Renews River Salmonid Research Project: Year 2 (2008) Data and Results.

G. Veinott

Science Branch
Department of Fisheries and Oceans
P.O. Box 5667
St. John’s NL Canada A1C 5X1

2010

Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2927

Fisheries and Oceans Canada   Pêches et Océans Canada

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of Fisheries and Oceans Canada, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in the data base *Aquatic Sciences and Fisheries Abstracts*.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 1426 - 1550 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques de Pêches et Océans Canada, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications à part entière. Le titre exact figure au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la base de données *Résumés des sciences aquatiques et halieutiques.*

Les rapports manuscrits sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre.

Les numéros 1 à 900 de cette série ont été publiés à titre de Manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme Manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de Rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de Rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Canadian Manuscript Report of
Fisheries and Aquatic Sciences 2927

2010

RENEWS RIVER SALMONID RESEARCH PROJECT: YEAR 2 (2008) DATA AND RESULTS

by

G. Veinott

Fisheries and Oceans Canada
Science Branch
P.O. Box 5667
St. John's NL A1C 5X1

Cat. No. Fs 97-4/2927E ISSN 0706-6473

Correct citation for this publication:

Veinott, G. 2010. Renews River Salmonid Research Project: Year 2 (2008) Data and Results. Can. Manuscr. Rep. Fish. Aquat. Sci. 2927: v + 49 p.

TABLE OF CONTENTS

ABSTRACT

Veinott, G. 2010. Renews River Salmonid Research Project: Year 2 (2008) Data and Results. Can. Manuscr. Rep. Fish. Aquat. Sci. 2927: v + 49 p.

This report provides an overview of the data collected in the second year (2008) of a planned six year study of salmonid populations in the Renews River watershed. Distribution and abundance of juvenile Atlantic salmon and brown trout in the main stem of the river was similar to that reported in 2007. Juvenile fish densities remain low. Growth and condition indices remained comparable to 2007 data, but brook trout caught in Big Butterpot Pond in the winter only weighed 77% of the North American standard for brook trout in good condition. There was a shift to smaller fish being caught in the recreational brown trout fishery in 2008 compared to 2007. In 2008 the modal size group was 15-20 cm compared with 30-35 cm in 2007. An estimated 260 fish were taken in the brown trout fishery with the highest numbers of fish taken in the evenings and on weekdays. The greatest effort occurred early in the angling season when the largest fish were taken. Acoustic tags revealed that some brown trout smolt, decending the river in spring, leave the harbour and at least one brown trout migrated northward along the coast for at least 16 km. Large numbers of juvenile salmon and trout, 2 and 3 years of age, descend the river in the spring and are likely the main source of recruitment for the recreational fishery. Only 4% of the brown trout sampled in the recreational fishery showed any spawning marks on their scales. First spawning occurs at age 4 or 5. The total number of seals counted in the harbour in 2008 decreased by 70% over 2007. There was also a significant decline in the average number of cormorants and terns in 2008 compared to 2007. There was no evidence of anthropogenitic pollution entering Renews River but peak water temperatures frequently exceeded 25ºC and at times would be considered lethal for juvenile salmonids.

RÉSUMÉ

Veinott, G. 2010. Renews River Salmonid Research Project: Year 2 (2008) Data and Results. Can. Manuscr. Rep. Fish. Aquat. Sci. 2927: v + 49 p.

Le présent rapport donne un aperçu des données recueillies au cours de la deuxième année (2008) d'une étude des populations de salmonidés du bassin versant de la rivière Renews qui doit s'étaler sur six ans. La répartition et l'abondance des saumons atlantiques juvéniles et des truites de mer dans le cours principal de la rivière étaient semblables à ce qui avait été observé en 2007. La densité des poissons juvéniles demeure faible. Les indices de la croissance et de la condition restent comparables à ceux de 2007, mais les truites de mer capturées dans l'étang Big Butterpot en hiver ne pesaient que 77 % du poids nord-américain standard de la truite de mer en bonne condition. Comparativement à 2007, de plus petits poissons ont été capturés dans la pêche récréative de la truite de mer en 2008. La fourchette de tailles modale en 2008 était de 15-20 cm, par rapport à 30-35 cm en 2007. On estime à 260 le nombre de truites de mer capturées dans la pêche, la plus grande part d'entre elles ayant été pêchée en soirée et en semaine. L'effort a été le plus élevé au début de la saison de pêche récréative, quand les plus gros poissons ont été pris. Il ressort d'une opération de marquage au moyen d'étiquettes acoustiques que lors de leur avalaison printanière, certaines jeunes truites de mer quittent le port et qu'au moins une truite de mer a migré le long de la côte vers le nord sur une distance minimale de 16 km. Un grand nombre de saumons et de truites juvéniles, de 2 et 3 ans, descendent la rivière au printemps et sont vraisemblablement la principale source de recrutement à la pêche récréative. Seulement 4 % des truites brunes échantillonnées dans la pêche récréative présentaient des signes de frai sur leurs écailles. Le premier frai a lieu à l'âge 4 ou 5. Le nombre total de phoques recensé dans le port en 2008 a diminué de 70 % par rapport à 2007. On a constaté aussi un important recul du nombre moyen de cormorans et de sternes en 2008 comparativement à 2007. Il n'y avait pas de signe de pénétration de pollution anthropique dans la rivière Renews, mais les températures maximales de l'eau dans celle-ci dépassent souvent 25 ºC et à certains moments elles seraient considérées comme létales pour les jeunes salmonidés.

INTRODUCTION

Renews River is on the east coast of the Avalon Peninsula on the island of Newfoundland, Canada (See Fig. 1). It is a scheduled Atlantic salmon (*Salmo salar*) river but the main recreational fishery is for brown trout (*Salmo trutta*). The brown trout fishery is a rod and reel shore fishery carried out primarily at the mouth of the river in the estuary. In Newfoundland, the brown trout fishery falls under the same general regulations as “trout” which includes brook trout (*Salvelinus fontinalis*); brown trout, rainbow trout (*Oncorhynchus mykiss*); and landlocked Atlantic salmon also known as ouananiche. However, on scheduled salmon rivers the brown trout fishery is restricted and the legal fishing season can vary from the normal “trout” fishery.

Historically, high numbers of large brown trout (>5lb) were know to this area. Local residents became concerned when a large number of brown trout died as a result of an extreme cold event one winter. As well, the numbers of Atlantic salmon ascending Renews River seemed to be in decline. In response to these concerns a local stewardship group, the Renews River Conservation Association was formed in 2006 and the Department of Fisheries and Oceans (DFO) began a proposed 6 year study to address these concerns.

During public consultations 6 main objectives for the study were discussed. They included:

1. Study the distribution of Atlantic salmon and brown trout in the Renews River watershed;
2. Examine the biological and growth characteristics of the *salmo* species in the watershed;
3. Determine the habitat preferences of the *salmo* species in the watershed;
4. Determine the degree of anadromy of the brown trout population;
5. Estimate the population of brown trout in the estuary and in the freshwater portion of the system;
6. Observe and record the occurrence of seals in the estuary.

This report outlines the work carried out and the data collected during 2008 and compares these results to the 2007 results published in Veinott (2009).

METHODS

STUDY SITE

The study site was divided into four main areas (Fig. 1). First; the upper reaches of the river, consisting of the main stem and main tributary and all ponds upstream of Corner Pool. Second; the lower reaches of the river, consisting of the main stem of the river and, minor tributaries and small ponds below Corner Pool. Third; the inner estuary, which is the area seaward of the highway and landward of the narrow gut that protects the inner estuary, and fourth; the main bay, or Renews Harbour proper. There are two potential barriers to fish migration (First Falls and Second Falls) on the main stem of the river below Corner Pool, but there are no major tributaries or ponds in the watershed below Corner Pool. Trout leaving the river on a marine migration would have to pass through the inner estuary and Renews Harbour. Renews Harbour is the primary location where seals are seen and recorded.

The tide has a tremendous influence on the wetted area in the inner estuary. At low tide large areas of the inner estuary are drained of water. A narrow channel that runs from the estuary gut to the mouth of the river is the deepest portion of the inner estuary. At high tide the top 1 m of water just seaward of the highway is fresh and brackish water is only encountered at the very bottom (Veinott 2009). Salinity increases seaward of the bridge but full salinity seawater is not encountered until outside the gut.

FISH SAMPLING

Electrofishing

A Smith-Root LR24 backpack electrofisher was used on June 23-24, 2008 at four of the locations that were sampled in 2007 (Fig. 2) to compare electrofishing catch rates between years. To increase the biological characteristics data base, additional samples were collected near the mouth of the river, by electrofishing and beach seining. The electrofisher briefly immobilized the fish such that they could be collected by dip net. At each new site the electrofisher's Quick Setup feature (Smith-Root 2010) was used to initialize instrument settings. Voltage, frequency, and duty cycle were then adjusted manually, according to the instrument's operating instructions, to settings that caused fish to be drawn to the anode. Typical settings for Renews River were 750 volts, frequency of 40 Hz, and a 15% duty cycle.

Trap Fishing

A fyke trap was used in the river to capture migrating fish. Between April 24 and May 11, 2008 the trap captured downstream migrating fish. The trap did not fish continually for that time because high water caused the trap to be washed out on several occasions. However, from May 6 to May 10 the trap fished continually. Atlantic salmon smolt that were captured between May 6 and May 10 were marked by removing the tip of their caudal fin, transported approximately 1 km upstream to just downstream of First Falls and released. The daily efficiency of the trap was estimated using the Peterson mark-recapture equation (Carlson et al. 1998). From September 25 until October 20, 2008 the fyke trap sampled fish moving upstream. The trap did not fish continually due to times of high water and debris. At this time the cod end would be opened or the wings released to prevent the trap from being washed away.

A modified capelin trap (Fig. 3) approximately 10m X 7m X 2m was used in the estuary from June 18 to June 27, 2008, and from August 24, to September 07, 2008. The trap would fish for 24-48 hours before checking. At times when the trap could not be checked the doors were closed to stop the trap from fishing.

Ice Fishing

A single ice fishing event took place on Big Butterpot Pond (Fig. 1) February 16, 2008. Holes were drilled through the ice in a “T” formation covering the length and width of the pond and fish were caught using bated hook and line.

FISH TAGGING

PIT Tags

The majority of brown trout, greater that 10 cm, regardless of the means of capture, were implanted with passive integrated transponder (PIT) tags (model RI-TRP-WRHP; Texas Instruments Inc., 23.1 mm in length and 3.9 mm in diameter, mass in air of 0.6 g). These tags are small electronic devices that do not emit a signal until they encounter a specific antenna array. The tag identification information, and time and date of detection can be recorded and stored by a hand held mobile unit or at a land based station. After capture, fish were individually anaesthetised (clove oil; 0.6 mg l^{-1}) and tagged by making approximately a 0.6 cm incision on the ventral surface, posterior to the pelvic girdle. The tag was inserted through the incision and smoothly pushed forward into the body cavity. The incision was closed using one silk suture (4-0 SofSilk™). Fish were then allowed to recover in a holding tank until they were swimming freely and displaying flight reflex reactions. Fish were then released near the original point of capture.

Acoustic Tags

Twelve fish (5 Atlantic salmon smolt and 7 brown trout) captured in the fyke trap on May 10 and 11, 2008 were implanted with acoustic transmitters (Vemco Inc. model V7 7X18mm, 0.7g). The transmitters emit an acoustic signal at set time intervals and at a specific frequency that can be detected by receivers in the marine environment. Handling of the fish and the surgery was carried out under the same conditions as for the PIT tags except that a slightly larger incision was made and two sutures were used to close the incision. Hydroacoustic receivers were deployed in three locations: one in the inner estuary and two in Renews Harbour (Fig. 2). For logistic reasons the locations were labelled 2, 4 and 6.

Radio Tags

Between October 12 and October 15, 2008, five brown trout caught in the fyke trap were implanted with a radio tag (Lotek Wireless Model NTC-4-2L 8mm x 18mm 2.10 g). These tags emit a signal at specific frequencies that can be detected by a radio receiver. This allowed for manual tracking, from land, of individual fish in the freshwater environment. The purpose was to try to identify spawning or overwintering habitat. Similar handling and surgery procedures were used as with the PIT and acoustic tags but for the radio tags an antenna remains outside the body of the fish.

CREEL SURVEY

A stratified creel survey (Malvestuto et al. 1978; Beckley et al. 2008) was used to estimate effort and catch in the recreational brown trout fishery. In summer, the recreational brown trout fishery in Renews takes place almost exclusively in the inner estuary (Fig. 2). The entire estuary can be observed from a single vantage point. Therefore, total effort for a single sampling unit can be determined. Sampling units consisted of 4 hour blocks with each day of the survey period divided into three sampling units: AM, 0700h-1100h; Noon, 1100h-1500h; and PM, 1500h-1900h. The day of the week and the sampling unit when a survey was to be conducted were randomly selected. Anglers were asked the number of hours fished, expected total hours they would fish, number of brown trout caught, number released and number retained.

Total effort, in terms of angler trips and hours fished; catch per unit effort; and total number of fish angled, were calculated for each strata of the survey using the equations of Beckley et al. (2008). Strata consisted of month, time of the week (weekday or weekend, where weekends consisted of Saturday, Sunday and holidays) and time of day (AM, Noon, PM).

BIOLOGICAL CHARACTERISTICS

Biological characteristics were collected in the same manner as in 2007 (Veinott 2009). Briefly, the fork length (FL), whole weight (WW) and a scale sample was taken for fish collected either as part of a deliberate sampling effort (i.e. electrofishing) or during the creel survey. Fork lengths were taken using a measuring board and recorded to the nearest mm. Whole weights were taken on a portable electronic balance and recorded to the nearest 0.1 g. Scale samples were taken from a standardized location on the fish (above the lateral line and posterior of the dorsal fin). Scales were cleaned and aged according to the techniques outlined in ICES (1984) for Atlantic salmon or Elliott and Chambers (1996) for brown trout. For each species the Fulton condition factor (Ricker 1975) was also calculated using the formula: $K=W/L^3$ where K is the Fulton condition factor; W is the weight of the fish in grams; and L is the fork length of the fish in cm. For brook trout caught in Big Butterpot Pond, weights were compared to a proposed standard weight for North American brook trout (Hyatt and Hubert 2001).

Often during the creel surveys of the brown trout fishery it was possible to obtain the head and guts of retained fish. In these cases the otoliths were removed and a sex determination attempted.

PREDATOR SURVEY

The 2008 predator survey was carried out using the same methodology as that used in 2007 (Veinott 2009). However, observations began earlier and ended earlier in 2008 running from May 6 to October 16. Observations on the presence and numbers of potential salmonid predators were carried out from two observation stations on three areas of the study site: the mouth of the river; the inner estuary; and the main bay (Fig. 2). Day, and time of day, was randomly selected for 30 minute predator surveys. During the 30 minutes an observer would scan each of the observation areas, using binoculars, for 10 minutes and identify and count potential salmonid predators. Logs were kept of numbers of each species observed, observation conditions based primarily on weather conditions as (very good, good, fair, poor), as well as a reliability rating for the species. The reliability rating was logged as a percentage where 100% was a positive identification and 50% indicated a lack of confidence on the identification.

WATER CHEMISTRY

Water samples were collected in 2008 approximately monthly from June to October. The purpose of the water sampling was to test for possible evidence of anthropogenic pollution. Samples were collected near site 100 and at Corner Pool (Fig. 2). Samples were analyzed for chloride, phosphate, potassium, nitrate, sulphate, alkalinity, and hardness as total Ca and Mg. All measurements were taken in the field with a portable LaMotte Smart 2 colorimeter using LaMotte reagents.

A Vemco Minilogger TX was installed in Renews River near Station 100 to monitor water temperatures. The logger was placed in the water on May 26, 2008 and water temperatures were measured and stored each hour until the logger was removed on December 16, 2008.

RESULTS

ATLANTIC SALMON AND BROWN TROUT DISTRIBUTION AND ABUNDANCE

The electrofishing survey produced similar findings in the spring of 2008 as the fall of 2007 (Fig. 4.). No brown trout were sampled above Second Falls but juvenile Atlantic salmon were found at all sites. Also, the greatest abundance of juvenile brown trout was found near the mouth of the river at site 100.

The fyke trap set in the river in the spring of 2008 captured downstream migrating brown trout parr and smolt, as well as Atlantic salmon parr and smolt. The greatest abundance captured were Atlantic salmon parr, averaging 52 fish per day from May 6 to May 11 (Fig. 5). At the end of the sampling period large numbers of salmon parr were still being captured whereas the number of salmon smolt had tapered off (Fig. 5). The total number of brown trout captured remained fairly consistent during May averaging 8 fish per day.

Fifty-four salmon smolt were marked, by clipping the tip of the caudal fin, over four days in May. Of those, 5 were re-captured with at least one re-capture the day following the release of newly marked fish. This suggests that approximately 10% of the smolt run was being captured by the fyke trap.

Using the constant 10% fyke trap efficiency value and comparing it to the Peterson mark-recapture equation to reconstruct the smolt run, produced similar patterns (Fig. 6). The number of smolt migrating downstream peaked in early May at about 300 fish per day. If the smolt run began in April and followed the typical pattern for smolt in Newfoundland rivers, that is, increasing to a peak then declining, then a crude estimate of the total number of smolt leaving the river would be about 1200-1400. This is similar to the average number of smolt counted (approx. 1600) over the past 5 years at Northeast Brook, Trepassey, another salmon river on the Avalon Peninsula near Renews.

The modified capelin trap that operated in the estuary in June and again in August-September caught very few fish. It is not clear why more fish were not trapped. However, it is possible that the strong currents in the estuary prevented the trap doors from remaining in an open position or the leader from remaining vertical throughout the tidal cycle.

BIOLOGICAL CHARACTERISTICS

Lacustrine Samples

The ice-fishing trip in February 2008 produced 13 brook trout (*Salvelinus fontinalis*), two brown trout, one Atlantic salmon kelt and two Atlantic salmon parr (Table 1). The salmon parr were being taken in a single hole at the eastern end of the lake so fishing was halted in that hole.

Brook trout lengths ranged from 192 to 291 mm (Table 1, Fig. 7) and ages consisted of 3, 4 and 5 year olds. Growth rates were approximately 4 cm/year. Only the 5 year old fish showed a spawning mark on its scale. The average Fulton condition factor (K) for the brook trout was similar to that of the two brown trout caught through the ice. However, caution should be used when comparing condition factors between species and fish of different sizes. The brook trout were compared to a standard weight for North American brook trout (Hyatt and Hubert 2001). The average relative weight produced was 77 which means the Big Butterpot brook trout were, on average, only 77% as heavy as North American trout of the same length in good condition.

Of the two brown trout taken through the ice, the scale age estimate of one fish was 5 years while the second was 6 years old. Both showed two years of apparent sea growth, but no spawning marks were present. The Atlantic salmon kelt was a female that had spawned after its first year at sea but showed no evidence of having spawned in 2008.

Fluvial Samples

The length-weight relationship of the 2008 fluvial sample was different from the 2007 sample (Fig. 8). Veinott (2009) described the length weight relationship for the 2007 sample using an exponential function. However, length weights in fish are more accurately described by a power function of the type $L= aW^b$ where L and W are length and weight, and a and b are coefficients describing the relationship between the two variables. The coefficient b describes the rate at which the weight increases relative to changes in length. In fish, b is generally near 3. Populations where b is less than 3 get thinner as they get longer and the change in weight with length of two groups can be compared by comparing the respective values of b (Anderson and Neumann 1996).

In 2007 and 2008 there was no difference in the growth curves between species within a year. However, the growth curves for salmon were different between years (Fig. 9). For example, the value of b (slope of the growth curve) for salmon in 2007 was 2.33, whereas in 2008 the value of b for salmon was significantly higher ($p<0.05$) at 2.93. This means that for a given length fish the 2008 samples were heavier compared to the 2007 samples. As well there was a difference in the slope of the length-weight curves between downstream migrating brown trout and brown trout caught in the estuary in the recreational fishery (Fig.10A-B). This difference in b is likely owing to the increased growth rate that occurs in the estuary (Veinott 2009).

The results of the length weight relationship seem to be in conflict with the Fulton K values. Condition indices are another way to describe the shape of a fish with shorter heavier fish having higher Fulton K values. However, when the K values of the 2007 and 2008 fluvial samples were compared the 2007 salmon sample had a significantly higher ($p<0.05$) mean K value (1.34 compared to 1.17) suggesting that the 2007 salmon parr sample was heavier for a given length compared to the 2008 sample. This apparent conflict between the values for b in the length weight analysis and the K values may be a result of the smaller fish in 2007 having some of the highest K values for that sample. The length weight curves for salmon cross at a length of about 10 cm (Fig. 9) so there may be a difference in the relationships for smaller and larger salmon.

Estuarine Samples

In 2008 there was a distinct shift in the size distribution of brown trout captured in the recreational fishery compared with 2007(Fig. 11). In 2007 the most abundant catch was in the 30-35 cm range whereas in 2008 it was the 15-20 cm range. The sampling of the recreational fishery started earlier in 2008 (June) compared to 2007 (July). However, if the early start to the sampling program was the reason the size shift occurred, one would predict that most of the small fish would be caught in June. That did not happen. In fact the opposite happened. In 2008 the largest fish were caught in June and the smallest were caught in September (Fig. 12). As well, there was an increase in the average length of fish caught between July and August in 2007 suggesting growth of a single cohort. The same pattern did not occur in 2008.

The most common or modal age of brown trout caught in the 2008 recreational fishery was 3 years (Fig. 13) which was the same as in 2007 (Veinott 2009). However, only 27% of the fish sampled in 2008 were greater than or equal to 4 years of age. In 2007, that number was over 42%. Only 9 of the 216 scales examined in 2008 had evidence of spawning and first spawning occurred at age 4 or 5. Of the 88 brown trout that were sexed, 57% were males. A fitted von Bertalanffy growth model suggested the same maximum growth of 60 cm as reported for 2007 by Veinott (2009) and similar growth rates (7-10 cm per year for the first 4 years then 2-5 cm for the next 5 years).

There was a difference in the river age of trout caught in the recreational fishery in 2008 compared to 2007. In 2008 the fish caught had a modal river age of 3 compared to 2 for 2007. Earlier data does not exist for downstream migrations but the modal age in the 2008 downstream migration was 3 years (Fig. 14) suggesting that this may be the more common age for trout to leave the river.

CREEL SURVEY

2008 was the first year that a formal creel survey was conducted in Renews. It was estimated that approximately 260 fish were caught between June and October with about 280 hours of effort expended. Most fish were taken during the week but more effort was expended on weekends (Fig. 15). With respect to time of day; very few fish were taken between 0700h and 1100h despite a fairly even distribution of effort throughout the day (Fig. 16). Effort generally declined throughout the season with August being the most productive for the angler (Fig. 17). Catch per unit effort was lowest in June with approximately 4 hours of effort required to catch one fish. However, as shown in Fig. 12, the effort was rewarded with generally larger fish being caught.

TAGGING

Pit Tags

After PIT tagging was initiated each subsequent fish capture was checked either for a fin clip, evidence of an incision or scanned with a hand held detector. As well, anglers were made aware of the tagging program and asked to return recovered tags to DFO. In 2008 no PIT tags were reported by anglers or recovered in any subsequent sampling by DFO staff. It is not clear why more PIT tags were not found but these tags are retained by fish for 6 to 8 years (Cucherousset et al. 2005) and may be picked up in future sampling.

Acoustic Tags

Of the 12 acoustic tags deployed in the spring of 2008 ten were detected by the stationary receivers in either the estuary or the bay (see Fig. 2 for locations). Figures 18A to J shows the relationship between date of detection at the receivers and the receiver location at which the detection took place.

Of the four detected salmon smolt, two (Figs. 18A and B) displayed a typical migration pattern that would be expected from a species preparing for a long marine migration. There is evidence of acclimation to the marine environment with a period within the estuary (receiver location 2) then movement between the estuary and inner bay (receiver locations 2 and 4), then movement to the outer bay (receiver location 6), then no further detections after early July when, presumably, the fish left the study area.

The other two salmon smolt (Figs. 18C and D) were detected within the inner estuary only until late May 2008. These fish may have fallen prey and been removed from the system, migrated out of the area without being detected, or the tags may have stopped transmitting. The gaps in the data where no detections were recorded for many hours, suggests the animals were alive and moving into areas where the signal from the tag could not be detected.

Data from the tagged brown trout produced similar patterns as those described above for Atlantic salmon smolt (Figs.18E-G) suggesting that at least some of the trout leave Renews Harbour and spend time in the open ocean. The data from brown trout “J” (Fig.18J) suggests that this fish died, or expelled the tag, and the tag remained stationary within the detection range of receiver 2. However, it is important to note that this tag remained active until October 26, 2008 which is approximately 150 days after it was first activated. This is the expected lifespan of these tags and provides evidence that non-detection of the other tags is likely caused by the fish leaving the study area, either from predation or migration. Furthermore, two of the tags (salmon smolt “A” and brown trout “E”, Figs. 18A and E) were detected by a receiver array located off Cape Broyle which is approximately 10 nautical miles north of Renews. These detections occurred approximately one week after the last time the tags were detected in Renews.

Radio Tags

Manual tracking of the five radio tagged brown trout occurred on October 20, 24, 27, 28, November 4, 16, and 27, 2008. Over that time the entire river from Corner Pool to the mouth of the river was covered at least once. As well, in November, tracking took place in Big Butterpot Pond, Little Butterpot Pond, Big Pond, Hollies Pond, Grassy Pond and Duck Pond as well as the outflows of Big Butterpot Pond, Big Pond, Grassy Pond, and Duck Pond. No fish were detected above First Falls. Four of the 5 tagged fish were detected after tagging. Figures 19 A-D shows the locations of the individual fish that were detected and the dates detected. All fish were only located within a few hundred meters of the mouth of the river. The final detection of three of the four fish occurred on Nov 27 near the bridge which is inside the tidal zone and suggests a directed movement out of the river.

PREDATOR SURVEY

The salmonid predator observations began earlier in 2008 (06 May) compared to 2007 (21 June) (See Veinott 2009). This resulted in early observations recording no sightings of seals, cormorants or terns and therefore, allowed for the observation of the timing of first arrival of these species (Fig. 20). Of the three main species observed, cormorants were the first to arrive, first appearing in the inner estuary on May 10 (Fig. 20B). However, most cormorants were observed in the main bay with up to 35 individuals counted in a single observation (Fig. 20A). Terns arrived on May 26th with the greatest number of observations occurring in the inner estuary (Fig. 20B). As in 2007, the terns left the study area in early September. With the exception of a single observation on June 17th, seals did not begin to be observed until August 29th. Seals were only observed in the main bay and continued to be spotted up to the end of the 2008 field season on October 28th.

The total number of seals observed in 2008 declined by approximately 70% compared to 2007 (370 in 2007 and 112 in 2008). The shortening of the observation season may account for some of the drop but the number of seals observed after October 28th 2007 (Veinott 2009) does not make up for the difference between the two years. As well, the average number of cormorants and terns observed declined (Fig. 21) and t-tests showed that these declines were significant ($p<0.05$).

WATER CHEMISTRY

For most of the parameters measured there was no obvious trend either with time or between the down stream and upstream stations (Fig. 22). The exceptions were hardness and chloride. Hardness concentrations were greater in the downstream site compared to the upstream site. It is not clear why this would occur and it did not happen in the 2007 samples (Veinott 2009). The other parameter that showed a trend was chloride, where there is an increase in chloride later in the summer and fall at both stations. However, these concentrations would not be considered high for stream water near the ocean.

When compared to samples analyzed in 2007 (Veinott 2009) nitrate, sulphate and phosphate were very similar, hardness and alkalinity were lower in 2007 and potassium was higher in 2007. However, none of the analytes are elevated enough to be outside what could be natural for stream water.

From mid June to mid September water temperatures in Renews River regularly exceeded 18ºC (Fig. 23) and on some days the daily minimum remained above 18ºC (Fig. 24). Peak temperatures exceeded 27ºC which would be lethal to salmonids (Elliott 1991; Elliott 1981).

DISCUSSION

SALMONID DISTRIBUTION AND ABUNDANCE

The 2007 electrofishing sampling took place in late summer. Although the general hypothesis that brown trout would be less abundant as sampling moved further upstream was supported by the data (Fig. 4), the total catch and catch per effort were considered low (Veinott 2009). One possible explanation for the low catch was the time of the year. Because water temperatures in the main stem of Renews River often exceed 20ºC during the summer (Fig. 23), it was possible that in 2007 fish had moved out of the main stem of the river to deeper cooler water in ponds or pools. Therefore, the 2008 electrofishing took place in the spring. However, the total numbers caught and the catch per effort improved only marginally in 2008 compared to 2007 (Fig. 4). In fact catch rates were so low in 2008 that it was decided that not all the 2007 electrofishing sites would be repeated in 2008. The poor catch rates suggest that the densities of trout and salmon in Renews River are low and support the same conclusions reached by Veinott (2009). Nevertheless, as in 2007, no brown trout were captured above Second Falls in 2008, so the hypothesis that First Falls and Second Falls are migratory barriers to brown trout is still supported.

Low densities do not necessarily equate to poor productivity. The main stem of the river may simply be a spawning area and a migration corridor. Over 80% of the salmon parr and brown trout sampled by electrofishing were less than 10 cm in length (Fig. 8 spring), which suggests that their age was 2 years or less (Veinott 2009 their Fig. 4). Further, there is a large downstream migration of juvenile fish (Fig. 5) which are presumably moving into the estuary. The fact that no fish larger than 15 cm were captured in the main stem of the river and that parr are leaving the river in the spring, lends support to the argument that the main stem of the river is suitable only as rearing habitat for very young salmon and trout.

The downstream migration of salmon parr to estuarine environments has been reported in Western Arm Brook, NL (Cunjak and Chadwick 1989) and other locations (Riley et al. 2008, 2002; Youngson et al. 1983). The assumption is that parr take up estuarine residence and either migrate back upstream in the fall or smoltify and migrate to the marine environment. Similar movement by juvenile brown trout is discussed by Jonsson and Jonsson (2004) (see references within). However, only small numbers of juvenile brown trout were captured in the fall migrating back upstream and no juvenile salmon were captured. The number of downstream spring migrants greatly exceeded the upstream fall migrants. This is also what Cunak et al. (1989) reported which they attributed to the difficulty in capturing small fish using a counting fence. However, the fall effort in this study used a fyke net which is designed to capture small fish. Perhaps a greater than anticipated number of juvenile fish are overwintering in the estuary or being preyed upon. However, if large numbers of juvenile fish are lost as a result of predation then the advantage of increased growth from an estuarine migration becomes less beneficial.

Despite the large numbers of juvenile salmon (almost 3X as many parr as smolt) and trout migrating out of the river in the spring, very few were captured in the estuarine trap. The purpose of the trap was to sample fish for a mark re-capture experiment in an attempt to estimate the population size in the estuary. However, too few fish were captured to allow this.

BIOLOGICAL CHARACTERISTICS

Length-Weight Relationships

Length-weight relationships are a simple way to study the change in weight of individual fish as they grow longer. Fish never stop growing but they usually become heavier more quickly than they lengthen. Heavier fish for a given length are generally thought to be healthier. Therefore, length-weight relationships and condition indices can be used to identify the fitter individuals in a population. However, comparisons should be made within species and within a given size range (Anderson and Neumann 1996).

When using a power function of the form $W=aL^b$ to describe the weight (W) length (L) relationship in fish, the coefficient b is the slope of the regression line generated by the log-log transformed length-weight curve. The slope then describes the rate of change between length and weight. Fish populations with a slope of 3 means that the shape of the fish does not change much as it grows (Anderson and Neumann 1996). In other words the fish is getting proportionally heavier as it gets longer. Significant differences in the slope can indicate differences in growth rate that may be linked to fecundity, reproduction, or mortality (Anderson and Neumann 1996). Often length-weight data is converted to condition indices, which again simply describes the shape of the fish with the assumption that heaver fish at a given length are more robust.

The slope (b) of the length-weight relationship for the brook trout from Big Butterpot Pond was almost exactly 3 (3.05) (Fig. 7). This indicates that the length and weight are increasing proportionally and the fish are not changing shape as they grow. However, the average relative weight (Table 1) suggests that the trout are not in optimal condition. In fact they are only 77% as heavy as the North American “standard” brook trout (Hyatt and Hubert 2001). However, Hyatt and Hubert (2001) did not include any trout from Newfoundland despite claiming their standard-weight equations should be suitable for all North American brook trout. The sampling season may have attributed to the low weight of the trout as well. It is likely that food in Big Butterpot Pond is less available during the winter.

The remaining samples collected in fresh water either by electrofishing, seine, or fyke net all had slopes of less than 3. Again, the slope simply relates the length to the weight of the fish, but as the slope of the line for a specific group of fish becomes lower, then fish in that group are lighter for a given length compared to other groups. When comparisons such as this are made within a year there was no difference in the length at weight between salmon and trout (Fig. 8). However, there was a significant difference in the slopes of the lines between salmon parr sampled in 2007 compared to 2008 (Fig. 9) with the 2008 sample having a significantly higher slope. This suggests that the 2008 sample was more robust. However there appears to be a contradiction in the data. Condition indices, which are another way of comparing the fitness of fish, produced the opposite result. The mean Fulton condition factor for the 2007 salmon parr sample was significantly higher ($p<005$) than the 2008 sample. This suggests that the 2007 sample was fitter.

A seasonal effect could be used to argue that the condition index for the 2007 parr would be expected to be higher. The 2007 fish were caught in the fall and presumably had the whole summer of growth to add fat to their bodies. The 2008 spring sample would have had little time to add weight after surviving the winter and therefore less robust. Yet the seasonal effect can not explain the difference between the slopes in the growth curves. The growth curves do cross. Perhaps the explanation then is that the small fish are more robust in 2007 and this is having a larger impact on the Fulton condition factor compared to the slope. Further analyses of more restricted size groups may be necessary to fully explain the different outcomes for the 2007 and 2008 parr samples.

Another comparison which had the potential to yield interesting results was that of the condition of the downstream migrating salmon parr and the riverine parr. However, there was no significant difference ($p>0.05$) in average condition indices between these two groups. Downstream migration could be driven by a number of factors including food availability (Wysujack et al. 2009). The main stem of Renews River may not be productive enough to sustain larger populations of juvenile fish and so some emigration is expected.

For the brown trout there was a difference in the slope of the length-weight curve between downstream migrants and fish caught in the recreational fishery (Fig. 10).

There is a difference in the average size of these two groups so caution should be used when comparing the slopes. However, it is interesting to note that the slope of the length-weight curve for the fish taken in the recreational fishery is almost exactly 3 (3.09), suggesting that the estuarine brown trout are more fit or robust than those remaining in the river or caught on the downstream migration to the estuary. This is not surprising as it is assumed that the great advantage of migrating to the estuary is the greater availability of food. And Veinott (2009) reported that the growth rate was higher in the estuary compared to the main stem of the river.

Barnham and Baxter (1998) suggested a grading system for brown trout based on the K value. They acknowledged that K can be influenced by age, sex, season, stage of maturation, etc, but still wanted a more objective assessment of the condition of the fish. They graded fish from Excellent (trophy class) if the K value was 1.60 or higher down to Extremely Poor if K was 0.80 or less, with gradings of good, fair and poor, in between. Barnham and Baxter (1998) found that a fair fish was acceptable to many anglers. When applying this system to fish caught in the Renews recreational fishery the majority of Renews fish fell into the poor and fair categories representing long thin fish some of which would be acceptable to many anglers but still not a well proportioned fish. So despite the improved growing conditions in the estuary, Renews is still not producing large numbers of trout that, compared to other parts of the world, would be considered good or excellent.

Age and Spawning

Few fish captured in 2008 showed any sign of spawning marks on their scales. This is somewhat disconcerting because it means that most of the fish taken in the winter and summer recreational fisheries have not had a chance to spawn. Of the 12 brook trout taken in Big Butterpot Pond only the single 5 year old fish had any spawning marks on its scales. Brook Trout in Newfoundland commonly only live for about 5 or 6 years (Blair Adams, Resource Manager, Government of Newfoundland and Labrador pers. comm.) so these trout may only get one spawning opportunity in their lives. Neither of the brown trout caught in Big Butterpot Pond had any spawning marks on their scales despite periods of rapid growth indicative of marine residency. The possibility that brown trout are moving between the marine environment and Big Butterpot Pond is being tested using tags and otolith analyses. However, no such movements had been confirmed at the time of this report.

There were few spawning marks found on the scales of brown trout taken in the summer fishery as well. Only 4% of the fish sampled had any indication that they had spawned prior to being caught, and these were the older, 4 and 5 year old fish. The most common age of fish taken in the estuary was 3 (Fig. 13). This matches the modal age of the down stream brown trout migrants (Fig. 14) which suggests that the recreational fishery depends heavily on the downstream migration as a supply of new recruits to the fishery. However, the down stream migrants are not being taken early in the fishing season. Figure 12 shows that the average length of the downstream migrants is much smaller than the average length of the June fish taken in the recreational fishery. It would seem then that the down stream migrating fish are too small early in the season but grow quick enough to become taken later in the summer.

Unlike brook trout, brown trout in Newfoundland can live for up to 9 years, and although they are not obligate consecutive spawners they can spawn multiple times in their lives. However, if the onset of spawning does not occur before 4 or 5 years of age then most of the trout taken in the recreational fishery have not spawned at all or have only spawned once. This raises the question of whether the number of available spawners can sustain the fishery if the main source of new recruits is Renews River. Attempts to estimate the standing stock of brown trout in the Renews estuary have been unsuccessful. However, estimates of the total recreational catch have been made and are discussed in the next section. As well, estimates of the number of trout moving down stream are available and this data will be used to build a population model in 2009 or 2010.

CREEL SURVEY

There was a large shift in the size distribution of the 2008 summer trout fishery compared to 2007 (Fig. 11). A shift to smaller sizes in a fishery could be reason for concern if the trend continued. However, preliminary data collected in 2009 suggest that the trend has not continued.

One of the more interesting results of the 2008 creel survey is that it showed that the largest fish were being taken early in the season (Fig. 12). Fish of this size were not caught migrating out of the river in the spring (Fig. 25) so the question of where these fish came from arises. Did they overwinter in the estuary or the marine environment? Evidence of this may be found in the Sr signature in the otolith but that work is still ongoing. They may have migrated out of the river earlier in the spring before the installation of the fyke trap, but that would require movement during cold water temperatures. Often fish migrations are triggered by water temperature and for salmon smolt in Northeast Trepassey near Renews it is around 5ºC (Art Walsh DFO Science, pers. comm.). Brown trout smolt were captured with Atlantic salmon smolt migrating in Renews River so it seems unlikely that larger fish would necessarily be migrating at a lower temperature. Again otolith analyses may resolve this.

It was estimated that approximately 260 brown trout were taken in the summer recreational fishery. Not surprisingly the greatest effort and the largest number of fish were taken in the evening (Fig. 15 and 16). Brown trout are considered nocturnal feeders so they would be becoming active in the evening. However, it was surprising to see so much effort on the weekdays and even in the mornings (Fig. 15 and 16). Despite the lack of success in the mornings, anglers continued to expend effort. Effort declined throughout the year with the greatest effort expended early in the season. These are likely anglers anxious to begin fishing after the winter closure. Although fishing success was not high early in the season, successful anglers were rewarded with larger fish and possibly true “sea trout”. That is anadromous fish returning from the marine environment.

Without some estimate of the standing stock of brown trout in Renews estuary it is difficult to determine whether removing 260 individuals, most of which have never spawned, from the population is sustainable. Exploitation rates in brown trout fisheries as high as 90% have been reported for a stocked system (Skurdal et al. 1989), but more commonly exploitation rates are in the 5 to 20 % range for wild or mixed stocks. (Shields et al. 2006; Euzenat et al. 1999; Faragher and Gordon 1992).

If it is assumed that brown trout in the downstream migration are caught in the fyke trap with the same efficiency as the salmon smolt, then the total number of brown trout entering the estuary (see Fig. 5) would be roughly equal to the total size of the salmon smolt run, which was estimated to be about 1500 fish. Most of the brown trout entering the estuary in the spring are too small to be exploited by the angling fishery. However, previous years runs or growth may recruit them into the fishery. Nevertheless, if the downstream migration is the primary source of recruits to the fishery then 260 fish would represent approximately 20% of the downstream migration. Additional data collected in 2009 and planed for 2010 will provide insight into whether that rate of exploitation is sustainable.

TAGGING

The purpose of the PIT tagging was to track the growth of individual fish. However no PIT tags were recovered in 2008 so information on individual fish was not available. The PIT tags should last several years and may be picked up in later samples.

The data from the acoustic tags showed a directed movement by some fish out of Renews Harbour toward the open ocean (Fig. 18). The record of movement in and out of the estuary then inner and outer parts of the harbour suggest an acclimation or growth period prior to the initiation of the marine migration. This was expected for the salmon smolt but it was not certain the brown trout would behave in the same manner. The fact that a salmon smolt and a brown trout were detected off Cape Broyle a week after their last detection in Renews confirms that the loss of signals at the Renews receivers was not necessarily symptomatic of tag loss or predation.

Aside from the one tag that seemed to be stationary and likely a result of a dead fish or an excreted tag (Fig. 18J) only one other tag was detected in the estuary in July (Fig. 18H). Since all tags were implanted into downstream migrating fish it would seem that the brown trout “smolt” that are leaving the river in the spring are true anadromous sea trout. This then has implications for estimates of the number of recruits to the recreational fishery. If the smolt sized trout are leaving the estuary on a marine migration they would not be available to be angled. As well, any marine migrant would be expected to sustain high mortality. Recently Atlantic salmon smolt from Newfoundland have only had marine survival rates of less than 8% (CSAS 2008).

However, it is unlikely, based on the age and growth of the trout being caught in the Renews estuary, that the trout are taking the same migrations as Atlantic salmon. No data were found on the migratory behaviour of brown trout in Newfoundland. However, brown trout can spend as little as a couple of months up to 2 years at sea before returning to freshwater (Thomsen et al. 2007; Berg and Berg 1987). Marine residency seems to be confined to coastal areas though, but the range of movement can be on the order of hundreds of kilometres (Rikardsen et al. 2007; Okumus et al. 2006; Caballero et al. 2006). Since most of the rivers on the Avalon have brown trout populations it is not unreasonable to expect some movement between river systems.

The radio tags that were implanted in upstream migrating fish in the fall allow for the tracking of individual fish using a directional antenna. This means that specific fish can be placed in very specific locations such as behind a rock or under an overhanging branch. In the case of the radio tagged Renews fish, no individual was found further upstream than half way to First Falls. One fish appeared to be moving away from the tracker as tracking proceeded upstream so it may have been fleeing the tracker. Despite efforts to locate fish further upstream and in several ponds no fish were detected beyond the lower reaches of the river. As well, three of the fish (Fig. 18 A, B and C) were found at the mouth of the river on November 27. If these fish spawned earlier, this downstream movement to brackish waters would suggest a return to the estuary and it seems unlikely that they would be preparing for a migration upstream to overwinter in the ponds in the upper reaches of the river.

It was assumed that the upstream migrating fish were moving into the river to spawn. However, Thomsen, et al. (2007) showed that brown trout will move into freshwater to avoid salt and low temperatures associated with marine waters without necessarily being prepared to spawn. The spawning condition of the radio tagged fish was not determined, but they were much larger than the average fish being taken in the recreational fishery and several males had developed a kype typical of salmonids preparing to spawn. This suggests that the lower portion of Renews River may be an important spawning area for brown trout. Although Veinott (2009) reported little evidence of spawning in this part of the river, Limburg et al. (2001) reported the use of marginal spawning streams by Baltic Sea brown trout. In fact, Limburg et al. (2001) suggested that spawning may be taking place within the tidal zone and that riverine spawning is not essential for brown trout to complete their lifecycle.

PREDATORS

Veinott (2009) discussed the importance of availability and size of prey in the context of potential impact of predators on the salmonid populations in Renews. For example, it was unlikely that the common tern was preying on smolt sized fish but that cormorants certainly could. As in 2007, seals did not appear in the study area in 2008 until after the smolt run was over. Even given the fact that the tagging data showed that smolt didn’t leave the bay until July (Fig. 18), the seals still had not taken up residency in the bay by that time (Fig. 20A). However, the migration of smaller fish into the estuary and their subsequent residency and growth in the estuary could make them targets of the late arriving seals.

Local knowledge suggested that the terns would return to Renews on the Victoria Day holiday weekend (May 24) and they did, with the first sighting occurring May 26, 2008 (Fig. 20E). Although the total number of terns observed in 2008 did not change compared to 2007, the average number observed per observation session did drop significantly (Fig. 21). The same trend held for cormorants and seals with a 70% decline in the total number of seals counted.

Terns seem to be enjoyed by the local residents whereas seals and cormorants are considered nuisance animals. This is despite the fact that terns are the most abundant piscivorous predator and may consume large numbers of parr sized or larger salmonids. Local residents have expressed a desire to cull seals and cormorants but there is no evidence that this has occurred. The fact that the number of terns had declined along with the number of cormorants and seals suggests that the cause may be natural. In 2007 the number of adult Atlantic salmon that returned to Newfoundland rivers was at an all time low. If this was indicative of other species it is possible that food was difficult to find in 2007 and it had a direct impact on the number of fish eating predators in 2008.

WATER QUALITY

The chemical parameters measured in 2008 were the same as those determined in 2007 with the addition of chloride (Fig. 22). However, because of the similarity of the results in 2007 only two stations were sampled in 2008; one near the mouth of the river and the other upstream at Corner Pool. As in 2007, the water samples from 2008 produced no evidence of anthropogenic pollution entering Renews River. The concentrations of phosphate nitrate, sulphate, and potassium were well below that which is recommended for the protection of aquatic life (Canadian Council of Ministers of the Environment 2003, 2004; Government of British Columbia 2000) but the river is still considered to be highly sensitive to acidification.

Chloride concentrations did increase throughout the sampling season (Fig. 18A), and chloride can come from anthropogenic sources such as the incineration of waste and road salt. However, the concentrations in Renews River are within the natural range for a marine environment (Smart et al. 2001). The increase in chloride in the fall may be a reflection of increased rainfall or storms.

As in 2007, the temperature logger showed that from mid June to mid September water temperatures in Renews River regularly exceeded 18 °C (Fig. 23). This is the temperature at which survival rates for hooked and released Atlantic salmon begin to decline significantly (Dempson et al. 2001). A closer examination of daily fluctuations revealed that on some days during the summer the water temperature never dropped below 18 °C (Fig. 24). Peak temperatures exceeded 27ºC which would be lethal to salmonids (Elliott 1991). As well, the peak temperatures occurred around 15:00 hours and slowly declined after that. This is important because salmon angling often occurs in the evening and although the air temperature may be dropping the water temperatures could still be detrimental to hooked and released fish.

FUTURE PLANS

At the time of the writing of this report most of the 2009 field work was completed but unprocessed. The creel survey was completed and additional acoustic tags were implanted in fish to study the difference in movement between spring and fall. Otoliths collected in 2007 were analyzed to determine time of entry into the marine environment and subsequent duration of marine residency. The otolith data, creel survey, and acoustic data will likely be published as scientific papers in the primary literature. It is unlikely that annual reports such as this one will continue because the data is more suited to primary publications on specific aspects of the project.

ACKNOWLEDGMENTS

This work was wholly funded by the Government of Canada, Department of Fisheries and Oceans. Special thanks to Linda Reddy for her valuable field work. Thanks to: Bob Whalen, Art Walsh, Bruce Short, and Vicki Morris for field assistance; Don Caines for aging scales; Curtis Pennell, Craig Kelley and Maitland Sampson for deploying and retrieving the acoustic receivers; Milton Shears for preparing otoliths; and Neila Cochrane for technical assistance. Thanks to Peter Wesley from the Oceans Sciences Centre for providing lengths and weights of Renews River brown trout to add to our length weight analyses. Thanks to Martha Robertson and Rebecca Poole for their valuable comments on the manuscript.

REFERENCES

Anderson, R.O. and Neumann, R.M. 1996. Length, weight and associated structural indices. *In*: Fisheries Techniques, 2nd edition. Edited by B.R. Murphy and D.W. Willis. Am. Fish. Soc., Bethesda, Maryland.

Barnham, C. and Baxter, A. 1998. Condition factor, K, for salmonid fish. Fisheries Notes, State of Victoria, Department of Primary Industries 2003. ISSN 1440-2254.

Beckley, L.E., Fennessy, S.T. and Everett, B.I. 2008. Few fish but many fishers: a case study of shore-based recreational angling I a major South African estuarine port. Afric. J. Mar. Sci. 30: 11-24.

Berg, O. K. and Berg, M. (1987). Migrations of sea trout, *Salmo trutta*, from the Vardnes River in northern Norway. J. Fish Biol. 31: 113–121.

Caballero, P. Cobo, F. and González, M.A. 2006. Life history of a sea trout (*Salmo trutta* L.) population from the north-west Iberian Peninsula (River Ulla, Galicia, Spain). *In* Sea Trout; Biology, Conservation, and Management. Edited by Graeme Harris and Nigel Milner. Proceedings of the first international sea trout symposium, Cardiff, July 2004. Blackwell Publishing, Oxford. pp. 234-247.

Canadian Council of Ministers of the Environment. 2003. Canadian water quality guidelines for the protection of aquatic life: Nitrate iIon. *In* Canadian environmental quality guidelines, 2004, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment. 2004. Canadian water quality guidelines for the protection of aquatic life: Phosphorous: Canadian Guidance Framework for the Management of Freshwater Systems. *In* Canadian environmental quality guidelines, 2004, Canadian Council of Ministers of the Environment, Winnipeg.

Carlson, S.R., Coggins, L.G., and Swanton, C.O. 1998. A simple stratified design for mark-recapture estimation of salmon smolt abundance. Alaska Fish. Res. Bull. 5: 88-102.

CSAS. 2008. Stock assessment of Newfoundland and Labrador Atlantic salmon - 2008. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep 2008/63.

Cunjak, R.A. and Chadwick, E.M.P. 1989. Downstream movements and estuarine residence by Atlantic salmon parr (*Salmo salar*). Can. J. Fish. Aquat. Sci. 46: 1466-1471.

Cucherousset, J. Ombredane, D., Charles, K., Marchand, F. and Bagliniere, J-L. 2005. A continuum of life history tactics in a brown trout (*Salmo trutta*) population. Can. J. Fish. Aquat. Sci. 62: 1600-1610.

Dempson, J.B., O'Connell, M.F., and Cochrane, N.M. 2001. Potential impact of climate warming on recreational fishing opportunities for Atlantic salmon, *Salmo salar* L., in Newfoundland, Canada. Fisher. Manag. Ecol. 8: 69-82.

Elliott, J.M. 1981. Some aspects of thermal stress on freshwater teleosts. *In* Stress and Fish. Edited by A. D.Pickering. Academic Press, London.

1991. Tolerance and resistance to thermal stress in juvenile Atlantic salmon, *Salmo salar* (L.). Freshwat. Biol. 25: 61-70.

Elliott, J.M., and Chambers, S. 1996. A guide to the interpretation of sea trout scales. National Rivers Authority R&D Report 22. Bristol. ISBN 1 873160 29 1.

Euzenat, G., Fournel, F., Richard, A., and Fagard, J.L. 1999. Sea trout (*salmo trutta*, L.) in Normandy and Picardy. *In* Biology and Ecology of the Brown and Sea Trout. Edited by Jean-Luc Baginière and Gerard Maisse. Praxix Publishing, UK. Pp. 175-204

Faragher, R.A. and Gordon, G.N.G. 1992. Comparative Exploitation by recreational anglers of brown trout, *salmo trutta*, L., and rainbow trout, *Oncorhynchus mykiss* (Walbaum), in Lake Eucumbene, New South Wales. Aust. J. Mar. Freshwater Res. 43: 835-845.

Government of British Columbia. 2000. Ambient water quality guidelines for sulphate. 01 Jan 2008. <http://www.env.gov.bc.ca/wat/wq/BCguidelines/sulphate/sulphate.html>

Hyatt, M.W., and Hubert, W.A. 2001. Proposed standard-weight equations for brook trout. N. Am. J. Fisher. Manag. 21: 253-254.

ICES. 1984. Atlantic Salmon Scale Reading. Report of the Atlantic Salmon Scale Reading Workshop. Aberdeen, Scotland, 23-28 April 1984.

Jonsson, B. and Jonsson, N. 2006. Life history of the anadromous trout *Salmo trutta*. In: Graeme Harris and Nigel Milner *eds*. Sea Trout; Biology, Conservation, and Management. Proceedings of the first international sea trout symposium, Cardiff, July 2004. Blackwell Publishing, Oxford. 499p.

Limburg, K.E., Landergren, P., Westin, L., Elfman, M. and Kristiansson, P. 2001. Flexible modes of anadromy in Baltic sea trout: making the most of marginal spawning streams. J. Fish. Biol. 59: 682-695.

Malvestuto, S.P., Daves, W.D., and Shelton, W.L. 1978. An evaluation of the roving creel survey with nonuniform probability sampling. Trans. Amer. Fish. Soc. 107: 255-262.

Okumuş, I, Kurtoglu, I. Z. and Atasaral, Ş. 2006. General overview of Turkish sea trout (*Salmo trutta* L.) populations. In: Graeme Harris and Nigel Milner *eds*. Sea Trout; Biology, Conservation, and Management. Proceedings of the first international sea trout symposium, Cardiff, July 2004. Blackwell Publishing, Oxford. pp. 115-127

Ricker, W.E. 1975. Computation and interpretation of the biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 1-382.

Rikardesen, A. H., Diserud, O.H., Elliott, J.M., Dempson, J.B., Sturlaugsson, J. and Jensen, A.J. 2007. The marine temperature and depth preferences of Arctic charr (*Salvellinus alpinus*) and sea trout (*Salmo trutta*), as recorded by data storage tags. Fish. Oceanogr. 16: 436-447.

Riley, W.D., Eagle, M.O. and Ives, S.J. 2002. The onset of downstram movement of juvenile Atlantic salmon, *Salmo salar* L., in a chalk stream. Fish. Manag. Ecol. 9: 87-94.

Riley, W.D., Ibbotson, A.T., Lower, N., Cook, A.C., Moore, A., Mizuno, S., Pinder, A.C., Beaumont, W.R.C. and Privitera, L. 2008. Physiological seawater adaptation in juvenile Atlantic salmon (*Salmo salar*) autumn migrants. Freshwat. Biol. 53: 745-755.

Shields, B.A., Aprahamian, M.W., Bayliss, B.D., Davidso, I.C., Elsmere, P. and Evans, R. 2006. Sea trout (*Salmo salar* L.) exploitation in five rives in England and Wales. In: Graeme Harris and Nigel Milner *eds*. Sea Trout; Biology, Conservation, and Management. Proceedings of the first international sea trout symposium, Cardiff, July 2004. Blackwell Publishing, Oxford. pp. 417-433.

Skurdal, J., Hegge, O., Hesthagen, T. 1989. Exploitation rate, survival and movements of brown trout (*Salmo trutta* L.) stocked at takeable size in the regulated rivers Laagen and Otta, southern Norway. Regul. Riv. Res. Manage. 3: 247-253.

Smart, R., White, C.C., Townend, J. and Cresser, M.S. 2001. A model for predicting chloride concentrations in river water in a relatively unpolluted catchment in north-east Scotland. Sci. total Enviro. 265: 131-141.

Smith-Root. 2010. User's Manual LR-24 Electrofisher. http://www.smith-root.com/downloads/product_manuals/15/15/name/ASC/

Thomsen, D.S., Koed, A, Nielsen, C. and Madsen, S.S. 2007. Overwintering of sea trout (*Salmo trutta*) in freshwater: escaping salt and low temperature or an alternate life strategy? Ca. J. Fish. Aquat. Sci. 64: 793-802.

Veinott, G. 2009. Renews River Salmonid Research Project: Year 1 (2007) Data and Results. Can. Manuscr. Rep. Fish. Aquat. Sci. 2894: ix + 30 p.

Wysujack, K. Greenberg, L.A., Bergman, E. and Olsson, I.C. 2009. The role of the environment impartial migration; food availability affects the adoption of a migratory tactic in brown trout *Salmo trutta*. Ecol. Freshwat. Fish. 18: 52-59.

Youngson, A.F., Hansen, L.P., Jonsson, B. and Nesje, T.F. 1983. The autum and spring emigrations of juvenile Atlantic salmon, *Salmo salar* L., from the Girnock Burn, Aberdeenshire, Scotland: environmental release if migration. J. Fish Biol. 23: 625-639.

Table 1. Data from samples collected on ice fishing trip to Big Butterpot Pond, February 2008.

Specimen Number	Species	Fork Length (mm)	Weight (g)	Total Length* (mm)	Std Weight	Rel Weight	Fulton K	Total Age
RR08-001	Brook Trout	230	115	235	148	78	0.945	3
RR08-003	Brook Trout	261	158	266	219	72	0.889	4
RR08-004	Brook Trout	217	84	221	123	68	0.822	3
RR08-006	Brook Trout	290	233	296	303	77	0.955	5
RR08-007	Brook Trout	233	123	238	154	80	0.972	4
RR08-008	Brook Trout	267	189	272	235	81	0.993	4
RR08-009	Brook Trout	285	231	291	287	80	0.998	4
RR08-010	Brook Trout	188	64	192	79	81	0.963	3
RR08-011	Brook Trout	255	154	260	203	76	0.929	4
RR08-012	Brook Trout	250	136	255	191	71	0.870	4
RR08-013	Brook Trout	234	114	239	156	73	0.890	4
RR08-014	Brook Trout	235	125	240	158	79	0.963	4
RR08-015	Brook Trout	189	65	193	80	81	0.963	3
RR08-002	Brown Trout	371	437	380	589	74	0.856	5
RR08-016	Brown Trout	365	454	374	561	81	0.934	6
RR08-005	Salmon	566	1358				0.749	5
RR08-017	Salmon Parr	161	45.6				1.093	3
RR08-018	Salmon Parr	148	32.9				1.015	3
					MEAN	77		

* Total length (TL) was calculated from fork length (FL) using the equation: TL = FL*1.02 (Hyatt and Hubert 2001)

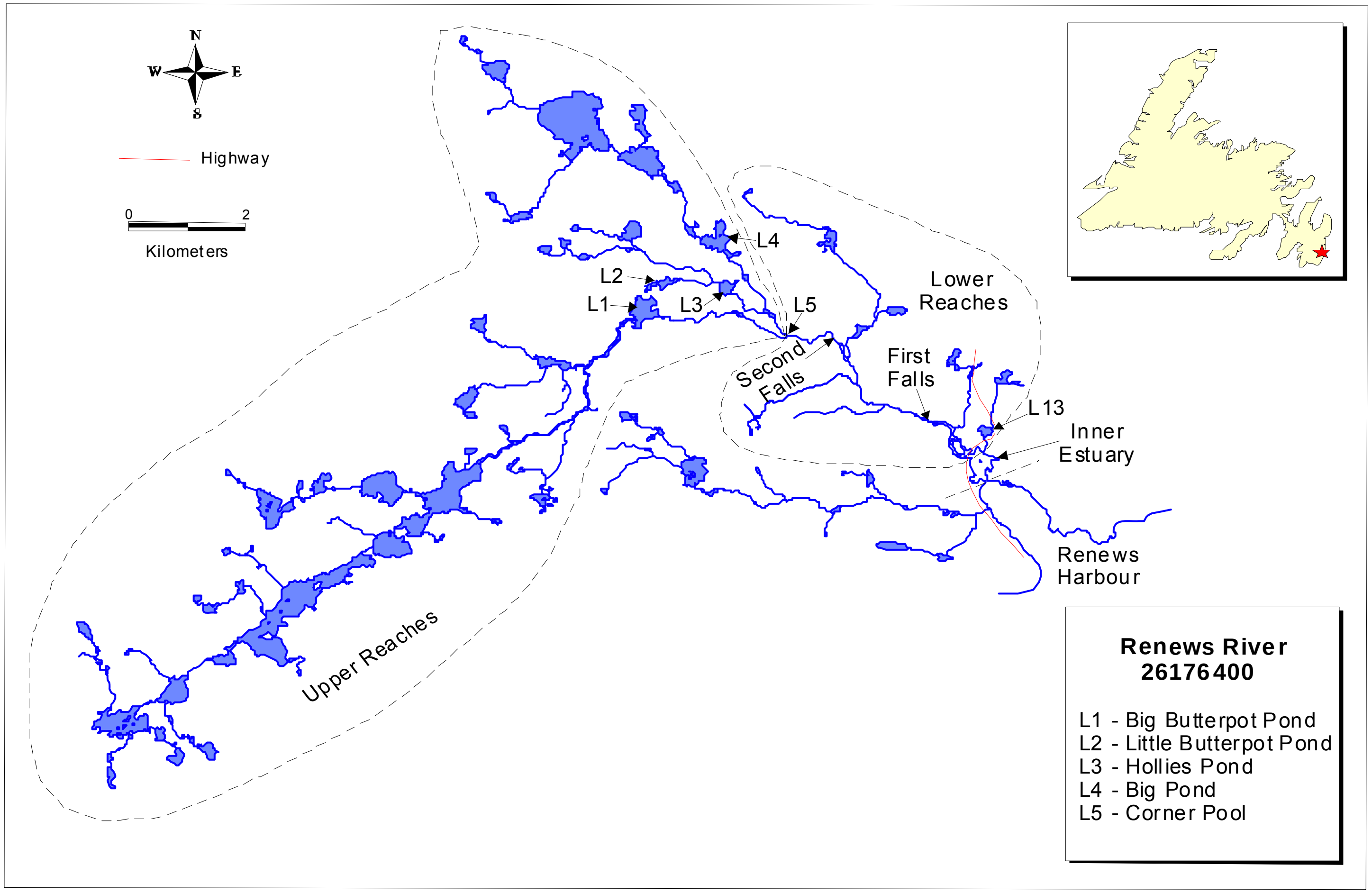


Figure 1. Map of Renews River, NL Canada showing main features and water bodies. Insert shows location of Renews.

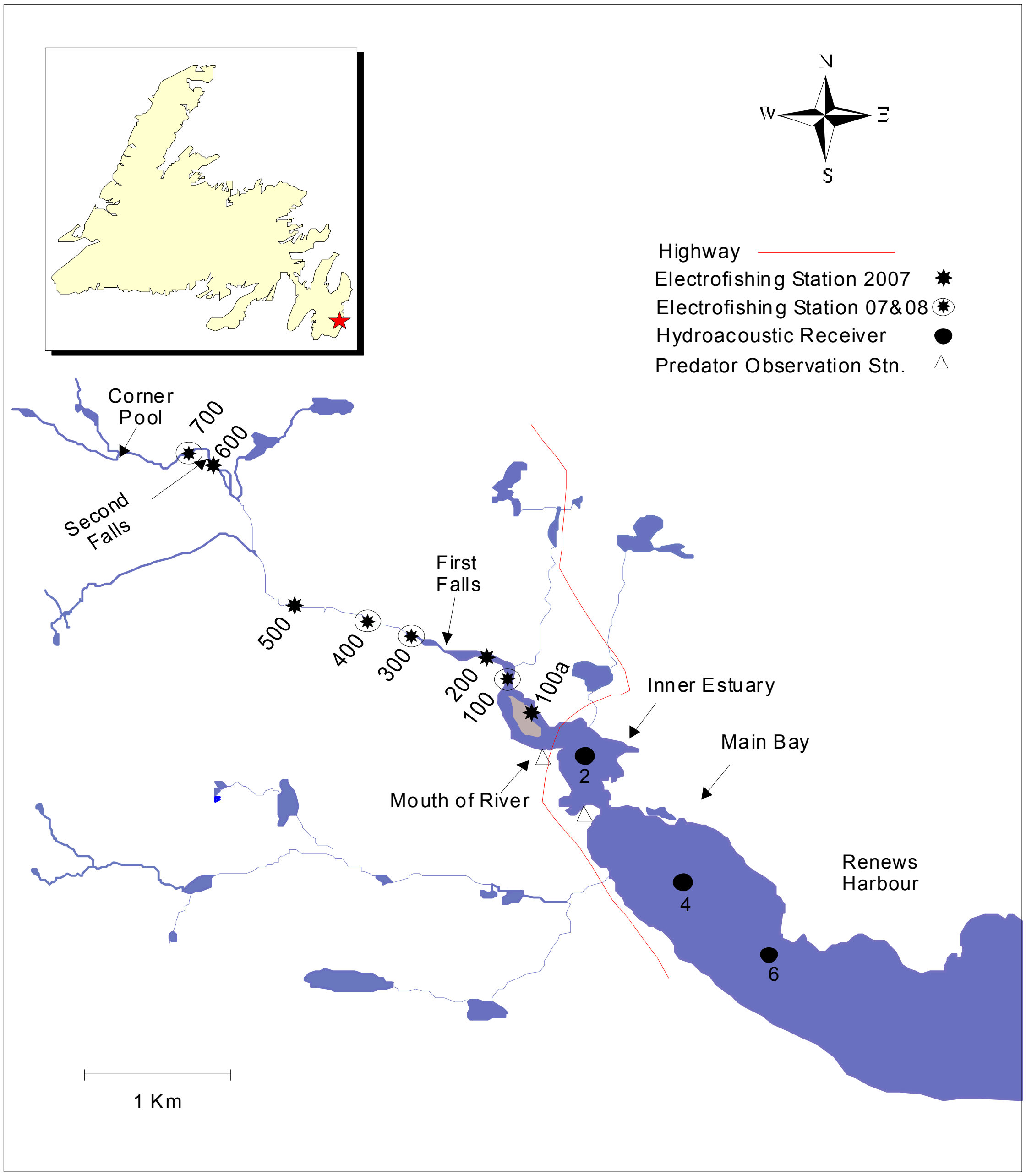


Figure 2. Map of the lower reaches of Renews River, the inner estuary, and Renews Harbour showing sampling and observation sites

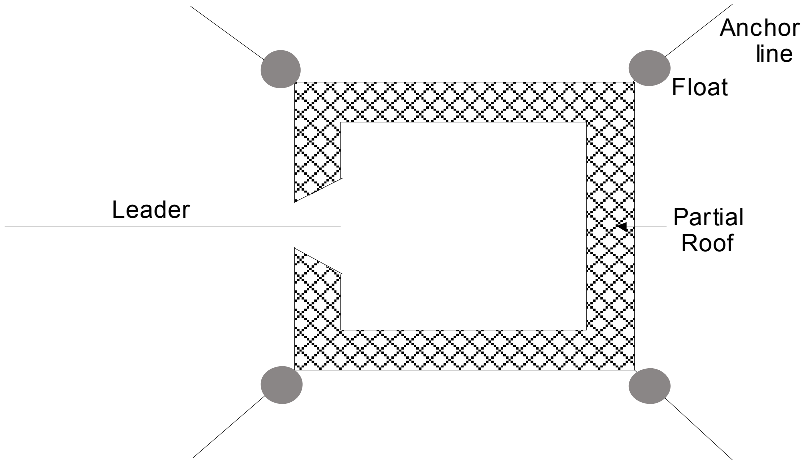
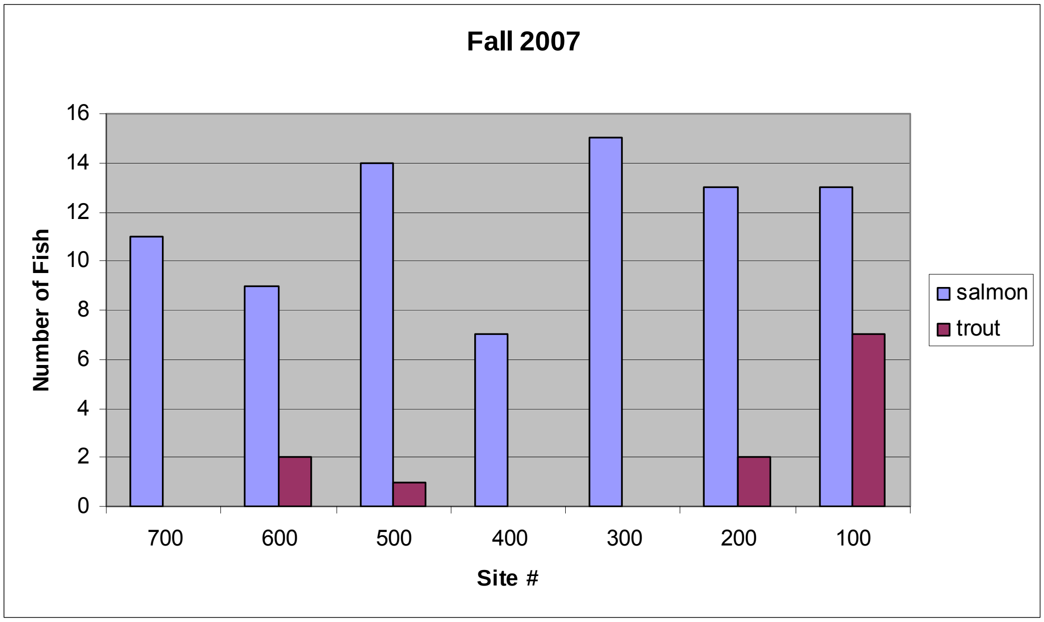


Figure 3. Schematiic of modified capelin trap used in the inner estuary



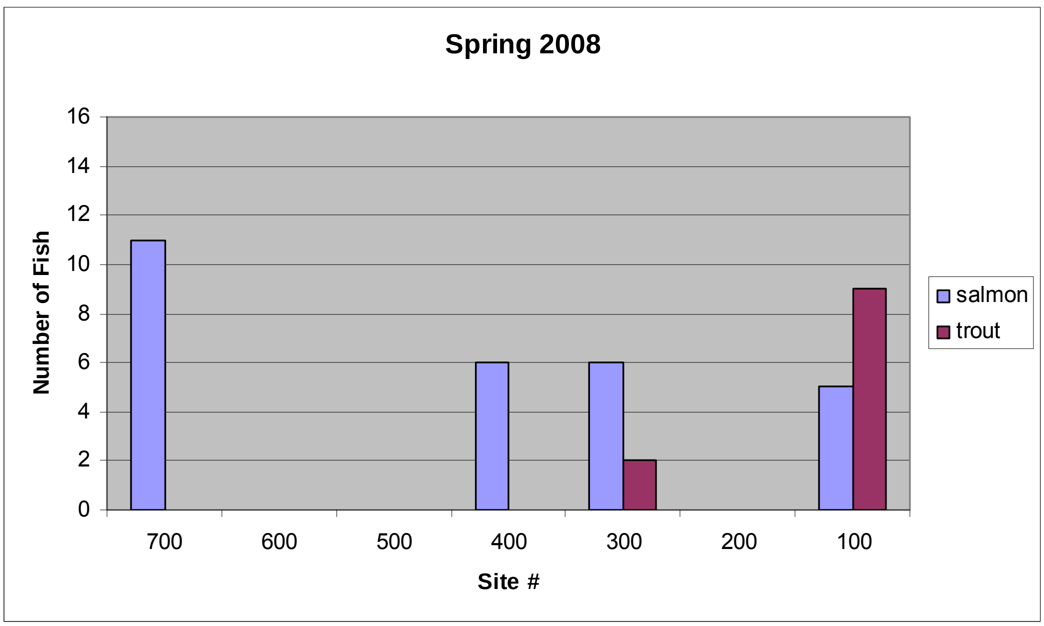


Figure 4. Results from the electrofishing surveys. Sites are numbered in order from upstream (Site 700 is above Second falls) to downstream (Site 100 is near the mouth of the river).

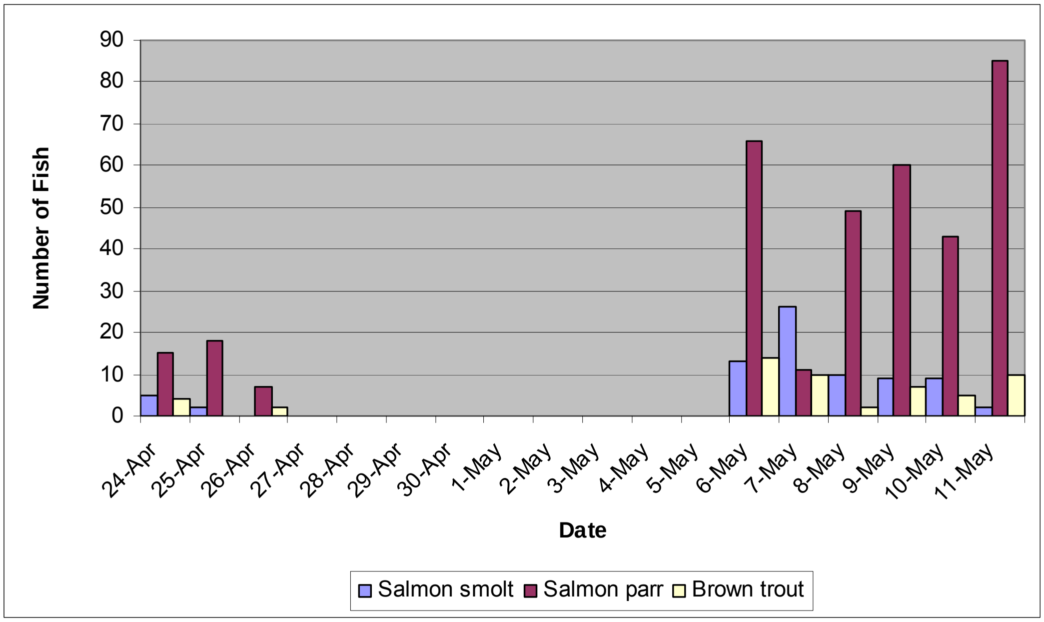


Figure 5. Downstream catch.

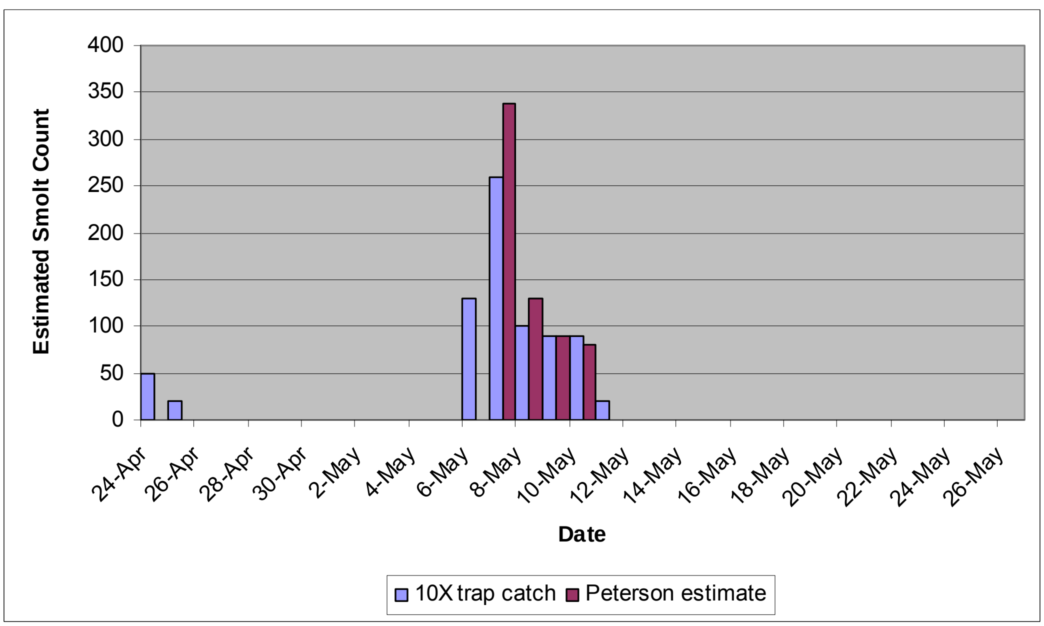


Figure 6. Estimated smolt run.

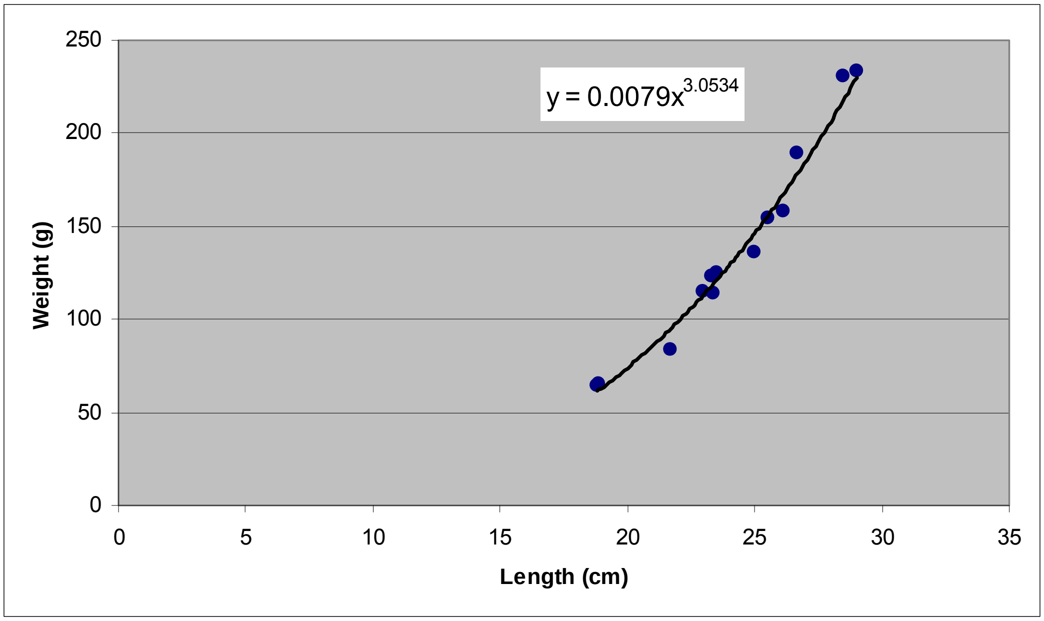


Figure 7. Length-weight relationship for Brook trout from Big Butterpot Pond.

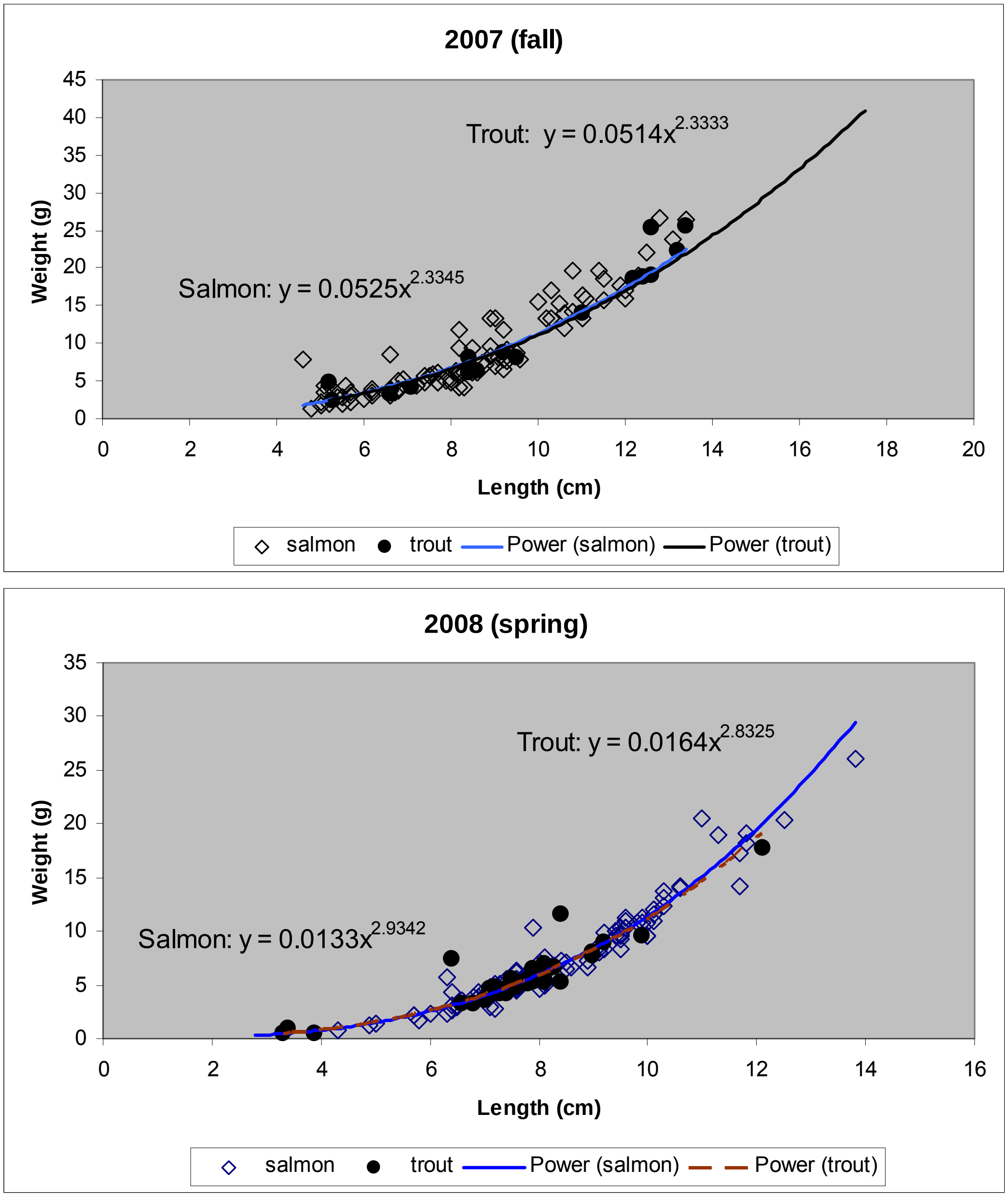


Figure 8. Length-weight relationship of Atlantic salmon and brown trout in Renews River.

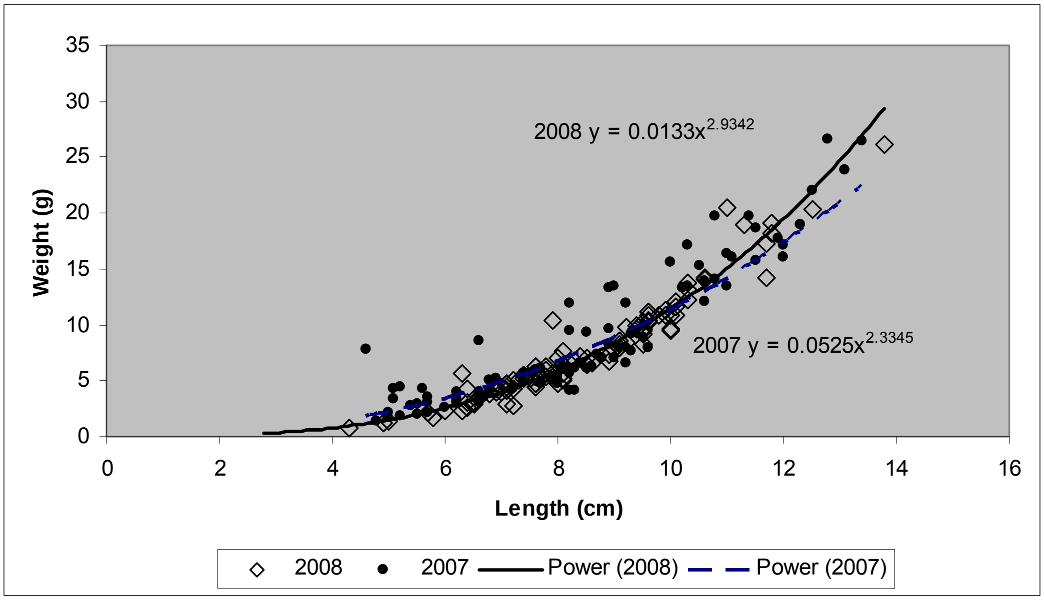


Figure 9. Comparison between the length and weight of salmon parr captured in Renews River in 2007 and 2008.

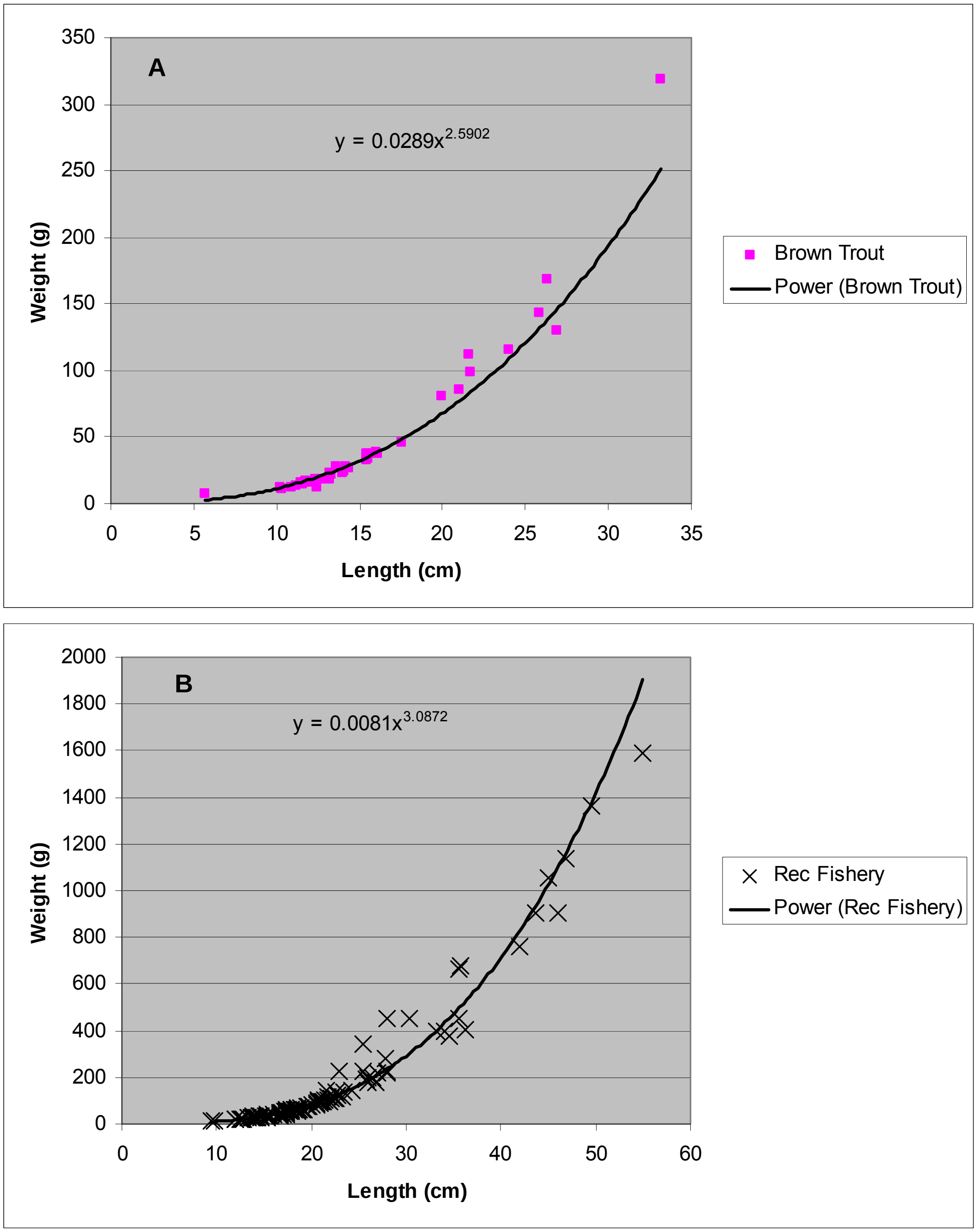


Figure 10. Length-weight relationship for Renews River brown trout (A) and brown trout from the recreational fishery in the estuary (B).

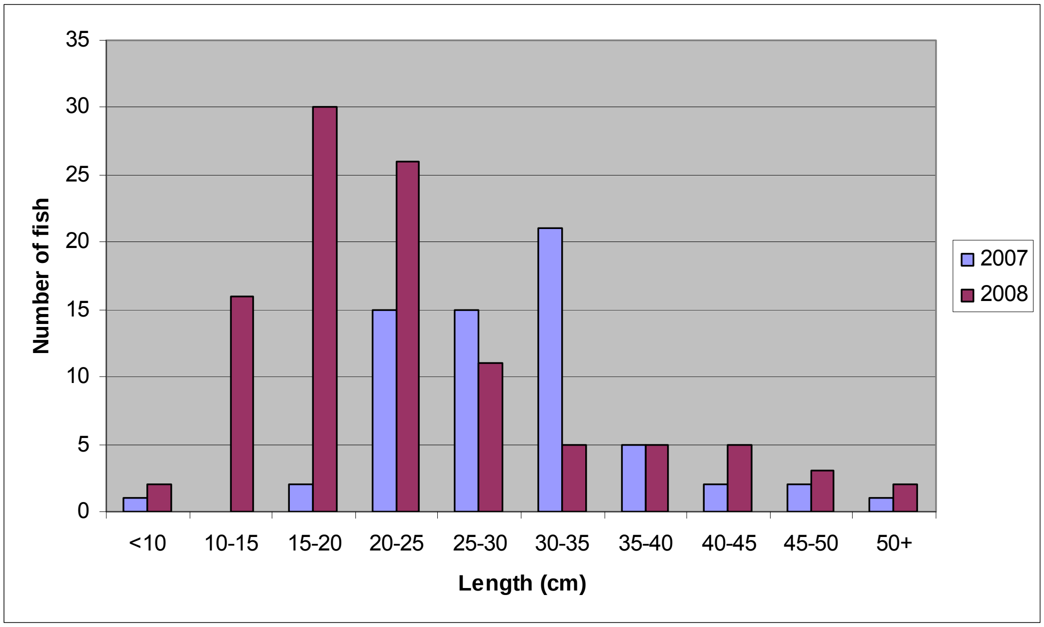


Figure 11. Length distribution of brown trout caught in the Renews recreational fishery in the estuary.

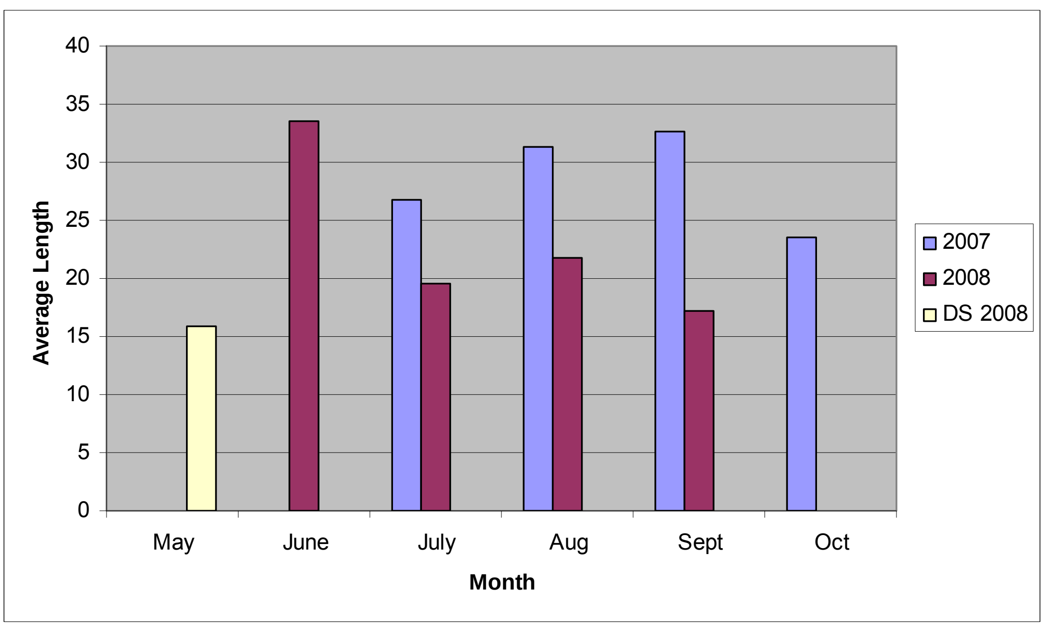


Figure 12. Average length by month of brown trout caught in the Renews recreational fishery and the downstream spring migration.

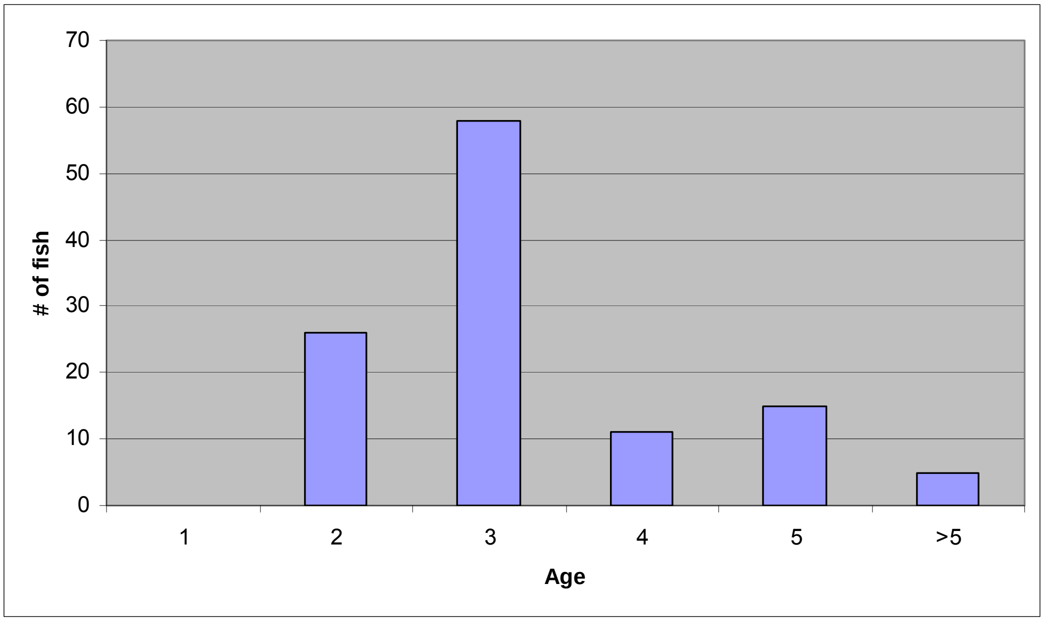


Figure 13. Age distribution of brown trout caught in the Renews River recreational fishery.

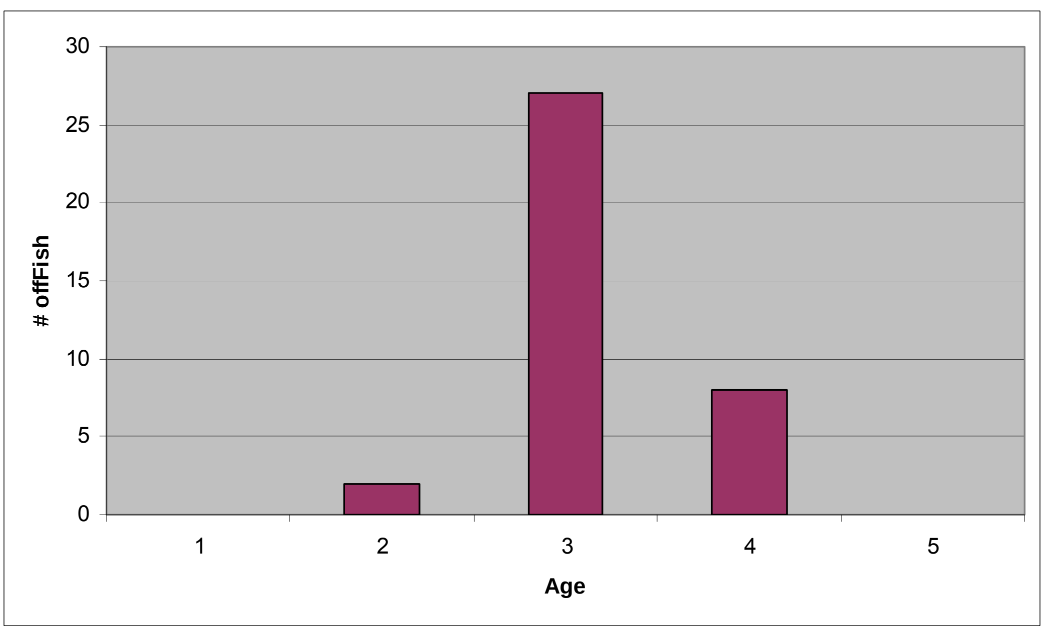


Figure 14. Age distribution of brown trout in the Renews River spring down stream migration.

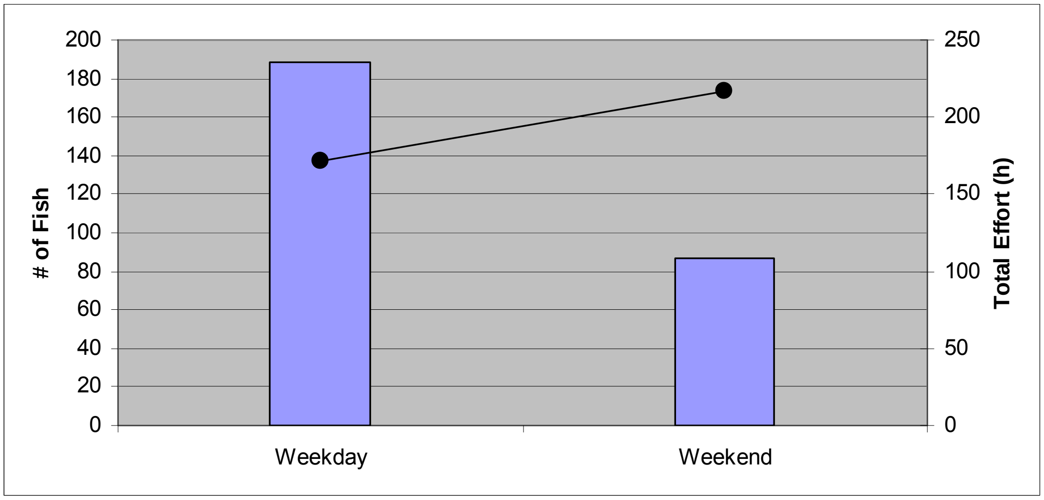


Figure 15. Comparison of the weekday and weekend catch and effort in the Renews River brown trout recreational fishery. Bars represent catch and dots joined by a solid line represent effort.

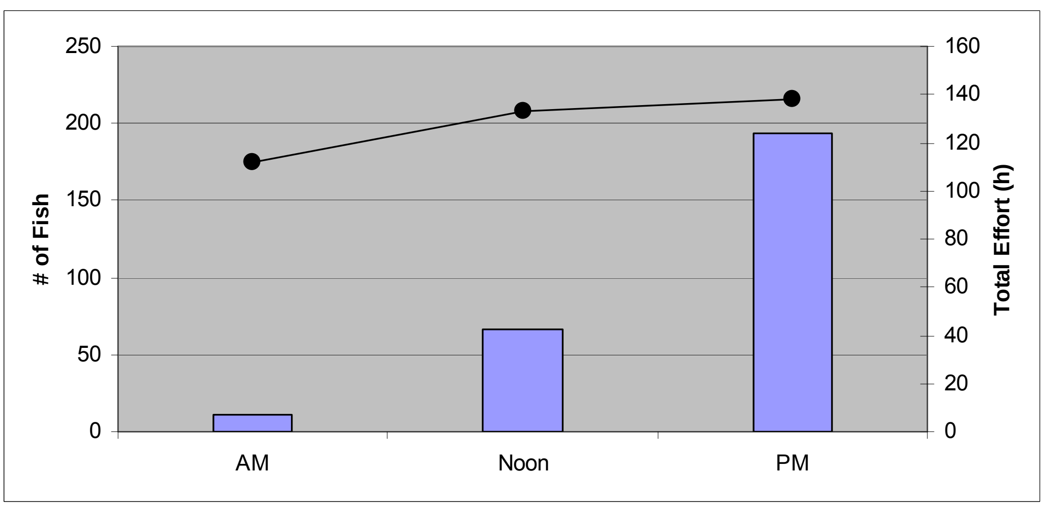


Figure 16. Comparison of the morning (AM) noon and evening (PM) catch and effort in the Renews River brown trout recreational fishery. Bars represent catch and dots joined by a solid line represent effort.

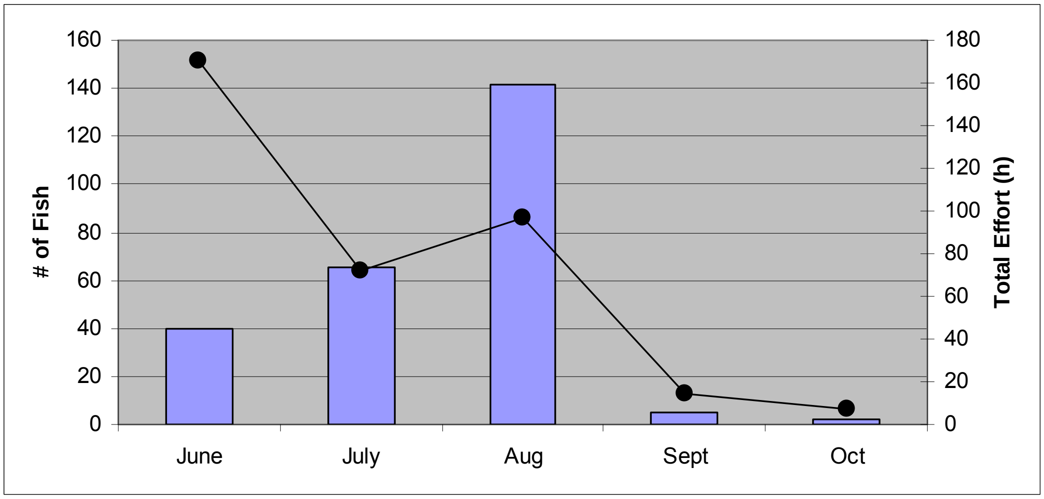


Figure 17. Comparison of the monthly catch and effort in the Renews River brown trout recreational fishery. Bars represent catch and dots joined by a solid line represent effort.

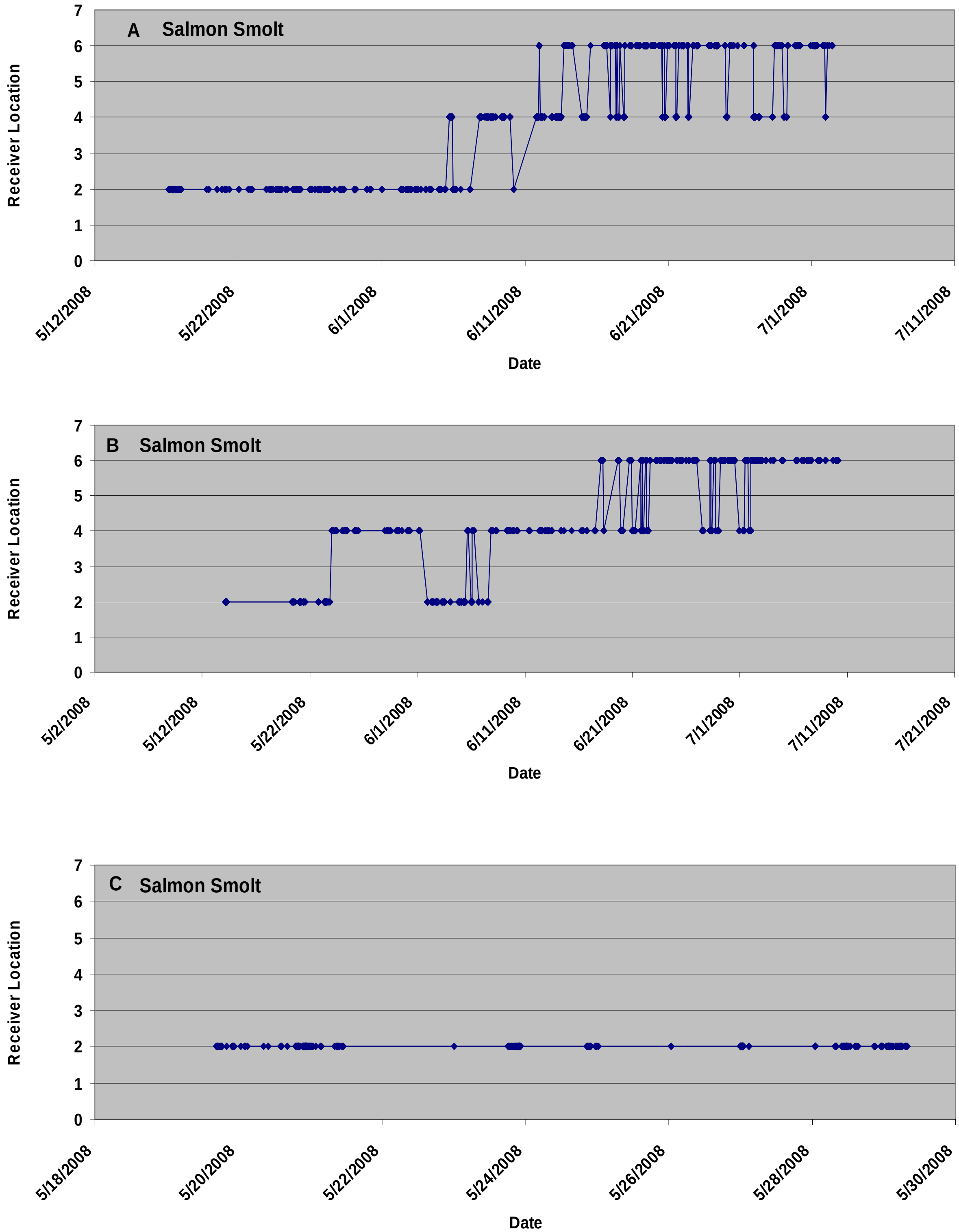


Figure 18. Dates at which hydroacoustic receivers detected a signal from tagged fish.

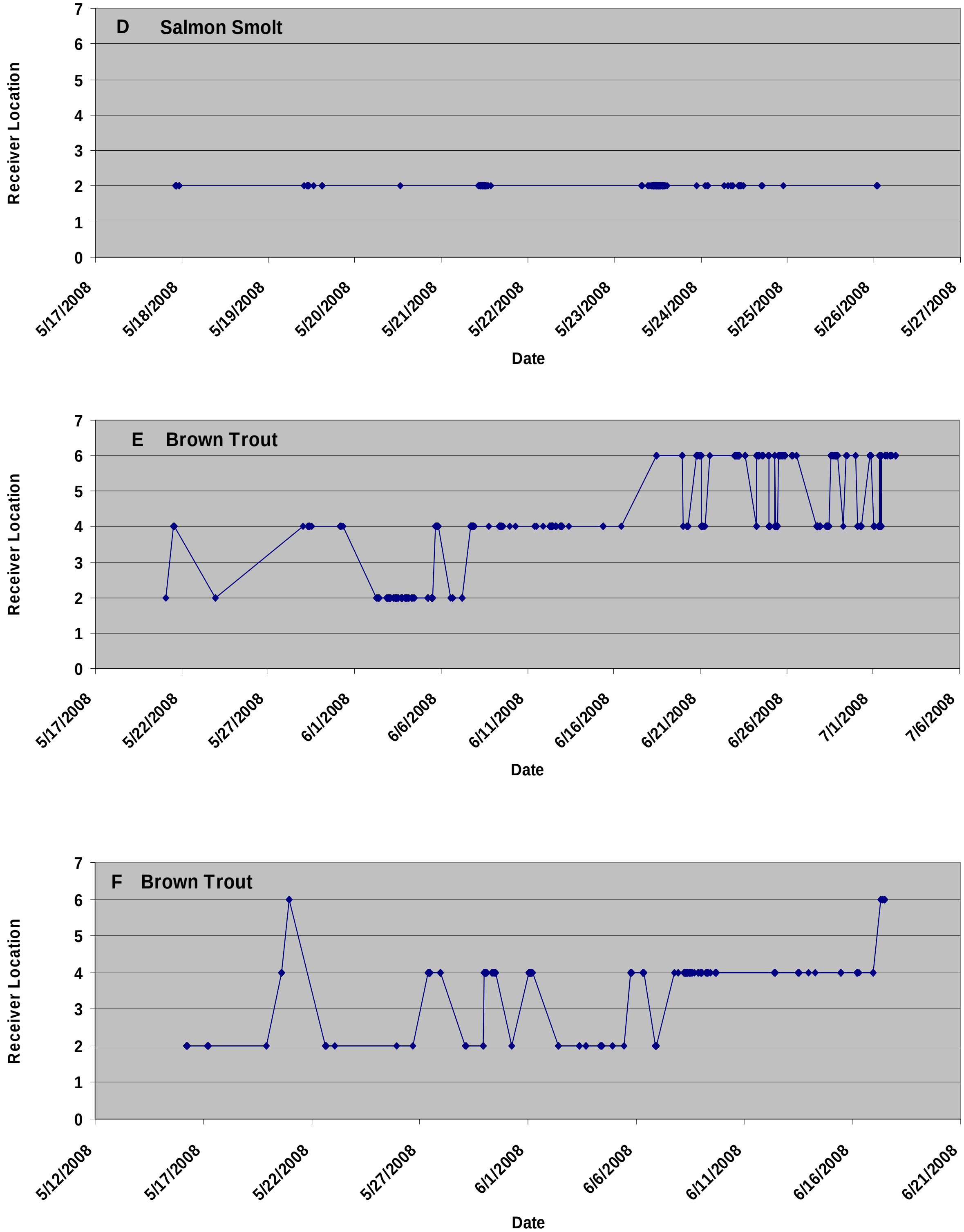
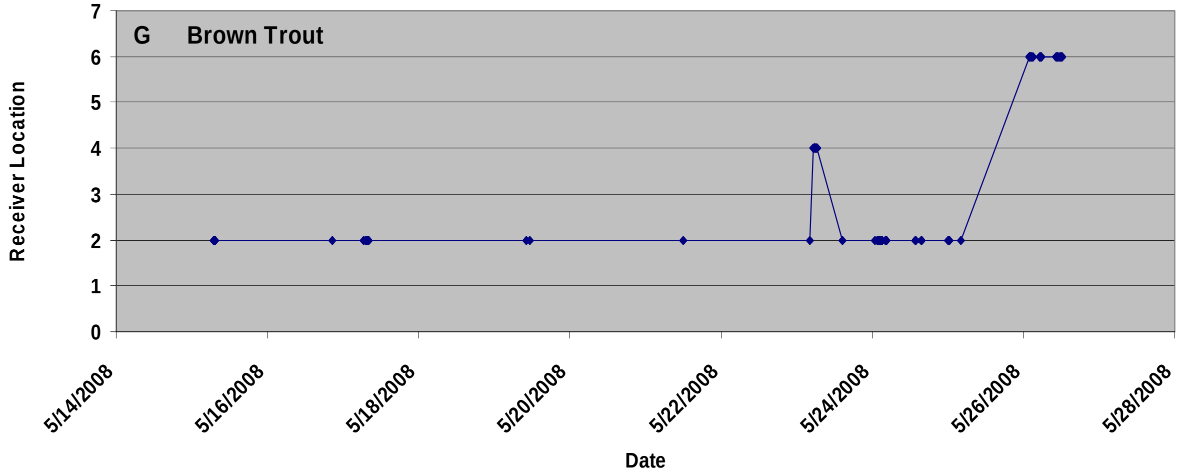
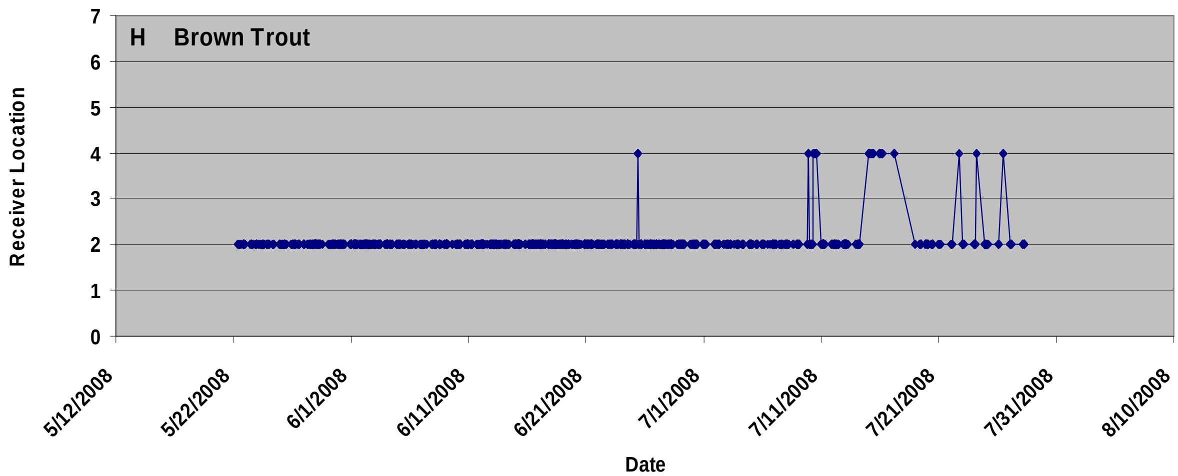


Figure 18 (Cont'd.).





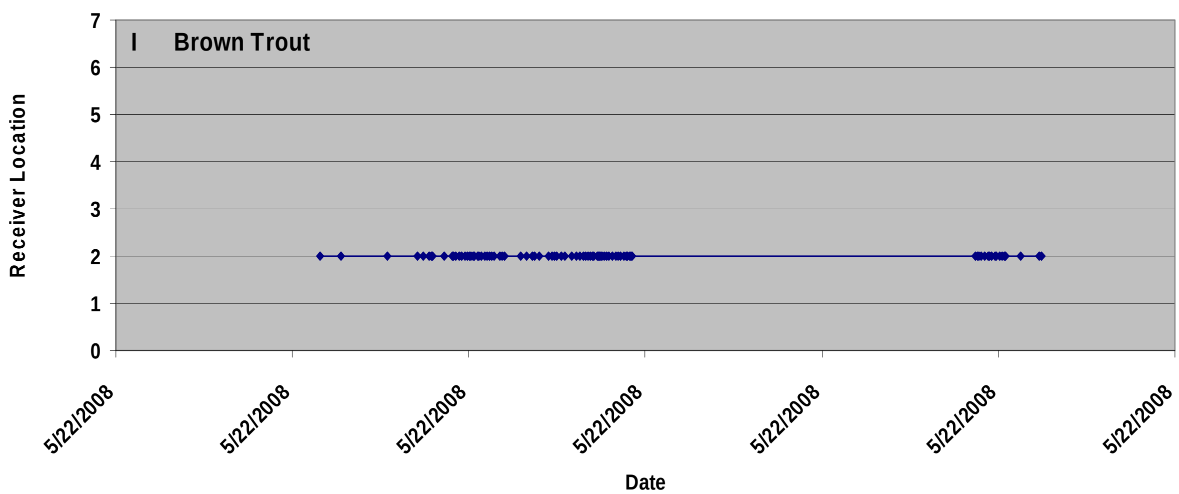


Figure 18 (Cont’d.).

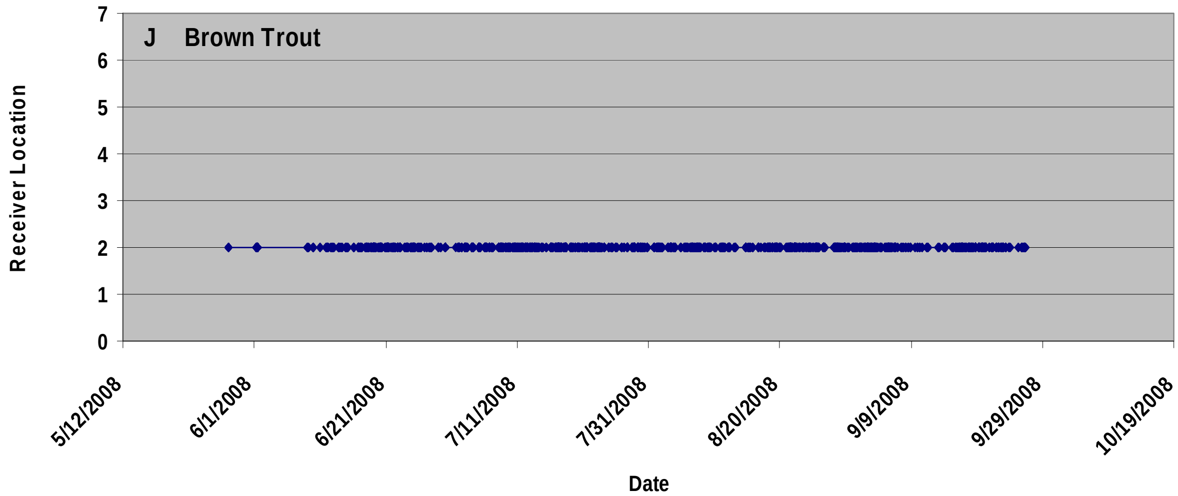
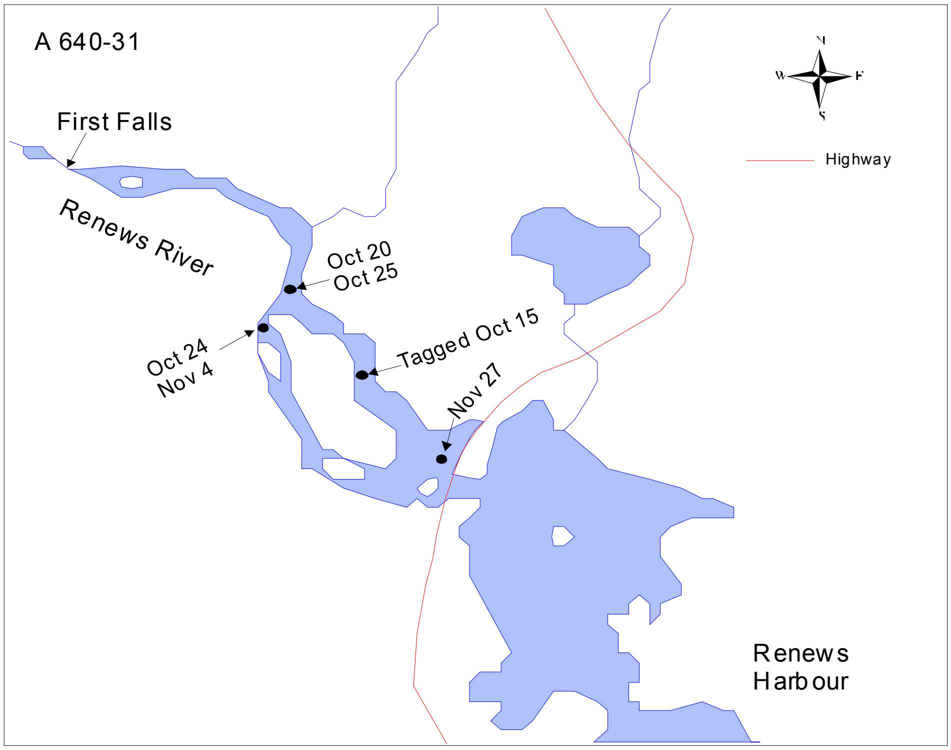


Figure 18 (Cont'd.).



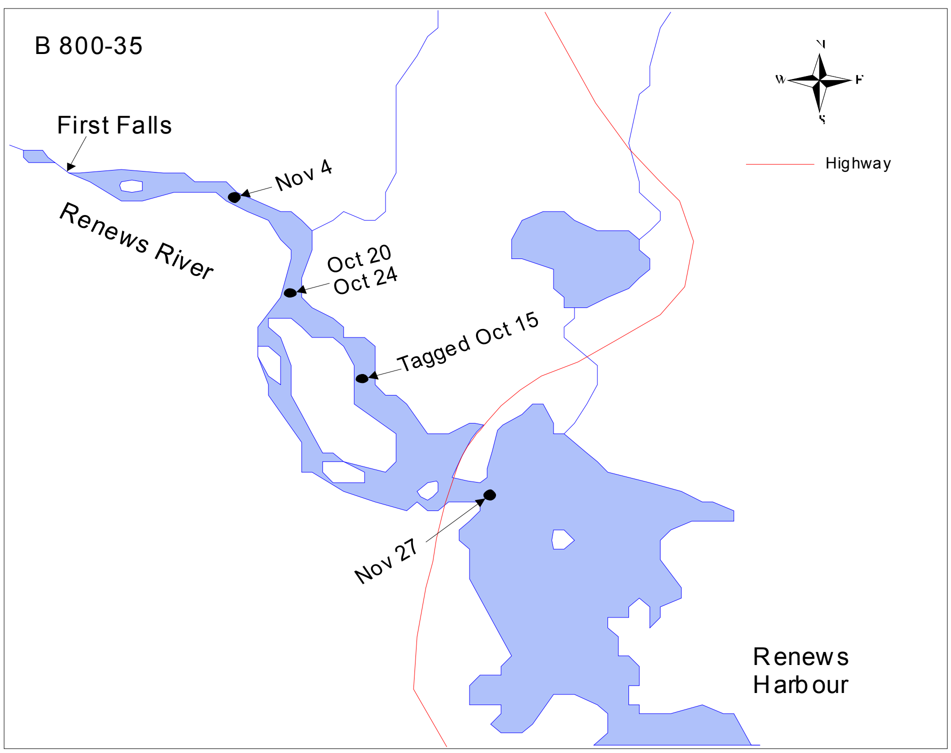
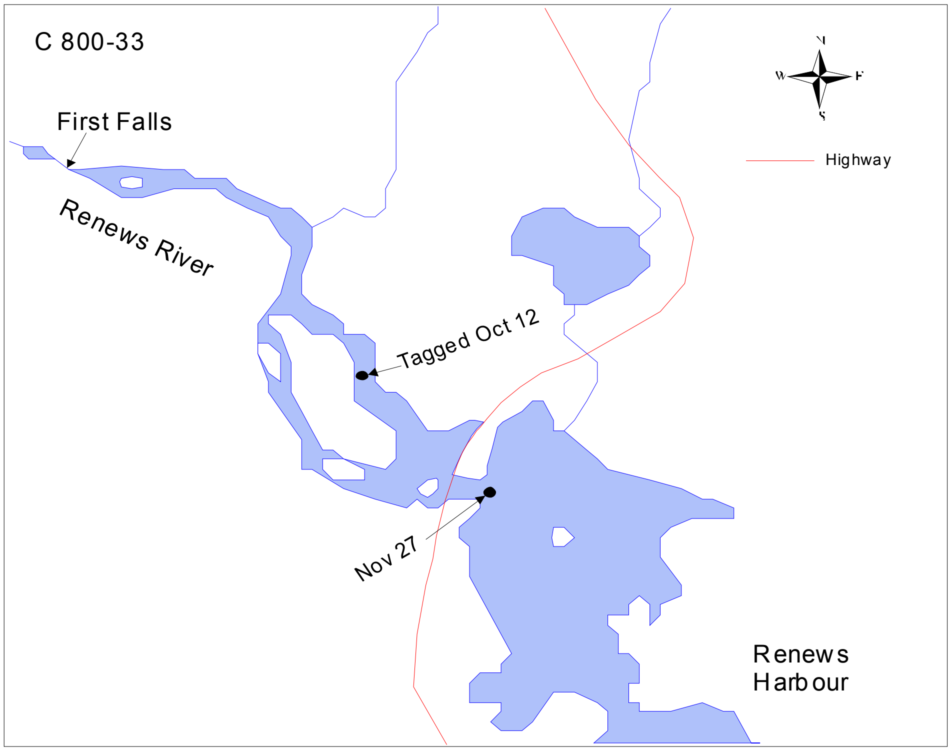


Figure 19 A and B. dates and locations where radio tagged fish were found. Numbers in the top left indicate radio frequency.



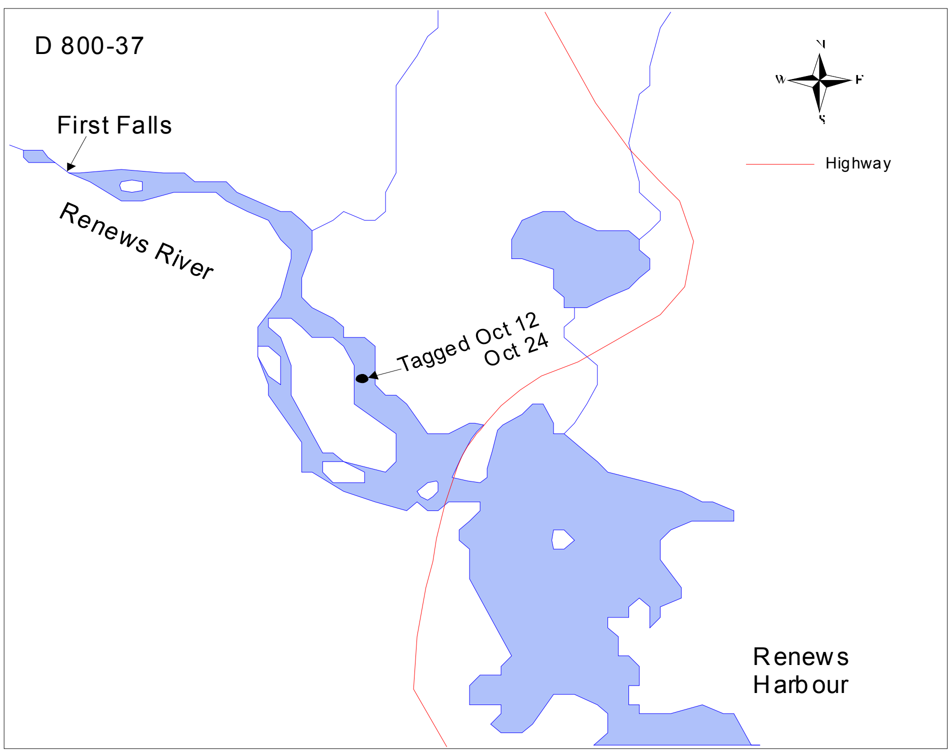
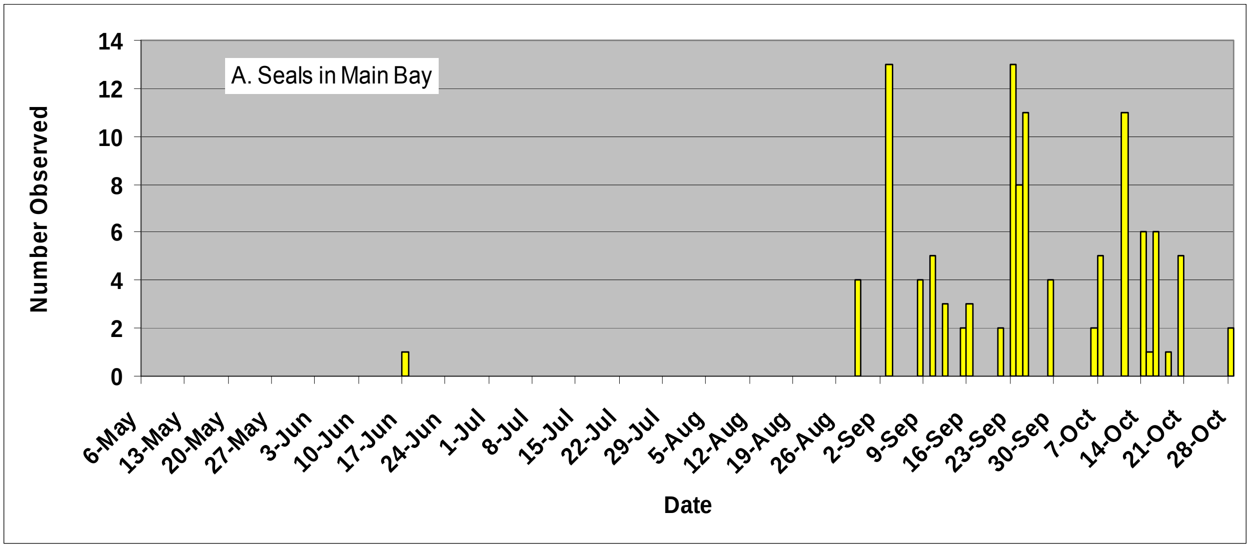
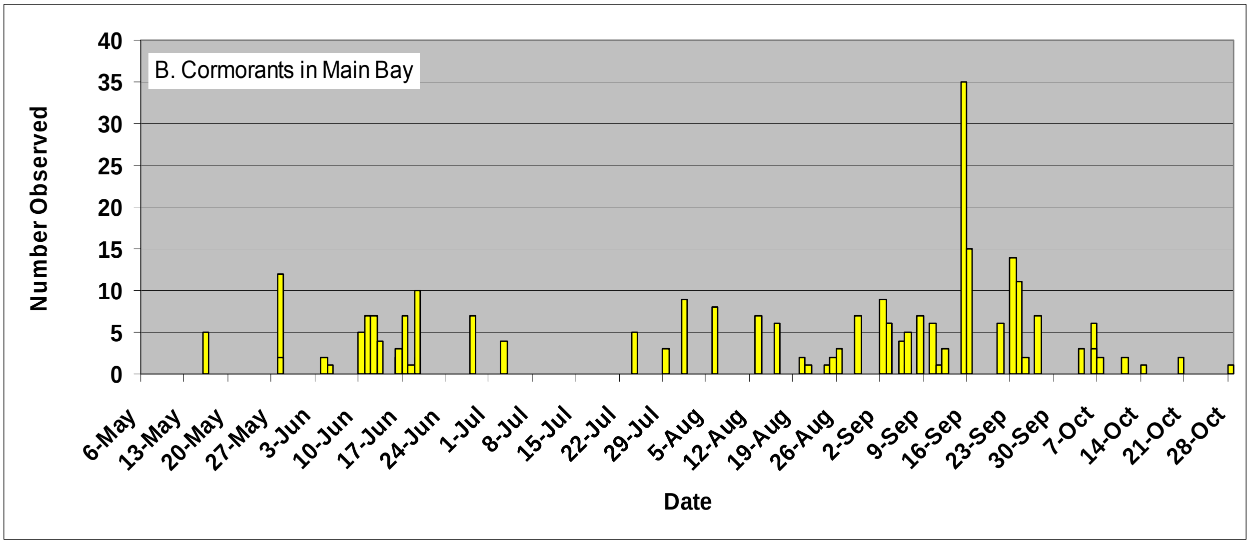


Figure 19 C and D. dates and locations where radio tagged fish were found. Numbers in the top left indicate radio frequency.


A. Seals in Main Bay
Number Observed
0
2
4
6
8
10
12
14
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
7-Oct
14-Oct
21-Oct
28-Oct
Date


B. Cormorants in Main Bay
Number Observed
0
5
10
15
20
25
30
35
40
6-May
13-May
20-May
27-May
3-Jun
10-Jun
17-Jun
24-Jun
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
7-Oct
14-Oct
21-Oct
28-Oct
Date

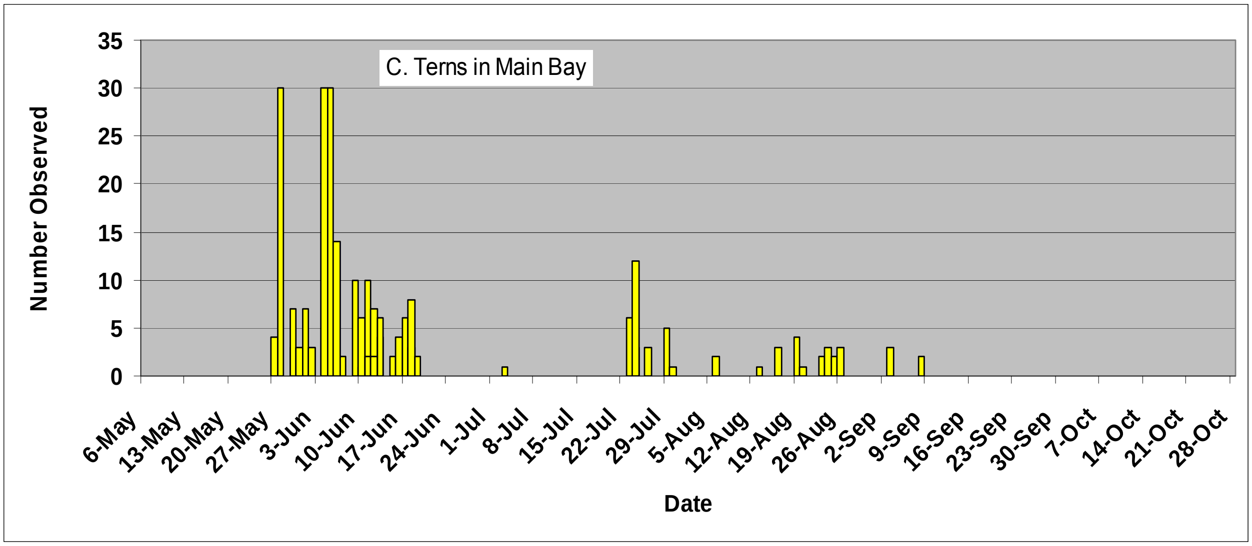


Figure 20. Date and number of predators observed in Renews.

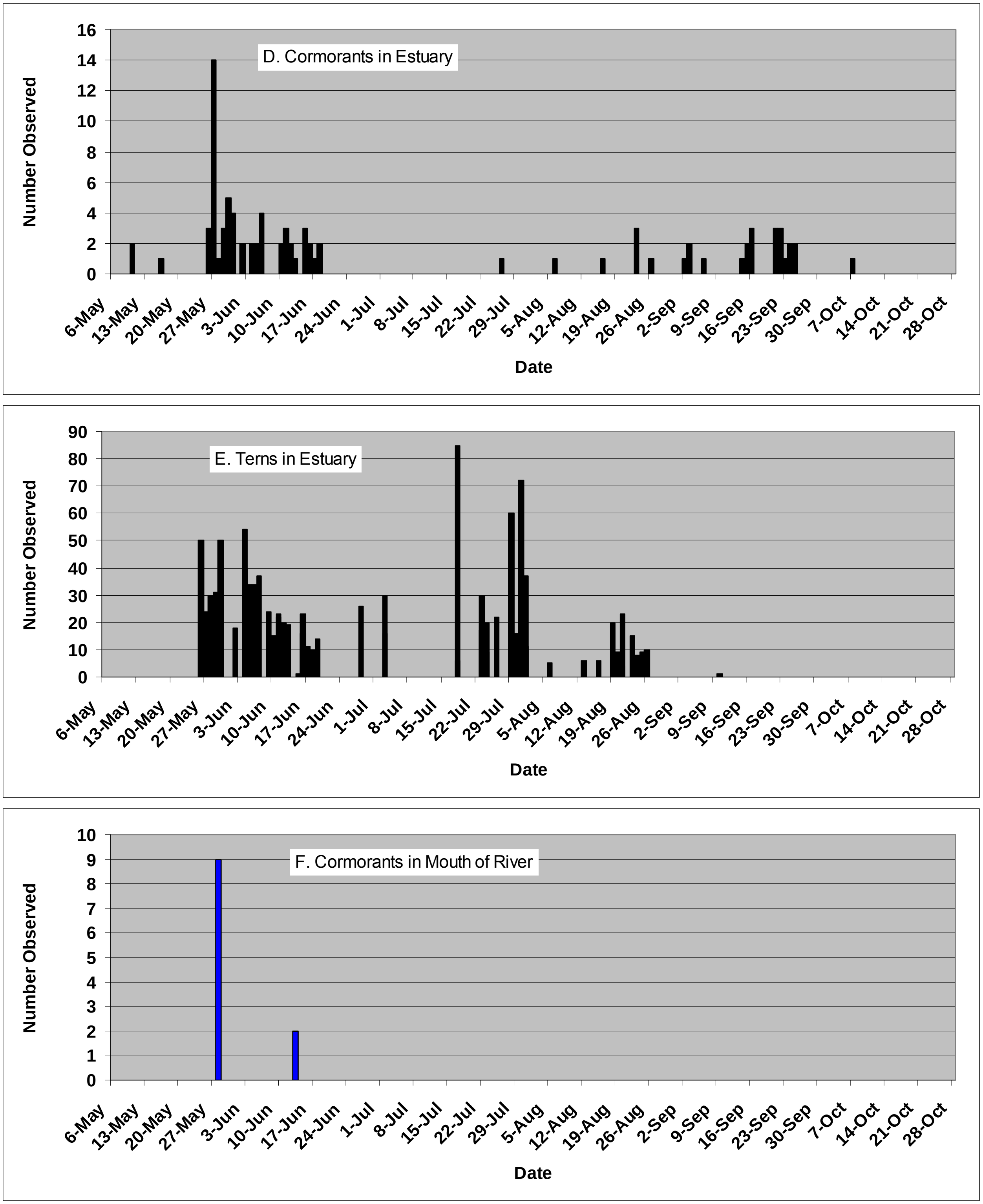


Figure 20 (Cont’d.).

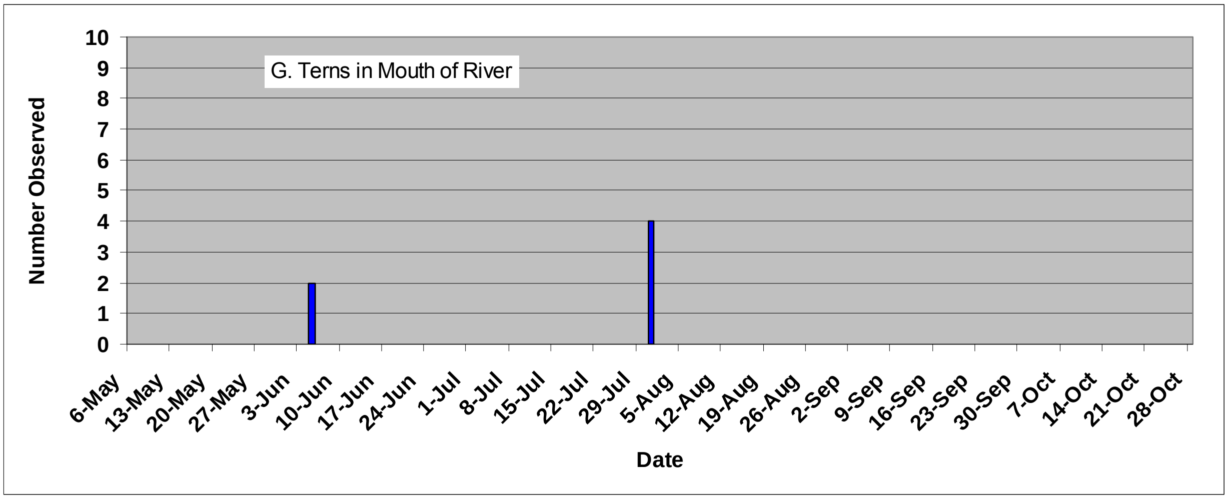


Figure 20 (Cont'd.).

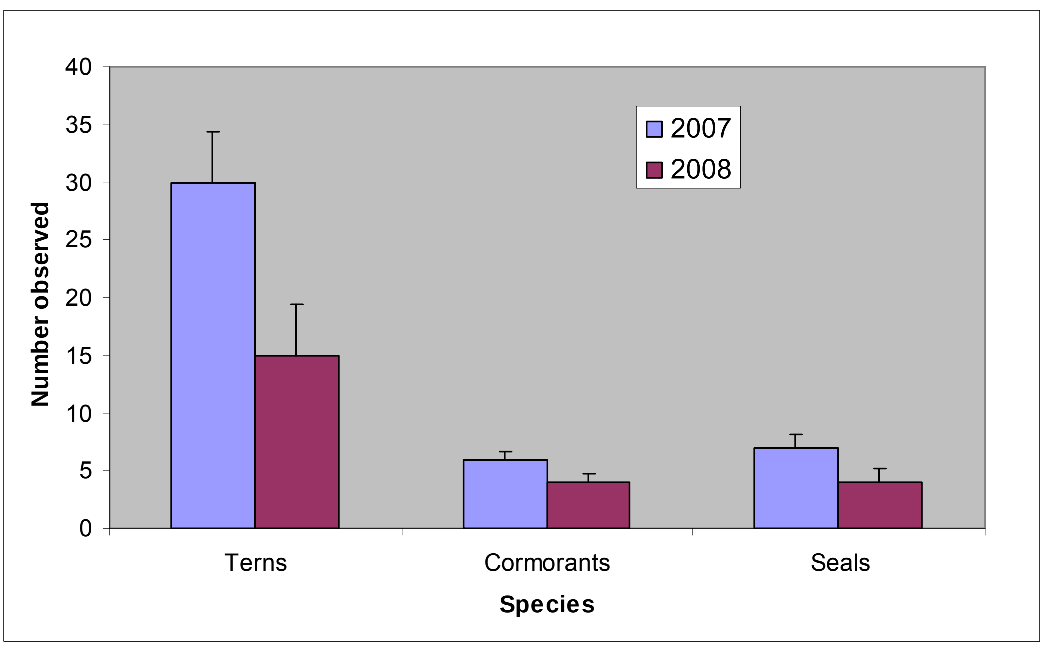


Figure 21. Average number of predator observations per observing session where predators were reported. Error bars represent one standard error.

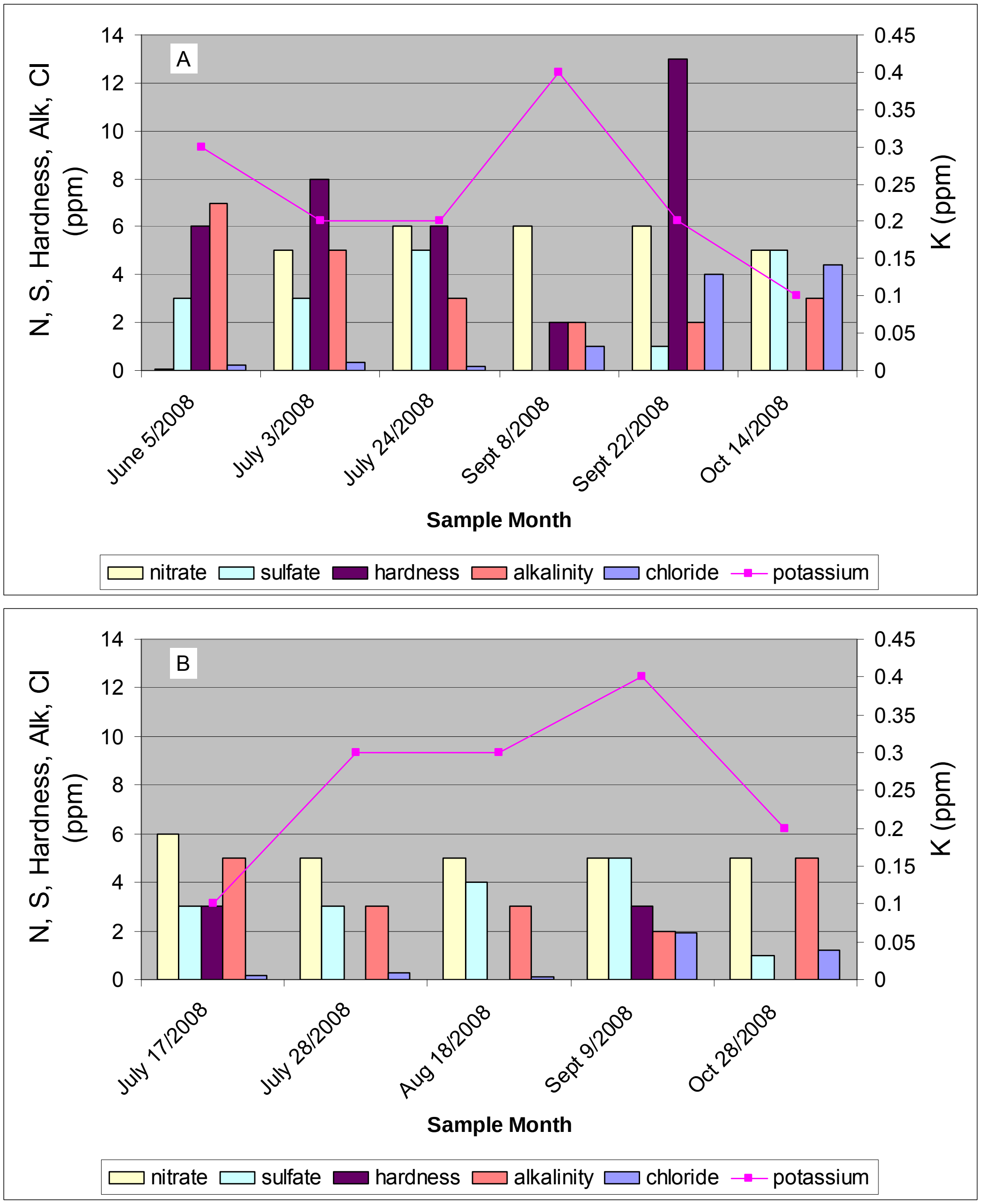


Figure 22 A and B. Water chemistry of Renews River.

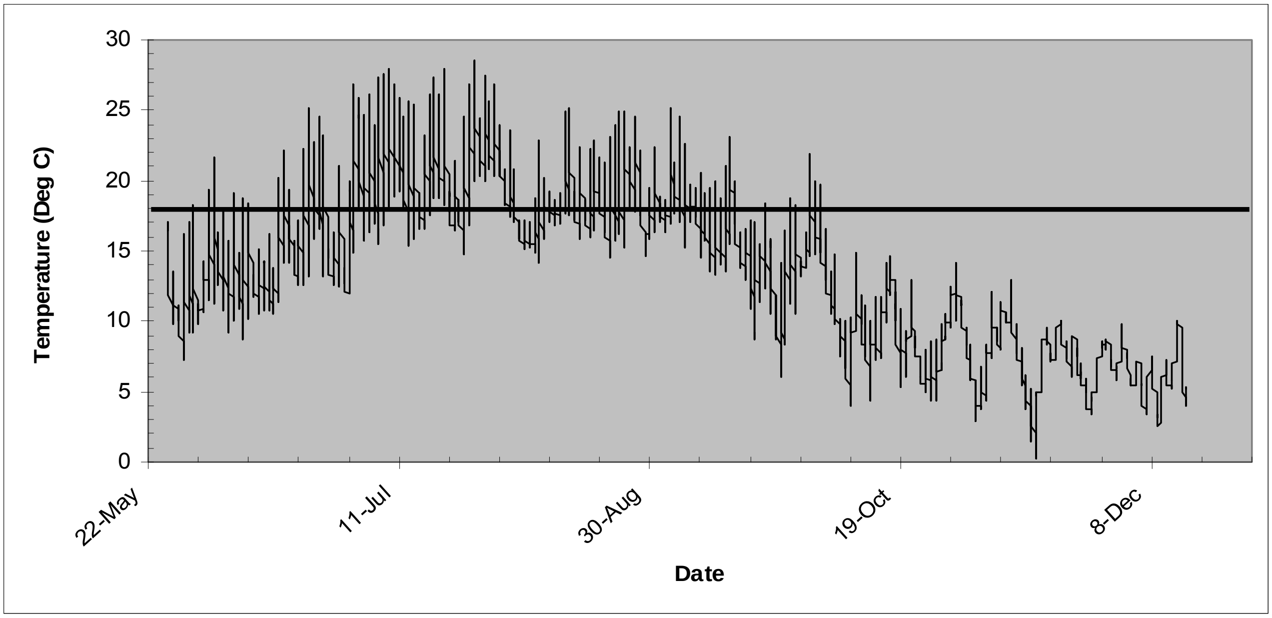


Figure 23. Temperature of Renews River water. Solid horizontal line represents 180C

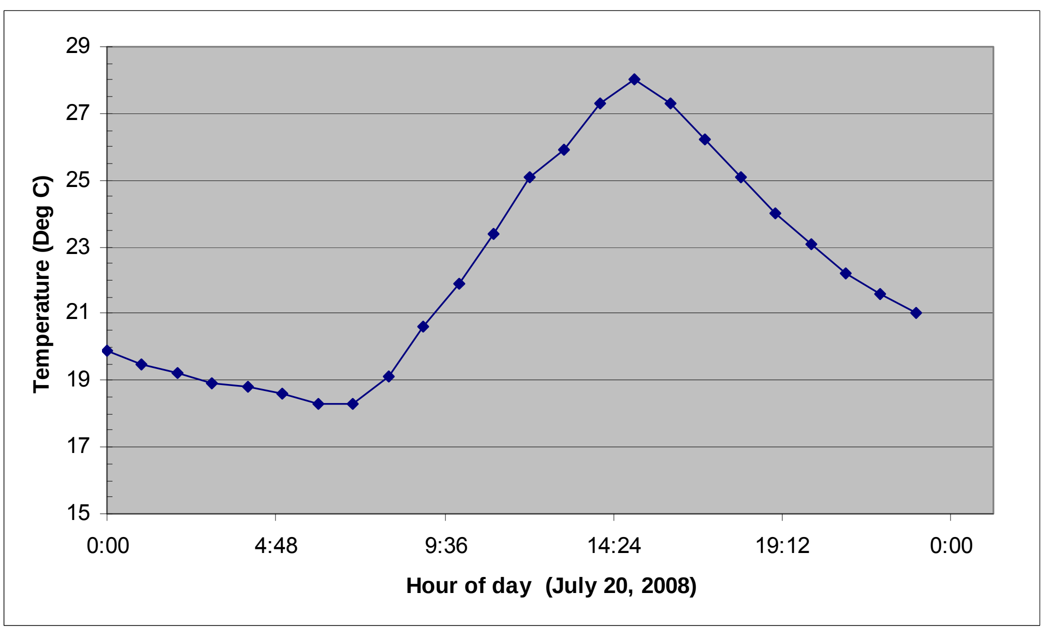


Figure 24. Hourly changes in water temperature for July 20, 2008.

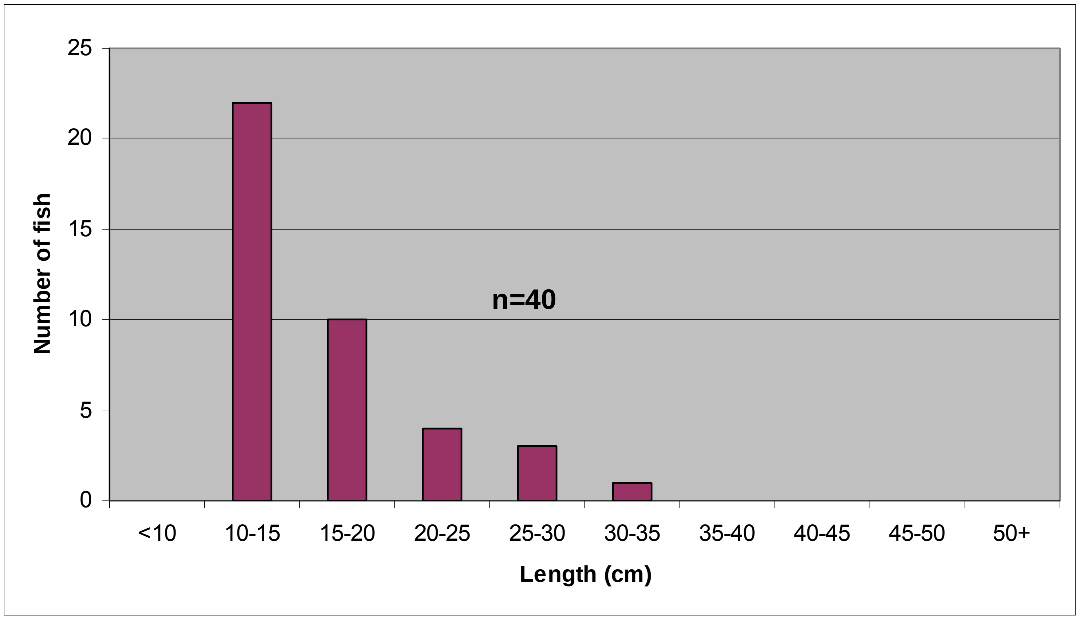


Figure 25. Length distribution of brown trout migrating out of Renews River in the spring.