

Vermont Fish and Wildlife Department Annual Report

State: Vermont

Project No.: F-35-R-14

Grant Title: Lake Champlain Fisheries Restoration and Management

Study No. II

Study Title: Forage Fish Monitoring

Period Covered: July 1, 2011 to June 30, 2012

Summary of Activity:

Lake Champlain forage fish assessment sampling in 2011 was carried out beginning on July 27 and ending on August 23. Calculated mean CPUE's were well below historic numbers at all stations. All three main lake stations had less than 100 fish per net as did both the Malletts Bay and Northeast Arm stations. The Northeast Arm station had the lowest CPUE ever recorded at 37 smelt per net. Floating gill nets were utilized to sample alewife. Alewives were captured at all stations with the greatest catch being at the Valcour Island station. Results from Acoustic sampling agree with patterns found at the five stations for rainbow smelt. The acoustic sampling is also showing an increase in fish above the thermocline which, based on gillnets and shallow trawls, is likely a combination of alewife and white perch.

INTRODUCTION

In the fall of 1990, an 8-year experimental program for management of sea lamprey (*Petromyzon marinus*) in Lake Champlain began. In conjunction with sea lamprey control measures, several assessment programs were initiated to help determine the overall effect of the program on the lake's fisheries. Rainbow smelt (*Osmerus mordax*) are the primary food for salmonid predators in the lake and also comprise an important winter recreational fishery. Lake Champlain fishery managers predicted that as sea lamprey populations were reduced there could be accompanying changes in predator mortality rates and growth and thus increased consumption rates of rainbow smelt by predators. Thus, an 8-year program was initiated to monitor rainbow smelt stocks in several areas of the lake using the technique of stepped-oblique midwater trawling (Kirn and LaBar 1991, LaBar 1999). At the conclusion of the 8-year experimental sea lamprey control program, the Lake Champlain Technical Committee recommended that the smelt monitoring program be continued by the Vermont Department of Fish and Wildlife (VTDFW). This document reports the findings of the VTDFW's forage fish sampling efforts.

PROCEDURES

Standard Rainbow Smelt Monitoring

Five stations were sampled in 2011 for rainbow smelt in Lake Champlain (Figure 1). These sites include three main lake stations, one station in Malletts Bay, and one station in the

Inland Sea (also known as the Northeast Arm). The five sites are stations that have been historically sampled. Station locations are shown in Figure 1 and Table 1.

Midwater trawling was carried out at night as described by Kirn and LaBar (1991). The midwater trawl used measures 5 meters (m) by 5 m with large mesh near the mouth grading to smaller mesh near the end, and terminating in a cod end with a 0.6 cm square mesh liner. For each trawl, the net was lowered to approximately 35 m depth or to just above the bottom, whichever came first. The net was towed at the maximum depth for 10 minutes allowing it to stabilize. The net was then raised about 3 m and towed for an additional 5 minutes. This step is repeated until the net was 10 m below the surface and then it is hauled back to the boat. Thus, in deep-water sites, each trawl lasted for 55 minutes, and at the shallower sites, 40-45 minutes. Four trawls were conducted at each site. During each trawl, the net was monitored for depth using a remote transmitter affixed to the head rope on the net. Prior to sampling at each station a temperature profile was taken.

Catch-per-unit-effort (CPUE) is expressed in terms of catch per 55-minutes of trawling (catch X 55 min/trawling time). A sample of 50 fish was randomly selected from each haul and frozen for later otolith extraction. In the laboratory, the smelt were thawed, measured, weighed, and otoliths were extracted. Otoliths were placed in an ethanol/glycerine mixture (70:30) to help clear them and later aged with a binocular dissecting scope at 10 - 45X magnification.

Young-of-year (YOY) smelt were saved and later measured to the nearest millimeter in the laboratory. Any cisco (*Coregonus artedi*) collected were also counted and measured. All other fish species collected are identified and counted.

Alewife Monitoring

Alewife (*Alosa pseudoharengus*) were first discovered in Lake Champlain in 2004 and their numbers have increased since. A sampling program is being developed to monitor their abundance and population characteristics. Floating gill nets were utilized to collect alewife samples for age and growth analysis. These nets were set in the early evening (1 per night) prior to the standard smelt trawling or acoustic sampling (when possible) and retrieved at the conclusion of the night's sampling. The net measured 6m deep by 21m in length with 7 panels of mesh sizes 6.25, 8, 10, 12, 15, 18 and 25mm.

Catch-per-unit-effort is expressed in terms of catch per 4-hour net set (catch X 4 hr/net set time). Captured alewives were frozen for later otolith extraction. In the laboratory, alewife were thawed, measured, weighed, and otoliths were extracted. The otoliths were stored dry in vials and later aged with a binocular dissecting scope at 10 - 45X magnification.

FINDINGS

Standard Monitoring

Catch-Per-Unit-of-Effort --- A total of 19 midwater trawls were conducted between August 1 and August 15, 2011 (Table 2). Calculated mean CPUE's in 2011 at all stations were well below historic numbers (Figure 2). Table 2 compares 2011 CPUE with long-term mean and median

values. All three main lake stations had less than 100 fish per net as did both the Malletts Bay and Northeast Arm stations. The Northeast Arm station had the lowest CPUE ever recorded at 37 smelt per net.

Age and Growth --- Mean age of smelt sampled in 2011 ranged from 1.6 to 2.8 years (Table 3 and Figures 3 and 4). Age composition of the samples from each station is illustrated in Figure 5 and compared to previous years in Figures 6-10. Age one smelt, which were absent in the 2008 sample, were again nearly absent in the Northeast Arm and Malletts Bay. Age 3 smelt made up nearly 75 percent of the aged sample in the Northeast Arm while age 2 and 3 smelt dominated in Malletts Bay (~70% of aged smelt). Only half of the usual number of smelt were collected from Malletts Bay for age analysis. Mean length of smelt at these two stations appear to be increasing relative to previous years (Table 4, Figures 11 - 15). Mean weight at age of smelt collected in 2011 is summarized in Table 5.

Young-of-Year Rainbow Smelt --- It's important to note that the sampling gear is not designed to effectively sample YOY smelt and that the YOY data must be viewed cautiously. Large numbers of YOY smelt were found at all stations in 2011 (Table 6 and 7). Smelt YOY mean lengths were similar at the main lake stations ranging from 31 to 60 mm.

Hydro Acoustics

Acoustic work was performed lake-wide in 2011, which include the three basins of Lake Champlain (Malletts Bay, Northeast Arm and Main Lake) and resulted in over 75.5 nautical miles of sampling. The survey sampled 11.5 nautical miles in Malletts Bay, 10 nautical miles in Northeast Arm and 54 nautical miles in Main Lake. Three transects were not completed due to high winds and wave conditions. Data were visually examined to ensure data integrity and backup. Physical samples were also taken using a Sea Bird CTD (conductivity, temperature, depth, pH) profiler. In 2011 a total of 26 profiles were taken: 16 Main Lake, 6 Inland Sea and 4 Malletts Bay. Additional physical samples were performed using various trawls (tucker – young of year, midwater – older) to confirm species of acoustic targets (Table 8a – 2010-CPUE not reported in last year's report and Table 8b-2011). A total of 11 tucker trawls and 8 midwater trawls were performed in 2011 (Table 8b).

Processed Data --- Processing is ongoing but some general trends have appeared. Generally fish density is highest in the upper 10 to 15 meters of water. In both Malletts Bay and Northeast Arm adult smelt numbers (acoustic targets below the thermocline) appear to be staying low (2008 - 2011) compared to early years (2005 - 2007) (Figure 16). In the Northeast Arm the targets above the thermocline showed a strong increase in 2008 - 2011 but 2009 was similar to earlier years. Malletts Bay targets above the thermocline were higher in 2008 and 2011 than earlier years. The Malletts Bay estimate in 2009 is not display on the graph due to noise problems. Operation of a new sonar unit on the boat caused slight noise interference. Examination of the noise suggests that with time the noise can be manually removed from the data. Based on shallow midwater trawls and floating gillnets catches we suspect that most of the acoustic targets above the thermocline are a mix of alewife and white perch. The Main Lake Area seems to have annual fluctuations in acoustic targets but there are no overarching trends in fish numbers. North main lake showed low smelt numbers but south main lake had higher numbers. Main Lake seemed to stay consistent.

Targeted Trawls --- In 2011 alewife were collected in many of the trawls. The CPUE is difficult to compare because trawls are targeting acoustic targets, therefore they typically are sampling high density areas.

Alewife

Catch-Per-Unit-of-Effort --- Ten floating gill nets were set in 2011 (Table 9). Five nets were fished in the main lake with the Valcour Island station recording the greatest CPUE of YOY and adult alewife at 130 and 87 fish, respectively. Two nets were fished in Malletts Bay and 2 nets were set in the Northeast Arm. Fewer adult alewife were recorded in all lake basins.

Age and Growth --- Alewife collected by gill net ranged in age from YOY (0+) to 2 year-olds (Table 10, Figure 17). Most stations were dominated by age-one alewives. Mean lengths were similar across sampling stations with age-2 alewife mean length declining in all basins in 2011 (figure 18).

Midwater trawl numbers --- Seventeen adult alewives were collected by midwater trawl in 2011. Most of the alewives (8) were collected at Barber Point followed by Malletts bay (7); 2 were collected at Valcour Island and no alewife were netted at Juniper Island or the Northeast Arm. Alewife YOY were also collected at all stations (Table 6). The largest numbers of YOY alewife were collected in Malletts Bay (estimated 2,258 fish).

Cisco

A total of 45 cisco was collected during the 2011 forage fish sampling effort (Table 11). Twenty-nine were collected at Valcour Island and 13 at Juniper Island. It should be noted that data prior to 1999 should be viewed cautiously as it's uncertain how well cisco numbers were monitored in earlier years.

As in previous years, nearly all of the measured cisco fell into the 240 – 330 mm length class (mean length=289 mm, sd=34). One YOY (87 mm) was collected during the 2011 sampling season.

Temperature

Figure 19 shows temperature profiles for the sampling period. Temperature profiles varied slightly at different stations. Thermoclines generally were determined to exist below 12 meters in depth.

RECOMMENDATIONS

1. Continue to monitor rainbow smelt populations.
 2. Develop means of sampling alewife populations.
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Table 1. Rainbow smelt sampling station locations in Lake Champlain. North and south refer to the approximate location of the northern and southern ends of the trawled transect.

| Station name | Depth (meters) | Location (latitude and longitude) | |
|---------------------|----------------|-----------------------------------|----------------------------|
| | | North | South |
| Main Lake | | | |
| Barber Point | 50 - 60 | 44 ° 10.85' 73 ° 23.64' | 44 ° 08.97' 73 ° 23.74' |
| Juniper Island | 70 - 90 | 44 ° 28.87' 73 ° 18.33' | 44 ° 26.75' 73 ° 18.09' |
| Valcour Island | 56 - 62 | 44 ° 38.50' 73 ° 23.50' | 44 ° 36.50' 73 ° 23.50' |
| Malletts Bay | | | |
| Malletts Bay | 22 - 32 | 44 ° 36.07' 73 ° 16.59' | 44 ° 34.65' 73 ° 16.82' |
| Inland Sea | | | |
| Northeast Arm | 22 - 40 | 44 ° 47.02' 73 ° 15.39' | 44 ° 45.36' 73 ° 14.69' |

Table 2. Mean catch per 55 minute trawl (CPUE with 95% confidence interval) of rainbow smelt in 2011 and comparison to long-term mean and median CPUE.

| Station | Number of trawls | CPUE | Mean | Median | N years |
|---------------------|------------------|---------|------|--------|---------|
| Main Lake | | | | | |
| Barber Point | 4 | 66 ± 5 | 259 | 206 | 18 |
| Juniper Island | 4 | 67 ± 25 | 173 | 97 | 22 |
| Valcour Island | 3 | 71 ± 14 | 245 | 138 | 12 |
| Malletts Bay | | | | | |
| Malletts Bay | 4 | 61 ± 18 | 956 | 634 | 22 |
| Inland Sea | | | | | |
| Northeast Arm | 4 | 37 ± 8 | 1016 | 692 | 22 |

Table 2. Mean catch per 55 minute trawl of rainbow smelt in 2011 and comparison to long-term mean and median CPUE, pre- and post-alewife invasion.

| | Barber Pt. | Juniper Is. | Valcour Is. | Malletts Bay | Northeast Arm |
|---|-------------------|--------------------|--------------------|---------------------|----------------------|
| <i>All Years</i> | | | | | |
| Mean | 259 | 173 | 245 | 956 | 1016 |
| Median | 206 | 97 | 138 | 634 | 692 |
| N | 18 | 22 | 12 | 22 | 22 |
| <i>1990-2004: Pre-Alewife Invasion</i> | | | | | |
| Mean | 206 | 180 | 423 | 1124 | 1363 |
| Median | 138 | 111 | 285 | 654 | 1103 |
| N | 11 | 15 | 5 | 15 | 15 |
| <i>2005-2011: Post-Alewife Invasion</i> | | | | | |
| Mean | 342 | 159 | 117 | 595 | 272 |
| Median | 256 | 77 | 77 | 252 | 151 |
| N | 7 | 7 | 7 | 7 | 7 |

Table 3. Mean and maximum age of rainbow smelt sampled by station in 2011. Number in parenthesis is change from previous year.

| Station | Mean age | Maximum age |
|---------------------------|------------|-------------|
| Main Lake Stations | | |
| Barber Point | 1.6 (---) | 4 |
| Juniper Island | 1.6 (-0.1) | 5 |
| Valcour Island | 2.0 (+0.8) | 4 |
| Malletts Bay | | |
| Malletts Bay | 2.8 (---) | 8 |
| Inland Sea Station | | |
| Northeast Arm | 2.6 (+0.6) | 4 |

Table 4. Mean length and standard deviation in millimeters, by age class of rainbow smelt sampled in 2011. Number of smelt aged in parenthesis.

| Station | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 |
|---------------------------|-------------------|------------------|------------------|------------------|------------------|-----------------|
| Main Lake Stations | | | | | | |
| Barber Point | 116 ± 10 (126) | 130 ± 14 (37) | 138 ± 8 (31) | 197 ± 17 (4) | --- | --- |
| Juniper Island | 115 ± 9 (129) | 128 ± 7 (47) | 137 ± 13 (36) | 153 (1) | 157 (1) | --- |
| Valcour Island | 116 ± 11 (72) | 131 ± 6 (46) | 136 ± 6 (66) | 160 ± 16 (2) | --- | --- |
| Malletts Bay | | | | | | |
| Malletts Bay | 127 ± 16 (9) | 140 ± 9 (74) | 149 ± 9 (40) | 158 ± 18 (15) | 165 ± 17 (17) | 162 ± 17 (4) |
| Inland Sea | | | | | | |
| Northeast Arm | 121 ± 10 (14) | 145 ± 8 (15) | 152 ± 7 (83) | 180 (1) | --- | --- |

Table 5. Mean weight and standard deviation in grams, by age class of rainbow smelt sampled in 2011. Number of smelt in parenthesis.

| Station | Age 1 | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 |
|---------------------------|----------------|----------------|----------------|-----------------|----------------|---------------|
| Main Lake Stations | | | | | | |
| Barber Point | 9 ± 3 (126) | 11 ± 6 (37) | 13 ± 3 (31) | 43 ± 14 (4) | --- | --- |
| Juniper Island | 8 ± 2 (129) | 10 ± 2 (47) | 13 ± 4 (36) | 18 (1) | 18 (1) | --- |
| Valcour Island | 9 ± 2 (72) | 11 ± 2 (46) | 13 ± 2 (66) | 20 ± 6 (2) | --- | --- |
| Malletts Bay | | | | | | |
| Malletts Bay | 12 ± 5 (9) | 17 ± 4 (74) | 20 ± 4 (40) | 23 ± 11 (15) | 24 ± 8 (17) | 22 ± 6 (4) |
| Inland Sea | | | | | | |
| Northeast Arm | 11 ± 3 (14) | 18 ± 3 (15) | 20 ± 4 (83) | 30 (1) | --- | --- |

Table 6. Summary of young-of-year rainbow smelt and alewife (in parenthesis) collected during midwater smelt trawls, 1999-2011. Larger numbers are estimated based on weighed and counted subsamples.

| Year | Barber | Juniper | Valcour | Malletts Bay | Northeast Arm |
|------|-------------------|--------------|----------------|--------------------------|------------------|
| 1999 | 4172 | 2588 | 830 | 3095 | 1690 |
| 2000 | 5667 | 1350 | 774 | 3629 | 881 |
| 2001 | 7961 | 13253 | 7378 | 103000 | 6015 |
| 2002 | 29 | 10 | 23 | 65 | 8 |
| 2003 | 3 | 109 | 397 | 57 | 230 |
| 2004 | 15 | 400 | NA | 102 | 397 |
| 2005 | 9717 (1) | 700 | 6283 | 1022 | 798 |
| 2006 | 31350 (2) | 624 | 561 | 1529 | 916 |
| 2007 | 129 | 109 | 1447 (1728) | 5 | 392 |
| 2008 | 201 (1) | 36 | 3796 (60) | 187 (2308) | 796 (244) |
| 2009 | 0 (0) | 450 (0) | 349 (91) | 485 (383) | 35 (57) |
| 2010 | 6 (75) | 39 (74) | 202 (659) | 0 (0) | 0 (est. 1400) |
| 2011 | est. 8990 (10) | 3078 (15) | 1034 (88) | est. 3240 (est. 2258) | 986 (290) |

Table 7. Number, mean length (standard deviation) and range of young-of-year smelt sampled in 2011.

| Station | Number Collected | Mean Length | Number Measured | Range |
|---------------------|------------------|-------------|-----------------|---------|
| Main Lake | | | | |
| Barber Point | 8990 | 49 ± 6 | 45 | 37 - 60 |
| Juniper Island | 3078 | 41 ± 5 | 95 | 32 - 54 |
| Valcour Island | 1034 | 39 ± 3 | 35 | 33 - 47 |
| Malletts Bay | | | | |
| Malletts Bay | 3240 | 41 ± 5 | 45 | 31 - 56 |
| Inland Sea | | | | |
| Northeast Arm | 986 | 45 ± 4 | 60 | 37 - 53 |

Table 8a. CPUE of targeted acoustic trawls in 2010. For example sampling number AT100803001 is sample collected on 08/03/10 and is net number 001.

| Sample | Gear | Area | CPUE (10 minutes) | | | | | | | |
|------------|--------|-----------|-------------------|-------|-------------|--------------|----------|----------|---------------------|-----------|
| | | | Alewife | Smelt | White Perch | Yellow Perch | Cypr Sp. | Centr Sp | Unknown Larval fish | Other |
| AT10080301 | Mid | NEA | 918.0 | - | 2.0 | - | - | - | - | - |
| AT10080302 | Tucker | NEA | - | - | - | - | - | - | - | - |
| AT10080303 | Tucker | NEA | 0.7 | - | - | - | - | - | - | - |
| AT10080304 | Tucker | NEA | 20.0 | - | - | - | - | - | - | - |
| AT10080305 | Mid | NEA | - | - | - | - | - | - | 240.0 ^a | - |
| AT10080401 | Mid | NEA | 35.5 | 22.5 | 0.5 | - | - | - | - | - |
| AT10080402 | Mid | NEA | - | - | - | - | - | - | ab | - |
| AT10080403 | Tucker | NEA | - | - | - | - | - | - | 6.7 ^a | - |
| AT10080404 | Tucker | NEA | 1.5 | 3.1 | - | - | - | - | - | - |
| AT10080501 | Mid | Main lake | 1134.0 | 8.0 | - | - | - | - | - | - |
| AT10080502 | Mid | Main lake | 189.1 | 44.5 | - | - | - | - | - | - |
| AT10080503 | Mid | Main lake | 73.3 | 18.0 | - | - | - | - | - | Cisco-3.3 |
| AT10081001 | Mid | Main lake | 823.3 | 2.7 | - | - | - | - | - | - |
| AT10081002 | Mid | Main lake | 156.7 | 72.0 | - | - | - | - | - | - |
| AT10081003 | Mid | Main lake | 314.0 | 35.3 | - | - | - | - | - | - |
| AT10081004 | Tucker | Main lake | - | - | - | - | - | - | - | - |
| AT10081101 | Tucker | Main lake | - | 143.0 | - | - | - | - | - | - |
| AT10081102 | Mid | Main lake | 71.1 | 8.4 | - | - | 3.2 | - | - | - |
| AT10081201 | Mid | Main lake | 1679.0 | - | - | - | - | - | - | - |
| AT10081202 | Tucker | Main lake | - | 2.5 | - | - | - | - | - | - |
| AT10081801 | Mid | Malletts | 342.0 | 3.0 | - | - | - | - | - | - |

^a Larval fish were unidentifiable due to freezer problem.

^b Larval fish were decomposed too much to count due to freezer problem.

Table 8b. CPUE of targeted acoustic trawls in 2011. For example sampling number AT110803001 is sample collected on 08/03/11 and is net number 001.

| Sample | Gear | Area | Depth (m) | CPUE (10 minutes) | | | | | | | |
|------------|--------|-----------|-----------|-------------------|--------|-------------|--------------|----------|----------|---------------------|-------|
| | | | | Alewife | Smelt | White Perch | Yellow Perch | Cypr Sp. | Centr Sp | Unknown Larval fish | Other |
| AT11080301 | Tucker | Malletts | 13 | 367.1 | 1148.6 | - | - | - | - | - | - |
| AT11080302 | Mid | Malletts | 13.5 | 183 | 273 | - | - | - | - | - | - |
| AT11080303 | Tucker | Malletts | 8.5 | 194 | 6 | - | - | - | - | - | - |
| AT11080304 | Tucker | Malletts | 10.9 | 640 | 12 | - | - | - | - | - | - |
| AT11081001 | Mid | NEA | 13.5 | 9.3 | 6.7 | 0.7 | 0.7 | - | - | - | - |
| AT11081002 | Tucker | NEA | 5.6 | 12 | - | - | - | - | - | - | - |
| AT11081003 | Tucker | NEA | 17 | 4 | 56 | - | - | - | - | - | - |
| AT11081004 | Tucker | NEA | 13.4 | 1.7 | 36.7 | 23.3 | - | - | - | - | - |
| AT11081101 | Mid | Main Lake | 7.4 | 38.9 | 46.7 | - | 1.1 | - | - | - | - |
| AT11081102 | Tucker | Main Lake | 12.8 | 128 | - | - | - | - | - | - | - |
| AT11081103 | Tucker | Main Lake | 13 | 297.1 | 8.6 | - | - | - | - | 1.4 | - |
| AT11081104 | Mid | Main Lake | 1.2 | 21 | 15 | - | - | - | - | - | - |
| AT11081601 | Mid | Main Lake | 2.3 | 92 | 7 | - | - | - | - | - | - |
| AT11081602 | Mid | Main Lake | 2.3 | 28 | 92 | - | - | - | - | - | - |
| AT11081603 | Tucker | Main Lake | 15.3 | - | 82 | - | - | - | - | - | - |
| AT11081604 | Tucker | Main Lake | 20 | - | 101.7 | - | - | - | - | - | - |
| AT11081701 | Mid | Main Lake | 1.4 | 85.8 | 25 | - | - | - | - | - | - |
| AT11081702 | Mid | Main Lake | 5.9 | - | - | - | - | - | - | - | - |
| AT11082301 | Tucker | Main Lake | 15.8 | 4 | 188 | - | - | - | - | - | - |

Table 9. Floating gill net catch per 4 hour set (expanded from total minutes fished) of alewife in 2008 - 2011. YOY = young of year; YAO = yearling and older.

| 2008 | | | |
|--|-------------|-------|-------|
| Station | Sample No. | YOY | YAO |
| Main Lake | | | |
| Barber Point | FGN08080401 | 2.5 | 0 |
| Potash Bay | FGN08080501 | 16.6 | 60.7 |
| Juniper Island | FGN08072101 | 0 | 101.6 |
| Valcour Island | FGN08081201 | 305.2 | 155.2 |
| Malletts Bay | | | |
| Malletts Bay | FGN08081101 | 33.8 | 2.2 |
| Inland Sea | | | |
| Ladd Point | FGN08072801 | 0 | 0 |
| Knight Island | FGN08073001 | 0.7 | 7.4 |
| 2009 | | | |
| Station | Sample No. | YOY | YAO |
| Main Lake | | | |
| Barber Point | FGN09081001 | 0 | 119.1 |
| Barber Point (same location as above) | FGN09081201 | 0 | 6.7 |
| Button Bay | FGN09081202 | 0 | 2.3 |
| Juniper Island | FGN09081701 | 17.4 | 106 |
| Valcour Island | FGN09081801 | 14 | 93 |
| Cumberland Head | FGN09080601 | 4.5 | 35.6 |
| Malletts Bay | | | |
| Malletts Bay | FGN09073001 | 5.4 | 47.9 |
| Inland Sea | | | |
| Ladd Point | FGN09080301 | 3.1 | 30.9 |
| Hyde Point | FGN09080501 | 20.8 | 13.2 |
| Savage Island | FGN09080502 | 4.2 | 8.9 |

Table 9. Continued.

| 2010 | | | |
|---------------------|-------------|-------|-------|
| Station | Sample No. | YOY | YAO |
| Main Lake | | | |
| Barber Point | FGN10080901 | 172.7 | 193.6 |
| Hunter Bay | FGN10081001 | 136.3 | 77.7 |
| Juniper Island | FGN10082301 | 26.9 | 7.0 |
| Starr Farm Beach | FGN10081201 | 28.5 | 3.2 |
| Valcour Island | FGN10072901 | 44.7 | 226.0 |
| Valcour Island | FGN10072902 | 19.6 | 279.3 |
| Cumberland Head | FGN10080501 | 101.7 | 121.5 |
| Malletts Bay | | | |
| Malletts Bay | FGN10072701 | 8.1 | 77.0 |
| Inland Sea | | | |
| Ladd Point - South | FGN10080201 | 34.6 | 74.2 |
| Woods Island | FGN08073001 | 3.0 | 40.7 |

Table 9. Continued.

| 2011 | | | |
|---------------------|-------------------|------------|------------|
| Station | Sample No. | YOY | YAO |
| Main Lake | | | |
| Barber Point | FGN11081501 | lost | lost |
| Shelburne Point | FGN10081701 | 14.9 | 0 |
| Juniper Island | FGN10082301 | 31 | 42.2 |
| Valcour Island | FGN10080101 | 130.4 | 87 |
| Martin Point | FGN10081101 | 53.6 | 0 |
| Malletts Bay | | | |
| Malletts Bay | FGN10080201 | 12.5 | 33.7 |
| Malletts Bay | FGN10080301 | 61.3 | 58 |
| Inland Sea | | | |
| Northeast Arm | FGN10080801 | 1.1 | 11.7 |
| Savage Island | FGN08081001 | 7.5 | 7.5 |

Table 10. Mean total length and standard deviation in millimeters, by age class of alewife sampled by floating gill net in 2011. Number of alewife aged in parenthesis.

| YOY | Age 1 | Age 2 | Age 3 | Age 4 |
|---------------------------|-------------------|------------------|-------|-------|
| Main Lake Stations | | | | |
| 59 ± 9 (135) | 141 ± 10 (114) | 169 ± 16 (21) | --- | --- |
| Malletts Bay | | | | |
| 55 ± 5 (77) | 135 ± 10 (82) | 167 ± 13 (22) | --- | --- |
| Inland Sea | | | | |
| 58 ± 9 (12) | 156 (1) | 174 ± 12 (4) | --- | --- |

Table 11. Summary of total numbers of cisco collected, 1990-2011. Only one cisco has been collected in the Inland Sea (in 1991). Data prior to 1999 should be viewed cautiously. N/A = no sampling occurred.

| Year | Barber Point | Juniper Island | Valcour Island | Malletts Bay |
|-------------|---------------------|-----------------------|-----------------------|---------------------|
| 1990 | N/A | 15 | N/A | 1 |
| 1991 | N/A | 25 | N/A | 3 |
| 1992 | N/A | 34 | N/A | 12 |
| 1993 | 22 | 0 | N/A | 0 |
| 1994 | 0 | 0 | N/A | 0 |
| 1995 | 30 | 14 | N/A | 3 |
| 1996 | 19 | 15 | N/A | 4 |
| 1997 | 11 | 25 | N/A | 11 |
| 1998 | N/A | 45 | N/A | 2 |
| 1999 | 122 | 13 | 31 | 7 |
| 2000 | 51 | 20 | 31 | 1 |
| 2001 | 47 | 26 | 152 | 3 |
| 2002 | 26 | 94 | 139 | 1 |
| 2003 | 49 | 40 | 7 | 0 |
| 2004 | 65 | 37 | N/A | 0 |
| 2005 | 43 | 22 | 31 | 3 |
| 2006 | 17 | 10 | 17 | 0 |
| 2007 | 7 | 0 | 15 | 0 |
| 2008 | 16 | 13 | 10 | 1 |
| 2009 | 0 | 9 | 13 | 0 |
| 2010 | 4 | 9 | 16 | 0 |
| 2011 | 3 | 13 | 29 | 0 |

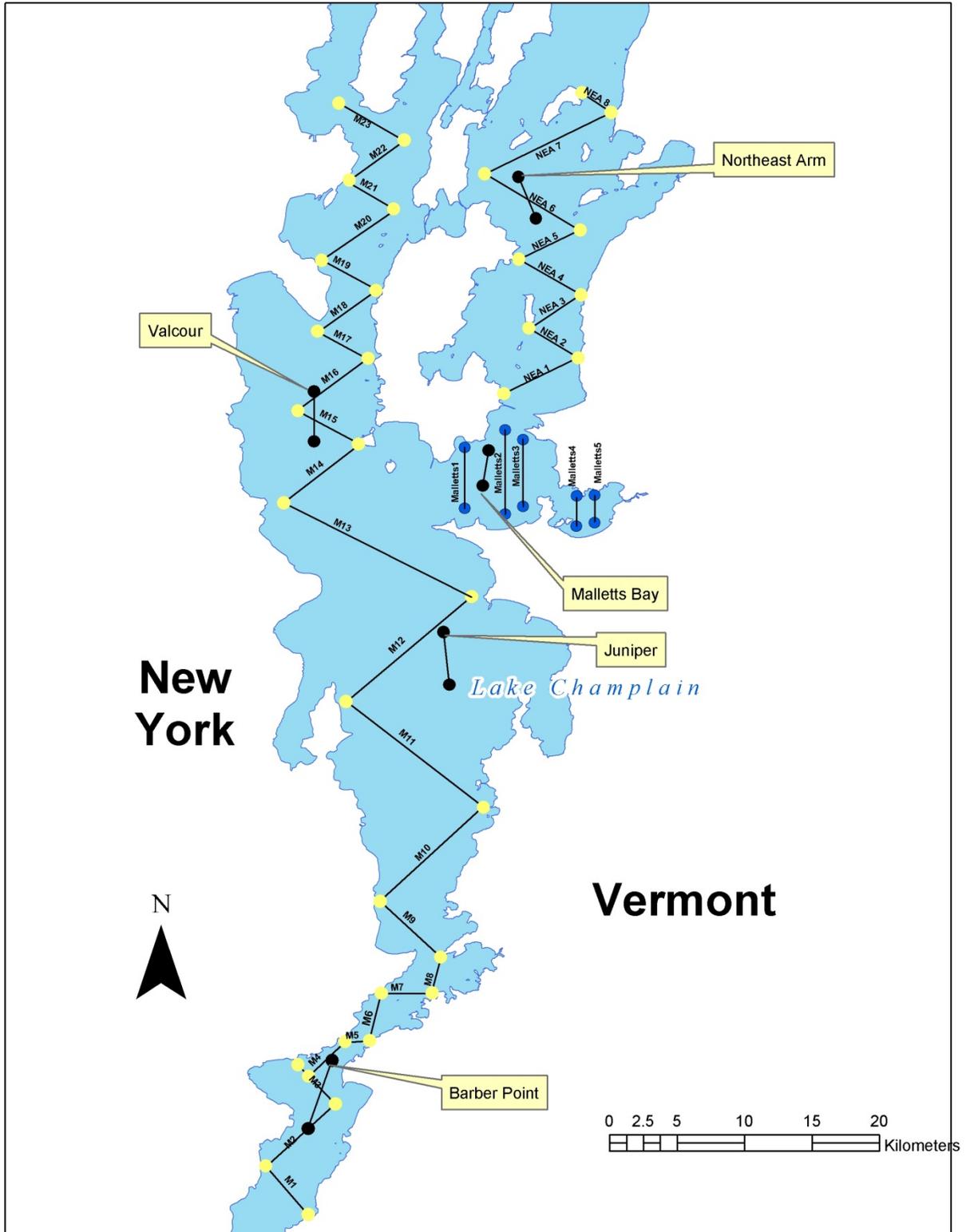


Figure 1. Rainbow smelt sampling stations (text boxes) and acoustic transects with transect name.

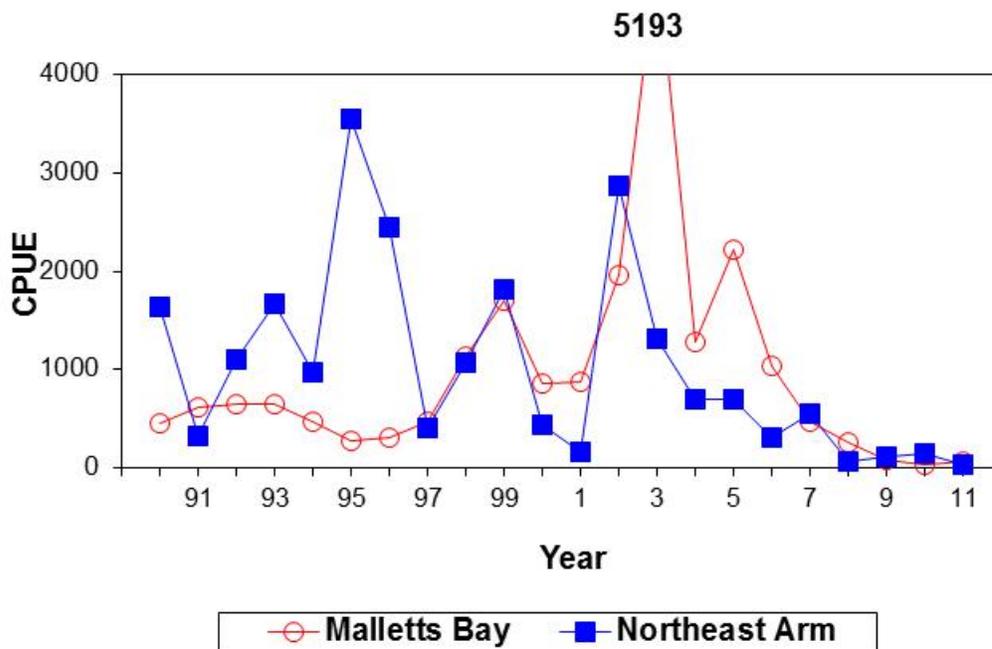
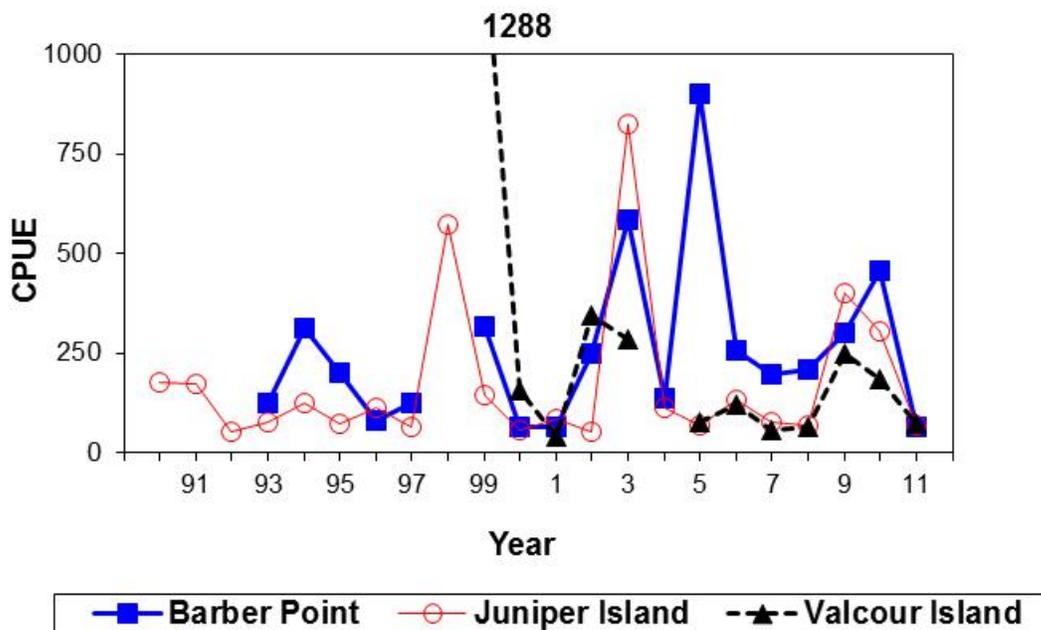


Figure 2. Mean CPUE of smelt for Lake Champlain, 1990-2011.

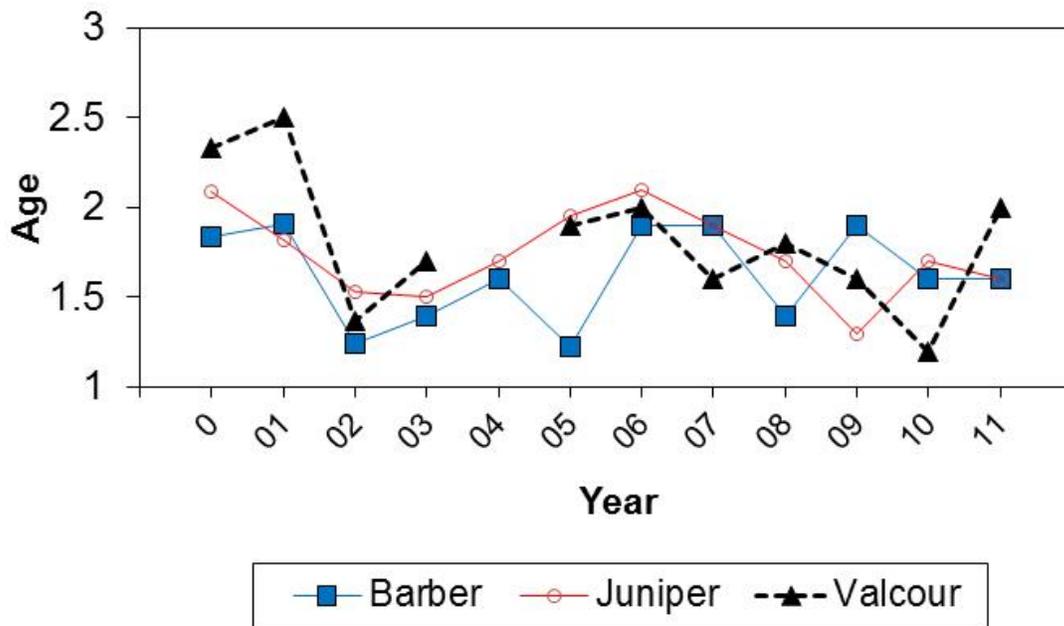


Figure 3. Mean age of rainbow smelt sampled at three main lake stations, 2000-2011.

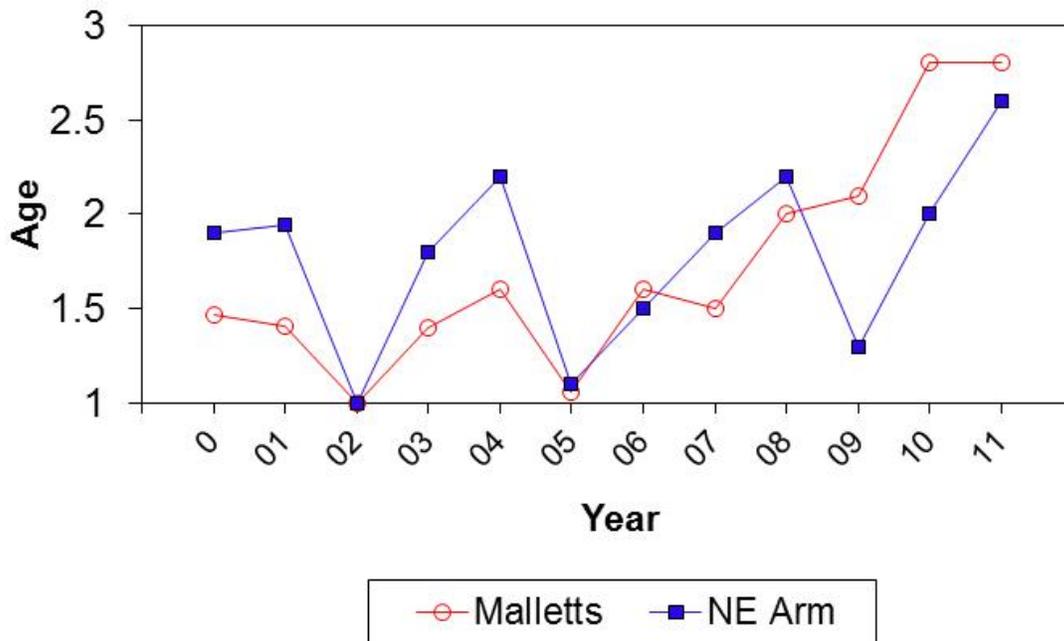


Figure 4. Mean age of rainbow smelt sampled at Malletts Bay and the Northeast Arm stations, 2000-2011.

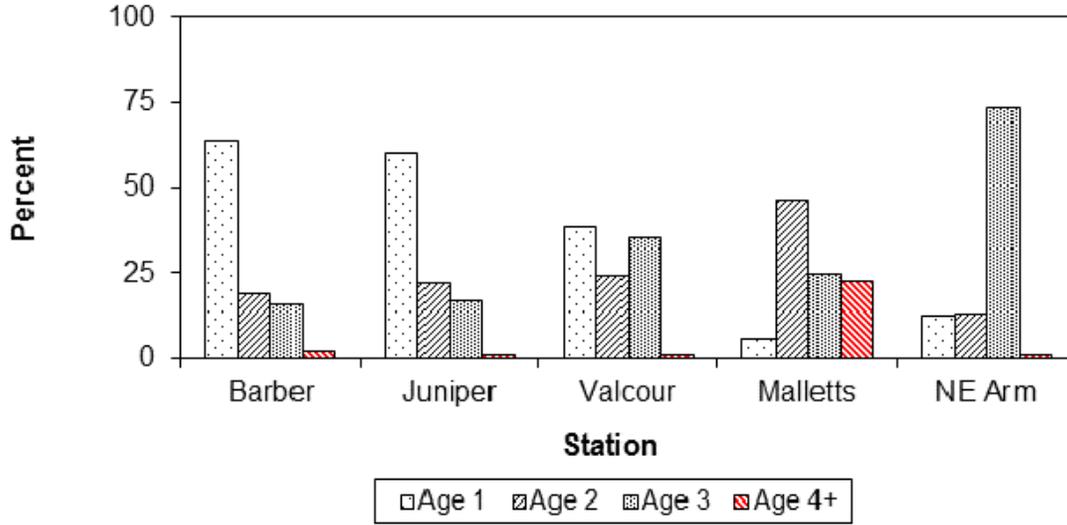


Figure 5. Percent composition by age class of rainbow smelt sampled in Lake Champlain in 2011.

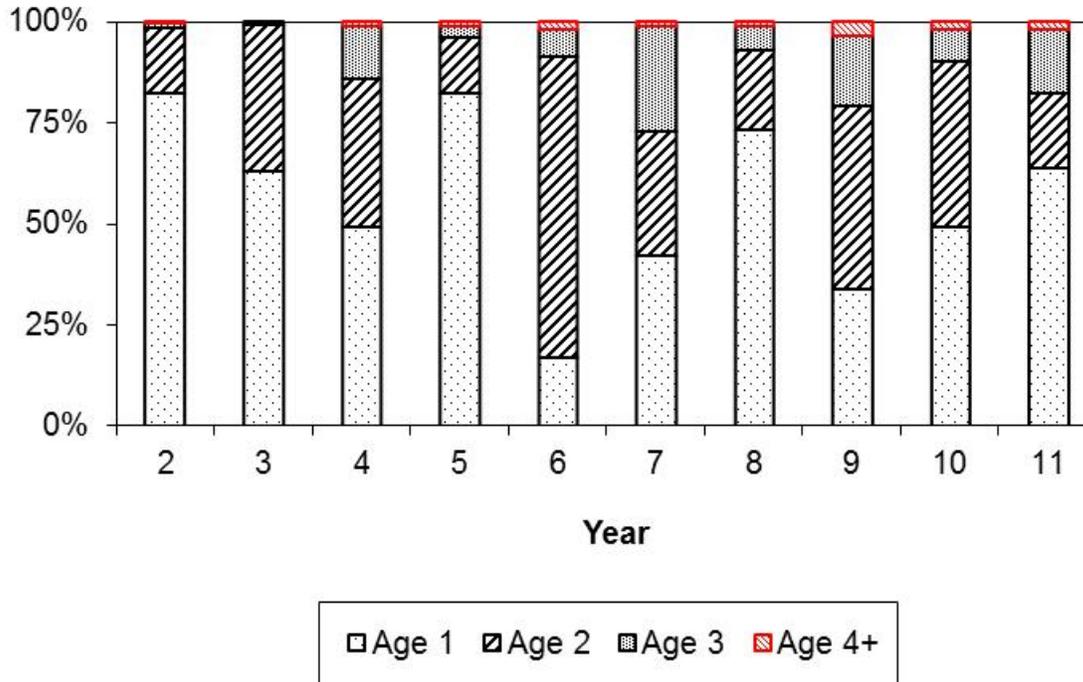


Figure 6. Percent composition by age class for rainbow smelt sampled at Barber Point, 2002 - 2011.

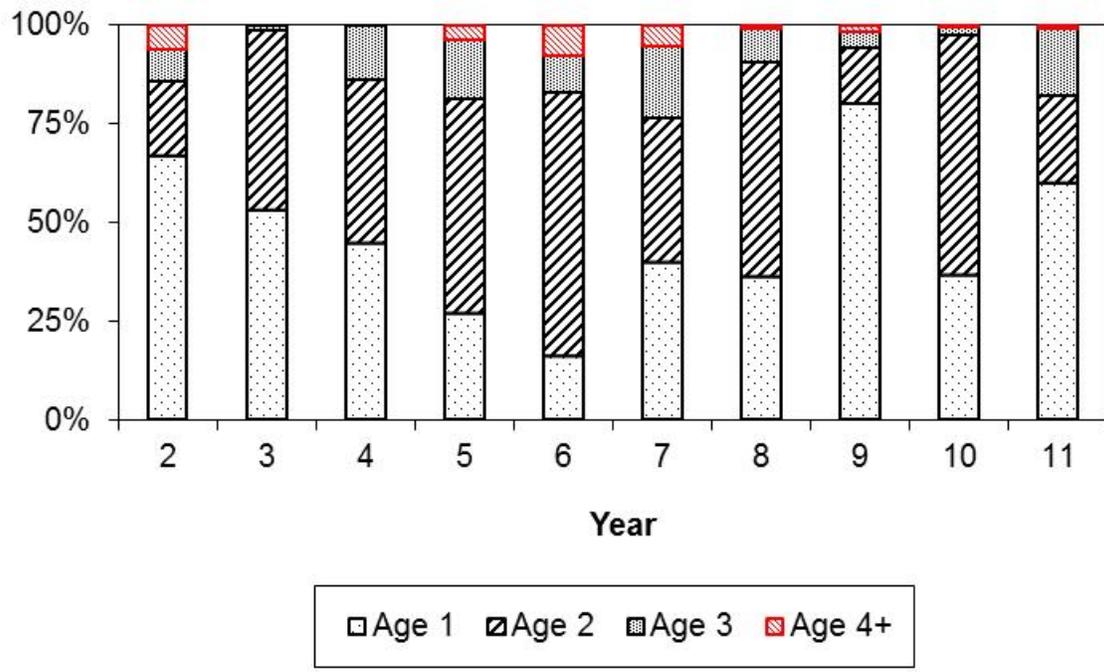


Figure 7. Percent composition by age class for rainbow smelt sampled at Juniper Island, 2002 - 2011.

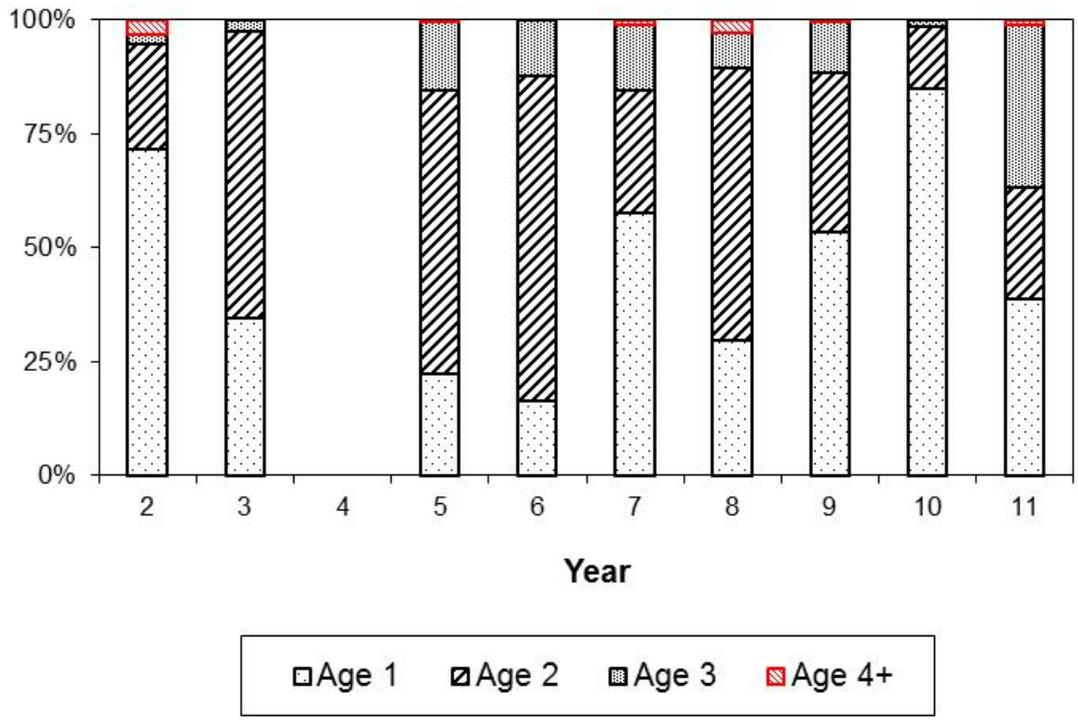


Figure 8. Percent composition by age class for rainbow smelt sampled at Valcour Island, 2002 - 2011.

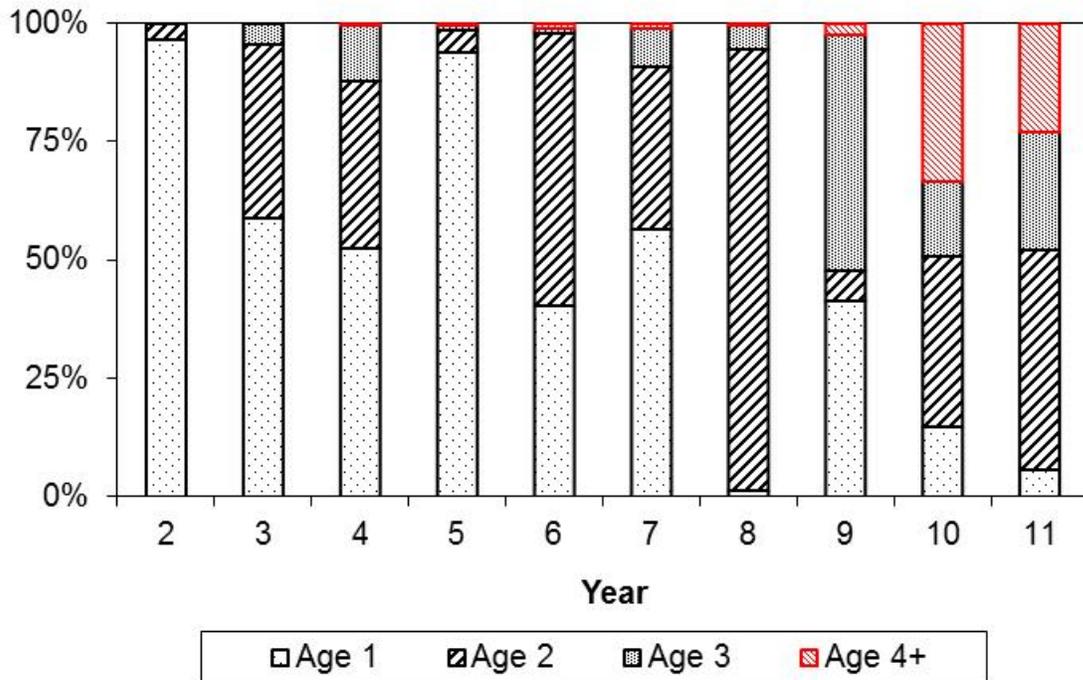


Figure 9. Percent composition by age class for rainbow smelt sampled in Malletts Bay, 2002 - 2011.

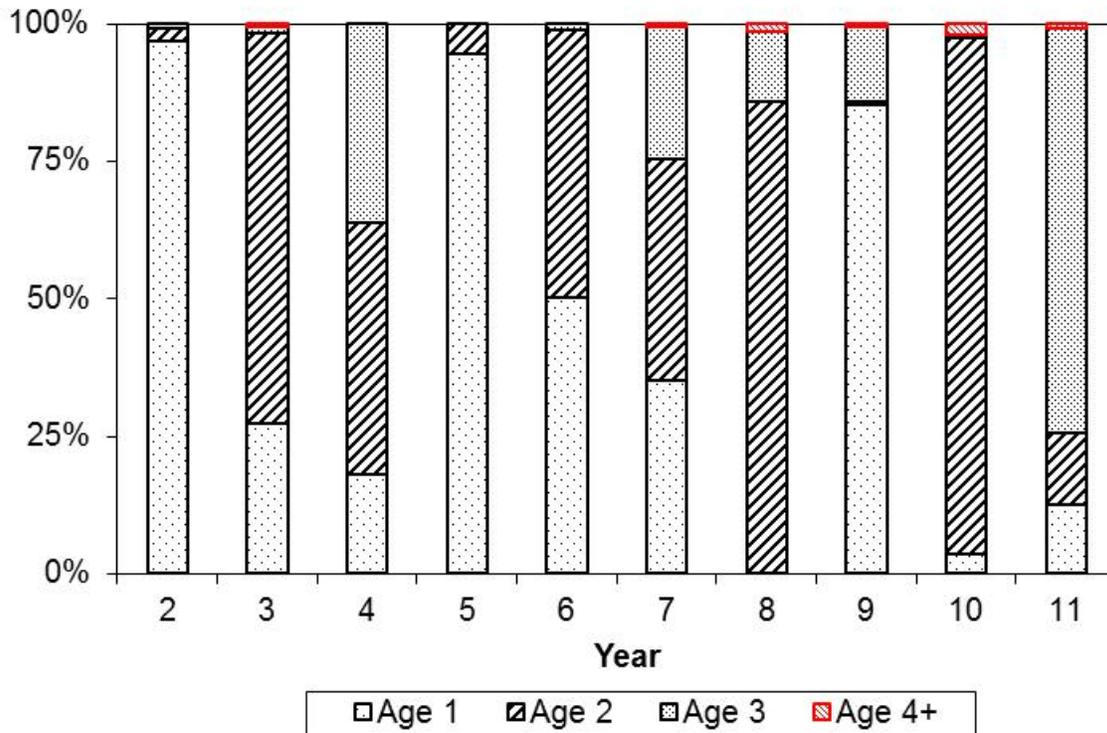


Figure 10. Percent composition by age class for rainbow smelt sampled in the Northeast Arm 2002 - 2011.

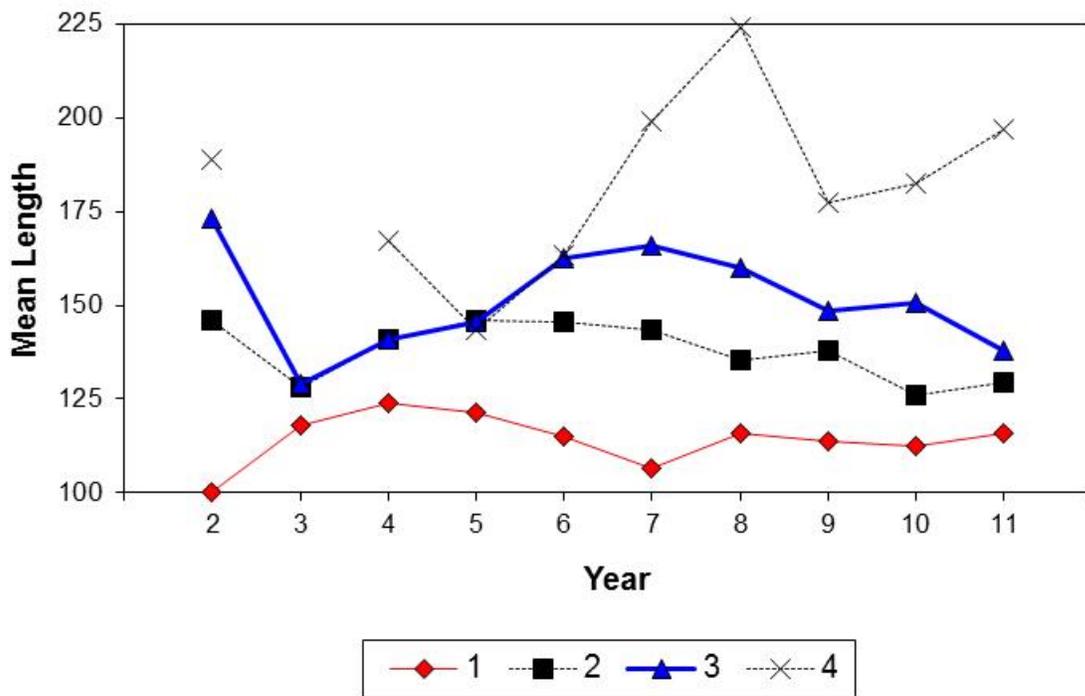


Figure 11. Mean length (mm) at age of rainbow smelt sampled at Barber Point, 2002 - 2011.

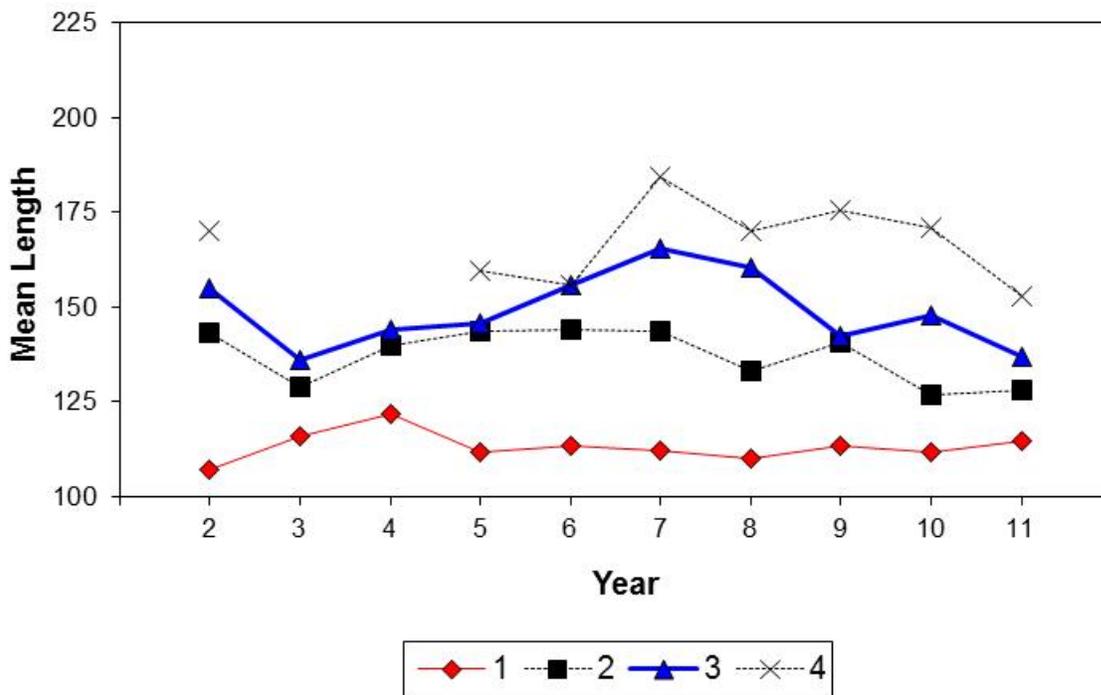


Figure 12. Mean length (mm) at age of rainbow smelt sampled at Juniper Island, 2002 - 2011.

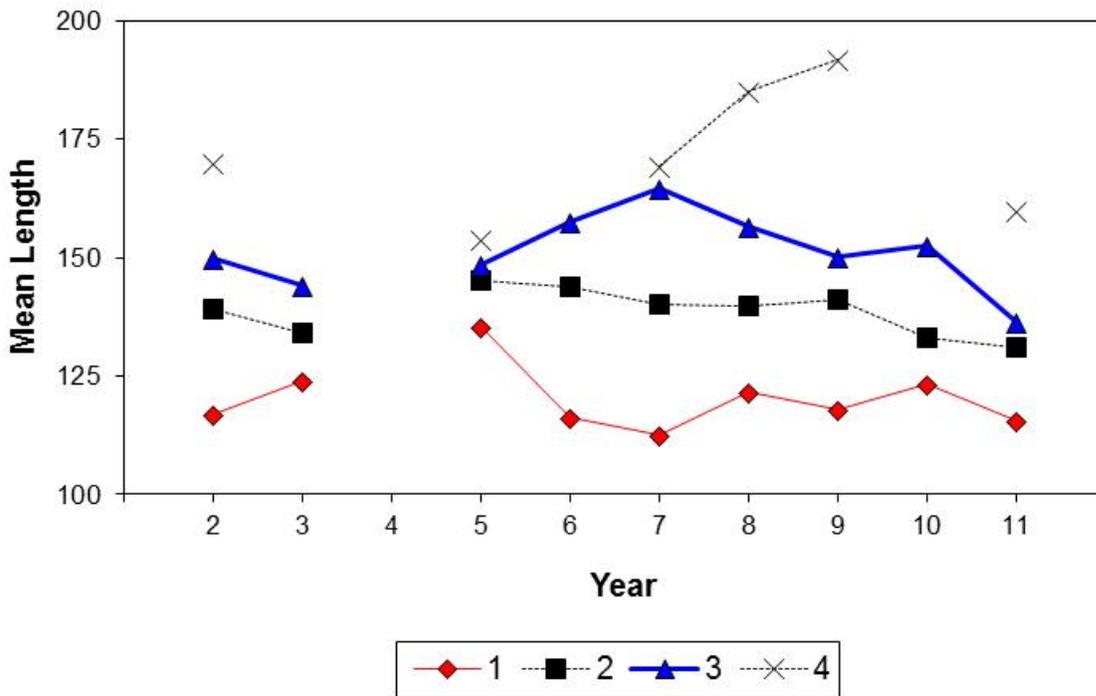


Figure 13. Mean length (mm) at age of rainbow smelt sampled at Valcour Island, 2002 - 2011.

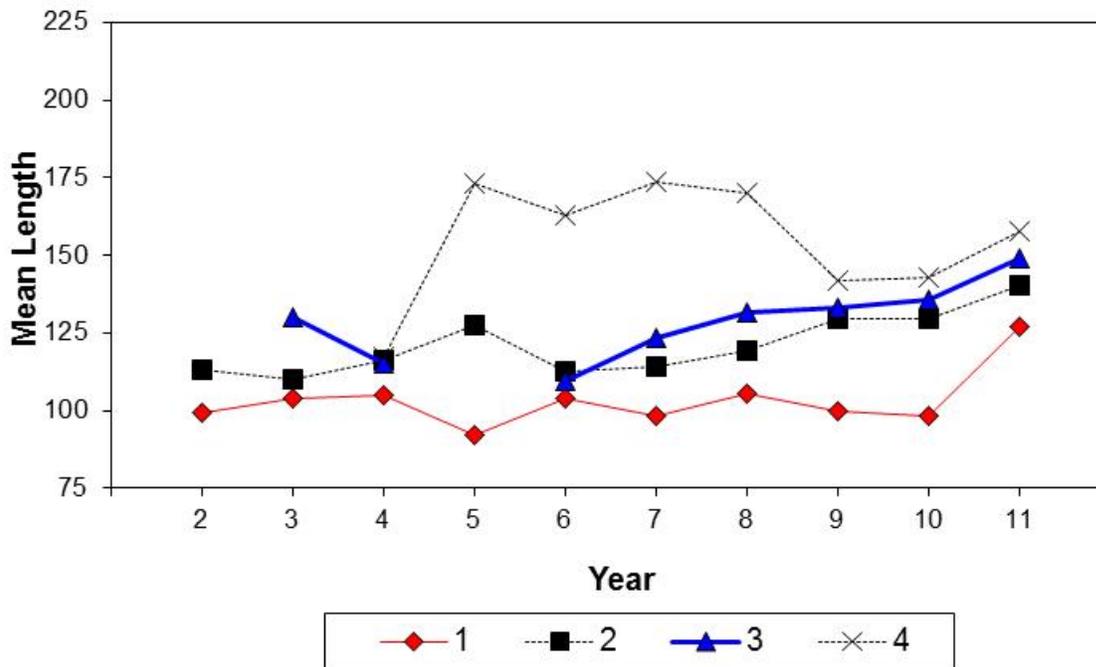


Figure 14. Mean length (mm) at age of rainbow smelt sampled in Malletts Bay, 2002 - 2011.

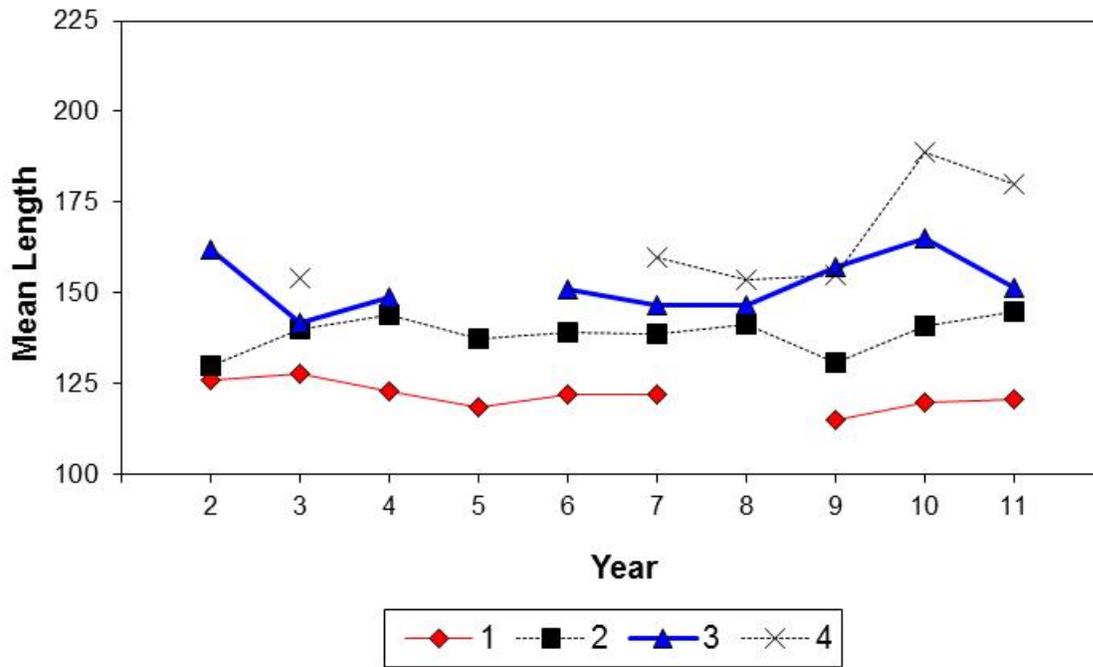


Figure 15. Mean length (mm) at age of rainbow smelt sampled in the Northeast Arm, 2002 - 2011.

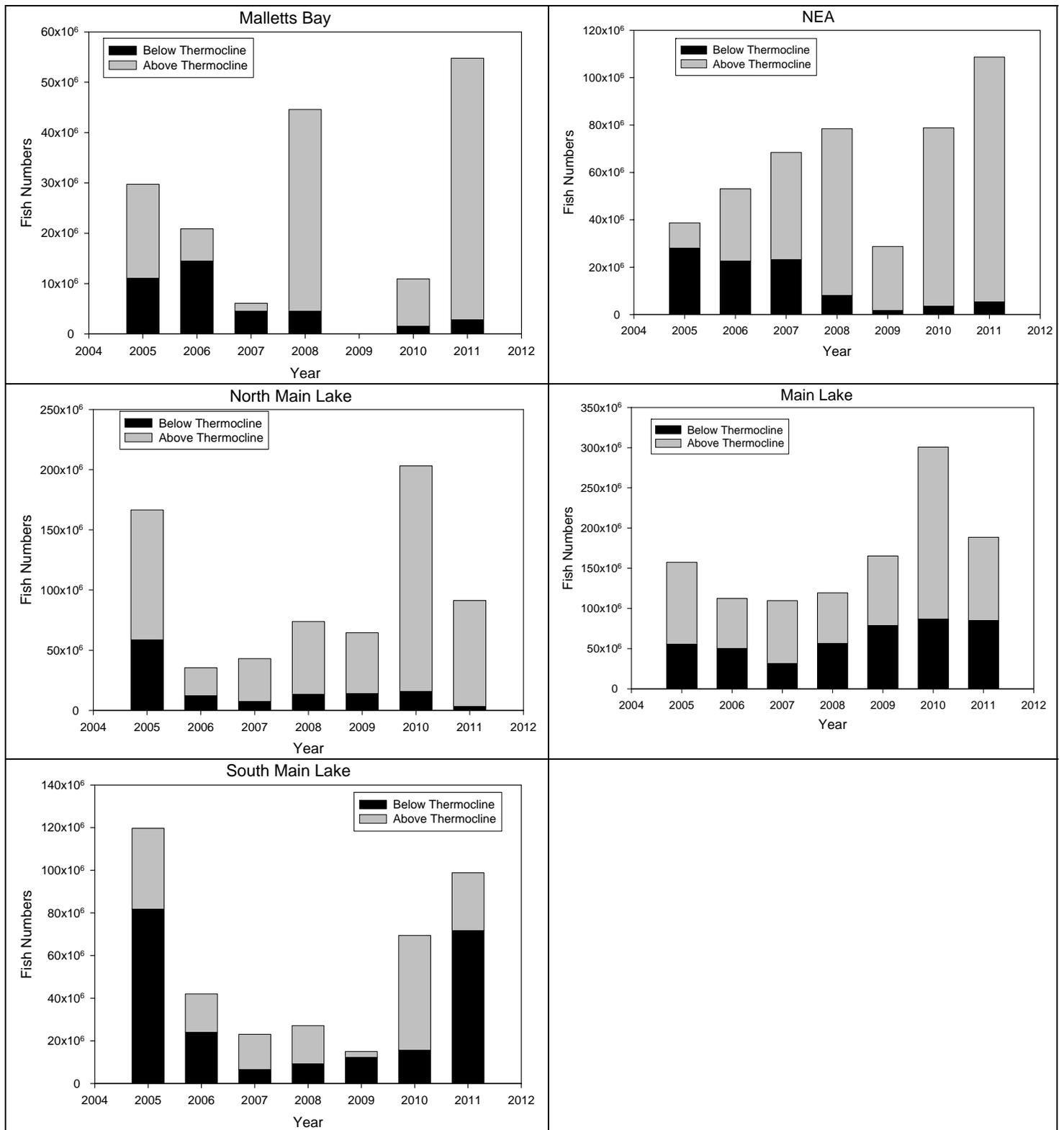


Figure 16. Estimated numbers of yearling and older fish (>-61 dB) in different areas of Lake Champlain from Acoustic data. Rainbow smelt are the primary fish found below the thermocline. Common species found above the thermocline include white perch and alewives.

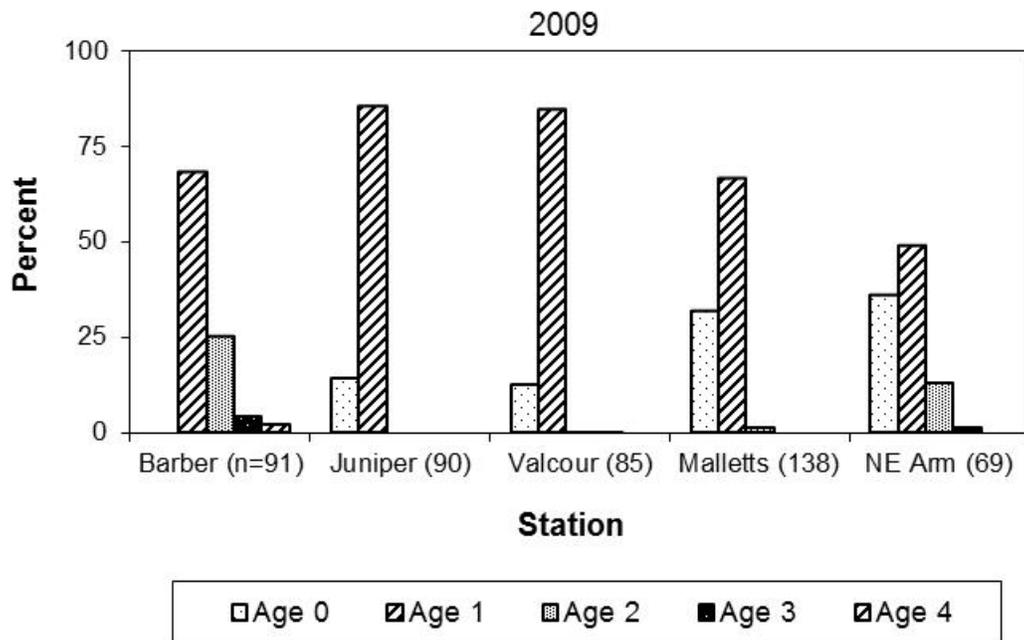
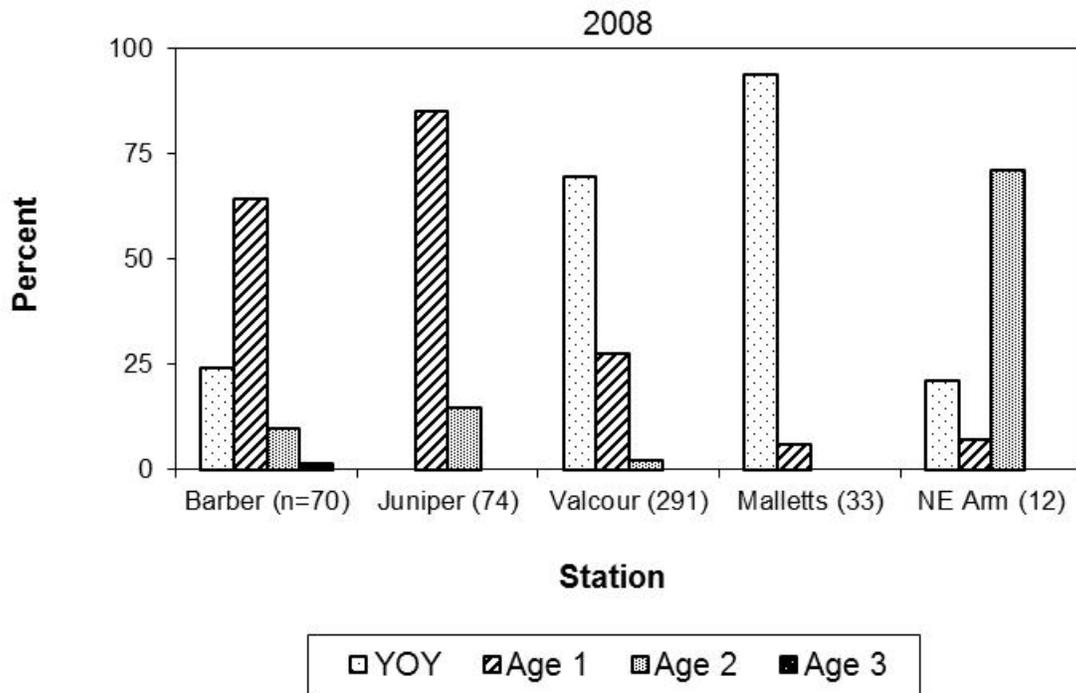


Figure 17. Age composition by station of alewife collected by floating gill net in 2008 - 2011.

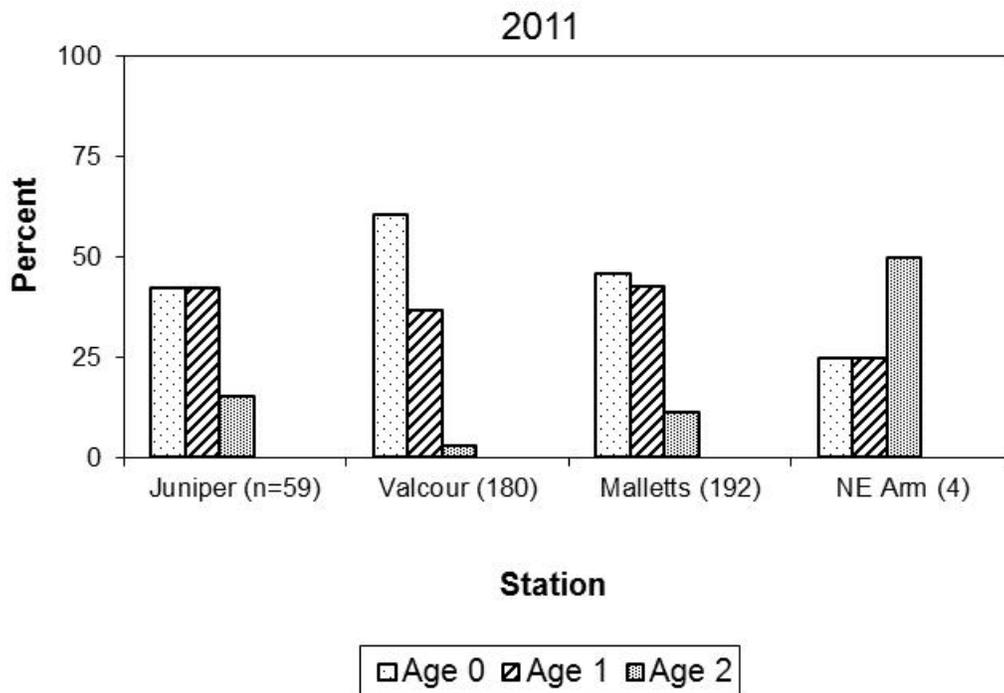
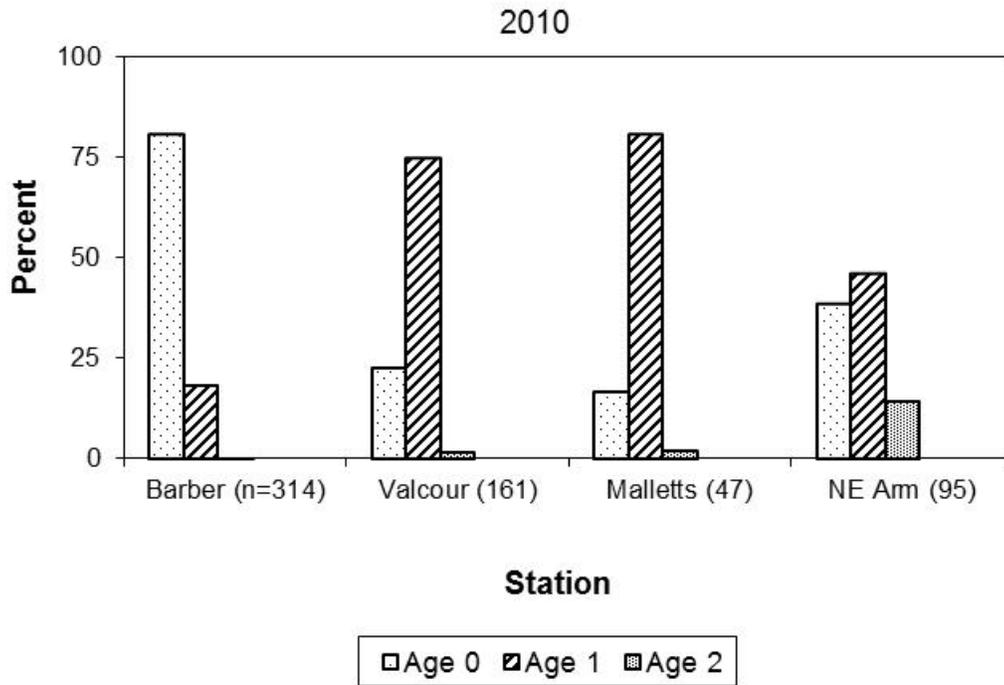


Figure 17. Continued.

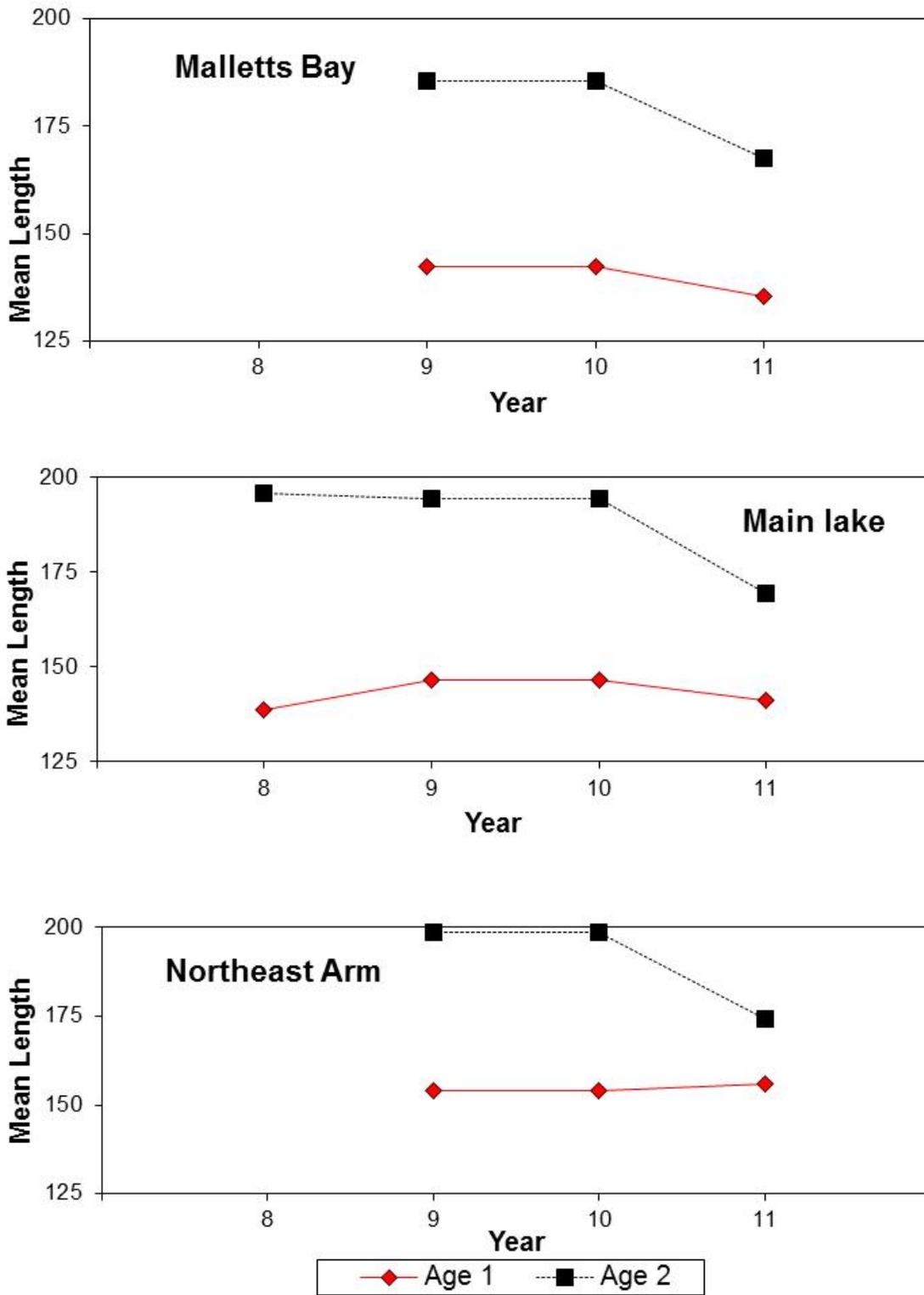


Figure 18. Mean length (mm) at age of alewife sampled by floating gillnet, 2008 – 2011.

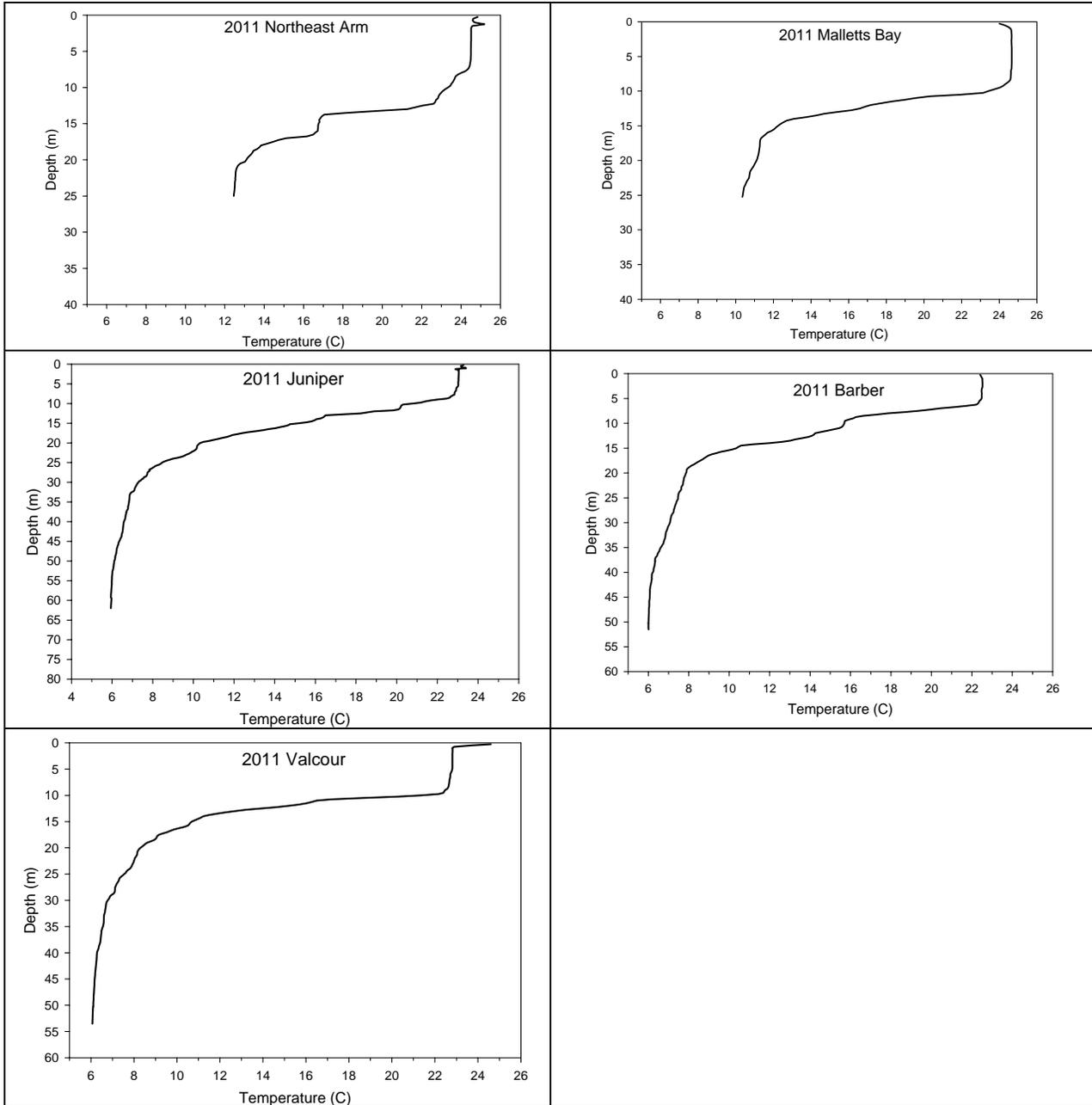


Figure 19. Temperature profiles collected in 2011 at the five standard trawling stations: Northeast Arm, Malletts Bay, Juniper, Barber Point, and Valcour.