate the total returns from a single brood year (for sockeye, 4 for chum). Such data does not exist for Lower Cook Inlet. Furthermore, AWL catch sampling should be initiated for all streams with escapement goals that do not have any existing catch sampling data. These streams are Kamishak-Douglas for sockeye salmon and Port Graham, Dogfish, Rocky River, and Nuka Bay for chum salmon. While having AWL data from all of the streams with escapement goals is preferred, two streams may be assigned a lower catch sampling priority for various reasons: Anderson Bay (very small annual run size) for sockeye salmon and Douglas Main Left (siltation, flooding, beaver dams, and glacial water have eliminated spawning in this stream) for chum salmon.

Presently, hatchery returns of sockeye salmon are sampled in China Poot, Chenik, and Resurrection Bays because they constitute the bulk of the sockeye harvest. Although there is a need to monitor hatchery returns to evaluate hatchery production it should not be at the expense of collecting wild stock data.

Scheduled Formal Review of Escapement Goals

The Ricker curves in this report were not intended to be and should not be used as a formal review. All of the escapement goals should be rigorously reviewed when the Lower Cook Inlet escapement data base is more complete. However, the formal review for sockeye and chum salmon may have to be delayed until additional sockeye and chum salmon age composition data are collected.

For sockeye salmon, seven consecutive years of sampling is required to obtain five complete data sets (i.e., ages 4, 5, and 6). Lower Cook Inlet has no complete sockeye salmon data sets, i.e., total return from a single brood year escapement. Sockeye salmon age composition data has not been collected from a single area for at least 3 consecutive years. However, for Nuka Bay, Aialik, and Mikfik, there are 2 consecutive years of age composition data that began in 1988. If we continue to collect age composition data annually from these systems, the first complete return-from-escapement data set will be available in 1990. The fifth complete data set will be available in 1994.

For chum salmon, eight consecutive years of sampling is required to obtain five complete data sets (i.e., ages 3, 4, 5, and 6). Lower Cook Inlet has only one chum salmon data set with 3 consecutive years of age composition (McNeil River between 1975 and 1977). Essentially, all chum salmon system sampling would have to be reinitiated. Chum salmon catch samples were not collected in 1989 and 1990 because there was significant harvest.

Considering the cost of obtaining samples, it might be advisable to select a few streams for a formal review every 10 years. That way, if funds are limited, then the priority catch samples would be determined in part by the streams whose escapement goals are being evaluated during that decade.

Meanwhile, there are several pink salmon stocks where additional data is needed. Resurrection Bay had data for only three odd-numbered years. Two additional odd-year cycles should be completed by 1993, when a Ricker curve for the odd-year data escapement goal could be made. In Port Chatham, there is no way to determine when the next escapement of less than 3,500 would occur, providing the fifth data point.

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Table 1. Inventory of catch and escapement data, existing escapement goals, and Ricker curves for Lower Cook Inlet pink salmon.

Catch Area	Spawning Stream	Escapement Goal	Ricker Curve	Remarks
Humpy Creek	Humpy Creek	yes	yes	
Halibut Cove			no	hatchery release
Tutka Bay	Tutka Lagoon	yes	no	mixed with hatchery return
Seldovia Bay	Seldovia Creek	yes	yes	
Port Graham	Port Graham	yes	yes	
Dogfish Bay	Dogfish Lagoon	no	yes	pink harvest bycatch of chum harvest
Pot Chatham	Port Chatham streams	yes	yes	
Windy Bay	Windy Creek Left	yes	yes	stream of origin estimated from
	Windy Creek Right	yes	yes	escapement ratios
Rocky Bay	Rocky River	yes	yes	
Port Dick Bay	Port Dick Creek	yes	yes	stream of origin estimated from
	Island Creek	yes	yes	escapement ratios
Nuka Island	South Nuka Island	yes	yes	
East Nuka Bay	Desire Lake Creek	yes	yes	stream of origin estimated from
	James Lagoon	yes	yes	escapement ratios
Resurrection Bay	Bear Creek	yes	yes	spawning streams lumped together
	Salmon Creek	yes		
	Mayor Creek	yes		
	Clear Creek	yes		
	Thumb Cove	yes		
	Humpy Cove	yes		
	Tonsina Creek	yes		
Bruin Bay	Amakdedori Creek	yes	yes	
	Bruin Bay River	yes		
Rocky & Ursus Cove	Sunday Creek	yes	yes	streams of origin estimated from
	Brown's Peak Creek	yes	yes	escapement ratios
Iniskin-Cottonwood		no	no	interception catch
Miscellaneous	China Poot Bay	yes	no	no discrete catch
	Barabara Creek	yes	no	no discrete catch
	Aialik Lagoon	yes	no	no discrete catch
	Big Kamishak River	yes	no	no discrete catch
	Little Kamishak River	yes	no	no discrete catch

Table 2. Inventory of catch and escapement data, existing escapement goals, AWL data, and Ricker curves, for Lower Cook Inlet sockeye salmon.

Catch Area	Spawning Stream	Escapement Goal	AWL Data/ Ricker Curve	Remarks
Resurrection Bay	Bear Lake	yes	no	hatchery release
Aialik Bay	Aialik Lake	yes	yes	
Nuka Bay	Delight Lake	yes	yes	1 year Delight Lake escapement samples, remainder are catch samples
	Desire Lake	yes		
Humpy Creek		no	no	interception catches
Tutka Bay		no	yes/no	interception catches
Seldovia Bay		no	yes/no	interception catches
Port Graham	English Bay	yes	yes/no	insufficient data for Ricker Curve
Kamishak-Douglas	Kamishak River	yes	no	
	Douglas River	yes	yes/no	insufficient data for Ricker Curve
	Douglas Beach	yes	no	
	Amakdedori Creek	no	no	
Mikfik Creek	Mikfik Lake	yes	yes/no	insufficient data for Ricker Curve[a]
Chenik Creek	Chenik Lake	yes	yes/no	hatchery release
Miscellaneous	Anderson Bay	yes	no	
Miscellaneous				AWL samples from China Poot, Kasitsna, and McDonald Spit

[a] Do not use catch data prior to 1982 as they are mixed stock estimates.

Table 3. Inventory of catch and escapement data, existing escapement goals, AWL data, and Ricker curves for Lower Cook Inlet chum salmon.

Catch Area	Spawning Stream	Escapement Goal	AWL Data/ Ricker Curve	Remarks
Tutka		no	yes/no	1 year AWL data, no escapement data
Port Graham	Port Graham	yes	no	
Dogfish	Dogfish Lagoon	yes	no	
Port Chatham		no	no	
Rocky-Windy	Windy Creek Right	no	no	
	Windy Creek Left	no		
	Rocky River	yes		
Port Dick	Port Dick	yes	yes/no	insufficient data for Ricker curve
	Island creek	yes		
Nuka Bay	Petrof River	yes	no	
Resurrection	Tonsina creek	no	yes/no	no escapement data
Douglas River	Silver Beach streams	no	yes/no	no escapement data
	Main Left streams	yes		
Kamishak River	Big Kamishak	yes	yes/no	insufficient data for Ricker curve
	Little Kamishak	yes		
McNeil River	McNeil River	yes	yes	
Bruin	Bruin River	yes	no	
Ursus-Rocky Coves	Sunday creek	no	yes/no	Insufficient data for Ricker curve. Spawning streams lumped together. 1 year Sunday Creek AWL data, but not used in forecast model.
	Ursus Cove streams	yes		
Cottonwood-Iniskin	Cottonwood Creek	yes	yes	spawning streams lumped together
	Iniskin River	yes		
Miscellaneous			no	

Table 4. Definition of odd, even, peak, and off-cycle-years for pink salmon.

Location	Cycle (brood year)	Remarks
Humpy Creek	>40K escapement:62,70-71,75,77-81,83-86 <40K escapement:60,61,63-69,72-74,76,82	Right fork used only when escapements exceed 40,000, thus definition of peak-year.
Seldovia	even 60-68,84-86 odd 69-83	Mostly Intertidal spawning. No relationship between escapement size and cycle.
Port Graham	even 60-68 odd 71-79 peak 70,80-82,84-86 off-cycle 69,83	Mostly Intertidal spawning. Peak escapement are greater than 7,000.
Port Chatham	odd 61-79 peak 80-81,84-86 off-cycle 82	Some upstream spawning during peak-years. During off years, escapements less than 3,500.
Windy Left	even 60-66 odd 67-85	Upstream spawning during large escapement. 6,000-13,000 appear to be between peak and off year escapement.
Windy Right	even 62-66 odd 67-85 peak 60,61	3,000-5,000 appear to be between peak and off year escapement.
Rocky River	even 60-70,84-86 odd 82-83	Intertidal spawning only. 12,000 appear to be between peak and off year escapement. Some spawners in left stream. Main stream changed from flooding because of logging. No longer used by spawners.
Pt Dick	even 60-68 odd 71-85 peak 65,84,86 off-cycle 69,70	During years of large escapement, intertidal spawning observed in Middle, and Right (Slide) plus upstream spawning in Port Dick (Head End) Creek. Off cycle escapement 26,000-120,000; peak escapement 1,000-60,000.
Island Creek	even 60-70 off-cycle 71-80 peak 81-86	During years of large escapement, intertidal spawning observed in Middle, Right (Slide), and Island Creek. Off cycle escapement 100-3,600; peak escapement 4,300-35,000.
South Nuka Island	even 72-82 odd 71-81	Even year returns between 100 and 11,000. Odd year returns between 22,000 and 260,000.
East Nuka Bay	all 71-86	No discernable dominant year pattern.
Resurrection Bay (w/out Aialik)	even see remarks odd see remarks	Even year spawn mainly upstream in inner bay (Salmon, Bear). Odd year spawn mainly intertidal in outer bay (Thumb's Cove, Tonsina). Negligible spawning in Mayor, Clear, Humpy.
Bruin Bay	>50K escapement:60,62,70,79,80-82,84,86 <50K escapement:63-64,66-67,69,71-78,83,85	Mostly upstream spawning. No long term cycle observed. Escapements greater than 110,000 appear to NOT to replace itself. Spawners greater than 50,000 use areas subject to freezing.

-continued-

Table 4 (page 2 of 2).

Location	Cycle (brood year)	Remarks
Ursus & Rocky Cove	odd 71-81 even 82-86 off-cycle 69	Mostly upstream spawning. Peak-year escapement appear to be greater than 8,000.

Note: Even year cycle is a pattern of large escapement followed by a return of corresponding size during even numbered years.

Odd year cycle is a pattern of large escapement followed by a return of corresponding size during odd numbered years.

Peak escapement, in the absence of odd-even year cycle or when cycle is in transition, are those within or above the range observed for odd-even year escapements.

Off-cycle escapement, in the absence of odd-even year cycle or when cycle is in transition, are those below the range observed for odd-even year escapements.

Humpy Creek and Bruin Bay peak escapement based on spawning area.

Resurrection Bay odd-even cycle based on geography.

Table 5. Historical pink salmon escapement and percentage of intertidal spawning.

	Humpy Creek		Seldovia		Port Graham		Windy Left		Windy Right		Port Dick		Island Creek	
Year	No. Spawners	% Intertidal	No. Spawners	% Intertidal	No. Spawners	% Intertidal	No. Spawners	% Intertidal	No. Spawners	% Intertidal	No. Spawners	% Intertidal	No. Spawners	% Intertidal
70			23,000	68.69							34,500	33.36		
71					13,200	38.05	35,400	28.70	13,000	34.09	97,800	30.99		
72					2,400	6.88							1,700	65.07
73			14,500	66.30	7,000	12.35								
74	17,400	12.66	13,700	56.34	2,800	20.31								
75	64,000	8.04	36,200	36.07	27,300	39.64	9,700	64.83					100	8.65
77	86,000	16.95	35,700	81.10	20,600	67.29	47,300	33.62	11,100	56.58				
78			24,600	74.48	6,700	16.24								
81			62,700	61.01	18,400	61.94	31,300	2.90	4,700	38.83			25,000	91.36
82			38,400	61.93	28,900	65.73	4,400	40.93	4,700	43.27	19,900	93.52	15,000	89.42
83	104,000	5.73	27,900	50.44	4,600	57.99	11,900	7.60	4,300	42.99			15,300	86.59
84	84,200	13.83	14,200	69.92	10,900	67.83	2,500	56.12	3,400	81.43			35,000	73.51
85	117,000	8.8	22,800	64.97	26,300	56.50	8,900	35.57	5,400	51.85	65,300	61.47	27,900	83.76
86	49,700	25.27	28,200	67.36	17,500	66.01	2,200	54.07	2,500	87.06	41,600	89.11	16,600	89.29
87	26,600	16.34	7,600	81.01	3,800	54.56	5,600	34.27	2,000	47.52	4,500	79.60	100	76.92
88	21,400	25.83	16,900	80.48	7,900	69.55	3,400	53.09	1,300	86.25	12,000	98.12	7,200	79.43
89		10.03		59.47		51.41		19.00		72.94		86.51		46.74
avg		13.04		65.06		47.02		35.89		58.44		77.05		71.89
r^2		0.34		0.11		0.23		0.25		0.27		0.48		0.24
d.f.		7		12		13		9		8		5		8

Table 6. History of Lower Cook Inlet pink salmon escapement goals.

Location	Year	Low	High	Remarks
SOUTHERN DISTRICT				
Humpy	70[a]	22,500	30,000	
	75[b]		30,000	No range presented.
	77,79-81[d,e,f,g]	22,500	30,000	
	82-89[h,i,j,k,l,m,n,o]	25,000	50,000	Manager felt old escapement range low for stream spawning potential. (Schroeder, personal communication)
Tutka	70[a]	4,500	6,000	
	75[b]		7,000	No range presented.
	77,79-81[d,e,f,g]	4,500	7,000	Could not find explanation for revision.
	82-89[h,i,j,k,l,m,n,o]	6,000	10,000	Manager felt escapement range low for stream spawning potential (Schroeder, personal communication).
Seldovia	70[a]	18,000	24,000	
	75[b]		24,000	No range presented.
	77[d]	18,000	24,000	
	79-81[e,f,g]	24,000	30,000	Could not find explanation for revision.
	82-89[h,i,j,k,l,m,n,o]	25,000	35,000	Manager felt escapement range low for stream spawning potential (Schroeder, personal communication).
Port Graham	70[a]	45,000	60,000	
	75[b]		60,000	No range presented.
	77,79-81[d,e,f,g]	20,000	40,000	Could not find explanation for revision.
	82[h]	20,000	30,000	30,000 is a typographical error in ADF&G 1982b. Should be 40,000 (Schroeder personal communications).
	83-89[i,j,k,l,m,n,o]	20,000	40,000	Could not find explanation for revision.
China Poot	82-89[h,i,j,k,l,m,n,o]		5,000	
Barabara	82-89[h,i,j,k,l,m,n,o]	18,000	24,000	
OUTER DISTRICT				
Port Chatham	82-89[h,i,j,k,l,m,n,o]	10,000	15,000	

-Continued-

Table 6. (page 2 of 4)

Location	Year	Low	High	Remarks
Rocky	70[a]	37,500	50,000	
	75[b]		50,000	No range presented.
	77[d]	35,000	50,000	Uncertain if 35,000 was a typographical error or not.
	79-81[e,f,g]	37,500	50,000	
	82-89[h,i,j,k,l,m,n,o]	50,000		Lower range dropped, manager felt too low for stream spawning potential. (Schroeder, personal communication)
Windy Creek L	70[a]	7,500	10,000	
	75[b]		10,000	No range presented.
	77[d]	7,500	10,000	
	79-81[e,f,g]	7,500	10,000	Alternate range of 25,000-35,000 for years where large numbers of upstream spawners return.
	82-89[h,i,j,k,l,m,n,o]	30,000	50,000	Manager felt escapement range low for stream spawning potential. (Schroeder, personal communication)
Windy Creek R	70[a]	7,500	10,000	
	75[b]		10,000	No range presented.
	77,79-81[d,e,f,g]	7,500	10,000	
	82-89[h,i,j,k,l,m,n,o]	10,000		Lower range dropped, manager felt too low for stream spawning potential. (Schroeder, personal communication)
Port Dick	70[a]	22,500	30,000	
	75[b]		30,000	No range presented.
	77[d]	22,000	30,000	Uncertain if 22,000 was a typographical error.
	79-81[e,f,g]	22,500	30,000	Alternate range of 70,000-100,000 for years with large upstream escapement.
	82-89[h,i,j,k,l,m,n,o]	20,000	100,000	Manager felt escapement range low for stream spawning potential. (Schroeder, personal communication)
Island Creek	70[a]	18,000	24,000	
	75[b]		24,000	No range presented.
	77,79-81[d,e,f,g]	10,000	15,000	Could not find explanation for revision.
	82-89[h,i,j,k,l,m,n,o]	12,000	18,000	Manager felt escapement range low for stream spawning potential. (Schroeder, personal communication)
South Nuka Island	82-89[h,i,j,k,l,m,n,o]	10,000		
Desire lake	86-89[l,m,n,o]	10,000	20,000	
James Lagoon	86-89[l,m,n,o]	5,000	10,000	

-Continued-

Table 6. (page 3 of 4)

Location	Year	Low	High	Remarks
KAMISHAK DISTRICT				
Big Kamishak	82-89[h,i,j,k,l,m,n,o]	20,000		
Little Kamishak	82-89[h,i,j,k,l,m,n,o]	20,000		
Amakdedori	82-89[h,i,j,k,l,m,n,o]	5,000		
Bruin Bay	75[b]	25,000		
	82-89[h,i,j,k,l,m,n,o]	25,000	50,000	Could not find explanation for revision.
Sunday Creek	?		50,000	Schroeder (Personal Communications)
	75[b]		30,000	See text for revision rationale.
	82-88[h,i,j,k,l,m,n]	10,000		Could not find explanation for revision
	89[o]	10,000	20,000	Manager felt escapement range low for stream spawning potential. (Schroeder, personal communication)
Brown's Peak	82-88[h,i,j,k,l,m,n]	10,000		
	89[o]	10,000	20,000	Manager felt escapement range low for stream spawning potential. (Schroeder, personal communication)
EASTERN DISTRICT				
Aialik	86-89[l,m,n,o]	5,000		
Bear Creek	76[c]	4,000	5,000	
	82-89[h,i,j,k,l,m,n,o]	5,000		Not reported in ADF&G 1982b and 1982c.
Salmon Creek	76[c]	5,000	10,000	
	82-89[h,i,j,k,l,m,n,o]	10,000		Not reported in ADF&G 1982b and 1982c.
Mayor Creek	76[c]	1,000	2,000	
	82-89[h,i,j,k,l,m,n,o]	2,000		Not reported in ADF&G 1982b and 1982c.
Clear Creek	76[c]	1,000	2,000	
	82-89[h,i,j,k,l,m,n,o]	2,000		Not reported in ADF&G 1982b and 1982c.
Thumb Cove	76[c]	500	1,000	
	82-84[h,i,j]	1,000		Not reported in ADF&G 1982b and 1982c.
	85-89[k,l,m,n,o]	4,000		Manager felt that spawning goal was low for stream spawning potential. (Schroeder, personal communication)

-Continued-

Table 6. (page 4 of 4)

Location	Year	Low	High	Remarks
Humpy Cove	76[c]	500	1,000	
	82-89[i,j,k,l,m,n,n,o]	2,000		Not reported in ADF&G 1982b and 1982c.
Tonsina Creek	76[c]	2,000	3,000	
	82-89[i,j,k,l,m,n,n,o]	5,000		Not reported in ADF&G 1982b and 1982c.
Airport Creek	76[c]	300	400	
Grouse Creek	76[c]	1,000	2,000	

[a] Davis and Valentine 1970.
[b] 75 BOF (ADF&G 1975).
[c] 76 BOF (ADF&G 1976).
[d] 77 BOF (ADF&G 1977)
[e] 79 BOF (ADF&G 1979).
[f] 80 BOF (ADF&G 1980) and 80 AMR "index stream table" (ADF&G 1982b).
[g] 81 BOF (ADF&F 1981) and 81 AMR "index stream table" (ADF&G 1982c).
[h] 82 BOF (ADF&G 1982a), "escapement goal tables" in the 80 and 81 AMR (ADF&G 1982b and 1982c), and 82 AMR (ADF&G 1983).
[i] 83 BOF (ADF&G 1984a) and 83 AMR (ADF&G 1985c).
[j] 84 BOF (ADF&G 1984b) and 84 AMR (ADF&G 1985d).
[k] 85 BOF (ADF&G 1985f), "escapement goal table" in the 85 AMR (ADF&G 1985e), and the "escapement goal tables" except for Thumb Cove in the 76-77, 78-79, and 84 AMR (ADF&G 1985a, 1985b, and 1985d).
[l] 86 BOF (ADF&G 1986), 86 AMR (ADF&G 1987a), and 85 AMR (ADF&G 1985e sic).
[m] 87 AMR (ADF&G 1987b sic).
[n] 88 BOF (Schroeder and Morrison 1988) and 88 AMR (Schroeder and Morrison 1989).
[o] 89 AMR (Schroeder and Morrison 1990).

Table 7. History of Lower Cook Inlet sockeye salmon escapement goals.

Location	Year	Low	High	Remarks
SOUTHERN DISTRICT				
English Bay	82-89[a,b,c,d,e,f,g,h]	10,000	20,000	
OUTER DISTRICT				
Delight Lake	82-89[a,b,c,d,e,f,g,h]		10,000	
Desire Lake	82-89[a,b,c,d,e,f,g,h]		10,000	
Anderson Beach	82-89[a,b,c,d,e,f,g,h]		2,000	
EASTERN DISTRICT				
Aialik Lake	82-89[a,b,c,d,e,f,g,h]	2,500	5,000	
Bear Lake	83[c]		500	Maximum, either sex. Uncertain how long this was in effect. See page 22 of 84 AMR.
	84[c]		500	Maximum 250 of each sex.
	85-89[d,e,f,g,h]		1,000	Adoption of Bear Lake Management Plan by Alaska board of Fisheries.
KAMISHAK DISTRICT				
Mikfik	82-87[a,b,c,d,e,f]	5,000		
	88[g]	5,000	7,000	Appendix 1 of 88 BOF. 5,000 was reported elsewhere in 88 BOF and AMR.
	89[h]	5,000		
Chenik	82-89[a,b,c,d,e,f,g,h]	10,000	20,000	

[a] 82 BOF (ADF&G 1982a) and 82 AMR (ADF&G 1983).
[b] 83 BOF (ADF&G 1984a) and 83 AMR (ADF&G 1985c).
[c] 84 BOF (ADF&G 1984b) and 84 AMR (ADF&G 1985d).
[d] 85 BOF (ADF&G 1985f) and 85 AMR (ADF&G 1985e) plus 76-77, 78-79 AMR except Bear Lake (ADF&G 1985a, 1985b, and 1985d).
[e] 86 BOF (ADF&G 1986) and 86 AMR (ADF&G 1987a).
[f] 87 AMR (ADF&G 1987b sic).
[g] 88 BOF (Schroeder and Morrison 1988) and 88 AMR (Schroeder and Morrison 1989).
[h] 89 AMR (Schroeder and Morrison 1990).

Table 8. History of Lower Cook Inlet chum salmon escapement goals.

Location	Year	Low	High	Remarks
OUTER DISTRICT				
Dogfish	79-81[b,c,d]	10,000	15,000	
	82-89[e,f,g,h,i,j,k,l]	5,000	10,000	Manager felt old range was high for spawning potential (Schroeder, personal communication).
Rocky	79-81[b,c,d]	20,000	40,000	Upper range when upstream spawning occurs (Schroeder, personal communication).
	82-89[e,f,g,h,i,j,k,l]	20,000		
Port Dick(Head End)	79-81[b,c,d]	4,000	5,000	Upper range when upstream spawning occurs. (Schroeder, personal communication)
	82-89[e,f,g,h,i,j,k,l]	4,000		
Island Creek	79-89[b,c,d,e,f,g,h,i,j,k,l]	10,000	15,000	May have been based on spawning area (Schroeder, personal communication)
Petrof River	82-89[e,f,g,h,i,j,k,l]	2,000	5,000	
KAMISHAK DISTRICT				
Main Left	82-89[e,f,g,h,i,j,k,l]	5,000	10,000	
Big Kamishak	79-81[b,c,d]	20,000	50,000	Upper range when upstream spawning occurs. (Schroeder, personal communication)
	82-89[e,f,g,h,i,j,k,l]	20,000		
Little Kamishak	79-81[b,c,d]	20,000	30,000	Upper range when upstream spawning occurs. (Schroeder, personal communication)
	82-89[e,f,g,h,i,j,k,l]	20,000		
McNeil-Amakdedori	75[a]	30,000		Pink salmon escapement goal?
McNeil River	79-81[b,c,d]	20,000	50,000	
	82-87[e,f,g,h,i,j]	10,000	20,000	Manager felt old range high for spawning potential. (Schroeder, personal communication)
	89-89[k,l]	20,000	40,000	Manager felt old range low for spawning potential. (Schroeder, personal communication)
Bruin River	79-81[b,c,d]	5,000	10,000	Upper range when upstream spawning occurs. (Schroeder, personal communication)

82-87[e,f,g,h,i,j]	5,000			AMR has 5,000-10,000 range while BOF has 5,000.
88-89[k,l]		5,000	10,000	88 & 89 AMR "index stream" tables also revised to 5,000-10,000.

-Continued-

Table 8. (page 2 of 2)

Location	Year	Low	High	Remarks
Ursus Cove	75[a]		37,000	Pink salmon escapement goal?
	79-81[b,c,d]	8,000	12,000	
	82-89[e,f,g,h,i,j,k,l]	5,000	10,000	Manager felt old range high for spawning potential. (Schroeder, personal communication)
Cottonwood-Iniskin	75[a]		30,000	This may have been a combined goal split equally between both streams.
Cottonwood Creek	79-81[b,c,d]	10,000	15,000	Upper range when upstream spawning occurs. (Schroeder, personal communication)
	82[d,e,f,g,h,i,j,k,l]	10,000		
Iniskin River	79-81[b,c,d]	10,000	15,000	Upper range when upstream spawning occurs. (Schroeder, personal communication)
	82-89[e,f,g,h,i,j,k,l]	10,000		No upper range reported.
SOUTHERN DISTRICT				
Port Graham	79-81[b,c,d]	4,000	5,000	
	82-89[e,f,g,h,i,j,k,l]	4,000	8,000	Manager felt old upper range too low for upstream spawning potential. (Schroeder, personal communication)

[a] 75 BOF (ADF&G 1975).
[b] 79 BOF (ADF&G 1979).
[c] 80 BOF (ADF&G 1980) and 80 AMR "index stream" table (ADF&G 1982b).
[d] 81 BOF (ADF&G 1981) and 81 AMR "index stream" table (ADF&G 1982c).
[e] 82 BOF (ADF&G 1982a), "escapement goal tables" in the 80 and 81 AMR (ADF&G 1982b and 1982c), and 82 AMR (ADF&G 1983).
[f] 83 BOF (ADF&G 1984a) and 83 AMR (ADF&G 1985c) except "index stream tables".
[g] 84 BOF (ADF&G 1984b) and 84 AMR (ADF&G 1985d) except "index stream tables".
[h] 85 BOF (ADF&G 1985f), "escapement goal table" in the 76-77, 78-79, and 85 AMR (ADF&G 1985a, 1985b, and 1985e (sic)).
[i] 86 BOF (ADF&G 1986) and 86 AMR (ADF&G 1987a) except "index stream tables".
[j] 87 AMR (ADF&G 1987b sic) except "index stream tables".
[k] 88 BOF (Schroeder and Morrison 1988) and 88 AMR (Schroeder and Morrison 1989).
[l] 89 AMR (Schroeder and Morrison 1990).

Table 9. Results from fit of Ricker's curve to pink salmon data.

Stock	Escapement Cycle	Mean Annual Return	Mean Ret/Esc Ratio	Existing Goal	Ricker Curve Results	within existing range?
Humpy Creek	all	124,304	3.63		51,900	no
	<40K	109,000	5.44	25,000	18,500	no
	>40K	141,000	1.67	50,000	n/m	n/m
Seldovia	all	86,000	3.30		33,600	yes
	off	51000	2.02	25,000	29,700	yes
	peak	114000	4.32	35,000	26,500	yes
Port Graham	all	33,000	3.10		13,900	no
	off	18,000	4.32	20,000	n/m	n/m
	peak	42,000	2.38	40,000	16,800	no
Port Chatham	all	33,425	6.27		n/m	n/m
	off	4,625	9.03	10,000	n/d	n/d
	peak	43,025	5.35	15,000	13,500	yes
Windy Left	all	43,764	3.18		38,200	yes
	off	4,915	2.14	30,000	2,000	no
	peak	79,838	4.14	50,000	30,400	yes
Windy Right	all	13,707	2.50	10,000	n/m	n/m
	off	2,251	1.94		1,000	no
	peak	22,871	2.95		n/m	n/m
Rocky River	all	42,000	2.97	50,000	11,400	no
	off	15,000	1.72		3,300	no
	peak	81,000	4.14		32,000	no
Port Dick	all	264,069	6.21		n/m	n/m
	off	73,541	4.78	20,000	20,400	yes
	peak	395,056	7.20	100,000	112,700	no
Island Creek	all	57,415	24.62		11,000	no
	off	24,103	41.98	12,000	800	no
	peak	93,503	5.81	18,000	12,400	yes
South Nuka Is.	all	64,154	7.19	10,000	n/m	n/m
	off	3,551	9.00		n/d	n/d
	peak	94,455	6.28		n/m	n/m

- continued -

Table 9. (page 2 of 2)

Stock	Escapement Cycle	Mean Annual Return	Mean Ret/Esc Ratio	Existing Goal	Ricker Curve Results	within existing range?
Desire Lake	all	60,224	5.31		12,100	yes
	off	n/d	n/d	10,000	n/d	n/d
	peak	n/d	n/d	20,000	n/d	n/d
James Lagoon	all	11,153	2.92		3,100	no
	off	n/d	n/d	5,000	n/d	n/d
	peak	n/d	n/d	10,000	n/d	n/d
Resurrection	all	75,884	5.19	35,000	17,600	no
Bay (without)	odd	71,133	8.79		n/d	n/d
Aialik Lagoon	even	77,310	4.11		19,800	no
Bruin Bay	all	154,948	4.05		47,100	yes
	<50K	62,464	4.72	25,000	15,800	no
	>50K	298,811	3.03	50,000	42,200	yes
Sunday Creek	all	25,492	6.80		17,600	yes
	off	10,197	11.71	10,000	1,600	no
	peak	33,616	3.23	20,000	17,900	yes
Brown's Peak	all	16,996	3.01		8,400	no
	off	4,317	4.05	10,000	n/m	n/m
	peak	12,913	2.52	20,000	7,700	no

note: n/m = not meaningful, e.g. curve not dome-shaped over range of observed data or optimum escapement greater than largest escapement in data set.

n/d = insufficient data for Ricker curve.

Table 10. Results of Ricker curve fit to sockeye and chum salmon data.

Species	Location	Age	Existing Goal Low	Existing Goal High	Mean Ret/Esc	Ricker Curve Result
sockeye	Aialik	total	2,500	5,000		5,800
		1.2			2.98	5,400
		1.3			2.73	6,200
		2.2			0.30	n/m
		2.3			0.42	n/m
	Nuka	total		20,000		5,100
		1.2			1.08	3,900
		1.3			7.10	5,300
		2.2			4.99	n/m
		2.3			0.69	n/m
chum	McNeil	total	20,000	40,000		10,500
		0.2			.01	n/d
		0.3			1.47	10,200
		0.4			1.60	n/m
		0.5			.15	n/d
	Cottonwood -Iniskin	total		20,000		8,900
		0.2			0.05	n/m
		0.3			2.27	9,900
		0.4			0.96	6,700
		0.5			.02	n/d

Note: total Ricker curve optimum escapement = age specific results weighted by mean return/esc ratio

Breakdown of Nuka Bay goal: Desire Lake = 10,000, Delight Lake = 10,000
Breakdown of Cottonwood-Iniskin goal: Cottonwood = 10,000, Iniskin = 10,000

n/m = not meaningful, no dome-shaped curve over range of observed data, or optimum escapement outside of data range.

n/d = not enough data for Ricker curve fit.

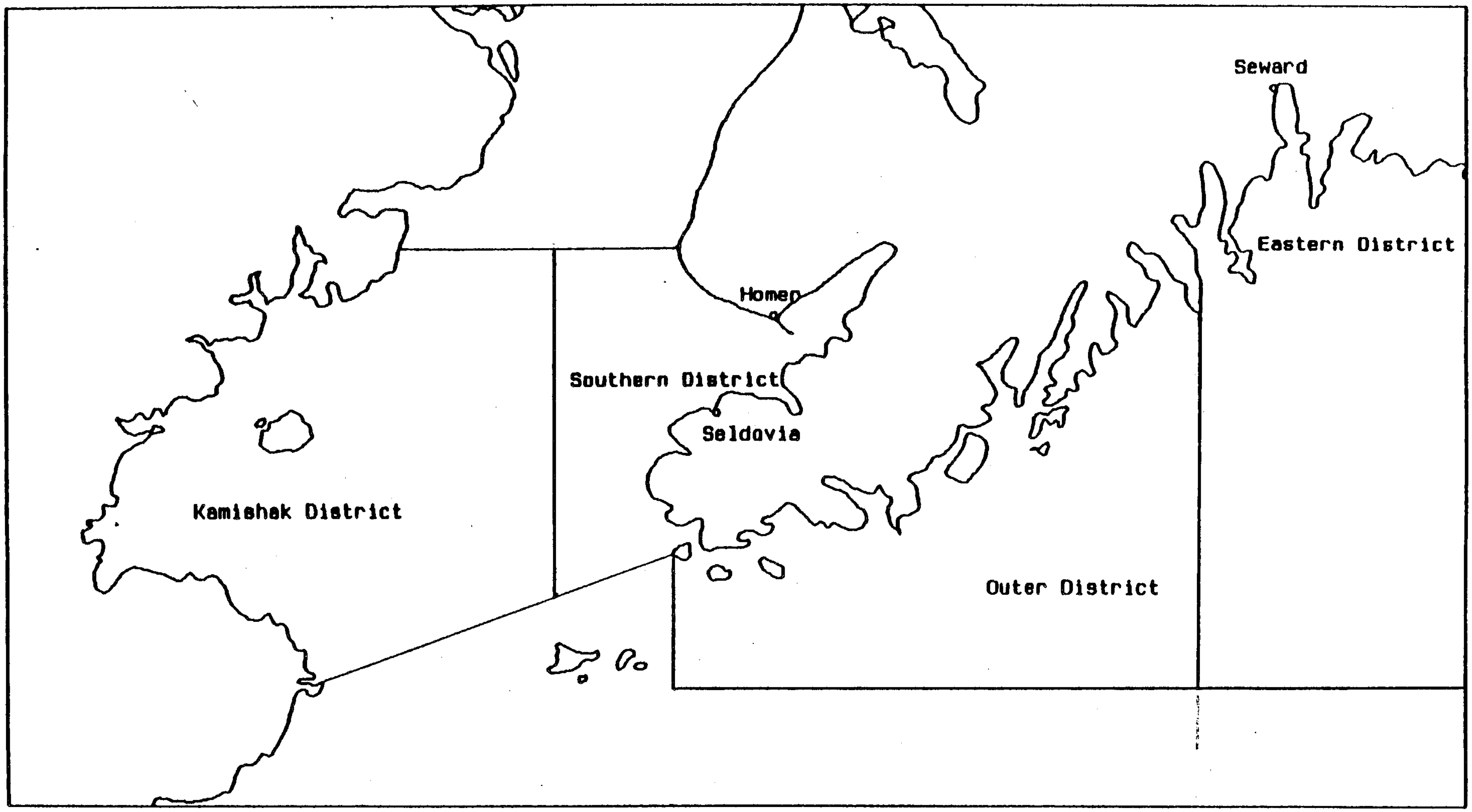

Figure 1. Kamishak, Southern, Outer, and Eastern Districts of Lower Cook Inlet Management Area.

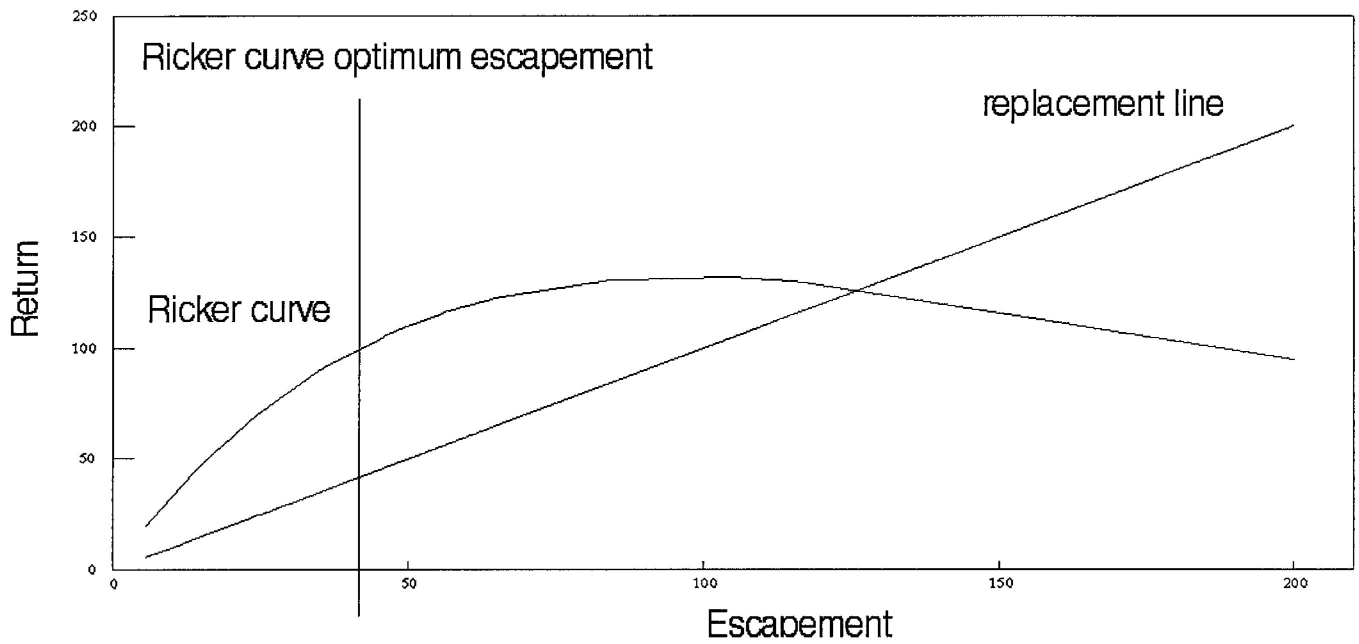

Figure 2. Ricker curve, replacement line, and optimum escapement.

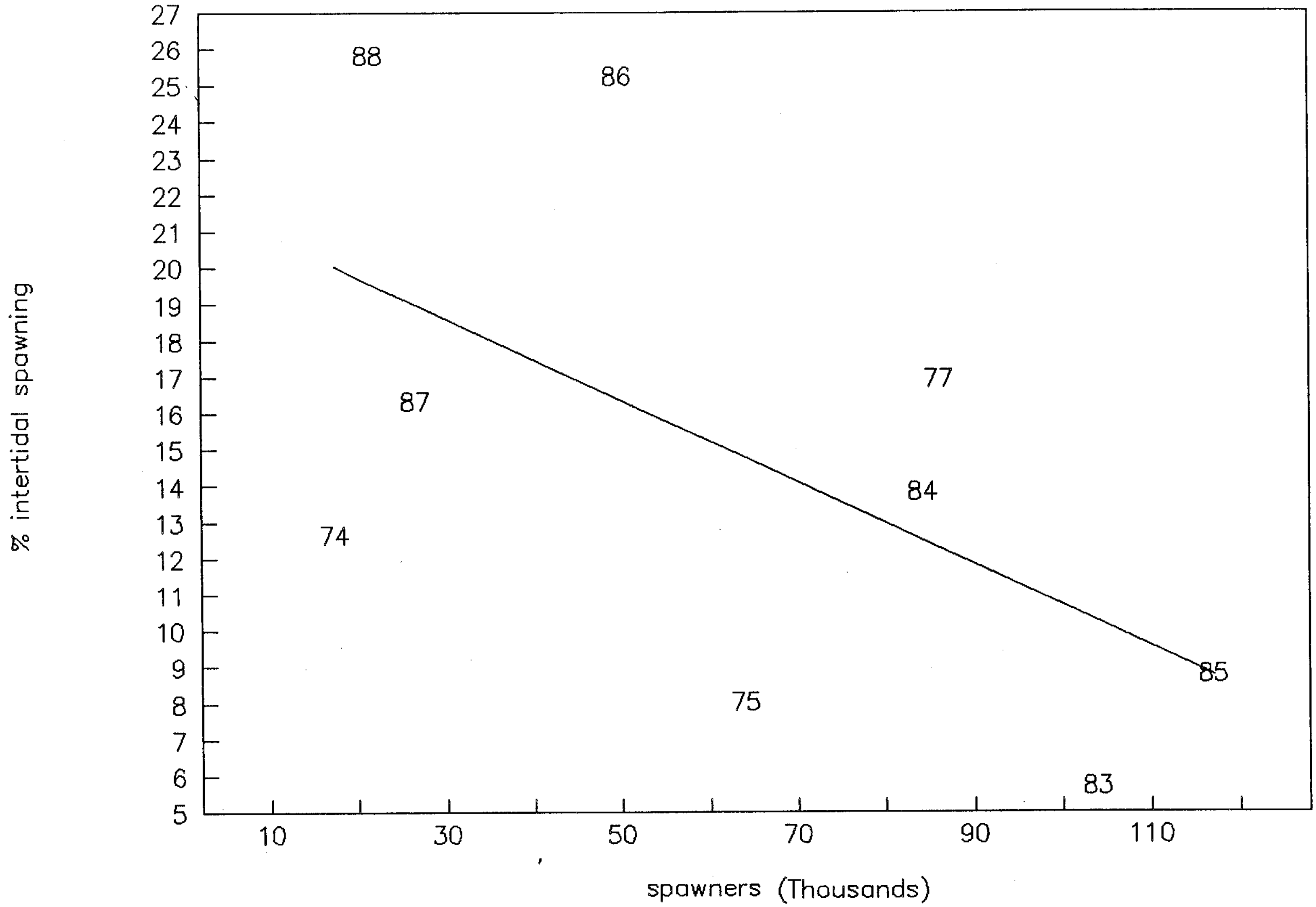

Figure 3. Humpy Creek pink salmon escapement & % intertidal spawning.

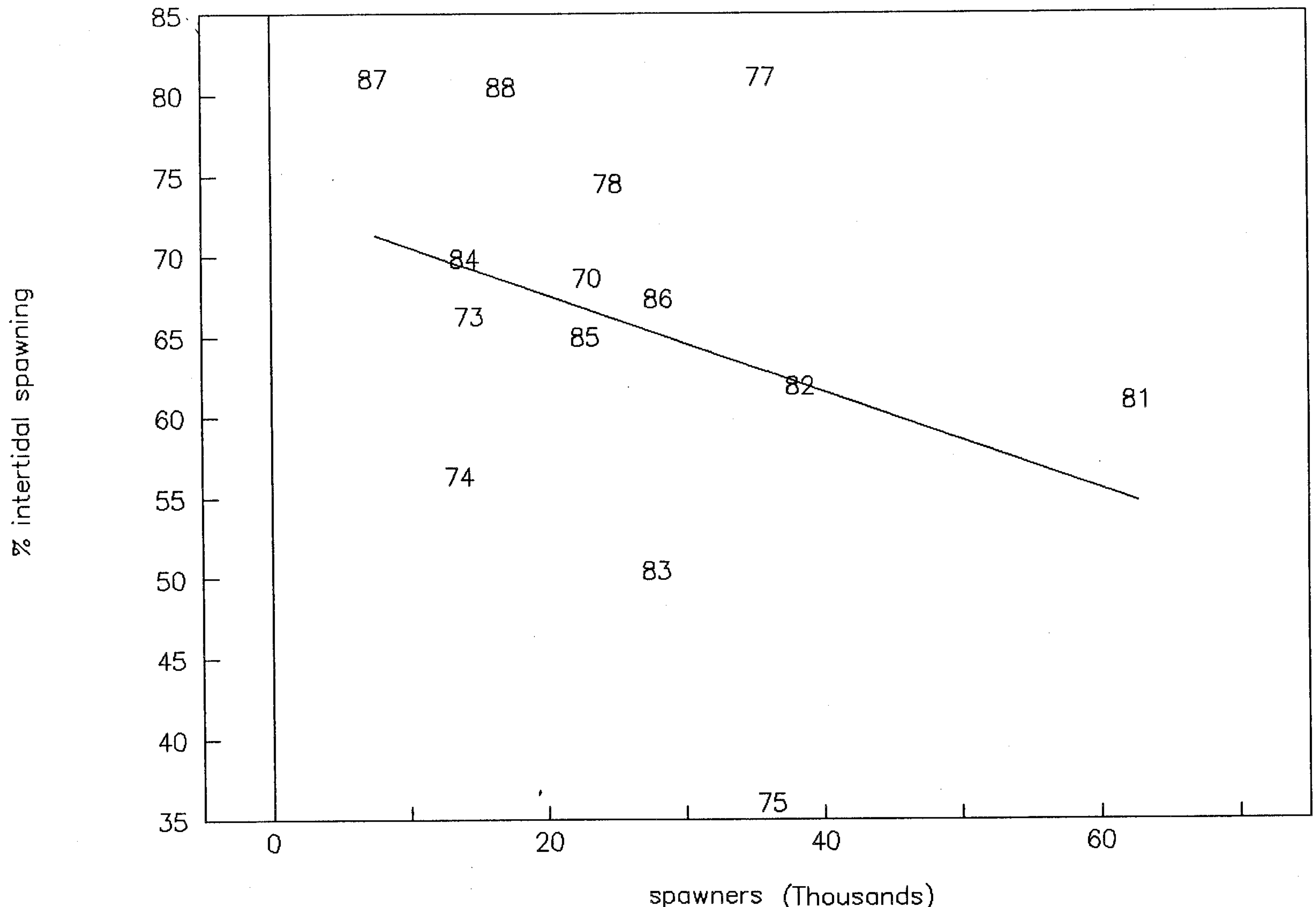

Figure 4. Seldovia pink salmon escapement & % intertidal spawning.

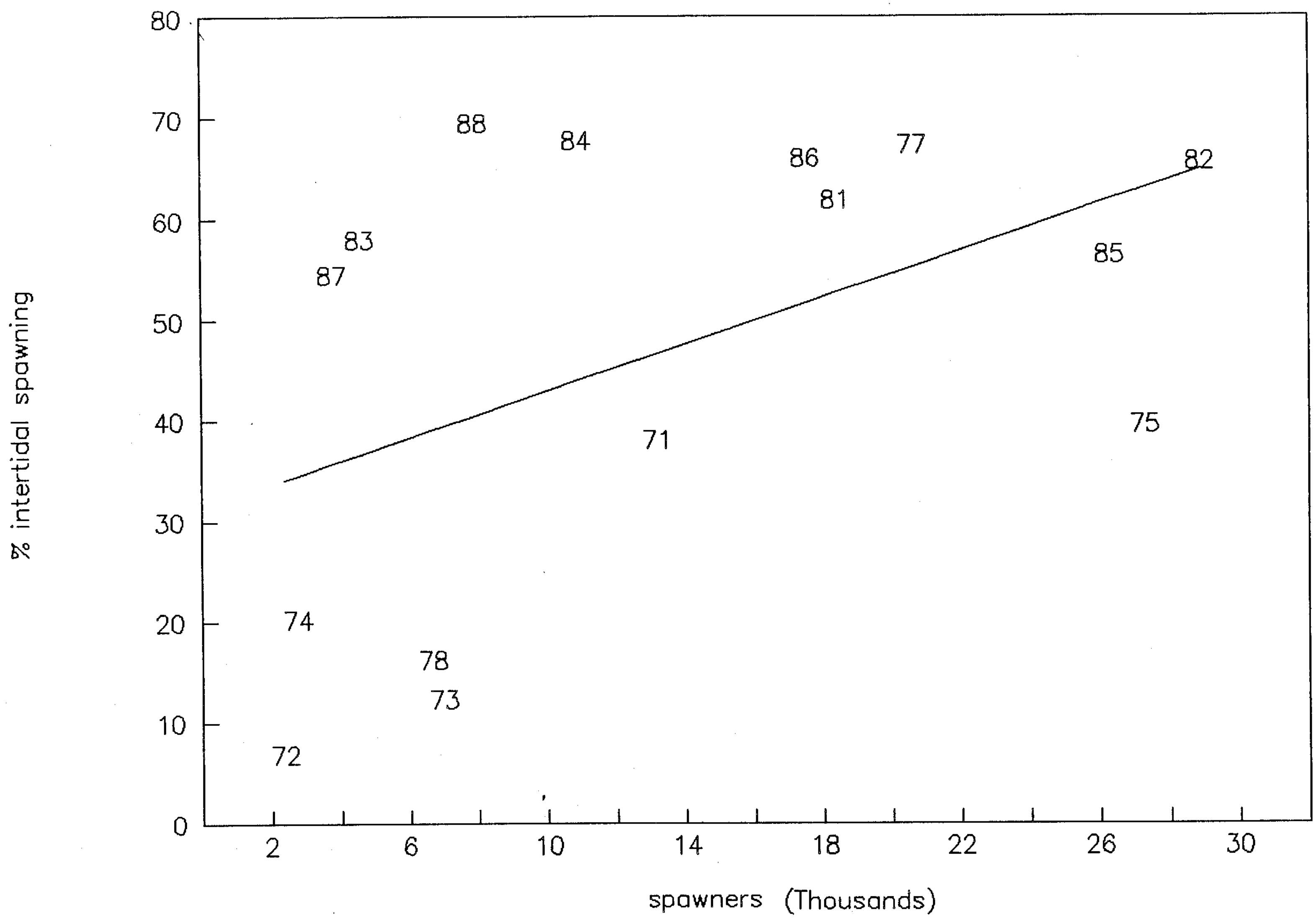

Figure 5. Pt. Graham pink salmon escapement & % intertidal spawning.

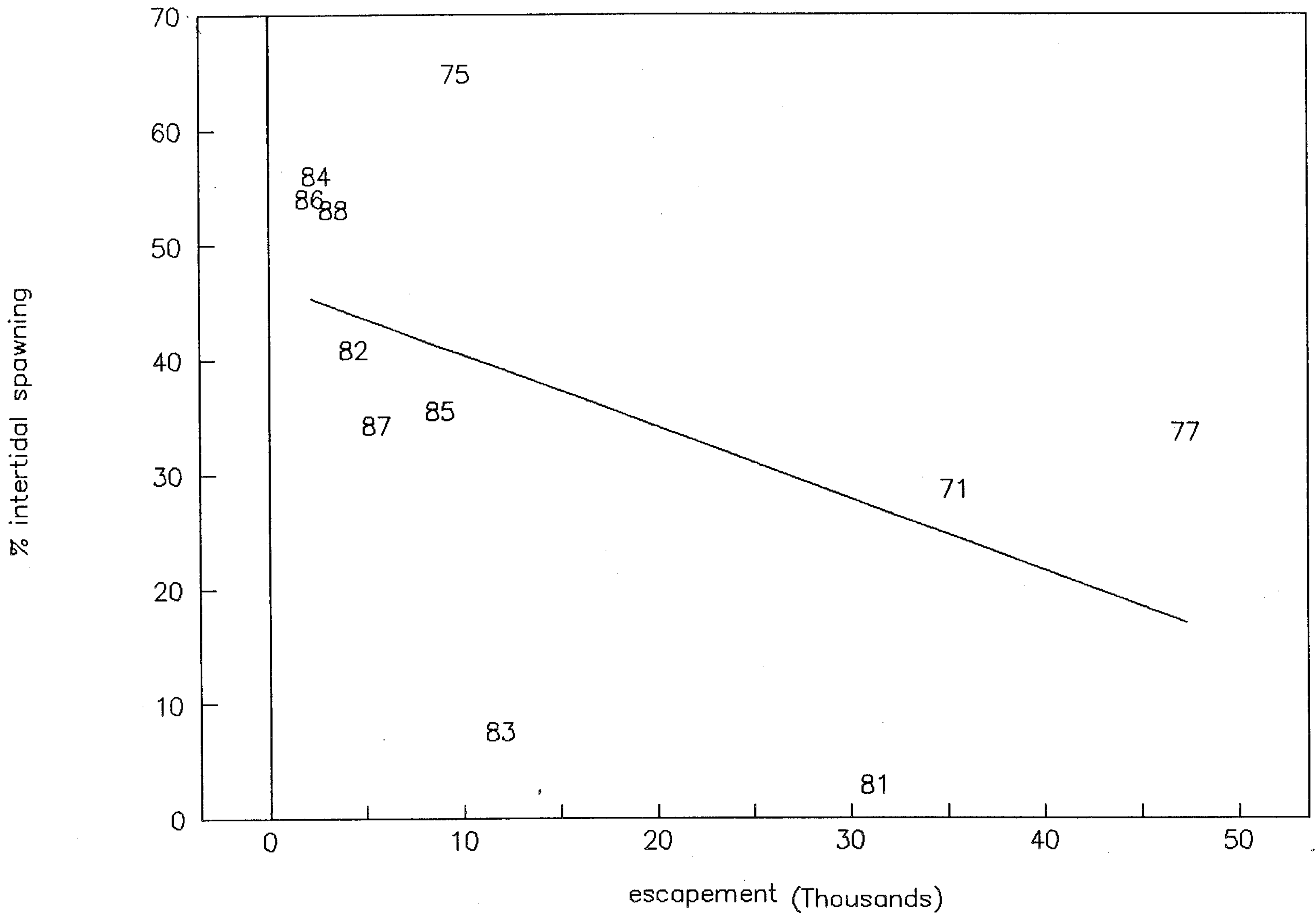

Figure 6. Windy left pink salmon escapement & % intertidal spawning.

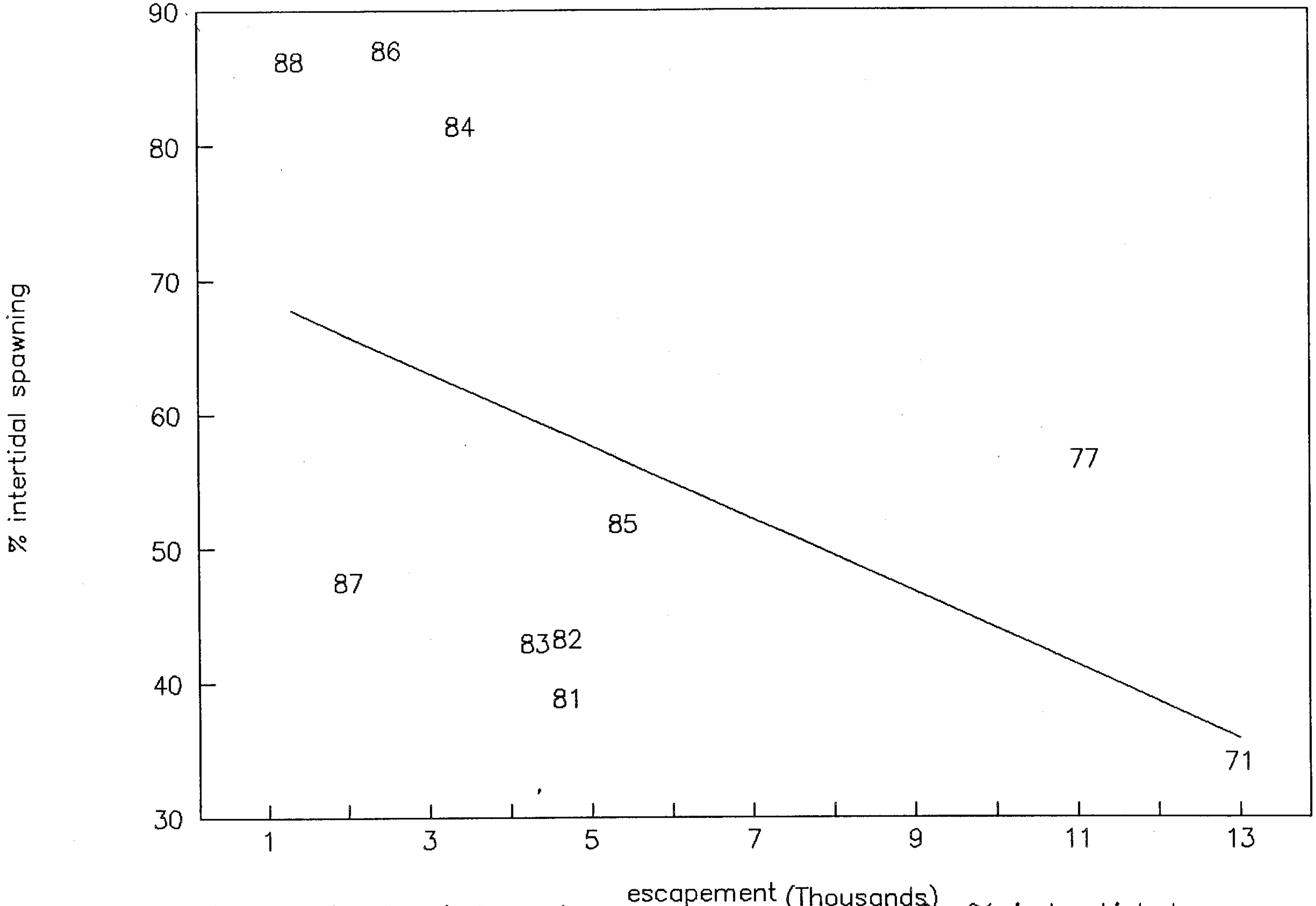

Figure 7. Windy Right pink salmon escapement & % intertidal spawning.

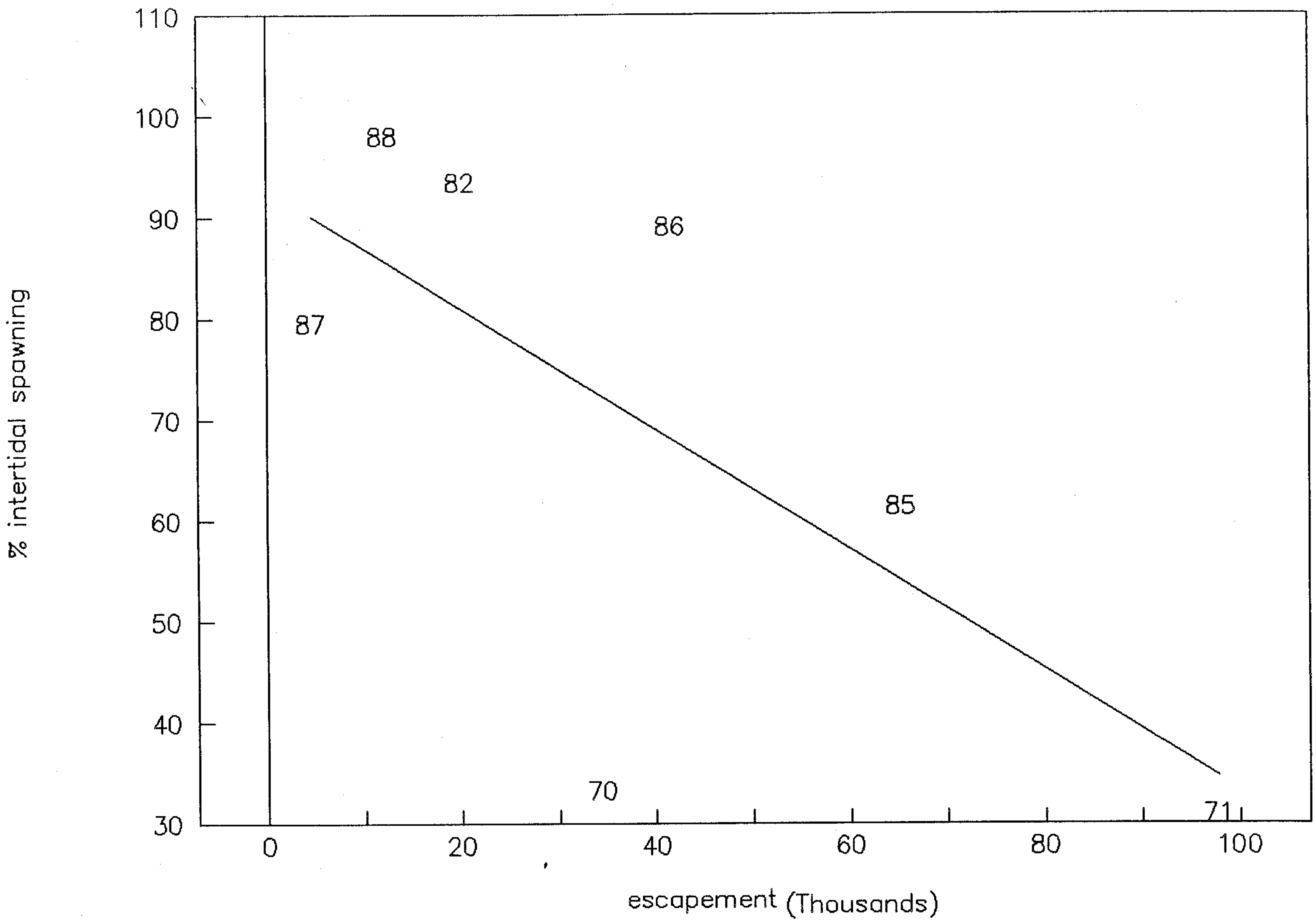

Figure 8. Pt. Dick pink salmon escapement & % intertidal spawning.

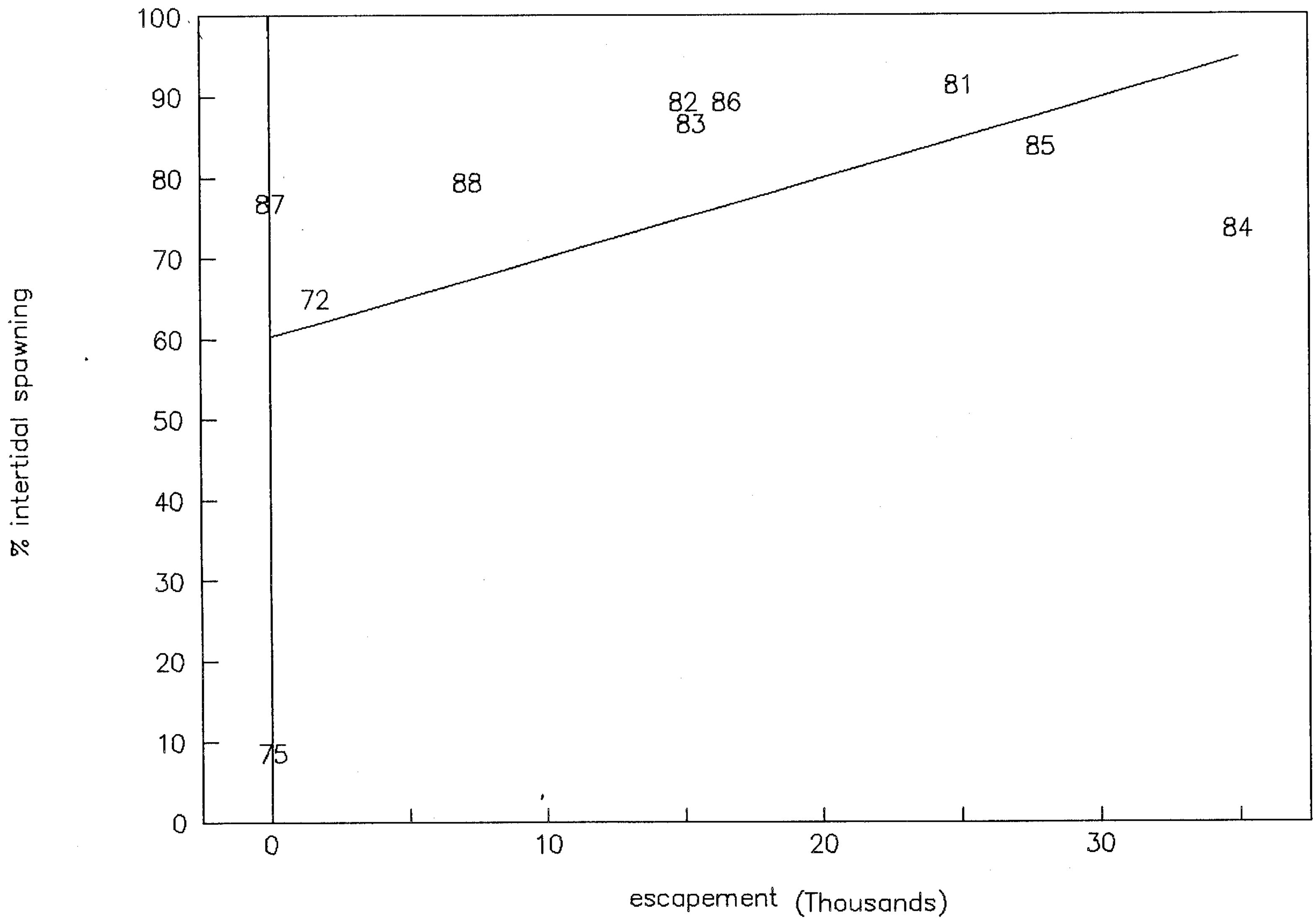

Figure 9. Island Creek pink salmon escapement & % intertidal spawning.

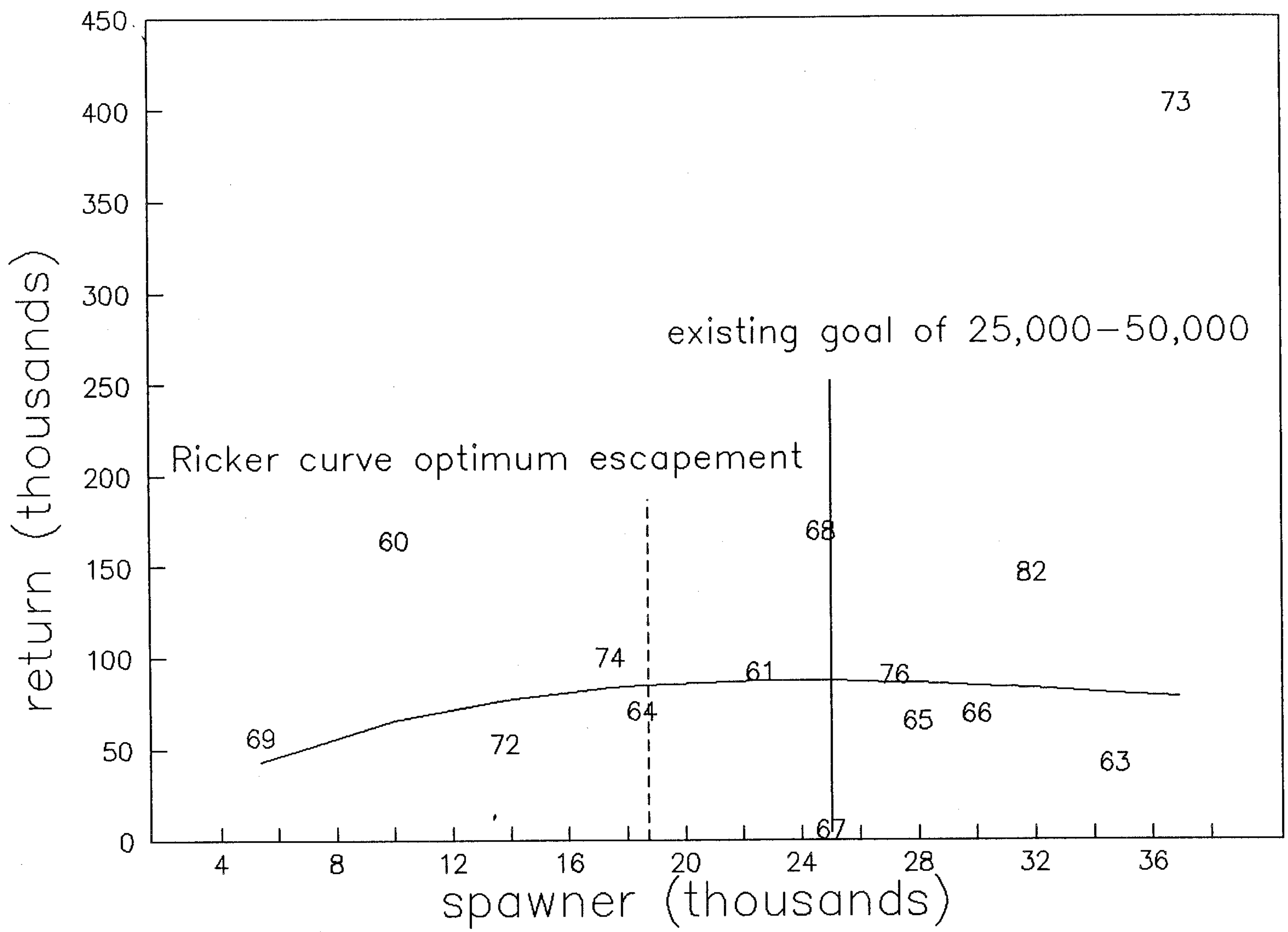

Figure 10. Humpy Creek pink salmon Ricker curve, escapement <40,000 only.

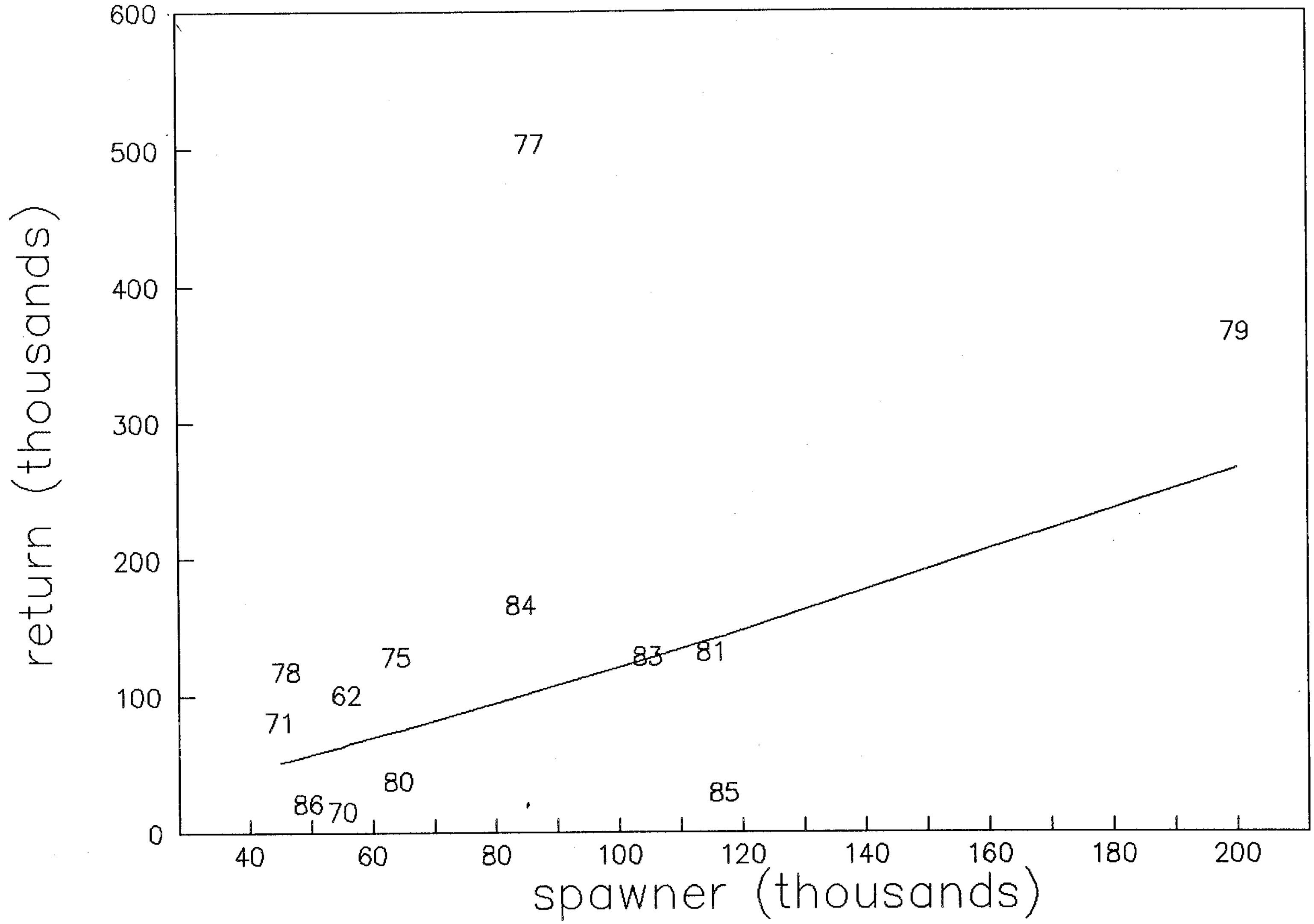

Figure 11. Humpy Creek pink salmon Ricker curve, escapement >40,000 only.

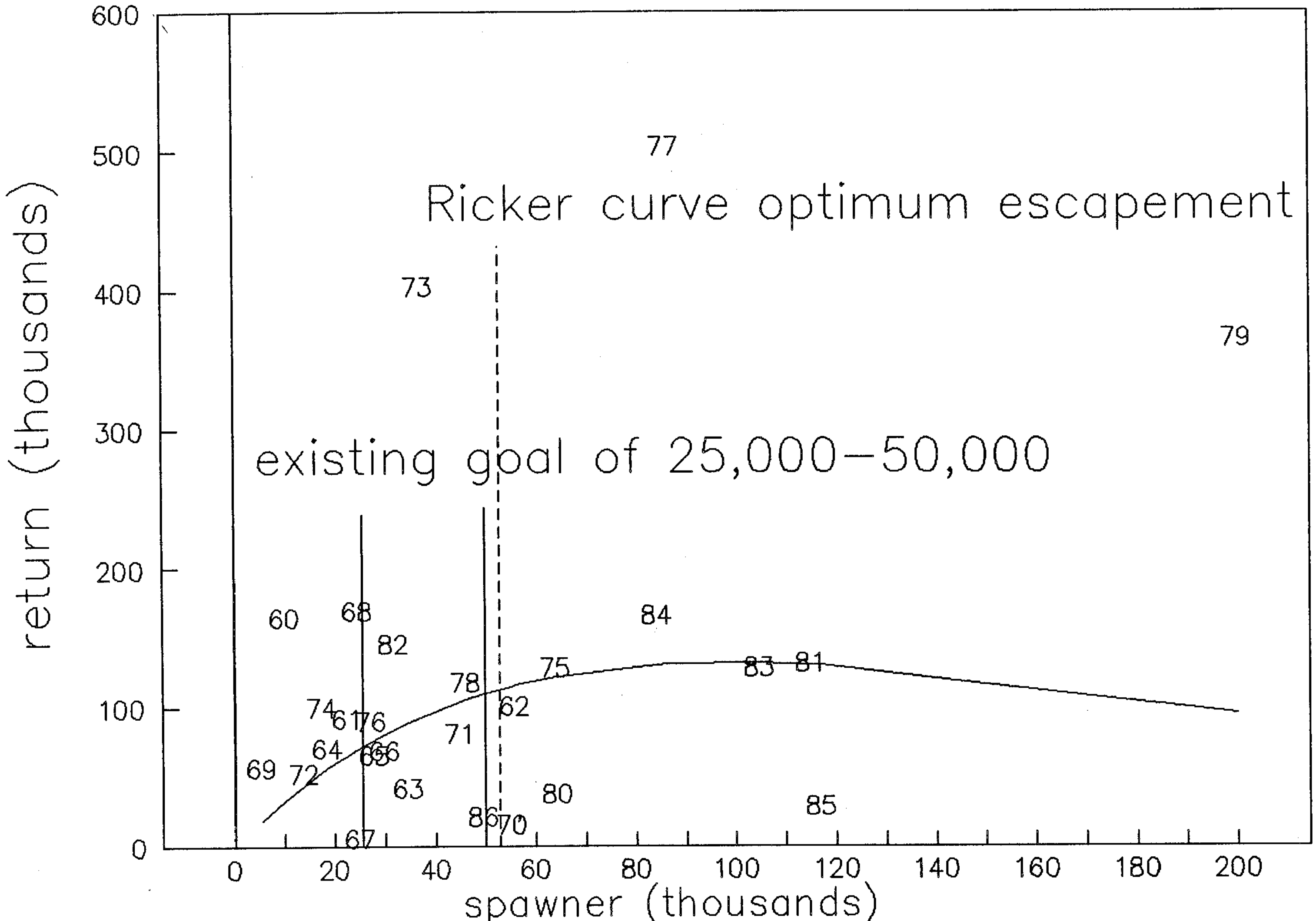

Figure 12. Humpy Creek pink salmon Ricker curve, all escapement levels.

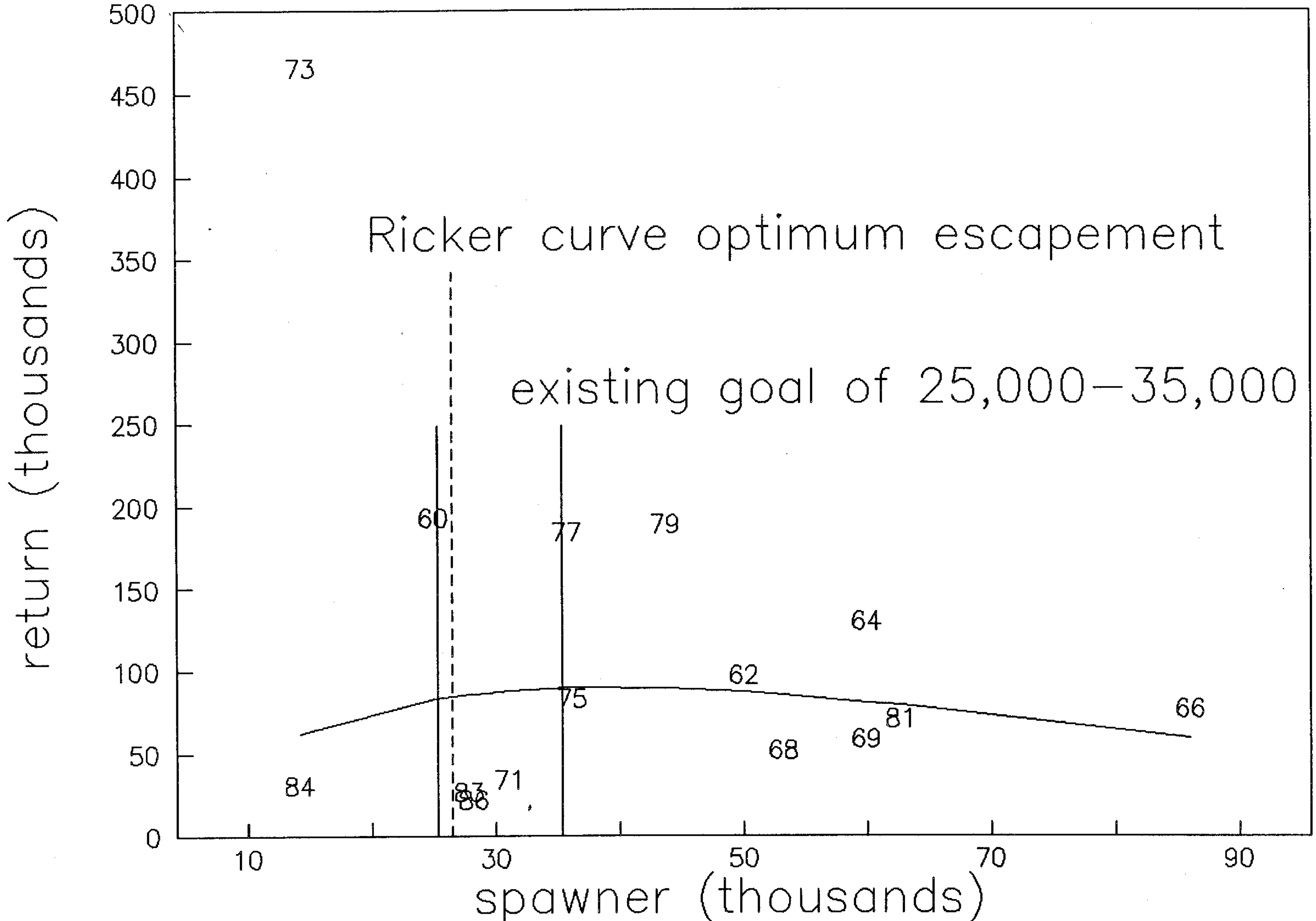

Figure 13. Seldovia pink salmon Ricker curve, peak years only.

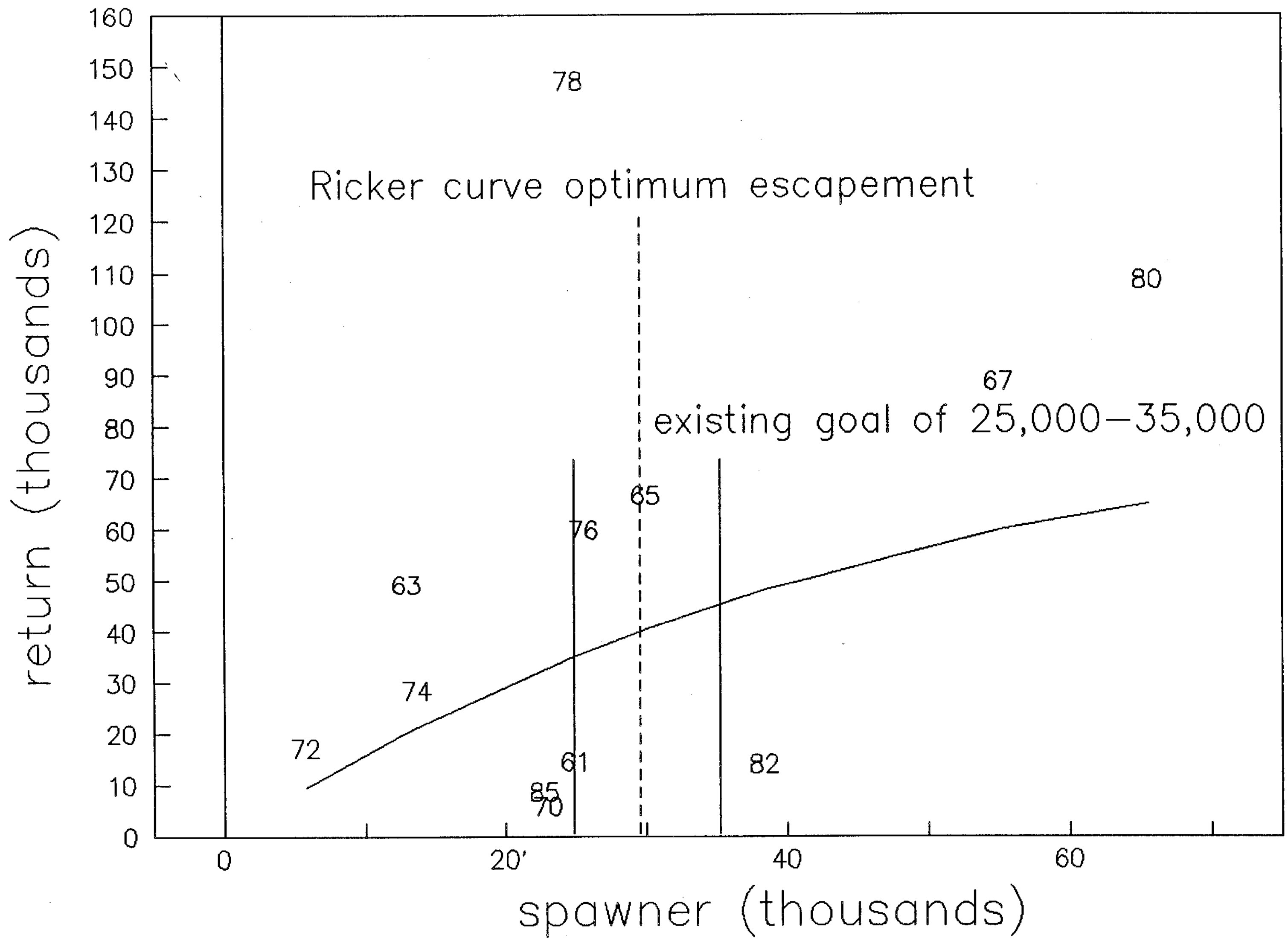

Figure 14. Seldovia pink salmon Ricker curve, off cycle years only.

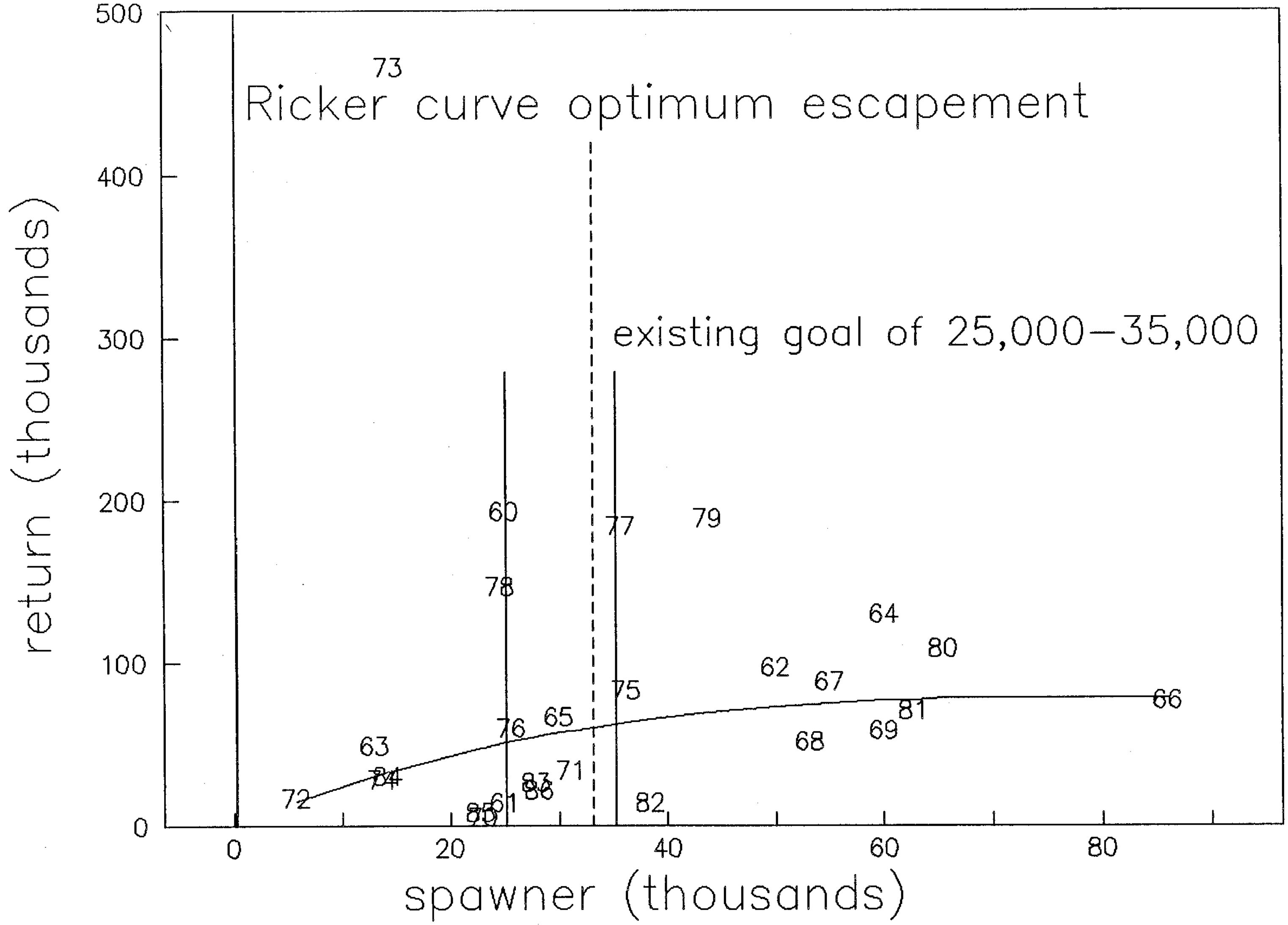

Figure 15. Seldovia pink salmon Ricker curve, all years.

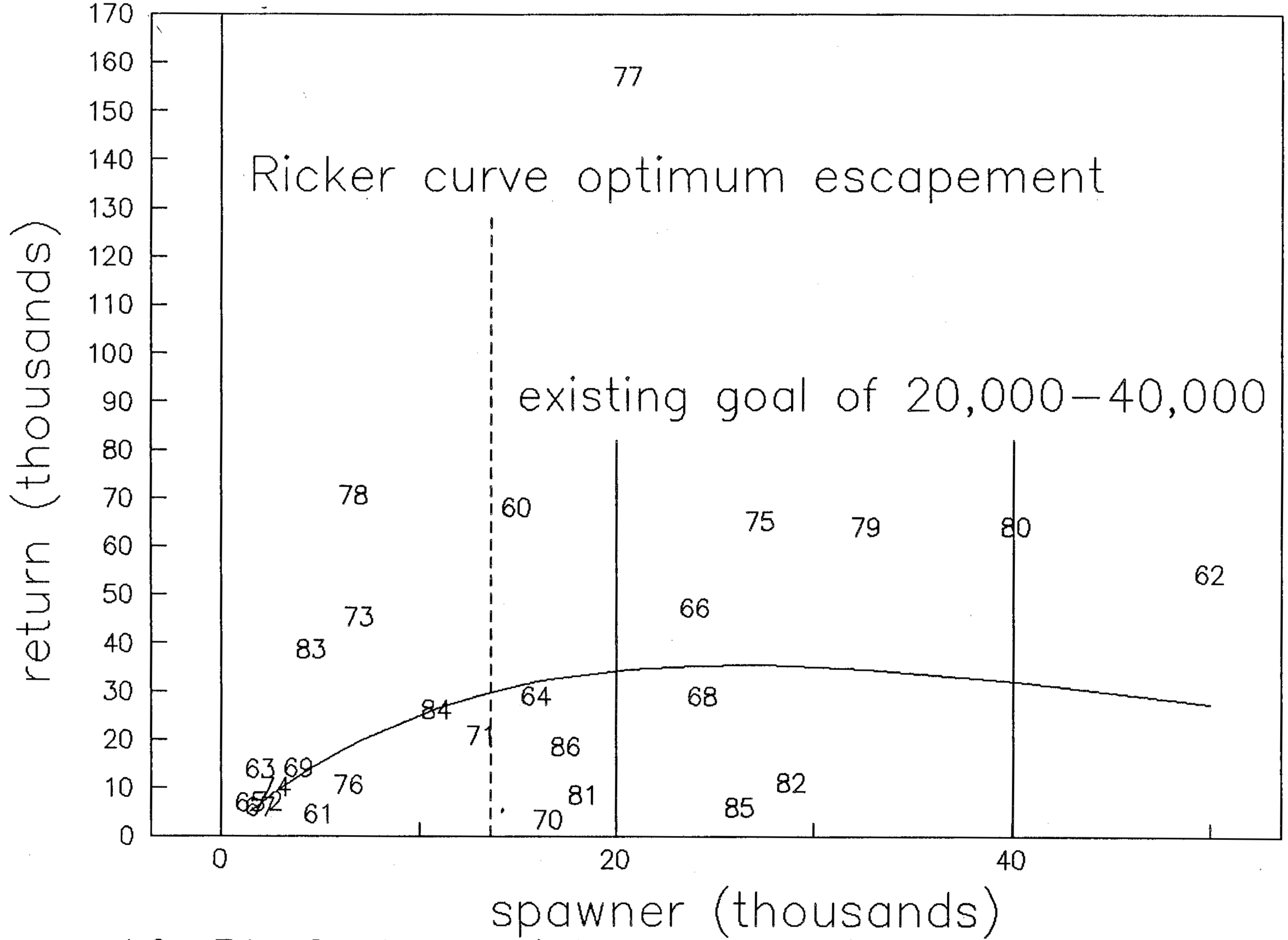

Figure 16. Pt. Graham pink salmon Ricker curve, all years.

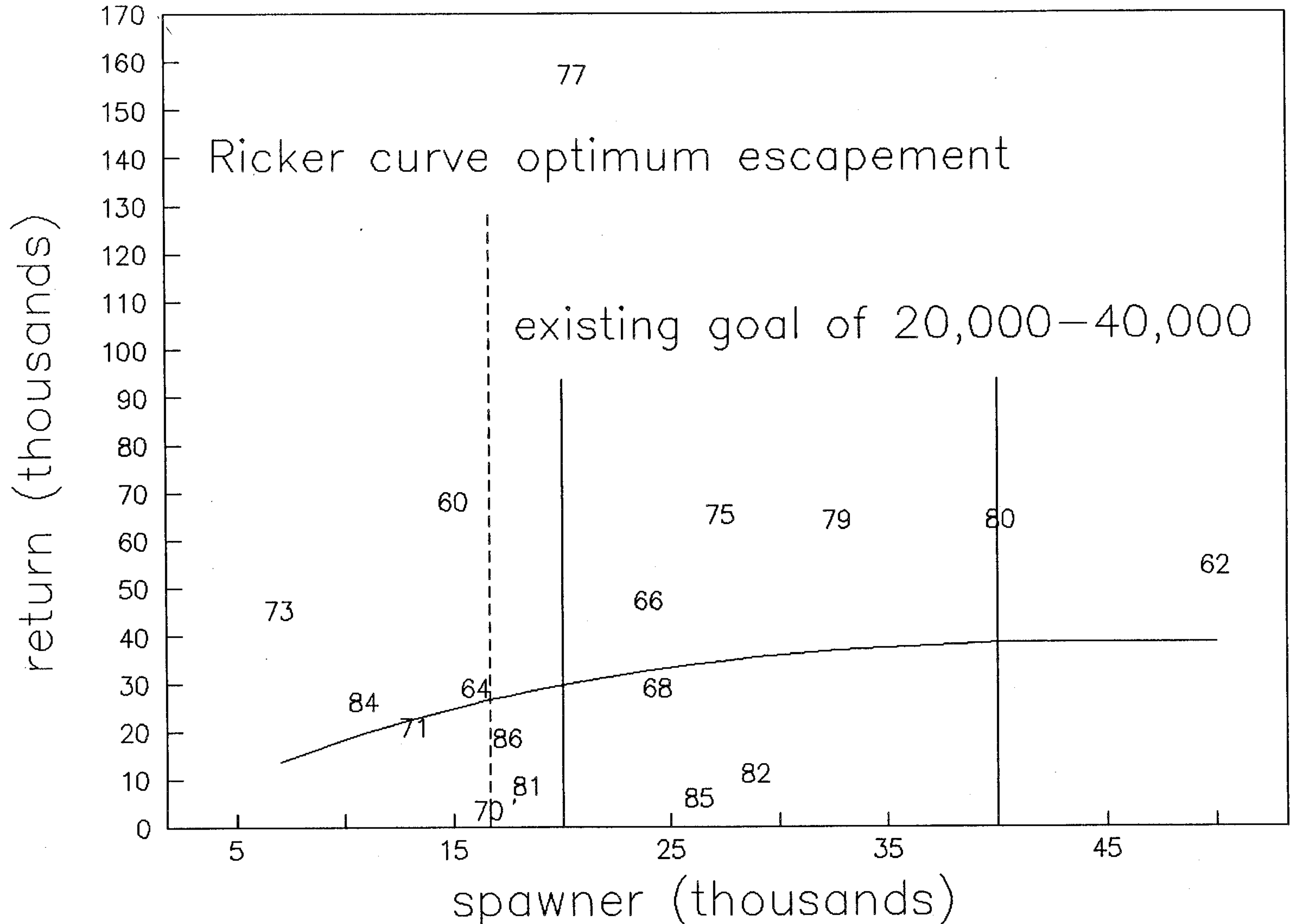

Figure 17. Pt. Graham pink salmon Ricker curve, peak years only.

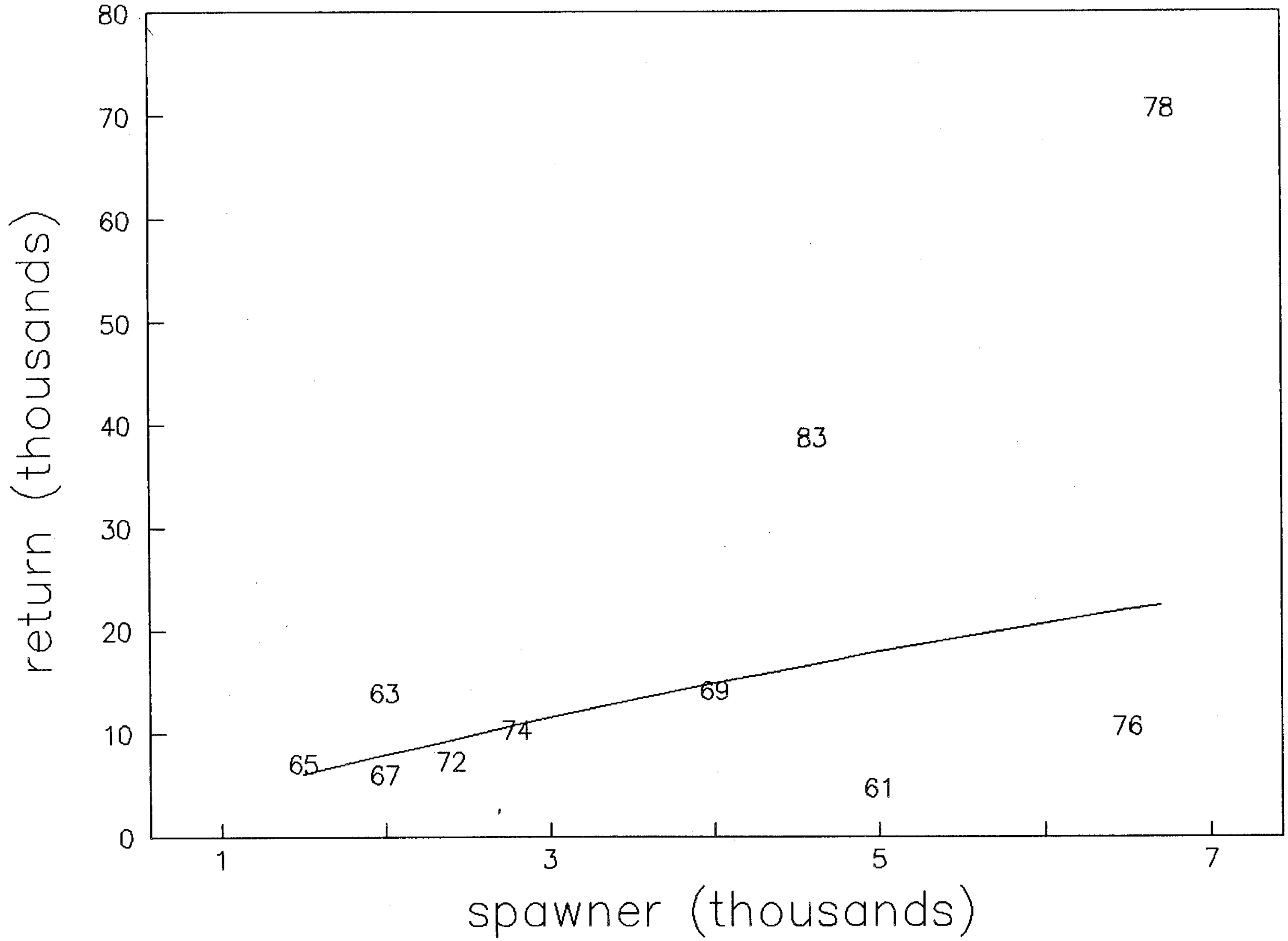

Figure 18. Pt. Graham pink salmon Ricker curve, off cycle years only.

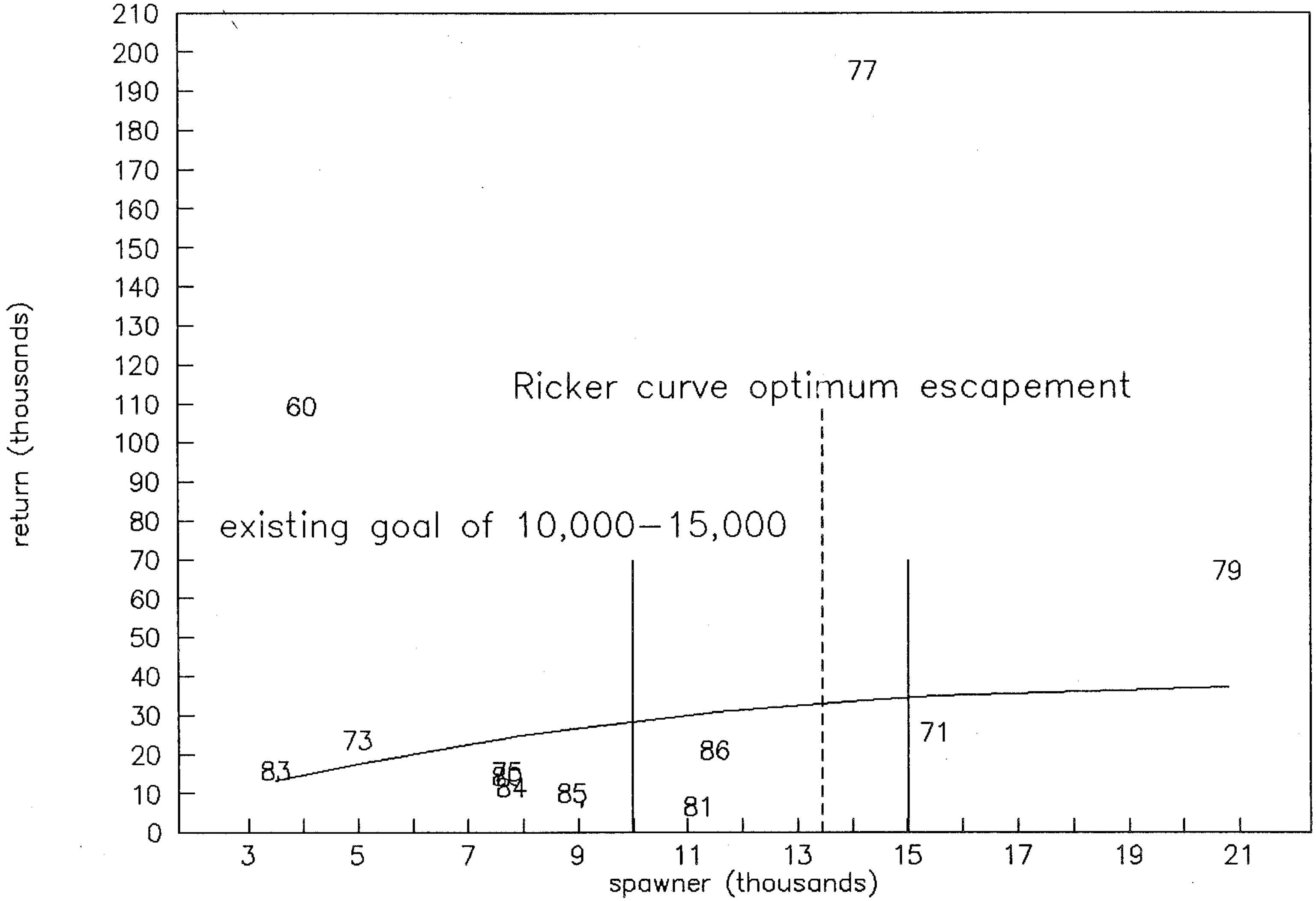

Figure 19. Pt. Chatham pink salmon Ricker curve, peak years only.

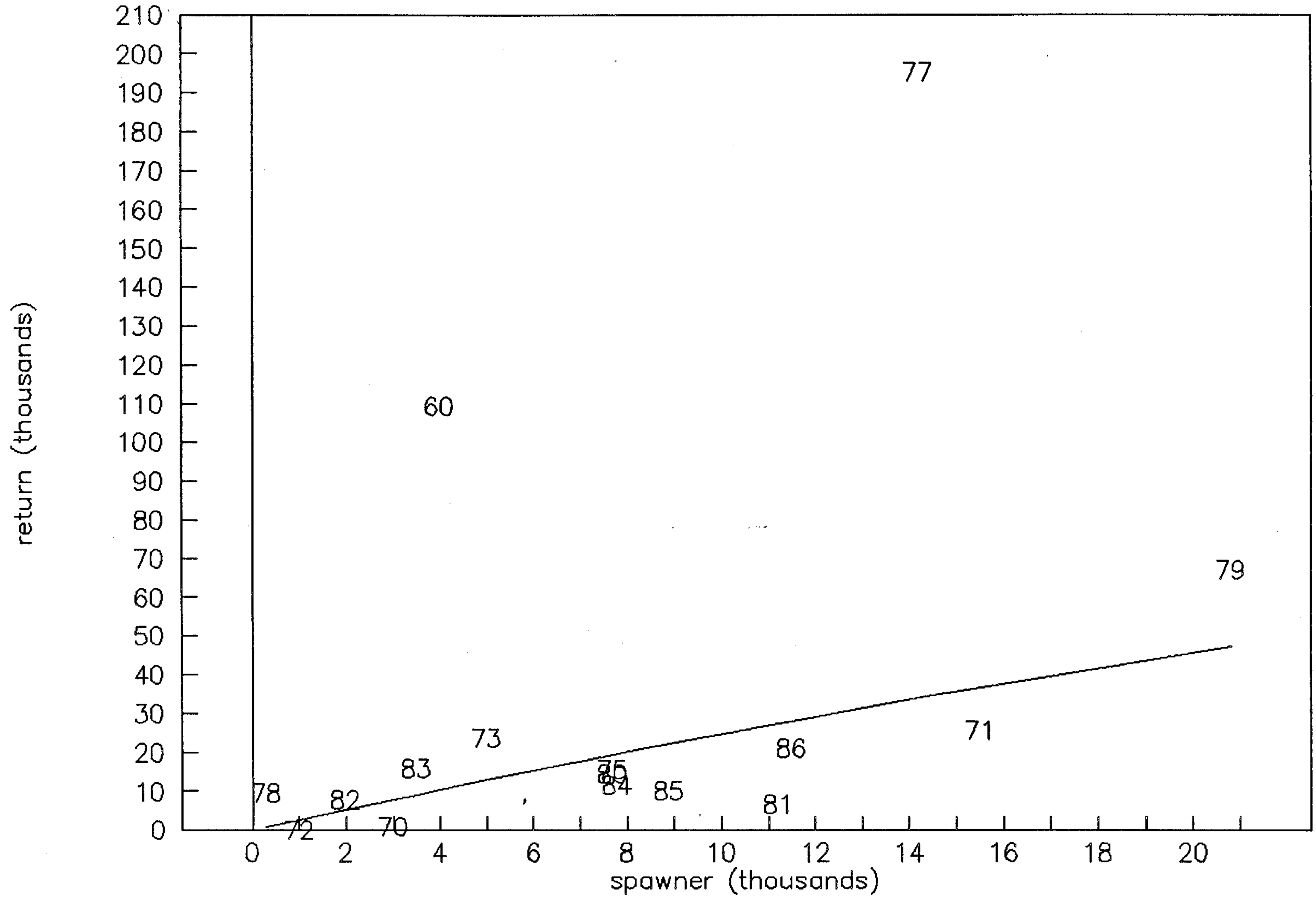

Figure 20. Pt. Chatham pink salmon Ricker curver, all years.

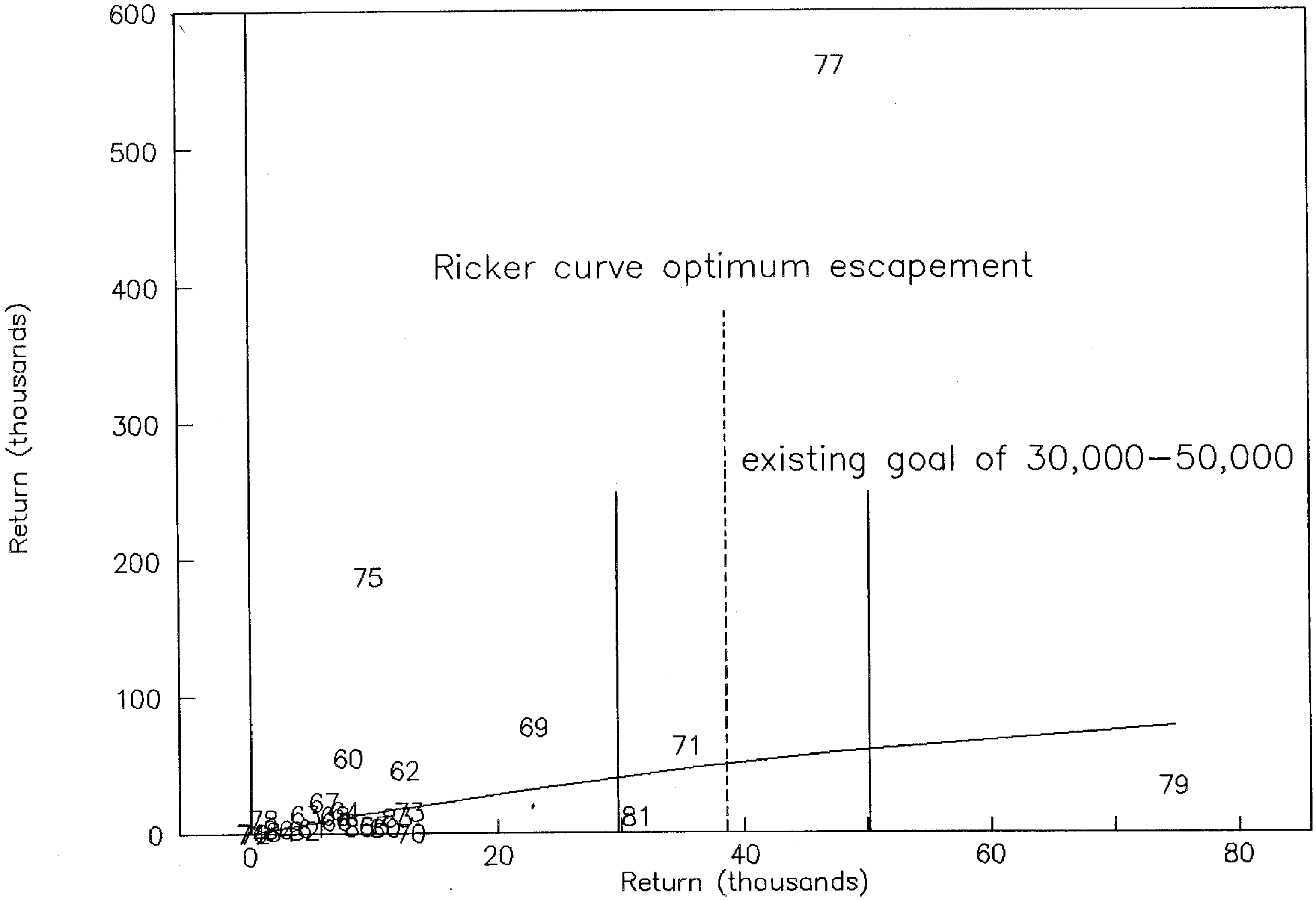

Figure 21. Windy Left pink salmon Ricker curve, all years.

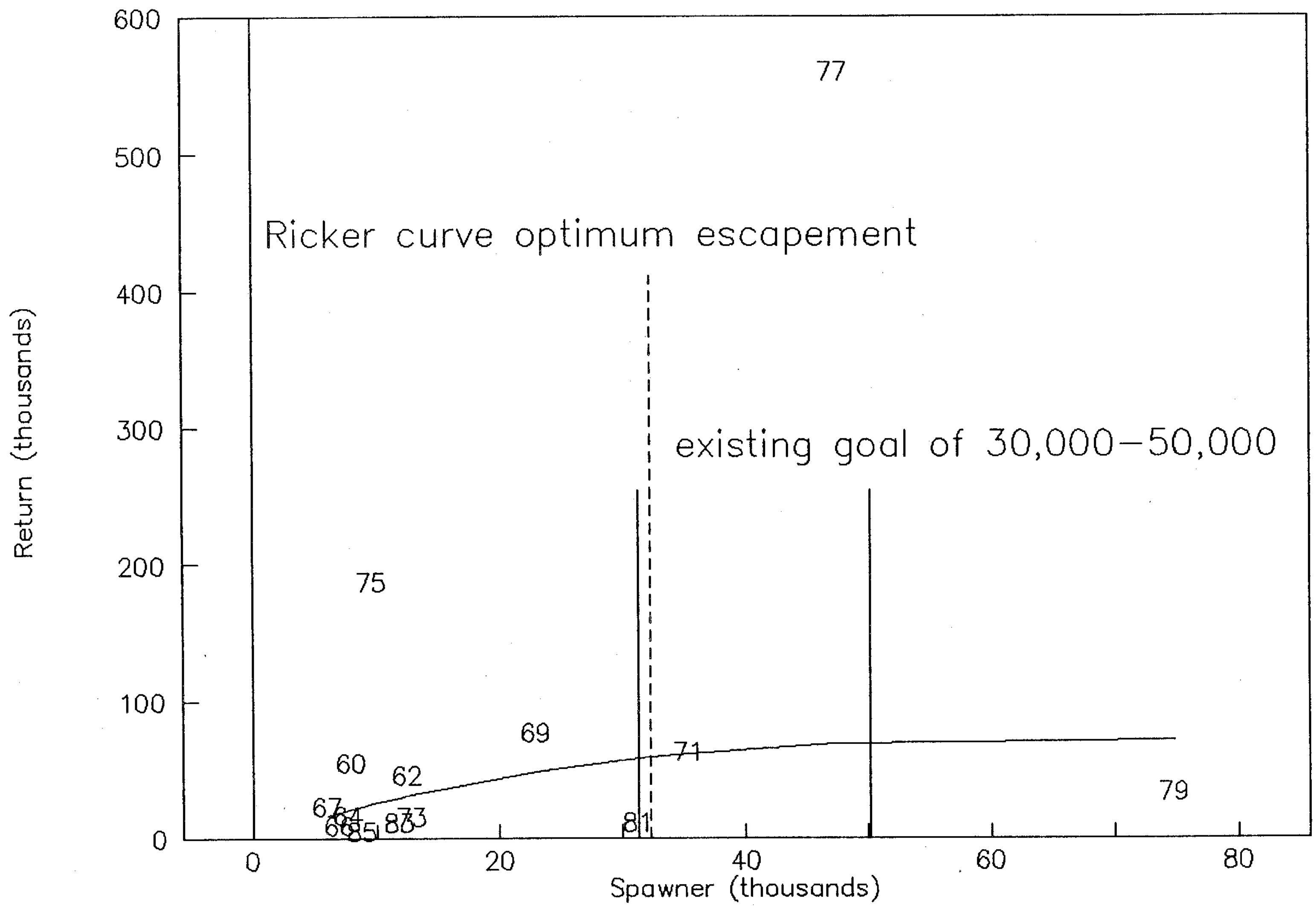

Figure 22. Windy Left pink salmon Ricker curve, peak years only.

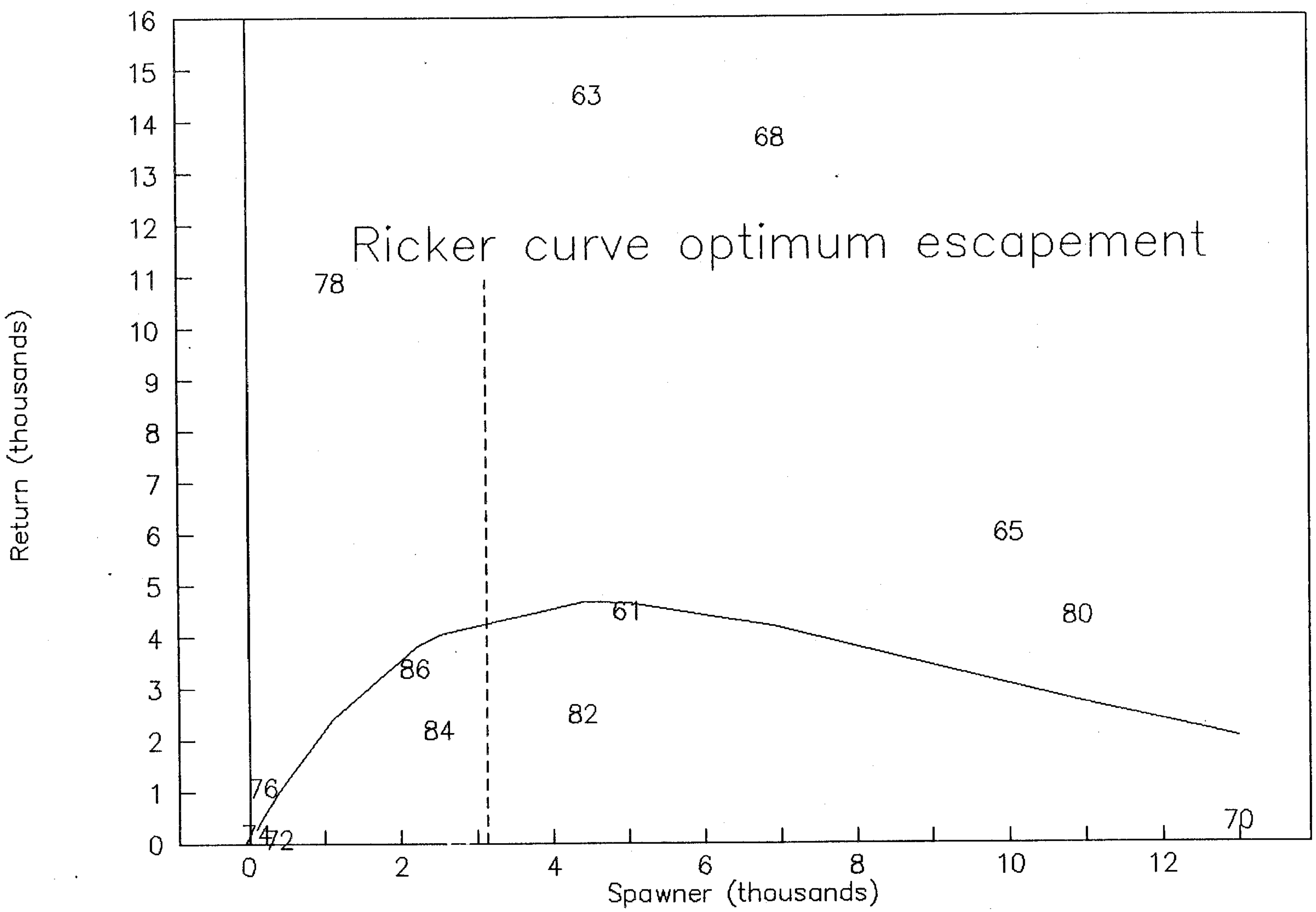

Figure 23. Windy Left pink salmon Ricker curve, off cycle years only.

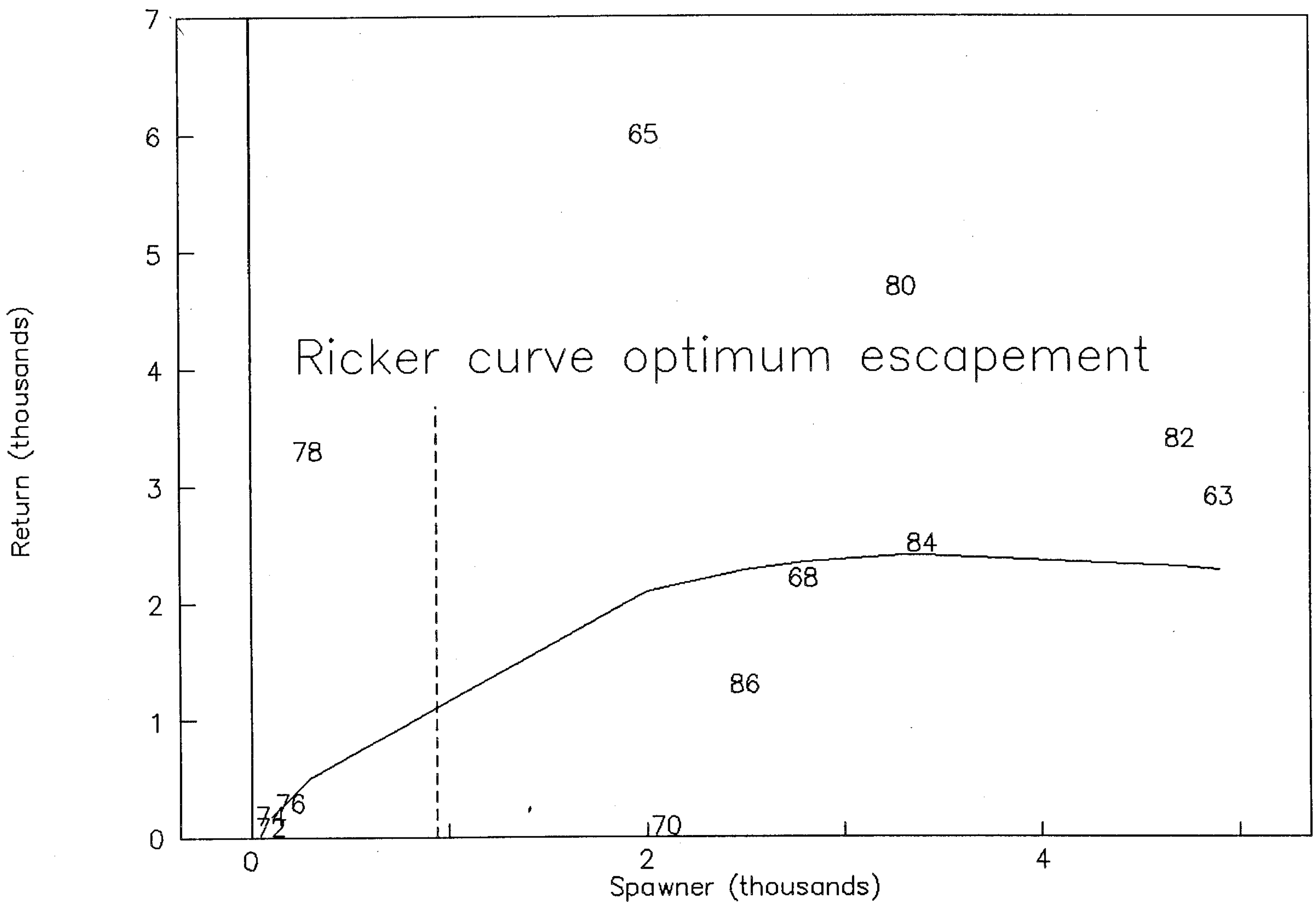

Figure 24. Windy Right pink salmon Ricker curve, off cycle years only.

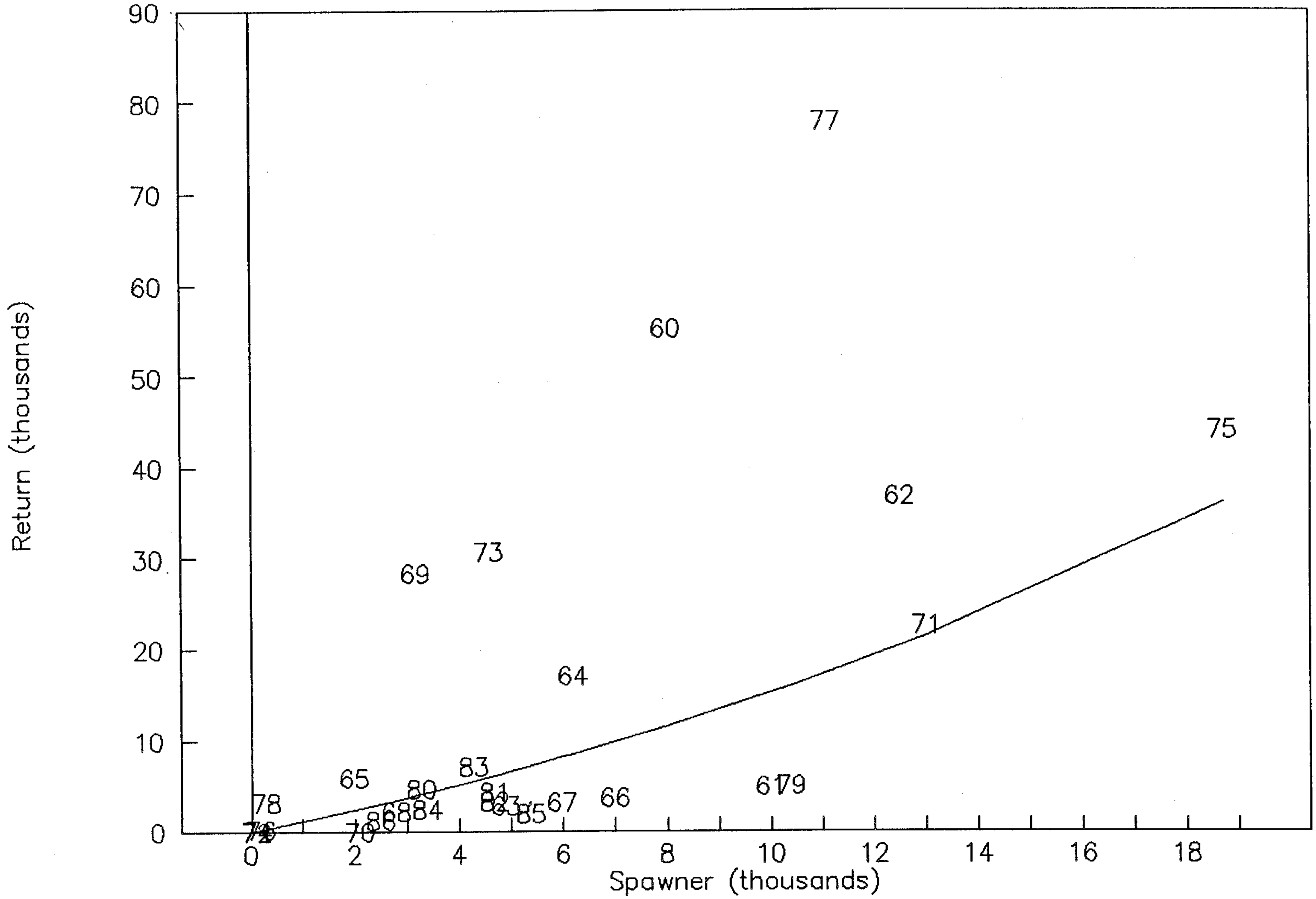

Figure 25. Windy Right pink salmon Ricker curve, all years.

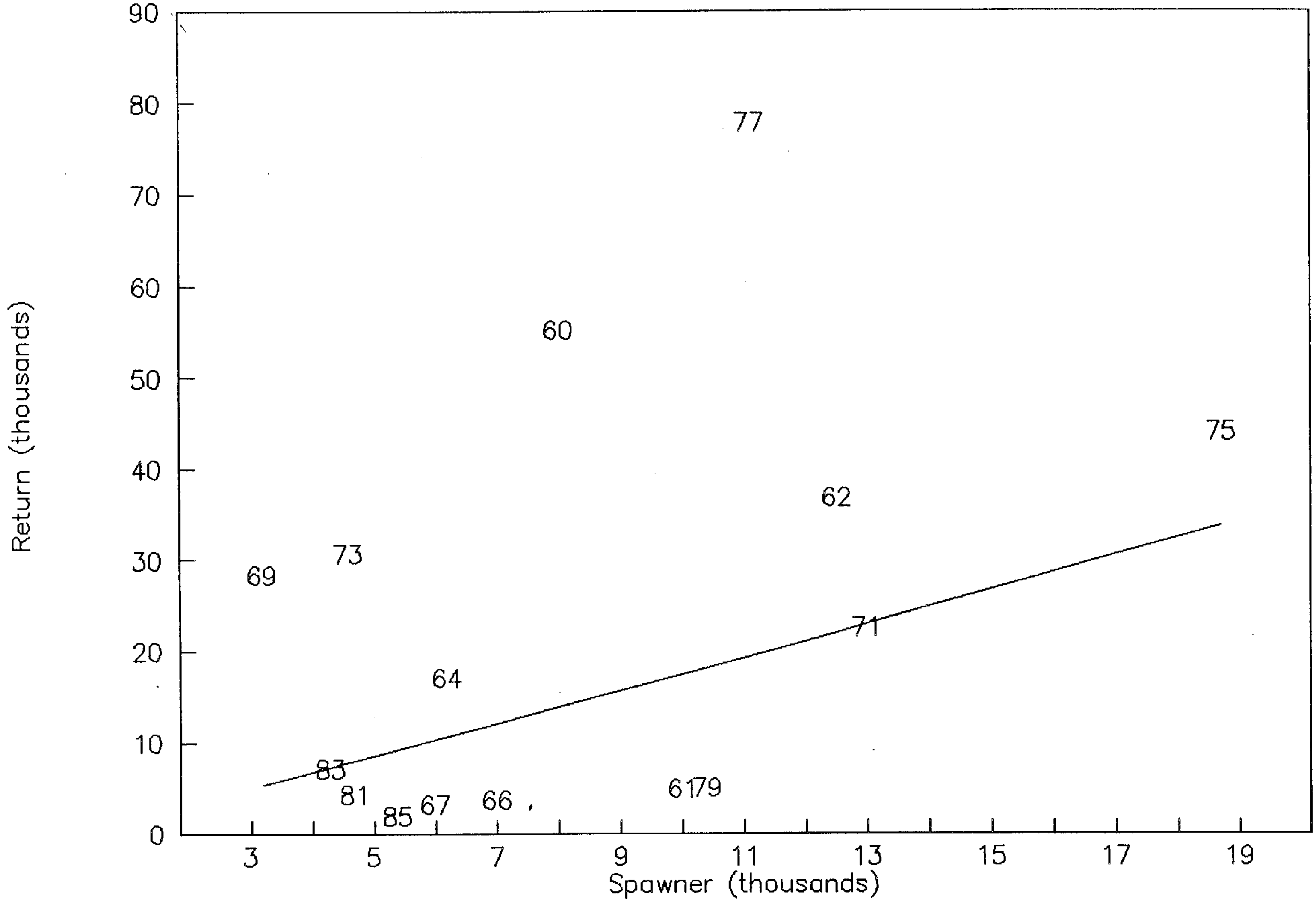

Figure 26. Windy Right pink salmon Ricker curve, peak years only.

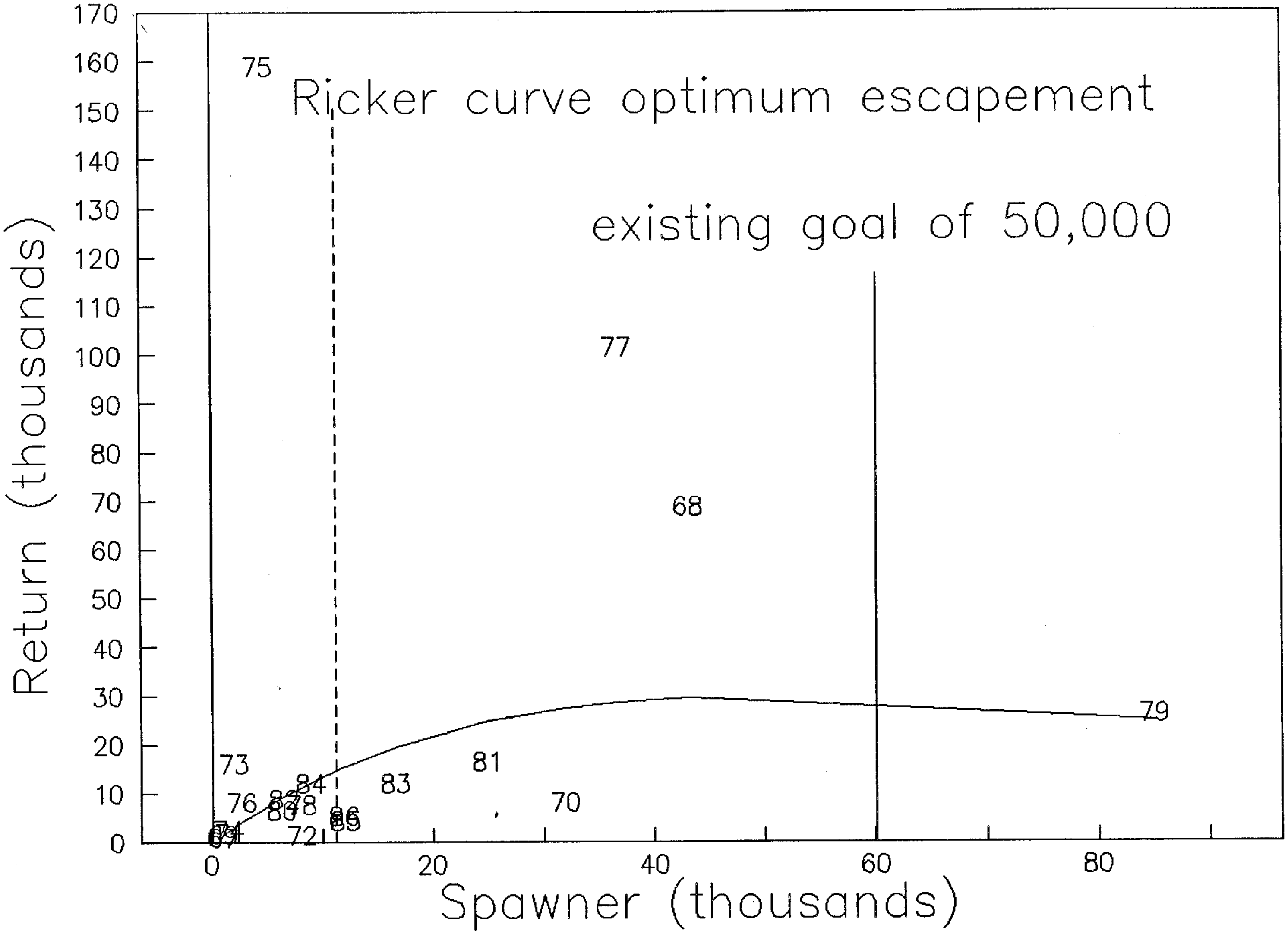

Figure 27. Rocky River pink salmon Ricker curve, all years.

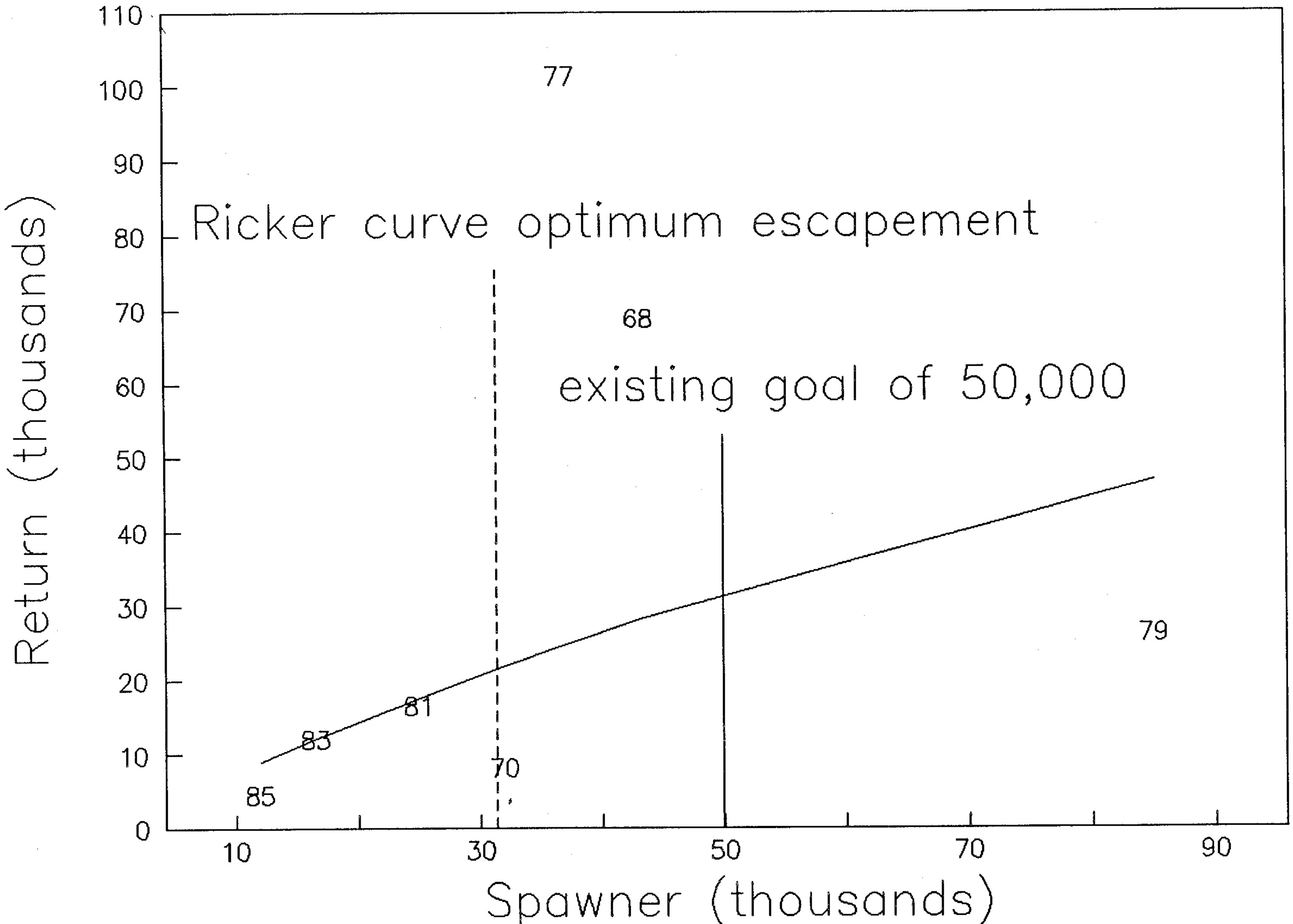

Figure 28. Rocky River pink salmon Ricker curve, peak years only.

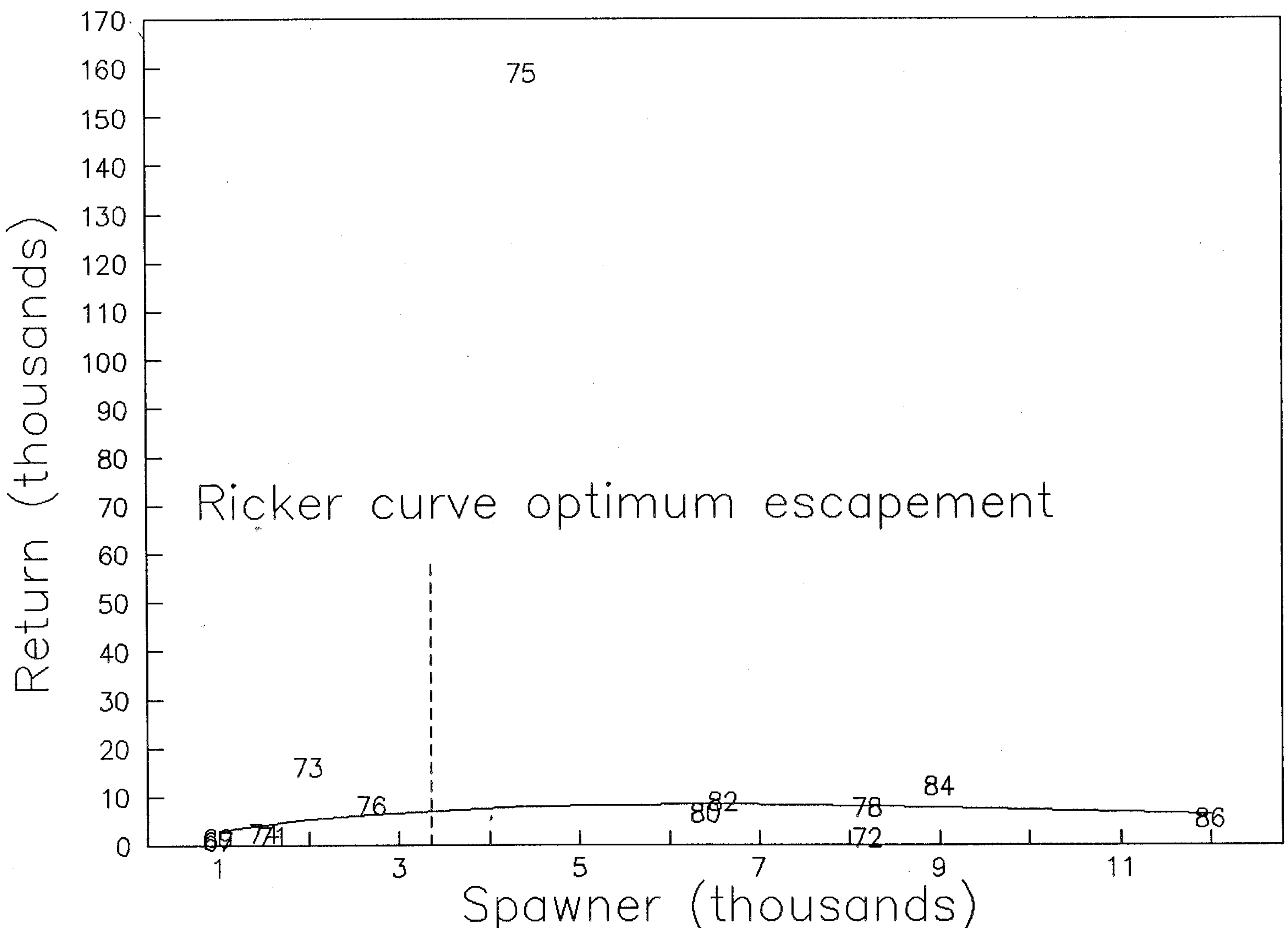

Figure 29. Rocky River pink salmon Ricker curve, off cycle years only.

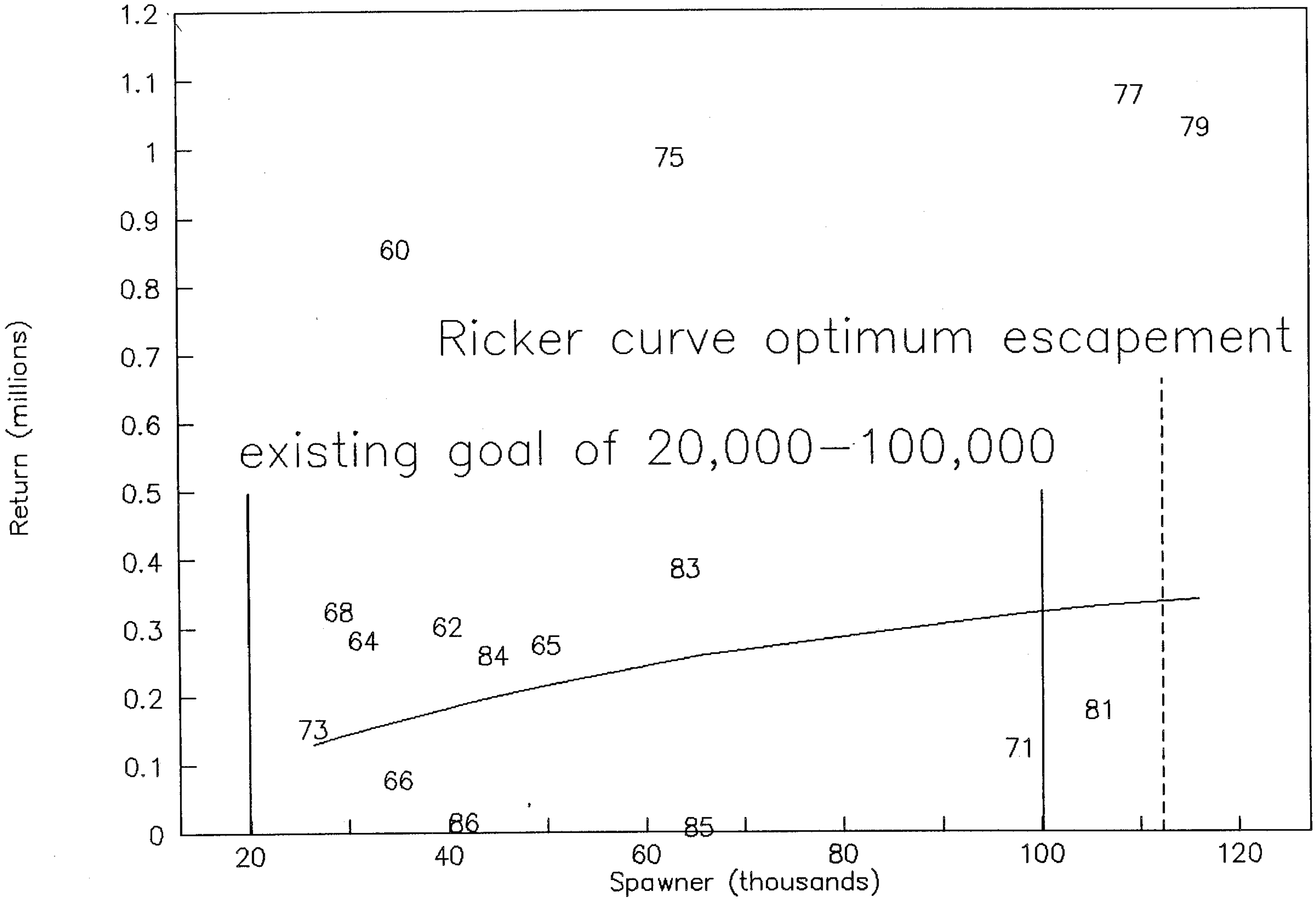

Figure 30. Pt. Dick pink salmon Ricker curve, peak years only.

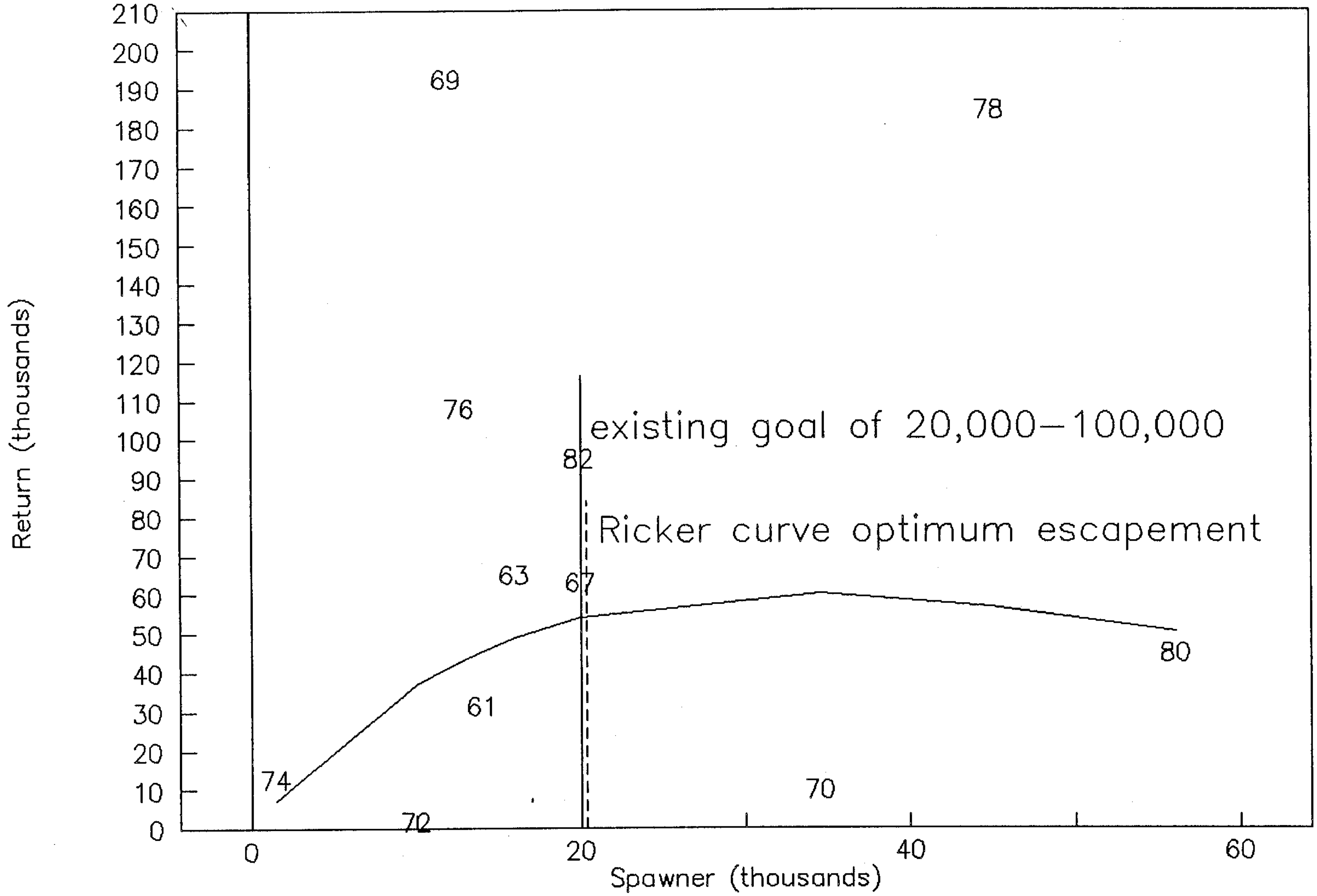

Figure 31. Pt. Dick pink salmon Ricker curve, off cycle years only.

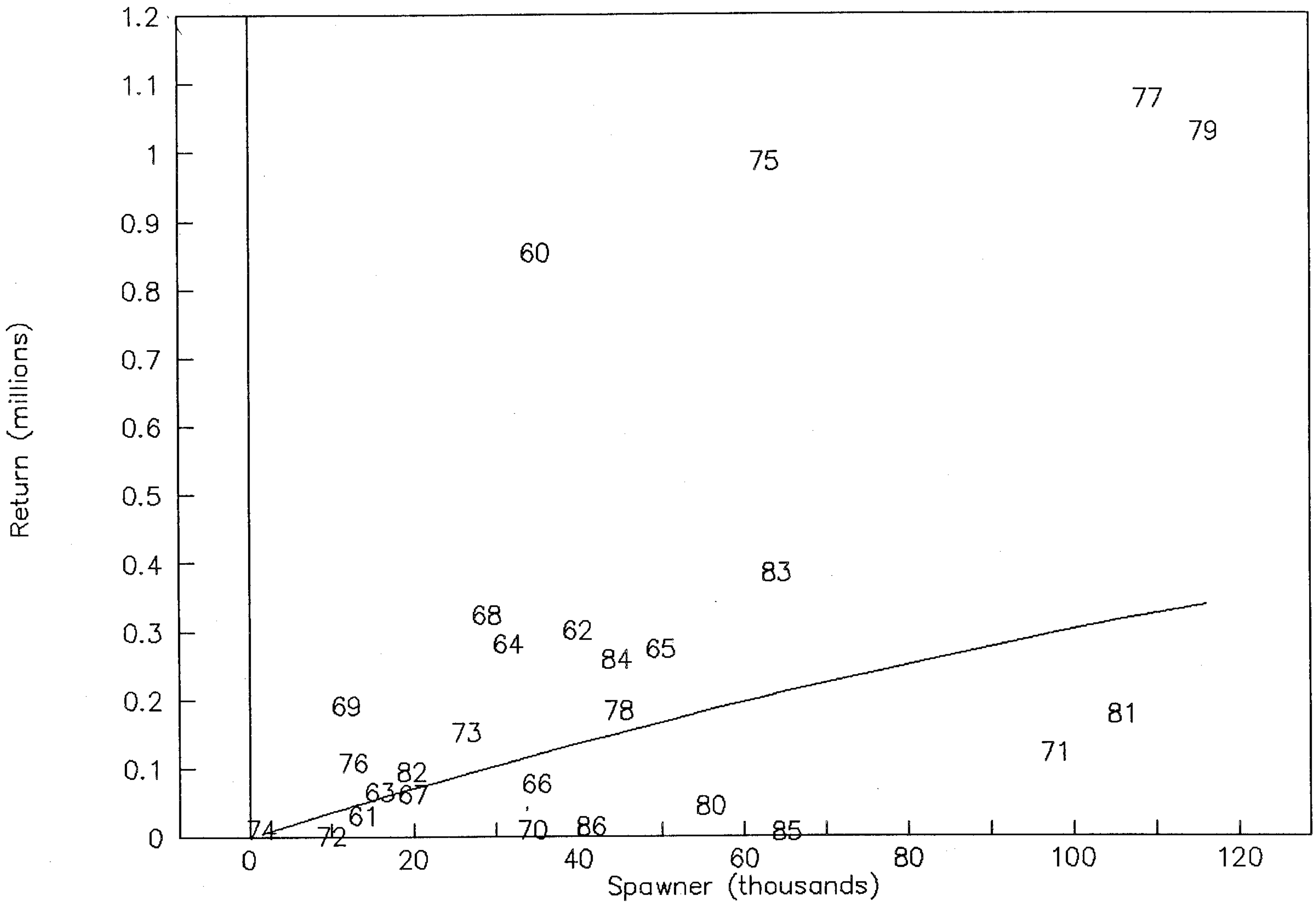

Figure 32. Pt Dick pink salmon Ricker curve, all years.

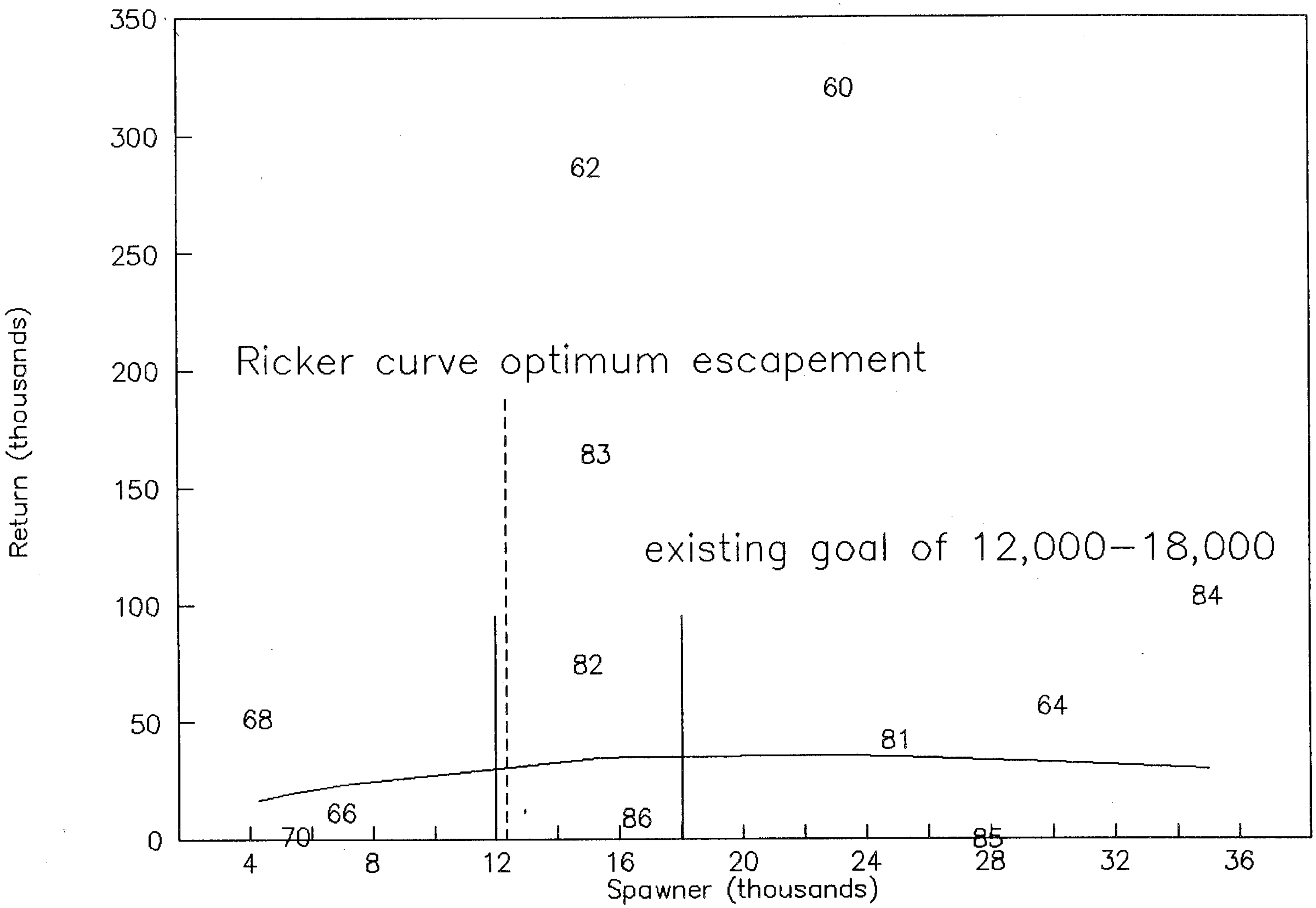

Figure 33. Island Creek pink salmon Ricker curve, peak years only.

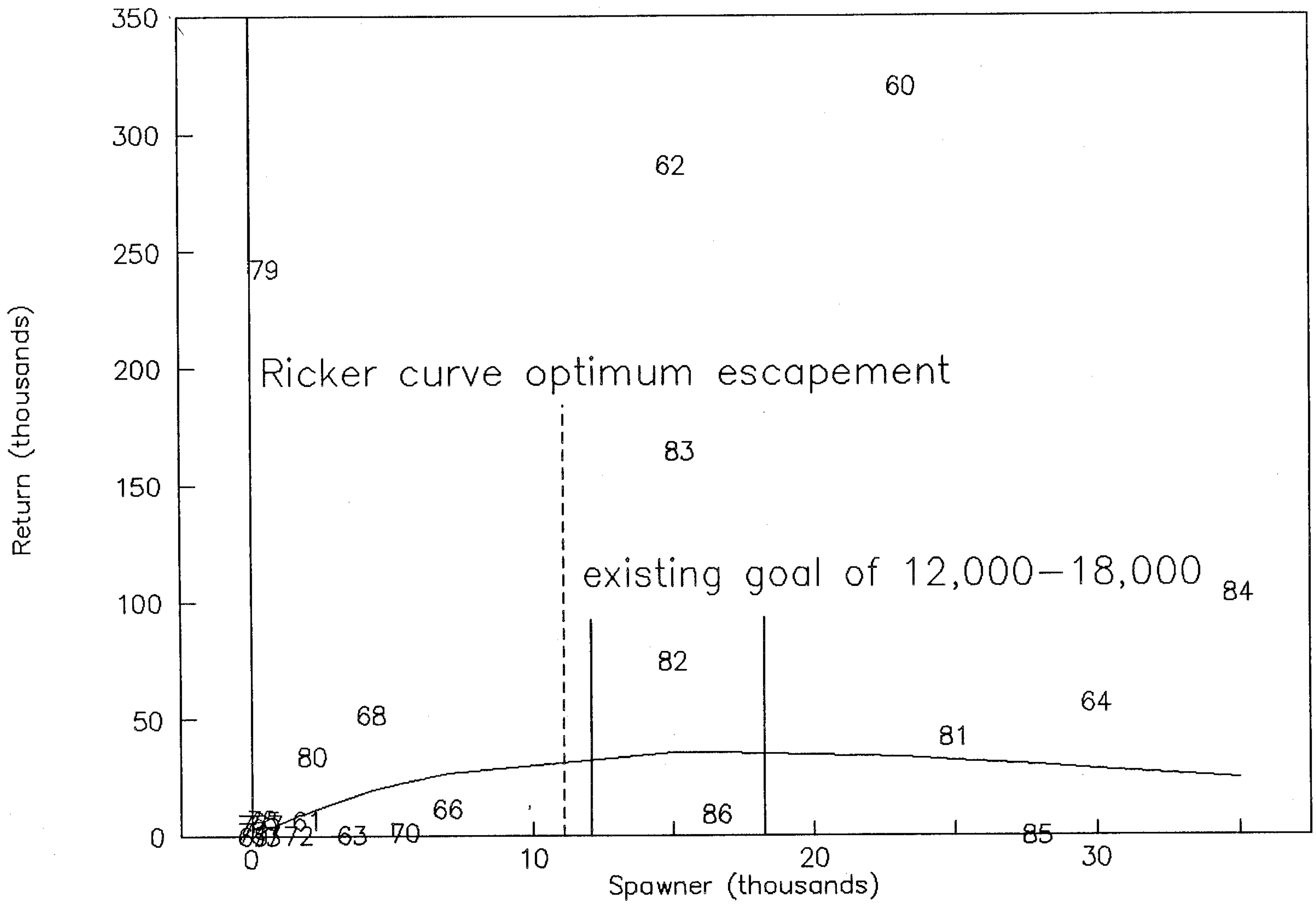

Figure 34. Island Creek pink salmon Ricker curve, all years.

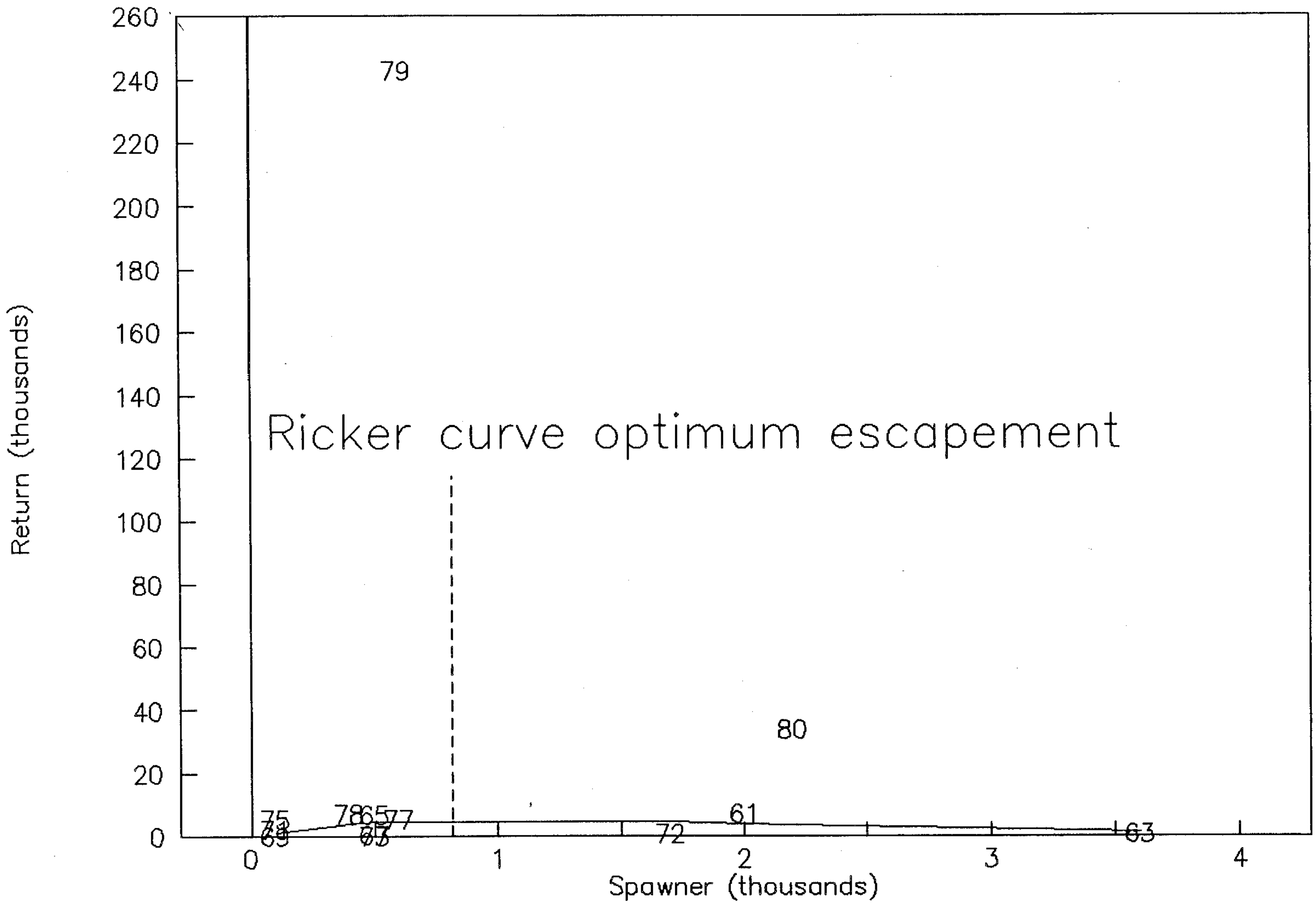

Figure 35. Island Creek pink salmon Ricker curve, off cycle years only.

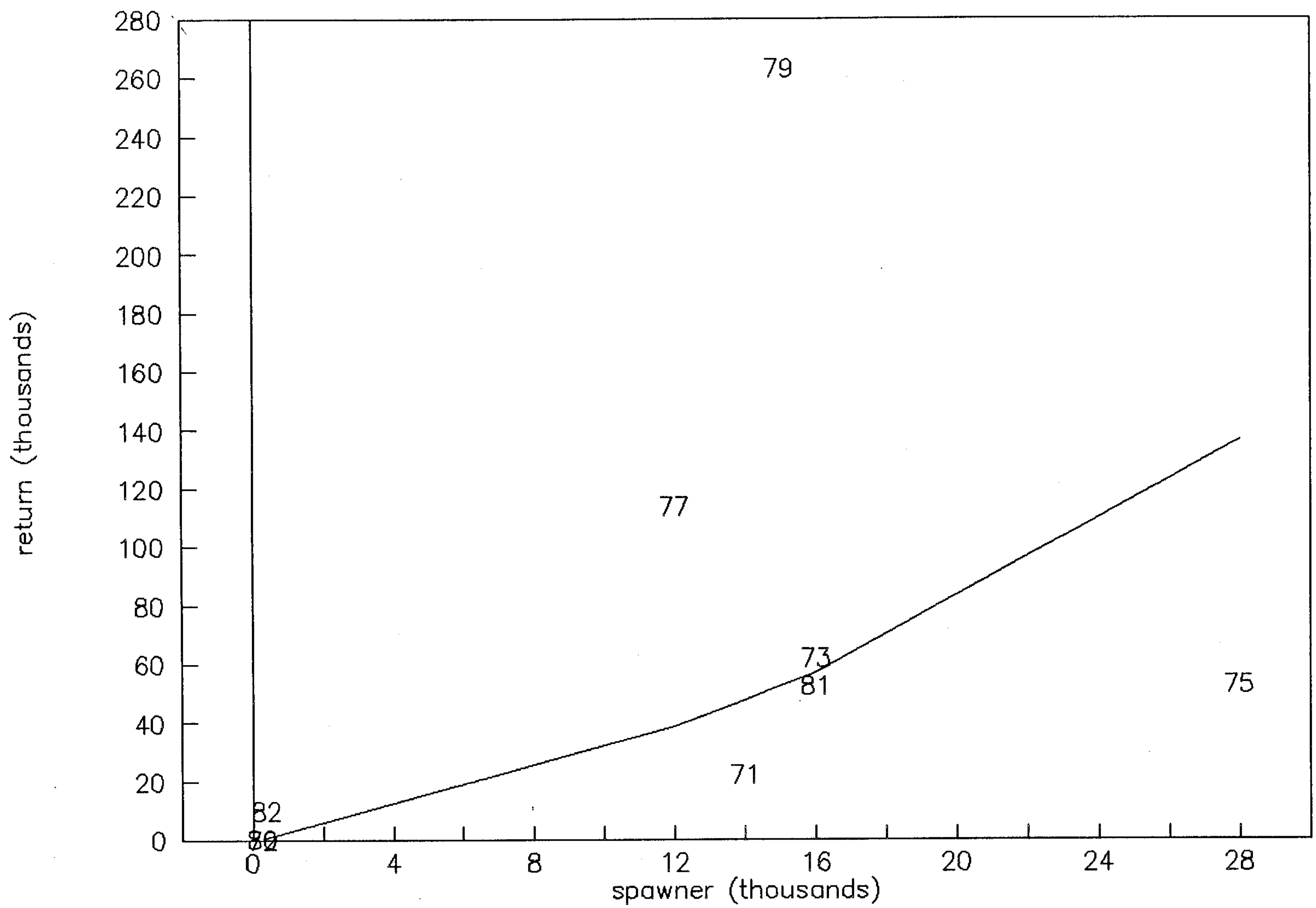

Figure 36. South Nuka pink salmon Ricker curve, all years.

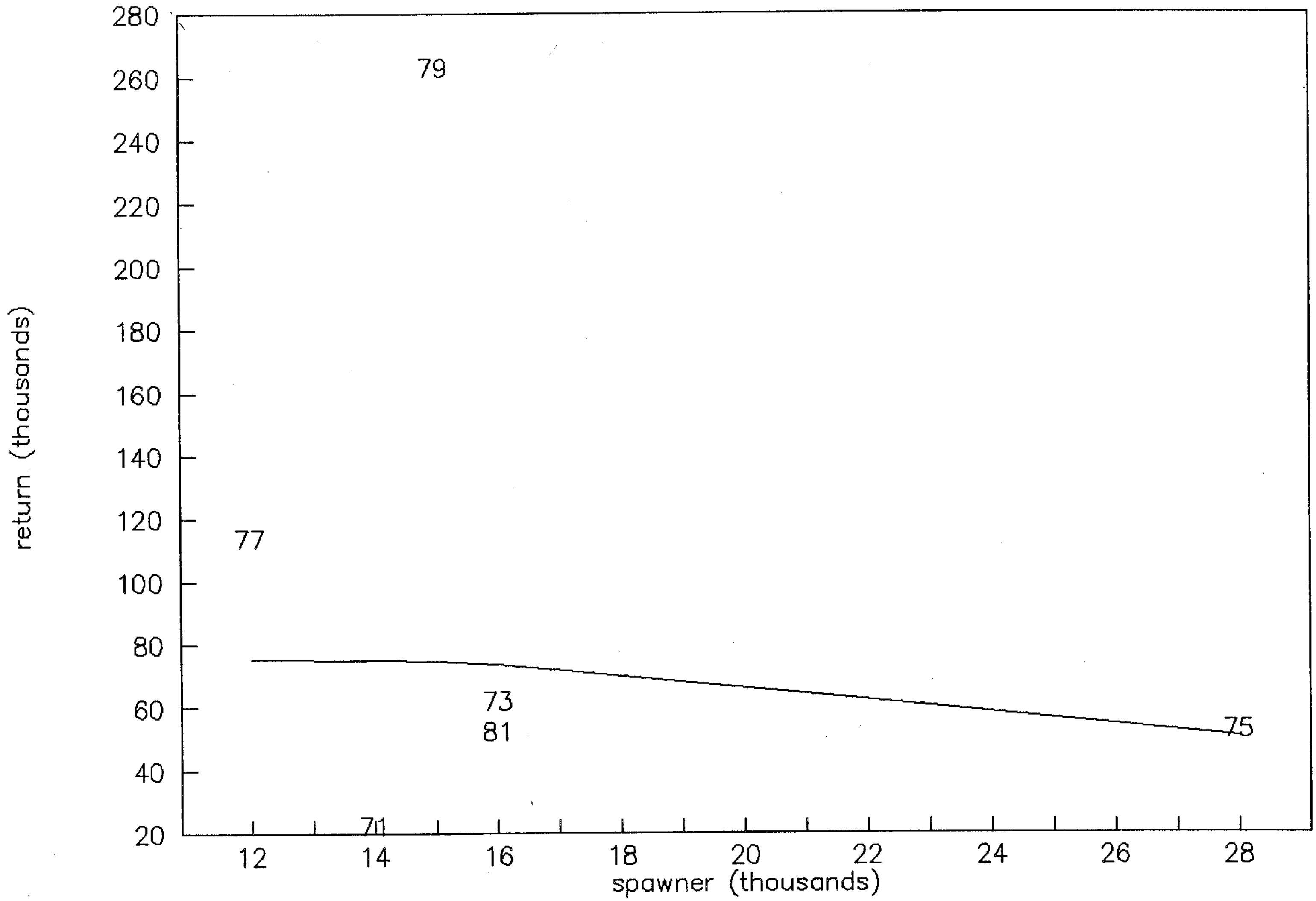

Figure 37. South Nuka pink salmon Ricker Curve, odd years only.

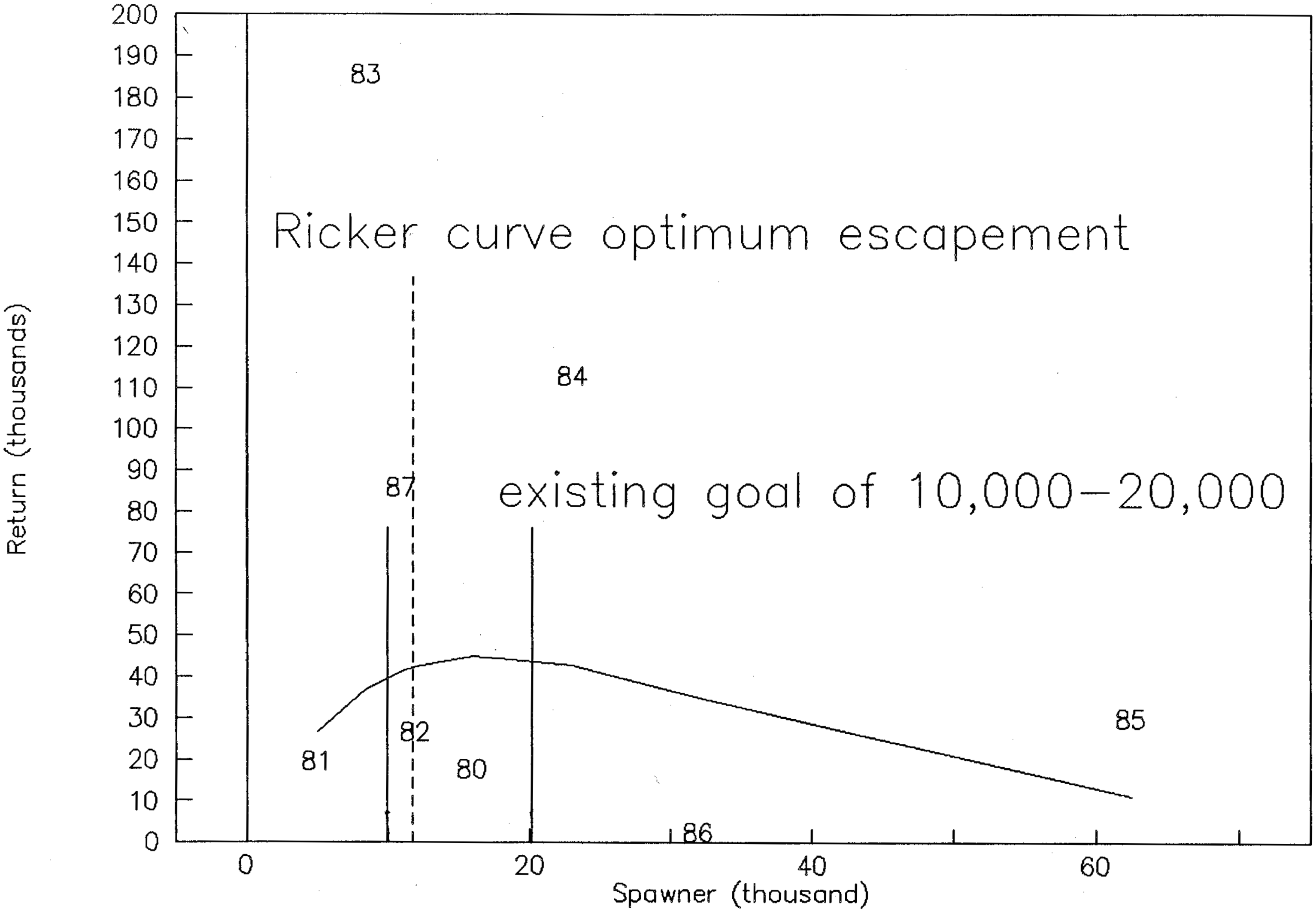

Figure 38. Desire pink salmon Ricker curve, all years.

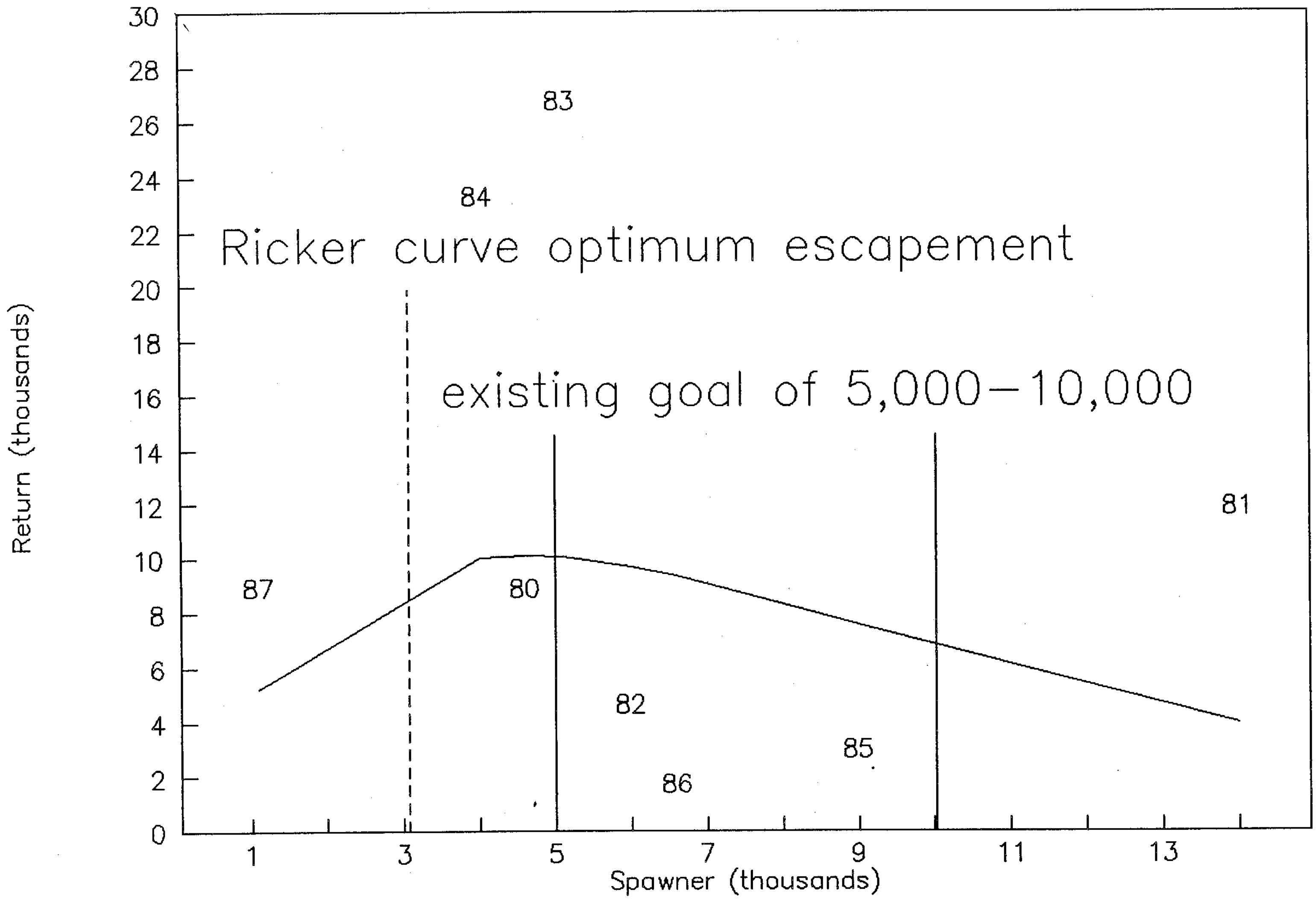

Figure 39. James Lagoon pink salmon Ricker curve, all years.

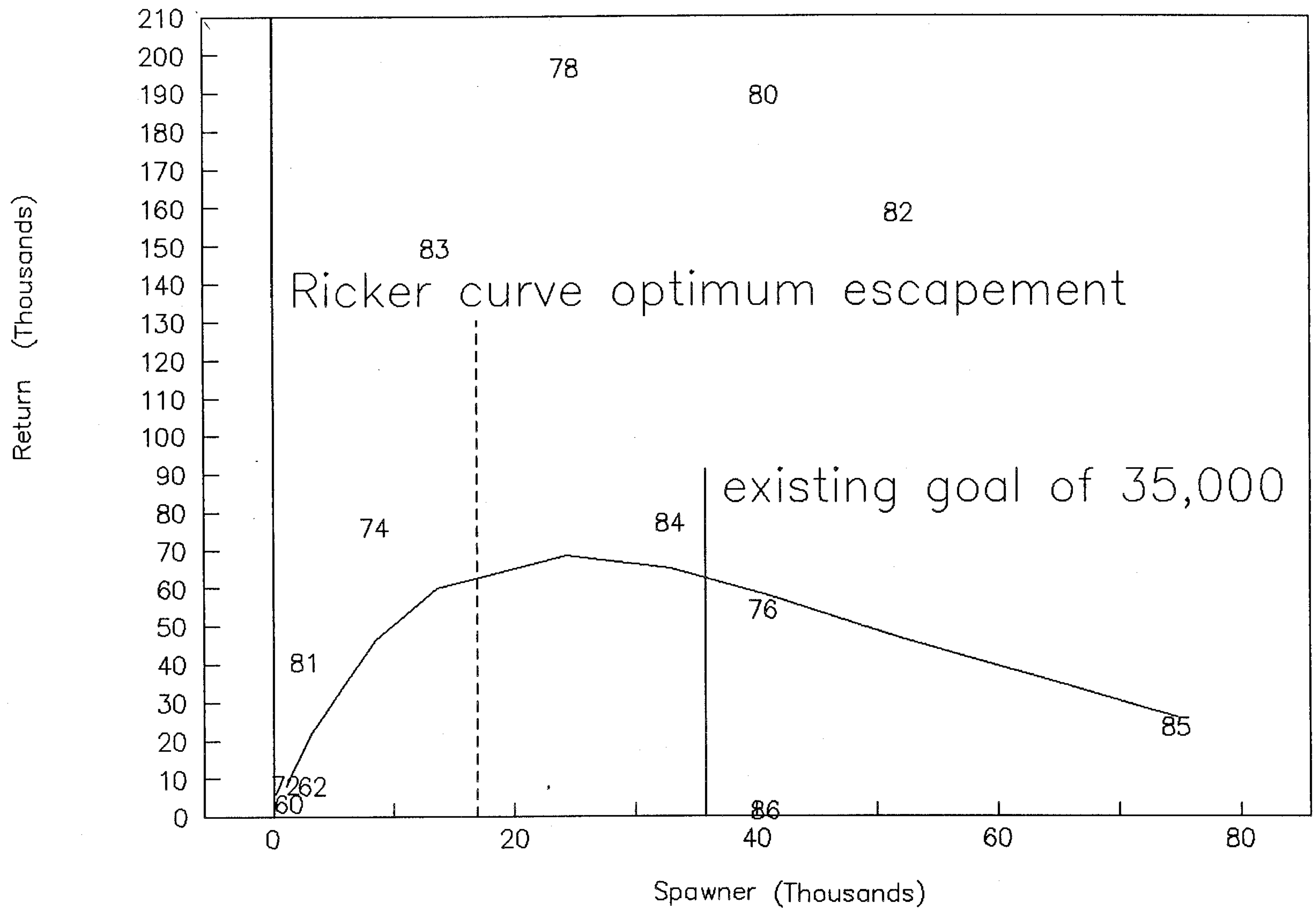

Figure 40. Resurrection Bay pink salmon Ricker curve, all years.

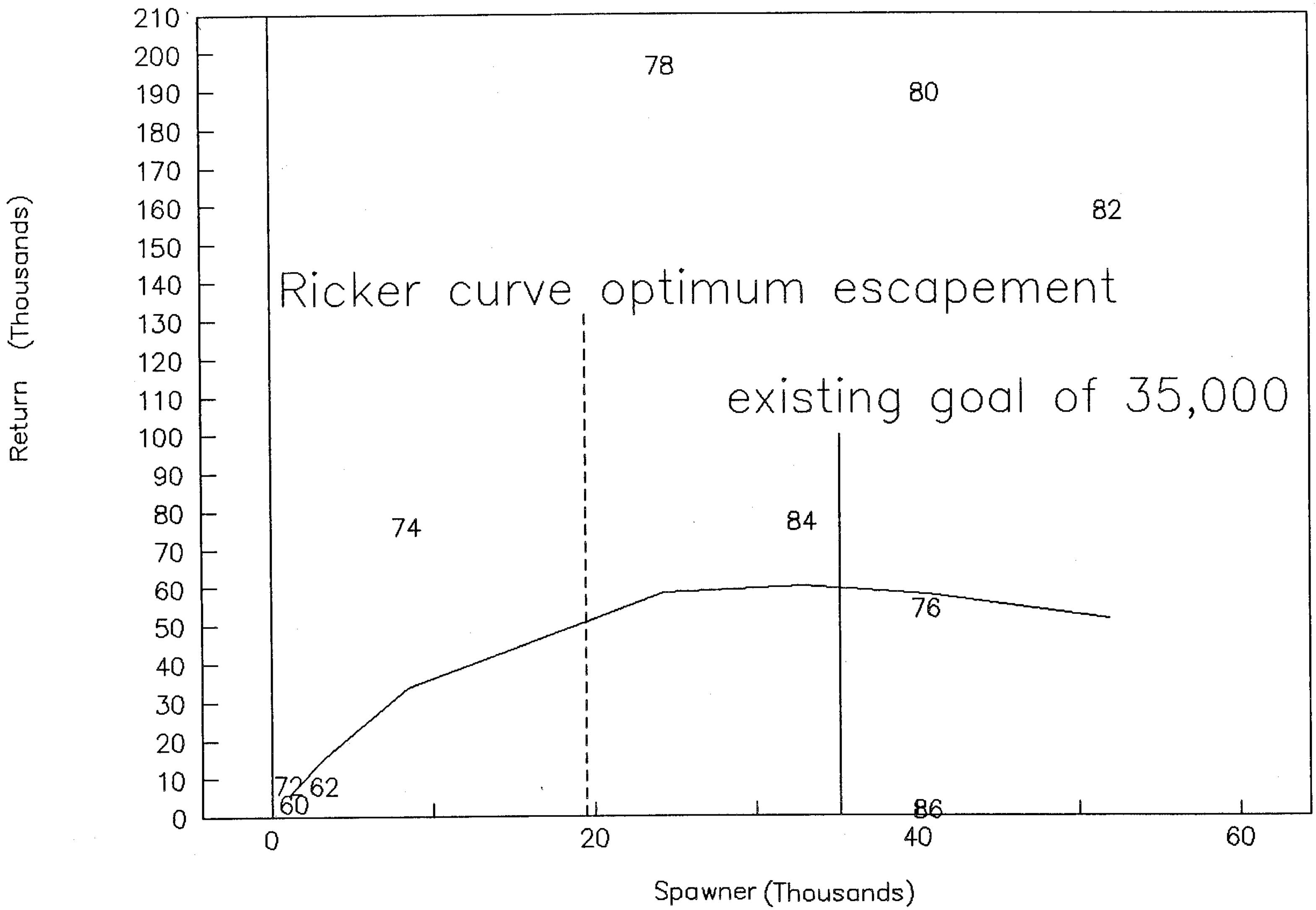

Figure 41. Resurrection Bay pink salmon Ricker curve, even years only.

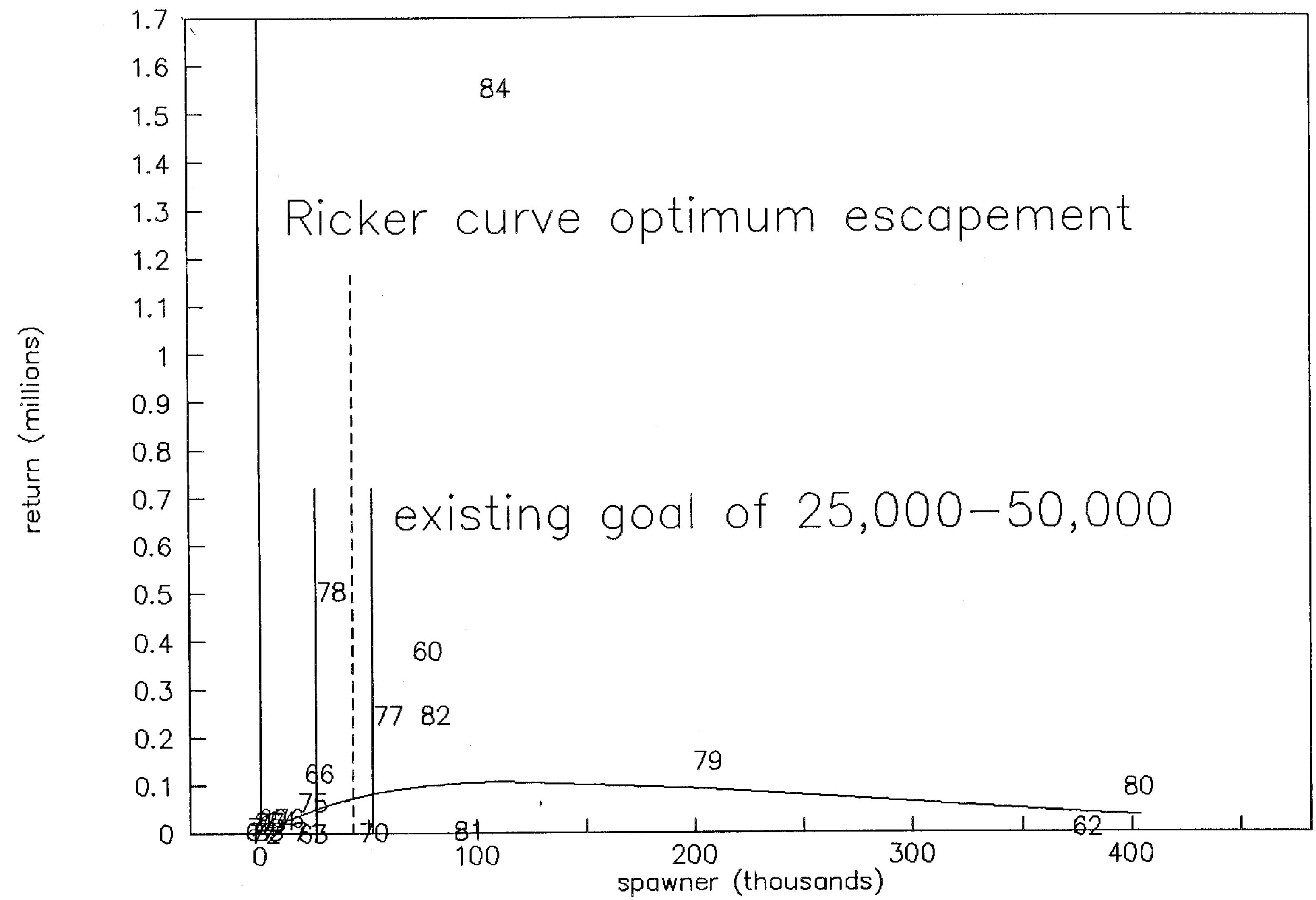

Figure 42. Bruin Bay pink salmon Ricker curve, all years.

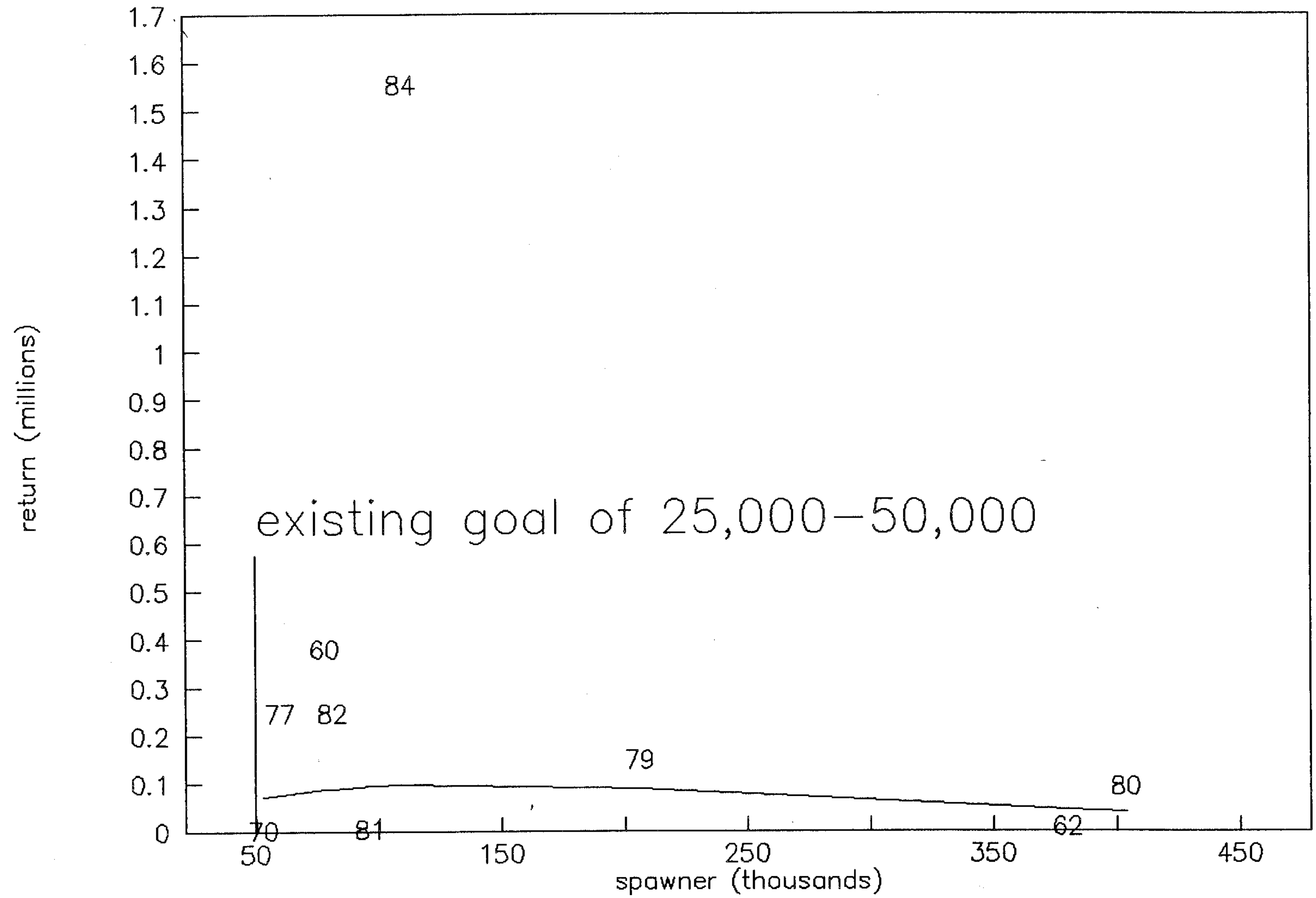

Figure 43. Bruin Bay pink salmon Ricker curve, peak years only.

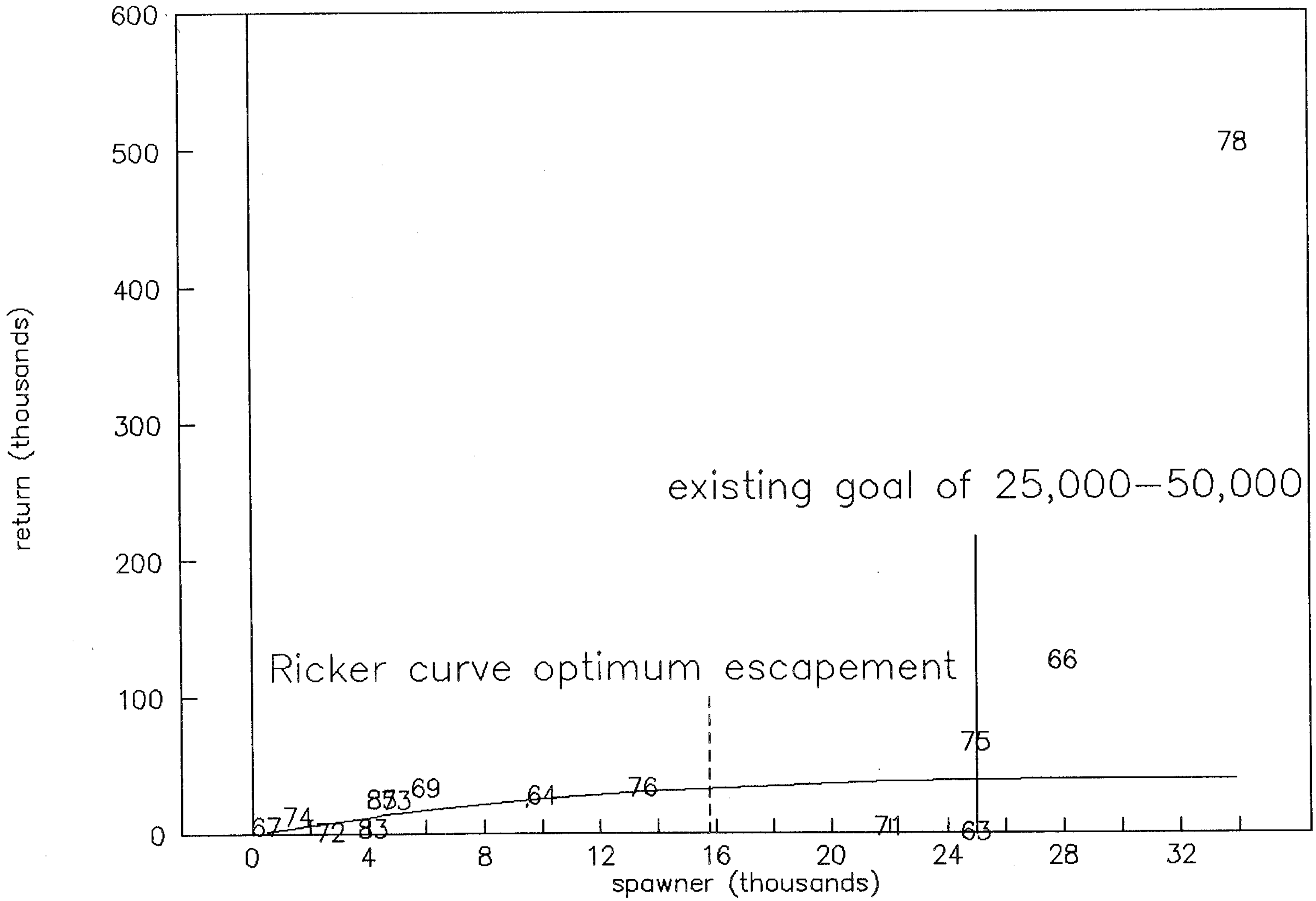

Figure 44. Bruin Bay pink salmon Ricker curve, off cycle years only.

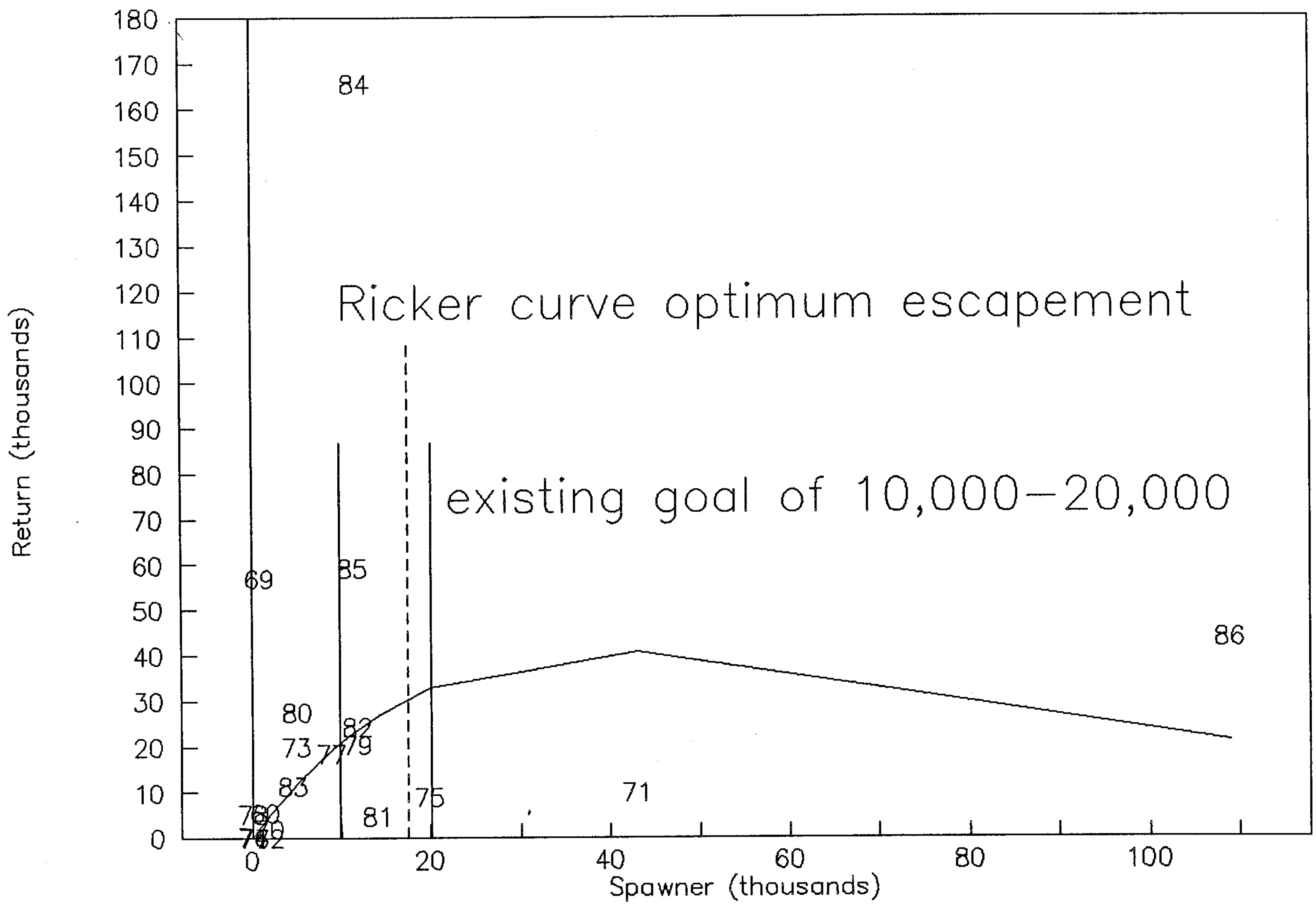

Figure 45. Sunday Creek pink salmon Ricker curve, all years.

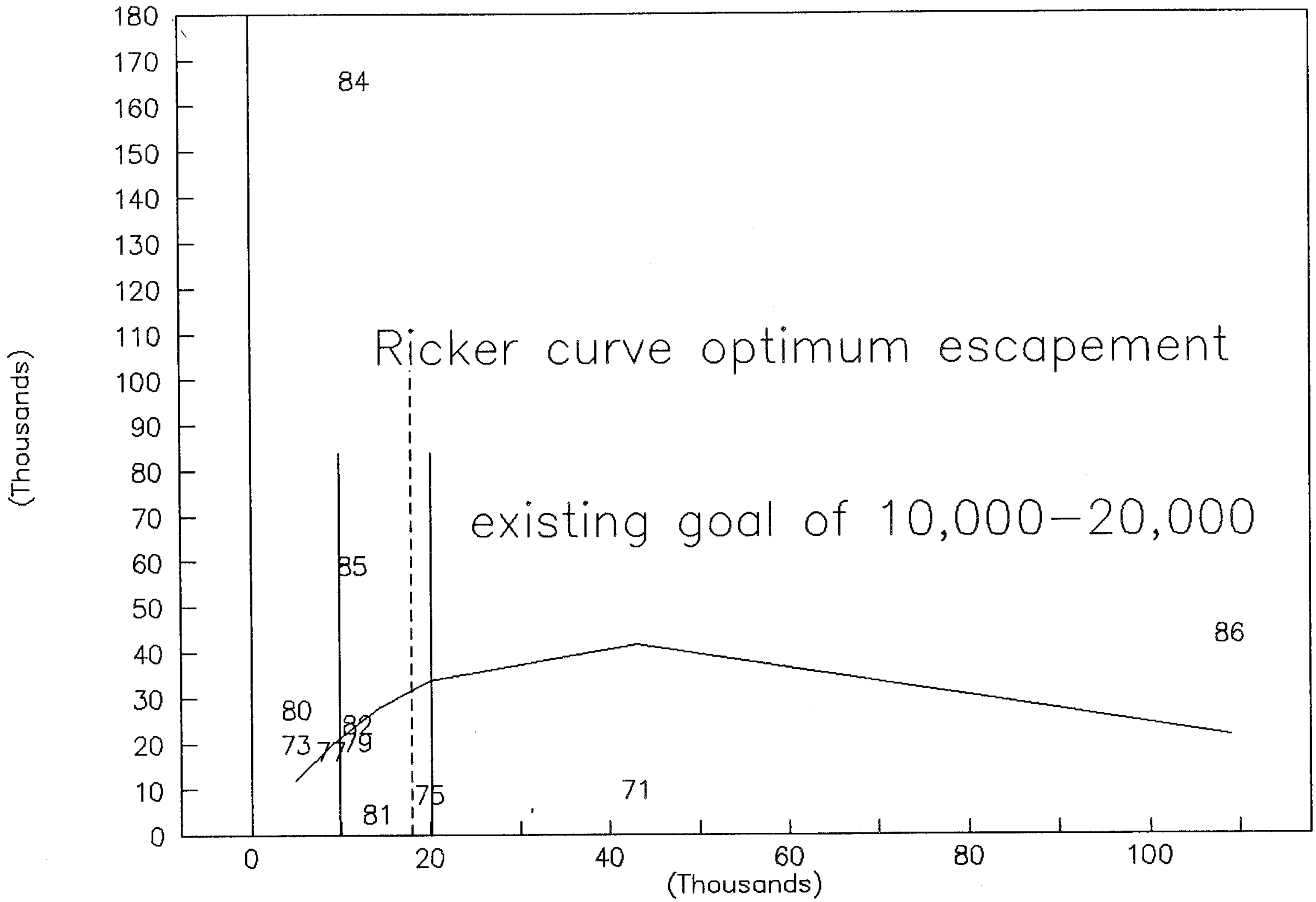

Figure 46. Sunday Creek pink salmon Ricker curve, peak years only.

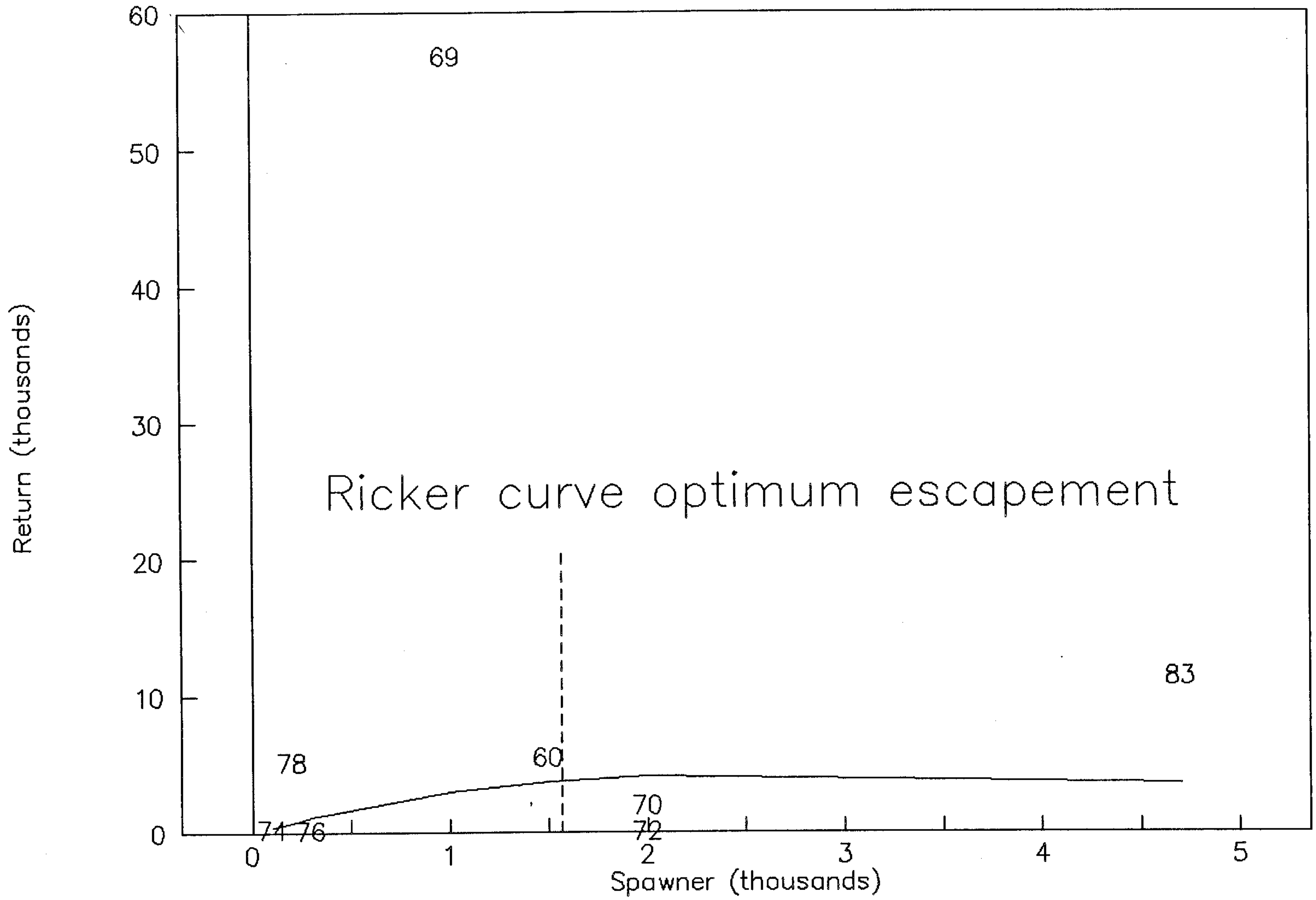

Figure 47. Sunday Creek pink salmon Ricker curve, off cycle years only.

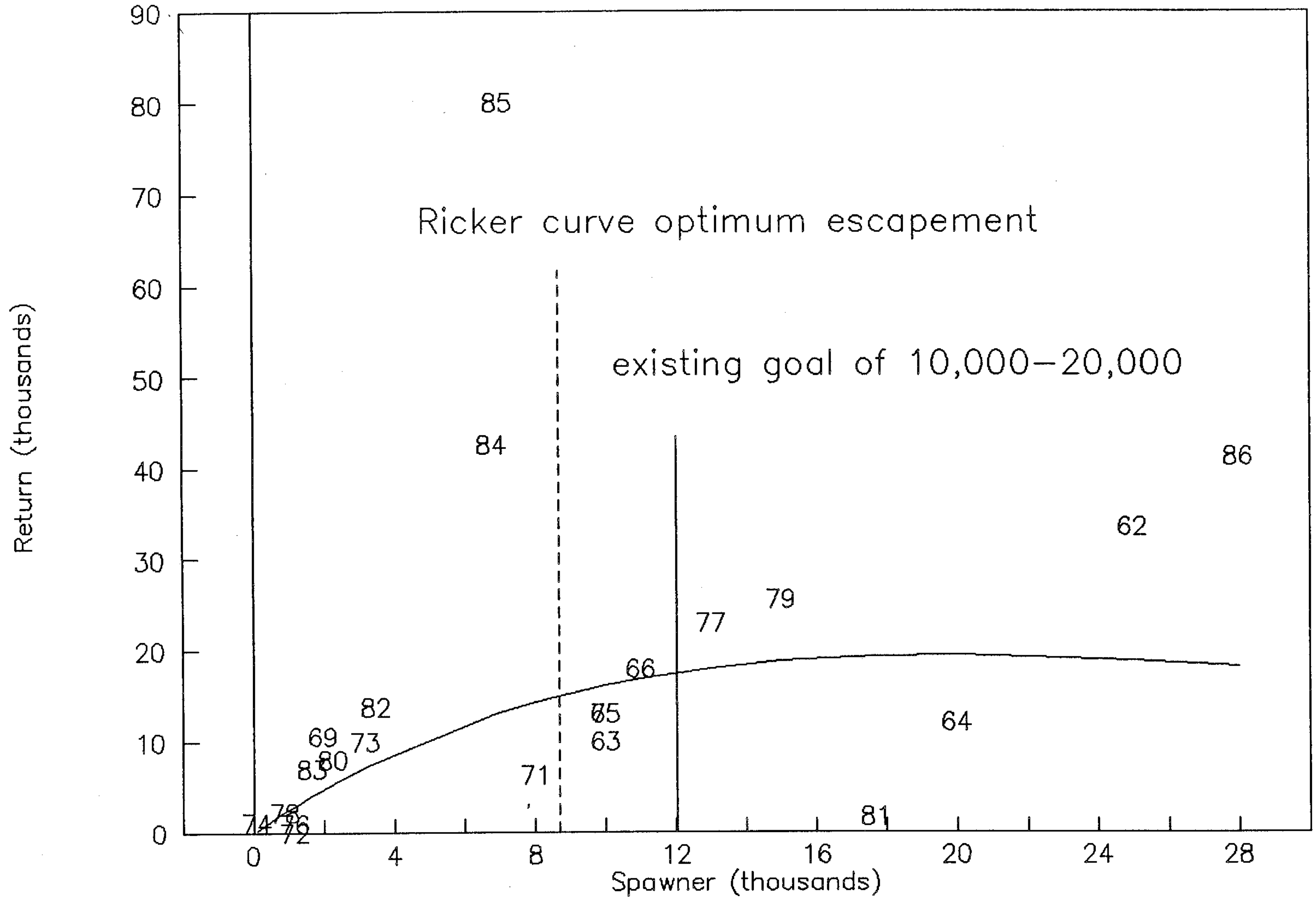

Figure 48. Brown's Peak pink salmon Ricker curve, all years.

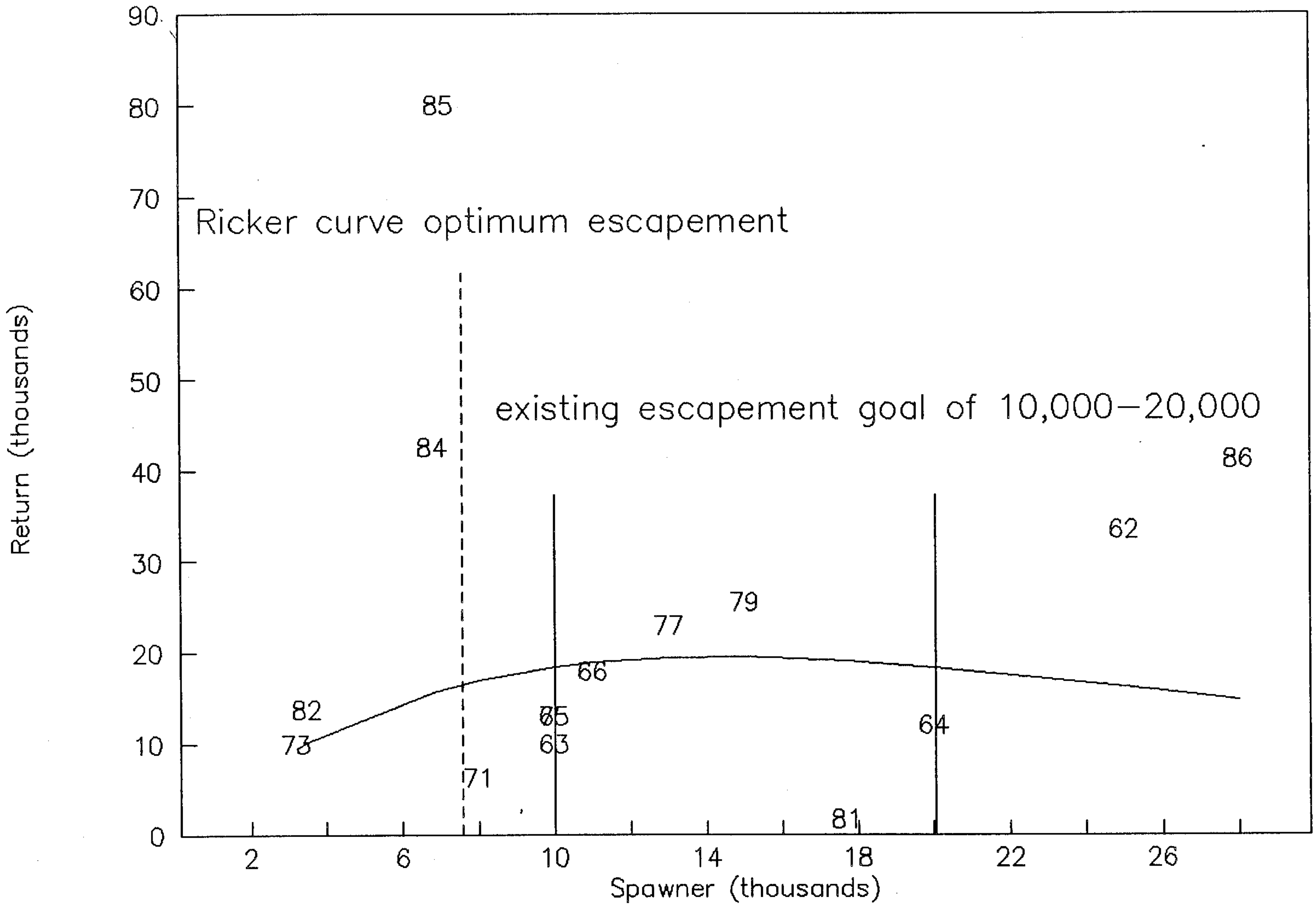

Figure 49. Brown's Peak pink salmon Ricker curve, peak years only.

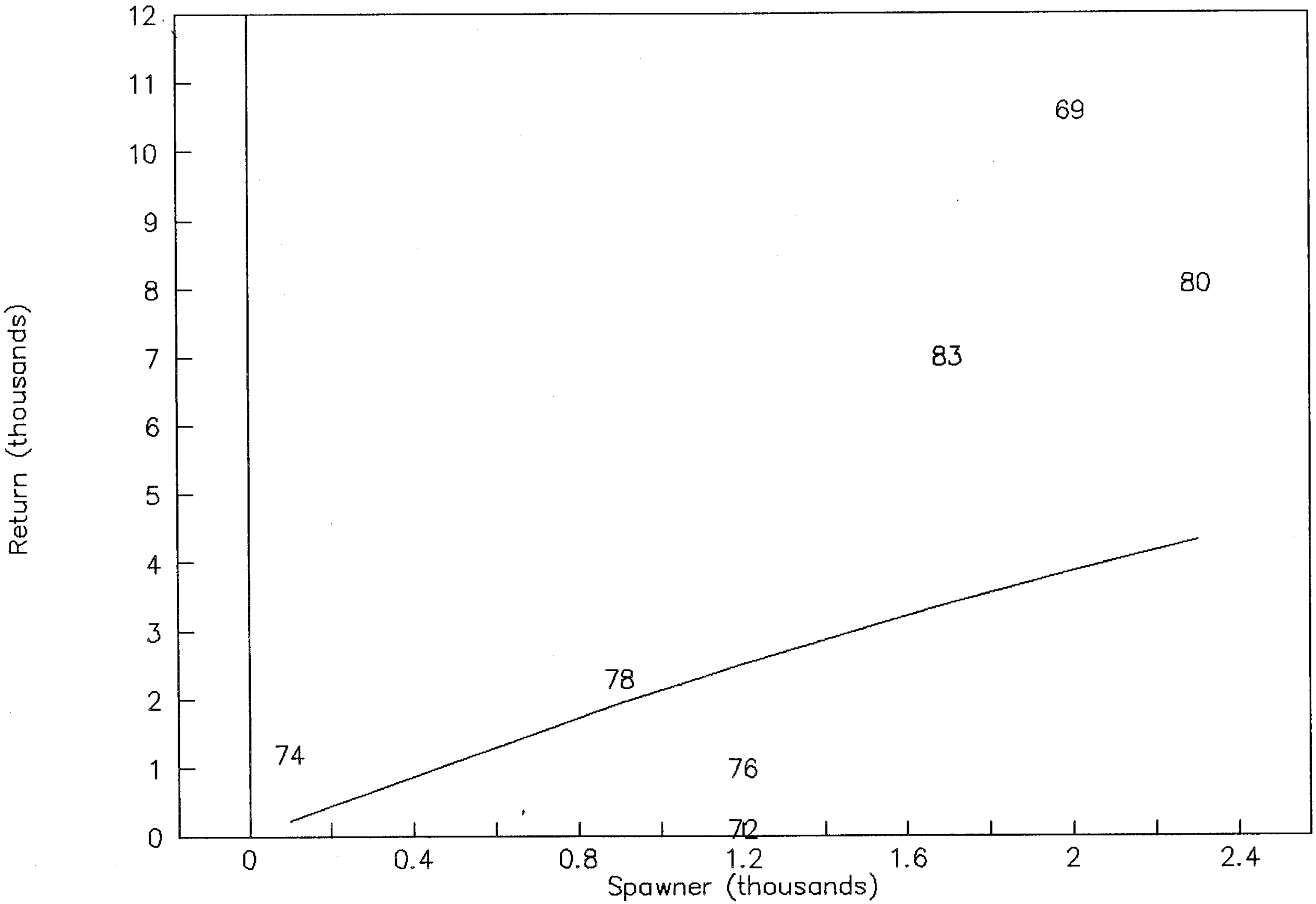

Figure 50. Brown's Peak pink salmon Ricker curve, off cycle years only.

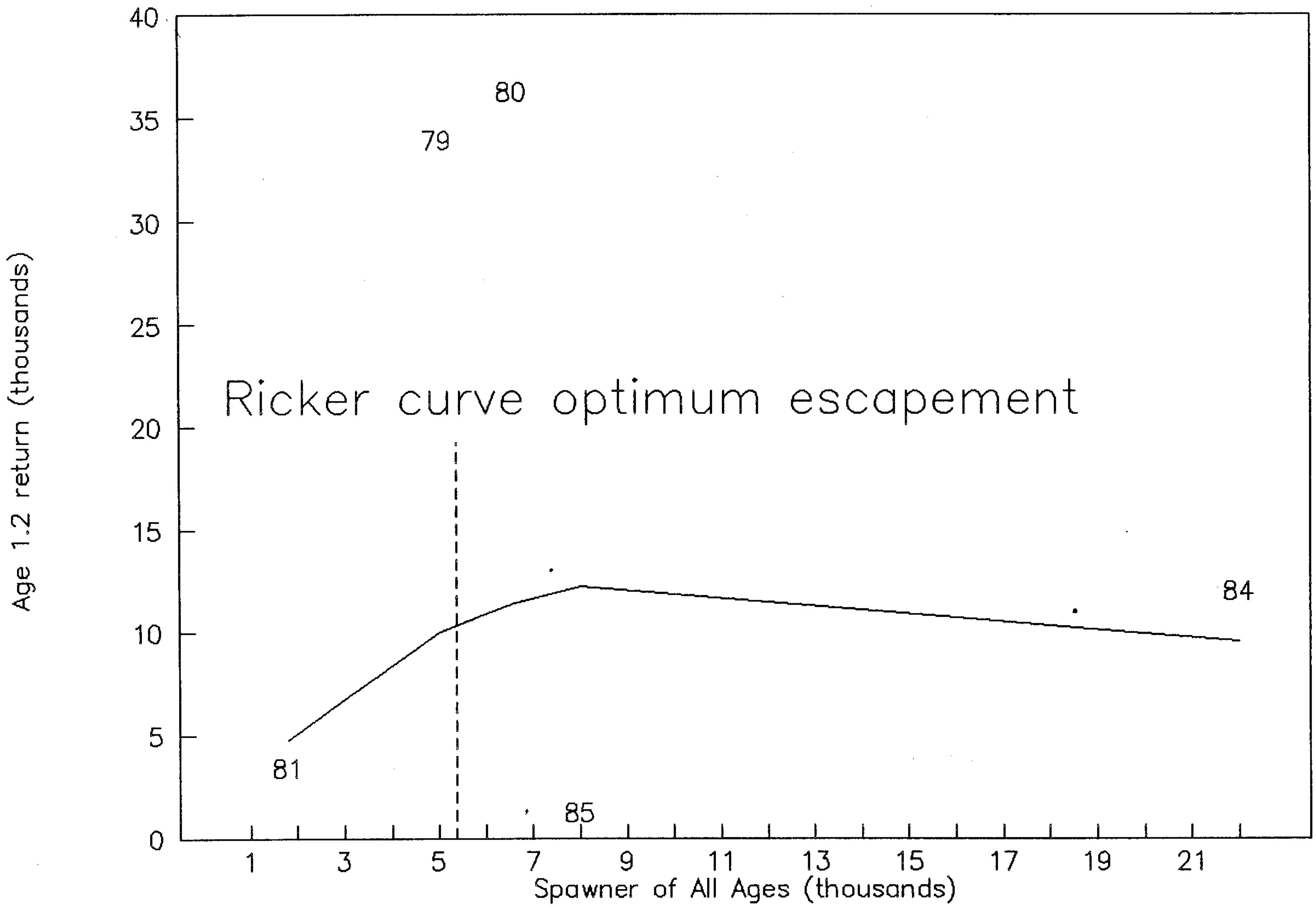

Figure 51. Aialik age 1.2 sockeye salmon Ricker curve.

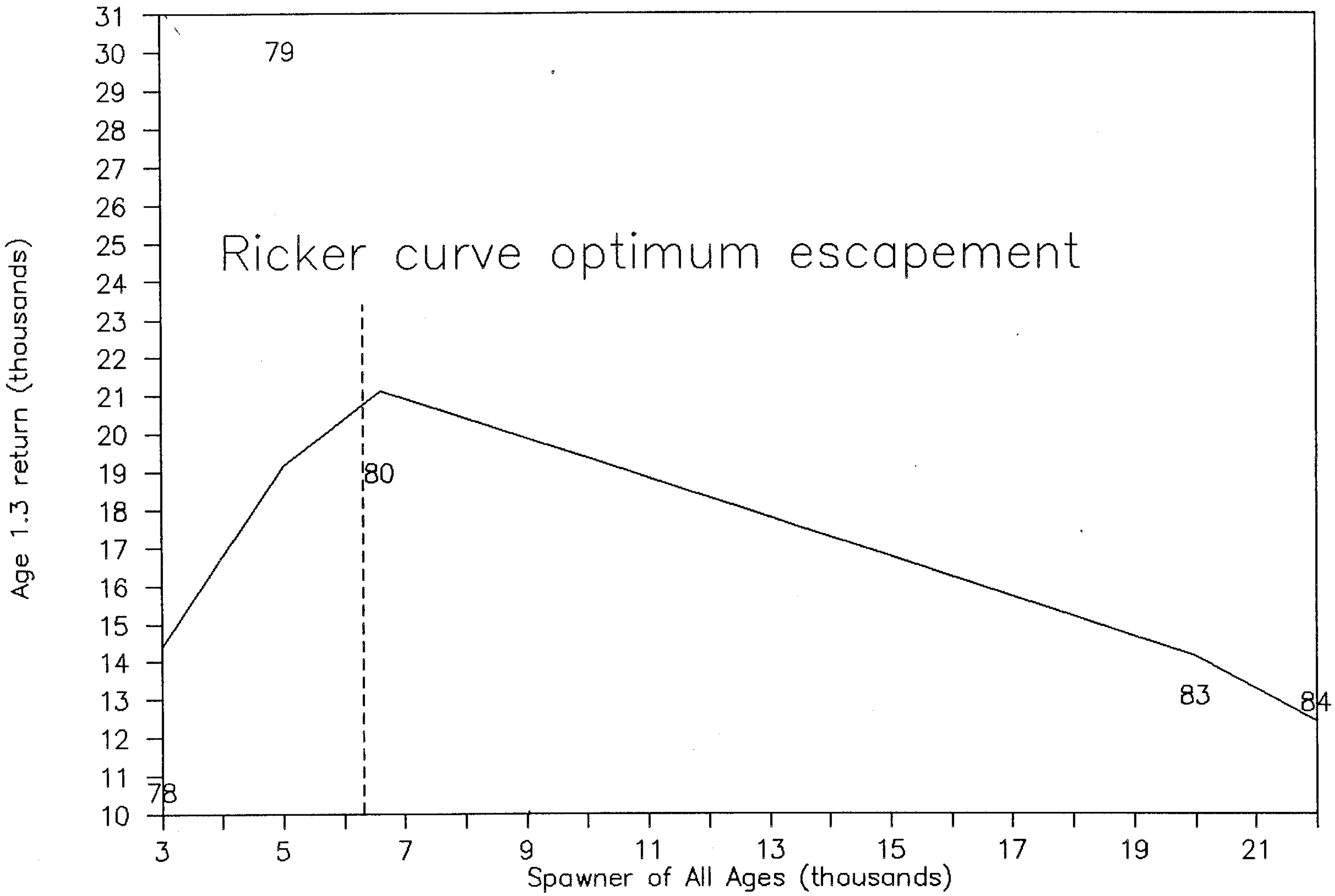

Figure 52. Aialik age 1.3 sockeye salmon Ricker curve.

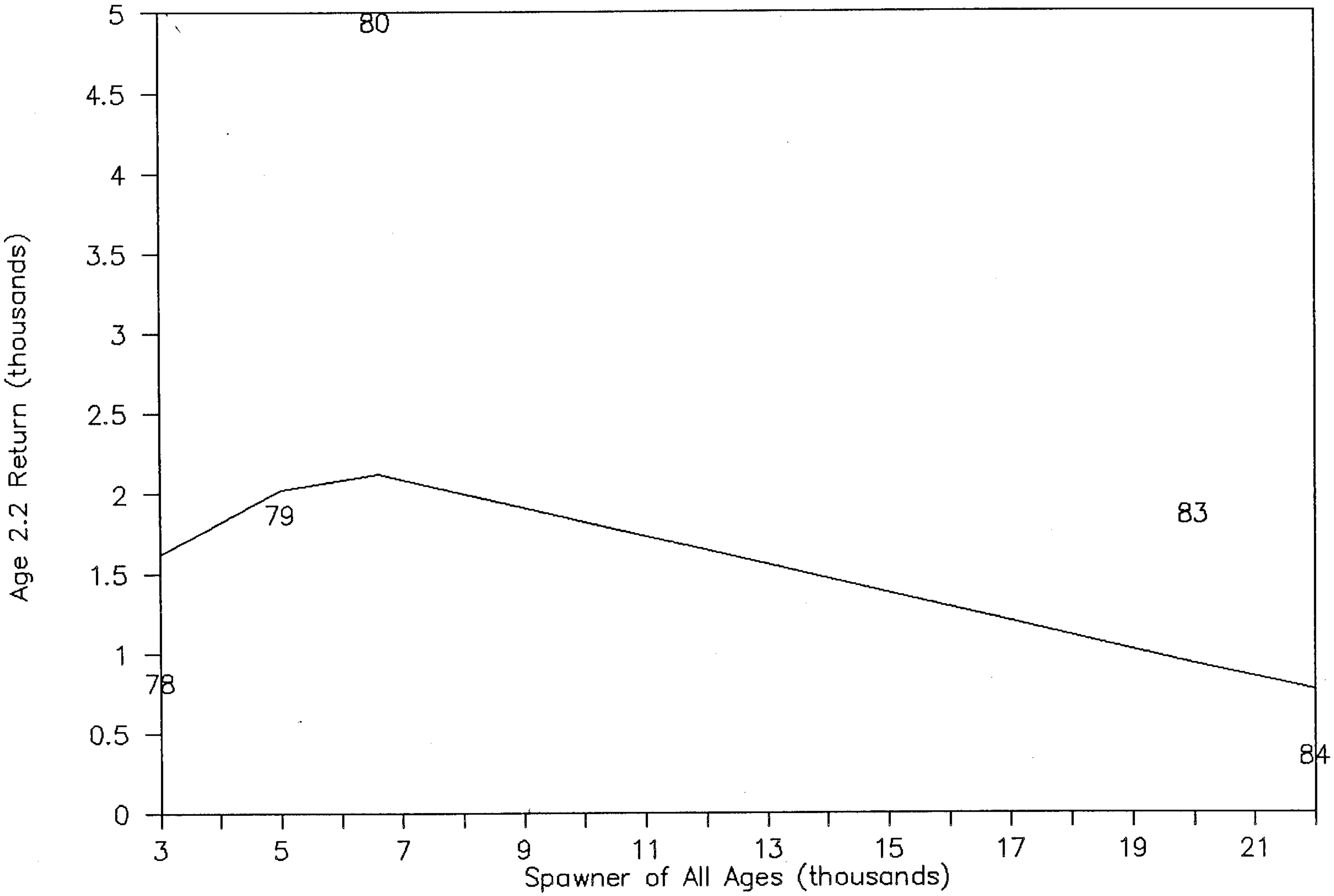

Figure 53. Aialik age 2.2 sockeye salmon Ricker Curve.

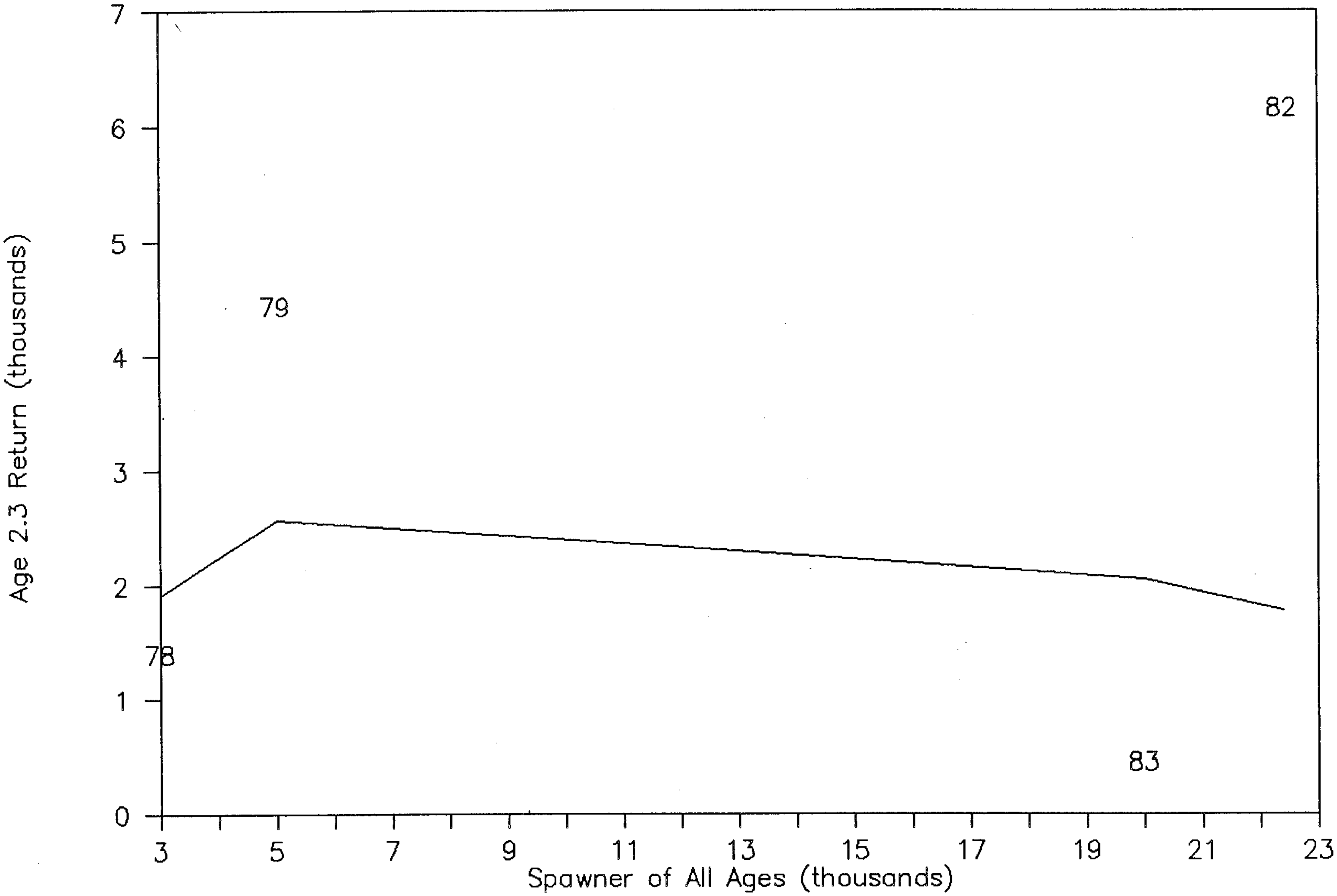

Figure 54. Aialik age 2.3 sockeye salmon Ricker curve.

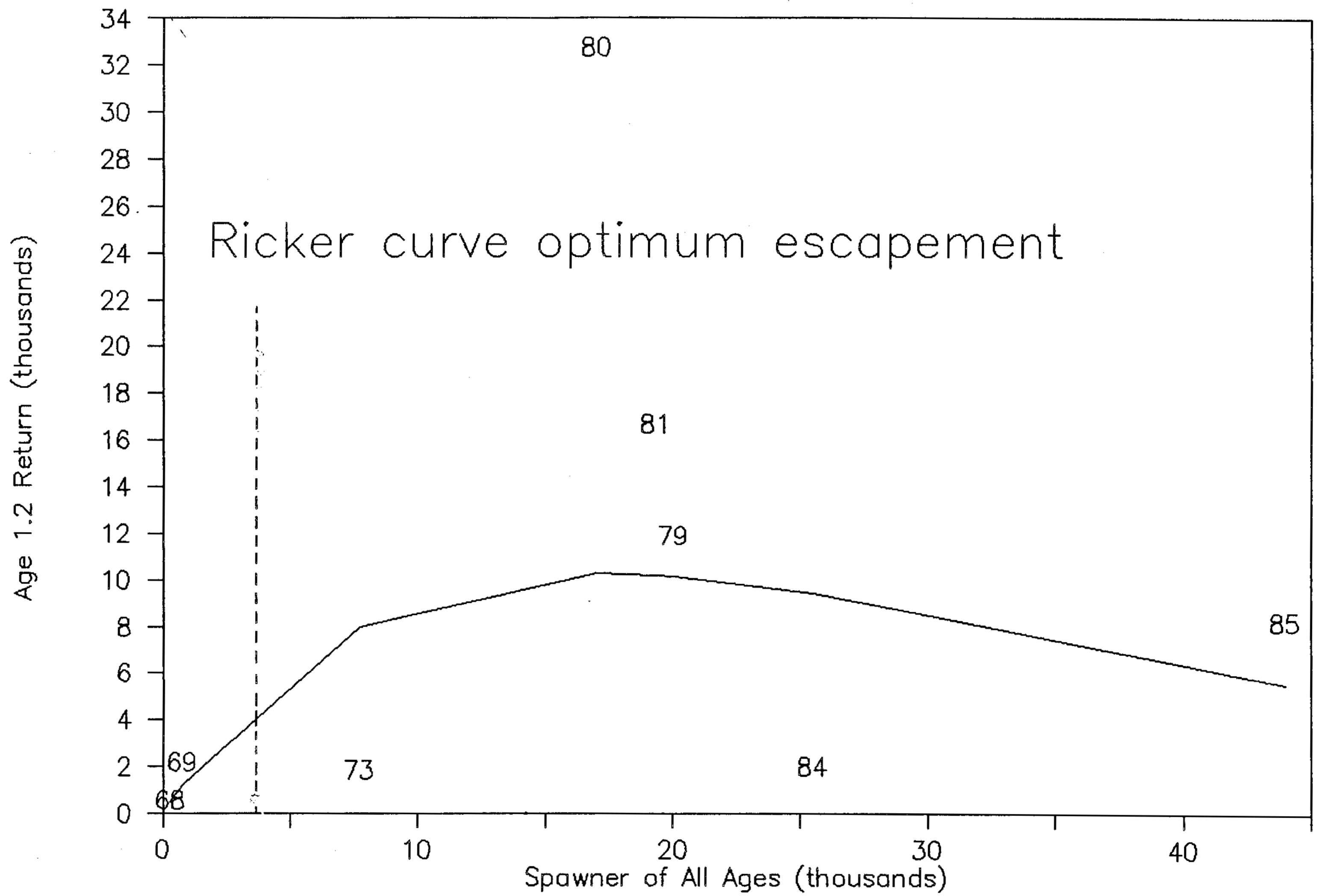

Figure 55. Nuka Bay age 1.2 sockeye salmon Ricker curve.

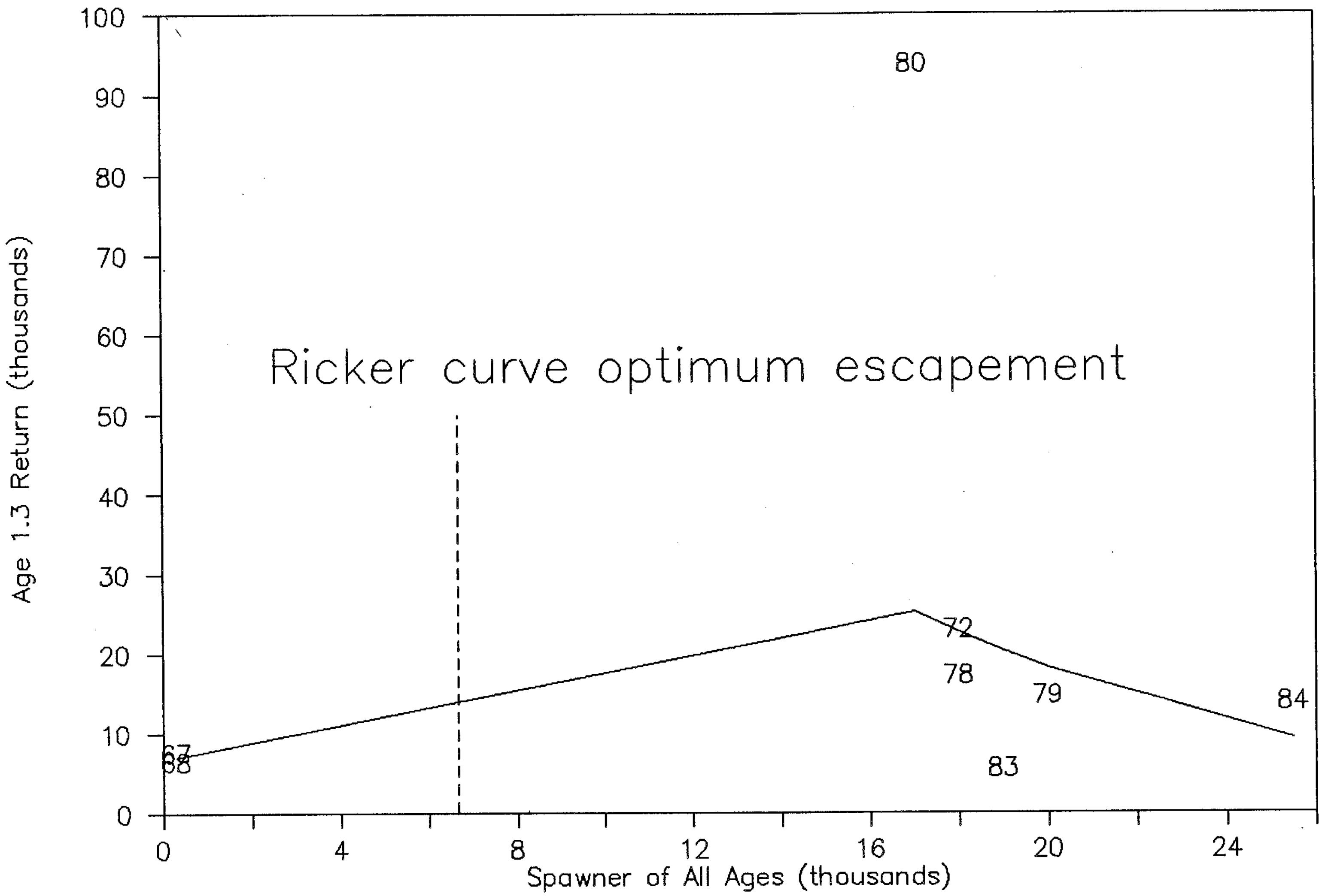

Figure 56. Nuka Bay age 1.3 sockeye salmon Ricker curve.

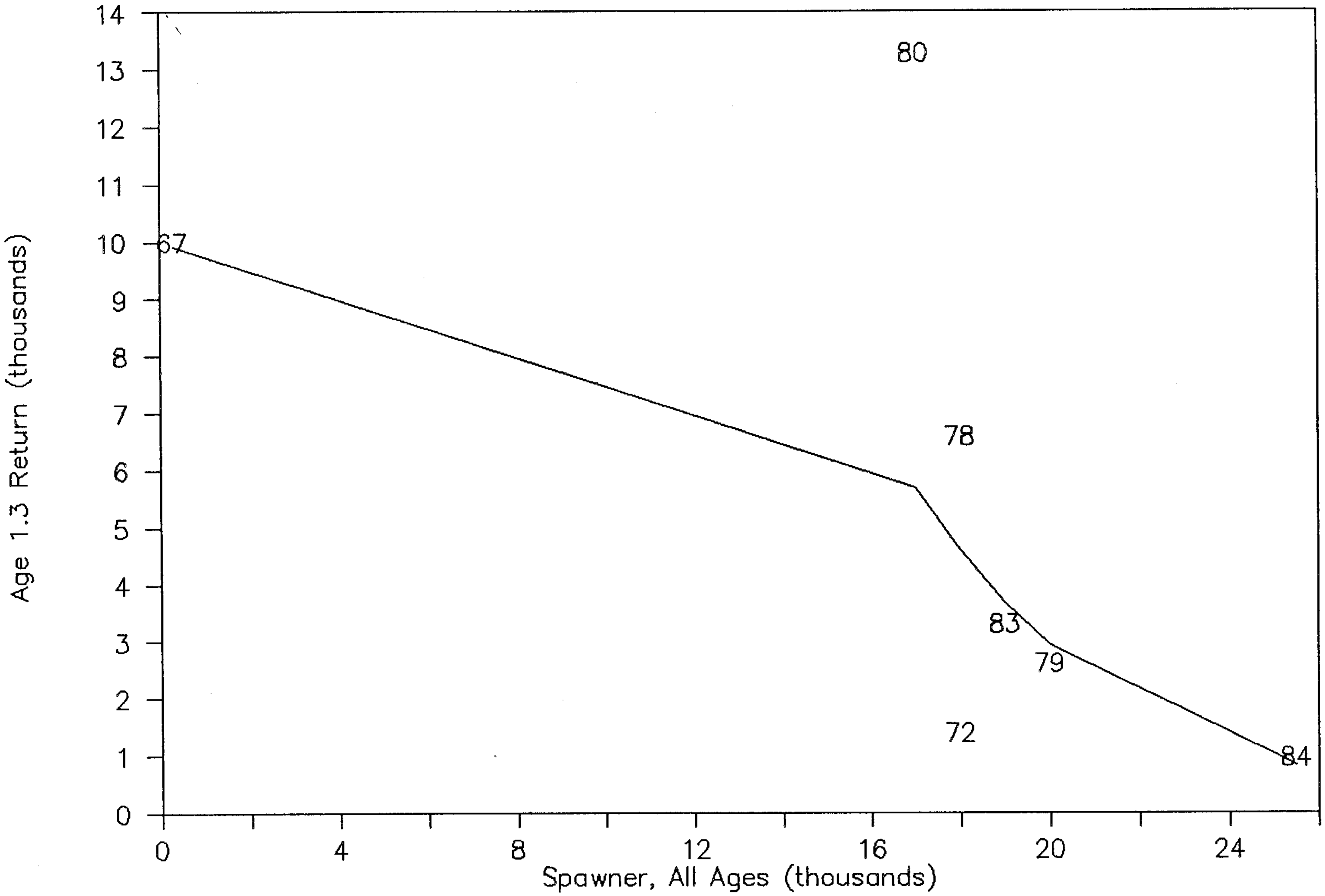

Figure 57. Nuka Bay age 2.2 sockeye salmon Ricker curve.

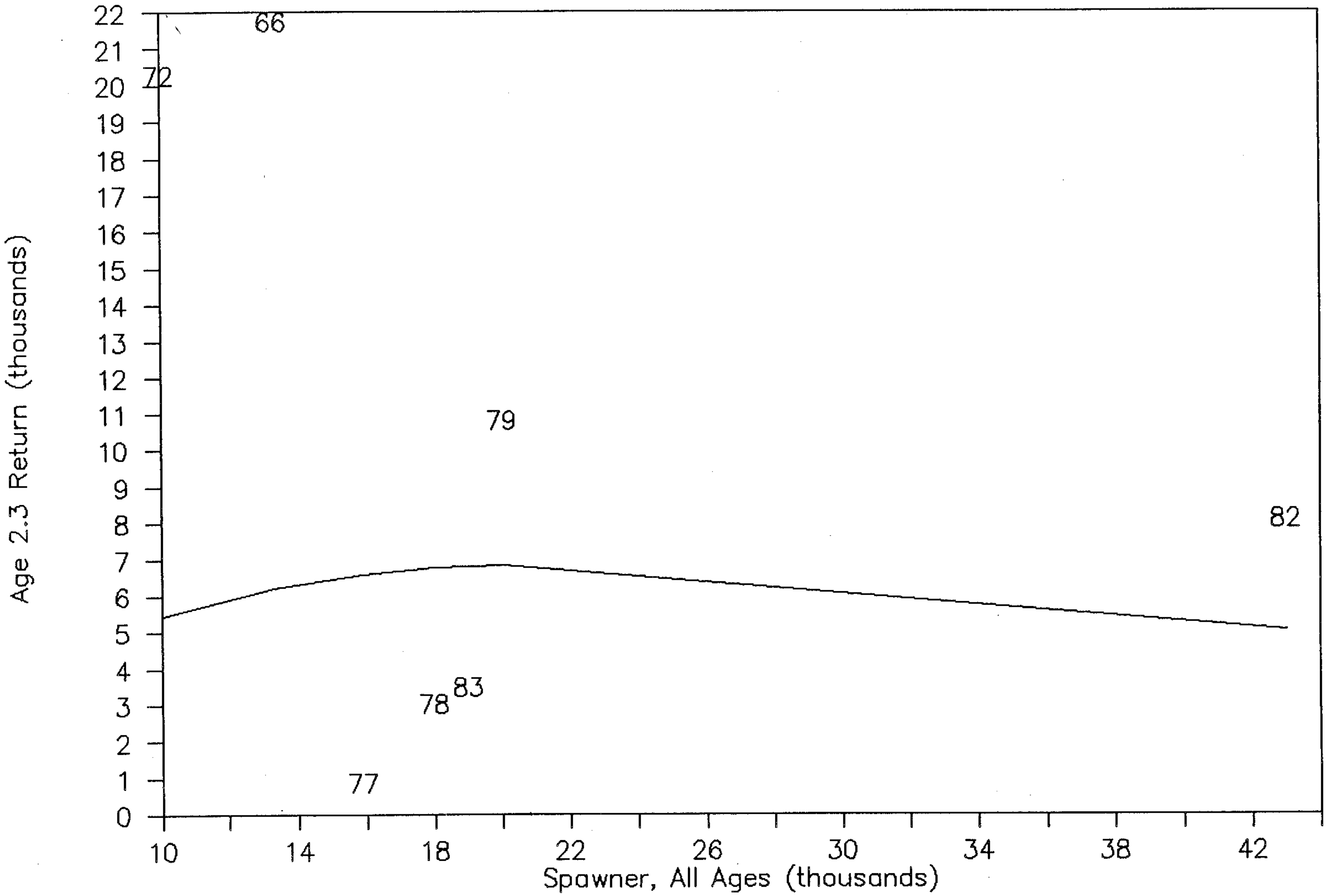

Figure 58. Nuka Bay age 2.3 sockeye salmon Ricker curve.

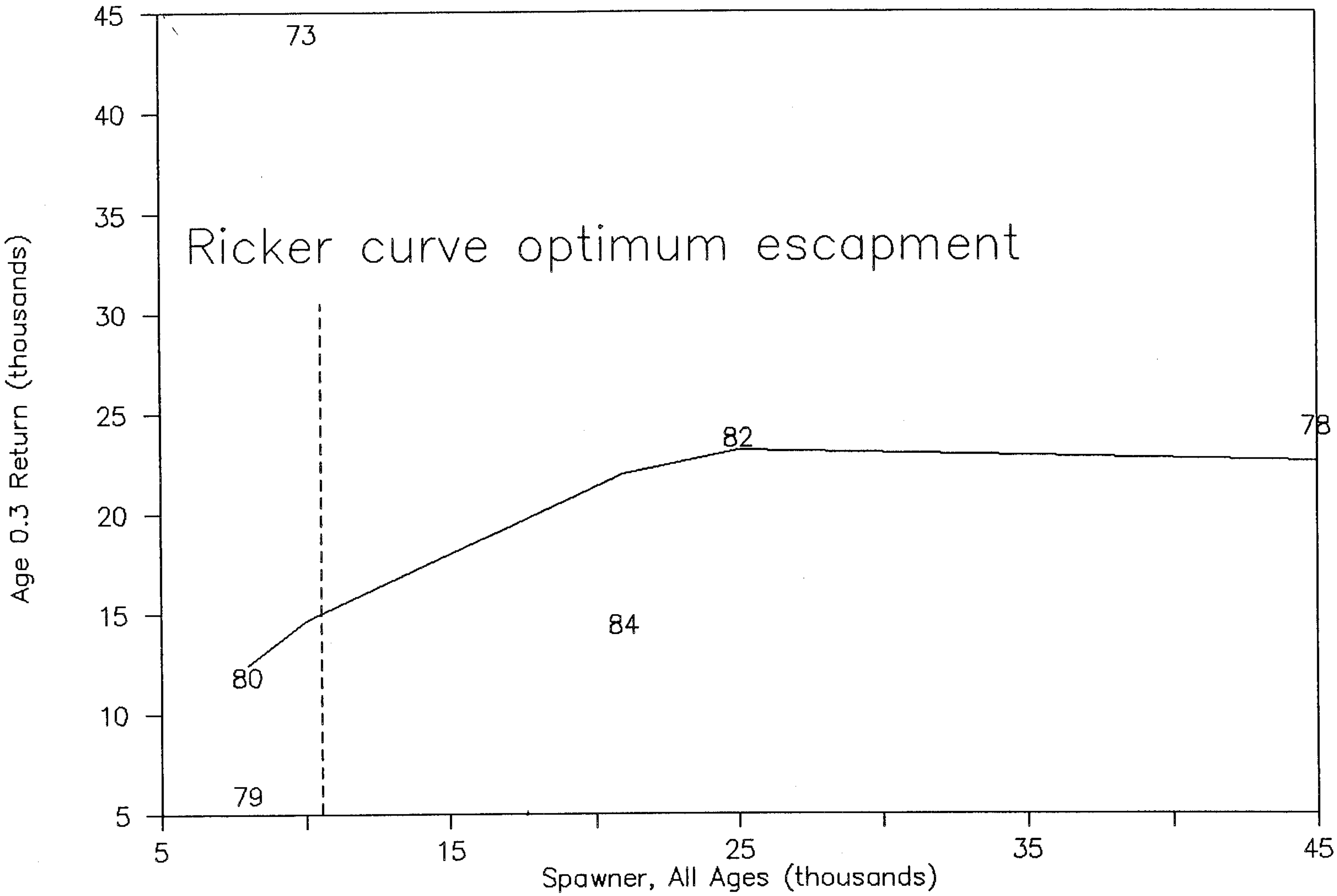

Figure 59. McNeil age 0.3 chum salmon Ricker curve.

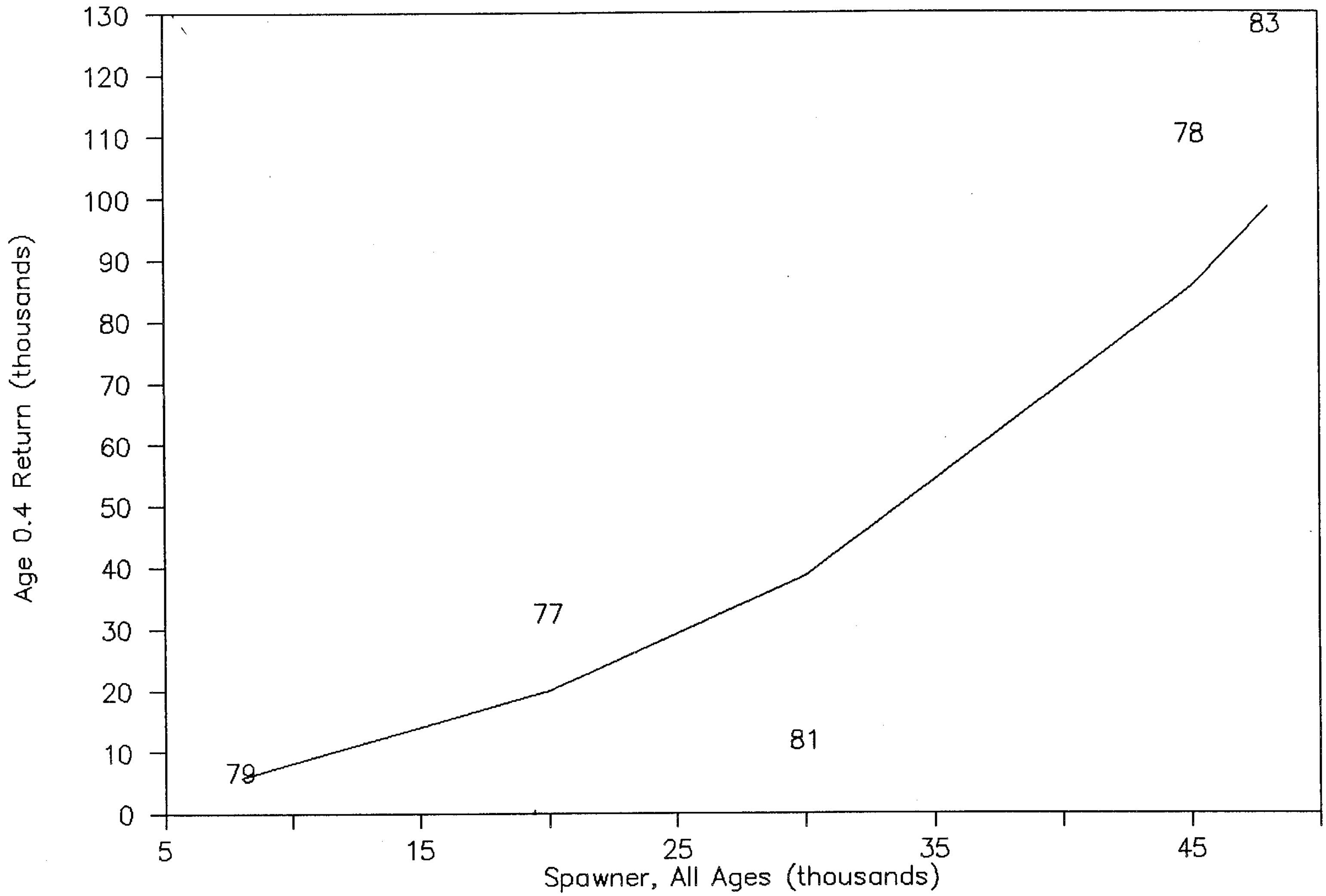

Figure 60. McNeil age 0.4 chum salmon Ricker curve.

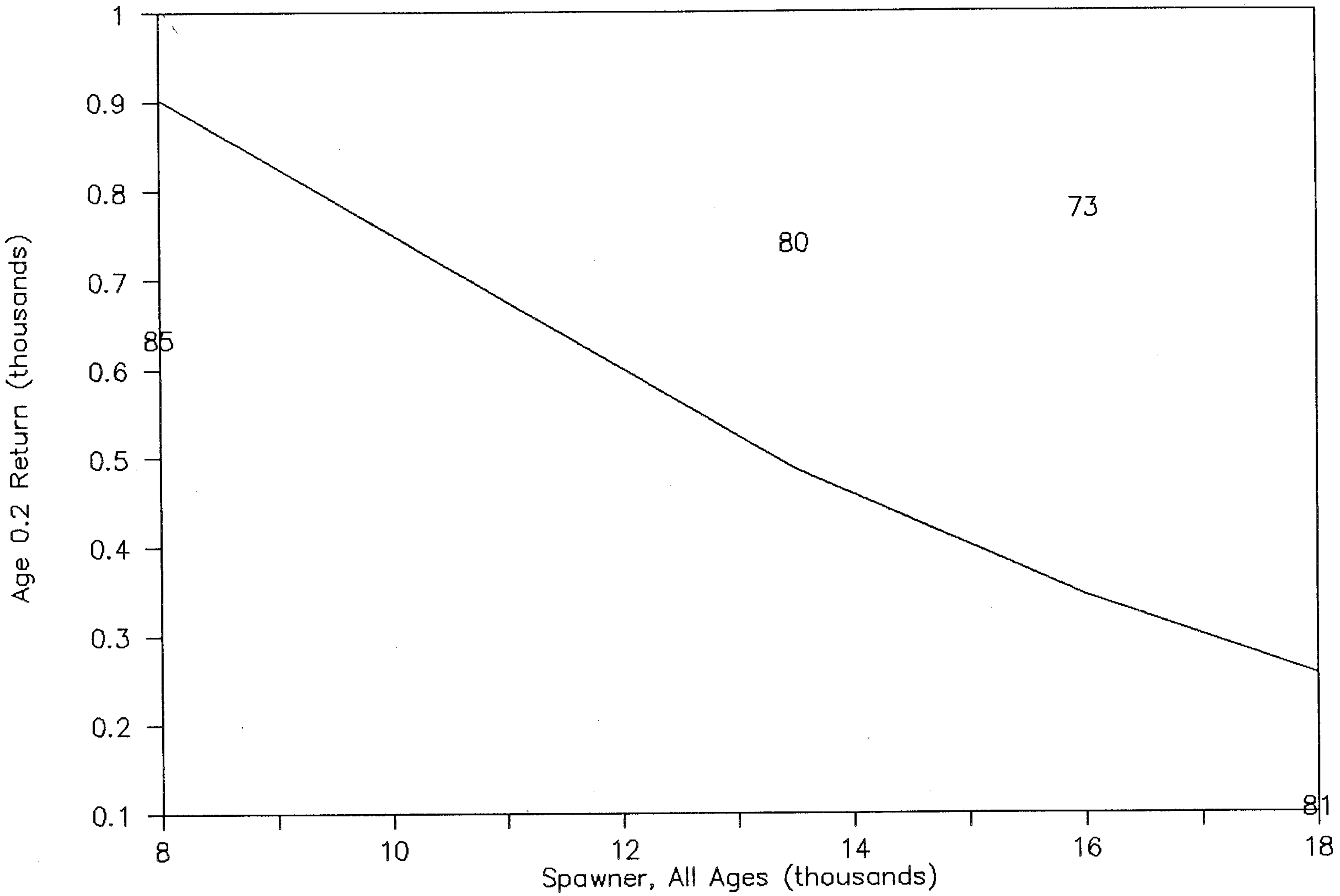

Figure 61. Cottonwood–Iniskin age 0.2 chum salmon Ricker curve.

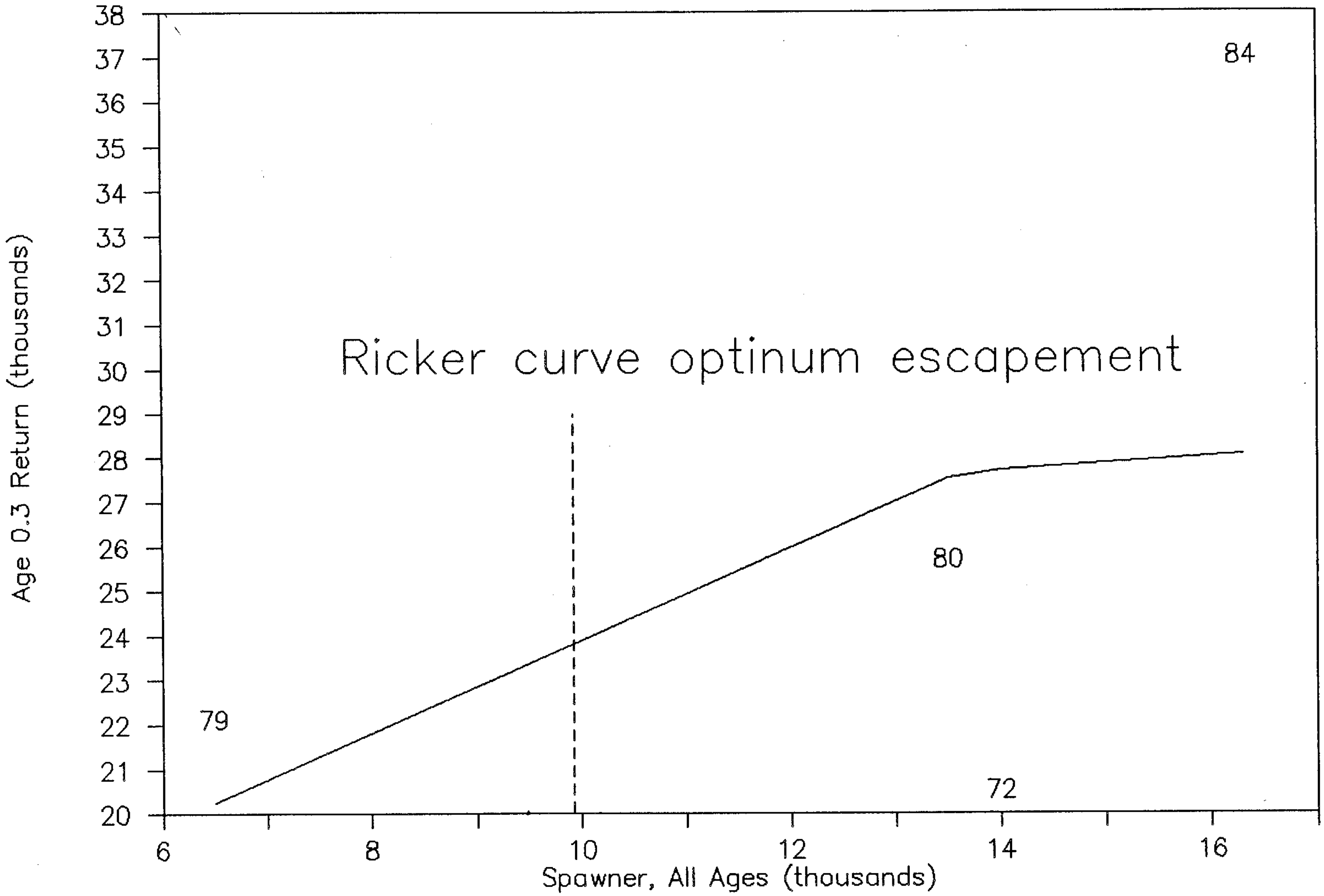

Figure 62. Cottonwood–Iniskin age 0.3 chum salmon Ricker curve.

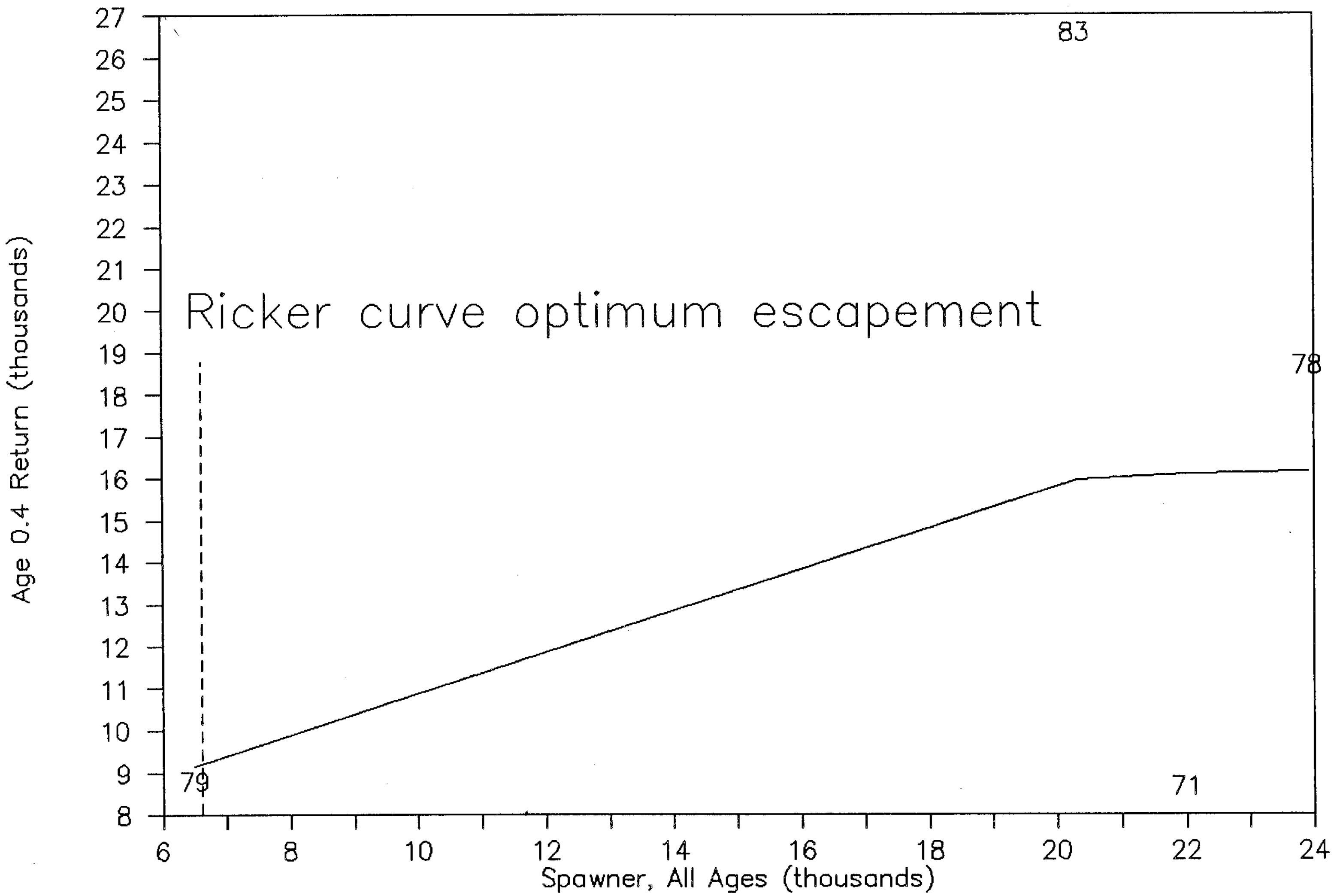

Figure 63. Cottonwood–Iniskin age 0.4 chum salmon Ricker curve.

Appendix A. 1. J. Rearden's Lower Cook Inlet salmon escapement goal history correspondence.

Jim Rearden
413 E. Lee Drive
Homer, Alaska 99603

Phone: (907) 235-8543

Member, American Society
of Journalists & Authors

March 21, 1991

Henry Yuen, Fishery Biologist
Alaska Dept. Fish and Game
Commercial Fisheries Division
333 Raspberry Road
Anchorage, Alaska 99518-1599

Dear Henry:

Escapement goals for salmon in Cook Inlet during my 11 years (1959-1969) as a management biologist in the Inlet were pretty much in the development stage.

I don't know if this will be of any value, but here is the situation: Over the years, the Bureau of Commercial Fisheries and the Fish and Wildlife Service management people wrote annual reports based on their guesses as to what happened each season. In time, a stream catalogue was developed, which we inherited in 1960 when management was transferred to the state.

In 1959, Bud Weberg (then Area Biologist) and I (Assistant Area Biologist until 1961, when I became Area Biologist) accompanied Jack Skerry (the last FWS manager for the Inlet) and his staff into the field to see how they managed the fishery. At the time the FWS hired 10 to 15 stream guards for the Inlet. One of the jobs of the stream guards was to count escapment.

Weekly flights with a Grumman Goose were made from Anchorage headquarters. An attempt was made to survey streams with the Goose - if you can imagine. Even with the bubble windows, it was virtually impossible to make decent surveys. Nevertheless, for some years the figures that were recorded in the stream survey catalogs came from aerial surveys from a Goose - and ground counts by stream guards..

The stream guards were often college students, hired only for the summer, mostly from outside of Alaska. Few had ever seen salmon before coming to Alaska.

No account was made of total escapement into the streams of the lower inlet - (outer district). Peak numbers of fish seen on the spawning grounds were the ones usually entered into the catalog.

At one time we had the annual reports of the Bureau and FWS here at the Homer office. They extended back to the 1920s. About ten years ago I wanted to look up some of the information in these records, went to the office, and was told that all those old federal records had been tossed out. Whoever did that should be shot. There were records of weir counts at English Bay, Chenik, Fish Creek, and Packer's Lake, plus a lot of other good information.

When we started managing the fishery (1960) we started flying stream surveys with Super Cubs, and we made several flights a week in the Southern (Kachemak Bay) Outer, and Kamishak Districts. If there was such a thing as an escapement goal for various streams, it was the crude figure in the federal stream survey log. We had nothing else to go by.

We soon realized that those figures were so crude that they were meaningless. We started putting in a few weirs, and, in those days, we used counting towers. We had towers at Russian River, Fish Creek, and on the Deshka. I think we had one at English Bay one season. We tried a weir on the Deshka one year, but our inexperience with weirs killed the operation.

The year 1962 was one of the big pink seasons for the lower Cook Inlet. We had fish coming out of our ears. Every little trickle seemed to be crowded with fish. We had a couple of years of experience by then, and were beginning to develop figures that we felt made more sense than had those recorded by the feds on their weekly Goose flybys.

As example, we had what we thought was a terrific escapement into Rocky River. As I recall, peak number was somewhere around 70,000. Mostly pinks, some chum.

That fall, heavy rains came, and we discovered that Rocky River has a fairly unstable bottom - and that the barren watershed of Red Mountain really pours the water into the river with heavy rains. We lost most of the spawn from Rocky River that fall/winter. After that, we decided to go for a more moderate escapement into Rocky. That's how crude our escapement goal system was at first.

In the 1960s the main office for the Cook Inlet Managment area was at Homer. The area ran from Cape Fairfield, to Cape Douglas - and included the entire Inlet. After several years, I had one full time assistant management biologist at Anchorage (Julius Reynolds, Carl Yanagawa, and Don Stewart at various times), and one at Homer (Al Davis, Loren Flagg). Another lived at Seldovia - a shellfish biologist (Ben Hilliker), for the king crab fishery was beginning to develop. That Seldovia biologist turned to salmon during summers. In addition, we hired around 8 or 10 temporaries summers - putting them at counting towers. Remember, this was for all of Cook Inlet - a helluva big area, and a darned small staff.

The stream guard program was dropped by the enforcement people early in the 1960s, so we used some of the temporary management people to make foot surveys during the season. After the commercial fishery ended in the upper inlet, we sent survey crews all over the inlet to walk and fly as many streams as possible to evaluate escapement. All they could come up with, of course, were comments like "excellent" "fair" "poor". Almost meaningless.

We couldn't develop escapement goals with the information we were collecting.

One of the first attempts to develop good goals was when we put in a wier at Humpy Creek, here on Kachemak Bay. We did decide, I think (it's been a lot of years now) that a total escapement of about 30,000 was a good figure for Humpy Creek.

Then a research position opened, and Al Davis started working on forecasting pink runs for the Southern District (Kachemak Bay) and Outer District. Over the years his forecasts improved, and by the time I left the Department in 1969, we were beginning to learn what kind of escapements various streams needed, and what kind of returns we could expect. In other words, meaningful escapement goals for the lower Inlet weren't really possible until Al's forecasts were developed.

I realize you aren't concerned about the gillnet fishery north of Anchor Point, but it was the major fishery, and our escapement information and goals were even worse than those for the clearwater streams of the Lower Cook Inlet.

I remember one fall that Al Davis, as a temporary (we liked his work so well we hired him as a permanent when he finished school) took a jet boat up Kenai River, from the mouth to Kenai Lake, trying to get a handle on escapement. It was a hopeless effort - as were aerial surveys of the silty Kasilof, and much of the Susitna.

We put a fishwheel in the Susitna River for a few years (Joe Redington ran it for us for a time), using it to sample the runs, trying to get some idea of what was going on there. We did the same for the Kenai and Kasilof Rivers. Again, it was pretty sketchy information.

You won't believe how we determined the strength of the Inlet run. It was based on the catch. We knew fairly close how many nets were fishing, and after each fishing period we insisted on getting fish tickets. We'd add them up - and compare the figures to previous years of the same date, taking into account fishing pressure, weather, and any other factors we felt were involved.

Variables? You bet. A storm could change figures drastically. A strike screwed us up. Yet, it was all we had to go by. We guessed our escapement of sockeye for the upper inlet based on the catch. Good catch, good escapement, we figured. We'd try to verify by fishwheel counts, and we tried with aerial surveys. The Russian River counting tower (weir at first, counting tower later) was a critical one. The wier and later the tower at Fish Creek were also indicative.

During World War II I was a sonar operator, and knew how sonar works. During the 1960s, after a year or so of looking at the murky streams of the Inlet and wondering how many salmon swam in them, I decided that sonar might be a way of counting salmon escapement. I got permission from Commissioner Kirkness to write sonar companies to ask if any would be interested in developing a sonar salmon counter. I wrote about six or eight of the major companies.

Bendix was the only company to answer.

The following year Bendix sent Al Menin to Alaska with a rig he had developed. He came to Homer and I sent Rae Baxter out with him. They went to the Kasilof River to find out if sonar could sense salmon in silty water. Honest - we didn't even know if it would. It was late in the season, and the reds were gone. Rae managed to catch a few silver salmon.

Al Menin learned that sonar could sense salmon in silty water when Rae Baxter pulled a dead silver salmon through the water in front of the sonar trandsducers!

The next season, Menin showed up with a sonar machine and we flew him to the Kvichak where he installed it beside a counting tower. In that clear water Menin managed to get the thing working pretty well. He then bought it to the Kenai River, and the rest is history.

As far as I know, all of the salmon-counting sonar machines now in use throughout Alaska came from Bendix and the work of Al Menin. I'd be interested in knowing how many sonar salmon counters are used by the state now, and where they are in use. Just curious. For the first few years Al Davis worked with Menin. Later, Menin developed the sonar smolt counter.

It took a few years, but with the sonar counts, it was possible to gradually develop some escapement goals that made biological sense. By then, I was long gone from the Department.

This then was the ground work to develop escapement goals for Cook Inlet streams.

I don't know if any of this is of value to you. I've read your report, and can't really add anything to it. It's been so long that I'm not even sure where some of the streams listed are any more - and a few new names have come into use in the past 20+ years.

Thanks for asking.

Best,

Jim Rearden

Appendix A. 2. Table 9 from 1976 Board of Fisheries Report.

Table 9 Pink salmon escapements to spawning streams in Resurrection Bay, Lower Cook Inlet, 1960-76.1/

Spawning Systems	1960-74 Peak Spawning Density	Date Observed	1976 Peak Count	1976 Estimated Escape.	Estimated Spawning Capacity
Humpy Cove	600	8/19/74	1,400	1,400	500 - 1,000
Thumb Cove	1,100	8/19/74	1,860	1,860	500 - 1,000
Tonsina Creek	2,860	8/23/68	2,050	2,050	2,000 - 3,000
Airport Creek	340	9/06/62	40	40	300 - 400
Sawmill Creek	-	-	350	350	-
Bear Creek	6,400	8/20/64	7,960	10,030	4,000 - 5,000
Mayor Creek	1,600	8/31/68	3,550	4,270	1,000 - 2,000
Clear Creek	1,520	8/24/64	1,660	1,950	1,000 - 2,000
Salmon Creek	8,000	8/20/74	11,910	16,900	5,000 - 10,000
Grouse Creek	2,000	8/16/60			1,000 - 2,000
Totals	24,420		30,780	38,850	15,700 - 26,400

1/ Escapement estimates prior to 1976 usually consisted of a single count made during what was estimated to be the peak spawning time.

Appendix A. 3. T. Schroeder's "Mikfik sockeye salmon mgmt." memo.

STATE OF ALASKA — MEMORNADUM

To: John Hilsinger
Regional Mgmt. Biologist
Commercial Fisheries
Anchorage

Date: Sept. 14, 1987

From: Thomas R. Schroeder
Area Management Biologist
Commercial Fisheries
Homer

Subject: Mikfik Sockeye Salmon Mgmt.

The escapement goal for sockeye salmon in Mikfik Lake has always been 5,000 fish. While this figure is somewhat arbitrary, it is based on looking at escapement goals for other Lower Cook Inlet sockeye producing systems and was somewhat tempered in recent years due to the increased bear activity - I will explain this further later on.

Lake	Escapement Goal	Surface Acres	Ave. Escapement
Mikfik	5,000	est. 120 - 140	5,500
Aialik	2,500 - 5,000	75	6,300
Chenik	10,000	290	2,700
Delight	10,000	600	8,000
Desire	10,000	400	8,800

Based on observations of the total returns to Mikfik it appears that this escapement level is appropriate. The largest return to this system in 1985, which totalled 87,000 sockeye was from 1980 and 1981 escapements of 6,500 and 5,300, respectively. Recent strong returns are definitely due primarily to environmental conditions rather than escapement levels as this trend has been an area-wide phenomenon.

Since the steady fishing began in the lagoon to harvest the strong sockeye returns, we have basically tried to get 3,000 fish inside the lagoon before allowing fishing 7 days per week. After the 5,000 fish were committed to the stream, the lagoon was opened on a continual basis until the main part of the run was over. In most prior years a net was used to block off the return to maximize the harvest. All of this has changed radically in the past three years to accommodate the Game Divisions concerns.

We now open the subdistrict on June 1 and as soon as 2-3,000 fish reach the lagoon or that the catch starts building, fishing is allowed 7 days per week. The lagoon is only opened after the 5,000 fish goal is achieved. A net was used in 1987, but proved useless and a Department net, will in all likelihood, not be used again. The escapement in 1987 was estimated to be 9,000 sockeye and, since the large returns began in 1982, has never been below 6,000 fish and has ranged from 6,000 - 35,000. Total returns from the large 1982 spawning population of 35,000 fish were estimated to be 20,600 in 1986 (4-year old) and 10,500 in 1987 (5 year old) for a total of 31,100 fish. This represents only a 0.89 return per spawner, whereas, lower escapements in Mikfik and other systems in Cook Inlet generally produce R/S ratios of 3 or 5 to 1.

Even with continuous fishing, with no net in the creek or continuous or periodic openings on high tides, sockeye continue to move through the fishery and into Mikfik Creek on a steady basis. This is already providing additional fish for the bears and photographers and since 1982 over 54,800 sockeye, over and above the escapement goal, have gone upstream to provide food for bears.

McNeil Lake is the largest, clear freshwater lake in Lower Cook Inlet and has an excellent potential for producing additional salmon for fishermen in LCI. The lake is approximately 6 miles long and 1,200 - 1,400 surface acres (5 times the size of Chenik or Leisure Lakes). If an early returning brood-stock (month of June) could be located, the return would be over in late June along with Mikfik before the McNeil chum salmon begin.

A total enhancement project which would include fertilization, could produce an adult return of 400 - 900,000 fish based on data from other projects in LCI. At an average weight of 5 pounds and $1.50 per pound, the return would have an ex-vessel value of $2.4 - 5.4 million, assuming an 80-90 percent harvest rate.

I am fairly certain that if allowed to enhance McNeil Lake with sockeye salmon, LCI seiners would voluntarily give up commercial fishing in McNeil Lagoon on Mikfik sockeye. Perhaps a special harvest by one or two vessels could be allowed, if a surplus occurred, to fund the McNeil Lake project. The project over time might actually draw more bears to McNeil falls in June as fish would be available, but I doubt that the sockeye escaping upriver would move fish away from McNeil falls. Upriver chum salmon escapements of 20-40,000 fish have not attracted appreciable numberof bears in July because the river is too large. The surplus sockeye would congregate in a narrow, steep sided canyon over 20 miles upriver and I doubt that many bears would even locate them for years.

That's about all I have for now.

cc: Florey
Dudiak

Appendix B. 1. Humpy Creek pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	10,000	164,800	0
61	22,600	92,100	0
62	56,000	100,900	1
63	34,700	41,800	0
64	18,500	70,700	0
65	28,000	65,400	0
66	30,000	68,600	0
67	25,000	6,000	0
68	24,700	169,300	0
69	5,400	56,400	0
70	55,200	15,900	1
71	45,000	81,200	1
72	13,800	52,800	0
73	36,900	403,300	0
74	17,400	100,300	0
75	64,000	128,700	1
76	27,200	90,100	0
77	86,000	504,000	1
78	46,100	117,700	1
79	200,000	365,900	1
80	64,400	37,900	1
81	115,000	131,700	1
82	31,900	145,900	0
83	104,800	128,400	1
84	84,200	166,400	1
85	117,000	28,600	1
86	49,700	21,400	1

Note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B. 2. Seldovia pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	25,000	192,800	1
61	25,000	14,600	0
62	50,000	97,400	1
63	13,000	49,200	0
64	60,000	130,100	1
65	30,000	66,700	0
66	86,000	76,800	1
67	55,000	88,800	0
68	53,200	51,600	1
69	60,000	58,400	1
70	23,000	6,000	0
71	31,100	33,900	1
72	5,800	17,200	0
73	14,500	465,800	1
74	13,700	28,600	0
75	36,200	83,300	1
76	25,600	60,000	0
77	35,700	184,500	1
78	24,600	147,200	0
79	43,700	189,100	1
80	65,500	108,700	0
81	62,700	71,200	1
82	38,400	14,300	0
83	27,900	26,600	1
84	14,200	31,000	1
85	22,800	8,800	0
86	28,200	22,400	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B. 3. Port Graham pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	15,000	68,100	1
61	5,000	4,700	0
62	50,000	54,400	1
63	2,000	13,900	0
64	16,000	29,100	1
65	1,500	7,100	0
66	24,000	47,400	1
67	2,000	6,000	0
68	24,400	29,100	1
69	4,000	14,200	0
70	16,600	3,500	1
71	13,200	20,900	1
72	2,400	7,300	0
73	7,000	45,600	1
74	2,800	10,400	0
75	27,300	65,400	1
76	6,500	10,700	0
77	20,600	157,400	1
78	6,700	70,700	0
79	32,700	64,300	1
80	40,200	64,300	1
81	18,400	8,700	1
82	28,900	11,200	1
83	4,600	38,800	0
84	10,900	26,300	1
85	26,300	6,100	1
86	17,500	18,600	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B. 4. Port Chatham pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	4,000	109,200	1
61	7,000	0	2
62	7,000	0	2
63	0	0	2
64	0	16,700	2
65	0	0	2
66	10,000	0	2
67	0	0	2
68	0	4,900	2
69	0	41,800	2
70	3,000	1,000	0
71	15,500	25,600	1
72	1,000	,200	0
73	5,000	23,700	1
74	,200	0	2
75	7,700	15,600	1
76	0	,300	2
77	14,200	195,200	1
78	,300	9,500	0
79	20,800	67,000	1
80	7,700	14,600	1
81	11,200	6,800	1
82	2,000	7,800	0
83	3,500	15,900	1
84	7,800	11,500	1
85	8,900	10,200	1
86	11,500	21,000	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B. 5. Windy Left pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	8,000	55,250	1
61	5,000	4,500	0
62	12,500	45,701	1
63	4,500	14,500	0
64	7,700	17,050	1
65	10,000	6,000	0
66	7,000	9,319	1
67	6,000	23,000	1
68	6,900	13,689	0
69	23,000	77,310	1
70	13,000	400	0
71	35,400	63,394	1
72	400	100	0
73	12,900	15,882	1
74	100	200	0
75	9,700	187,580	1
76	,200	1,100	0
77	47,300	560,034	1
78	1,100	10,900	0
79	74,800	33,821	1
80	10,900	4,400	0
81	31,300	11,900	1
82	4,400	2,500	0
83	11,900	11,887	1
84	2,500	2,200	0
85	8,900	5,600	1
86	2,200	3,400	0

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B. 6. Windy Right pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	8,000	55,250	1
61	10,000	4,900	1
62	12,500	36,799	1
63	4,900	2,900	0
64	6,200	17,050	1
65	2,000	6,000	0
66	7,000	3,781	1
67	6,000	3,200	1
68	2,800	2,211	0
69	3,200	28,390	1
70	2,100	100	0
71	13,000	22,606	1
72	100	100	0
73	4,600	30,618	1
74	100	200	0
75	18,700	44,020	1
76	200	300	0
77	11,100	77,866	1
78	300	3,300	0
79	10,400	5,079	1
80	3,300	4,700	0
81	4,700	4,300	1
82	4,700	3,400	0
83	4,300	7,213	1
84	3,400	2,500	0
85	5,400	2,000	1
86	2,500	1,300	0

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B. 7. Rocky River pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	130,000	425,900	2
61	2,000	12,100	2
62	200,000	133,200	2
63	12,000	0,300	2
64	80,000	44,000	2
65	0,300	1,000	2
66	44,000	53,900	2
67	1,000	1,100	0
68	43,100	68,800	1
69	1,000	1,800	0
70	32,000	8,200	1
71	1,600	2,000	0
72	8,200	1,500	0
73	2,000	16,000	0
74	1,500	2,700	0
75	4,400	158,900	0
76	2,700	8,200	0
77	36,700	101,500	1
78	8,200	7,800	0
79	85,000	26,300	1
80	6,400	6,600	0
81	25,000	16,600	1
82	6,600	9,000	0
83	16,600	12,100	1
84	9,000	12,000	0
85	12,100	4,500	1
86	12,000	5,400	0

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B. 8. Port Dick pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	35,000	853,309	1
61	14,000	31,510	0
62	40,000	301,068	1
63	16,000	65,149	0
64	31,500	282,333	1
65	50,000	273,561	1
66	35,000	76,898	1
67	20,000	63,074	0
68	29,000	324,731	1
69	12,000	192,303	0
70	34,500	10,000	0
71	97,800	121,204	1
72	10,000	1,950	0
73	26,400	152,956	1
74	1,500	12,700	0
75	62,800	986,186	1
76	12,700	107,938	0
77	109,300	1075,835	1
78	44,900	184,370	0
79	116,000	1029,171	1
80	56,100	44,989	0
81	106,000	177,123	1
82	19,900	94,971	0
83	64,100	384,513	1
84	44,600	258,892	1
85	65,300	7,435	1
86	41,600	15,688	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B. 9. Island Creek pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	23,200	319,991	1
61	2,000	7,090	0
62	15,000	286,732	1
63	3,600	651	0
64	30,000	56,467	1
65	500	6,839	0
66	7,000	11,402	1
67	500	526	0
68	4,300	51,769	1
69	100	197	0
70	5,500	1,700	1
71	100	2,296	0
72	1,700	650	0
73	500	244	0
74	500	0	0
75	100	5,414	0
76	0	962	0
77	600	5,565	0
78	400	7,230	0
79	600	242,729	0
80	2,200	33,911	0
81	25,000	42,277	1
82	15,000	74,529	1
83	15,300	164,287	1
84	35,000	103,308	1
85	27,900	165	1
86	16,600	9,413	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B.10. South Nuka Island pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
71	14,000	22,517	1
72	300	44	0
73	16,000	62,151	1
74	0	0	0
75	28,000	52,646	1
76	0	2,998	0
77	12,000	113,866	1
78	0	302	0
79	15,000	263,194	1
80	300	400	0
81	16,000	52,357	1
82	400	10,210	0
83	22,200	0	2
84	600	0	2
85	3,600	0	2
86	7,000	0	2

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B.11. Desire Lake pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
80	16,000	17,811	1
81	5,000	19,823	1
82	12,000	26,752	1
83	8,500	185,905	1
84	23,000	113,054	1
85	62,500	29,955	1
86	32,000	2,538	1
87	11,000	85,950	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B.12. James Lagoon pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
80	4,600	8,905	1
81	14,000	11,894	1
82	6,000	4,653	1
83	5,100	26,770	1
84	4,000	23,317	1
85	9,000	2,995	1
86	6,600	1,726	1
87	1,100	8,961	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B.13. Resurrection Bay pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	1,400	3,400	1
61		1,400	2
62	3,300	8,200	1
63	1,400	0	2
64	7,900	0	2
65		0	2
66		45,000	2
67		200	2
68	7,600	0	2
69	200	0	2
70		19,300	2
71		0	2
72	1,100	8,500	1
73		0	2
74	8,500	76,000	1
75		200	2
76	40,600	54,000	1
77	200	0	2
78	24,300	196,500	1
79		35,300	2
80	40,700	189,300	1
81	2,700	40,700	0
82	51,900	158,400	1
83	13,600	149,300	0
84	32,900	77,200	1
85	74,700	23,400	0
86	40,700	1,600	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B.14. Bruin Bay pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	78,000	380,000	1
61	0	37,300	2
62	380,000	10,000	1
63	25,000	900	0
64	10,000	28,000	0
65	0	2,600	2
66	28,000	126,200	0
67	500	6,000	0
68	0	63,200	2
69	6,000	33,700	0
70	53,000	2,700	1
71	22,000	5,000	0
72	2,700	1,600	0
73	5,000	25,000	0
74	1,600	13,500	0
75	25,000	66,200	0
76	13,500	33,900	0
77	60,000	246,300	1
78	33,900	504,400	0
79	206,000	148,400	1
80	403,800	94,600	1
81	96,500	4,500	1
82	81,300	247,100	1
83	4,200	4,500	0
84	110,000	1,555,700	1
85	4,500	25,600	0
86	1,206,000	30,500	2

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B.15. Sunday Creek pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	1,500	5,533	0
61	0	9,367	2
62	5,000	0	2
63	2,000	0	2
64	0	21,871	2
65	0	0	2
66	20,000	0	2
67	0	18,600	2
68	0	9,500	2
69	1,000	56,827	1
70	2,000	2,000	0
71	43,000	9,817	1
72	2,000	100	0
73	5,000	20,000	1
74	100	300	0
75	20,000	9,000	1
76	300	218	0
77	9,000	18,400	1
78	200	5,200	0
79	12,000	20,476	1
80	5,200	27,639	0
81	14,200	4,700	1
82	12,000	24,319	1
83	4,700	11,400	0
84	12,000	165,569	1
85	11,400	59,188	1
86	109,000	43,663	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B.16. Brown's Peak Creek pink salmon escapement and return by brood year.

Brood Year	Escapement	Return	Cycle
60	0	27,667	2
61	0	46,833	2
62	25,000	33,500	1
63	10,000	10,000	1
64	20,000	12,029	1
65	10,000	13,000	1
66	11,000	18,000	1
67	0	37,200	2
68	0	0	2
69	2,000	10,573	0
70	0	1,200	2
71	8,000	6,283	1
72	1,200	100	0
73	3,200	10,000	1
74	100	1,200	0
75	10,000	13,000	1
76	1,200	982	0
77	13,000	23,000	1
78	900	2,300	0
79	15,000	25,524	1
80	2,300	8,061	0
81	17,700	1,700	1
82	3,500	13,781	1
83	1,700	7,000	0
84	6,800	42,531	1
85	7,000	80,112	1
86	28,000	41,237	1

note 0 = off-cycle-year, 1 = peak-year, 2 = did not use this data

Appendix B.17. Aialik sockeye salmon return by age class from brood year escapement.

Brood Year	Escapement	Age 1.2	%	Age 1.2/ esc	Age 1.3	%	Age 1.3/ esc	Ages 1.3/1.2	Age 2.2	%	Age 2.2/ esc	Age 2.3	%	Age 2.3/ esc	Ages 2.3/2.2	Total	ret/esc
78	3,000				10,614	77	3.54		817	6	.27	1,400	10	.47	1.714	13,609	4.54
79	5,000	33,966	48	6.79	30,036	42	6.01	.884	1,868	2	.37	4,438	6	.89	2.376	70,409	14.08
80	6,600	36,263	59	5.49	18,961	31	2.87	.523	4,942	8	.75					60,492	9.17
81	1,800	3,429	90	1.91												3,787	2.10
82	22,400											6,161	100	.28		6,161	.28
83	20,000				13,109	84	.66		1,864	12	.09	461	2	.02	.247	15,434	.77
84	22,000	12,038	47	.55	12,939	50	.59	1.075	354	1	.02					25,410	1.16
85	8,000	1,261	100	.16												1,261	.16

Total includes ages 1.2, 1.3, 2.2, 2.3, and others.

Appendix B.18. Nuka Bay (Delight and Desire Lake) sockeye salmon return by age class from brood year escapement.

Brood Year	Escapement	Age 1.2	%	Age 1.2/ esc	Age 1.3	%	Age 1.3/ esc	Ages 1.3/1.2	Age 2.2	%	Age 2.2/ esc	Age 2.3	%	Age 2.3/ esc	Ages 2.3/2.2	Total	ret/esc
66	13,300											21,754	90	1.64		24,110	1.81
67	300				7,642	43	25.47		9,998	56	33.33					17,640	58.80
68	300	585	8	1.95	6,600	91	22.00	11.282								7,185	23.95
69	800	2,200	100	2.75												2,200	2.75
70	6,600															313	.05
71	10,000											20,297	97	2.03		20,922	2.09
72	18,000				23,105	94	1.28		1,404	5	.08					24,509	1.36
73	7,700	1,873	74	.24												2,498	.32
74																156	.00
75	8,500															0	.00
76	17,000															0	.00
77	15,900											860	70	.05		1,213	.08
78	18,000				17,350	61	.96		6,596	23	.37	3,038	10	.17	.461	28,020	1.56
79	20,000	11,902	28	.60	14,771	35	.74	1.241	2,619	6	.13	10,813	26	.54	4.129	41,109	2.06
80	17,000	32,792	23	1.93	93,921	66	5.52	2.864	13,285	9	.78					140,246	8.25
81	19,300	16,683	97	.86												17,169	.89
82	43,000											8,121	99	.19		8,180	.19
83	19,000				5,630	45	.30		3,320	26	.17	3,506	28	.18	1.056	12,456	.66
84	25,500	2,016	11	.08	13,941	82	.55	6.915	979	5	.04					16,995	.67
85	44,000	8,234	98	.19												8,397	.19

Total includes ages 1.2, 1.3, 2.2, 2.3, and others.

Appendix B.19. McNeil River chum salmon return by age class from brood year escapement.

Brood Year	Escapement	Age 0.2	%	Age 0.2/ esc	Age 0.3	%	Age 0.3/ esc	Ages 0.3/0.2	Age 0.4	%	Age 0.4/ esc	Ages 0.4/0.3	Age 0.5	%	Age 0.5/ esc	Ages 0.5/0.4	Total	ret/esc
73	10,000				43,934	100	4.39										43,934	4.39
74	1,500	0	0	.00													0	.00
75	1,500																0	.00
76	10,000												0	0	.00		0	.00
77	20,000								32,493	97	1.62		703	2	.04	.022	33,196	1.66
78	45,000				24,371	16	.54		110,401	74	2.45	4.530	13,749	9	.31	.125	148,521	3.30
79	8,000	737	5	.09	5,996	44	.75	8.136	6,876	50	.86	1.147					13,609	1.70
80	8,000	0	0	.00	11,875	100	1.48						0	0	.00		11,875	1.48
81	30,000	0	0	.00					11,901	100	.40						11,901	.40
82	25,000				23,799	69	.95						10,497	30	.42		34,296	1.37
83	48,000	0	0	.00					128,025	100	2.67						128,025	2.67
84	21,000				14,430	100	.69										14,430	.69
85	9,500	0	0	.00													0	.00

Total includes ages 0.2, 0.3, 0.4, 0.5, and others.

Appendix B.20. Cottonwood-Iniskin chum salmon return by age class from brood year escapement.

Brood Year	Escapement	Age 0.2	%	Age 0.2/ esc	Age 0.3	%	Age 0.3/ esc	Ages 0.3/0.2	Age 0.4	%	Age 0.4/ esc	Ages 0.4/0.3	Age 0.5	%	Age 0.5/ esc	Ages 0.5/0.4	Total	ret/esc
71	22,000								8,671	100	.39						8,671	.39
72	14,000				20,549	100	1.47										20,549	1.47
73	16,000	780	100	.05													780	.05
74	9,500																0	.00
75	15,000																0	.00
76	18,500																0	.00
77	14,400												125	100	.01		125	.01
78	23,900								18,685	95	.78		849	4	.04	.045	19,534	.82
79	6,500				22,148	71	3.41		8,821	28	1.36	.398					30,969	4.76
80	13,500	742	2	.05	25,725	97	1.91	34.670									26,467	1.96
81	18,000	105	100	.01													105	.01
82	19,800												475	100	.02		475	.02
83	20,300								26,592	100	1.31						26,592	1.31
84	16,300				37,039	100	2.27										37,039	2.27
85	8,000	634	100	.08													634	.08

Total includes ages classes 0.2, 0.3, 0.4, 0.5, and others.

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