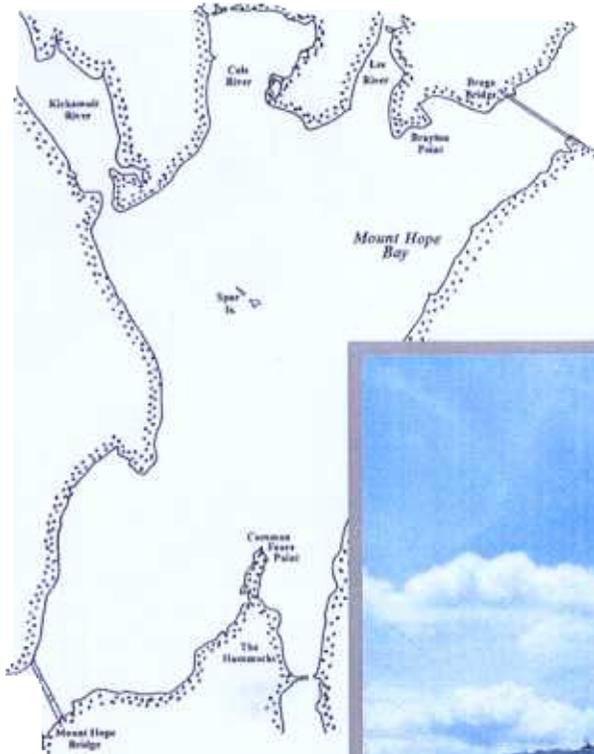


Dominion Brayton Point

Brayton Point Station

AR 4058
EXHIBIT R19



2004 Annual Report

Hydrological and Biological Monitoring Program

Brayton Point Station
Somerset, Massachusetts

10 Winter Flounder Collection Temperature Analysis

10.1 INTRODUCTION

In addition to the evaluation of macro-trends in species abundance and diversity within Mount Hope Bay, the ongoing fish collection programs and the associated water temperature measurements provide an opportunity to assess how winter flounder abundance varies with water temperature. The focus of this analysis is to discern if age-0 juvenile winter flounder continue to be collected at representative levels as water temperatures rise during the warm summer season.

10.2 METHODS: BEACH SEINE PROGRAMS AND ANALYSIS

As detailed in Section 7.3, MRI performs a 50-ft beach seine program to index spatial and temporal trends in young-of-the-year (i.e., age-0) juvenile winter flounder abundance in the tributaries to Mount Hope Bay. Two surveys each are performed in June and July, and one survey in August. This program began in 1992. In addition to the collection of winter flounder in hauls of a beach seine, supplementary data on water temperatures are also collected by MRI.

A second data set is collected by the Rhode Island Division of Fish and Wildlife (RIDFW), which conducts beach seine surveys at 18 shallow or littoral stations in Narragansett Bay. This is done on a monthly basis from June through October. Water temperature is also recorded at each station, and the catch of the seine is enumerated by species, which includes catches of age-0 juvenile winter flounder.

The data were evaluated by developing histograms (i.e., frequency distributions) comparing water temperature to the number of age-0 juvenile winter flounder caught. The analysis accounts for the fact that beach seine sampling events were not evenly distributed over the range of observed temperatures. To correct for this, the catch per seine haul for each 1°C temperature increment was used as the index of winter flounder abundance.

The MRI and RIDFW data sets were examined using two periods of interest, specifically – the most recent 2004 calendar year information and an aggregate historical data set ending in 2003.

10.3 RESULTS

10.3.1 MRI Age-0 Juvenile Beach Seine Program

Figure 10-1 shows the average number of age-0 juvenile winter flounder caught per seine haul for the MRI aggregate historical data set from 1992 to 2003. Also included in the figure is the number of sampling events that occurred within each 1°C temperature increment.

The overall average number of juvenile winter flounder caught per seine haul over the observed temperature range was 4.5. As shown in Figure 10-1, catch results at water temperatures 19°C through 27°C were equal to or greater than the average.

Figure 10-2 shows the average number of age-0 juvenile winter flounder caught per seine haul for the 2004 MRI data. In general, it appears that 2004 was a relatively cool year compared to the 1992 to 2003 aggregate data set (e.g., the highest sampled water temperature in 2004 was 26.0°C, which was the lowest annual maximum for the MRI 1992-2004 beach seine data set). The overall average number of juvenile winter flounder caught per seine haul over the observed temperature range was 6.0. The average catch results exceeded this overall average at both the lower and upper ends of the observed water temperature range (i.e., 19°C-20°C and 25°C-26°C).

The 1992 to 2003 MRI juvenile winter flounder catch results shown in Figure 10-1 extended up to 32°C, and were close to the overall mean catch (per seine haul) at 30°C (i.e., a mean of 4.5 versus 3.75 at 30°C). The 2004 data in Figure 10-2 show that the highest catch (per seine haul) was observed at the highest sampled water temperature increment (26°C).

An additional method of evaluating how abundance varies with temperature is provided in Figure 10-3, which depicts water temperature versus the cumulative proportion of MRI YOY winter flounder collected from 1992 through 2004. The rate of change in the cumulative proportion curve remains relatively constant (i.e., linear) through the area of 22°C to 27°C collection temperatures. Linearity through this temperature range indicates that each 1°C increase in water temperature corresponds to a steady incremental increase in the cumulative proportion of age-0 winter flounder (i.e., average catch within each of these temperature intervals was generally similar in size).

10.3.2 RIDFW Age-0 Juvenile Winter Flounder Program

Figure 10-4 shows average number of age-0 juvenile winter flounder caught per seine haul for the RIDFW aggregate historical data set from 1992 to 2003.¹ The observed temperature range for the RIDFW data is lower than MRI's June through August data set because the sampling extends into October. The average number of juvenile winter flounder caught over the observed temperature range was 11.6. As shown in Figure 10-4,

¹ Note that September 2002 data are unavailable.

the average catch results at water temperatures 18°C to 20°C, and 22°C to 28°C exceeded this overall average.

Figure 10-5 shows the average number of age-0 juvenile winter flounder caught per seine haul for the 2004 RIDFW data. As was the case with the MRI data, water temperatures in 2004 were relatively cool (e.g., the maximum sampled water temperature was 26.3°C). The overall average number of juvenile winter flounder caught over the observed temperature range was 14.5. The average catch results at water temperatures 18°C, 19°C, 22°C, 23°C, and 25°C exceeded this overall average.

Figure 10-6 depicts water temperature versus the cumulative proportion of RIDFW YOY winter flounder collected from 1992 through 2004. A linear rate of change in the cumulative proportion curve is shown through the area of 22°C to 28°C, which indicates that each 1°C increase in water temperature corresponds to a steady incremental increase in the cumulative proportion of age-0 winter flounder (i.e., average catch within each of these temperature intervals was generally similar in size).

The RIDFW data shows that when water temperatures rise during the summer period, age-0 juvenile winter flounder continue to occupy the near-shore habitat. As shown in Figure 10-4, the 1992 to 2003 catch results exceeded overall mean catch (per seine haul) at water temperature increments from 25°C through 28°C. The 2004 RIDFW data in Figure 10-5 shows that the catch per seine haul was close to the overall mean at the highest sampled water temperature increment of 26°C (i.e., a mean of 14.5 versus 11.5 at 26°C). As shown in Figure 10-6, no deflection in the cumulative proportion of age-0 winter flounder collected was observed from 22°C to 28°C.

10.4 CONCLUSIONS

Analysis of warmer collection temperatures shows that age-0 juvenile winter flounder are routinely found at above-average abundance levels between 24°C and 28°C. During the relatively cool 2004 sampling season, the highest average winter flounder catches in Mount Hope Bay were recorded at 26°C, which was also the highest temperature recorded during the sampling season. These observations are consistent with established knowledge regarding fish physiology:

- As water temperatures increase, fish physiologically adjust by a process called acclimation, allowing them to tolerate higher temperatures (Brett 1956; Coutant 1972).
- Species such as winter flounder that use dynamic estuarine environments like Mount Hope for habitat typically have a robust physiology and the ability to adapt to a wide range of naturally varying water temperatures (LMS 2002).

10.5 REFERENCES

- Brett, J.R. 1956. Some principles in the thermal requirements of fishes. *Quarterly Review of Biology*. 31(2): 72–87.
- Coutant, C.C. 1972. Biological aspects of thermal pollution. Vol. I: entrainment and discharge canal effects. *Critical Review in Environmental Control*. 3:341–381.
- LMS 2002. LMS Response to EPA MA0003654 Determinations Document. Part 1, pp. I-1 to I-3. Submitted to U.S. EPA Region 1 on October 4, 2002.

10.6 FIGURES

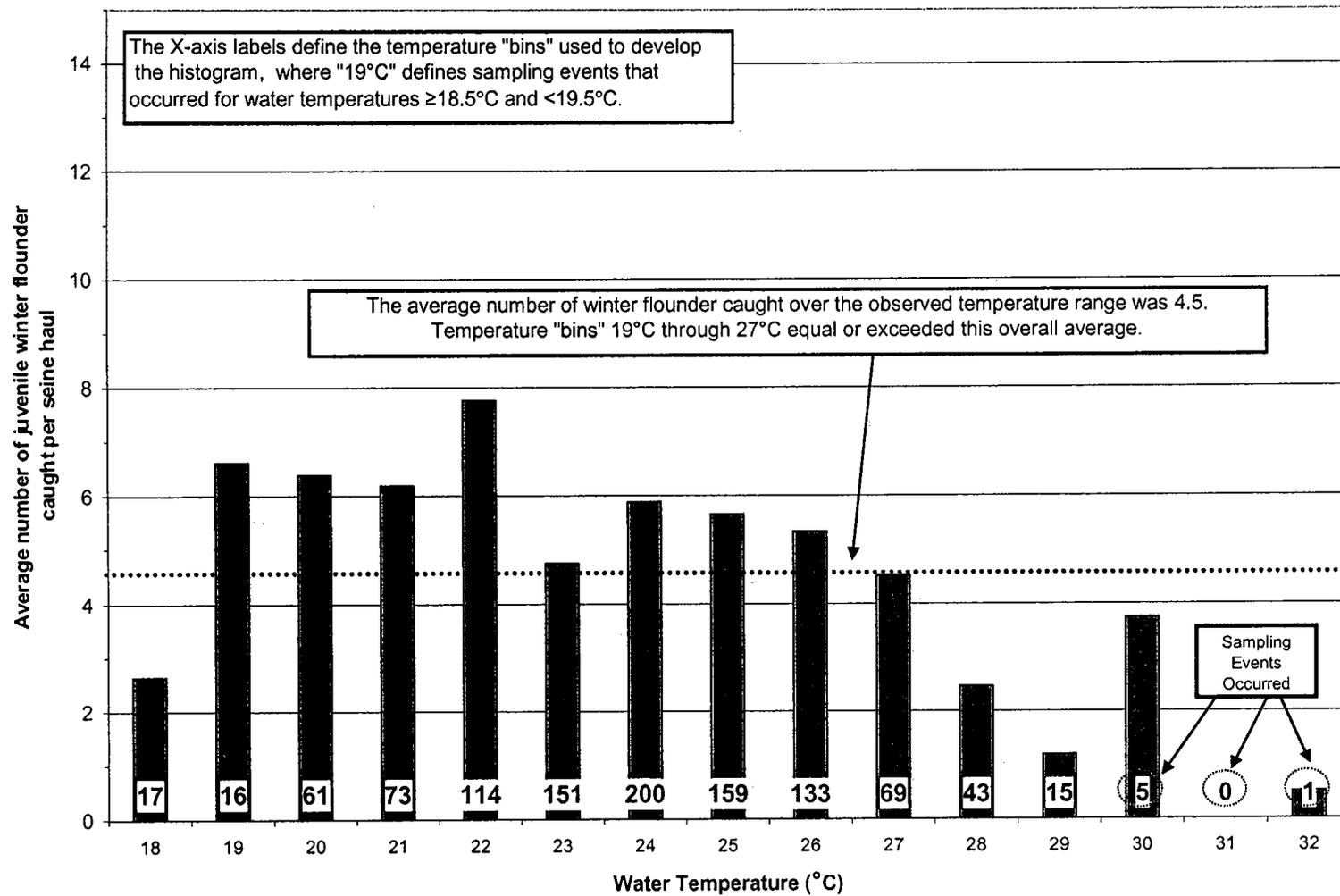


Figure 10-1. Winter Flounder Catch Compared to Water Temperatures (1992-2003 MRI Beach Seine Data in Mount Hope Bay)

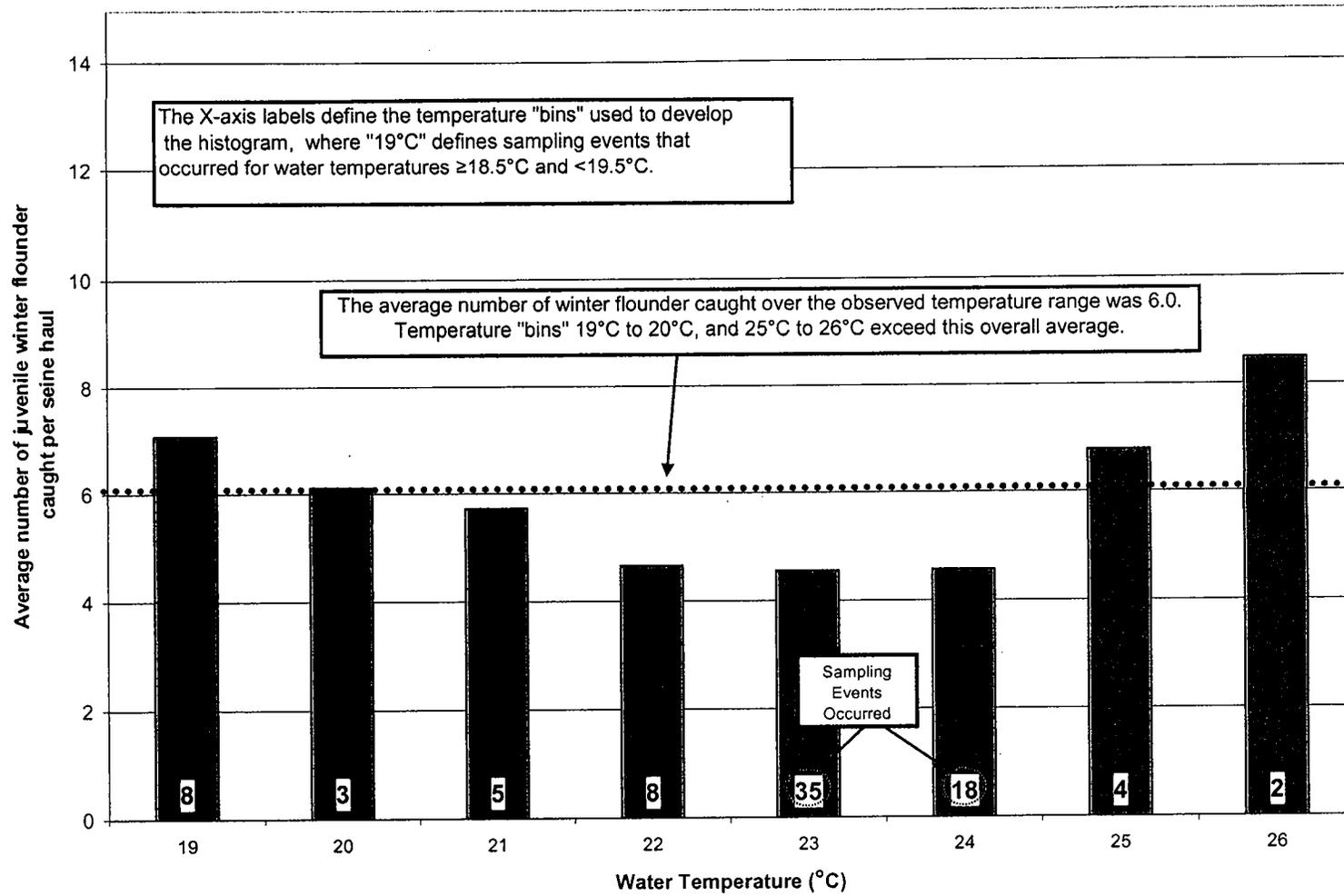


Figure 10-2. Winter Flounder Catch Compared to Water Temperatures (2004 MRI Beach Seine Data in Mount Hope Bay)

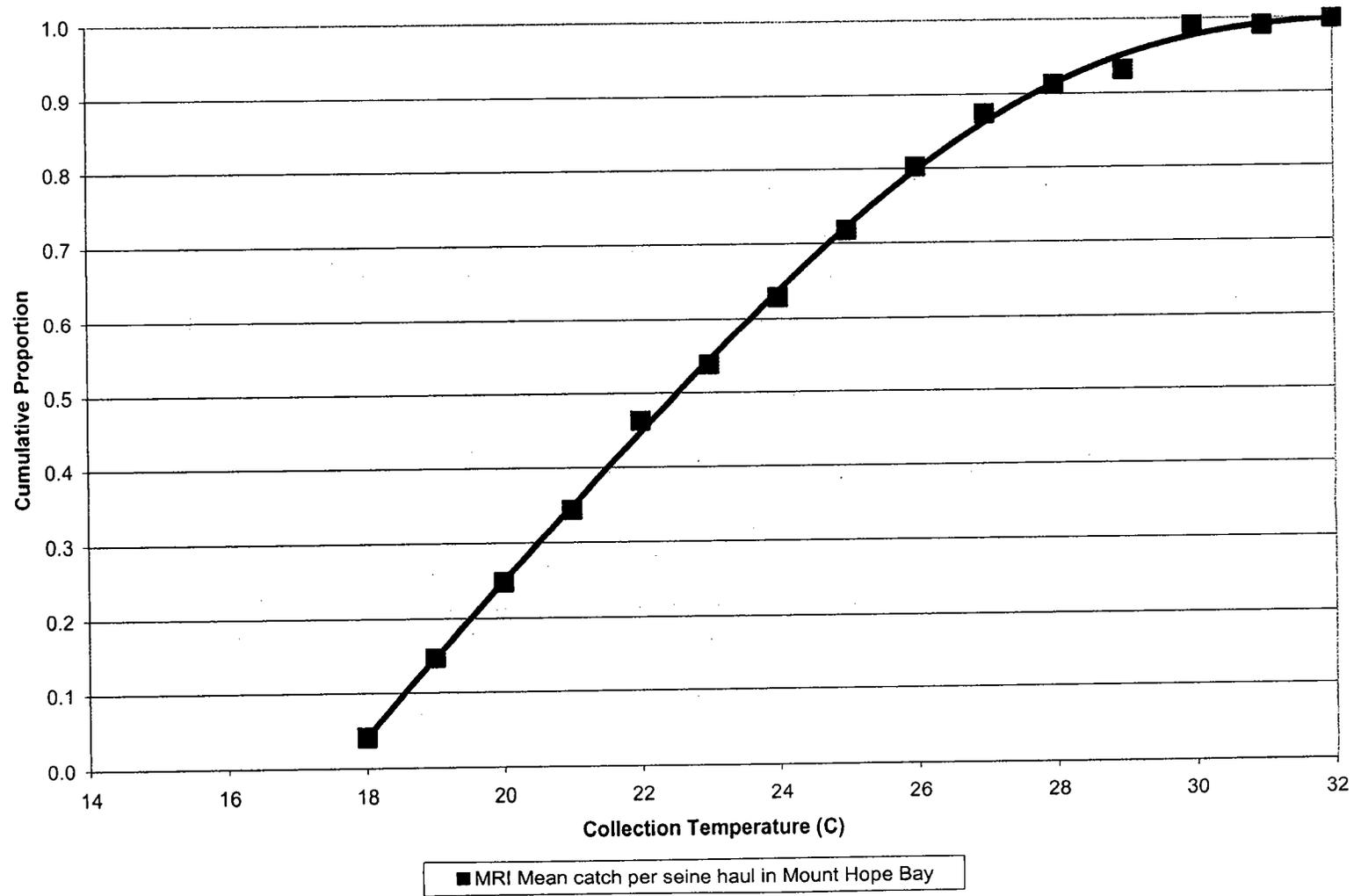


Figure 10-3. Winter Flounder Collection Temperature Summary (1992- 2004 MRI Beach Seine Data in Mount Hope Bay)

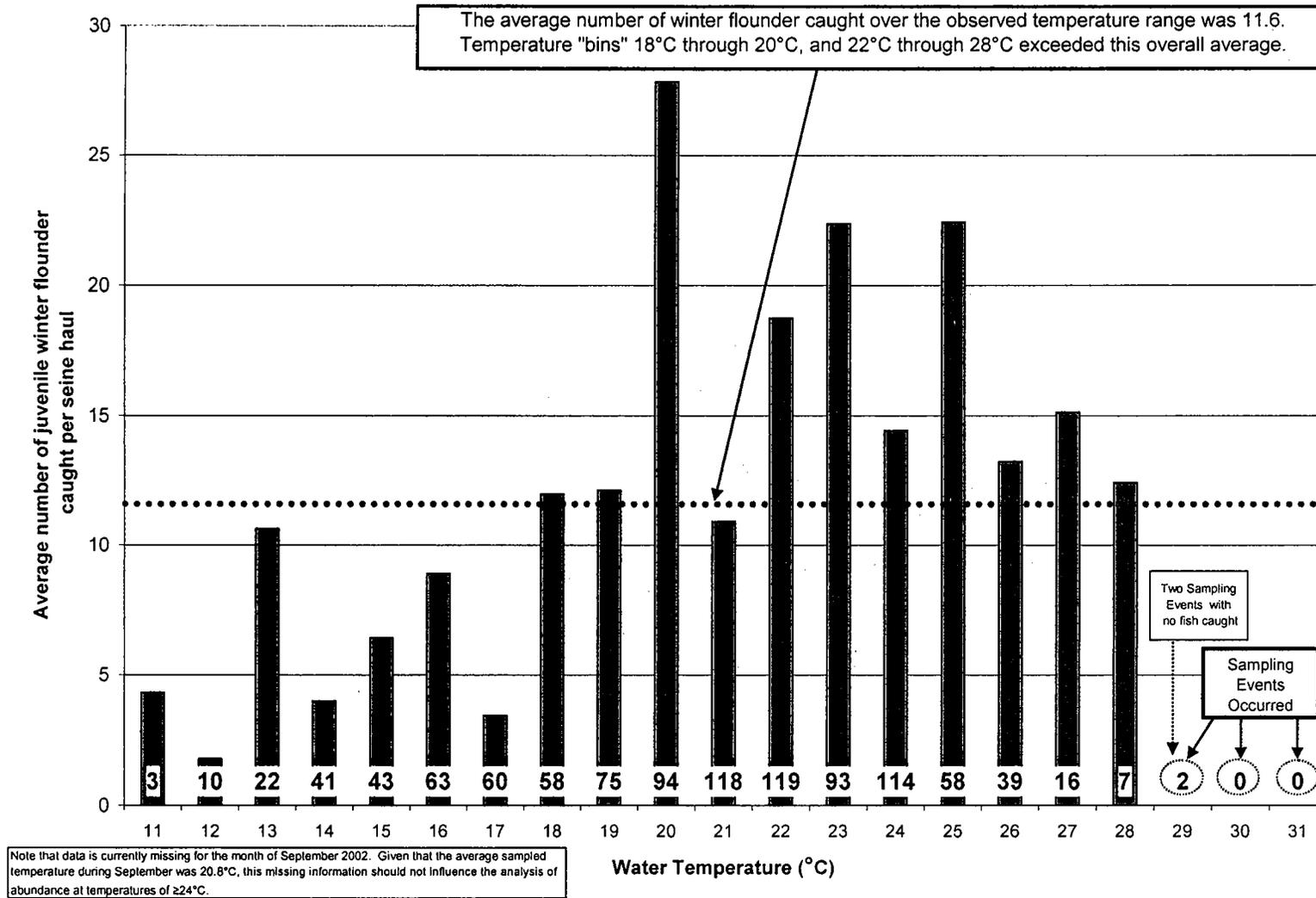


Figure 10-4. Winter Flounder Catch Compared to Water Temperatures (1992-2003 RIDFW Beach Seine data in Narragansett Bay)

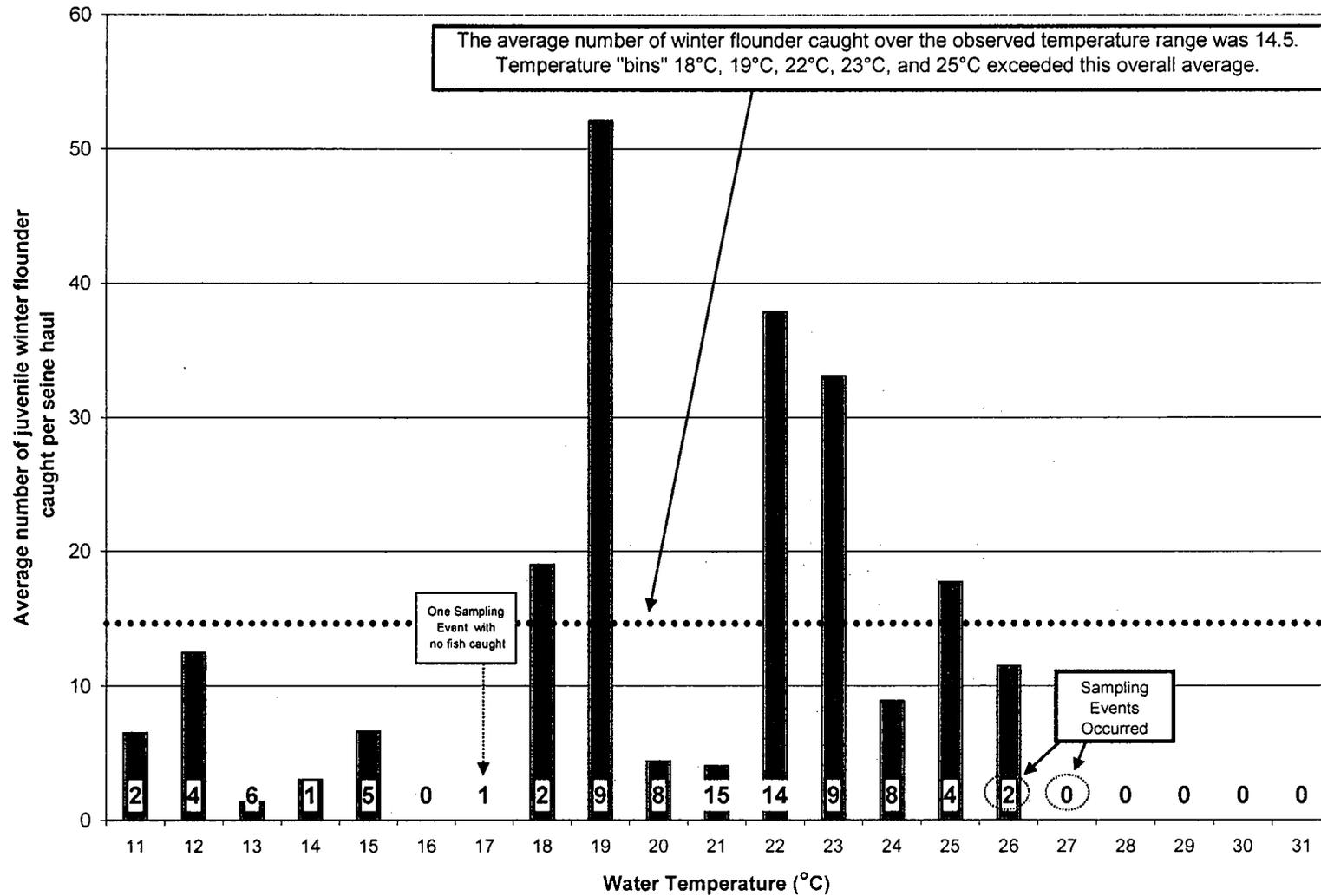


Figure 10-5. Winter Flounder Catch Compared to Water Temperatures (2004 RIDFW Beach Seine data in Narragansett Bay)

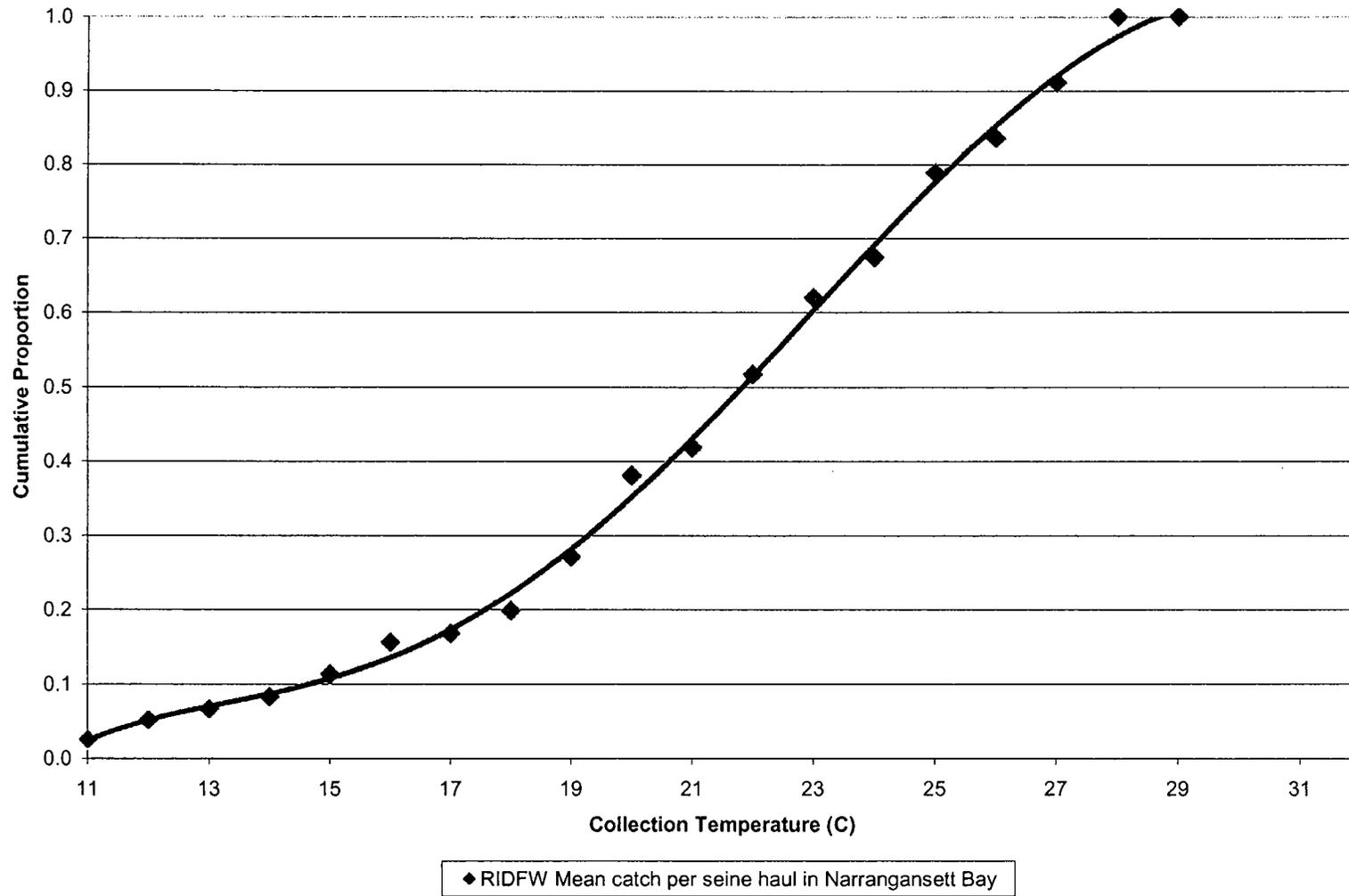


Figure 10-6. Winter Flounder Collection Temperature Summary (1992- 2004 RIDFW Beach Seine data in Narragansett Bay)