The Migration of Atlantic Salmon (*Salmo salar*) Smolts from the Margaree River, Nova Scotia, 2004 to 2009

C. Breau, G. Chaput, and P. LeBlanc

Fisheries and Oceans Canada
Oceans and Science Branch
P.O. Box 5030
Moncton, NB
E1C 9B6

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Oceans and Science Branch
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ABSTRACT

Breau, C., Chaput, G., and LeBlanc, P. 2010. The migration of Atlantic salmon (*Salmo salar*) smolts from the Margaree River, Nova Scotia, 2004 to 2009.

This document presents the results of the Atlantic salmon (*Salmo salar*) smolt monitoring program conducted in Margaree River, Nova Scotia during 2004 to 2009. The main objective of the program was to estimate the freshwater smolt production from the river and to determine if the abundance of adult Atlantic salmon was being constrained by freshwater production. The report presents information on the timing of migration, the estimated population size, and the biological characteristics of the smolts. The population size was estimated using a mark-recapture experiment. The peak run timing of smolts coincided with the mean daily water temperature exceeding 10°C. More than 90% of the smolts captured were 2 year and 3 year old fish with more than 70 % of the smolts being females. The estimated population size of wild smolts leaving the river ranged from a low of 94,200 in 2005 to a high of 128,800 in 2008. Based on the estimated rearing habitat of 2.8 million m^2, smolt production varied from 2.3 to 4.6 smolts per 100 m^2. Relative survival rates of parr to smolts were in the order of 2.9% to 7.2%. The return rates of smolts to small salmon were lower (values of 0.2% to 1.6%) than the return rates to large salmon (1.9% to 6.2%). Freshwater production from the Margaree River is considered to be very good and the variations in adult returns to the Margaree River are primarily determined by variations in marine survival.

RÉSUMÉ

Nous présentons les résultats du programme de surveillance des saumonneaux de saumon atlantique (*Salmo salar*) exécuté dans la rivière Margaree, en Nouvelle-Écosse, de 2004 à 2009. Le principal objectif du programme était d'estimer la production de saumonneaux en rivière et d'établir si la production de saumonneaux en eau douce limitait l'abondance des saumons adultes. Nous présentons de l'information sur le moment de la migration, la taille estimative de la population et les caractéristiques biologiques des saumonneaux. Nous avons estimé la taille de la population des saumonneaux d'après les résultats d'une expérience de marquage-recapture. Le pic de la dévalaison des saumonneaux a coïncidé avec une température quotidienne moyenne de l'eau supérieure à 10°C. Plus de 90 % des saumonneaux capturés étaient des individus de 2 ans et de 3 ans; plus de 70 % étaient des femelles. La taille estimative de la population de saumonneaux sauvages quittant la rivière allait d'un creux de 94 200 en 2005 à un pic de 128 800 en 2008. D'après une superficie d'habitat de grossissement estimative de 2,8 millions m^2, la production de saumonneaux variait de 2,3 à 4,6 smolts par 100 m^2. Le taux de survie relatif des tacons jusqu'au stade de saumonneaux était de l'ordre de 2,9 % à 7,2 %. Le taux de retour des saumonneaux comme saumons de petite taille était plus faible (de 0,2 à 1,6 %) que le taux de retour comme saumons de grande taille (1,9 à 6,2 %). La production dans la rivière Margaree est considérée comme étant très bonne, les variations dans le niveau de survie en mer déterminant principalement le taux de retour des adultes dans la rivière Margaree.

INTRODUCTION

In response to declines in Atlantic salmon in eastern Canada and particularly in the Maritime provinces, commercial fisheries for Atlantic salmon (*Salmo salar*) were closed in 1984 and mandatory catch and release measures on large Atlantic salmon (>= 63 cm fork length) were introduced in the recreational fishery (DFO 1984). In subsequent years, juvenile densities in monitored rivers of the southern Gulf of St. Lawrence, including those of Gulf Nova Scotia, increased compared to densities observed in the 1970s (Breau et al. 2009; Cameron et al. 2009; Chaput et al. 2009). In the Margaree River, young-of-the-year densities doubled after 1984 (Breau et al. 2009); an indication that a greater number of adults ascended the river to spawn. Despite the increase and sustained high abundance of juveniles post-1984, the adult returns to the Margaree River fluctuated around 3,000 large salmon during 2000 to 2008. Conservation requirements have been met every year since 1985 (Breau et al. 2009).

There were concerns that the increased juvenile abundances observed in the Margaree River did not result in greater and more sustained adult returns compared to those of the mid 1980s. The lack of observed increase in adult returns despite the increased juvenile indices could be explained by a lack of increase in smolt production from increased abundance of juveniles, or lower marine survival in the past decade despite a higher production of smolts, or a combination of both. In the absence of information on the number of smolts migrating to the ocean, the cause(s) of the lack of increase in adult returns can not be readily explained. In freshwater, low winter survival of juveniles and high predation rate could contribute to low smolt production (Cunjak et al. 1998). In contrast, if smolt production was related to juvenile abundance, then the lower than expected abundance of adults would be due to low marine survival. Marine survival rates of Atlantic salmon in eastern Canada have declined since the mid 1990s (DFO 2003). Estimating smolt production from the Margaree River was an essential piece of information to determine if the freshwater environment (last stage in freshwater) was a limiting factor for salmon recruitment.

Typically, Atlantic salmon juveniles of Gulf Nova Scotia rivers become smolts after two or three years in freshwater but smolts as old as five years have been sampled from the Margaree River (Leblanc et al. 2005; Clément et al. 2007). Females comprised more than 70% of the migrating smolts (Clément et al. 2007). Most Atlantic salmon from the Margaree River spend two or more years at sea before returning to spawn (Breau et al. 2009). These salmon can undergo long oceanic migrations, as far as West Greenland, as observed by the recovery of tagged smolts and tagged bright salmon from Margaree River recovered along the Strait of Belle Isle, the northeast coast of Newfoundland and at West Greenland (Chaput et al. 1993; Breau et al. 2009).

The purpose of the smolt monitoring program was to characterize the Atlantic salmon smolt migration from the Margaree River (Clément et al. 2007) in order to address the questions of inter-stage survival rates of Atlantic salmon. This report presents the results of the monitoring program for 2004 to 2009 including the timing of migration, the biological characteristics of the fish, the estimated population size of smolts and the catches of all other fish species. Estimates of year class specific production are presented and approximate return rates of smolt to small salmon (one-sea-winter or 1SW) and large salmon (mostly two-sea-winter or 2SW) are provided.

MATERIALS AND METHODS

Study Area

The Margaree River (46°30'N, 61°10'W), located on the northwest coast of Cape Breton Island (Nova Scotia), is the largest river in Gulf Nova Scotia (Salmon Fishing Area 18) with a drainage area of 1,178 km^2 (Fig. 1). The Margaree River consists of two main branches that converge at Margaree Forks: the Southwest Branch originating from Lake Ainslie and the Northeast Branch from Cape Breton Highlands.

In total, thirteen fish species are known to inhabit the Margaree system (Clément et al. 2007). Of these, eight are diadromous fishes utilizing the Margaree River during part of their life cycle: Atlantic salmon, gaspereau (*Alosa pseudoharengus* and *Alosa aestivalis*), rainbow smelt (*Osmerus mordax*), American eel (*Anguilla rostrata*) and sea lamprey (*Petromyzon marinus*). American shad (*Alosa sapidissima*) and striped bass (*Morone saxatilis*) have been captured in the Margaree River but they do not spawn in the river (Chaput and Bradford 2003; Douglas et al. 2003). Atlantic salmon is the most common diadromous fish encountered throughout the Margaree River at juvenile, smolt and, second only to gaspereau, at the adult life stage.

Field Operations

A rotary screw trap (RST) (Chaput and Jones 2004) was installed approximately 600 m above the head of tide in a constricted section of the Margaree River (Fig. 1). The RST has a drum diameter of 1.82 m (Mill Construction Ltd., Ladysmith, BC) and was anchored in the river with an overhead cable (see Clément et al. 2007). Wings were attached to the RST to increase the capture efficiency of fish. When required, the RST could be moved vertically, horizontally and laterally.

Generally, visual checks were conducted in early evening to ensure that the RST was operating. The RST was fished usually once a day, early in the morning. All fish captured were identified to species and counted. Length measurements were obtained on most fish captured, depending on abundance. With the exception of Atlantic salmon and some special collections, all fish were released to the river at the RST location immediately after sampling. Mortalities were identified to species, counted, measured when possible and discarded.

Water level was recorded daily from a water level gauge installed approximately 150 m upstream of the RST. A temperature recorder (VEMCO Minilog©) was installed at the RST and recorded water temperature every half hour. Every day on arrival, air and water temperature, percent cloud cover and comments relating to weather were recorded. After fish sampling was completed and the RST cleaned of debris (when required), the speed of rotation of the RST was recorded by counting the number of rotations of the RST drum relative to a fixed time interval (usually one minute).

Special collections for eel research were completed in 2004 to 2007. These animals were sacrificed for the determination of sex and extraction of otoliths for age determination.

Atlantic salmon sampling procedures

A smolt was identified based on several characteristics: a silver body colouration with black edges on the fins, a fork length of at least 10.5 cm and parr marks weakly to not visible. Smolts

of hatchery origin were also caught at the RST both as hatchery smolts released in the previous fall as age 0 or older parr and as one-year old smolts released in the spring. Hatchery-origin salmon were identified based on an adipose-fin clip, having been marked before release. In the spring, the physical appearance of smolts released as fall parr was similar to wild smolts except that the adipose fin was clipped. One year old hatchery smolts released in the spring were distinguished from hatchery smolts produced from fall fingerling stocking by a strong yellow/green body colouration and important fin erosion caused by rearing fish in tanks. Fork length and opportunistic sampling of scales of hatchery smolts were obtained.

Sampling and tagging for wild smolts

Fork length was recorded for up to 60 wild smolts each day (except 2004 with a maximum of 30 fish). Every fifth smolt (maximum of 10 per day; maximum of 6 per day in 2004) was sacrificed for detailed sampling including fork length (0.1 cm), weight (0.1 g), sex determination and scales for age determination.

Tagging procedures

Wild smolts (up to a target number of 100 per day) were tagged with individually numbered clear polyethylene streamer tags (size 13P, Hallprint©) inserted anterior and below the dorsal fin. Batches of up to 25 tagged fish were placed in plastic pails (20L) with lids (with water circulation holes in the lids and around the upper portion of the pail) and placed in the river awaiting completion of the RST sampling. Tagged smolts were transported in the pails 5.3 km upstream by truck and released at Doyle's Bridge in the Northeast Margaree River (a trip which took approximately ten minutes from the time leaving the RST to being released at Doyle's Bridge) (Fig. 1). At the release site, smolts were checked for condition, dead or very weak tagged smolts were removed and others were released. Additional tagging was conducted in 2008 and 2009 in support of the marine research program in the Labrador Sea. These smolts were tagged and released directly at the RST location.

Other wild smolts

All captured smolts were examined for the presence of tags or tagging scars, counted and released at the RST. Scars on the anterior dorsal fin indicated tag loss. Recaptured smolts had the tag number recorded before release at the RST.

Estimation of smolt run size

Run size of smolts was determined by mark and recapture experiments. Mark and recapture data were analyzed using an aggregated Bayesian model assuming a binomial distribution for the catches (Gazey and Staley 1986). A survival rate of 90% for tagged smolts to recapture was assumed. Tag loss was identified by the presence of a tagging scar.

Changes in RST capture efficiencies for smolts would be expected based on factors such as changes in water level, water temperature and run timing. Possible variation in recapture efficiencies were examined by plotting the proportion of a tag group recaptured over time and relating this to variations in water temperature or relative water level. Where variations in RST capture efficiency were suspected, a stratified population estimation model (Darroch Model; Arnason et al. 1996) was used as well as the aggregated model.

RESULTS

Operating conditions of the RST during 2004 to 2009 are summarized in Table 1. The RST was usually operational from early May until the third week of June. Each year, the RST jammed due to the accumulation of debris but the number of days varied annually from 2 to 14 (Table 1). The length of time during which the RST was not turning on any given day is uncertain as the obstruction could have occurred anytime during the night. The RST operated between 80% and 95% of the nights over the five years. Water levels were generally higher in May than in June with occasional high water events (Figs. 2 to 7). Mean daily water temperature varied between 4.5 and 19.2°C over the five years, becoming progressively warmer from May into June (Table 1). The first day when water temperature >= 10°C was as early as May 4 in 2005 and as late as June 2 in 2004 (Table 1).

Run timing of wild smolts

In all years, wild smolts were captured the first night that the RST operated but the number caught was small (< 61 smolts; 123 smolts in 2006) compared to the total caught over the season (Table 2). The date of median catch (when 50% of the smolts for the year were captured; excludes the recaptures) varied from as early as May 19 in 2006 to as late as June 13 in 2004 (Table 2). In all years, 90% of the smolt catches occurred over 20 to 21 days (Tables 3 to 8).

Except for 2004 and 2006, smolt migration followed the “usual” pattern of run timing; migration beginning in early May, peaking in late May to early June and finished by mid June. The catches peaked when mean daily water temperatures exceeded 10°C. In 2004, mean water temperature remained cool until June (>= 10°C on June 2) resulting in a delayed migration (Fig. 2). In 2006, warmer water temperatures, exceeding 10°C, were experienced in early May leading to the earliest run timing within monitored years (Fig. 4). Increases in water level were not associated with large smolt catches (Figs. 2 to 7).

The number of smolt mortalities at the RST were higher than anticipated, ranging from 402 in 2009 to 781 in 2006 (Tables 3 to 8). Relative to the total catch, mortalities consisted of less than 6% (Tables 3 to 8) and were most important with large daily catches.

Estimates of population size of wild smolts

The number of smolts tagged and released upstream at Doyle’s Bridge ranged from a low of 1,413 smolts in 2005 to a high of 1,943 smolts in 2004 (Tables 3 to 8; Appendices 1 to 6). The time until recapture of tagged smolts released varied within and among years (Tables 9 to 19). The longest time interval from release to recapture was 17 days but most (> 80%) were recaptured within three to four days post-release. Downstream movements of tagged smolts were most rapid in 2007 (days to recapture varying from 1 to 6 days) with almost 50% of the smolts recaptured after one day post-release (Table 15). Days to recapture were usually longer at the start of the season (in May) than in June especially in 2004 and 2006 when tagged smolts stayed longer upstream. Of the total smolts tagged and released, the percent recaptured varied by year and ranged from 7.9% (2009) to 15.3% (2006). One to five smolts with tagging scars were observed each year (Tables 3 to 8). The proportion of a tagged group recaptured varied

within season and generally increased as water levels declined and water temperature increased. The total smolt run estimates ranged from a low of 63,200 smolts in 2002 to a high of 128,800 smolts in 2008 (Fig. 8).

2004

Of the 1,943 tagged smolts released upstream, 182 fish were recaptured at the RST (Table 9; Appendix 1). The percent recaptured by tagging group varied from 6.3 to 8.7% in May and increased to 9.8 to 21.4% during June. More than 70% of the smolts were recovered within three days of marking and 4% of the released smolts took 10 to 17 days before being recaptured in the RST (Table 9). Based on the mark-recapture data, both the stratified and aggregated models gave similar estimates of the population size. The stratified model gave an estimate of 105,764 fish (95 % C.I. 90,140 to 121,388) and the Bayesian model gave an estimate of 108,650 fish (95 % C.I. 94,650 to 126,500) (Table 10; Fig. 9). Capture efficiency did not vary during the season which is why the two models gave similar results.

2005

A total of 1,413 tagged smolts were released in 2005 and 157 of these were recaptured at the RST (Table 11; Appendix 2). The percent recaptured by tagging group was 4.8% to 17.2% in May and remained at approximately 13% in June. More than 80% of the tagged smolts were recovered at the RST within three days and 3% remained upstream 10 to 13 days before being recaptured at the RST (Table 11). The estimated population size was 94,224 fish (95 % C.I. 79,775 to 108,673) with the stratified model and 94,700 fish (95 % C.I. 81,800 to 111,800) with the Bayesian model (Table 12; Fig. 9). Both models gave similar estimates because capture efficiency varied little during the peak period of the run.

2006

During 2006, 207 of the 1,515 tagged smolts were recaptured (Table 13; Appendix 3). The percent of the tagging group recaptured varied between 11.9% and 14.9% during the season. More than 80% of the tagged smolts were recovered at the RST within three days and 4% took between 8 and 14 days before being recovered at the RST (Table 13). The two models gave similar estimates of the number of smolts migrating from the Margaree River. The estimate was 113,741 fish (95 % C.I. 99,138 to 128,345) with the stratified models and 114,800 fish (95 % C.I. 100,400 to 131,900) with the Bayesian model (Table 14; Fig. 9).

2007

A total of 1,498 smolts were tagged and 121 of these were recaptured in the RST (Table 15; Appendix 4). The percent of the tagging group recaptured was higher in May than in June (Table 15). Capture efficiency was lower in early May because of the high water level. More than 90% of the smolts released were recaptured at the RST within three days and all of the recaptures were caught in the RST within six days (Table 15). Based on the mark-recapture data, the estimated population size was 112,385 fish (C.I. 91,555 to 133,215) with the stratified model and 107,300 fish (C.I. 91,100 to 130,100) with the Bayesian model (Table 16; Fig. 9). The stratified model gave a slightly higher estimate because the model took into account the variation in capture efficiency over the sampling period.

2008

A total of 1,759 smolts were tagged and 178 of these recaptured at the RST (Table 17; Appendix 5). As in 2007, the percent recaptured by tagging group was higher in May than in June (Table 17). More than 80% of the tagged smolts released at Doyle's Bridge were recovered at the RST within three days and less than 1% took over ten days to migrate downstream to the RST (Table 17). The stratified model gave a larger estimate of smolt run size than the Bayesian model for this year. The stratified model gave an estimation of 128,400 fish (C.I. 101,249 to 156,431) and the Bayesian estimation was 97,300 fish (C.I. 84,700 to 113,500) (Table 18; Fig. 9). Capture efficiencies, as estimated by the stratified Darroch model, decreased by half over the season.

2009

A total of 1,836 smolts were tagged and 146 of these recaptured at the RST (Table 19; Appendix 6). The percent recaptured by tagging group was 6.6% to 9.6% early in the season and remained at approximately 6.5% later in the season. More than 80% of the tagged smolts released at Doyle's Bridge were recovered at the RST within three days and less than 2% took more than six days to migrate downstream (Table 19). The stratified model gave a slightly larger estimate of smolt run size than the Bayesian model for this year. The stratified model gave an estimation of 96,754 fish (C.I. 76,286 to 117,222) and the Bayesian estimation of was 86,100 fish (C.I. 74,100 to 102,300) (Table 20; Fig. 9).

Biological characteristics of wild smolts

The modal lengths varied between 12.5 cm and 13.0 cm for all years (Fig. 10). The maximum fork length varied between 26 cm and 27.7 cm in all years except a smolt measuring 30.5 cm was captured in 2005.

The average daily fork length fluctuated between 11.8 cm and 15.5 cm with larger smolts migrating during the latter part of the season (Fig. 11); a phenomenon that was less pronounced in 2004. For example, in 2005, average daily fork length exceeded 14 cm from June 11 onward compared to the daily averages being below 13 cm earlier in the season.

Females comprised 70% to 77% of the smolt run (annual sample size of 168 to 380) in any given year (Table 21). Age 2 and age 3 smolts were the predominant age groups composing over 90% of the smolt run in all years (Table 21). Age 4 and age 5 smolts were present but in fewer numbers. In 2006, one 1 year old smolt was caught and likely was of hatchery origin. The average fork lengths of females (12.9 cm to 13.5 cm) were similar to the fork length of males (12.6 cm to 13.7 cm).

Within years, weight to length relationship was similar between males and females (Fig. 12). For instance, in 2004, a 12 cm smolt weighed 16.4 g irrespective of sex. However, length to weight relationships varied between years such that a 12 cm smolt weighed 16.4 g in 2004, 17.3 g in 2005, 16.9 g in 2006, 17.2 g in 2007, 17.0 g in 2008 and 16.8 g in 2009.

Relative inter-stage survival

Mean densities of juvenile Atlantic salmon at index sites in the Margaree River have been estimated based on sampling from 5 to 13 sites annually since 1957 (Breau et al. 2009). The mean densities do not represent the abundance over the entire river but are specific to the sites sampled. Therefore, relative survival rates from fry (age 0 year) to parr (age 1+ year) and from parr to smolts are presented. The juvenile habitat rearing area of the Margaree is estimated at 2.8 million m² (Chaput et al. 1993).

Relative survival rates of fry to the parr stage ranged from 47% to 215% (Table 22). Relative survival rates of parr to the smolt stage were lower and variable with 3% to 7% of the parr attaining the smolt stage. Mean production of smolts ranged from 2.3 to 4.6 smolts per 100 m² (Table 22).

Adult return estimates to the Margaree are available in Breau et al. (2009). Based on the smolt estimates, return rates of smolts to small salmon ranged between 0.2% and 1.6% whereas return rates to large salmon varied between 1.9 and 6.2% (Table 22).

Hatchery-origin smolts

In the Margaree River, the fish culture station released annually approximately 44,000 to 92,000 adipose-fin clipped (and unclipped in 2008 and 2009) fall fingerlings and 13,000 to 61,000 one year old smolts in the spring (DFO unpubl. data). During 2004 to 2009, the highest catches in the RST were of 1 year spring smolt released, with more than 2,000 captured annually, compared to hatchery-origin smolts from fall fingerling stocking (Table 23; Fig. 13). In 2008, only 534 one year spring released smolts were caught. The low number of captures was explained by the fact that the fish were released after the RST sampling was completed (Shawn Neary, personal communication). Peak catch of 1 year spring smolts was within a few days of release (Fig. 13). The daily catch of hatchery origin smolts from fall fingerling stocking followed a similar pattern to the daily catch of wild smolts.

The average fork length of spring-released hatchery smolts captured in the RST varied between 12.7 cm and 14.6 cm (range: 9.4 cm to 17.1cm) during 2004 to 2009. Hatchery smolts released as fall parr were on average smaller with fork lengths of 12.5 cm to 13.3 cm (range: 9.6 cm to 19.3 cm) during 2004 to 2009, and comparable to wild smolt length frequencies.

Other salmon life stages

Wild and hatchery-reared Atlantic salmon parr were captured in the RST. Parr were captured in the RST throughout the monitoring period without any distinct peak of capture (Table 23; Fig. 14). The exception was 2006 when hundreds of parr were captured in early May. In any given year, the number of hatchery-reared parr sampled at the RST was less than 50 fish (Table 23).

Other fishes

In addition to the Atlantic salmon, 15 other fish species were captured in the RST during the spring monitoring period of 2004 to 2009 (Table 23). All years combined, the fishes that were most frequently captured during the study period, after salmon, were stickleback (*Gasterosteus*

spp.), American eel (*Anguilla rostrata*), rainbow smelt (*Osmerus mordax*) and gaspereau (*Alosa pseudoharengus* and *Alosa aestivalis*) (Figs. 15 to 18). Atlantic salmon (all life stages) was the most abundant catch comprising 66% to 84% of the total first catch. The banded killifish and the Atlantic silverside, two native species, were occasionally caught in the RST. Rainbow smelt were an infrequent part of the catch in most years except for 2006 (Table 23). Stickleback and gaspereau were mainly captured at the end of May and in June (Figs. 15 and 16); except in 2006 when sticklebacks were caught throughout the season. White suckers (*Catostomus commersonii*) were captured throughout the season but in low numbers (Fig. 17). Annual catches of eels were less than 300 fish (Fig. 18). In 2004, 2005 and 2007, eels were predominantly caught in June. In the other years, similar numbers were caught throughout the sampling period. The other fish species captured in the RST consisted of less than 100 fish annually with the exception of 138 brook trout caught in 2006 (Table 23). Except for brown trout, a non-native species, all other fishes captured were native to the Margaree River system. Other organisms captured included frogs, toads, mice, muskrats and occasionally beavers and ducks.

DISCUSSION

In response to the management plan established in 1984, abundances of juvenile Atlantic salmon at index sites in the Margaree River more than doubled in subsequent years (Breau et al. 2009) due to the increased deposition of eggs in the river. However, as for other rivers in eastern Canada, the adult returns to Margaree River have not followed the same increasing trend. Smolt monitoring in other rivers of eastern Canada indicated that freshwater production was high and marine survival low (DFO 2001). Low marine survival of the smolts from the Margaree River was speculated and this hypothesis required validation. The monitoring program in the Margaree provided the information required to address competing hypotheses of constraints to adult Atlantic salmon abundance, due to low freshwater production or low marine survival. Bottleneck effects such as winter mortality (Cunjak et al. 1998) or elevated temperature stress (Breau et al. 2007) could reduce growth and survival of juvenile salmon. As a result, fewer smolts could be migrating to the marine environment. High abundance of smolts migrating from the river and good fish condition would suggest that the marine environment was controlling the abundance of adults.

The increase in water temperature during spring is a known factor initiating smolt migration (Jonsson 1991; McCormick et al. 1998). Typically, peak catches of smolts in Margaree River coincided with the period when the mean daily water temperature exceeded 10°C and in given years, peak catches occurred when the temperature reached 12°C. Generally, mean daily water temperature reached 10°C to 12°C during late May and early June. However, in warmer or cooler years, smolt migration displayed a similar trend to the temperature regime. In 2004, mean daily water temperature reached 10°C later in June corresponding to a later run timing. In 2006, the smolt run began in early May corresponding to warm water early in the season. A similar association between peak catches and water temperature was observed in the Margaree River during 2001 to 2003 (Clément et al. 2007). In Miramichi River, peak catches occur earlier in May and correspond to mean daily water temperature reaching 15°C (Chaput et al. 2002).

Run timing of smolt in Margaree River occurred two weeks later compared to the more northern rivers in New Brunswick and Québec and earlier than the rivers in Newfoundland. Date of peak catches in Margaree varied by 26 days during the six years which is similar to some rivers in Newfoundland (Dempson et al. 1998). Another difference between the rivers was the variation in the date of peak catch. The date of the median catch of smolts occurred in late May to early

June; a date that resembled other southern rivers (e.g. Big Salmon River, Jessop 1975). In more northern rivers, such as the Miramichi River and the Restigouche River, the median catch occurred at earlier dates in mid-May (Chaput et al. 2002; Chaput et al. 2004).

Increases in water flow have been associated with higher numbers of smolts moving downstream (e.g. Hesthagen and Gärnäs 1986). In rivers of the southern Gulf of St. Lawrence, the relationship rarely exists. In Margaree River, peak catches did not increase with increases in water level, with perhaps one exception during 2007. In 2007, peak catches increased with increased water level but the mean daily water temperature was also in excess of 10°C. Similarly, no consistent correlation is present between peak catches and water level in the Miramichi River and the Restigouche River (e.g. Chaput et al. 2002; Chaput et al. 2004).

In all years monitored, 95% of the smolt migration occurred over a period of 20 days irrespective of whether the run was early, normal or late. More than 70% of the recycled smolts migrated the 5.3 km downstream stretch from Doyle's Bridge (release site for tagged smolt) to the RST within three days. Generally, migration time from the release site to the RST was faster after peak migration than earlier in the season. In May, a proportion of tagged smolts took between 10 and 17 days before being recaptured in the RST. The faster downstream movement in the later part of the season may have been motivated by physiology, presumably corresponding to the physiological "window" that guide smolt migration to the sea (McCormick et al. 1998).

Capture efficiency at the RST varied somewhat annually and the high efficiencies provided very informative data to estimate reliably the smolt production. Population estimates for 2004 to 2009 varied between 94,200 and 128,800 smolts with 95% confidence that at least 75,000 smolts migrated out of the Margaree River in any year. Based on a juvenile rearing habitat of 2.8 million m^2 (Marshall 1982), the smolt production estimates correspond to 3.3 to 4.6 smolts per 100 m^2. Comparatively, the smolt estimates for the Restigouche and the Kedwick River varied between 1.9 to 3.8 smolts per unit of habitat during 1999 to 2008 (Cameron et al. 2009). In the Miramichi River, the smolt estimate per unit habitat has been lower than expected with values between 1.3 and 3.3 smolts per 100 m² (Chaput et al. 2010).

The modal length of smolt on Margaree River was similar between years with sizes ranging between 12.5 and 13.0 cm. Sizes of smolt in the Margaree River were comparable to smolts on the Miramichi River and Restigouche River in New Brunswick (Chaput et al. 2002; Chaput et al. 2004). The daily average smolt size increased later in the season, an observation made in other systems such as the Miramichi River (Chaput et al. 2002). There was a small proportion of 5 year old smolts in the Margaree River. As well, some salmon juveniles migrate and reside in Lake Ainslie (Southwest Margaree branch) and these fish migrate at very large fork lengths, exceeding 25 cm.

Every year, females were more abundant than males; results consistent with 2002 to 2003 (Clément et al. 2007). Females comprised more than 70% of the smolt run in any given year which is typical for multi-sea-winter rivers found in the Maritimes (e.g. Gulf Nova Scotia) (Chaput et al. 2002; Caron et al. 2002).

Overall, transition rates between life stages were highly variable decreasing from juveniles to smolts and to the adult stage. Relative survival rates of fry to parr ranged between 47% and 215% during 2002 to 2009. During 2003 and 2009, there were early spring high discharge events (March and April) that could explain the lower fry density during those years. Possibly,

immigration of parr into the sites in 2003 could have led to the high survival rate observed that year. The relative survival rate of parr to the smolt stage was lower varying between 3% and 7%. There was no relation between parr density in a given fall and smolt estimate the following spring. Parr densities were >= 45 fish per 100 m^2. The absence of a relationship could be explained by density-dependent mechanisms (Elliott 2001). At lower parr densities, smolt production would be expected to increase with increasing parr abundance.

Return rates of large salmon ranged from 2.4% to 6.2% whereas return rates were 0.3% to 0.8% for small salmon. Higher returns of large salmon are expected because the Margaree River is largely dominated by 2SW salmon. In the Restigouche River, 50 smolts were estimated to be produced per one large salmon (Cameron et al. 2009). Even if the smolt production per unit area is lower than for the Margaree River, the number of smolts produced per large salmon is comparable with one large salmon producing 31 to 46 smolts in the Margaree River. More smolts emigrating from the river did not coincide with more adults returning over the following years suggesting that low marine survival plays a key role in determining the adult returns to the Margaree River.

In conclusion, there was a good freshwater production of juvenile Atlantic salmon in the Margaree River and the variations in adult returns to the Margaree River are determined by variations in marine survival. In total, 16 fish species were captured in the wheel in the Margaree River during spring 2004 to 2009. The additional years of sampling after 2003 (Clément et al. 2007; 13 species captured) led to the occasional capture of banded killifish and Atlantic silverside. The American shad and the striped bass, native fish in the Margaree system, were not captured in the RST. Except for brown trout, a non-native species, all other fishes captured were native to the Margaree system.

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Table 1. Summary of field operations of the rotary screw trap (RST) set on the Margaree River during 2004 to 2009.

	Year					
	2004	2005	2006	2007	2008	2009
RST set date	May 12	May 4	May 3*	May 2	May 7	May 10
RST finish date	June 23	June 21	June 16	June 20	June 20	June 12
Number of days RST not fishing or jammed	5	6	10	14	2	3
Wheel operating range – RPM	7.0 to 11.5	7.0 to 10.75	7.75 to 11.0	7.25 to 11.5	7.25 to 12.25	6.25 to 11.5
Water level range (m)	1.18 to 3.10	0.78 to 2.54	0.10 to 2.00	1.00 to 3.30	0.72 to 2.72	1.64 to 3.20
Mean daily water temperature range (°C)	6.4 to 14.9	4.8 to 16.2	10.6 to 16.5	4.5 to 18.8	6.1 to 19.2	7.9 to 15.5
First day when mean temperature >= 10°C	June 2	May 4	May 7	May 26	May 7	May 14

* Mean daily water temperature already exceeding 10˚C when the RST was set.

Table 2. Run timing of wild smolts in Margaree River during 2004 to 2009.

	2004	2005	2006	2007	2008	2009
Catch of wild smolts on first day of operation	1	7	123	3	61	34
Date of first capture	May 13	May 5	May 4	May 3	May 8	May 10
Date of 5th percentile of catch	May 25	May 16	May 8	May 20	May 16	May 13
Date of median catch	June 13	June 2	May 19	June 1	May 29	May 25
Date of 95th percentile of catch	June 19	June 15	June 1	June 14	June 13	June 6
Date of last catch	June 23	June 21	June 16	June 20	June 20	June 12

Table 3. Daily catch and fate of wild Atlantic salmon smolts at the rotary screw trap in Margaree River during 2004. Total catch refers to first time catch of smolts (excludes recaptures).

Month	Day	Total Catch	Released		Mortalities			Recaptures		Wheel condition
			Untagged	Tagged	Sacrificed	Holding box	After Tagging	Live	Mortalities	
May	12									Wheel set
	13	1	1	0	0	0	0	0	0	Not turning
	14	9	9	0	0	0	0	0	0	Turning
	15	3	3	0	0	0	0	0	0	Turning
	16	6	5	0	1	0	0	0	0	Turning
	17	50	40	0	8	2	0	0	0	Turning
	18	13	11	0	2	0	0	0	0	Turning
	19	30	5	20	4	1	0	0	0	Turning
	20	34	8	20	6	0	0	0	0	Not turning in PM
	21	13	11	0	0	2	0	0	0	Turning
	22	29	0	25	4	0	0	0	0	Turning
	23	70	33	31	6	0	0	1	0	Turning
	24	97	30	61	6	0	0	5	0	Turning
	25	78	29	23	6	2	18	4	0	Turning
	26	217	110	97	6	3	1	1	0	Turning
	27	78	32	39	6	1	0	0	0	Turning
	28	152	39	101	6	6	0	11	1	Turning
	29	159	30	79	6	36	8	6	0	Turning
	30	64	31	27	6	0	0	1	0	Turning
	31	114	108	0	6	0	0	0	0	Not turning in AM
June	1	288	182	100	6	0	0	2	0	Turning
	2	154	49	99	6	0	0	3	0	Turning
	3	203	97	99	6	0	1	14	0	Turning
	4	53	21	0	0	32	0	1	1	Not turning in AM
	5	328	221	100	6	1	0	3	0	Turning
	6	262	153	100	7	2	0	7	0	Turning
	7	287	177	99	6	4	1	2	0	Turning
	8	161	61	73	6	21	0	3	0	Turning
	9	123	35	66	6	15	1	1	0	Not turning in AM
	10	509	389	100	6	14	0	4	0	Turning
	11	684	541	100	6	37	0	11	0	Turning
	12	799	615	99	6	78	1	18	0	Turning
	13	871	680	99	6	85	1	13	0	Turning
	14	624	498	71	6	45	4	9	0	Turning
	15	962	849	71	6	33	3	23	0	Turning
	16	1,033	849	0	6	178	0	14*	0	Turning
	17	788	686	74	6	21	1	4	0	Turning
	18	571	447	0	0	124	0	4	1	Turning
	19	582	580	0	0	2	0	3	0	Turning
	20	100	78	22	0	0	0	1	0	Turning
	21	276	210	48	0	17	1	6*	0	Turning
	22	311	309	0	0	2	0	3	0	Turning
	23	102	102	0	0	0	0	1	0	Wheel removed
	Total	11,288	8,364	1,943	176	764	41	179	3	

* 1 smolt with a tagging scar

Table 4. Daily catch and fate of wild Atlantic salmon smolts at the rotary screw trap in Margaree River during 2005. Total catch refers to first time catch of smolts (excludes recaptures).

Month	Day	Total Catch	Released		Mortalities			Recaptures		Wheel condition
			Untagged	Tagged	Sacrificed	Holding box	After Tagging	Live	Mortalities	
May	4									Wheel set
	5	7	6	0	1	0	0	0	0	Turning
	6	13	11	0	2	0	0	0	0	Turning
	7	13	7	0	1	5	0	0	0	Turning
	8	8	7	0	1	0	0	0	0	Turning
	9	9	7	0	1	1	0	0	0	Not turning in AM
	10	22	9	10	2	1	0	0	0	Turning
	11	45	21	20	4	0	0	0	0	Not turning in AM
	12	71	32	31	5	2	1	1	0	Turning
	13	144	137	0	7	0	0	2	0	Turning
	14	86	83	0	0	3	0	0	0	Turning
	15	83	82	0	0	1	0	1	0	Turning
	16	192	122	0	0	70	0	1	0	Not turning in AM
	17	47	47	0	0	0	0	0	0	Turning
	18	58	58	0	0	0	0	1*	0	Turning
	19	47	12	29	6	0	0	0	0	Turning
	20	73	73	0	0	0	0	0	0	Turning
	21	74	12	58	2	2	0	0	0	Turning
	22	91	13	69	6	1	2	2	0	Turning
	23	139	18	113	3	3	2	9	0	Turning
	24	430	358	64	6	2	0	21	1	Turning
	25	320	264	49	7	0	0	8	0	Turning
	26	449	332	99	6	12	0	1	0	Not turning in AM
	27	317	200	100	6	11	0	6	0	Turning
	28	586	559	0	9	18	0	5	0	Turning
	29	447	431	0	10	6	0	2	0	Turning
	30	785	765	0	8	12	0	2	0	Turning
	31	453	422	0	10	21	0	0	0	Turning
June	1	519	385	96	9	26	3	0	0	Turning
	2	743	615	77	8	41	2	2	0	Turning
	3	922	799	98	10	14	1	4	1	Turning
	4	691	554	94	8	29	6	9	1	Turning
	5	558	401	98	8	49	2	18	1	Turning
	6	226	107	98	9	10	2	8	0	Turning
	7	338	206	97	10	22	3	14	0	Turning
	8	272	173	0	6	93	0	5	6	Turning
	9	437	390	0	5	42	0	3	1	Turning
	10	590	558	20	5	5	2	3	0	Turning
	11	265	212	46	6	1	0	4	0	Turning
	12	285	279	0	5	1	0	4	2	Turning
	13	73	25	47	0	0	1	2	0	Turning
	14	42	41	0	0	1	0	2	1	Turning
	15	215	208	0	6	1	0	1	1	Turning
	16	131	131	0	0	0	0	1	0	Turning
	17	50	50	0	0	0	0	0	0	Turning
	18	65	65	0	0	0	0	0	0	Turning
	19	47	42	0	5	0	0	0	0	Turning
	20	41	41	0	0	0	0	0	0	Turning
	21	101	96	0	5	0	0	0	0	Wheel removed
	Total	11,620	9,466	1,413	208	506	27	142	15	

* 1 recaptured smolt with a tagging scar

Table 5. Daily catch and fate of wild Atlantic salmon smolts at the rotary screw trap in Margaree River during 2006. Total catch refers to first time catch of smolts (excludes recaptures).

Month	Day	Total catch	Released		Mortalities			Recaptures		Wheel condition
			Untagged	Tagged	Sacrificed	Holding box	After Tagging	Live	Mortalities	
May	3									Wheel set
	4	123	111	0	9	3	0	0	0	Not turning in AM
	5	82	71	0	10	1	0	0	0	Not turning in PM
	6	352	287	50	10	5	0	0	0	Turning
	7	172	160	0	11	1	0	2	0	Reset at 18h55
	8	304	244	49	10	1	0	0	0	Turning
	9	936	864	49	10	11	2	6	0	Turning
	10	285	187	74	10	13	1	1	0	Turning
	11	448	441	0	7	0	0	13	0	Turning
	12	504	471	0	10	23	0	4	0	Reset at 19h15
	13	474	341	111	10	9	3	4	0	Turning
	14	965	844	108	10	2	1	6	0	Turning
	15	817	801	0	10	6	0	16	0	Turning
	16	804	789	0	10	5	0	2	0	Turning
	17	1,095	1,073	0	10	12	0	1	0	Turning
	18	800	666	100	10	24	0	0	0	Turning
	19	526	356	103	9	51	7	2	1	Turning
	20	324	314	0	10	0	0	2	0	Reset at 22h15
	21	643	487	99	10	46	1	4	0	Turning
	22	680	423	96	10	147	4	3	0	Turning
	23	467	279	99	10	78	1	6	0	Reset at 21h30
	24	869	717	95	10	42	5	26*	1	Turning
	25	769	595	93	10	64	7	21	0	Turning
	26	519	379	98	9	32	1	17*	0	Turning
	27	435	407	0	10	18	0	11	0	Reset at 20h30
	28	996	866	99	10	19	2	11	0	Turning
	29	1,346	1,225	99	10	11	1	10	0	Turning
	30	368	212	93	10	47	6	7	0	Turning
	31	291	207	0	10	74	0	20	2	Turning
June	1	184	174	0	10	0	0	7	0	Turning
	2	48	40	0	8	0	0	0	0	Turning
	3	182	168	0	10	4	0	0	0	Turning
	4	36	36	0	0	0	0	0	0	Turning
	5	75	59	0	10	6	0	0	0	Turning
	6	69	51	0	10	8	0	0	0	Turning
	7	95	83	0	9	3	0	0	0	Turning
	8	43	33	0	9	1	0	0	0	Not turning in AM
	9	18	15	0	3	0	0	0	0	Turning
	10	38	31	0	7	0	0	0	0	Reset at 19h40
	11	58	40	0	9	9	0	0	0	Turning
	12	45	35	0	5	5	0	0	0	Turning
	13	21	17	0	4	0	0	0	0	Turning
	14	23	19	0	4	0	0	0	0	Turning
	15	16	16	0	0	0	0	0	0	Turning
	16	8	8	0	0	0	0	0	0	Wheel removed
	Total	17,353	14,642	1,515	373	781	42	200	5	

* 1 recaptured smolt with a tagging scar on each day

Table 6. Daily catch and fate of wild Atlantic salmon smolts at the rotary screw trap in Margaree River during 2007. Total catch refers to first time catch of smolts (excludes recaptures).

Month	Day	Total catch	Released		Mortalities			Recaptures		Wheel condition
			Untagged	Tagged	Sacrificed	Holding box	After Tagging	Live	Mortalities	
May	2									Wheel set
	3	3	3	0	0	0	0	0	0	Turning
	4	2	2	0	0	0	0	0	0	Turning
	5									Not fishing
	6									Not fishing
	7									Reset at 14h20
	8	7	6	0	1	0	0	0	0	Turning
	9	1	0	0	0	1	0	0	0	Not turning in AM
	10									Not fishing
	11									Not fishing
	12									Not fishing
	13									Not fishing
	14									Reset at 17h30
	15	123	62	50	11	0	0	0	0	Turning
	16	59	53	0	6	0	0	0	0	Turning
	17	78	65	0	11	2	0	0	0	Turning
	18	108	49	50	8	1	0	0	0	Turning
	19	95	36	50	7	2	0	1	0	Turning
	20	192	171	0	10	11	0	1	0	Turning
	21									Not fishing
	22	101	87	0	10	4	0	0	1	Reset at 19h40
	23	88	30	50	5	3	0	0	0	Turning
	24	390	260	97	9	23	1	0	0	Turning
	25	41	34	0	7	0	0	4	0	Turning
	26	538	384	98	10	44	2	3	0	Turning
	27	938	807	99	10	21	1	18	0	Turning
	28	950	778	97	10	63	2	17	1	Turning
	29	556	390	99	10	56	1	7	0	Not turning
	30	130	119	0	10	1	0	8	0	Not turning
	31	376	259	99	9	8	1	6	1	Turning
June	1	123	106	0	10	7	0	6	0	Turning
	2	313	224	25	9	30	0	0	0	Turning
	3	168	108	50	9	1	0	1	0	Not turning
	4	501	359	98	10	32	2	5	0	Turning
	5	220	152	49	10	9	0	1	0	Turning
	6	307	190	72	10	32	3	5	0	Turning
	7	280	173	74	10	22	1	1	1	Reset at 19h40
	8	405	341	49	10	5	0	6	0	Turning
	9	462	299	98	10	53	2	4	0	Reset at 20h00
	10	517	385	97	10	23	2	8	1	Turning
	11	576	486	47	10	30	3	6	1	Turning
	12	350	279	50	10	11	0	5	0	Turning
	13	105	77	0	10	18	0	1	0	Turning
	14	132	104	0	8	20	0	0	0	Turning
	15	129	111	0	10	8	0	0	0	Turning
	16	114	100	0	10	4	0	0	0	Turning
	17	87	66	0	10	11	0	0	0	Turning
	18	51	38	0	9	4	0	0	0	Turning
	19	11	10	0	1	0	0	0	0	Turning
	20	15	12	0	2	1	0	1*	0	Wheel removed
	Total	9,642	7,215	1,498	322	561	21	115	6	

* 1 recaptured smolt with a tagging scar

Table 7. Daily catch and fate of wild Atlantic salmon smolts at the rotary screw trap in Margaree River during 2008. Total catch refers to first time catch of smolts (excludes recaptures).

Month	Day	Total catch	Released		Mortalities			Recaptures		Wheel condition
			Untagged	Tagged	Sacrificed	Holding box	After Tagging	Live	Mortalities	
May	6									Wheel set
	7	0	0	0	0	0	0	0	0	Turning
	8	61	51	0	10	0	0	0	0	Turning
	9	50	43	0	7	0	0	0	0	Turning
	10	38	10	24	2	1	1	0	0	Turning
	11	17	5	10	2	0	0	1	0	Turning
	12	27	10	15	2	0	0	0	0	Turning
	13	61	14	34	5	7	1	1	1	Turning
	14	106	25	39	9	1	2	4	0	Turning
	15	181	67	73	10	1	0	6	0	Reset at 20h04
	16	35	7	24	3	0	1	6	0	Reset at 19h40
	17	121	30	49	9	2	1	8	0	Not fishing
	18	96	18	49	8	0	1	9	0	Reset at 8h50
	19	502	230	92	10	34	8	15	3	Reset at 17h30
	20	619	305	50	25	77	0	12	1	Turning
	21	506	278	74	10	43	1	9	0	Turning
	22	104	89	0	10	5	0	3	0	Turning
	23	397	122	98	10	15	2	2	0	Turning
	24	405	172	98	10	23	2	12	0	Turning
	25	302	127	96	10	15	4	10*	0	Turning
	26	471	194	50	10	17	0	9	0	Turning
	27	474	192	46	20	13	4	4	1	Turning
	28	277	222	0	10	45	0	5	0	Not turning in AM; Reset at 17h45
	29	1,012	688	98	10	15	1	6	0	Turning
	30	592	260	99	10	26	1	7	0	Turning
	31	298	75	100	10	9	0	5	0	Rest at 21h00
June	1	254	180	48	10	14	2	3	1	Turning
	2	1,004	714	46	10	130	4	3	2	Turning
	3	408	205	75	10	18	0	2	0	Turning
	4	386	212	50	10	14	0	2	1	Turning
	5	192	126	48	10	6	2	1	0	Turning
	6	351	175	50	10	16	0	1	0	Turning
	7	244	108	50	7	29	0	2	1	Turning
	8	178	91	49	7	5	1	1	1	Turning
	9	129	86	25	11	7	0	2	1	Turning
	10	205	113	50	10	7	0	4	0	Turning
	11	167	104	50	10	3	0	3	0	Turning
	12	90	80	0	10	0	0	2	0	Turning
	13	51	44	0	6	1	0	2	0	Turning
	14	27	23	0	3	1	0	1	0	Turning
	15	70	62	0	6	2	0	1	0	Turning
	16	69	53	0	10	6	0	0	0	Turning
	17	130	118	0	10	2	0	0	0	Turning
	18	93	83	0	10	0	0	0	0	Turning
	19	67	58	0	9	0	0	0	0	Turning
	20	62	50	0	9	3	0	0	0	Wheel removed
	Total	10,929	5,919	1,759	400	613	39	166	12	

***** 1 recaptured smolt with a tagging scar

Table 8. Daily catch and fate of wild Atlantic salmon smolts at the rotary screw trap in Margaree River during 2009. Total catch refers to first time catch of smolts (excludes recaptures).

			Released		Mortalities			Recaptures		
Month	Day	Total catch	Untagged	Tagged	Sacrificed	Holding box	After tagging	Live	Mortalities	Wheel condition
May	9									Wheel set
	10	34	34	0	5	0	0			Wheel turning
	11	31	31	0	5	0	0			Wheel turning
	12	128	79	49	10	1	0			Wheel turning
	13	214	164	49	10	4	1	3	0	Wheel turning
	14	239	139	100	10	1	0	5	0	Not turning in AM
	15	0	0	0	0	0	0	0	0	Not turning
	16	0	0	0	0	0	0	0	0	Wheel turning
	17	374	274	100	10	0	0	0	0	Wheel turning
	18	340	240	100	10	0	0	3	0	Wheel turning
	19	353	304	49	10	3	0	10*	0	Wheel turning
	20	283	283	0	0	98	0	3	2	Not turning in AM
	21	394	294	100	10	6	0	2	0	Wheel turning
	22	410	312	98	10	1	0	3*	0	Wheel turning
	23	596	496	98	10	5	2	9	0	Wheel turning
	24	371	272	99	10	2	0	10*	0	Wheel turning
	25	369	270	98	11	10	1	5	0	Wheel turning
	26	370	270	98	10	8	2	8	0	Wheel turning
	27	147	97	49	10	0	1	6	0	Wheel turning
	28	279	179	97	10	11	3	6	1	Wheel turning
	29	312	212	96	10	22	4	4	4	Wheel turning
	30	138	88	48	10	4	2	4	0	Wheel turning
	31	168	118	44	10	36	6	5*	0	Wheel turning
June	1	405	306	99	10	15	0	5*	2	Wheel turning
	2	225	125	100	10	10	0	7	0	Wheel turning
	3	453	353	99	10	85	1	8	0	Wheel turning
	4	372	298	74	10	78	0	16	1	Not turning in PM
	5	153	103	50	10	0	0	8	0	Not turning in PM
	6	95	83	12	10	0	0	2	0	Wheel turning
	7	128	97	30	10	1	1	0	0	Wheel turning
	8	104	104	0	10	0	0	3	0	Wheel turning
	9	36	36	0	6	0	0	1	0	Wheel turning
	10	46	46	0	8	0	0	0	0	Wheel turning
	11	33	33	0	5	1	0	0	0	Wheel turning
	12	13	13	0	2	0	0	0	0	Wheel removed
	Total	7,613	5,753	1,836	282	402	24	136	10	

*1 recaptured smolt with a tagging scar on each day

Table 9. Percent wild Atlantic salmon smolts recaptured according to the number of days since tagging during 2004.

Days since tagging	Tagging group							
	May 19-23	May 24-28	May 29 - June 2	June 3-7	June 8-12	June 13-17	June 18-21	All Groups
1	50.0% (3)	35.7% (10)	43.5% (10)	27.3% (9)	20.0% (11)	25.8% (8)	40.0% (6)	29.4% (53)
2	33.3% (2)	28.6% (8)	34.8% (8)	15.2% (5)	27.3% (15)	45.2% (14)	33.3% (5)	30.0% (54)
3	16.7% (1)	14.3% (4)	4.3% (1)	12.1% (4)	20.0% (11)	9.7% (3)	0	13.3% (24)
4	0	7.1% (2)	0	0	14.5% (8)	9.7% (3)	20.0% (3)	7.2% (13)
5	0	3.6% (1)	0	9.1% (3)	7.3% (4)	6.5% (2)	6.7% (1)	5.6% (10)
6	0	0	0	3.0% (1)	5.5% (3)	0	0	2.2% (4)
7	0	3.6% (1)	0	12.1% (4)	1.8% (1)	3.2% (1)	0	3.9% (7)
8	0	3.6% (1)	0	3.0% (1)	1.8% (1)	0	0	1.7% (3)
9	0	0	0	15.2% (5)	0	0	0	2.8% (5)
10	0	0	4.3% (1)	0	1.8% (1)	0	0	1.1% (2)
11	0	0	0	0	0	0	0	0
12	0	0	0	3.0% (1)	0	0	0	0.6% (1)
13	0	0	4.3% (1)	0	0	0	0	0.6% (1)
14	0	0	8.7% (2)	0	0	0	0	1.1% (2)
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	3.6% (1)	0	0	0	0	0	0.6% (1)
Total recaptures	6	28	23	33	55	31	15	180*
Total tagged	96	321	305	398	438	315	70	1,943
Percent recaptured	6.3%	8.7%	7.5%	8.3%	12.6%	9.8%	21.4%	9.3%

* 2 recaptured smolts with tagging scars not included

Table 10. Mark and recapture data inputs (Aggregated and Stratified models) and estimates of wild Atlantic salmon smolt migration and the efficiencies of the RST for 2004.

Aggregated model

Tagging period May 19 to June 21			Recapture period May 13 – June 23	
Tags released	1,943		Tags recaptured	182
Tags available (adjusted for 10% mortality)	1,749		First time captures at RST	11,288
Estimates	Mode	2.5th percentile	97.5th percentile	CV
Run size	108,650	94,650	126,500	7%
RST efficiency (%)	10.4	8.9	11.9	

Stratified model

Tagging group date	Tags available (adjusted)	Recaptures by recapture period: May 13 to May 29	May 30 to June 4	June 5 to June 16	June 17 to June 23	Total
May 19 to May 28	378	29	4	1	0	34
May 29 to June 3	366	0	18	11	0	29
June 4 to June 15	886	0	0	95	7	102
June 16 to June 21	131	0	0	0	15	15
Total	1,749	29	22	107	22	180*
First time catch		1,039	876	6,643	2,730	11,288
Run size		11,078	13,164	57,680	23,842	105,764
95% C.I.						90,140 – 121,388
Efficiency (%)		9.4	6.7	11.5	11.5	10.7
95% C.I.						9.3 – 12.5

* 2 fish with tagging scars were not included in the Stratified model

Table 11. Percent of wild smolts recaptured based on number of days since tagging in 2005.

Days since tagging	Tagging groups							
	May 10-14	May 15-19	May 20-24	May 25-29	May 30 - June 3	June 4-8	June 9-14	All Groups
1	0	0	35.0% (14)	41.7% (5)	52.2% (12)	44.4% (24)	60.0% (9)	41.0% (64)
2	14.3% (1)	0	45.0% (18)	25.0% (3)	17.4% (4)	33.3% (18)	33.3% (5)	31.4% (49)
3	42.9% (3)	20.0% (1)	7.5% (3)	8.3% (1)	17.4% (4)	9.3% (5)	6.7% (1)	11.5% (18)
4	0	0	7.5% (3)	16.7% (2)	4.3% (1)	5.6% (3)	0	5.8% (9)
5	14.3% (1)	40.0% (2)	2.5% (1)	0	8.7% (2)	3.7% (2)	0	5.1% (8)
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	3.7% (2)	0	1.3% (2)
8	0	20.0% (1)	0	0	0	0	0	0.6% (1)
9	0	0	0	0	0	0	0	0
10	0	0	0	8.3% (1)	0	0	0	0.6% (1)
11	0	20.0% (1)	0	0	0	0	0	0.6% (1)
12	14.3% (1)	0	0	0	0	0	0	0.6% (1)
13	14.3% (1)	0	2.5% (1)	0	0	0	0	1.3% (2)
Total recaptures	7	5	40	12	23	54	15	156*
Total tagged	61	29	304	248	271	387	113	1,413
Percent recaptured	11.5%	17.2%	13.2%	4.8%	8.5%	14.0%	13.3%	11.0%

*1 recaptured smolt with tagging scar not included

Table 12. Mark and recapture data inputs (into the Aggregated and the Stratified models) and estimates of wild Atlantic salmon smolt migration and the efficiencies of the RST for 2005.

Aggregated model

Tagging period May 10 to June 13			Recapture period May 5 to June 21	
Tags released	1,413		Tags recaptured	157
Tags available (adjusted for 10% mortality)	1,272		First time captures at RST	11,620
Estimates	Mode	2.5th percentile	97.5th percentile	CV
Run size	94,700	81,200	111,200	8%
RST efficiency (%)	12.3	10.4	14.3	

Stratified model

		Recaptures by recapture period				
Tagging group date	Tagged fish released (adjusted)	May 5 to May 18	May 19 to May 31	June 1 to June 7	June 8 to June 21	Total
May 10 – May 17	55	5	2	0	0	7
May 18 to May 30	523	0	55	2	0	57
May 31 to June 6	592	0	0	56	15	71
June 7 to June 15	102	0	0	0	21	21
Total	1,272	5	57	58	36	156*
First time catch		798	4,211	3,997	2,614	11,620
Run size		5,850	38,623	37,054	12,697	94,224
95% C.I.						79,775 – 108,673
Efficiency (%)		13.6	10.9	10.8	20.6	12.3
95% C.I.						10.7 – 14.6

* 1 fish with tagging scars were not included in the Stratified model

Table 13. Percent of wild smolts recaptured according to number of days since tagging, 2006.

Days since tagging	Tagging group					All Groups
	May 6-10	May 11-15	May 16-20	May 21-25	May 26-30	
1	42.4% (14)	46.2% (12)	11.5% (3)	8.7% (6)	43.1% (22)	27.8% (57)
2	21.2% (7)	46.2% (12)	19.2% (5)	43.5% (30)	45.1% (23)	37.6% (77)
3	18.2% (6)	0	11.5% (3)	26.1% (18)	7.8% (4)	15.1% (31)
4	6.1% (2)	0	7.7% (2)	11.6% (8)	3.9% (2)	6.8% (14)
5	6.1% (2)	0	3.8% (1)	2.9% (2)	0	2.4% (5)
6	0.0%	0	15.4% (4)	4.3% (3)	0	3.4% (7)
7	3.0% (1)	0	15.4% (4)	1.4% (1)	0	2.9% (6)
8	0	3.8% (1)	7.7% (2)	0	0	1.5% (3)
9	0	0	7.7% (2)	0	0	1.0% (2)
10	0	3.8% (1)	0	1.4% (1)	0	1.0% (2)
14	3.0% (1)	0	0	0	0	0.5% (1)
Total recaptures	33	26	26	69	51	205*
Total tagged	222	219	203	482	389	1,515
Percent recaptured	14.9	11.9	12.8	14.3	13.1	13.5

*2 recaptured smolts with tagging scars not included

Table 14. Mark and recapture data inputs (into the Aggregated and the Stratified models) and estimates of wild Atlantic salmon smolt migration and the efficiencies of the RST for 2006.

Aggregated model				
Tagging period May 19 to June 21			Recapture period May 6 to 30	
Tags released	1,515		Tags recaptured	207
Tags available (adjusted for 10% mortality)	1,363		First time captures at RST	17,353
Estimates	Mode	2.5th percentile	97.5th percentile	CV
Run size	114,800	100,400	131,900	7%
RST efficiency (%)	15.2	13.2	17.3	

Stratified model					
		Recaptures by recapture period			
Tagging group date	Tagged fish released (Adjusted)	May 4 to May 15	May 16 to May 28	May 29 to June 16	Total
May 4 to May 14	299	53	6	1	60
May 15 to May 27	802	0	100	3	103
May 28 to May 30	262	0	0	42	42
Total	1,363	53	106	46	205*
First time catch		5,462	8,927	2,964	17,353
Run size		25,328	69,924	18,490	113,741
95% C.I.					99,138 – 128,345
Efficiency (%)		21.6	12.8	16.0	15.3
95% C.I.					13.5 – 17.5

* 2 fish with tagging scars were not included in the Stratified model

Table 15. Percent of wild smolts recaptured according to number of days since tagging, 2007.

Days since tagging	Tagging group						All Groups
	May 15-19	May 20-24	May 25-29	May 30 - June 3	June 4-8	June 9-12	
1	33.3% (1)	12.5% (2)	52.9% (27)	46.2% (6)	38.1% (8)	4.1% (12)	46.7% (56)
2	33.3% (1)	25.0% (4)	31.4% (16)	23.1% (3)	33.3% (7)	1.4% (4)	29.2% (35)
3	33.3% (1)	43.8% (7)	13.7% (7)	7.7% (1)	9.5% (2)	0	15.0% (18)
4	0	12.5% (2)	0	15.4% (2)	9.5% (2)	0	5.0% (6)
5	0	0	0	7.7% (1)	0	0	0.8% (1)
6	0	6.3% (1)	2.0% (1)	0	9.5% (2)	0	3.3% (4)
Total recaptures	3	16	51	13	21	16	120*
Total tagged	150	147	393	174	342	292	1,498
Percent recaptured	2.0%	10.9%	13.0%	7.5%	6.1%	5.5%	8.0%

* 1 recaptured smolt with tagging scar not included

Table 16. Mark and recapture data inputs (into the Aggregated and the Stratified models) and estimates of wild Atlantic salmon smolt migration and the efficiencies of the RST for 2007.

Aggregated model				
Tagging period May 19 to June 21			Recapture period May 15 to June 12	
Tags released	1,498		Tags recaptured	121
Tags available (adjusted for 10% mortality)	1,348		First time captures at RST	9,642
Estimates	Mode	2.5th percentile	97.5th percentile	CV
Run size	107,300	91,100	130,100	9%
RST efficiency (%)	9.	7.4	10.6	

Stratified model				
		Recaptures by recapture period		
Tagging group date	Tagged fish released (Adjusted)	May 3 to June 2	June 3 to 20	Total
May 3 to June 2	732	73	6	79
June 3 to 12	616	1	40	40
Total	1,348	74	46	120*
First time catch		5,212	4,430	9,642
Run size		45,207	66,558	112,385
95% C.I.				91,555 – 133,215
Efficiency (%)		10.8	7.0	8.6
95% C.I.				7.2 – 10.5

* 1 fish with tagging scars were not included in the Stratified model

Table 17. Percent of wild smolts recaptured according to number of days since tagging, 2008.

Days since tagging	Tagging groups					
	May 10-16	May 17-23	May 24-30	May 31- June 6	June 7-11	All Groups
1	34.3% (12)	43.3% (29)	31.0% (13)	58.8% (10)	37.5% (6)	39.5% (70)
2	31.4% (11)	34.3% (23)	42.9% (18)	23.5% (4)	37.5% (6)	35.0% (62)
3	11.4% (4)	13.4% (9)	11.9% (5)	5.9% (1)	12.5% (2)	11.9% (21)
4	8.6% (3)	3.0% (2)	4.8% (2)	5.9% (1)	6.3% (1)	5.1% (9)
5	5.7% (2)	3.0% (2)	4.8% (2)	5.9% (1)	0	4.0% (7)
6	5.7% (2)	0	2.4% (1)	0	0	1.7% (3)
7	0	0	2.4% (1)	0	0	0.6% (1)
8	2.9% (1)	1.5% (1)	0	0	6.3% (1)	1.7% (3)
9	0	1.5% (1)	0	0	0	0.6% (1)
Total recaptures	35	67	42	17	16	177*
Total tagged	219	412	487	417	224	1,759
Percent recaptured	16.0%	16.3%	8.6%	4.1%	7.1%	10.1%

* 1 recaptured smolt with tagging scar not included

Table 18. Mark and recapture data inputs (into the Aggregated and the Stratified models) and estimates of wild Atlantic salmon smolt migration and the catchability of the RST for 2008.

Aggregated model				
Tagging period May 10 to June 10			Recapture period May 8 to June 15	
Tags released	1,759		Tags recaptured	178
Tags available (adjusted for 10% mortality)	1,583		First time captures at RST	10,929
Estimates	Mode	2.5th percentile	97.5th percentile	CV
Run size	97,300	84,700	113,500	7%
RST efficiency (%)	11.2	9.6	12.9	

Stratified model				
		Recaptures by recapture period		
Tagging group date	Tagged fish released (Adjusted)	May 11 to May 27	May 28 to June 15	Total
May 10 to 26	787	115	15	131
May 27 to June 11	796	0	47	47
Total	1,583	115	62	177*
First time catch		4,573	6,356	10,929
Run size		21,193	107,646	128,840
95% C.I.				101,249 – 156,431
Efficiency (%)		21.5	5.9	8.5
95% C.I.				7.0 – 10.8

*1 fish with tagging scars were not included in the Stratified model

Table 19. Percent of wild smolts recaptured according to number of days since tagging, 2009.

Days since tagging	Tagging group					
	May 12 - 17	May 18 - 22	May 23 - 27	May 28 June1	June 2 - 7	All groups
1	53.8% (14)	78.3% (18)	41.9% (18)	57.7% (15)	65.2% (15)	56.7% (80)
2	30.8% (8)	8.7% (2)	25.6% (11)	34.6% (9)	26.1% (6)	25.5% (36)
3	11.5% (3)	8.7% (2)	14.0% (6)	7.7% (2)	8.7% (2)	10.6% (15)
4	3.8% (1)	0	11.6% (5)	0	0	4.3% (6)
5	0	0	2.3% (1)	0	0	0.7% (1)
6	0	0	2.3% (1)	0	0	0.7% (1)
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	4.3% (1)	2.3% (1)	0	0	1.4% (2)
Total recaptures	26	23	43	26	23	141*
Total tagged	298	347	442	384	365	1,836
Percent recaptured	8.7%	6.6%	9.6%	6.5%	6.3%	7.6%

* 5 recaptured smolts with tagging scars not included

Table 20. Mark and recapture data inputs (into the Aggregated and the Stratified models) and estimates of wild Atlantic salmon smolt migration and the catchability of the RST for 2009.

Aggregated model

Tagging period May 10 to June 7		Recapture period May 10 to June 12	
Tags released	1,836	Tags recaptured	146
Tags available (adjusted for 10% mortality)	1,652	First time captures at RST	7,613

Estimates	Mode	2.5th percentile	97.5th percentile	CV
Run size	86,100	74,100	102,300	8%
RST efficiency (%)	8.8	7.4	10.3	

Stratified model

		Recaptures by recapture period				
Tagging group date	Tagged fish released (Adjusted)	May 10 to May 22	May 23 to May 29	May 30 to June 1	June 2 to June 12	Total
May 10 to May 21	492	29	2	1	0	32
May 22 to May 28	573	0	50	8	2	60
May 29 to May 31	169	0	0	5	0	5
June 1 to June 7	417	0	0	0	44	44
Total	1,652	29	52	14	46	141*
First time catch		2,800	2,444	711	1,658	7,613
Run size		43,145	13,865	24,032	15,713	96,754
95% C.I.						76,286 – 117,222
Efficiency (%)		6.5	17.6	3.0	10.6	7.9
95% C.I.						6.5 – 10.0

* 5 fish with tagging scars were not included in the Stratified model

Table 21. Biological characteristics of wild Atlantic salmon smolts caught in the Margaree River during 2004 to 2009. Mean included for N<10 but standard error of the mean (SEM) not shown.

Year	Age	Sex combined % (N)	Female			Male		
			%	Mean FL (SEM)	Mean WT (SEM)	%	Mean FL (SEM)	Mean WT (SEM)
2004	Age 2	40.5 (68)	30.4	12.6 (0.12)	19.2 (0.61)	10.1	13.0 (0.23)	21.5 (1.30)
2004	Age 3	54.2 (91)	38.7	13.5 (0.11)	23.4 (0.65)	15.5	13.9 (0.20)	26.0 (1.32)
2004	Age 4	4.2 (7)	0.6	14.0	22.3	3.6	14.4	27.1
2004	Age 5	1.2 (2)	--	--	--	1.2	14.4	27.7
2004	**All**	**100.0(168)**	**69.6**	**13.1 (0.09)**	**21.6 (0.49)**	**30.4**	**13.7 (0.15)**	**24.7 (0.88)**
2005	Age 2	36.4 (67)	29.3	12.7 (0.14)	20.4 (0.67)	7.1	12.8 (0.29)	20.5 (1.47)
2005	Age 3	54.3 (100)	42.4	13.9 (0.14)	25.9 (0.92)	10.9	13.9 (0.24)	26.0 (1.37)
2005	Age 4	9.2 (17)	4.9	15.5	35.3	3.8	15.2	33.9
2005	**All**	**100.0 (184)**	**76.6**	**13.5 (0.12)**	**24.3 (0.63)**	**21.7**	**13.6 (0.18)**	**24.6 (0.96)**
2006	Age 1	0.3 (1)	0.3	11.9	18.0	--	--	--
2006	Age 2	66.7 (238)	50.7	12.3 (0.08)	18.5 (0.40)	16.0	12.4 (0.15)	19.3 (0.95)
2006	Age 3	31.1 (111)	20.4	13.7 (0.17)	24.7 (0.86)	10.6	13.8 (0.17)	25.9 (0.95)
2006	Age 4	2.0 (7)	0.6	20.4	22.0	1.4	14.2	24.8
2006	**All**	**100.0 (357)**	**72.0**	**12.8 (0.10)**	**20.4 (0.74)**	**2.8**	**13.0 (0.13)**	**22.1 (0.64)**
2007	Age 2	47.4 (144)	34.2	12.5 (0.10)	19.7 (0.49)	13.2	12.1 (0.15)	18.2 (0.66)
2007	Age 3	50.0 (152)	37.5	13.0 (0.08)	21.7 (0.44)	12.5	13.0 (0.17)	22.4 (0.92)
2007	Age 4	2.6 (8)	1.3	13.5	23.7	1.3	15.2	30.4
2007	**All**	**100.0 (304)**	**73.0**	**12.8 (0.07)**	**20.8 (0.33)**	**27.0**	**12.6 (0.13)**	**20.7 (0.63)**
2008	Age 2	48.9 (186)	39.7	12.5 (0.09)	20.1 (0.83)	9.2	12.5 (0.18)	20.2 (0.14)
2008	Age 3	48.4 (184)	33.9	13.7 (0.09)	24.4 (0.47)	14.5	13.9 (0.96)	27.4 (0.92)
2008	Age 4	2.6 (10)	0.8	15.4	36.2	1.8	15.5	34.2
2008	**All**	**100.0 (380)**	**74.5**	**13.1 (0.07)**	**22.2 (0.51)**	**25.5**	**13.5 (0.13)**	**25.3 (0.76)**
2009	Age 2	55.2 (154)	40.1	12.6 (0.11)	19.8 (0.59)	15.1	12.8 (0.20)	21.1 (0.99)
2009	Age 3	44.1 (123)	32.3	13.3 (0.10)	22.2 (0.46)	11.8	13.4 (0.16)	23.9 (0.75)
2009	Age 4	0.7 (2)	--	--	--	0.7	14.5	26.8
2009	**All**	**100.0 (279)**	**72.4**	**12.9 (0.08)**	**20.9 (0.39)**	**27.6**	**13.1 (0.13)**	**22.4 (0.65)**

Table 22. Estimates of relative year class survival rates and return rates of smolts to small salmon and large salmon (mostly 2SW) during the period of 2001 to 2009. Fry and and parr densities are from Breau et al. (2009). Smolt data for 2002 and 2003 are from Clément et al. (2007). Density is expressed as fish per 100 m² of habitat. One habitat unit is equal to 100 m².

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Fry density	57.1	93.9	21.6	171.6	189.8	120.1	115.8	83.2	27.9
Parr density	77.8	50.6	60.6	46.5	112.4	95.9	82.1	58.6	44.7
parr (year) per fry (year – 1)		88.6%	64.6%	215.3%	65.5%	50.5%	68.4%	46.9%	53.7%
Smolt per unit habitat		2.3	3.0	3.8	3.4	4.1	4.0	4.6	3.3
Smolt (year) per parr (year-1)		2.9%	5.9%	6.2%	7.2%	3.6%	4.2%	5.6%	5.9%
Smolt run size estimates		63,200	83,050	105,800	94,200	113,700	112,400	128,800	96,8900
small salmon returns (smolt year+1)		920	1,300	920	1,025	850	1,490	276*	
Return rate to small salmon		1.5%	1.6%	0.9%	1.1%	0.7%	1.3%	0.2%	
Large salmon returns (smolt year +2)		3,947	3,248	3,143	2,198	3,380	2,123*		
Return rate to large salmon		6.2%	3.9%	3.0%	2.3%	3.0%	1.9%		

*2009 adult return estimates are preliminary

Table 23. Number of fish caught by species at the RST in the Margaree River during 2004 to 2009.

		Total first time catch by year					
Species		2004	2005	2006	2007	2008	2009
Lamprey (ammocoete)		62	85	70	26	41	8
Gaspereau (alewife and blueback herring)		363	250	166	88	48	33
Atlantic salmon							
Wild origin	Parr	56	570	1587	664	657	165
	Smolt	11,288	11,620	17,353	9,642	10,937	7,613
	Black salmon		5	0	2	1	0
Hatchery origin	Parr	22	4	13	50	11	0
	Fall fingerling stocked smolt	377	859	504	213	204	182
	1 yr spring released smolt	2,700	299	2,159	3,299	534	925
Brook trout		22	57	138	13	42	28
Brown trout			1		2	5	2
Smelt		9	71	843	6	131	9
Dace	Not specified	19		18	43	18	18
	Blacknose	1		1			
	Northern red-belly		14				
Shiner	Not specified		1	1		1	1
	Golden	2					
White sucker		60	142	279	43	40	24
American eel		209	293	274	119	174	131
Banded killifish			1				2
Mummichog		7	8	8	5	13	0
Stickleback		707	1,148	5,386	787	957	707
Atlantic silverside		1	20	1			
White perch		4	13	5	5	9	7
All species		15,909	15,461	28,806	15,007	13,823	9,855

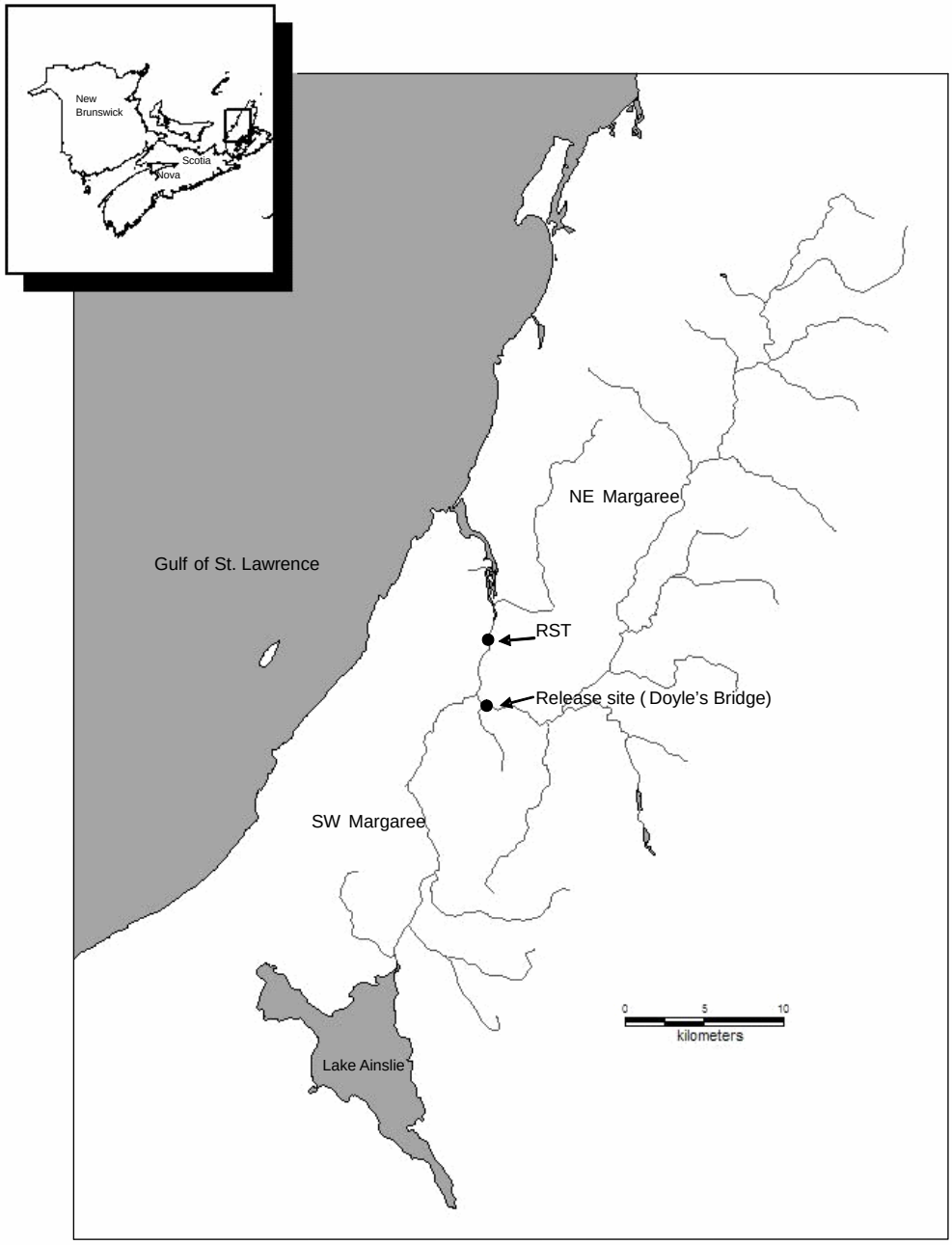

Figure 1. Location of the rotary screw trap (RST) and the release site of marked smolts at Doyle's Bridge in the Margaree River, 2004 to 2009.

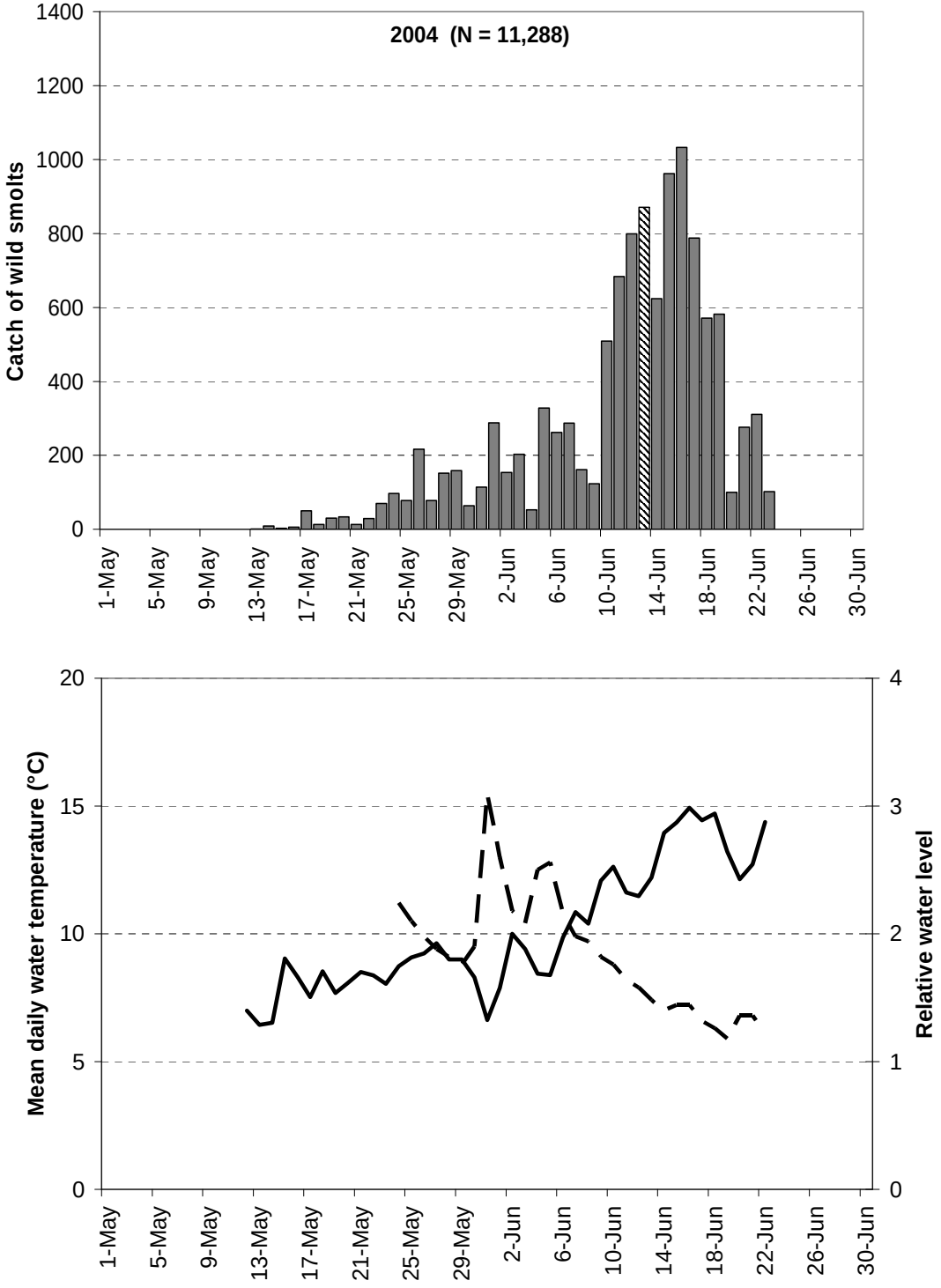

Figure 2. The daily catch of wild smolts (upper panel) and the mean daily water temperature and daily water level (lower panel; solid line = water temperature) in the Margaree River during 2004. The dashed bar represents the date of 50% of the catch.

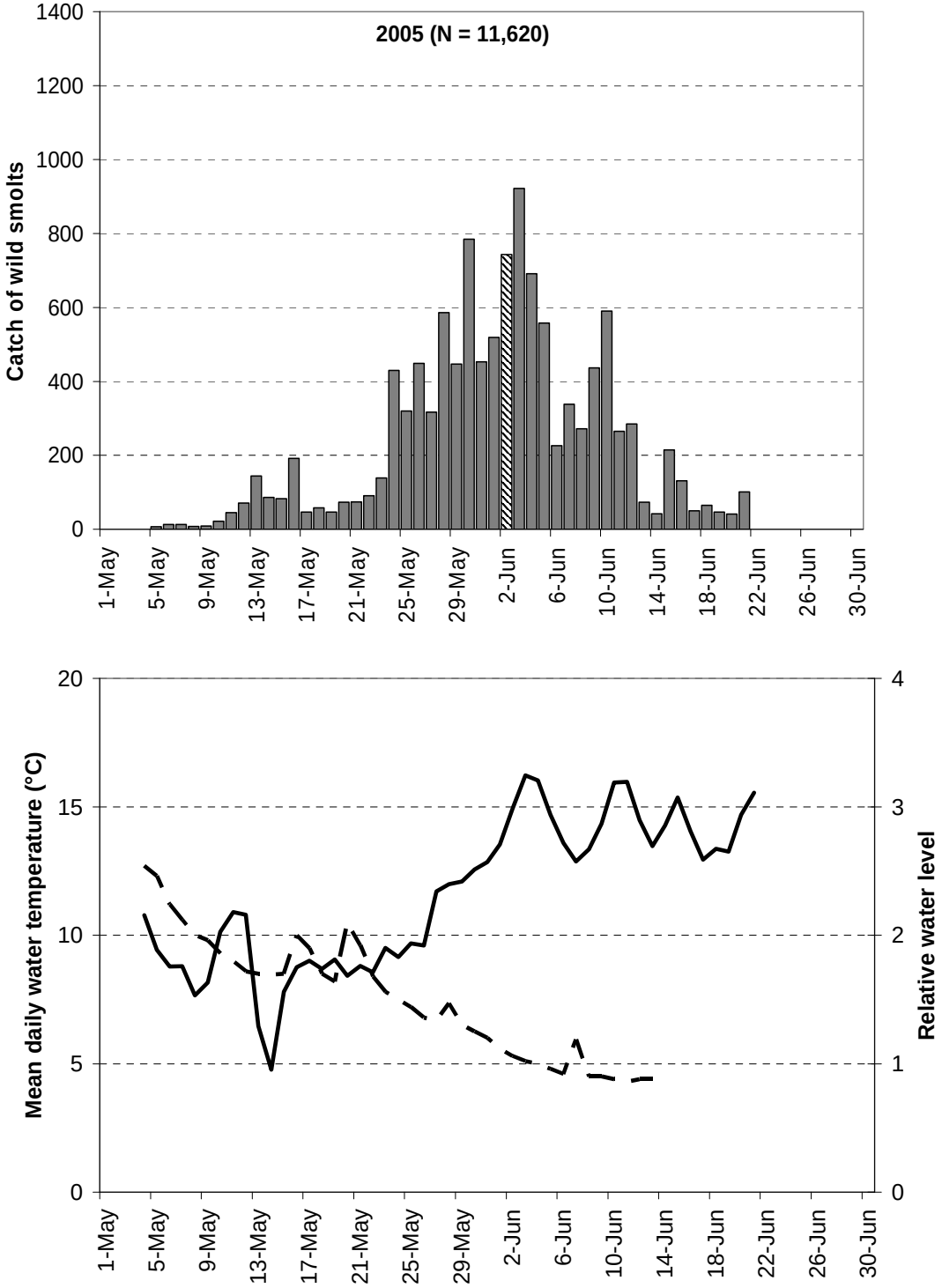

Figure 3. The daily catch of wild smolts (upper panel) and the mean daily water temperature and daily water level (lower panel; solid line = water temperature) in the Margaree River during 2005. The dashed bar represents the date of 50% of the catch.

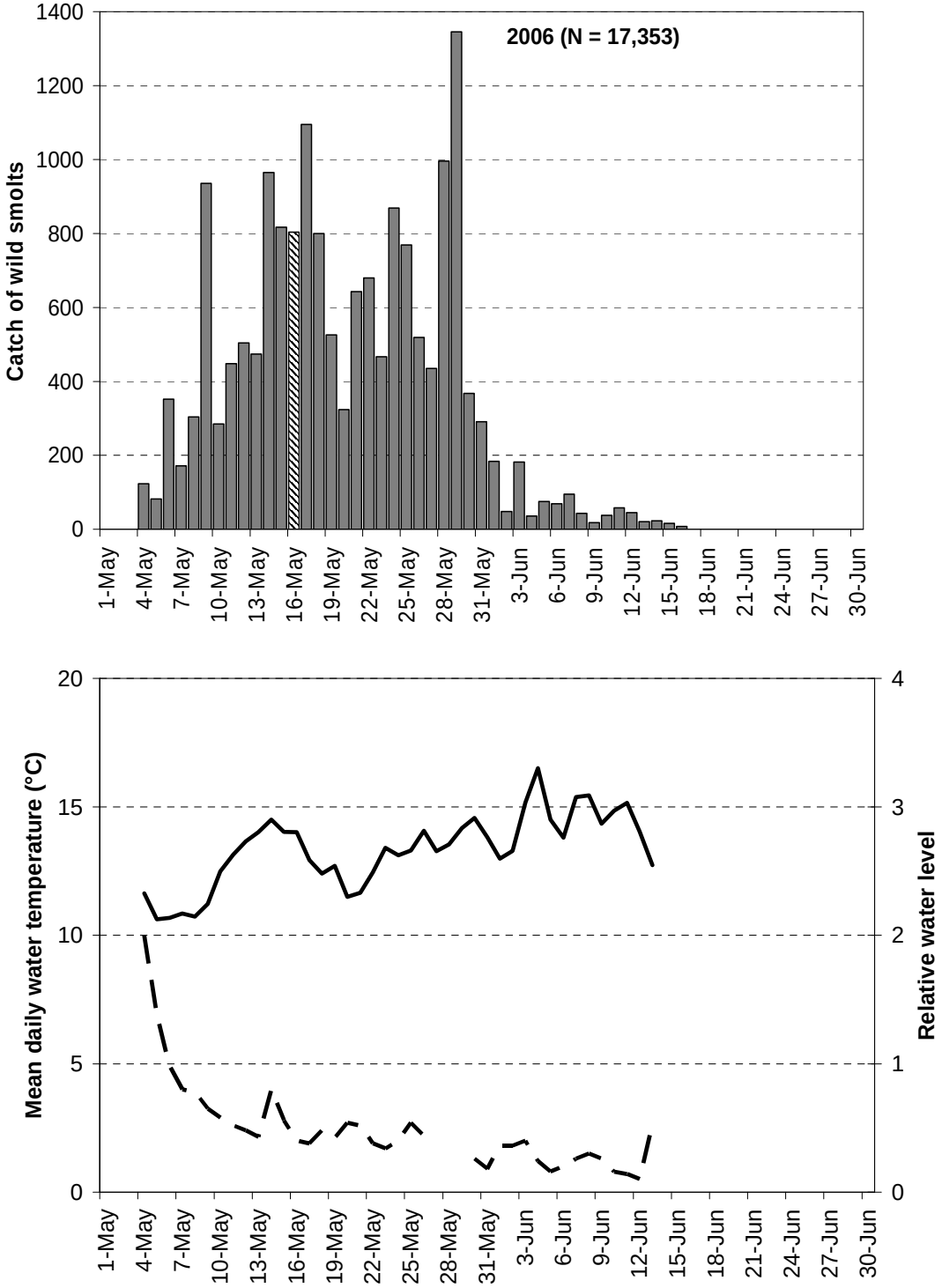

Figure 4. The daily catch of wild smolts (upper panel) and the mean daily water temperature and daily water level (lower panel; solid line = water temperature) in the Margaree River during 2006. The dashed bar represents the date of 50% of the catch.

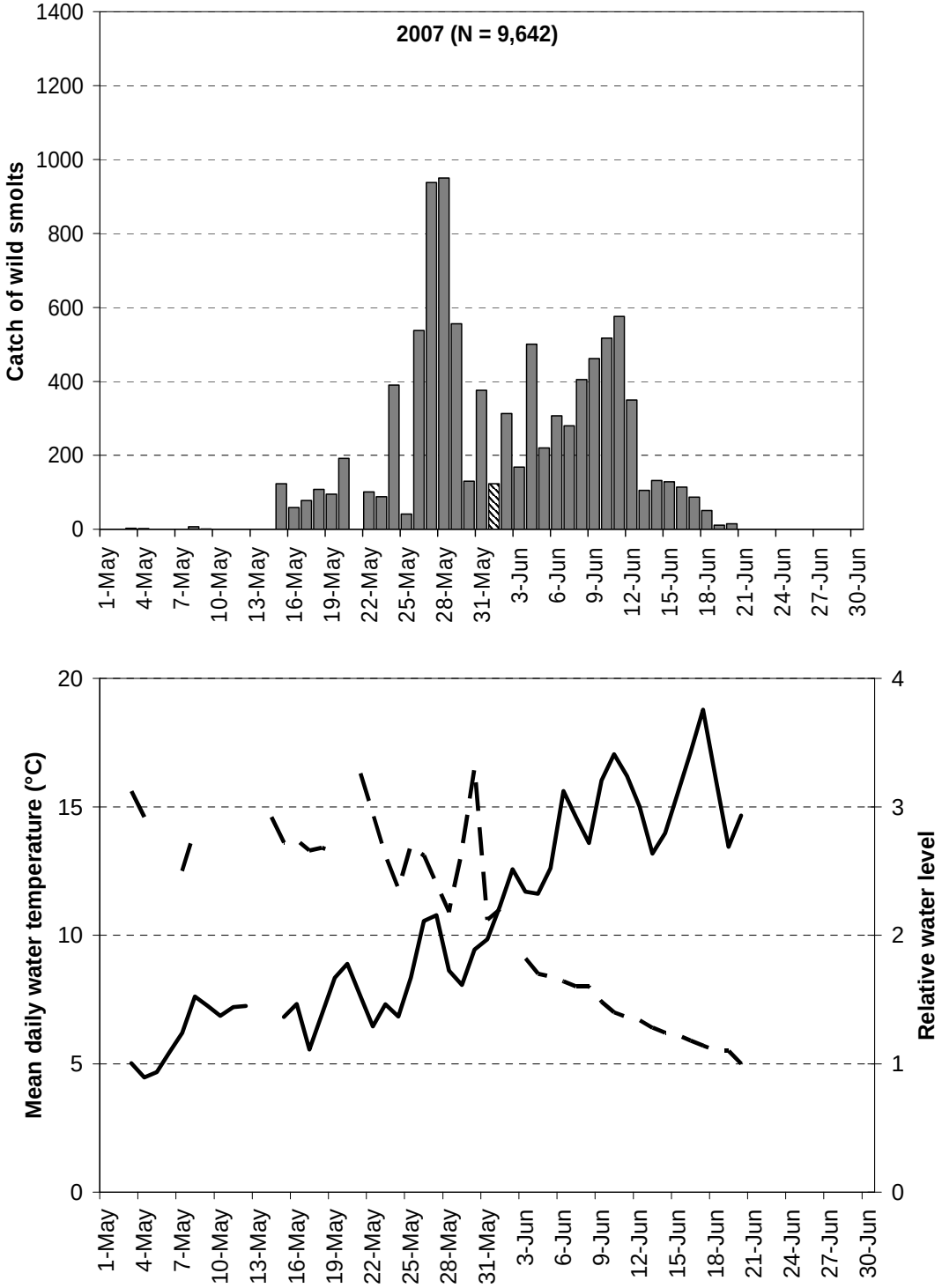

Figure 5. The daily catch of wild smolts (upper panel) and the mean daily water temperature and daily water level (lower panel; solid line = water temperature) in the Margaree River during 2007. The dashed bar represents the date of 50% of the catch.

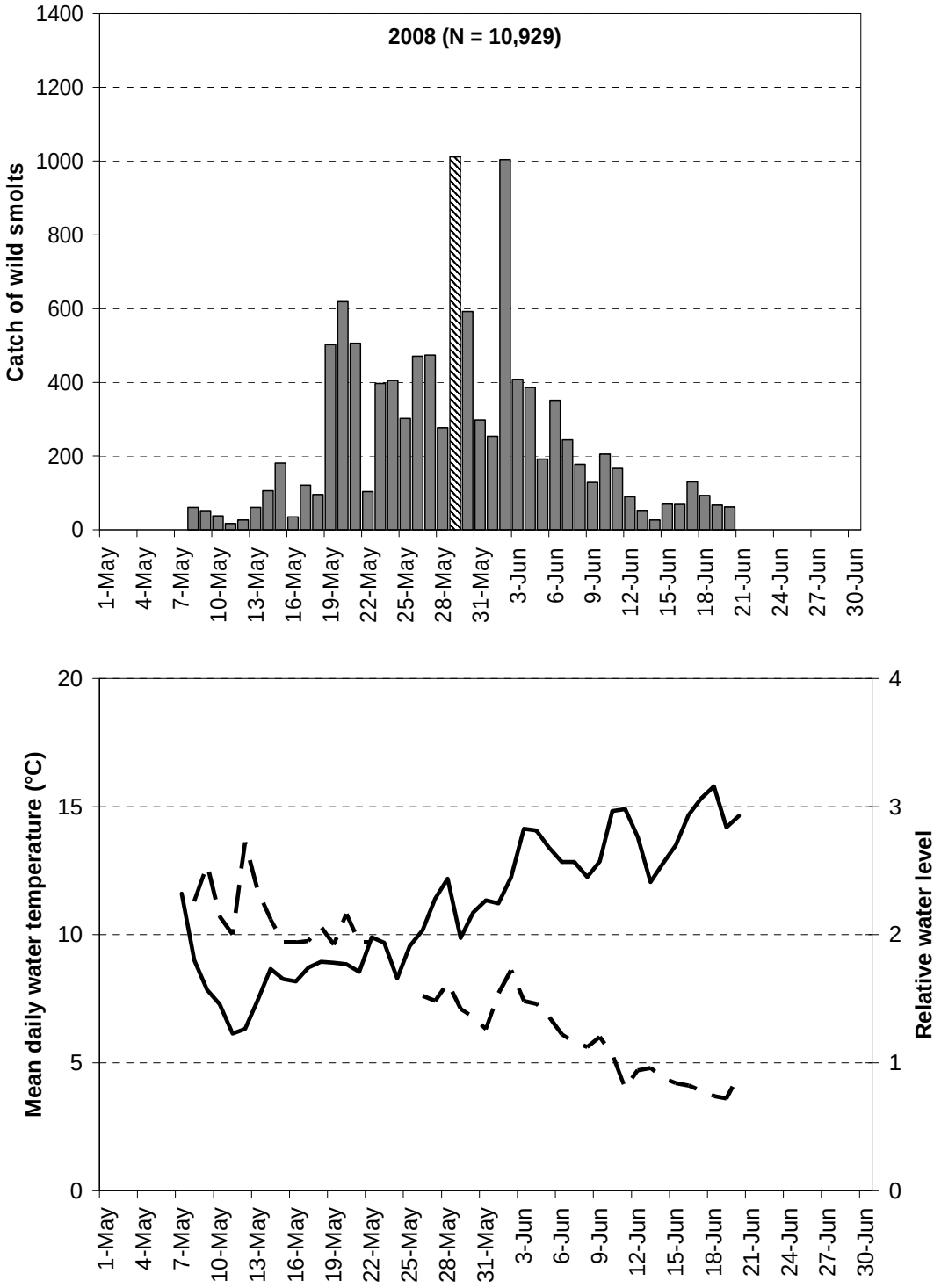

Figure 6. The daily catch of wild smolts (upper panel) and the mean daily water temperature and daily water level (lower panel; solid line = water temperature) in the Margaree River during 2008. The dashed bar represents the date of 50% of the catch.

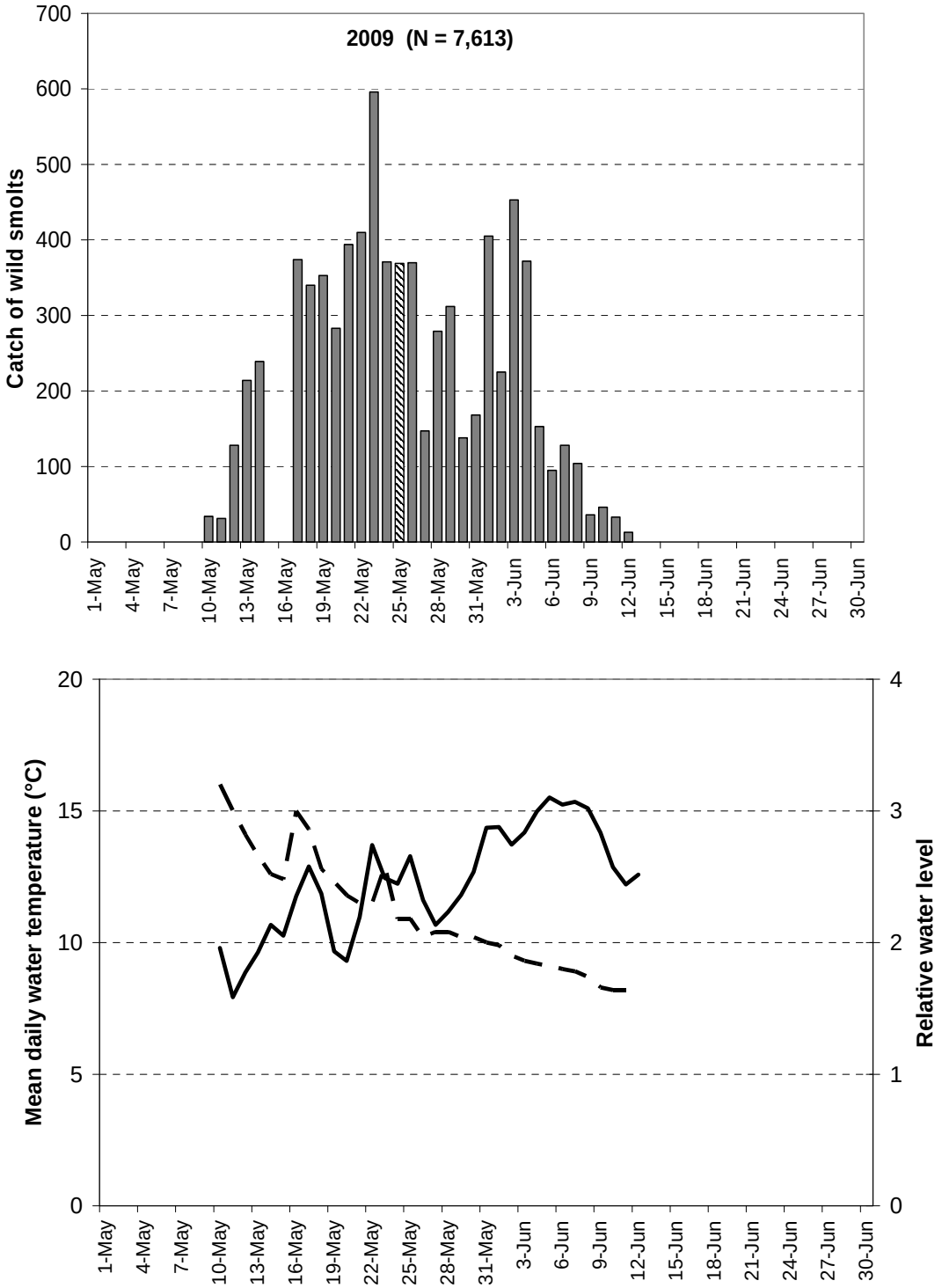

Figure 7. The daily catch of wild smolts (upper panel) and the mean daily water temperature and daily water level (lower panel; solid line = water temperature) in the Margaree River during 2009. The dashed bar represents the date of 50% of the catch.

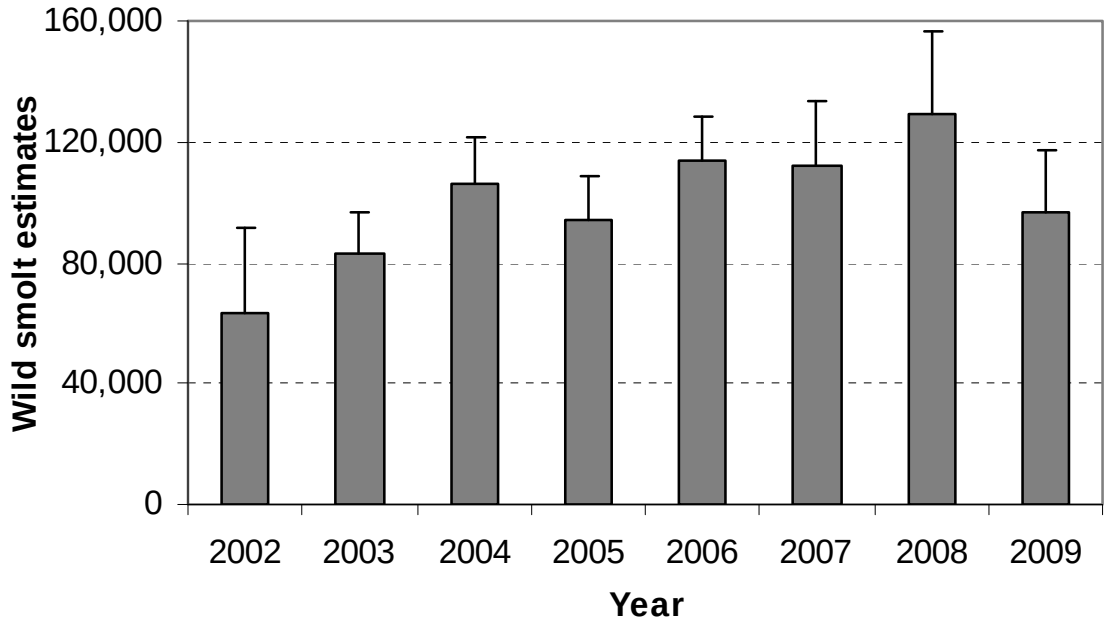

Figure 8. The point estimates (± 95% C.I.) of wild smolts migrating out of the Margaree River during 2002 to 2009. Estimates for 2002 and 2003 are from Clément et al. 2007. All estimates were obtained from the stratified model.

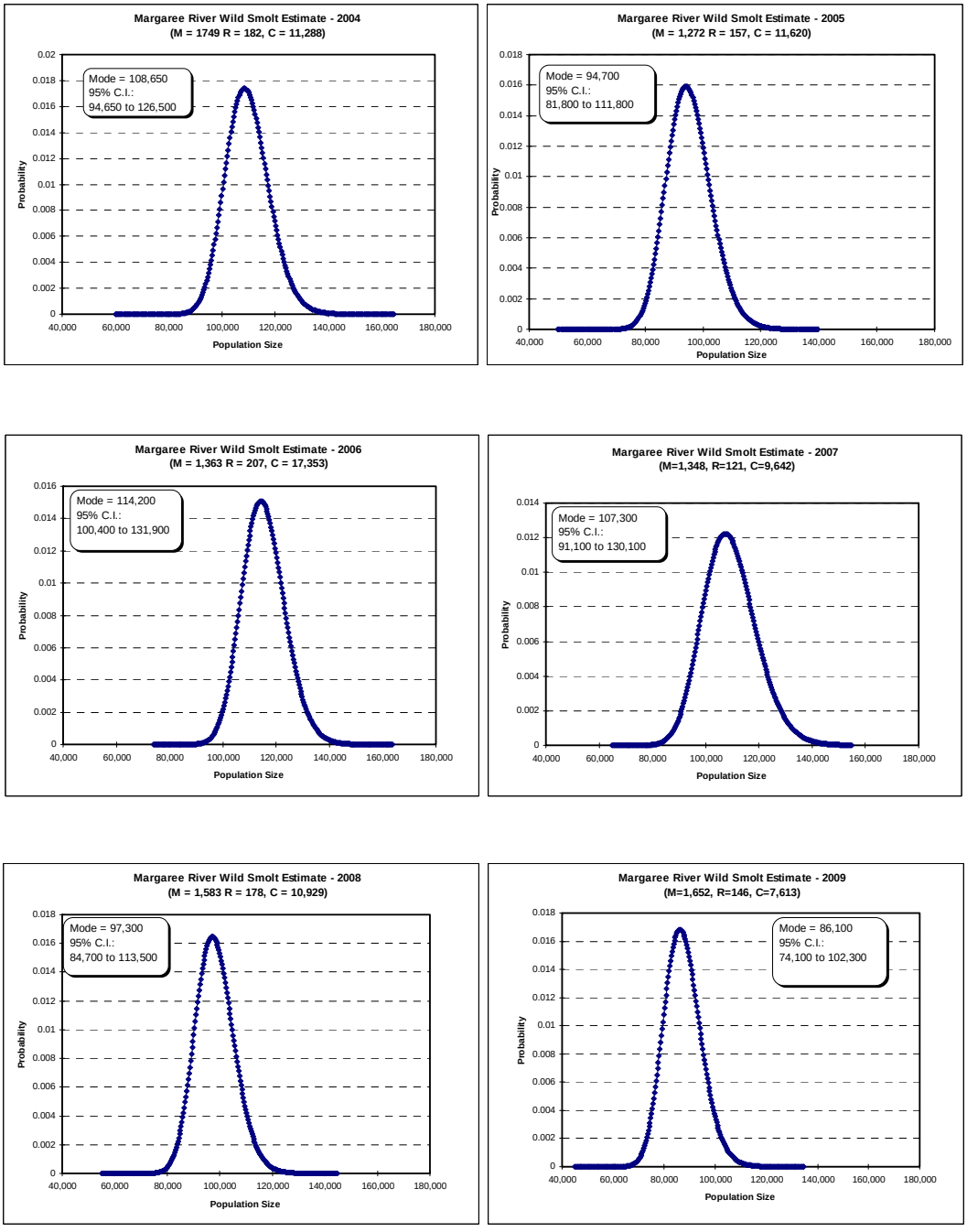

Figure 9. The probability profiles from the bayesian estimates of the run size of wild Atlantic salmon smolts from Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower). M = number of smolts marked, R = recaptures and C = total smolt catch (excludes recaptures).

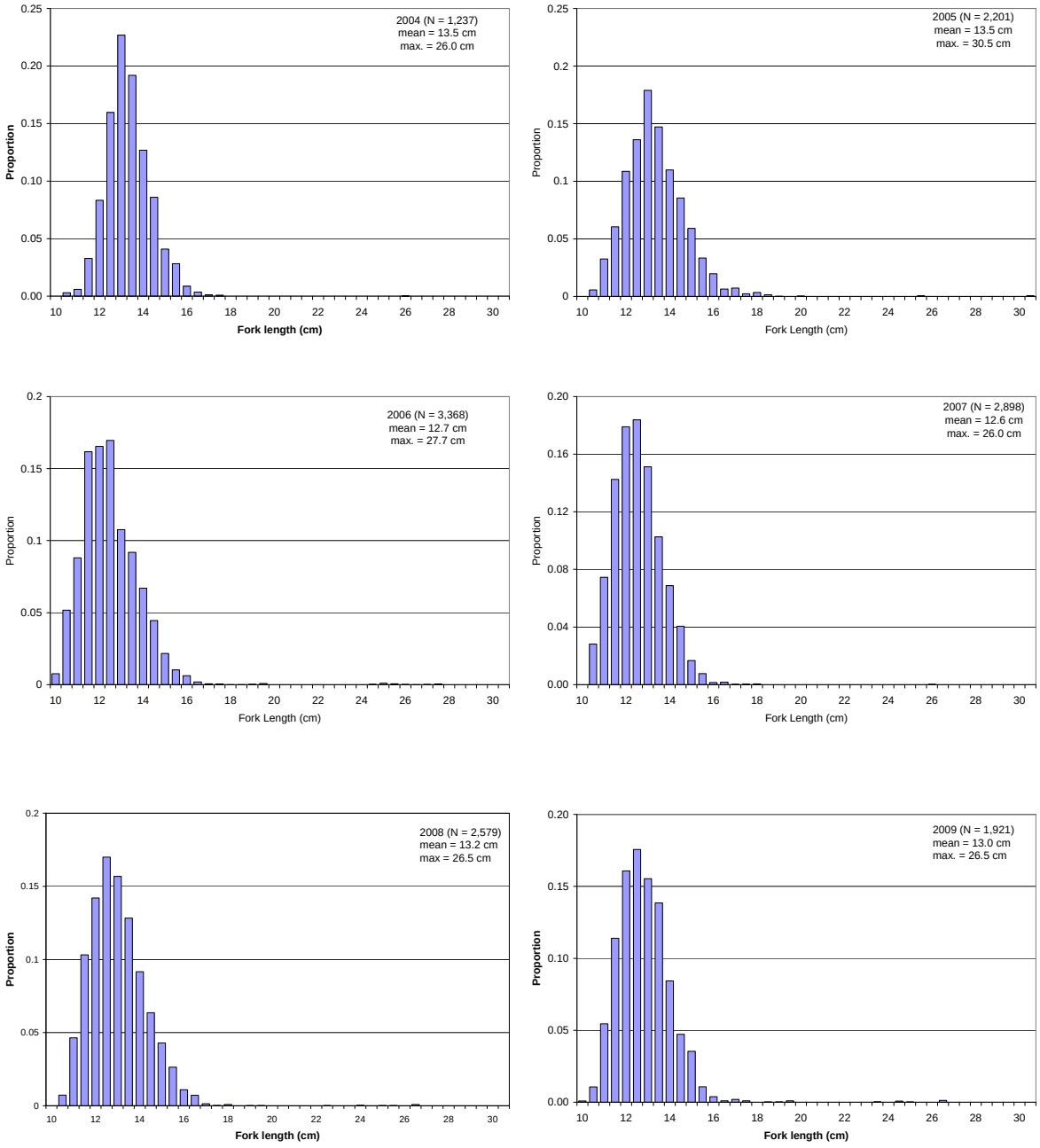

Figure 10. Fork length distribution of wild Atlantic salmon smolts captured at the rotary screw trap (daily samples weighted by the daily catch of smolts) in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower).

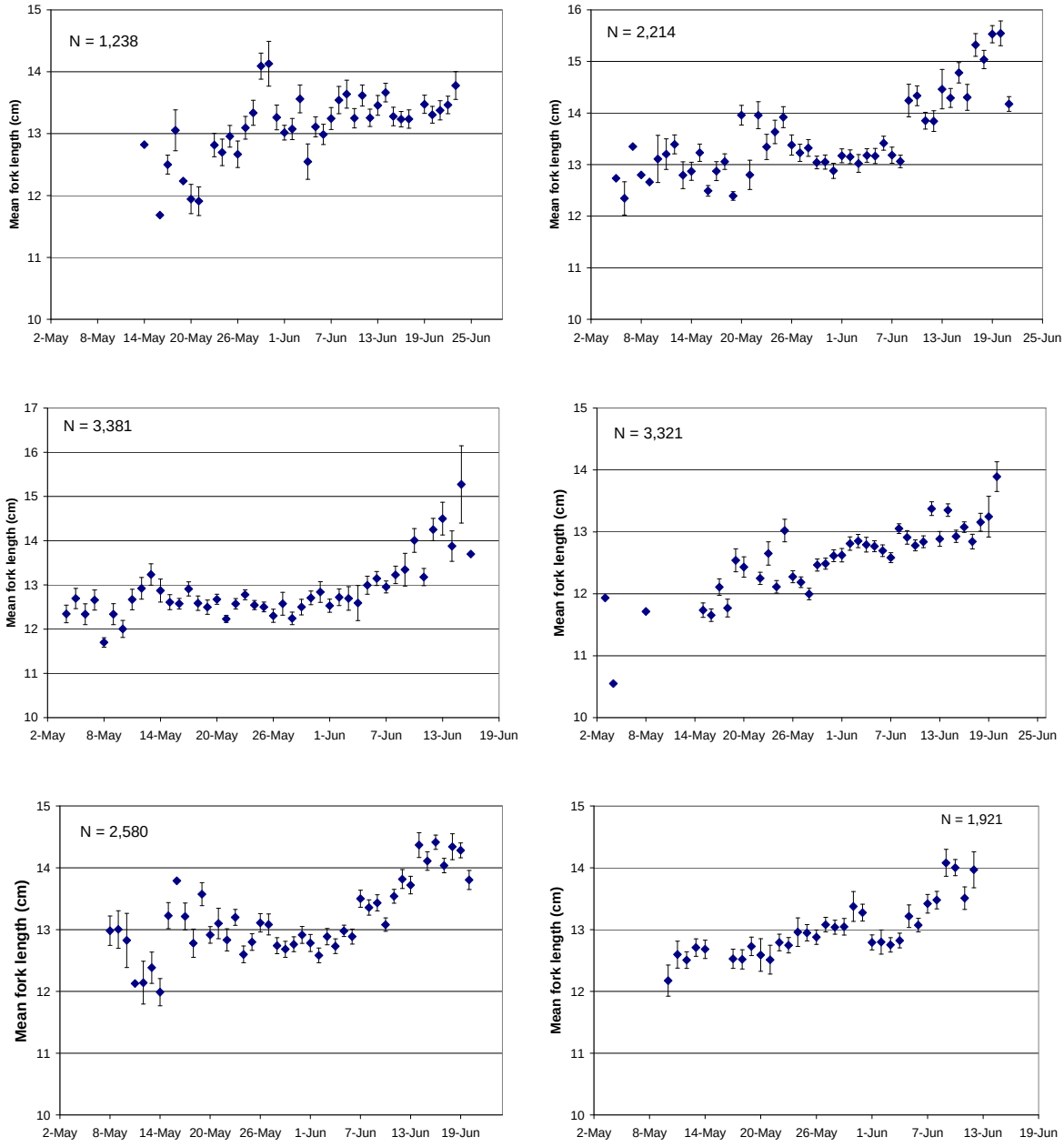

Figure 11. Mean fork length (± one standard error) of wild Atlantic salmon smolts captured at the rotary screw trap in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower). Standard error of the mean not included when n < 10 smolts.

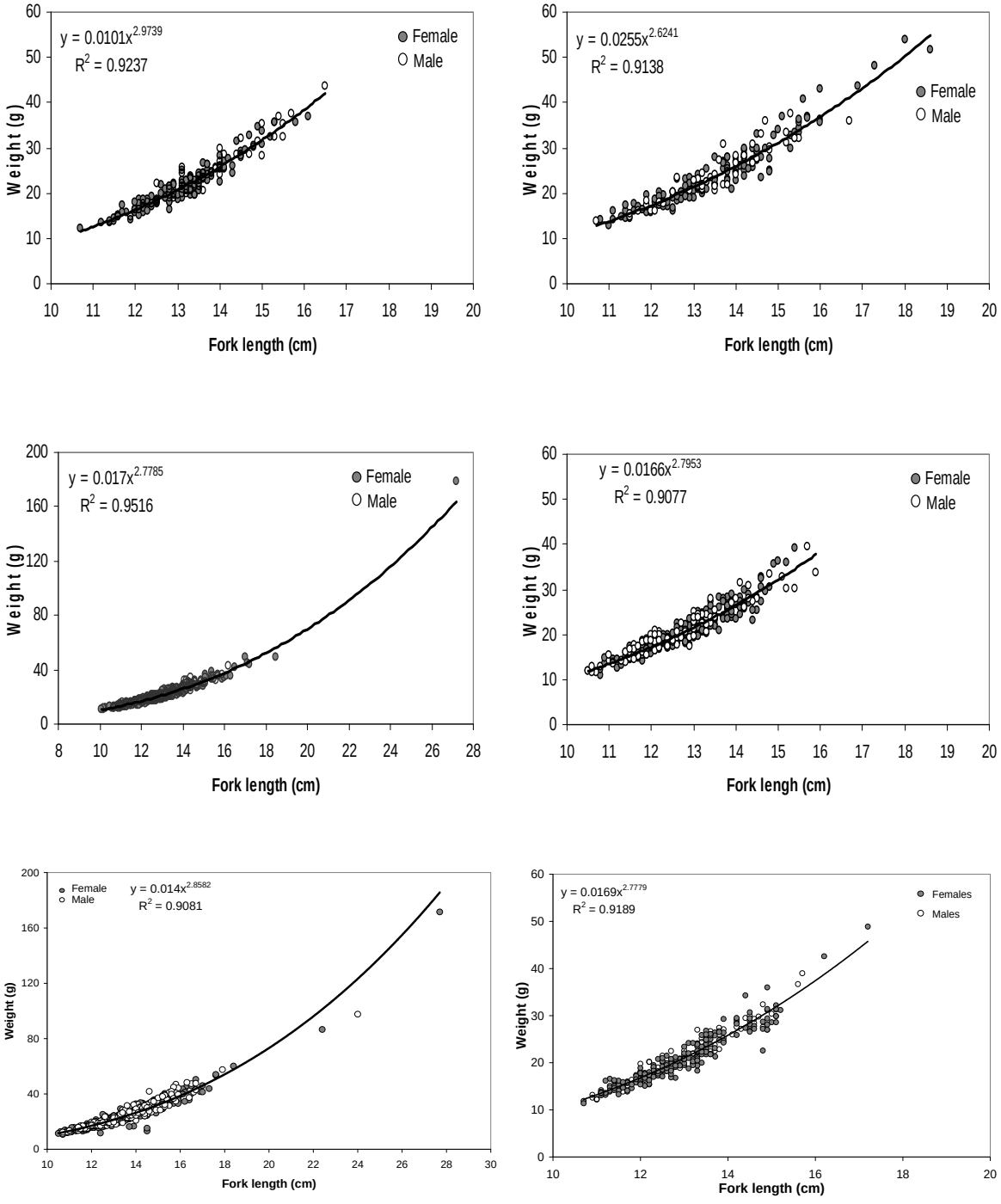

Figure 12. Weight to length relationship of wild Atlantic salmon smolts captured at the rotary screw trap in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower).

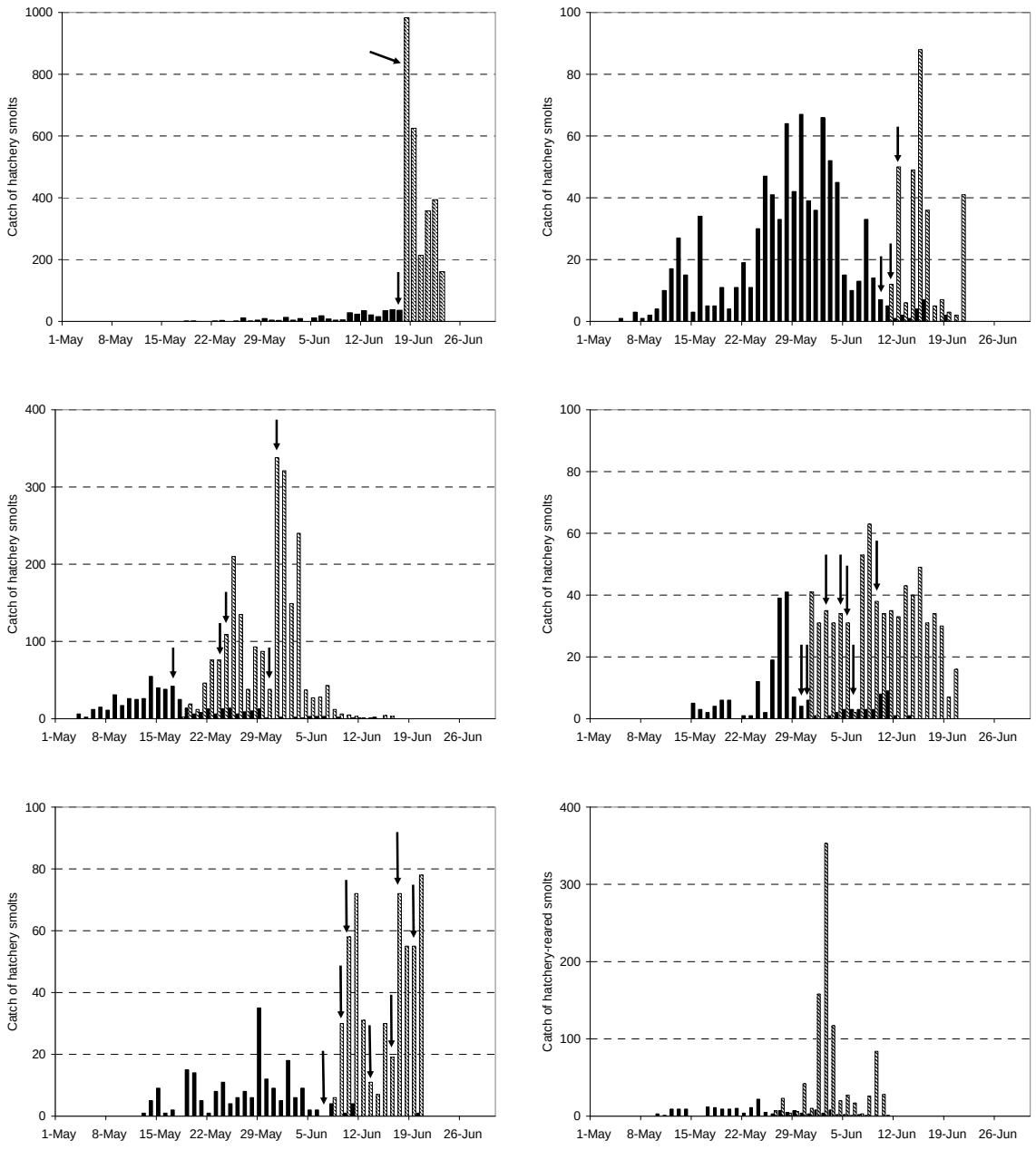

Figure 13. Daily catch of 1 yr spring released smolts (dashed bars) and hatchery smolts from fall fingerlings (solid bars) at the rotary screw trap in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower). The arrows indicate the dates that the 1 yr spring smolts were released.

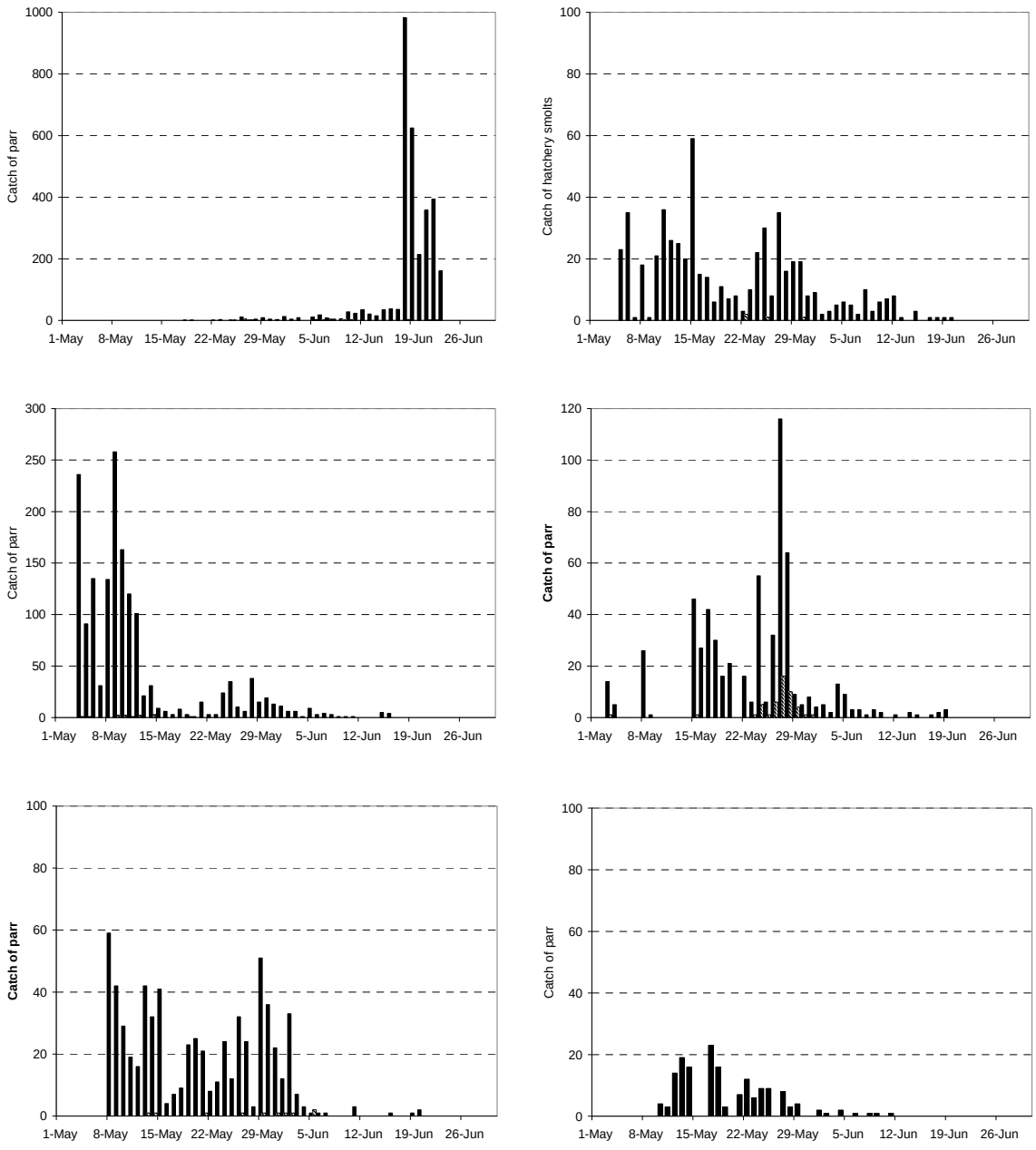

Figure 14. Daily catch of wild (solid bars) and hatchery-reared (dashed bars) parr at the rotary screw trap in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower).

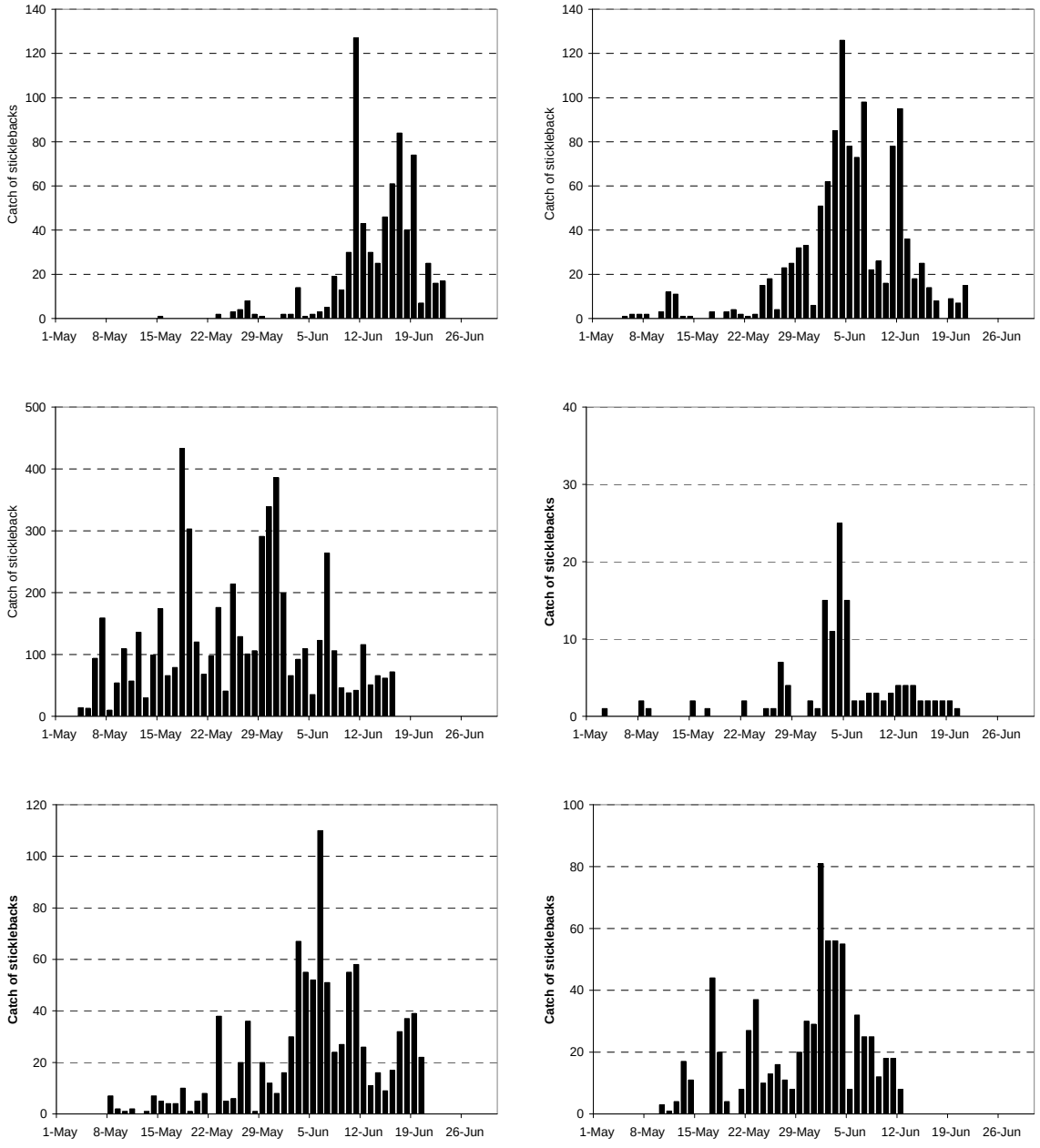

Figure 15. Daily catch of sticklebacks at the rotary screw trap in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower).

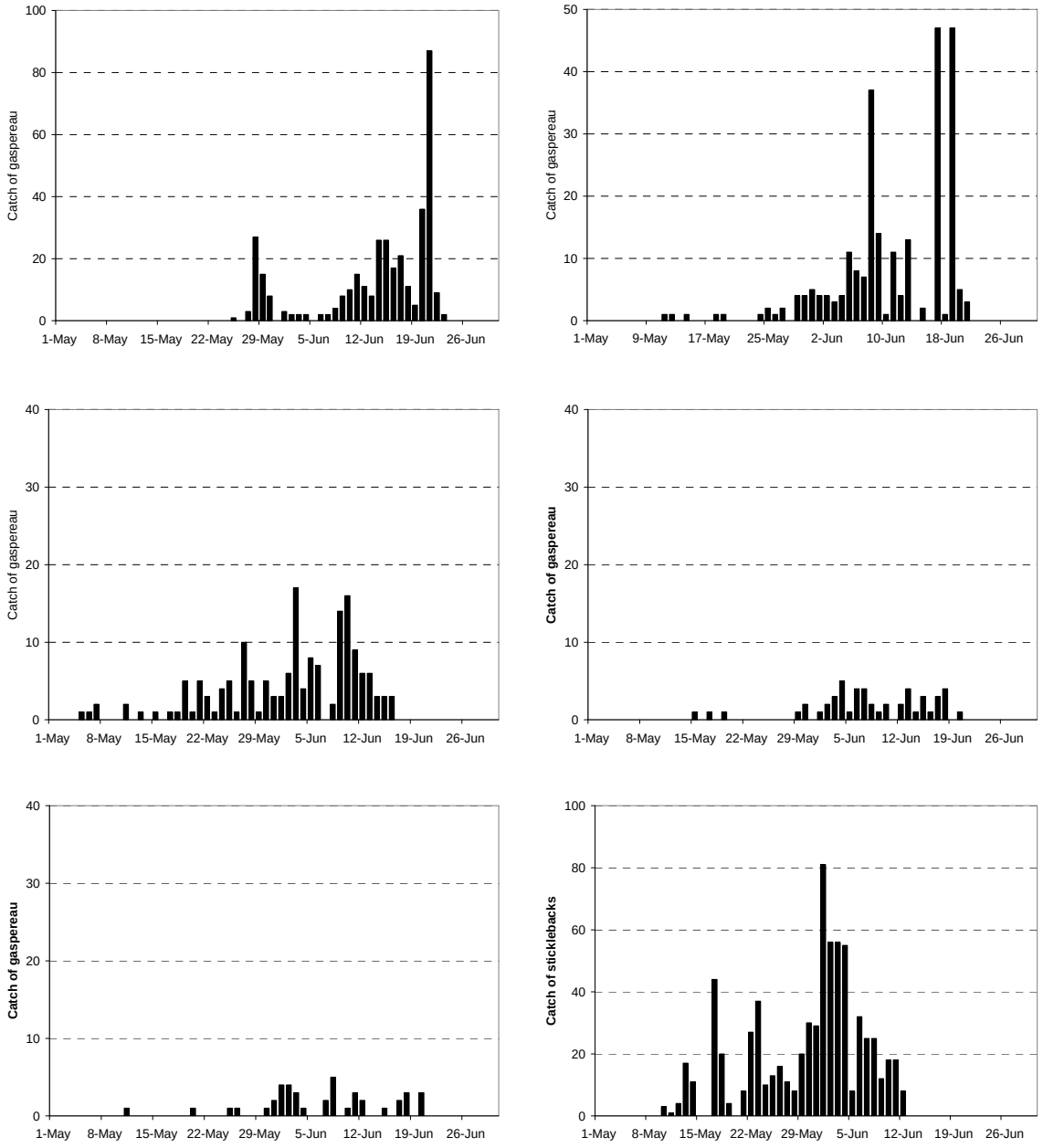

Figure 16. Daily catch of gaspereau at the rotary screw trap in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower).

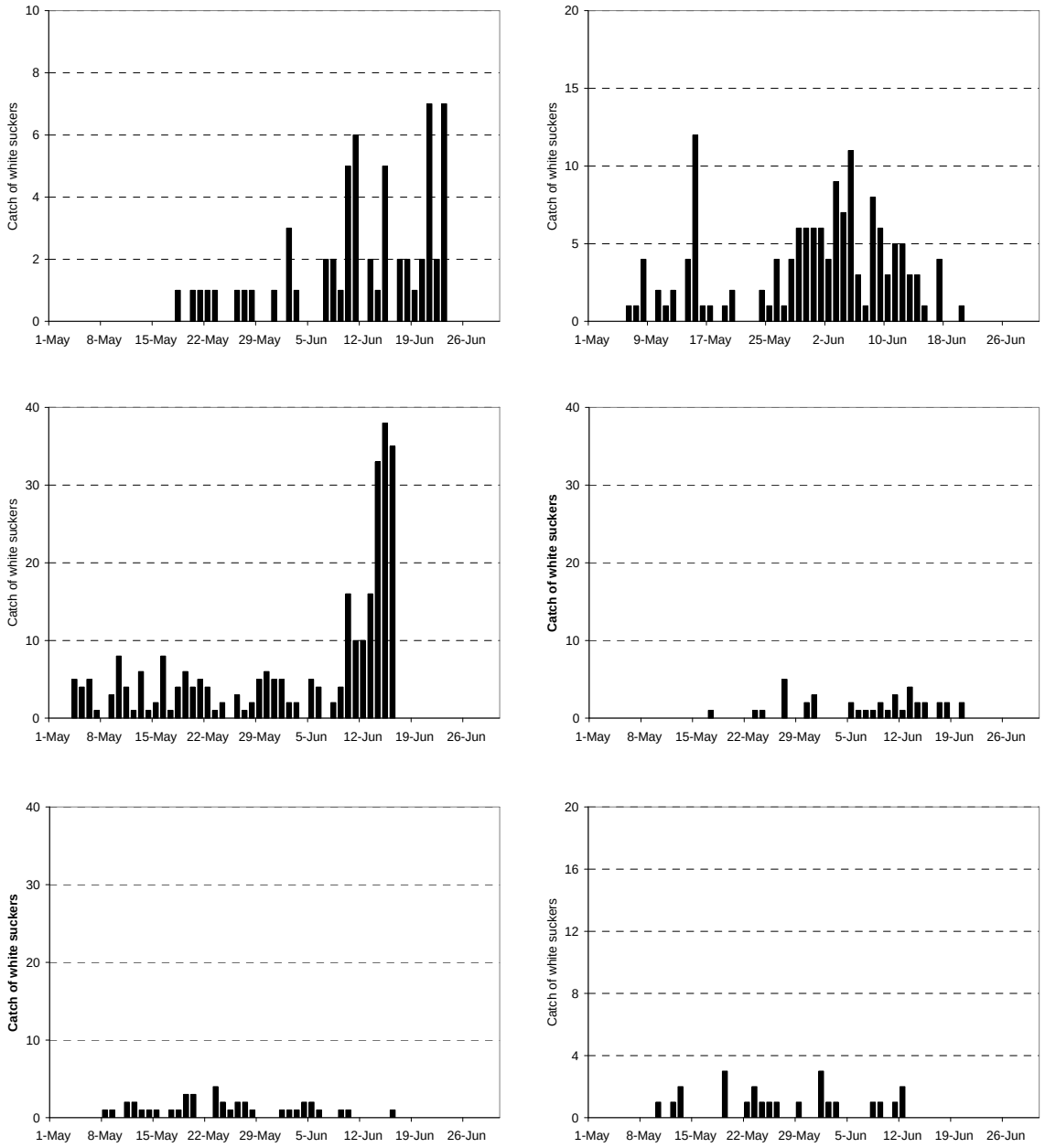

Figure 17. Daily catch of white suckers at the rotary screw trap in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower).

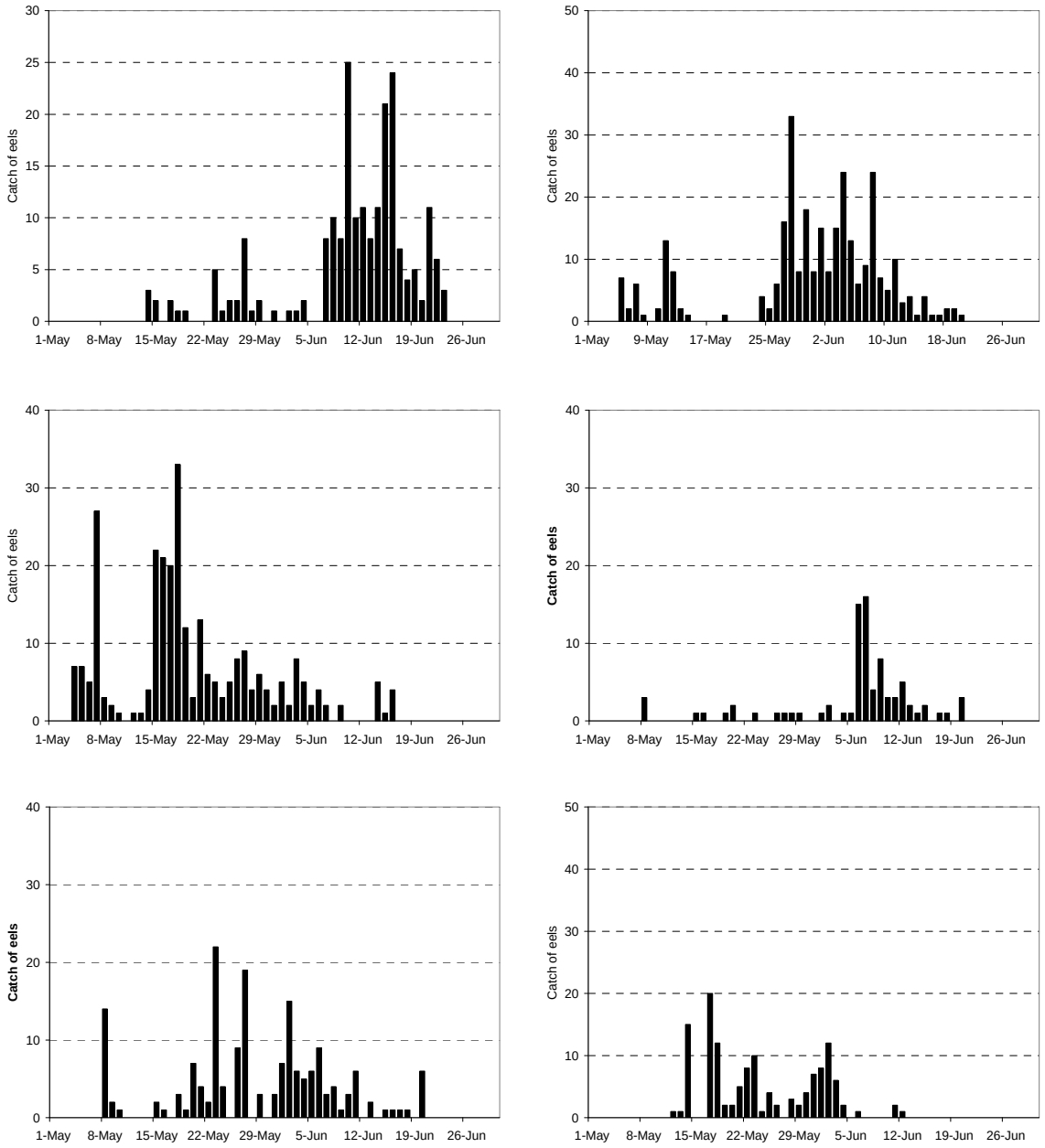

Figure 18. Daily catch of American eels at the rotary screw trap in the Margaree River during 2004 and 2005 (upper), 2006 and 2007 (middle) and 2008 and 2009 (lower).

Appendix 1. Recapture matrix of smolts tagged at the Margaree River RST in 2004. The tagged smolts were released 5.3 km upstream and recovered at the RST.

Date tagged	Number released	Date of recapture: May 13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total	Proportion recaptured
.																																				1					1			2	
13-May	0																																											0	0
14-May	0																																											0	0
15-May	0																																											0	0
16-May	0																																											0	0
17-May	0																																											0	0
18-May	0																																											0	0
19-May	20																																											0	0
20-May	20											1																																1	0.05
21-May	0																																											0	0
22-May	25												2																															2	0.08
23-May	31												3																															3	0.10
24-May	61													4			1																												5	0.08
25-May	23														1		2	1			1										1													6	0.26
26-May	97																6	2			1																									9	0.09
27-May	39																3	1																												4	0.10
28-May	101																	2	1			1																							4	0.04
29-May	79																																											0	0
30-May	27																																											0	0
31-May	0																																											0	0
1-Jun	100																					2	6								1			1	1								11	0.11
2-Jun	99																						8	2	1											1								12	0.12
3-Jun	99																								2	1					1	1			1								6	0.06
4-Jun	0																																											0	0
5-Jun	100																									6	1					1		2										10	0.10
6-Jun	100																										1	1			1	1	3		1									8	0.08
7-Jun	99																											2	1	3		2				1								9	0.09
8-Jun	73																															2		1	1	1								5	0.07
9-Jun	66																													1	4	2	1	1	2								11	0.17
10-Jun	100																														3	5	1		2									11	0.11
11-Jun	100																															4	5	2	4							1		16	0.16
12-Jun	99																																3	1	6	1	1							12	0.12
13-Jun	99																																	1	4	3		1		1				10	0.10
14-Jun	71																																		1	4								5	0.07
15-Jun	71																																			2	3								5	0.07
16-Jun	0																																											0	0
17-Jun	74																																					4	3		3	1			11	0.15
18-Jun	0																																											0	0
19-Jun	0																																											0	0
20-Jun	22																																									1	1		2	0.09
21-Jun	48																																									1	1	2	0.04
22-Jun	0																																											0	0
23-Jun	0																																											0	0
Total tagged	1,943	0	0	0	0	0	0	0	0	0	0	1	5	4	1	0	12	6	1	0	2	3	14	2	3	7	2	3	1	4	11	18	13	9	23	14	4	5	3	1	6	3	1	182	0.09
First time catch		1	9	3	6	50	13	30	34	13	29	70	97	78	217	78	152	159	64	114	288	154	203	53	328	262	287	161	123	509	684	799	871	624	962	1,033	788	571	582	100	276	311	102	11,288	

Appendix 2. Recapture matrix of smolts tagged at the Margaree River RST in 2005. The tagged smolts were released 5.3 km upstream and recovered at the RST.

Date tagged	Number released	Date of recapture: May 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total	Proportion recaptured
.															1																																			1	
5-May	0																																																0	0
6-May	0																																																0	0
7-May	0																																																0	0
8-May	0																																																0	0
9-May	0																																																0	0
10-May	10								1	2																																								3	0.30
11-May	20												1								1																													2	0.10
12-May	31											1									1																													2	0.06
13-May	0																																																0	0
14-May	0																																																0	0
15-May	0																																																0	0
16-May	0																																																0	0
17-May	0																																																0	0
18-May	0																																																0	0
19-May	29																		1		2			1			1																							5	0.17
20-May	0																																																0	0
21-May	58																		1	5	2	1	1																											10	0.17
22-May	69																			4	10	1																													15	0.22
23-May	113																				6	3		2										1																12	0.11
24-May	64																					3																													3	0.05
25-May	49																									1																									1	0.02
26-May	99																							3	3	1	1							1																9	0.09
27-May	100																								2																											2	0.02
28-May	0																																																0	0
29-May	0																																																0	0
30-May	0																																																0	0
31-May	0																																																0	0
1-Jun	96																												2	1	2	1	2																	8	0.08
2-Jun	77																													4	2	1																	7	0.09
3-Jun	98																														6	1	1																	8	0.08
4-Jun	94																															14	3	2																19	0.20
5-Jun	98																																2	8	2	1	1		2									16	0.16
6-Jun	98																																	4	5	1	2	1											13	0.13
7-Jun	97																																		4	2													6	0.06
8-Jun	0																																																0	0
9-Jun	0																																																0	0
10-Jun	20																																					3	1											4	0.20
11-Jun	46																																						3	2									5	0.11
12-Jun	0																																																0	0
13-Jun	47																																								3	2	1								6	0.13
14-Jun	0																																																0	0
15-Jun	0																																																0	0
16-Jun	0																																																0	0
17-Jun	0																																																0	0
18-Jun	0																																																0	0
19-Jun	0																																																0	0
20-Jun	0																																																0	0
21-Jun	0																																																0	0
Total tagged	1,413	0	0	0	0	0	0	0	1	2	0	1	1	0	1	0	0	0	2	9	22	8	1	6	5	2	2	0	0	2	5	10	19	8	14	11	4	3	4	6	2	3	2	1	0	0	0	0	0	157	0.11
First time catch		7	13	13	8	9	22	45	71	144	86	83	192	47	58	47	73	74	91	139	430	320	449	317	586	447	785	453	519	743	922	691	558	226	338	272	437	590	265	285	73	42	215	131	50	65	47	41	101	11,620	

Appendix 3. Recapture matrix of smolts tagged at the Margaree River RST in 2006. The tagged smolts were released 5.3 km upstream and recovered at the RST.

Date tagged	Number released	Date of recapture: May 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total	Proportion recaptured
.																						1		1																							2	
4-May	0																																													0	0
5-May	0																																													0	0
6-May	50				2			1																																					3	0.06
7-May	0																																													0	0
8-May	49						6		2		1																																			9	0.18
9-May	49								5	2	1	1																																			9	0.18
10-May	74								6	2	2				1							1																									12	0.16
11-May	0																																													0	0
12-May	0																																													0	0
13-May	111											5	10																																		15	0.14
14-May	108												7	2						1		1																									12	0.11
15-May	0																																													0	0
16-May	0																																													0	0
17-May	0																																													0	0
18-May	100																3	2	1				2	2	1																					11	0.11
19-May	103																		3	2	2	1	4	2		1																				15	0.15
20-May	0																																													0	0
21-May	99																				3	8	3		1	1			1																	17	0.17
22-May	96																				1	14	4	1		1																					21	0.22
23-May	99																					1	5	5	3	2	1																				17	0.17
24-May	95																						3	5	1																							9	0.09
25-May	93																							1	3		1																				5	0.05
26-May	98																								2	6																					8	0.08
27-May	0																																													0	0
28-May	99																										8	5	3	2																	18	0.18
29-May	99																											1	7	1																	9	0.09
30-May	93																												11	4																	15	0.16
31-May	0																																													0	0
1-Jun	0																																													0	0
2-Jun	0																																													0	0
3-Jun	0																																													0	0
4-Jun	0																																													0	0
5-Jun	0																																													0	0
6-Jun	0																																													0	0
7-Jun	0																																													0	0
8-Jun	0																																													0	0
9-Jun	0																																													0	0
10-Jun	0																																													0	0
11-Jun	0																																													0	0
12-Jun	0																																													0	0
13-Jun	0																																													0	0
14-Jun	0																																													0	0
15-Jun	0																																													0	0
16-Jun	0																																													0	0
Total tagged	1,515	0	0	0	2	0	6	1	13	4	4	6	17	2	1	0	3	2	4	3	6	27	21	17	11	11	10	6	22	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	207	0.14
First time catch		123	82	352	172	304	936	285	448	504	474	965	817	804	1,095	800	526	324	643	680	467	869	769	519	435	996	1,346	368	291	184	48	182	36	75	69	95	43	18	38	58	45	21	23	16	8	17,353	

Appendix 4. Recapture matrix of smolts tagged at the Margaree River RST in 2007. The tagged smolts were released 5.3 km upstream and recovered at the RST.

Date tagged	Number released	Date of recapture: May 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	Proportion recaptured
.																																																		1	1	0.02
3-May	0																																																			0	0
4-May	0																																																			0	0
5-May	0																																																			0	0
6-May	0																																																			0	0
7-May	0																																																			0	0
8-May	0																																																			0	0
9-May	0																																																			0	0
10-May	0																																																			0	0
11-May	0																																																			0	0
12-May	0																																																			0	0
13-May	0																																																			0	0
14-May	0																																																			0	0
15-May	50																																																			0	0
16-May	0																																																			0	0
17-May	0																																																			0	0
18-May	50																	1	1																																	2	0.04
19-May	50																				1																															1	0.02
20-May	0																																																		0	0
21-May	0																																																		0	0
22-May	0																																																		0	0
23-May	50																							2	1	2																									5	0.10
24-May	97																							2	2	6			1																					11	0.11
25-May	0																																																		0	0
26-May	98																									10	6	1																							17	0.17
27-May	99																										12	4	2																							18	0.18
28-May	97																											2	2	3																							7	0.07
29-May	99																												3	4	1			1																			9	0.09
30-May	0																																																		0	0
31-May	99																														5		1	1																			7	0.07
1-Jun	0																																																		0	0
2-Jun	25																																	2		1																3	0.12
3-Jun	50																																	1	1			1														3	0.06
4-Jun	98																																			3		1		1												5	0.05
5-Jun	49																																			1																1	0.02
6-Jun	72																																				2		1	1		1									5	0.07
7-Jun	74																																					4	2												6	0.08
8-Jun	49																																						1	2	1										4	0.08
9-Jun	98																																							5	1										6	0.06
10-Jun	97																																								5	2										7	0.07
11-Jun	47																																									2	1									3	0.06
12-Jun	50																																																		0	0
13-Jun	0																																																		0	0
14-Jun	0																																																		0	0
15-Jun	0																																																		0	0
16-Jun	0																																																		0	0
17-Jun	0																																																		0	0
18-Jun	0																																																		0	0
19-Jun	0																																																		0	0
20-Jun	0																																																		0	0
Total tagged	1,498	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	4	3	18	18	7	8	7	6	0	1	5	1	5	2	6	4	9	7	5	1	0	0	0	0	0	0	1	121	0.08
First time catch		3	2	0	0	0	7	1	0	0	0	0	0	123	59	78	108	95	192	0	101	88	390	41	538	938	950	556	130	376	123	313	168	501	220	307	280	405	462	517	576	350	105	132	129	114	87	51	11	15	9,642	

Appendix 5. Recapture matrix of smolts tagged at the Margaree River RST in 2008. The tagged smolts were released 5.3 km upstream and recovered at the RST.

Date tagged	Number released	Date of recapture: May 7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	Proportion recaptured
.																				1																											1	
7-May	0																																														0	0
8-May	0																																														0	0
9-May	0																																														0	0
10-May	24					1				1																																					2	0.08
11-May	10							1		1																																					2	0.20
12-May	15							1	2																																						3	0.20
13-May	34								2	3		2		1		1																														9	0.26
14-May	39									1	2	1			1																																5	0.13
15-May	73										4	2	3		1																																10	0.14
16-May	24											3	1																																		4	0.17
17-May	49												5	4	2																																11	0.22
18-May	49													13	4						1																										18	0.37
19-May	92														5	7	2						1																								15	0.16
20-May	50															1	1		2																												4	0.08
21-May	74																	2	6		1																										9	0.12
22-May	0																																														0	0
23-May	98																		4	5			1																								10	0.10
24-May	98																			4	6	1	1	1	1	1																				15	0.15
25-May	96																				1	2	2																								5	0.05
26-May	50																					1			1	1																				3	0.06
27-May	46																							5																								5	0.11
28-May	0																																														0	0
29-May	98																								5	2		1																			8	0.08
30-May	99																								1	2	3	1																			7	0.07
31-May	100																										1	2																			3	0.03
1-Jun	48																											2																			2	0.04
2-Jun	46																											1		1			1													3	0.07
3-Jun	75																													2																	2	0.03
4-Jun	50																														1	1															2	0.04
5-Jun	48																																														0	0
6-Jun	50																																2	1		1											4	0.08
7-Jun	50																																	1	2		1				1					5	0.10
8-Jun	49																																		1	2	1										4	0.08
9-Jun	25																																			1											1	0.04
10-Jun	50																																				2										2	0.04
11-Jun	50																																					1	2	1								4	0.08
12-Jun	0																																														0	0
13-Jun	0																																														0	0
14-Jun	0																																														0	0
15-Jun	0																																														0	0
16-Jun	0																																														0	0
17-Jun	0																																														0	0
18-Jun	0																																														0	0
19-Jun	0																																														0	0
20-Jun	0																																														0	0
Total tagged	1,759	0	0	0	0	0	0	1	2	4	6	6	8	9	18	13	9	3	2	12	10	9	4	5	6	8	6	4	0	7	3	1	1	3	2	3	4	4	1	2	1	0	0	0	0	0	178	0.10
First time catch		0	61	50	38	17	27	61	106	181	35	121	96	502	619	506	104	397	405	302	471	474	277	1,012	592	298	254	1,004	408	386	192	351	244	178	129	205	167	90	51	27	70	69	130	93	67	62	10,929	

Appendix 6. Recapture matrix of smolts tagged at the Margaree River RST in 2009. The tagged smolts were released 5.3 km upstream and recovered at the RST.

Date released	Number released	Date of recapture																																				Total	Proportion recaptured
		May																							June															
		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12		
.											1			1		1							1	1													5	
11-May	0																																			0	0
12-May	49				3	1																														4	0.08
13-May	49					4																														4	0.08
14-May	100																																			0	0
15-May	0																																			0	0
16-May	0																																			0	0
17-May	100									3	2	1																								6	0.06
18-May	100										7	2	2	1																						12	0.12
19-May	49											2																								2	0.04
20-May	0																																			0	0.00
21-May	100													1	1	1						1														4	0.04
22-May	98														8	1																				9	0.09
23-May	98															7		1																		8	0.08
24-May	99																5	1		1																7	0.07
25-May	98																	6	4	3	1															14	0.14
26-May	98																		2	3			1													6	0.06
27-May	49																				2	2						1								5	0.10
28-May	97																				5	1	1	3		1										11	0.11
29-May	96																							1												1	0.01
30-May	48																						2													2	0.04
31-May	44																							2												2	0.05
1-Jun	99																								7	3	1									11	0.11
2-Jun	100																									4	6									10	0.10
3-Jun	99																										10	5								15	0.15
4-Jun	74																											2								2	0.03
5-Jun	50																												2		2					4	0.08
6-Jun	12																																			0	0
7-Jun	30																														1	1				2	0.07
Total tagged	1,836	0	0	0	3	5			0	3	10	5	2	3	9	10	5	8	6	7	8	4	5	7	7	8	17	8	2	0	3	1	0	0	0	146	0.08
First time catch		34	31	128	214	239			374	340	353	283	394	410	596	371	369	370	147	279	312	138	168	405	225	453	372	153	95	128	104	36	46	33	13	7,613	