

PORTLAND CANAL JUVENILE CHUM SALMON
CODED WIRE TAGGING PROJECT, 1988

By
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TABLE OF CONTENTS

| | <u>Page</u> |
|--------------------------------------|-------------|
| LIST OF TABLES | iv |
| LIST OF FIGURES | iv |
| ABSTRACT | v |
| INTRODUCTION | 1 |
| OBJECTIVES | 1 |
| METHODS | 1 |
| RESULTS | 3 |
| Summary of Fyke Net Catches | 3 |
| Summary of Coded Wire Tagging | 3 |
| Analysis of Length Weight Data | 3 |
| SUMMARY AND CONCLUSIONS | 4 |

LIST OF TABLES

| <u>Table</u> | <u>Page</u> |
|---|-------------|
| 1. Summary of the Fish Creek fyke net catches 2 March to 23 May, 1989 | 5 |
| 2. Summary of coded wire tagging of Fish Creek juvenile chum salmon 2 March to 24 May, 1989 | 8 |
| 3. Fish Creek juvenile chum fry mean lengths and weights by week, 1989 | 9 |

LIST OF FIGURES

| <u>Figure</u> | <u>Page</u> |
|---|-------------|
| 1. The Salmon River drainage showing the Fish Creek tributary | 10 |
| 2. Fish Creek, showing the fyke net and tagging site | 11 |
| 3. Fish Creek Chum out-migration by 12 hour count days | 12 |
| 4. Fish Creek Chum out-migration by hour March 2 to March 9, 1989 | 13 |
| 5. Fish Creek Chum out-migration by hour March 12 to March 19, 1989 | 14 |
| 6. Fish Creek Chum out-migration by hour March 21 to March 28, 1989 | 15 |
| 7. Fish Creek Chum out-migration by hour March 30 to April 6, 1989 | 16 |
| 8. Fish Creek Chum out-migration by hour April 9 to April 16, 1989 | 17 |
| 9. Fish Creek Chum out-migration by hour April 18 to April 25, 1989 | 18 |
| 10. Fish Creek Chum out-migration by hour April 27 to May 4, 1989 | 19 |
| 11. Fish Creek Chum out-migration by hour May 7 to May 14, 1989 | 20 |
| 12. Fish Creek Chum out-migration by hour May 16 to May 23, 1989 | 21 |

ABSTRACT

Annex IV, Chapter 2 of the Pacific Salmon Treaty identifies specific concerns by both Alaska and Canada for chum salmon (*Oncorhynchus keta*) originating in Portland Canal tributaries. In an effort to learn more about the interception rates, harvest rates, migratory timing and migration routes of these fish a coded wire tagging study was initiated on Fish Creek near Hyder Alaska in 1988.

This report covers the second year of the tagging study. During the 1989 field season a total of 224,539 wild juvenile chum salmon fry were coded wire tagged with half-length tags from 2 March to 24 May, 1989. The fry were captured during the evening hours in two fyke nets attached to aluminum holding boxes and tagged the following day. The first adult returns from this tagging project are expected in 1990.

INTRODUCTION

The chum salmon *Oncorhynchus keta* stocks of southern Southeast Alaska and northern British Columbia have been designated as stocks of special concern to the U.S./Canada Pacific Salmon Treaty. Annex IV, Chapter 2 of the Pacific Salmon Treaty identifies specific concerns by both Alaska and Canada for chum salmon originating in Portland Canal tributaries. These chum salmon stocks contribute to the fisheries of both countries; the effective management of their fisheries requires knowledge of interception rates, harvest rates, migratory timing and migratory routes.

In an effort to determine these parameters for Portland Canal chum salmon stocks a juvenile coded wire tagging project was initiated on Fish Creek, a tributary of the Salmon River near Hyder Alaska in 1988 (Figure 1). This report covers the second year of the project.

OBJECTIVES

1. Identify the migratory timing and migration routes of Fish Creek chum salmon by the use of coded wire tagging methodology.
2. Estimate the total rate of exploitation of Fish Creek chum salmon by the gill net and purse seine fisheries in Alaska and the net and troll fisheries of British Columbia.
3. Obtain size, age, sex composition, stream life and migratory timing of the Fish Creek chum salmon escapement.
4. Obtain an estimate of the survival rate of Fish Creek chum salmon.
5. Identify problems in the coded wire tagging of wild juvenile chum salmon fry (tag loss, tagging mortality and straying of tagged fish).

METHODS

A site on Fish Creek approximately 2.4 km upstream from its confluence with the Salmon River was chosen as the capture and tagging site as it was easily accessible by road and was below the major spawning areas (Figure 2). Out-migrant chum fry were captured in two fyke nets attached to 1.5 m X 0.9 m X 0.45 m aluminum holding boxes. The fyke nets were 0.45 m by 0.9 m and were placed to fish a column of water 0.9 m wide. The nets were spaced 4.0 m apart and were placed in the middle of the stream. From 2 March to 20 April, 1.0 m high leads of plastic netting (3.2 mm mesh) were placed from the fyke nets to the stream banks effectively funneling all out-migrant fry into the two nets. The leads were removed due to high water on 20 April and were replaced on 9 May when water levels receded.

The enumeration of the fyke net catches was accomplished by the gravimetric method. A sub-sample of known weight was enumerated by species and the total weight of the fish captured was then expanded to estimate the total number of pink and chum fry. A total of 5,000 to 8,000 fry were held each night for coded wire tagging the following day.

The coded wire tagging operations were conducted in a 70.2 m tagging trailer which was parked next to Fish Creek at the fyke net site. The trailer was equipped with a 105 l anesthetic tank, tagging table and laboratory area. The trailer was wired for 110 volt AC current which was supplied by a 1400 watt gasoline generator.

The chum fry were anesthetized with MS-222 (tricaine methanesulfonate) at a concentration of 40 mg/l. Since MS-222 lowers the ph of the water the solution was buffered with sodium carbonate (Na_2CO_3) back to the ph of Fish Creek water (7.0). To reduce stress, non-iodized salt was added to the solution at a concentration of 0.5% to replace salts lost due to handling and to stimulate mucus flow. An effort was made to insure that the fry were not left in the anesthetic solution for more than five minutes.

The adipose fins of the chum fry were removed with surgical grade microscissors before being passed to the tagging machine operator. Only fry that had completely absorbed their yolk sacs were selected for tagging. All pink and coho salmon fry and chum with visible yolk sacs were released back into Fish Creek.

The tagging equipment consisted of a Northwest Marine Technology² Mark IV tag injector, quality control device and power supply. All chum fry were tagged with half length coded wire tags.

The quality control device was set up so that fry with tags were routed from the tagging trailer through a 63.5 mm diameter hose and out to a holding pen in Fish Creek. If the quality control device did not detect a tag it routed the fry into a bucket. These fry were then passed through the device again and if they did not register a tag the second time they were returned to the tagging machine operator and re-tagged.

At the end of the tagging day the tagged chum fry were held in holding pens and released during the late evening hours. Tagged fish mortalities were recorded at the time of release. Tag retention samples were also conducted at this time. A random sample of 200 fry was passed through the quality control device and the number of fry without tags were recorded. Tag retention percentages and tagged fish mortalities were then used to calculate the total number of valid tags released.

A total of 200 chum fry were sampled for length and weight each week. The fry were measured to the nearest 0.1 mm and weighed to the nearest 0.01 g.

² Mention of trade names does not constitute endorsement by ADF&G.

RESULTS

Summary of Fyke Net Catches

The numbers of fry captured in the fyke nets are summarized in Table 1. A graph of the bi-weekly 12 hour counts is presented in Figure 3. The decision was made to only attempt exact estimates of out-migrant fry every other night using the gravimetric method. On Sunday and Thursday nights the nets were fished for a 12 hour period (1800 to 0600 hours) and on Tuesday nights the nets were fished for a four hour period two hours before and after the last nights peak count. On the other nights the nets were fished only long enough to capture a sufficient number of chum fry for tagging the next day. During the study period the nets were fished for a total of 537.75 hours and captured a total of 3,114,001 chum salmon fry and 24,861 pink salmon fry.

The nightly out-migration did not commence until after dark, between 1800 and 1900 hours. Peak fry movement was between 2000 and 2300 with an occasional smaller peak between 0200 and 0700 hours. The out-migration usually ceased by 0600 hours. Figures 4-12 are graphs of the net catches, by hour, for the nights that 12 hour and 4 hour counts were made.

Since chum fry were captured the first night the nets were set in Fish Creek (1 March) it was obvious that the out-migration had been underway for a number of days. It is difficult to determine a peak period of out-migration as the plastic mesh wings, which were funneling all of the fry into the nets, were removed on 20 April due to high stream-flows.

Catches increased steadily through March and peak catches occurred on 9 April and 16 April with counts in excess of 300,000. Catch rates declined during mid May and the nets were removed on 23 May.

Summary of Coded Wire Tagging

Tagging at Fish Creek commenced on 2 March 1989. A summary of the tagging is presented in Table 2. Some problems with tag placement occurred during the first weeks of tagging resulting in less than acceptable tag retention rates. This problem was solved early by experimenting with different head molds. The overall tag retention rate was 92%. Tagging related mortality was low at only 0.2%. In order to spread the tagging over the complete duration of the out-migration a goal of 3,500 tags per day was set. The original tagging goal for this project was 200,000 tags released. The crew continued to tag until 24 May. The total number of tags released for the season was 224,539. The first adult returns from the 1989 tagging are expected in 1991 as age 3 fish.

Analysis of Length Weight Data

The mean lengths and weights by week are summarized in Table 3. The mean lengths and weights showed no significant variations throughout the duration of the out-migration. Weekly mean lengths and weights ranged from

39.0 mm to 40.4 mm and 0.37 g to 0.42 g, respectively. The overall mean lengths and weights of Fish Creek chum fry were 39.7 mm and 0.39 g, respectively.

SUMMARY AND CONCLUSIONS

This was the second year of a proposed six year study designed to determine the interception rates, harvest rates, migratory timing and migration routes of Portland Canal chum salmon stocks by the use of coded wire tagging methodology. During the first year of the project our crew successfully tagged over 145,000 wild juvenile chum fry with half length tags on Fish Creek with few problems being encountered. Due to the success of the 1988 tagging it was recommended that the tagging goal for 1989 be increased to 200,000. This goal was again easily reached in 1989 with over 224,000 chum fry being tagged.

The capture method for 1989 was identical to 1988 where two fyke nets attached to aluminum holding boxes where anchored in mid stream. Plastic vexar wings were attached from the nets to the stream banks and remained in place until they were removed due to high water. The 1989 net catches showed a major increase over the previous years count of over 1.78 million chum fry. A total of 3,114,000 fry were enumerated during the 1989 out-migration. Part of this increase can be attributed to the fact that the project was in operation 16 days longer than in 1988 and the nets were fished an additional 118 hours. In spite of the increased fishing time it appears that the overwinter survival of the eggs deposited in Fish Creek in 1988 was above average.

During the first year of tagging at Fish Creek there was some apprehension as to our ability to coded wire tag, with half length tags, chum fry that would average only 38-40 mm in length. Our crew quickly learned how to tag and handle these smaller fish but tag placement and tag retention continues to be a problem. Overall tag retention rates dropped 2% from 94% in 1988 to 92% in 1989. Experimenting with numerous standard and custom made head molds was the only way our crew was able to maintain proper tag placement which is essential for achieving acceptable tag retention rates. Other prerequisites for a successful tagging operation such as this include surgical grade fin clipping microscissors and a properly prepared anesthetic solution. As in 1988 tagging induced mortalities were less than 0.2%, a direct result of paying close attention to tag placement and the anesthetic solution. Due to the success of the second year of tagging at Fish Creek it is recommended that the tagging goal be increased to 300,000 IN 1990.

The overall mean length and weights of the Fish Creek chum fry in 1989 showed little difference from 1988. The mean length in 1988 was 39.7 mm and decreased slightly to 39.0 mm in 1989. The mean weight of the fry remained the same at 0.39 g for both years.

Adult chum salmon from the 1988 and 1989 tagging should enter the U.S. and Canadian fisheries and return to Fish Creek starting in 1990. The first adults will be age 3 fish, with 4 and 5 year old fish returning in 1991 and 1992, respectively. Tag recoveries from the fisheries of both countries and from Fish Creek should provide much needed information for the effective management of the Portland Canal chum salmon stocks.

Table 1. Summary of the Fish Creek fyke net catches 3 March to 30 April, 1989.

| Date | Chum Fry | | Daily | Pink Fry | | Coho Fry | | Dolly Varden | | Start Time | Stop Time | Total Hours | Enumeration Method |
|-------|-------------|------------|-------|------------|-------|------------|-------|--------------|-------|------------|-----------|-------------|--------------------|
| | Daily | Cumulative | | Cumulative | Daily | Cumulative | Daily | Cumulative | Daily | | | | |
| 03/01 | 3,000 | 3,000 | 0 | 0 | 0 | 0 | 0 | - | - | 1540 | 2130 | 6.00 | Visual |
| 03/02 | 9,720 | 12,720 | 2 | 2 | 1 | 1 | - | - | 1615 | 0600 | 12.00 | Gravimetric | |
| 03/03 | Not Fishing | | | | | | | | | | | | |
| 03/04 | Not Fishing | | | | | | | | | | | | |
| 03/05 | 21,172 | 33,892 | 30 | 32 | 1 | 2 | - | - | 1300 | 0600 | 17.00 | Gravimetric | |
| 03/06 | 9,000 | 42,892 | - | 32 | - | 2 | - | - | 1630 | 2030 | 4.00 | Visual | |
| 03/07 | 10,989 | 53,881 | - | 32 | - | 2 | 1 | 1 | 1630 | 2200 | | Gravimetric | |
| 03/08 | 9,000 | 62,881 | - | 32 | - | 2 | - | 1 | 1615 | 2030 | | Visual | |
| 03/09 | 29,728 | 92,609 | - | 32 | 1 | 3 | 5 | 6 | 1630 | 0600 | | Gravimetric | |
| 03/12 | 17,138 | 109,747 | - | 32 | 1 | 4 | 1 | 7 | 1530 | 0600 | | Gravimetric | |
| 03/13 | 6,500 | 116,247 | - | 32 | - | 4 | - | 7 | 1615 | 2000 | | Gravimetric | |
| 03/14 | 22,168 | 138,415 | 29 | 61 | - | 4 | - | 7 | 1615 | 2200 | | Gravimetric | |
| 03/15 | 9,500 | 147,915 | - | 61 | - | 4 | - | 7 | 1615 | 2000 | | Visual | |
| 03/16 | 51,805 | 199,720 | - | 61 | 4 | 8 | 1 | 8 | 1615 | 0700 | | Gravimetric | |
| 03/17 | 7,000 | 206,720 | - | 61 | - | 8 | - | 8 | 1615 | 2000 | | Gravimetric | |
| 03/18 | Not Fishing | | | | | | | | | | | | |
| 03/19 | 47,477 | 254,197 | 119 | 180 | 9 | 17 | 6 | 14 | 1630 | 0600 | | Gravimetric | |
| 03/20 | 6,000 | 260,197 | - | 180 | - | 17 | - | 14 | 1630 | 2000 | | Visual | |
| 03/21 | 38,990 | 299,187 | 51 | 231 | - | 17 | - | 14 | 1630 | 2200 | | Gravimetric | |
| 03/22 | 30,000 | 329,187 | - | 231 | - | 17 | - | 14 | 1630 | 2000 | | Visual | |
| 03/23 | 143,205 | 472,392 | 201 | 432 | 10 | 27 | 1 | 15 | 1630 | 0600 | | Gravimetric | |
| 03/24 | Not Fishing | | | | | | | | | | | | |
| 03/25 | Not Fishing | | | | | | | | | | | | |
| 03/26 | 181,342 | 653,734 | - | 432 | 4 | 31 | 16 | 31 | 1630 | 0600 | | Gravimetric | |
| 03/27 | 40,000 | 693,734 | - | 432 | - | 31 | - | 31 | 1630 | 2000 | | Gravimetric | |
| 03/28 | 96,425 | 790,159 | 271 | 703 | - | 31 | 1 | 32 | 1630 | 2200 | | Gravimetric | |
| 03/29 | 40,000 | 830,159 | - | 703 | - | 31 | - | 32 | 1630 | 2000 | | Visual | |
| 03/30 | 181,726 | 1,011,885 | 1,835 | 2,538 | 9 | 40 | 9 | 41 | 1630 | 0600 | | Gravimetric | |
| 03/31 | Not Fishing | | | | | | | | | | | | |
| 04/01 | Not Fishing | | | | | | | | | | | | |
| 04/02 | 240,121 | 1,252,006 | 1,304 | 3,842 | 23 | 63 | 10 | 51 | 1630 | 0600 | | Gravimetric | |
| 04/03 | 50,000 | 1,302,006 | - | 3,842 | 2 | 65 | - | 51 | 1630 | 2100 | | Visual | |
| 04/04 | 85,876 | 1,387,882 | 345 | 4,187 | 11 | 76 | 2 | 53 | 1630 | 1200 | | Gravimetric | |
| 04/05 | 30,000 | 1,417,882 | - | 4,187 | - | 76 | - | 53 | 1630 | 2100 | | Visual | |
| 04/06 | 157,714 | 1,575,596 | 3,219 | 7,406 | 7 | 83 | 2 | 55 | 1630 | 0600 | | Gravimetric | |
| 04/07 | Not Fishing | | | | | | | | | | | | |

--Continued--

Table 1. (page 2 of 3.)

| Date | Chum Fry | | Daily | Pink Fry | | Daily | Coho Fry | | Dolly Varden | | Start Time | Stop Time | Total Hours | Enumeration Method |
|-------|-------------|------------|-------|------------|------------|-------|----------|------------|--------------|------------|------------|-----------|-------------|--------------------|
| | Daily | Cumulative | | Cumulative | Cumulative | | Daily | Cumulative | Daily | Cumulative | | | | |
| 04/08 | Not Fishing | | | | | | | | | | | | | |
| 04/09 | 309,018 | 1,884,614 | 3,753 | 11,159 | 8 | 91 | 5 | 60 | 1630 | 0600 | | | | Gravimetric |
| 04/10 | 20,000 | 1,904,614 | - | 11,159 | - | 91 | - | 60 | 1630 | 2100 | | | | Visual |
| 04/11 | 113,836 | 2,018,450 | 1,728 | 12,887 | 20 | 111 | - | 60 | 1630 | 2100 | | | | Gravimetric |
| 04/12 | 20,000 | 2,038,450 | - | 12,887 | - | 111 | - | 60 | 1630 | 2130 | | | | Visual |
| 04/13 | 252,213 | 2,290,663 | 5,151 | 18,038 | 16 | 127 | 7 | 67 | 1630 | 0600 | | | | Gravimetric |
| 04/14 | Not Fishing | | | | | | | | | | | | | |
| 04/15 | Not Fishing | | | | | | | | | | | | | |
| 04/16 | 305,743 | 2,596,406 | 3,082 | 21,120 | 28 | 155 | 11 | 78 | 1630 | 0600 | | | | Gravimetric |
| 04/17 | 20,000 | 2,616,406 | - | 21,120 | - | 155 | - | 78 | 1630 | 2130 | | | | Visual |
| 04/18 | 100,808 | 2,717,214 | 2,042 | 23,162 | 14 | 169 | 4 | 82 | 1630 | 1200 | | | | Gravimetric |
| 04/19 | 120,000 | 2,737,214 | - | 23,162 | - | 169 | - | 82 | 1630 | 2000 | | | | Gravimetric |
| 04/20 | 30,597 | 2,767,811 | 208 | 23,370 | 3 | 172 | 2 | 84 | 1630 | 0600 | | | | Gravimetric |
| 04/21 | Not Fishing | | | | | | | | | | | | | |
| 04/22 | Not Fishing | | | | | | | | | | | | | |
| 04/23 | 33,280 | 2,801,091 | 318 | 23,370 | - | 172 | - | 84 | 1630 | 0600 | | | | Gravimetric |
| 04/24 | 6,000 | 2,807,091 | - | 23,370 | - | 172 | - | 84 | 1630 | 2030 | | | | Visual |
| 04/25 | 10,936 | 2,818,027 | 110 | 23,798 | - | 172 | - | 84 | 1630 | 1200 | | | | Gravimetric |
| 04/26 | 1,000 | 2,819,027 | - | 23,798 | - | 172 | - | 84 | 1630 | 1200 | | | | Visual |
| 04/27 | 9,603 | 2,828,630 | 288 | 24,086 | - | 172 | - | 84 | 1630 | 0600 | | | | Gravimetric |
| 04/28 | Not Fishing | | | | | | | | | | | | | |
| 04/29 | Not Fishing | | | | | | | | | | | | | |
| 04/30 | 1,094 | 2,829,724 | - | 24,086 | - | 172 | - | 84 | 1630 | 0600 | | | | Gravimetric |
| 05/01 | 7,500 | 2,837,224 | - | 24,086 | - | 172 | - | 84 | 1630 | 0100 | | | | Visual |
| 05/02 | 4,301 | 2,841,525 | - | 24,086 | - | 172 | - | 84 | 1630 | 1200 | | | | Gravimetric |
| 05/03 | 9,000 | 2,850,525 | - | 24,086 | - | 172 | - | 84 | 1630 | 0600 | | | | Visual |
| 05/04 | 15,650 | 2,866,175 | 146 | 24,232 | 3 | 175 | - | 84 | | | | | | Gravimetric |
| 05/05 | Not Fishing | | | | | | | | | | | | | |
| 05/06 | Not Fishing | | | | | | | | | | | | | |
| 05/07 | 14,504 | 2,880,679 | - | 24,232 | 5 | 180 | - | 84 | 1630 | 0600 | | | | Gravimetric |
| 05/08 | 500 | 2,881,179 | - | 24,232 | - | 180 | - | 84 | 1630 | 0600 | | | | Visual |
| 05/09 | 25,316 | 2,906,495 | 76 | 24,308 | 3 | 183 | 2 | 86 | 1630 | 0100 | | | | Gravimetric |
| 05/10 | 10,000 | 2,916,495 | - | 24,308 | - | 183 | - | 86 | 1630 | 1200 | | | | Visual |
| 05/11 | 49,982 | 2,966,477 | 250 | 24,558 | 10 | 193 | 3 | 89 | 1630 | 0600 | | | | Gravimetric |
| 05/12 | Not Fishing | | | | | | | | | | | | | |
| 05/13 | Not Fishing | | | | | | | | | | | | | |

--Continued--

Table 1. (page 3 of 3.)

| Date | Daily | Chum Fry Cumulative | Daily | Pink Fry Cumulative | Daily | Coho Fry Cumulative | Dolly Varden Daily | Dolly Varden Cumulative | Start Time | Stop Time | Total Hours | Enumeration Method |
|-------|-------------|------------------------|-------|------------------------|-------|------------------------|-----------------------|----------------------------|---------------|--------------|----------------|-----------------------|
| 05/14 | 58,688 | 3,025,165 | 176 | 24,734 | 51 | 244 | 4 | 93 | 1630 | 0600 | | Gravimetric |
| 05/15 | 4,500 | 3,051,280 | - | 24,734 | - | 244 | - | 93 | 1630 | 2000 | | Visual |
| 05/16 | 21,615 | 3,051,280 | 86 | 24,820 | 25 | 269 | 3 | 96 | 1630 | 0100 | | Gravimetric |
| 05/17 | 6,000 | 3,057,280 | - | 24,820 | - | 269 | - | 96 | 1630 | 2100 | | Visual |
| 05/18 | 23,934 | 3,081,214 | - | 24,820 | 22 | 291 | 3 | 99 | 1630 | 0600 | | Gravimetric |
| 05/19 | 6,000 | 3,087,214 | - | 24,820 | - | 291 | - | 99 | 1630 | 1200 | | Gravimetric |
| 05/20 | Not Fishing | | | | | | | | | | | |
| 05/21 | 17,165 | 3,104,379 | 41 | 24,861 | 21 | 312 | 1 | 100 | 1630 | 0600 | | Gravimetric |
| 05/22 | 6,000 | 3,110,379 | - | 24,861 | - | 312 | - | 100 | 1630 | 1230 | | Gravimetric |
| 05/23 | 3,622 | 3,114,001 | - | 24,861 | 2 | 314 | - | 100 | 1630 | 0100 | | Gravimetric |
| 05/24 | Not Fishing | | | | | | | | | | | |

Table 2. Summary of the coded-wire tagging of Fish Creek juvenile chum salmon 2 March to 24 May, 1989.

| Date | Number Tagged | Code |
|-------------|---------------|------------|
| 03/02-03/16 | 20,904 | 4-1-1-6-1 |
| 03/16-03/23 | 24,093 | 4-1-1-6-2 |
| 03/24-04/04 | 26,519 | 4-1-1-6-2 |
| 04/04-04/14 | 27,000 | 4-1-1-6-3 |
| 04/14-04/24 | 23,570 | 4-1-1-6-4 |
| 04/25-05/03 | 23,742 | 4-1-1-6-5 |
| 05/03-05/11 | 23,290 | 4-1-1-6-6 |
| 05/12-05/17 | 21,060 | 4-1-1-6-7 |
| 05/17-05/20 | 21,111 | 4-1-1-6-7 |
| 05/17-05/20 | 13,250 | 4-1-1-6-10 |
| Total | 224,539 | |

Table 3. Fish Creek Juvenile Chum Fry mean lengths and weights by week, 1989.

| Week | Mean Length (mm) | Mean Weight (g) | Sample Size |
|--------------|------------------|-----------------|-------------|
| 2/16-3/04 | 39.3 | 0.37 | 50 |
| 3/05-3/11 | 39.6 | 0.39 | 200 |
| 3/12-3/18 | 40.1 | 0.40 | 200 |
| 3/19-3/25 | 40.3 | 0.40 | 200 |
| 3/26-4/01 | 39.9 | 0.40 | 200 |
| 4/02-4/08 | 40.3 | 0.42 | 200 |
| 4/09-4/15 | 40.4 | 0.40 | 200 |
| 4/16-4/22 | 40.1 | 0.41 | 200 |
| 4/23-4/29 | 39.3 | 0.38 | 150 |
| 4/30-5/06 | 39.6 | 0.40 | 200 |
| 5/07-5/13 | 39.8 | 0.39 | 200 |
| 5/14-5/20 | 39.0 | 0.38 | 200 |
| 5/21-5/27 | 38.5 | 0.37 | 100 |
| Overall Mean | 39.7 | 0.39 | 2300 |

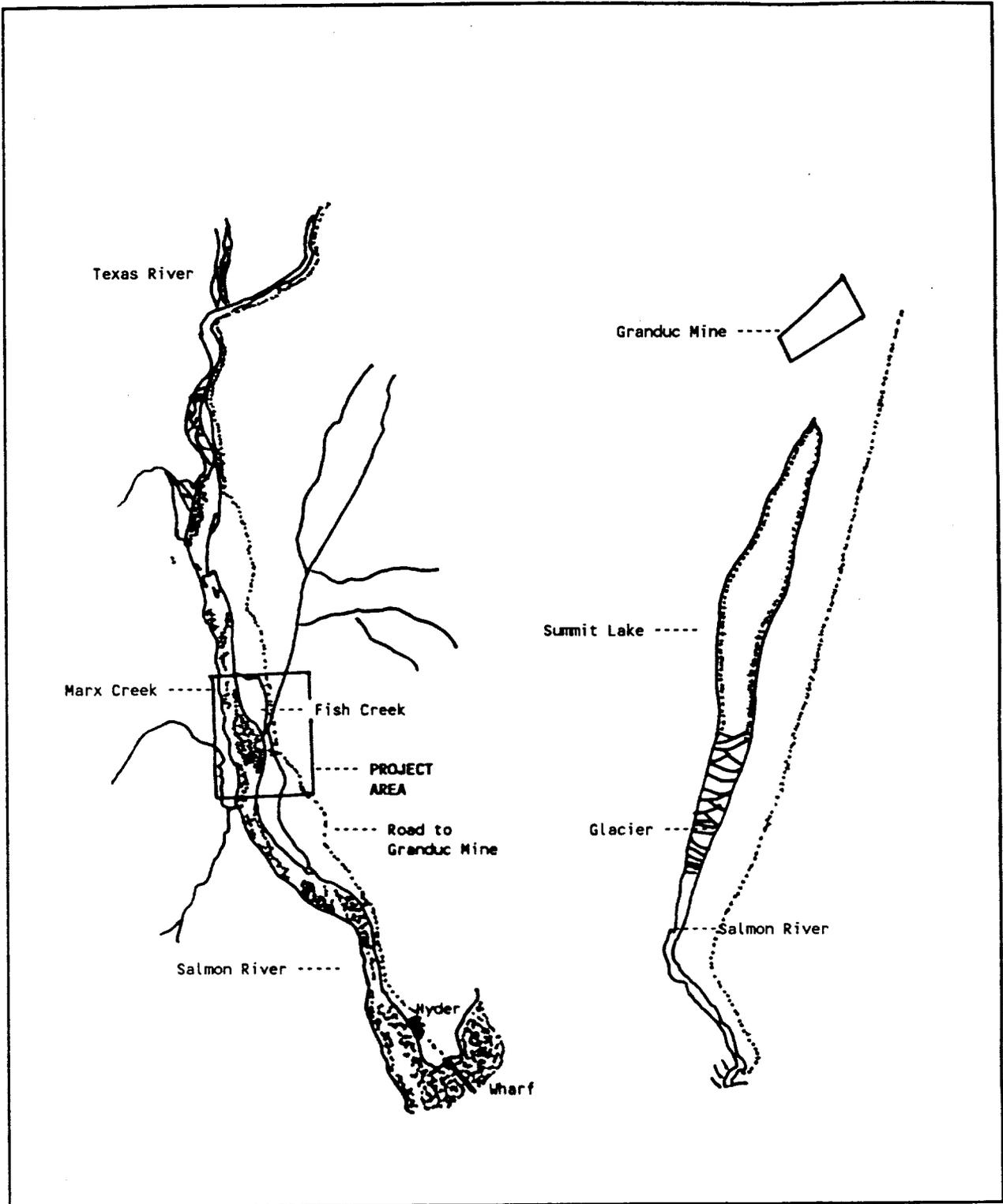


Figure 1. The Salmon River drainage showing the Fish Creek tributary.

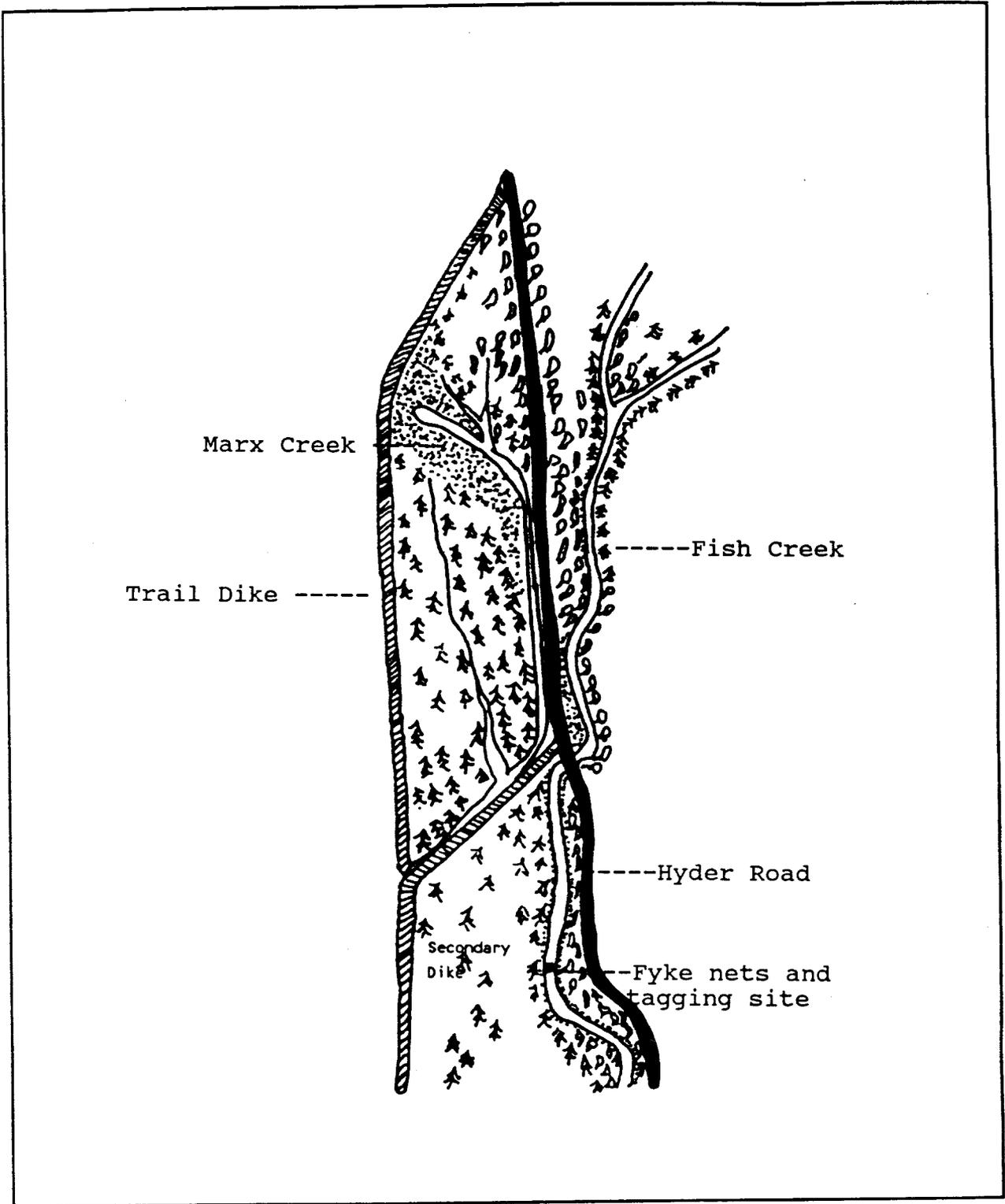


Figure 2. Fish Creek, showing the fyke net and tagging site.

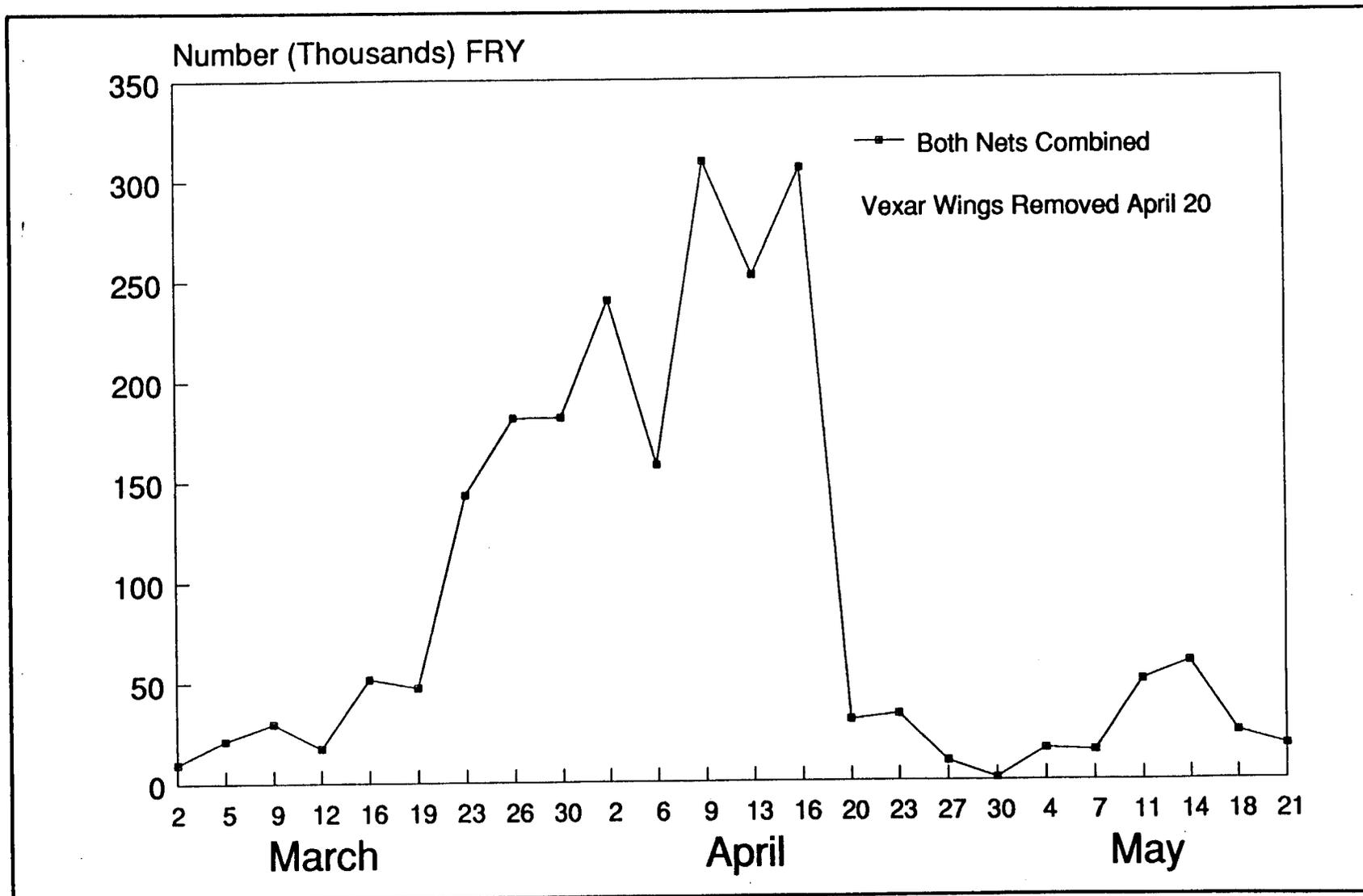


Figure 3. Fish Creek chum outmigration by 12-hour count days.

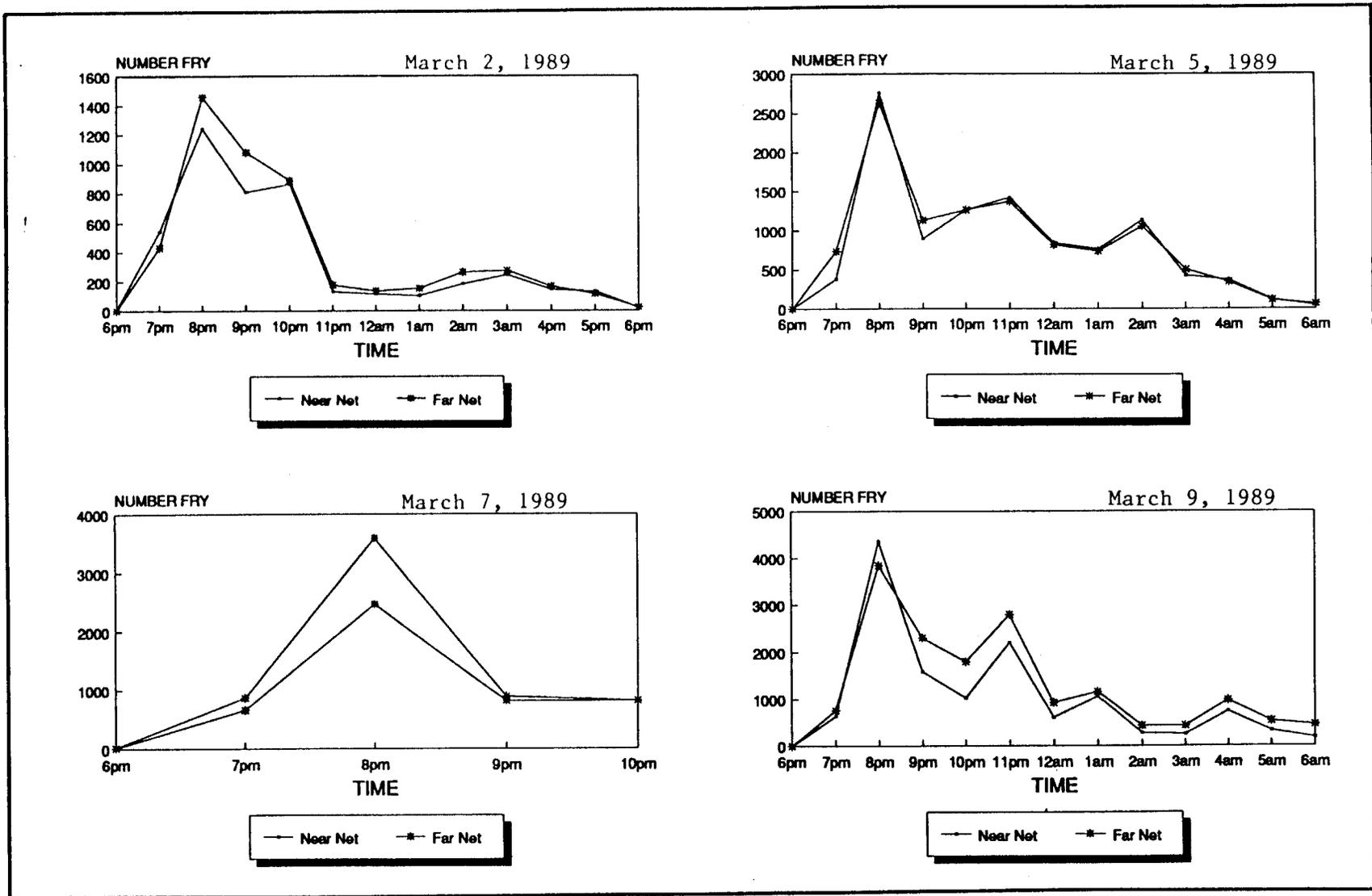


Figure 4. Fish Creek chum outmigration by hour March 2 to March 9, 1989.

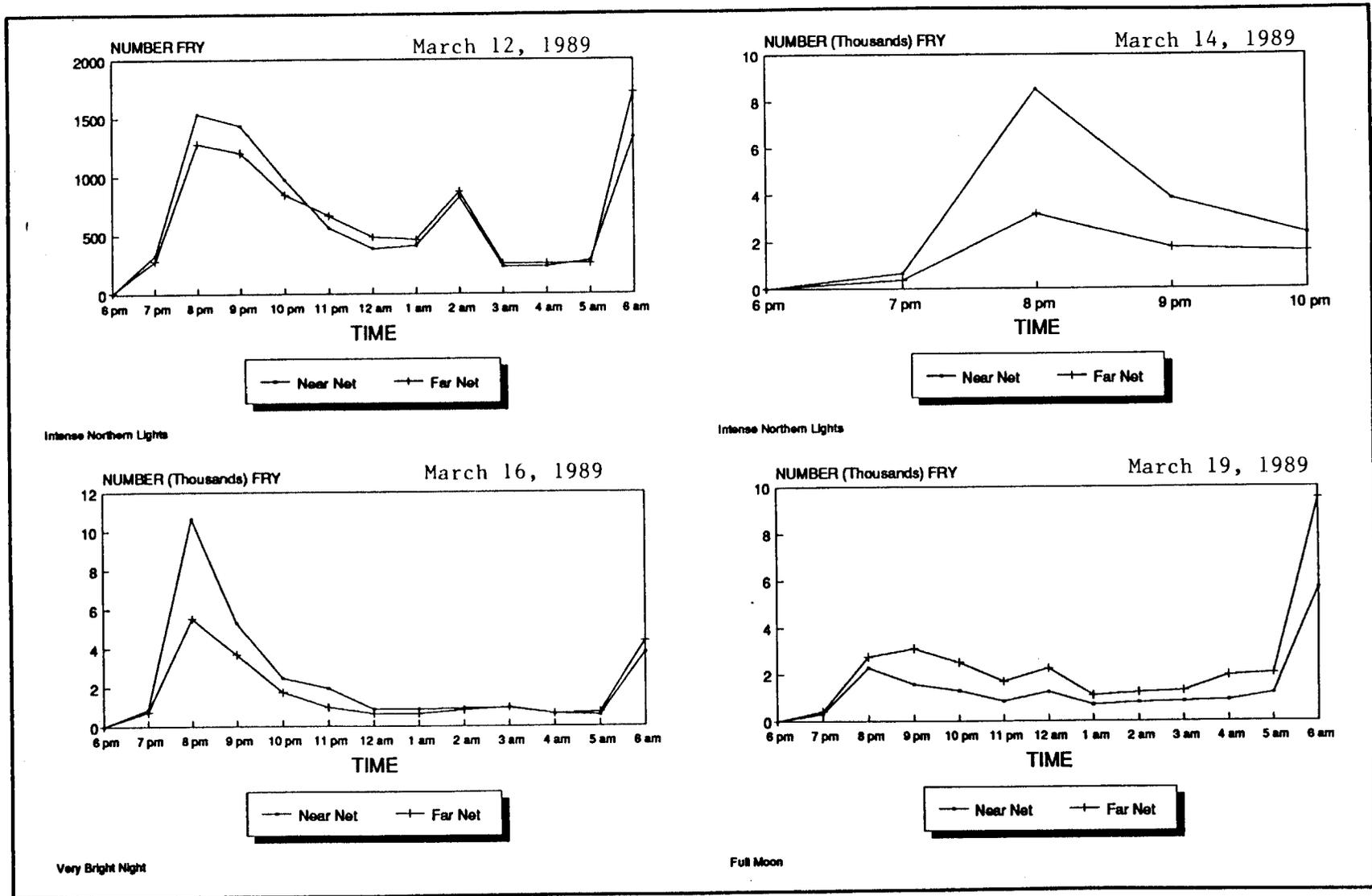


Figure 5. Fish Creek chum outmigration by hour March 12 to March 19, 1989.

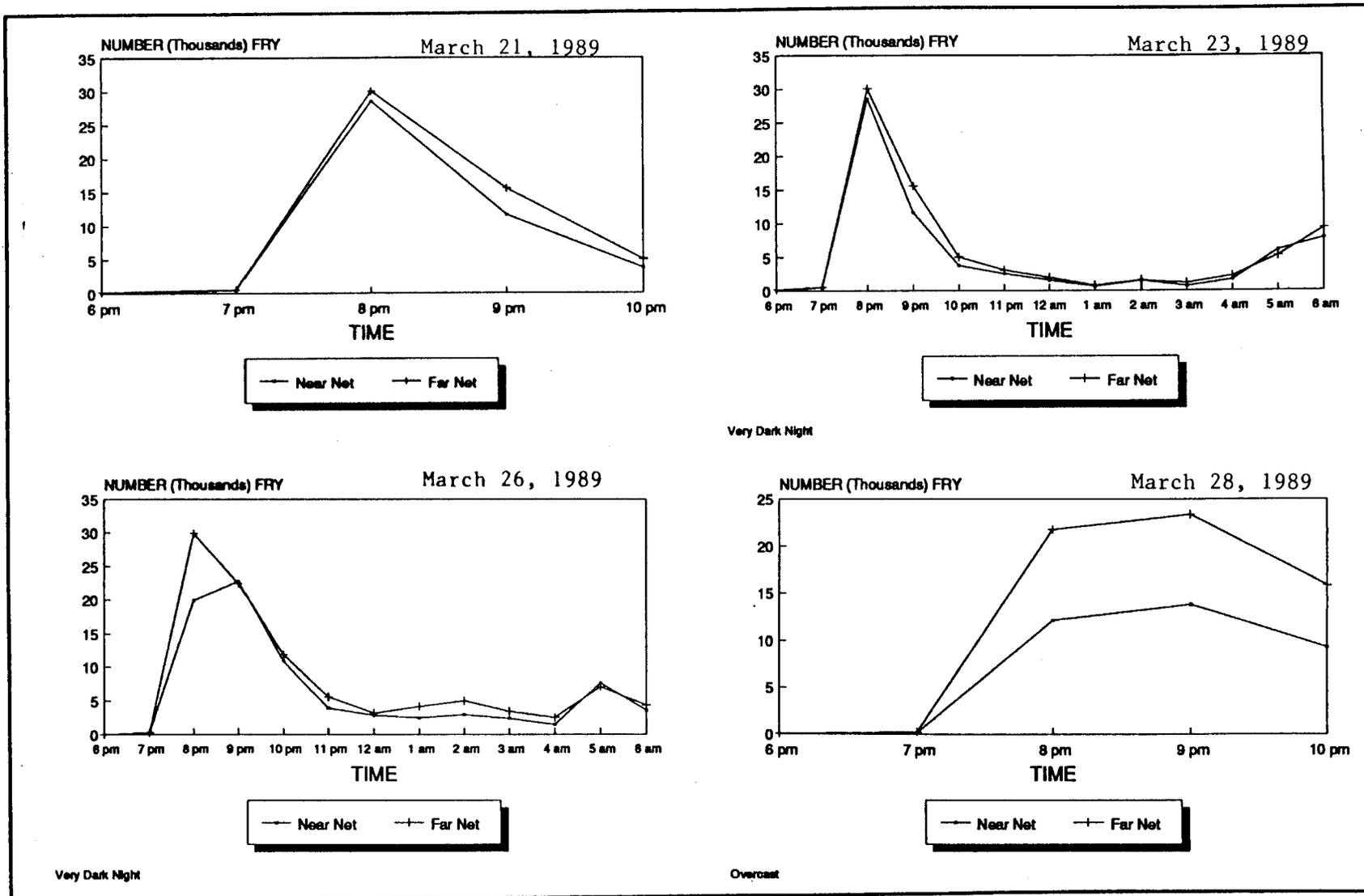


Figure 6. Fish Creek chum outmigration by hour March 21 to March 28, 1989.

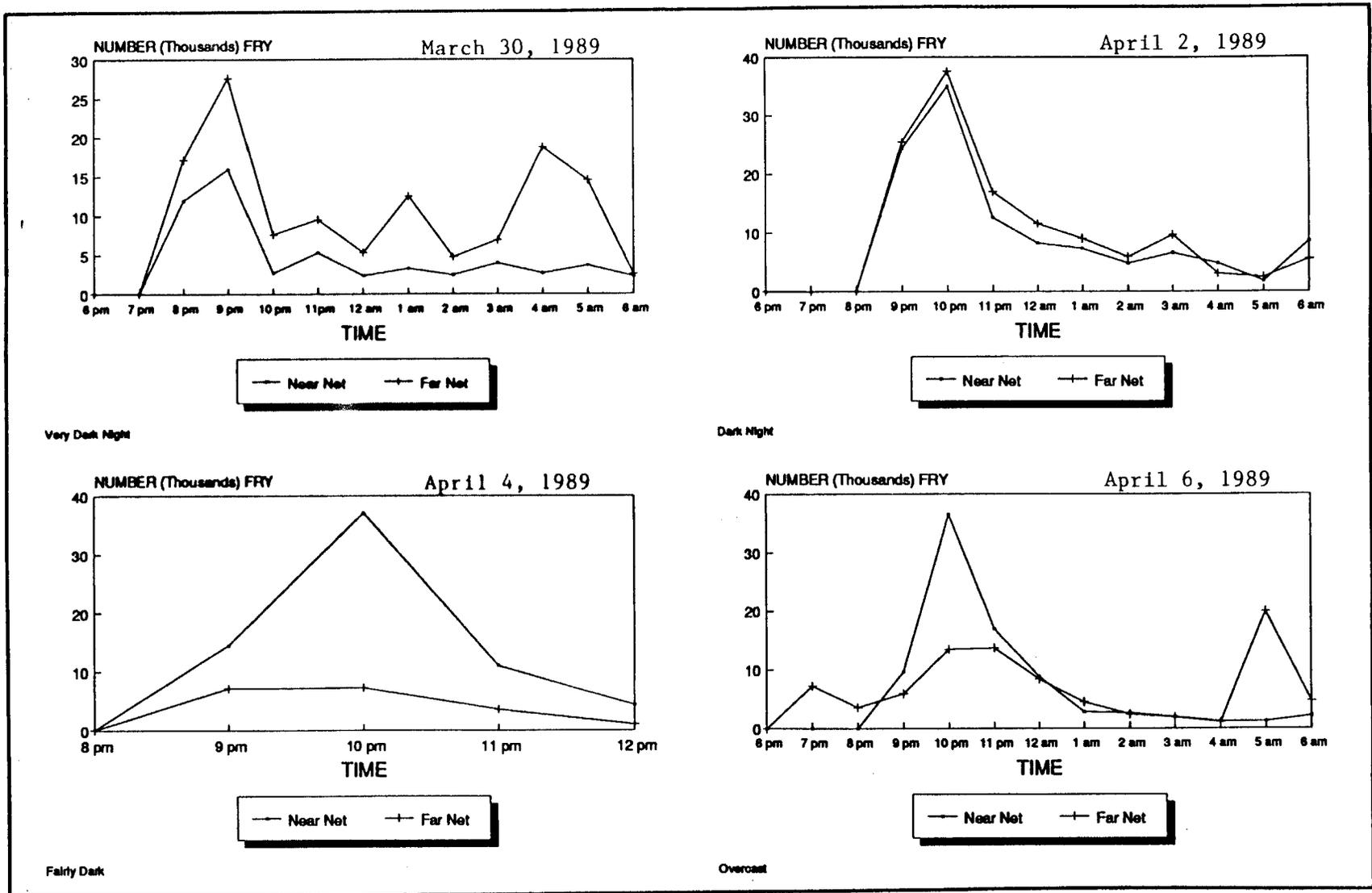


Figure 7. Fish Creek chum outmigration by hour March 30 to April 6, 1989.

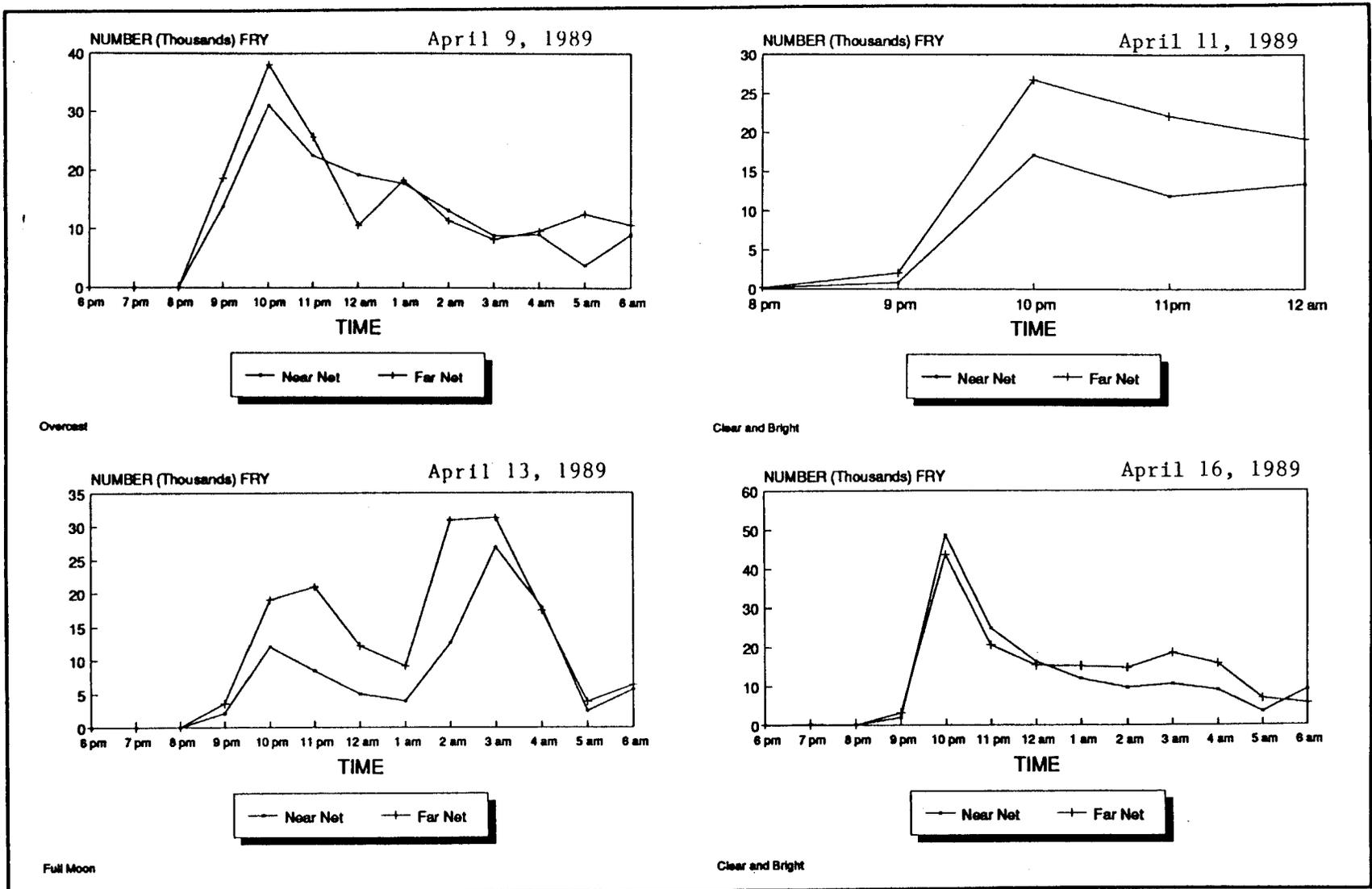


Figure 8. Fish Creek chum outmigration by hour April 9 to April 16, 1989.

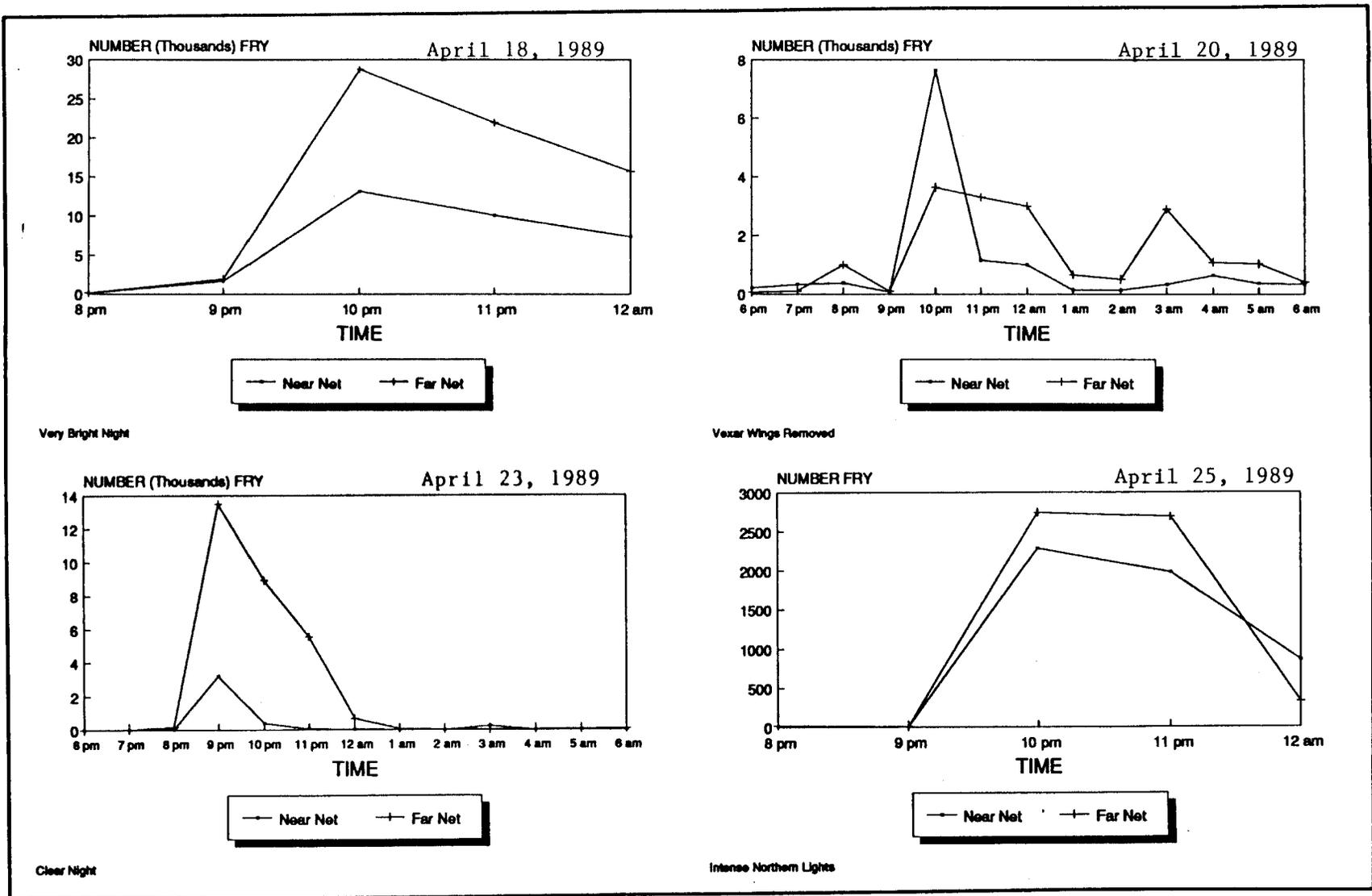


Figure 9. Fish Creek chum outmigration by hour April 18 to April 25, 1989.

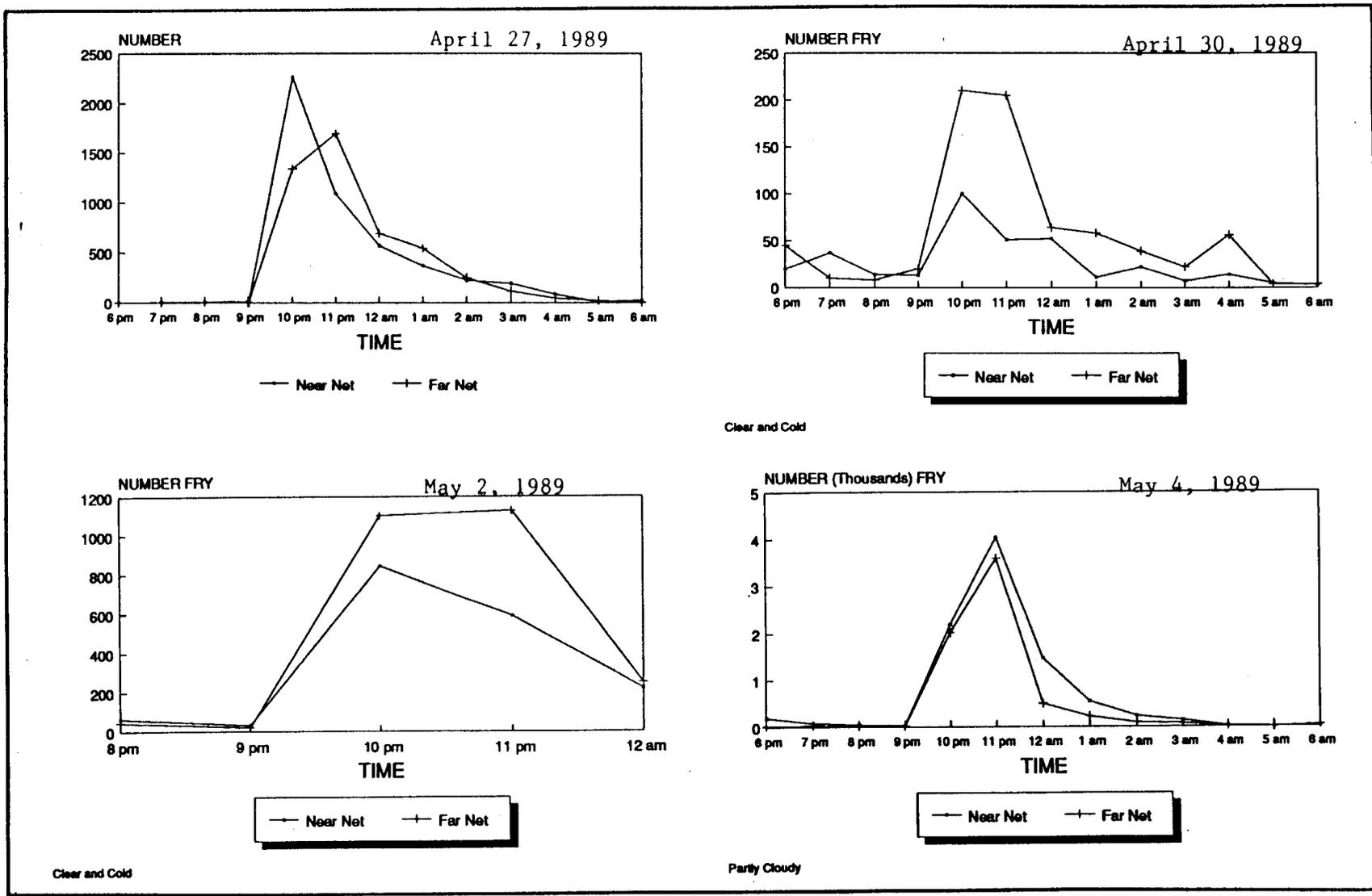


Figure 10. Fish Creek chum outmigration by hour April 27 to May 4, 1989.

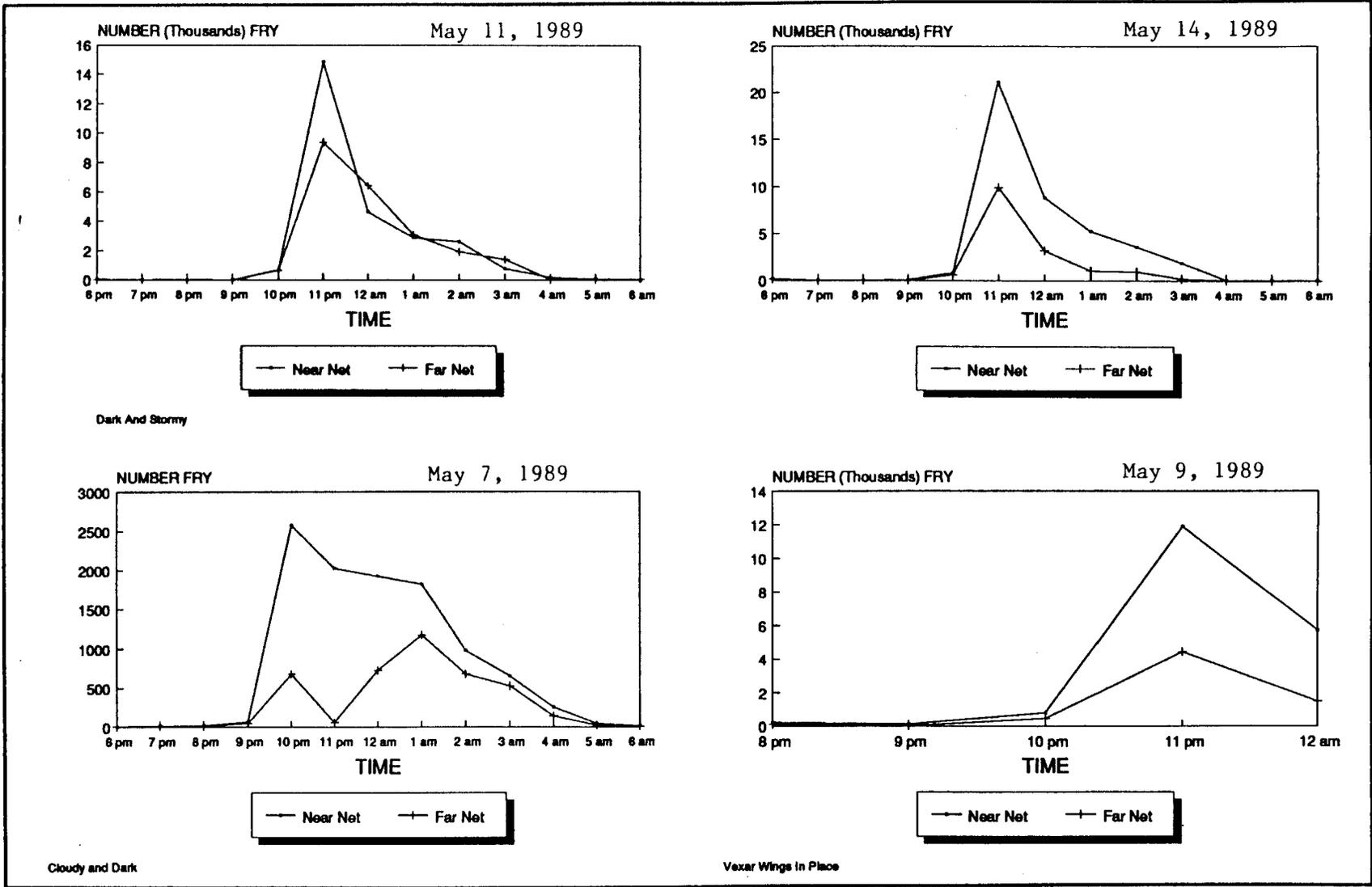


Figure 11. Fish Creek chum outmigration by hour May 7 to May 14, 1989.

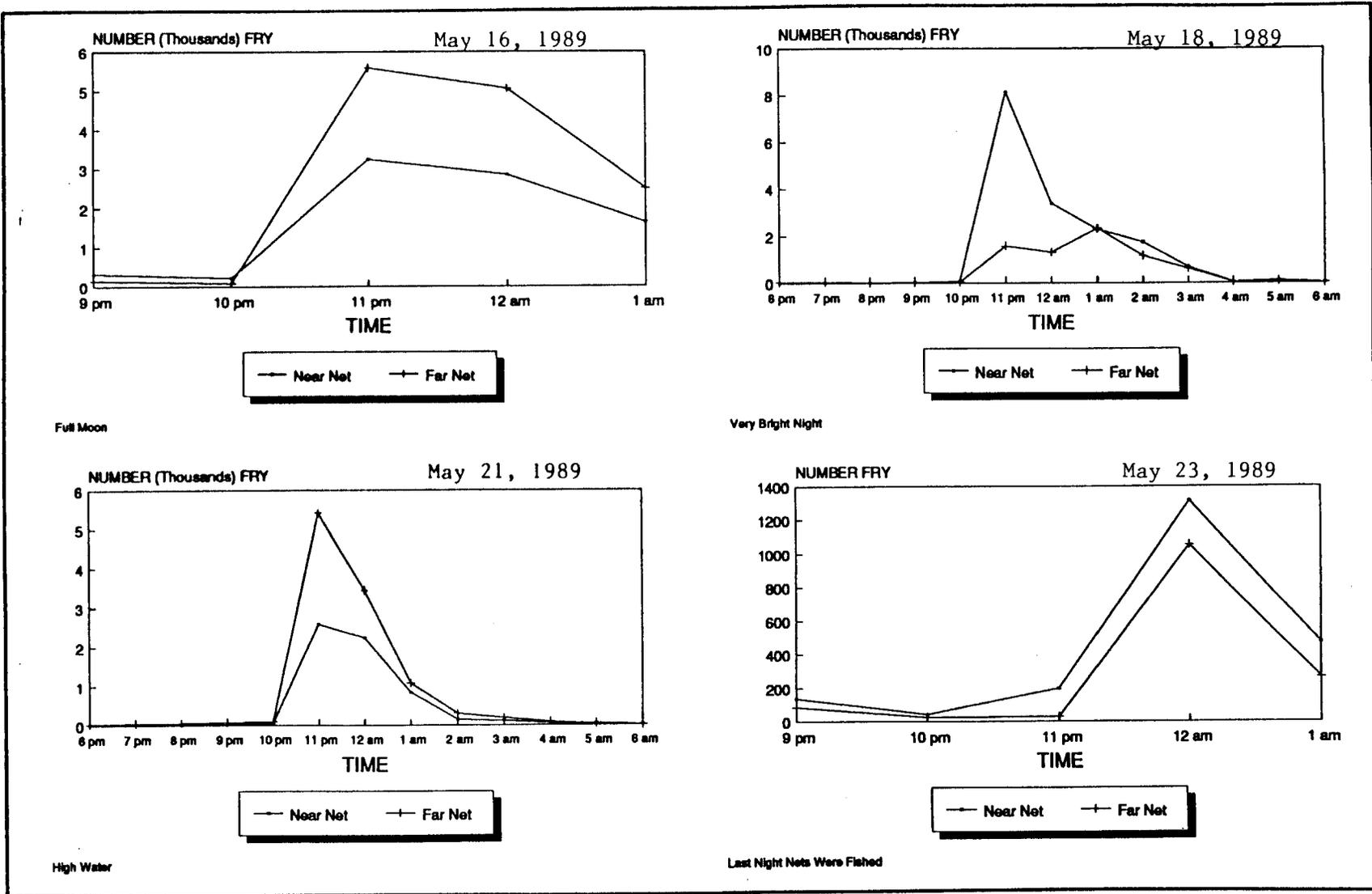


Figure 12. Fish Creek chum outmigration by hour May 16 to May 23, 1989.

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