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DFO Atlantic Fisheries Research Document 96/117

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A discussion document on the implications of catch-and-release angling for Atlantic salmon, with particular reference to water temperature-related river closures.

by

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[1] This series documents the scientific basic for the evaluation of fisheries resources in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

[1]La présente série documente les bases scientifiques des évaluations des ressources halieutiques sur la côte Atlantique du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considerés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

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Abstract

Based on recent research on the effects of catch-and-release fishing for Atlantic salmon, this paper models temperature-driven angling closures and raises issues related to both salmon management and research. It suggests that assumptions about the effects of catch-and-release fishing of salmon, previously considered sufficient, should be verified. It also demonstrates the need for a clear, consistent, easily-understood and communicated policy for closing, and subsequently reopening rivers for temperature-related reasons. A number of inputs should be sought and various factors carefully considered prior to the formulation of such a policy.

Résumé

Le présent document, fondé sur des recherches récentes concernant les effets de la pêche du saumon de l'Atlantique avec remise à l'eau des captures, traite des fermetures de la pêche à la ligne motivées par la température et soulève diverses questions liées à la gestion du saumon et à la recherche sur cette espèce. On y suggère de vérifier les postulats sur les effets de la pêche du saumon avec remise à l'eau des captures, auparavant jugés suffisants. Ce document établit aussi la nécessité d'avoir une politique claire, uniforme, compréhensible et bien communiquée en ce qui concerne la fermeture et la réouverture subséquente de la pêche dans les rivières pour des raisons liées à la température. Il conviendrait de solliciter un certain nombre d'avis et d'examiner soigneusement divers facteurs avant de formuler une telle politique.

Introduction

In Atlantic Canada mandatory catch and release of multi-sea-winter fish has been in place as a keystone Atlantic salmon management measure since 1984. In 1991, following controversy over a proposed extension of the angling season on the Miramichi river in New Brunswick, and in light of an almost complete lack of good scientific data on the effects of catch-and-release angling on Atlantic salmon, a comprehensive suite of studies was initiated by a variety of co-operators (Bielak and Tufts, 1995; Bielak et al. 1996).

The goal of the research was to establish a broad scientific data base on the catch-and-release issue and achieve the maximum enhancement benefits from this conservation practice. Initial research results raised several management-related opportunities and questions, including the dilemma of identifying the circumstances when rivers should be closed to angling. Furthermore, with recent developments such as court decisions related to Native fisheries, demands are increasing for ever-greater precision of estimates of spawning escapement of Atlantic salmon.

Some DFO (CAFSAC and the regional assessment process that succeeded it) documents have assumed a 5% "rule of thumb" mortality for angler-caught-and-released Atlantic salmon; a 3% and 6% mortality is assumed for MSW fish on the Miramichi and Restigouche rivers respectively (Bielak and Tufts, 1995; Chaput[1], pers. comm.) The 5% mortality is based on a NBDNRE study (Currie, 1985) in a coldwater tributary of the Miramichi that rarely reached the warmer experimental temperatures referred to below during the experimental period[2].

To stimulate and assist discussion on such topics, this paper briefly reviews the recent catch-and-release research, makes some assumptions about the effects of catch-and-release fishing, models temperature-driven fisheries closures and raises some issues in terms of both future salmon management options and research needs. It concludes with the desirability of formulating a clear, consistent, easily-understood and communicated policy for closing, and subsequently reopening rivers for temperature-related reasons. A number of inputs should be sought and various factors carefully considered prior to the formulation of such a policy.

Does Catch-and-release Kill Fish?

Issues addressed by the suite of catch-and-release studies included the following: Does late season angling have an adverse impact on spawning success in Atlantic salmon? Was physiological disturbance any greater in MSW salmon than in grilse. Was significant mortality associated with catch-and-release angling at various water temperatures and in different water conditions, and did different life stages respond differently to the stress of angling? A complete assessment of all the

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[1]G. Chaput, DFO Moncton.

[2]<u>Maximum</u> July and August water temperatures of 20°C or above were recorded only on 7 occasions out of 118 days sampled in 1982 and 1983. (The maximum temperature reached was 21°C on two days).

work described above is expected in late 1997, but an initial overview of results to date, including the physiological aspects, can be found in Bielak et al. (1996).

Generally, it appears that mortality is minimal in kelts angled during the spring and in salmon angled in the fall. What mortality does occur is probably related to direct injury of the fish rather than physiological factors. Salmon that have recently entered the river and are angled early in the season may experience higher mortality than fish that have been in freshwater for some time and are caught and released during the season. Fish caught and released during warm water events (at 20°C and above) appear to experience higher mortality than fish at other times.

In the fall experiments it was also found that grilse exhibited greater physiological disturbance than salmon, despite the much longer angling period for salmon (Booth et al., 1995). This suggests that, at least in the late season, the likelihood of delayed mortality in MSW salmon is no greater than it is in grilse - perhaps even less. In the same experiment, angled and control fish were transported back to the Miramichi Salmonid Enhancement Centre for spawning, to monitor gamete viability and survival. It was found that late season angling had no effect on gamete viability (Davidson et al., 1994; Booth et al., 1995). Since catch-and-release rules target MSW salmon (particularly egg-bearing females), both the above findings are encouraging from a conservation standpoint.

As an indication of orders of effects caused by catch-and-release angling, and to furnish a basis for discussion, the following figures are provided: In the black salmon component of the studies (at water temperatures of about 4°C) a single (predicted due to physical injury) mortality was observed among 89 kelt (Bielak et al., 1996). A total of 118 fish was used in the fall experiments on the Miramichi (at 5-6°C) with 0% mortality (Booth et al., 1995). In an experiment on the Upsalquitch, over the course of two summers, confirmed (conservative) mortality rates for angled fish were 5.4% in 1992 and 5% in 1993 (Booth, 1994). In another experiment on the Miramichi (at 16±1°C), three of 25 (12%) bright salmon died within 12 hours following angling (Brobbel et al, 1996).

In an experiment at about 20°C on the Miramichi mortality was 0% in the controls versus 40% in the angled fish (Tufts et al., 1996; Wilkie et al., 1996 a). (Caution should be used in extrapolating these figures since there was an additional stress on the fish beyond that of angling alone: Of 55 fish collected at the barrier and transferred to holding boxes during the experiment, 6 (9%) of those fish died. Of the remainder, 35 fish were subsequently used in the experiment.) In an experiment at the Margaree Salmonid Enhancement Centre, fish were held at 12°C, 18°C and 23°C. Although all surviving fish held at all three temperatures showed almost full physiological recovery within 4 hours, 30% of the fish acclimated to 23°C died within this period. No further mortality occurred after 4 hours and no mortality occurred in any of the control groups, or in fish exercised at 12°C or 18°C. (Wilkie et al.1996 b).

Implications for Salmon Management

The focus of preservationists and others is shifting to scrutiny of common angling - even research - practices. The public at large and special interest groups will increasingly demand assurances that every measure is being taken to ensure that angling or handling stress on fish is minimised. For instance, the Saint John River was closed to all salmon angling (including catch-and-release) in 1995, both because of dismal predicted returns as well as concerns related to mortality of released fish. With increased understanding of the effects of catch-and-release one could envisage development of a catch-and-release fishing "window" with negligible mortality, thus satisfying the diverse constituencies on the river.

Consequent to the research reported above, assumptions about the effects of catch-and-release fishing of salmon, previously considered sufficient, should be verified. Although other factors, such as degree of freshwater acclimation or of starvation of the fish may contribute, temperature is clearly a significant factor in post-catch-and-release mortality of salmon.

Better understanding of mortality rates in released salmon under various conditions, (particularly in the light of likely variations in mortality between warm and cool water circumstances) should allow fine tuning of stock assessments for different rivers and situations where accurate temperature record series are available. Such information will also lead to refinement of catch-and-release practices and allow more informed decision making regarding angling season extensions and closures. The results of the late season studies mentioned above (Booth et al., 1995) have already found wide application by fisheries managers, when considering extending salmon angling seasons.

Inevitably, plenty of questions remain to be answered on the scientific front. Nearly all of the work described has been on grilse or small salmon, and it would be valuable to know whether the results hold for large fish in the 10 - 20 kg. range. We must also conclusively deal with the question whether being played by an angler will affect the fish's migration to - and behaviour on - the spawning beds, and whether catch-and-release angling in the early, as opposed to the late, season has any effect on gamete fitness. The question of whether angling stress would make a fish more susceptible to a disease such as furunculosis would also have some applicability on a river such as the Restigouche.

Such information may also help managers to decide if certain stocks or valued stock components merit special protection and, if so, precisely at what temperatures to consider shutting down angling, or suspending other potentially stressful in-river procedures such as handling and tagging fish in the course of trap net, barrier pool or fishway operations or broodstock collecting. In light of potential elevated mortalities at high temperatures some argue it may be best to close rivers to angling when water temperatures get to such levels. Specifically, current DFO protocol in Newfoundland leads to complete angling closures of rivers at temperatures exceeding 22°C (Reddin, 1995[3]).

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[3]It was unclear from this reference whether the 22°C temperature referred to represented the daily mean temperature, a maximum or a punctual occurrence. For the purposes of this paper it was assumed to be a daily mean temperature. In fact, the actual protocol - outlined in an internal DFO memo from the Regional Director, Science - is that closure to angling should occur when temperatures measured at 2.00-3.00 p.m. exceed 22°C on two consecutive days (Reddin (DFO St. John's, Newfoundland) pers. comm.).

Some examples from the New Brunswick experience

If the Newfoundland approach were applied globally in New Brunswick, closures for the major part of the salmon season on certain rivers could be expected in low, and warm, water years such as 1995.

Current practice for river closures: As part of their regular patrols on the river DFO wardens take water temperatures when conditions are warm. When temperatures reach a point where fish mortalities are observed (including mortalities of released fish), water levels are low, and fish are congregating in specific areas where they are easily visible (and thus more accessible to jigging and poaching), wardens may decide that conservation is jeopardised and closure should be considered. Ideally they consult with colleagues and biologists, as well as with their supervisors, before making a formal recommendation for closure.

This recommendation, with supporting rationale, rises via the chain of command, and would now probably include consultation with the local watershed committee. Advantages of the system include the rapidity with which closures of specific areas can be effected, and the input of staff who are in close, daily contact with the resource and are networking with colleagues in different parts of the same watershed. A negative includes the potential for inconsistent or arbitrary decisions made in the absence of standardised guidelines for closing (and re-opening) fisheries. The lack of any current model for the prediction of water temperatures is also of significance in this respect.

If one adopted a "22°C rule" in New Brunswick, what would the implications be? In hydrological terms, Caissie (1996) demonstrated that, for new Brunswick, 1995 was characterised by low stream flows and high water temperatures during the summer, including record low flows on the Upsalquitch River, and temperatures that reached as high as 30°C on the Miramichi. Based on available temperature records, provided courtesy of DFO (Fig. 1), Figures 2 - 7 illustrate the number of days of potential closures during the 1995 salmon season for a number of rivers in the province. Calculations are based simply on the number of days that mean daily water temperatures exceeded 22°C. Figures 6 - 8 are also provided to stimulate discussion of other related considerations to be discussed below.

With closure above 22°C in 1995, the Nashwaak would have been closed a minimum 35 days over the course of the season (Fig. 2), and the Restigouche a minimum of 16 days during July and August (Fig 3). Temperature data for the Tobique (Fig. 2), and Restigouche and Nepisiguit rivers (Fig. 3) are incomplete or are not continuous to varying extents, illustrating the importance of having a full temperature record over the course of a salmon angling season in assessing potential closures.

For Miramichi tributaries, angling closures would have ranged from zero days for the Dungarvon (Fig. 4) to 51 days for the Southwest Miramichi at the Enclosure trap (Fig. 5.). If the "22°C rule" also applied to fish handling during research/assessment activities, operation of the barrier pool on the Dungarvon and at the Catamaran Brook counting fence (Fig 4.) would have been unaffected, while trapnetting at the Enclosure would have ceased for a significant portion of the total operational period.

The situation is more complex when multiple temperature records for a river exist such as in Figures 4 and 5 where data are available from various locations along a river. For the N.W. Miramichi (Fig. 4) headwater (Barrier pool) temperatures never approached the 22°C threshold, while lower in the system, at the Big Hole Protection Barrier, temperatures exceeded 22°C for 14 days during the period for which records are available. For the Main S.W. Miramichi (Fig. 5), not unexpectedly, Juniper barrier (headwater) temperatures are generally cooler than lower in the system (Millerton), and in the area of significant tidal influence (Enclosure).

For the Nepisiguit (Fig. 6), 8.00 a.m. thermometer readings, likely representing substantially lower than mean or maximum figures (Caissie, pers. comm[4].), are shown for 1992, 1993 and 1995; Based on these data significant closures would only have occurred in 1995. Note that there appears to be a discrepancy in the temperature data in 1993 where temperatures of below 0°C were reported in October. This error illustrates the importance of having reliable temperature recordings, preferably from a properly-calibrated datalogger as for the other data series presented.

Figure 7 illustrates the effect of using minimum, mean and maximum temperatures in closing fisheries. Using daily maxima the angling fishery on the Little Southwest Miramichi would have been closed for over two months (64 days) compared to 26 days using mean temperature and 4 days using minima. Caissie (1995) reports that for the Miramichi basin in 1994, the greatest daily difference between minimum and maximum temperatures (6.5°C) occurred on the Little S.W. Miramichi, while the smallest (1.5°C) was on the N.W. Miramichi.) In 1995 the greatest daily difference (11°C) was again on the Little Southwest Miramichi with minimum and maximum temperatures of 18°C and 29°C (daily mean - 23.5°C) being recorded on August 1 (Caissie, 1996). Figure 8 shows closures for the same river modelled at three different mean temperatures 23°C, 21°C and 19°C. Closures of 19, 45 and 61 days respectively would have ensued.

What does it really mean to the fish?

Even if one assumes any given level(s) of mortality attributable to catch and release, it is obvious that the above information is largely academic without a comprehensive evaluation. Factors for consideration include the role of coldwater holding pools in providing refuge to fish, the numbers of fish actually caught and released at various temperature regimes in various sections of the river, and the extent of potential biological, social and economic impacts. Other special considerations might include such elements as the disease status of a fish population.

As any conservation officer knows, the role and importance of coldwater holding areas is very important when considering closures. For example, on the main Southwest Miramichi, salmon congregate by the thousands at three major coldwater brook confluence pools (and in lesser, but still-significant, numbers in other locations with cool water inputs) to seek the respite provided by the

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[4]Caissie(DFO Moncton, pers. comm.) indicates that for Catamaran brook in 1995 the minimum daily temperature occurred at 10.00 (± 2 hr) a.m., the maximum at 7.30 (± 1.5 hr) p.m. and the mean at around 3.00 p.m.

cooler water when the main river is above 19°C degrees (Pero, 1994). Because fish are concentrated - and where such pools are not under private ownership/protection or active surveillance by protection staff - they become more vulnerable to jigging or poaching. In cases where poaching is not a concern, even if the fish are not taking a fly, they may be stressed by continuous angling disturbance over them in smaller pools where angler wading occurs.

One suspects that even if fish were not taking, at near-lethal temperatures of 27-29°C, even in protected major coldwater holding pools, there would be no hesitation in shutting down fishing activities that might stress fish. The decision on what might constitute a threshold temperature for such closure remains, particularly since fish are exposed to maximum temperatures only during part of the day. However, because a substantial proportion of the run could be located in such coldwater holding areas (Pero, 1994), another consideration is whether angling for relatively few fish dispersed along the remaining length of the river, would have significant biological repercussions. This is an important point since the presence of anglers on the river is considered to have a positive impact in deterring poaching.

A fundamental consideration is how many fish are angled and released once temperatures exceed 22°C when, as most anglers would argue, salmon appear much more reluctant to take a fly? On the Miramichi, for example, it appears the vast preponderance of fish is taken in the fall, when we might expect mortality to be much reduced. Does taking such factors into consideration make any difference in protecting particular elements, or all of the run? A 15% hook and release mortality might be of little concern to the angling fraternity (if not to preservationists) where a river is exceeding its spawning requirements, but of major concern in another where less than 50% of the target is being attained. Similar arguments might be valid in relation to certain in-river operations, such as trap netting, which may only affect a small proportion of the run.

Data by which to assess this specific question exist in the form of creel surveys such as those for the provincial Crown Reserves, or for specific locations such as the Quarryville Pool on the Miramichi. An analysis of the Upsalquitch crown reserve catches, as related to angling effort and river temperatures, is currently under way (Mowbray[5], pers. comm.) and should constitute an important first step in addressing the issue.

Even if a significant portion of a few released fish perish, does the need for protection override the economic disruption that would be caused by long periods of closure or the uncertainty of somewhat unpredictable breaks in the season. An analysis of the economic impacts of extended fisheries closures, such as those described in this document, would be important before adoption of any policy for river closures. Consideration should also be given to innovative suggestions, such as permitting angling only during the cooler (morning) hours of warm or low water episodes, or to mandating use of specific gear such as dry flies fished with a floating line. Similarly, analogous to closures of forestry operations during periods of high fire risk, consideration might be given to operating

[5]F. Mowbray, DFO, Moncton.

trapnets only during "windows" of minimum temperature.

Conclusion

In sum, if one wishes to provide a comprehensive base and structure for decisions about river closures, the above discussion indicates the desirability of having full and reliable temperature records available for several, strategically-chosen, locations within river systems, as well as adoption of a standard measure (e.g. daily mean, degree days of temperature event duration etc.) of temperature to be used. This requirement is particularly important because of the differences in temperature regime along a river system and in daily variation (maximum/minimum) between river systems. An added by-product of such monitoring would be collection of data which might be useful in the context of global climate change.

With the growing role of watershed groups in fisheries management, such data collection could easily be organised by the private sector. More-sophisticated arrangements could provide maximum efficiency by using real time data downloaded to a central facility and/or the development and use of forecasting techniques by which air temperatures one day are used to predict water temperatures the next (Caissie, 1995, and pers. comm.). It is also fundamental to undertake a comprehensive, general baseline analysis of the risks and potential biological and socioeconomic losses that might result from keeping angling fisheries open for catch-and-release (or perhaps even catch-and-kill) fishing at certain temperatures and/or in specific locations, or for closing them.

Because of the complex factors involved, to be effective such analysis should include input from hydrologists, biologists, fisheries managers, economists, resource users and conservation and protection staff. Once compiled, this information should provide the basis for more specific in-season decisions related to particular situations. Despite the inherent challenges, the ultimate goal should be to produce a formal policy for river closure and subsequent re-opening. It would be important for any such a policy to be consistent within individual watersheds, and possibly within or across the Atlantic provinces. The product should be a clearly articulated document laying out relevant considerations, responsibilities and mechanisms.

Acknowledgements

The closure, in 1995, of the St. John River to all angling, including catch-and-release, as well as renewed controversy over river closures and season extension on the Miramichi, spurred the production of this discussion document. Discussions with catch-and-release research collaborators Kevin Davidson and Bruce Tufts, as well as with many other salmon anglers, scientists and managers have helped shape some of my thinking. I wish to acknowledge sincerely the assistance of Chris Connell in drafting the figures presented in this document. I am also grateful to Gerald Chaput, Rick Cunjak, Kevin Davidson, Ross Jones, Andrea Locke, Fran Mowbray, and Larry Marshall, and particularly to Daniel Caissie, for generously providing the temperature data used to develop the figures. Stuart Manderson and Ron Whitehead provided some valuable insights into the way closures are generally handled by DFO Conservation and Protection staff. I also appreciate the comments of various DFO and DNRE colleagues that assisted me in improving earlier drafts of this document, as well as helpful formal reviews of the final document by Gary Atkinson and Dick Cutting.

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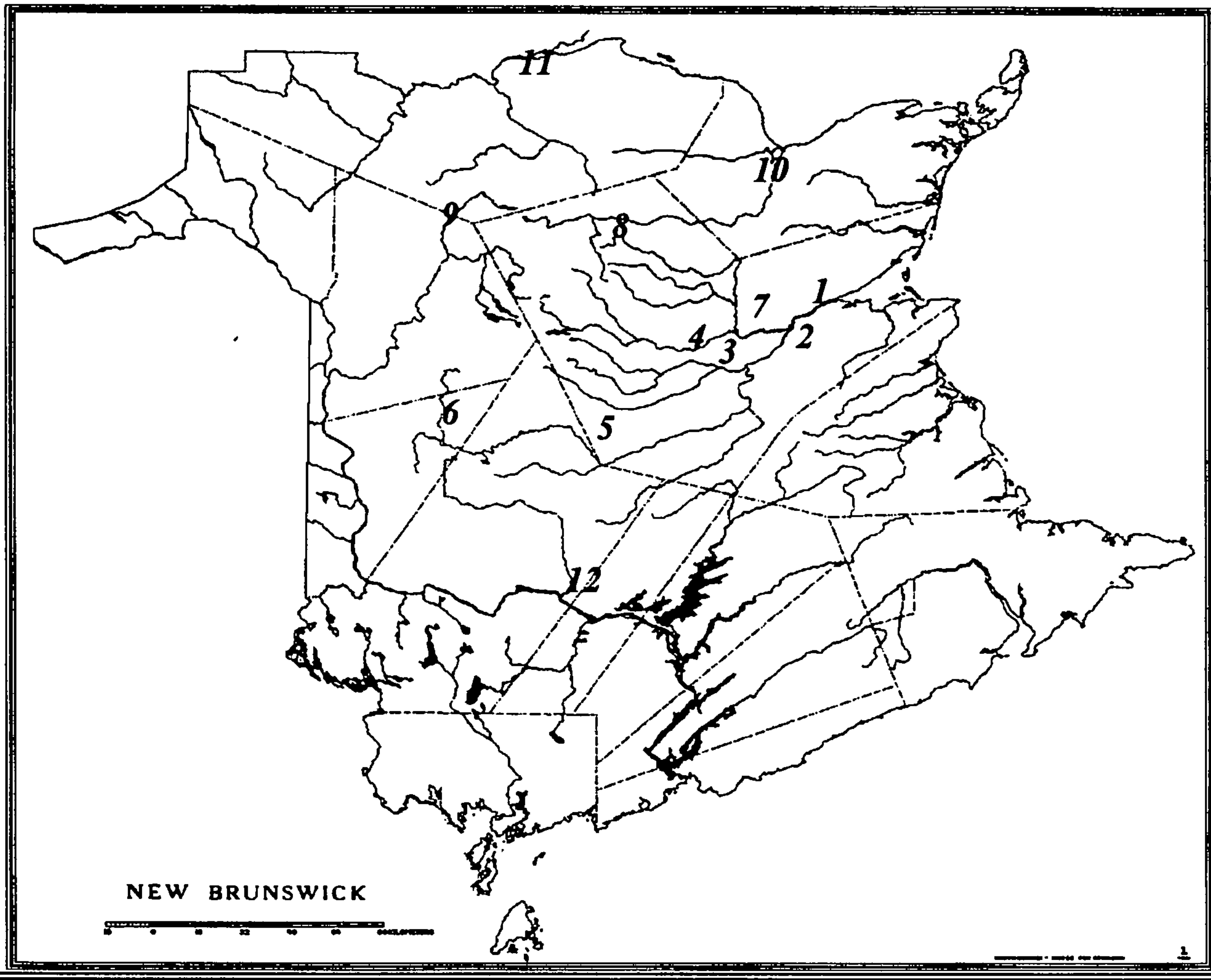
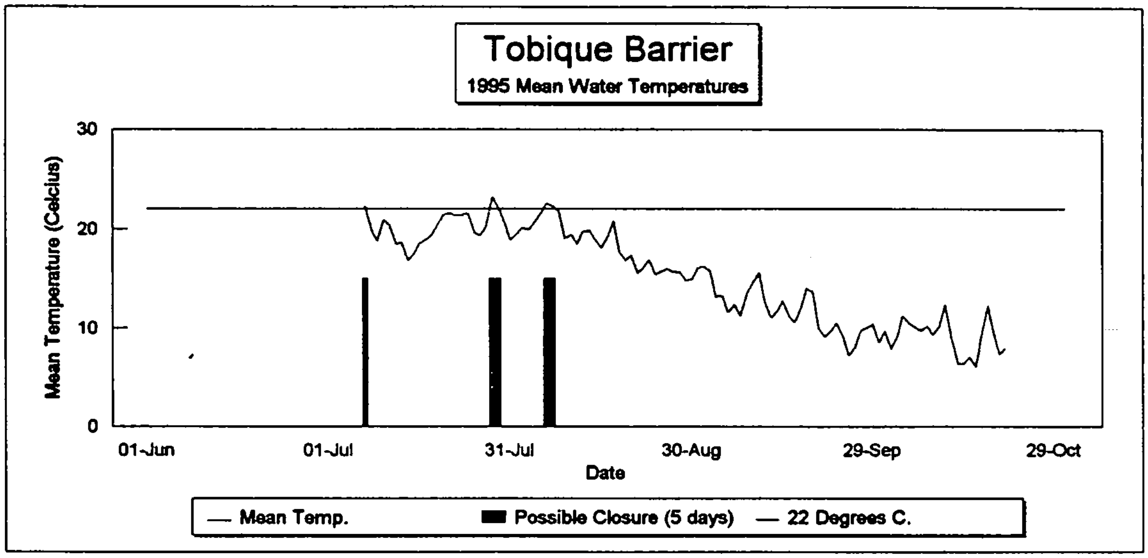
Water Temperature Locations



Legend - Water Temperature Locations

1 - S.W. Miramichi - Enclosure
2 - S.W. Miramichi - Millerton
3 - L.S.W. Miramichi
4 - Catamaran Brook
5 - Dungarvon - Barrier
6 - S.W. Miramichi Juniper
7 - N.W. Miramichi - Big Hole
8 - N.W. Miramichi - Barrier
9 - Tobique River
10 - Nepisiguit River
11 - Restigouche River
12 - Nashwaak River

Figure 1. Locations of river temperature sampling stations.



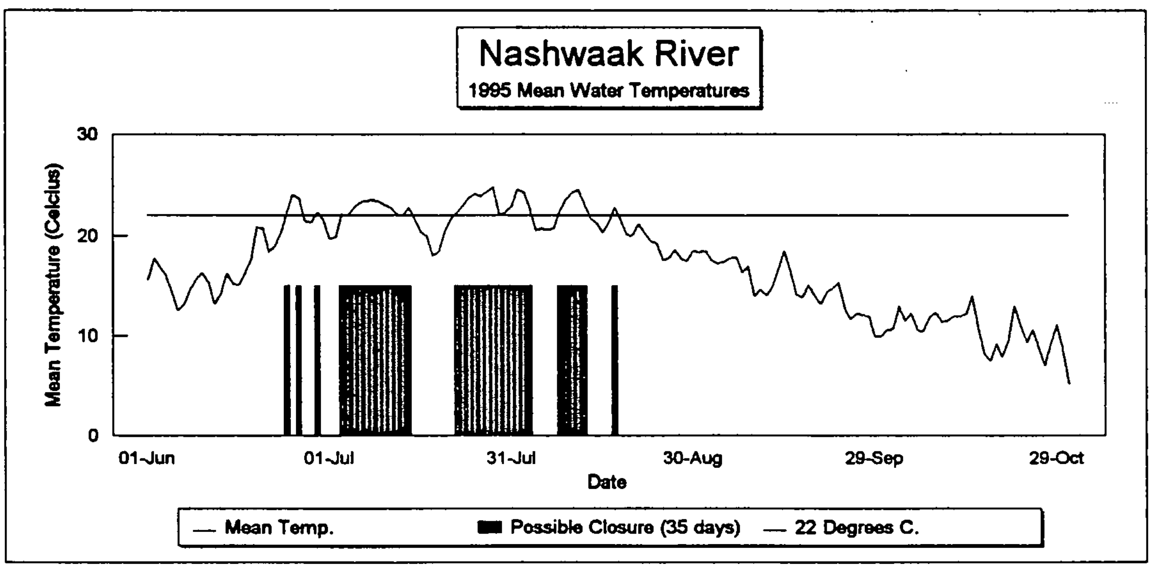
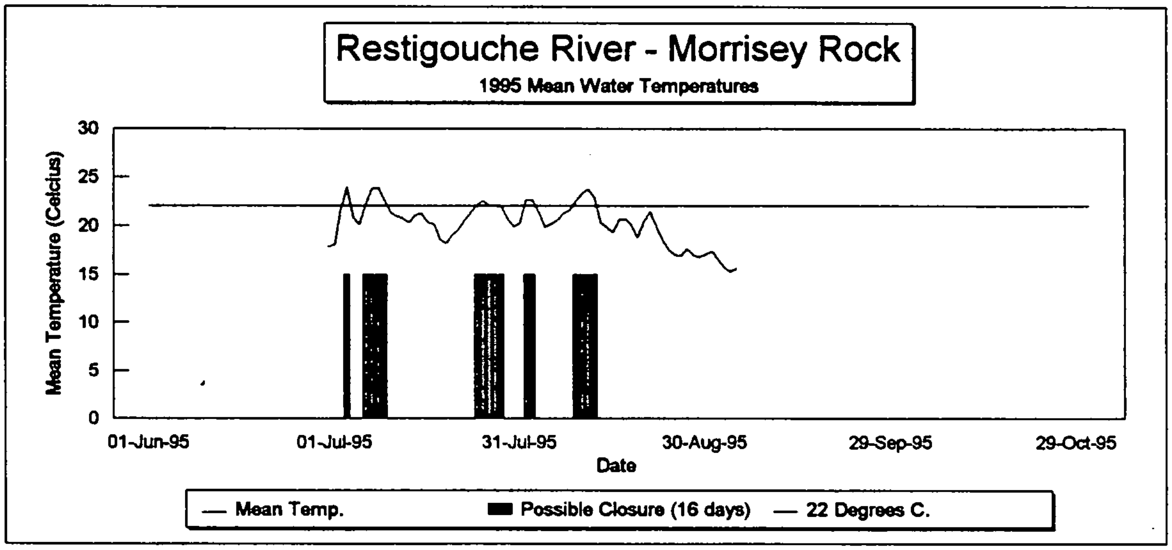


Figure 2. Mean 1995 daily water temperatures for Tobique and Nashwaak rivers, together with possible angling closures at 22 C.



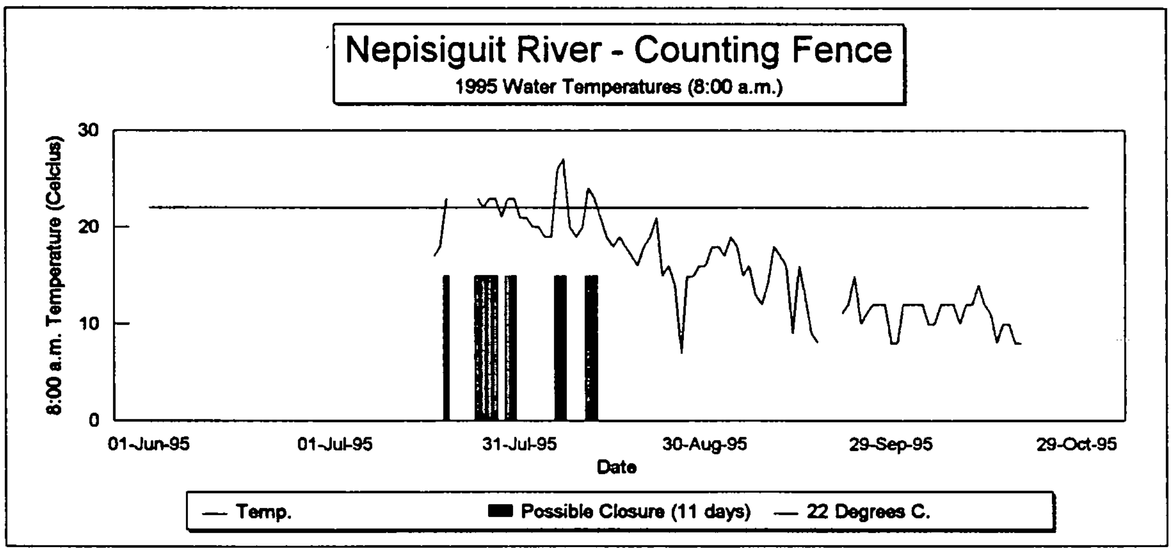
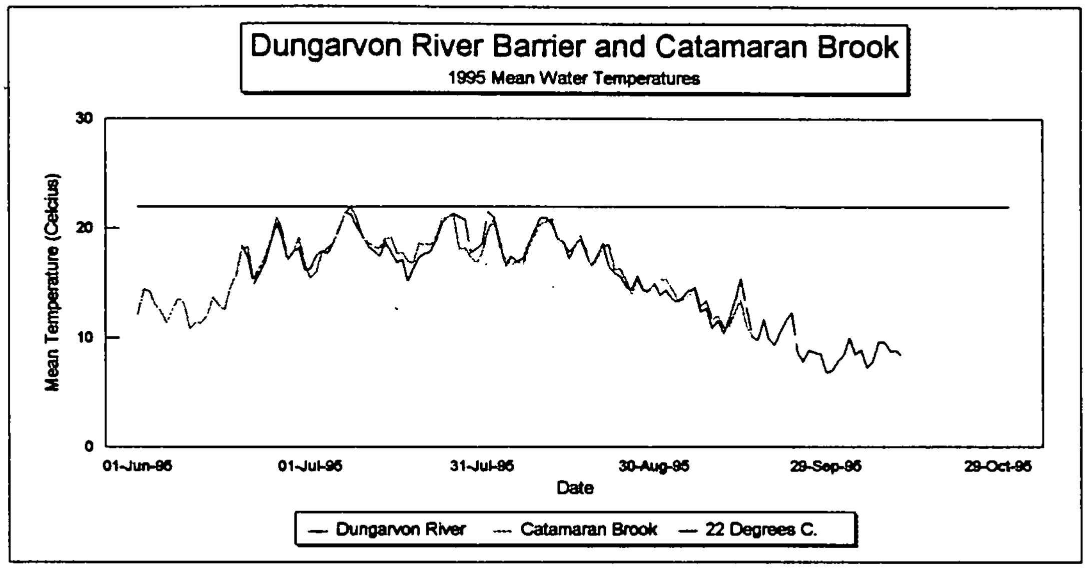
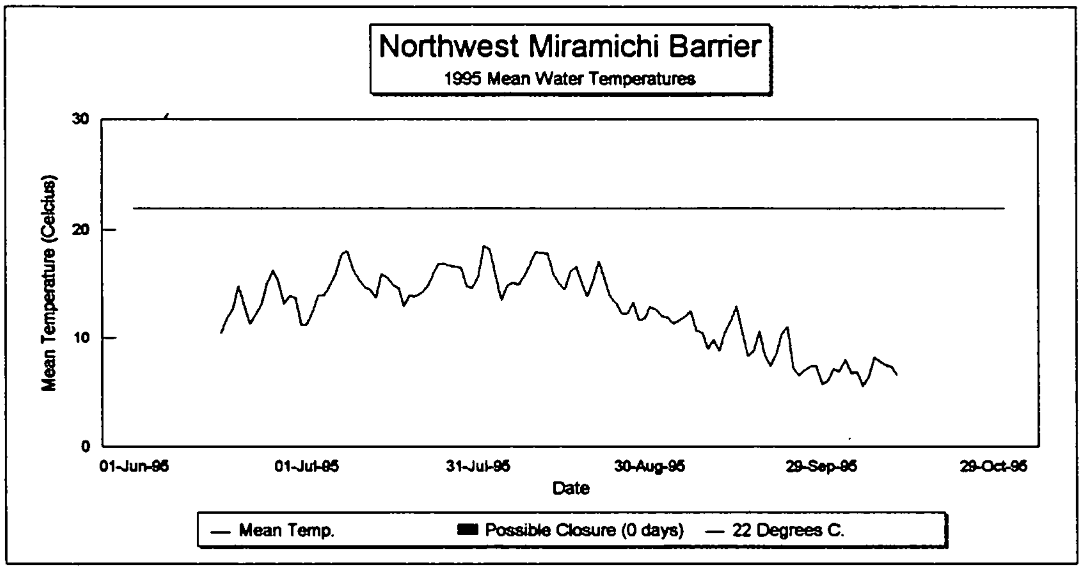


Figure 3. Mean 1995 daily water temperatures for Restigouche river and 8:00 a.m. temperature record for Nepisiguit river, together with possible angling closures at 22 C.





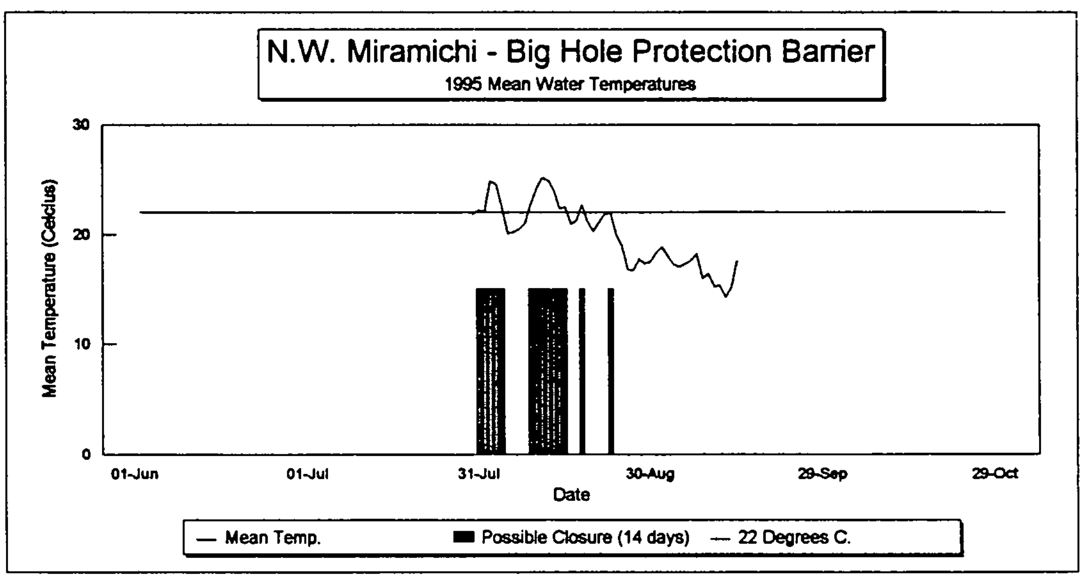
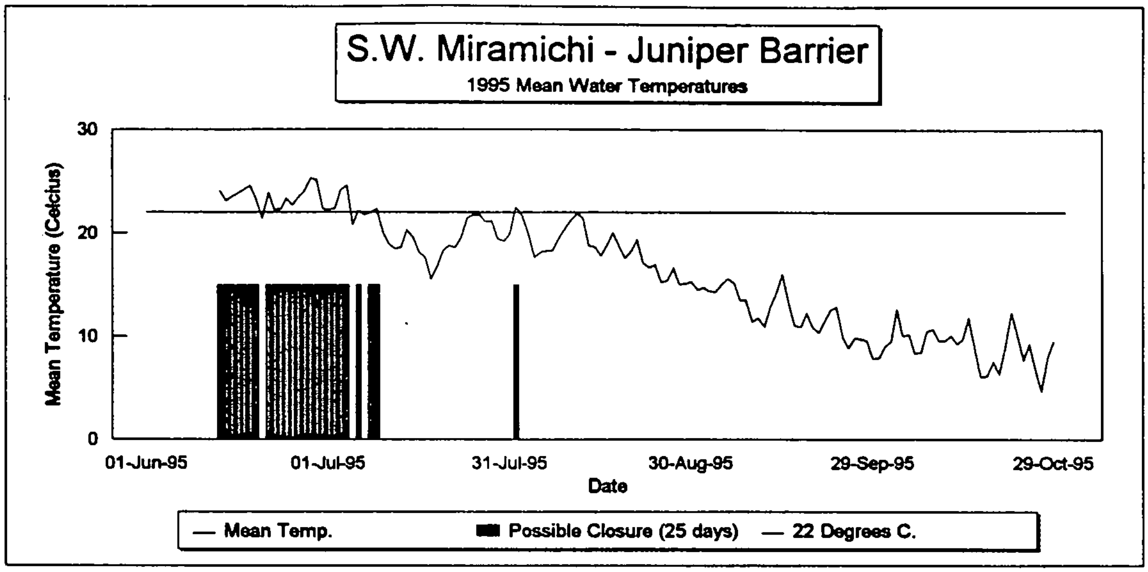
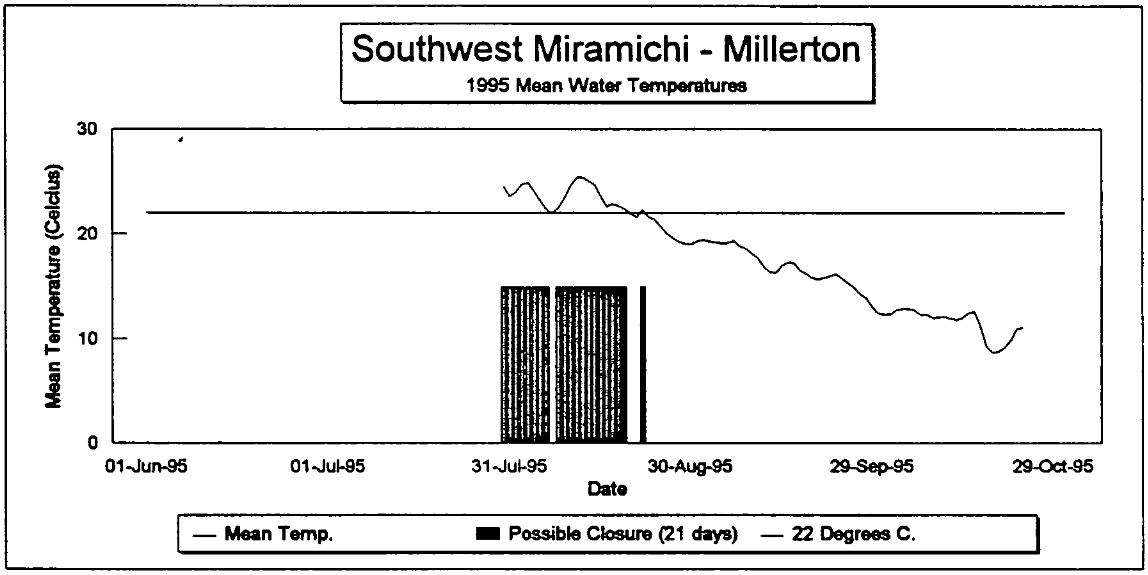


Figure 4. Mean 1995 daily water temperatures for Dungarvon river and Catamaran brook and for N.W. Miramichi river at two locations, together with possible angling closures at 22 C.





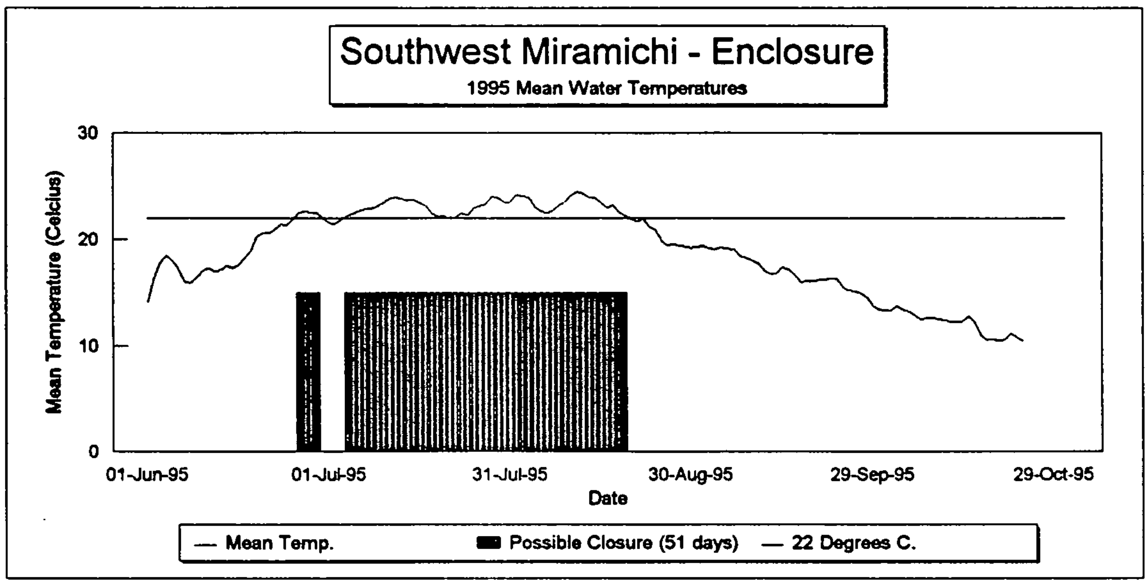


Figure 5. Mean 1995 daily water temperatures for Main S.W. Miramichi river at three locations, together with possible angling closures at 22 C.

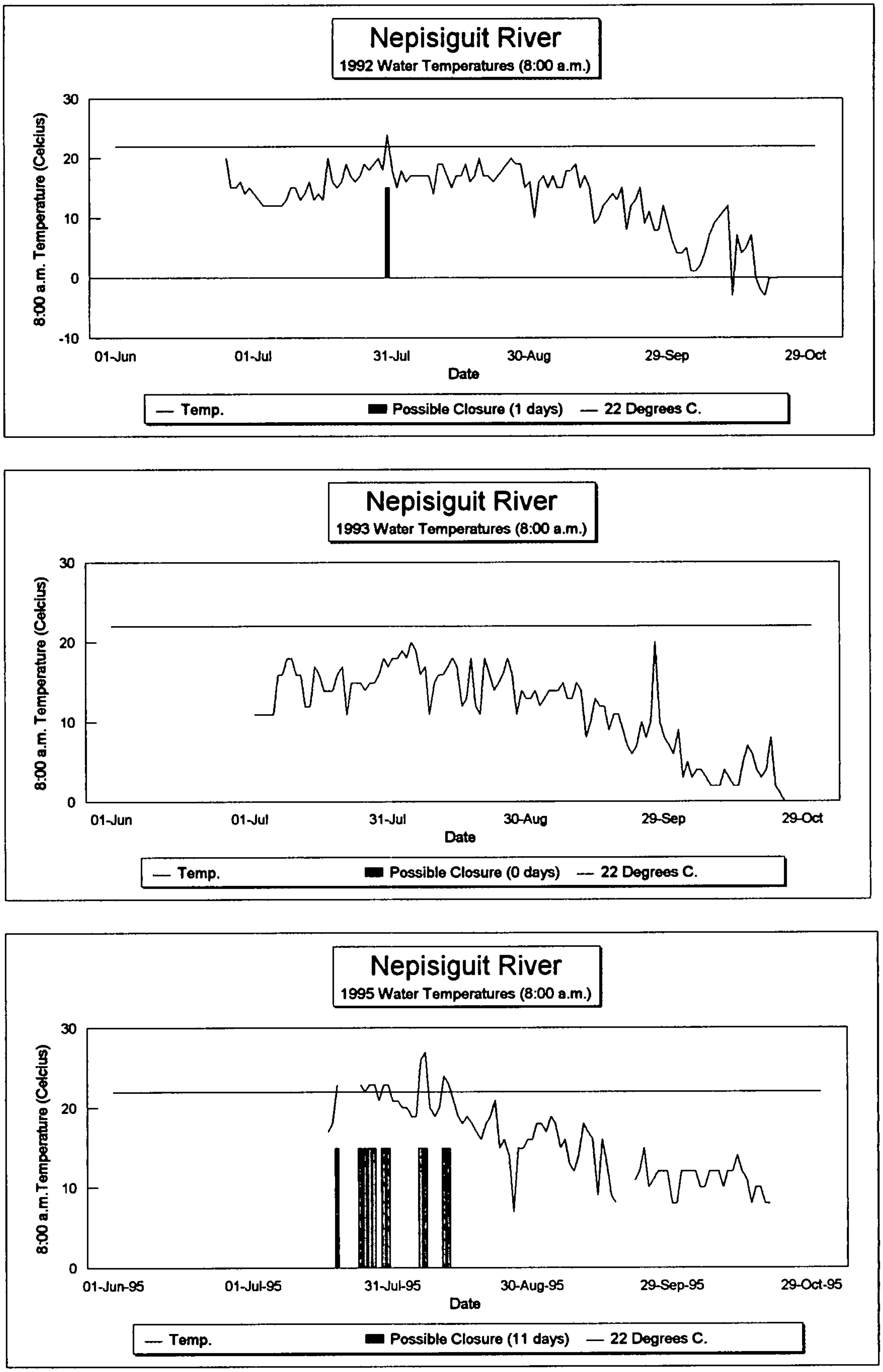


Figure 6. Daily 8.00 a.m. water temperatures for 1992, 1993 and 1995 on the Nepisiguit river, together with possible angling closures at 22 C.

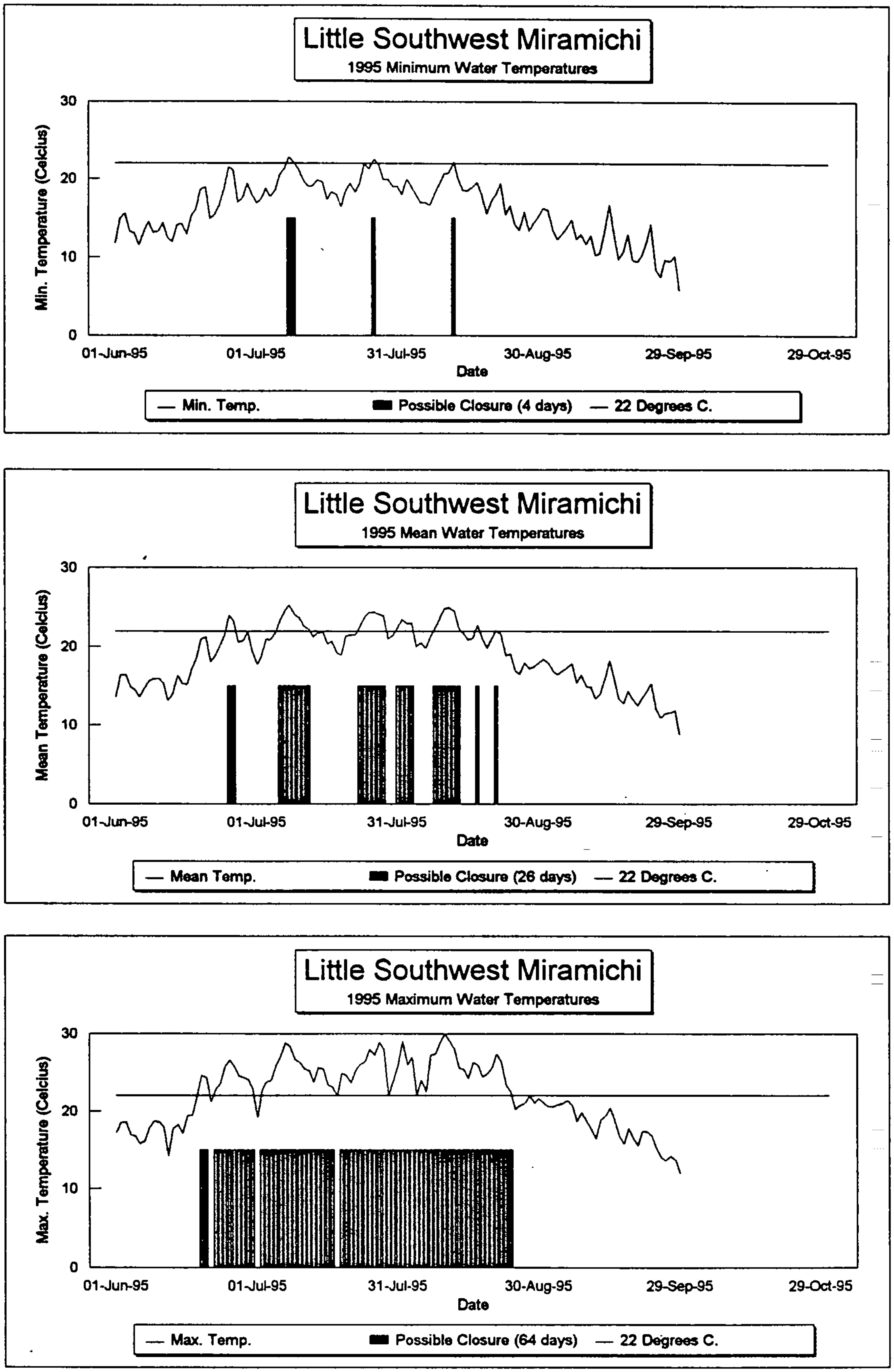


Figure 7. Minimum, Mean and Maximum 1995 daily water temperatures for Little S.W. Miramichi river, together with possible angling closures at 22 C.

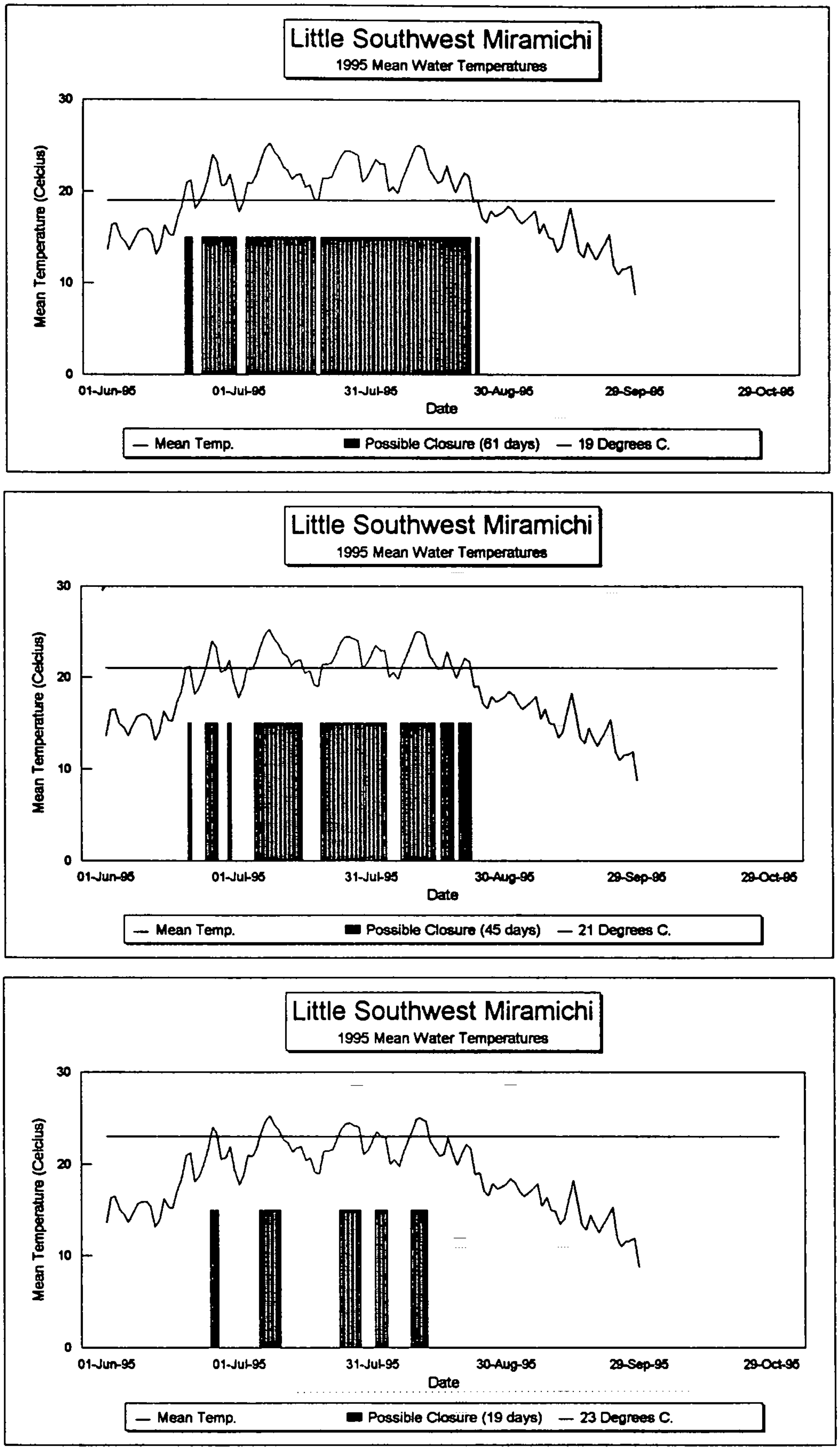


Figure 8. Mean 1995 daily water temperatures for Little S.W. Miramichi river, together with possible angling closures at 19, 21 and 23 C.