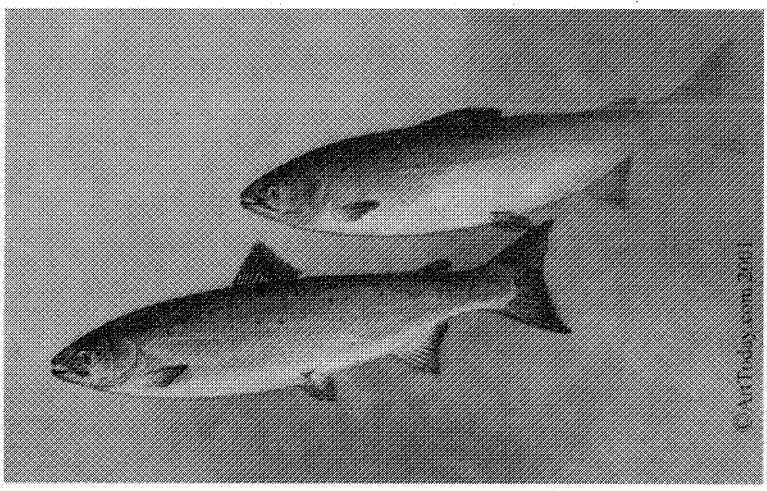
FUNDY ISSUES

Fundy's Wild Atlantic Salmon

Doomed or Simply Down?

Atlantic salmon, *Salmo salar*, throng the sheltered coastal waters of the Bay of Fundy. So abundant, they appear stacked like flashing silver ingots in the chill, clear water; so intensely ravenous that a maelstrom of glinting bodies and snapping jaws engulfs morsels dropped upon the shimmering surface. An angler's fondest dream come true? Hardly! These fish, fenced in by a curtain of stout mesh, are private property destined for the restaurants of Boston and New York. They will never lunge at a hook, leap a waterfall or lay eggs in the gravel of a far-off stream. These are farmed fish, a legacy of the aquaculture boom that dominates many coves in the outer Bay of Fundy and throughout the Maritimes. Ironically, as these "domesticated" salmon have prospered and multiplied, the populations of their wild, free-roaming kin have plunged alarmingly towards the brink of extirpation in the Northwest Atlantic. How has this undisputed king of fish, prized by generations of devoted anglers and other aficionados come to such a plight?



Atlantic salmon - "flashing silver ingots"

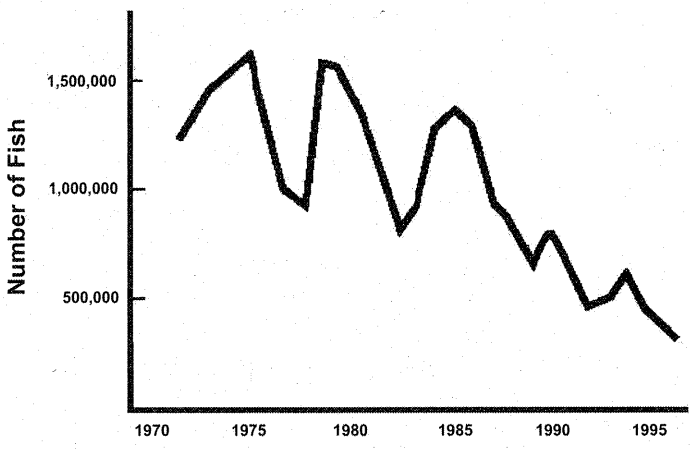
Flush with Fish

Rivers along the eastern seaboard of North America from Ungava Bay to Long Island Sound once teemed with wild salmon. In eastern Canada alone, 550 rivers supported runs and New Brunswick's Miramichi and Saint John rivers ranked among the most productive salmon waters in the world. On the Miramichi, anglers once reeled in almost 60,000 salmon a year, while commercial fishermen netted another 300,000 downstream in Miramichi Bay. Some believe that this one river was home to over a million fish. Hundreds of thousands may also have crowded into the Saint John River during their annual ascent from the Bay of Fundy to spawning tributaries. In those heady days, millions of pounds were harvested from all around the Bay of Fundy and shipped to New England markets. Few people now living witnessed this amazing abundance and we now find it difficult to visualize just how incredibly productive our rivers once were.

BoFEP BAY OF FUNDY Ecosystem Partnership

Troubling Trends

There have always been ups and downs in salmon numbers in response to changes in the environment and fishing pressures. These fluctuations are discernible in the commercial and sport fishery statistics gathered since before Confederation. The Ristigouche Salmon Club, for example, recorded almost every fish landed from its section of the Restigouche River in northwestern New Brunswick since its founding in 1880. In some years there were few fish; but salmon are resilient and even when numbers were low there was always the expectation that they would soon bounce back as they had always done. However, over past decades these periodic fluctuations obscured a more ominous trend - a relentless decline of natural populations. In the past 30 years the number of fish returning to East Coast rivers has declined by 75%. Populations are now at their lowest recorded levels, with no sign of recovery in spite of widespread conservation efforts. Not only are the numbers down, but the fish are now much smaller. In the 1970s, less than half were small grilse that had spent a single year at sea, but now they form three-quarters of the population. This is worrisome, because the bigger fish lay more eggs and are largely responsible for sustaining the population. However, before examining why salmon are in such a perilous strait we must consider their remarkable life history.

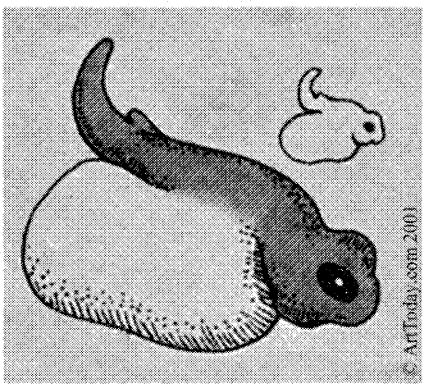


Numbers of Atlantic salmon returning to East Coast rivers have declined sharply in recent decades.

-based on Anderson, Whoriskey and Goode, 2000

Seasons of the Salmon

Egg laying is a good place to break into their life cycle and follow the spiral once around. As days shorten in the fall and streams cool, a mature female salmon returning to the home stream seeks an area of coarse gravel suitable for spawning. In this "redd" she sweeps out shallow depressions by vigorously flailing her tail to wash away fines. Into each of these "egg pits" she deposits several hundred pea-sized eggs. About 800 eggs are produced for each pound of body weight, so an average size fish may lay several thousands eggs in one or more redds. An attending male releases sperm or "milt" over the eggs and they are quickly covered with gravel. Ten centimetres or more under loose gravel, the fertilized eggs have their best chance to survive the winter. With spring warming, the embryos develop rapidly and by April tiny larvae called "alevins" wriggle free. At first, they don't need to venture from their gravelly sanctuary, for a bulging "yolk sac" suspended from their stomach provides ample nourishment. However, this reserve steadily shrinks and by the time the fish are about two centimetres long the sac is completely absorbed. The "fry", as they are now known, must emerge from the gravel to hunt farther afield for tiny animals. If food is abundant they grow rapidly and at four centimetres in length become "fingerling". When they are eight centimetres long, black vertical bars appear along their sides and they are known as "parr". Usually, only a tenth of the eggs laid ever reach this stage, as many eggs and young fish are eaten by predators or otherwise die. The parr grow steadily on a diet of aquatic insects and larvae and may remain in the river for two to seven years. But eventually, one spring, they feel the urgent call of the sea and their



An alevin with bulging yolk sac.

bodies slowly prepare for a very different existence. Patchy "parr marks" fade, flanks and stomachs glisten silver and tails grow longer and more forked. These "smolts" resemble miniature adults. As their bodies are transforming they ease downstream to the estuary. Here they linger in the brackish water, gradually adjusting physiologically to the saltiness that will dominate their environment in the coming months. Then, sensing that all is ready, they leave the estuary and head along the coast on a remarkable sea voyage.

"upon reentering freshwater their appetite abates and they fast. This is a fortunate evolutionary quirk, for the rivers teem with bite-sized parr, fingerling and smolt."

With biological compasses set to north, smolts destined to return as adults to Maritime rivers arrive off southeast Newfoundland by midsummer. Pressing on for another few thousand kilometres, they reach the coastal waters of West Greenland by late autumn. These chill subarctic waters are productive and the hungry smolts gorge themselves on abundant shrimp, herring, capelin and sand eels. On this diet they grow fast and can weigh as much as two and one half kilograms after one year, nine kilograms after two years and a whopping 18 kilograms after three years. They prosper in this nurturing sea, but eventually an insistent urge, possibly a response to hormones released by maturing gonads, announces that it is time to return to their place of birth. If this urge strikes after only one winter at sea the returning fish are called "grilse". Some remain for another winter or longer and are awkwardly termed "multi-sea-winter-salmon". Stars and subtle gravitational and magnetic clues probably guide their uncannily accurate journey back across the trackless ocean. Once in coastal waters, they smell or taste the long-remembered fragrance unique to the stream of their birth and follow it home. It is claimed that only one percent of them ever wind up in the wrong river. Curiously, upon reentering freshwater their appetite abates and they fast. This is a fortunate evolutionary quirk, for the rivers teem with bite-sized parr, fingerling and smolt. The arduous upriver journey is a struggle against swift currents, tumbling rapids and obstructing waterfalls, sometimes for hundreds of kilometres. Fish from the Bay of Fundy, for example, ascend the Saint John River to tributaries in northern New Brunswick and Maine to spawn. No one ever claimed that salmon have it easy.

"Over tens of thousands of years salmon have genetically 'adapted' to the unique conditions of their own stream and thus gradually evolved 'strains' or races, each with its own distinctive gene 'fingerprint'."

Subtleties of Stocks

This faithful doggedness of salmon in returning to their "home stream" has important genetic consequences. Salmon from one stream do not normally interbreed with ones in other nearby streams. The different river stocks are thus "reproductively and genetically isolated" and only rarely exchange genetic material. As a result, slight changes in the genes, or "mutations", present in one stock are not readily passed on to fish in other streams. No two streams are ever the same. There are subtle differences in current speeds, temperatures, water quality, food supply, timing of spring run-off and a host of other differences, mostly imperceptible to us. Over tens of thousands of years, salmon have genetically "adapted" to the unique conditions of their own stream and thus gradually evolved "strains" or races, each with its own distinctive gene "fingerprint". Most of the differences are subtle and only apparent after careful study of the fish's ecology, behaviour, biochemical makeup or gene composition. For example, there maybe slight differences in such things as growth rate, size at which they mature, number of eggs they lay, date they descend to the sea or date that they return to breed. Occasionally, however, fish from certain rivers are recognizable by an eye attuned to slight differences in colour or the size and shape of fins and body. The renowned "Serpentine Run" fish from the Serpentine River in northern New

Brunswick are shorter and stouter than other salmon - "just like bullets", according to Danny Bird of the Atlantic Salmon Federation.

But Nature's rules are seldom rigid and occasionally a salmon mistakenly ventures up the wrong river to breed and thus exchanges genetic material between the stocks. With increasing distance between rivers, chances of such "accidental" genetic sharing decrease. As a result, salmon from more widely separated rivers tend to be increasingly different in their genetic makeup. Thus, a molecular geneticist can readily distinguish Atlantic salmon from Scotland from those of Nova Scotia, while the differences between fish from Maine and Nova Scotia are less marked but still detectable. Fisheries managers regard such geographically and genetically distinct groups as regional "stocks". Curiously, two very distinctive regional salmon stocks are present in the Bay of Fundy.

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Fundy Phenomenon

It has been know for a century or more that two types of Atlantic salmon with very different life cycles live in the Bay. Tagging studies have shown that they spend their winters in different places. Smolts from the Saint John and rivers southward towards the mouth of the Bay migrate to West Greenland waters, as do most salmon from eastern North America. The majority that return to the rivers are large females that have spent two winters at sea and males that have been at sea for one winter.

"salmon from the inner Bay are genetically different from stocks all around the North Atlantic .... they are a 'rare and distinct lineage'."

In contrast, salmon from the 33 major rivers around the inner Bay, between the Saint John and Annapolis rivers, are noticeably different in several respects. They become smolts after about two years in freshwater and start moving seaward in late May, with the last ones leaving the rivers in July - a longer "run" than in other East Coast rivers. Surprisingly, it appears that they only migrate as far as the environs of Grand Manan and Passamaquoddy Bay near the mouth of Fundy to spend the winter. Fish tagged in inner Bay rivers were virtually never collected in Newfoundland or Greenland waters, while ones tagged in rivers of the outer Bay were frequently captured there. Plankton, juvenile herring and other food species are plentiful around the mouth of the Bay, but we know little about the feeding habits of the salmon that spend the winter there. Most mature after spending only a single winter at sea. Thus their average generation time is only three and a half years, much shorter than that of fish from outer Bay rivers. In addition, a larger percentage of them survive at sea and return to the rivers to spawn. This varied between 1% and 10% in different years, but on average about 6% of the fish leaving the Big Salmon River in Cobequid Bay returned to spawn. The relationship between the size of the female and the number of eggs produced is similar to that in other East Coast rivers. However, each year over half of the returning fish were small ones spawning for the first time and producing only a third of the total eggs laid. Larger fish that had already spawned at least once laid almost 70% of the eggs. There was a much greater dependence on such repeat spawners to sustain the stock than in other East Coast rivers.

Records from commercial salmon fisheries reveal that the yearly fluctuations in abundance of the inner and outer Bay stocks were also very different, confirming that their life histories are largely independent of each other. The salmon from the inner Bay are genetically different from stocks all around the North Atlantic. DNA analyses conducted by recognized salmon experts, convinces DFO salmon specialist Peter Amiro that they are a "rare and distinct lineage". Studies indicate that there are also "evolutionary significant units" present in the rivers flowing into the two main branches of the inner Bay. Amiro urges that "as a precaution, it is advisable to

accept the existence of at least two evolutionary defined Atlantic salmon meta populations in the inner Bay of Fundy - the Minas Basin and the Chignecto Bay stock groups". These distinctive inner Bay stocks are now at an all time low - in fact, in some rivers they may already be extinct.

Angling for Answers

With salmon populations plunging to unheard of lows, fisheries scientists, managers and conservationists are scrambling to find the cause. A few optimists argue that it is only an unusually large natural decline in a species noted for fluctuations; the stocks will eventually rebound as they have always done. However, most agree with Wilfred Carter of the Atlantic Salmon Federation that it is not "just part of the cycle". Mike Dadswell of Acadia University notes that it was possible to link most earlier declines to fairly obvious natural processes or human activities. However, this doesn't seem to be the case now. It is increasingly clear that some "other factor or factors" is behind the unfolding tragedy - but which? We have seen that salmon have a long, complex life cycle spread over thousands of kilometres of river, estuary, coastal water and open sea. They are vulnerable in so many places and in so many ways that finding the deadly "other factor" is a daunting prospect. The finger was pointed first at fishermen, both recreational and commercial. It was argued that fisheries around the North Atlantic had simply overexploited the stocks. As well as intense recreational angling for salmon in rivers and commercial netting in estuaries, there was also a heavy harvest during their offshore migrations. For centuries, large numbers were caught in drift nets off Newfoundland, in the Labrador Sea and in the waters around West Greenland. More than 90% of those caught were spending their first winter at sea and never got the chance to return to their rivers to spawn.

Over the years, salmon fishing has been increasingly restricted all along the eastern seaboard. New England banned commercial fishing as early as 1948. The drift net fishery off southern Newfoundland was banned in 1967. New Brunswick shut down commercial fishing in 1972, while in Nova Scotia it was halted in 1985. All commercial salmon fishing around the island of Newfoundland was closed in 1992, and in Labrador in 1998. Further afield, the Greenland fishery was limited to a local food fishery of 20 tonnes in 1998. As the crisis deepened, recreational fisheries were also curtailed. Anglers saw their bag limit reduced and were then restricted to catch-and-release fishing before finally being banned altogether from fishing in some places. All rivers of the inner Bay of Fundy have been closed to recreational salmon fishing since 1990. Resource managers were confident that closing the fisheries would allow salmon populations to recover. In the past, reducing fishing effort permitted depressed stocks to rebound rapidly. This time it didn't happen, in fact, the numbers continued to fall, forcing fisheries scientists to look elsewhere for plausible "factors". Could it be that there was something drastically wrong in the rivers where the fish spawned? Or were there problems in the ocean where they went to feed and fatten?

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Freshwater Faults?

Salmon can be finicky, making them good "biological indicators of water quality" according to Walter Regan of the Sackville River Association. They demand cool, clean, flowing water. There must be a variety of habitats to accommodate their needs at different times - gentle riffles, swift rapids and deep, calm pools to rest in as they migrate up and down river. The stream should also have boulders, cobble and coarse gravel, the latter being essential for spawning redds. Ideally, summer water temperature should be 15° to 25°C. The pH of the water is critical too, for eggs may die if it is too acidic. Conditions in many rivers nowadays are far from ideal. Could the unhealthy state of coastal rivers be responsible for the salmon's demise? Almost all waters have been degraded to some degree

by human activities - the evidence is often clearly visible and well documented in the scientific literature. We have corrupted our river systems in so many different ways, any one of which could have decimated salmon stocks.

The atrocious quality of water in many rivers has often been fingered as a possible cause for declining salmon stocks. For centuries, noxious wastes of every description were intentionally, unknowingly or accidentally dumped into rivers. Pulp mills, tanneries, starch plants and other industries conveniently voided their chemical by-products in the nearest rivers. These effluents, and those from municipal sewers and storm drains, mixed with insecticides, herbicides and fertilizers washed in from farms and forests to form a potent, poisonous cocktail. In New Brunswick alone in the 1950s and 60s more than two million acres of woodland were regularly sprayed with DDT to control spruce budworm. Much of this ended up in streams and killed large numbers of salmon. In 1969, heavy rains washed poisonous tailings from a lead-zinc mine into New Brunswick's Nepisiquit River wiping out the salmon. They avoided the river for five years while it slowly cleansed itself. Other rivers, particularly in southwestern Nova Scotia have been ruined by "acid rain", making them too acidic and toxic for salmon reproduction, thus ending the runs.

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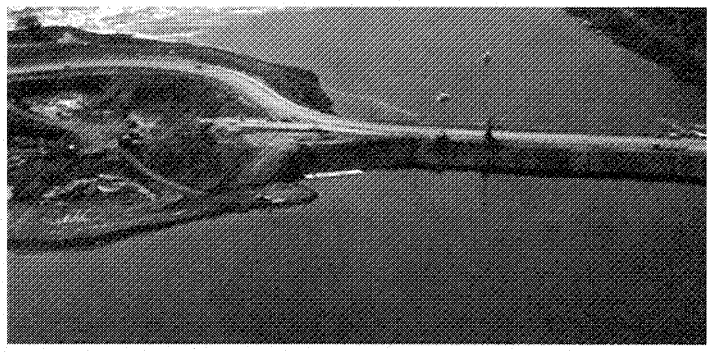
Warming is also a problem in rivers that have lost the cooling shade of streamside trees due to poor forestry and farming practices, or have been widened and shoaled by bank erosion and sediment accumulation. In some rivers, fine sediments washed in from land cleared by farming or forestry have choked spawning beds. Silting also occurred when logging roads or stream crossings were made without adequate erosion control. Intensive agriculture and forestry have been practiced throughout the Bay of Fundy watershed for centuries, with some local impacts on salmon stocks. However, Peter Amiro doubts that these are to blame for the sharp drop in salmon numbers since 1989, because activities near watercourses are now more carefully monitored and regulated.

Dams, causeways and other barriers on rivers and their estuaries have long been major impediments to migrating salmon. Runs on many East Coast rivers were wiped out in the 1800s by dams built with no provision for fish passage. More recently, hydroelectric dams on the Saint John River virtually eliminated the natural salmon run. It is now artificially sustained by a costly fish hatchery near the Mactaquac dam. Around the Bay of Fundy, 25 of the 44 principal rivers now have some sort of obstruction to water flow or fish passage. Some dams have fish ladders but these are often poorly designed, inadequately maintained and largely ineffective. Even when fish manage to get past the dams, their former spawning areas are either deeply submerged in the headpond or smothered with silt. Adding insult to injury, the whirling turbines of electrical generating plants in some dams kill and maim migrating fish. However, most of the larger dams were built long before the salmon crisis erupted and few have been built recently. Tellingly, salmon runs have also plummeted in rivers that are still free running. Thus, while dams may have reduced or eliminated stocks in certain rivers they don't appear to be the archculprit in the present crisis.



Barriers on rivers have long been major impediments to migrating salmon.

Photo G. Daborn

A major development over the past two decades has been the explosive growth of salmon farms in coastal waters on both sides of the outer Bay of Fundy. Many people are concerned about their possible detrimental effects on wild salmon stocks. Hatchery produced hybrids escaping from the farms could "genetically contaminate" wild salmon stocks

Salmon cage floating in the Annapolis Basin, N.S.

Photo J. Percy

by interbreeding with them, producing offspring less fit to survive in the wild. Escapees might compete for scarce river habitat with their wild counterparts, as well as prey on migrating smolt. Studies on New Brunswick's Magaguadavic River revealed that in 1995 almost 90% of the salmon in the annual run had escaped from fish farms. Salmon biologists are also concerned about the spread of diseases and parasites from crowded, stressed and susceptible penned fish to their wild relatives. This recently occurred in Norway, where a parasite spread from fish farms to wild salmon in at least 30 rivers, wiping out several stocks. Furthermore, there are concerns about the deterioration in water quality and sea floor habitat around fish farms and the effects that this might have on wild salmon passing through the area. Thomas Grasso, U.S. Director for the Marine Conservation Program of the World Wildlife Fund, concludes that unless stringent guidelines are developed "salmon farming will continue to be a major threat to the survival of wild Atlantic salmon". However, despite all these possible impacts, salmon runs have also been wiped out in rivers far removed from any fish farms, suggesting that aquaculture is not necessarily the "smoking gun" we seek.

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Although the condition of many rivers is undeniably deplorable, the available evidence supports the conclusion that the real cause of the present salmon crisis is probably not to be found in freshwater. Admittedly, over the past century or more there has been a steady decline in the freshwater habitat accessible to and suitable for salmon. But there have been no drastic changes recently that could account for the sudden widespread plunge in salmon numbers. Of course, it is not possible to completely rule out the possibility that there has been a relentless accumulation over a long period of many different, subtle and adverse changes to freshwater environments. In the past, when some development killed most of the fish in a particular river, the removal of the problem usually allowed rapid recovery. For example, a logging dam on the Alma River in New Brunswick virtually wiped out the salmon run. However, when the dam collapsed in 1964 salmon soon returned. Mike Dadswell counted a thousand or more moving upstream a scant three years later. Such recovery isn't happening now, in spite of improvements in water quality and accessibility in some rivers. Also, there are still rivers in the region that are relatively pristine, with good water quality and gravel beds suitable for spawning. They are also remote from aquaculture sites and free from recent disturbance by forestry or farming. They were, and still seem to be, prime salmon habitats; and yet their stocks are as depressed as those of other Maritime rivers. Salmon scientists, such as John Anderson, are now convinced that "the principal problems are not in the freshwater development stage" and "barring further evidence, the cause for the observed increase in mortality lies, by default, in the marine phase". But what could be

killing the salmon at sea now that the commercial fisheries are shut down?

Sea Survival

There have always been fluctuations in the numbers of salmon returning from the sea each year, with most rivers in a region following similar patterns. This led oceanographer Ken Drinkwater to suggest that the "numbers of returning salmon are most likely determined in the marine environment". In the 1960s, about 6% of the smolt leaving inner Bay of Fundy rivers eventually returned to spawn. By the early 1990s this had dwindled to 0.4% or less, convincing Peter Amiro that the problem was not low production of smolts in rivers but poor survival at sea. At its 1999 annual meeting, the North Atlantic Salmon Conservation Organization (NASCO) also conceded that the reasons for the decline "appear to be linked to conditions in the marine environment." This is ironic, given that it was long assumed that salmon were most at risk as they crowded into their native estuaries and rivers. There they suffered loss of habitat, pollution and the depredations of predators, anglers and commercial nets. Once they escaped to the all-encompassing sea they were thought to be relatively safe. Clearly this is not the case. But precisely what the lethal "something" is in the marine environment, and exactly where and when it strikes have thus far baffled scientists. There is no lack of plausible theories, but little hard science to support any of them. It's not that researchers haven't tried to find an answer, but once smolt move out into the sea they become "very rare fish", widely spread out and extremely elusive. Seeking them in the vast expanse of the ocean is a difficult and very expensive undertaking. Thus, it is not really surprising that we know so little about them during this phase of their existence. Recent efforts by scientists to learn more will be discussed later, but first we have to consider some of the possible marine threats.

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Tagging studies in the 1960s confirmed that the West Greenland fishery caught large numbers of salmon born in rivers of the eastern seaboard. Over the past two decades this lucrative harvest has been reduced and finally closed in the interests of conservation. However, a few researchers suspect that illegal salmon netting may still be happening on the high seas. Mike Dadswell suggests that the geographic pattern of salmon decline in East Coast rivers, the damping of the natural fluctuations in abundance and the small numbers of returning fish could be explained by heavy offshore "poaching". He speculates that this might occur in areas just outside Canadian jurisdiction where migrating salmon are known to congregate at certain times. Foreign trawlers legally fishing for other species could easily, and with little risk of detection, deploy large drift nets at night. The quantities of farmed salmon available would make it "easy to hide wild-caught salmon in the marketplace". Although he readily admits, "I have no hard information to back my claim", he feels that it could be the most straightforward explanation for the salmon crisis. He suggests that careful analysis of satellite photographs of the region should uncover any such illegal fishing.

It has been suggested, particularly by seal hunt supporters, that predation by over abundant seals, is behind the salmon decline. However, seals are opportunistic feeders and are more likely to encounter and eat other types of fish. This is born out by the fact that salmon remains are found in only a few of the many thousands of seal stomachs examined. Scientists from the Atlantic Salmon Federation are of the opinion that "seals are unlikely to pose a serious threat to salmon populations in the ocean".

Many marine scientists are leaning towards the

theory that the collapse of Atlantic salmon is probably a result of changes in the their oceanic environment, rather than anything that men or seals have done. The late Max Dunbar, of McGill University, examined fisheries and oceanographic records collected from North Atlantic waters over many years. He found that past fluctuations in the number of salmon and cod paralleled long-term variations in oceanographic conditions, particularly water temperature. Many scientists feel that this may be the key to the perilous states of both the salmon and cod fisheries. Animals usually try to stay within the temperature range they prefer, leading salmon scientist John Anderson to liken differences in ocean temperature to "a kind of fence" which keeps fish in certain areas. But unlike fences on land, these marine ones aren't fixed in one place. They continually shift up, down or sideways depending on the ways the warm and cold ocean currents and the deep and shallow waters move and mix together. Scientists at the Bedford Institute of Oceanography and elsewhere have been measuring shifts in temperature and salinity in the North Atlantic for decades. Much of the deep ocean water mixing takes place in a large area between Greenland and Europe. The extent and vigorousness of this mixing varies over time, affecting the surface temperatures over much of the North Atlantic. The mixing was unusually intense in the 1990s and the deeper waters became colder and less salty than at any time in the past 100 years. Things have warmed up again over the last three years, although salmon populations haven't improved. The cause of these fluctuations is not yet known, although it may be related to global warming and an accelerated melting of polar ice. Such shifts in oceanic "temperature fences" may shrink the "grazing grounds" where salmon feed and grow. The changes might also affect the availability of food species such as capelin, sand lance or shrimp-like euphausiids. Scientists don't know enough about the oceanic ecology of the salmon or their prey to be able to say for sure what is going on. The inflow of deep ocean water and the vertical mixing near the mouth of the Bay of Fundy is also what makes this region very productive. Thus, changing oceanographic conditions offshore might indirectly affect this coastal region as well and thus reduce its suitability as a wintering area for salmon from inner Bay of Fundy rivers.

Most scientists now surmise that there are probably several reasons for the devastation of salmon stocks. NASCO in a recent report concluded, "clearly, no single factor is responsible for the problems facing the Atlantic salmon". Certainly the relationships between animals and their environment are complex, ever changing and poorly understood. There are many processes going on in the ocean that we are presently only dimly, if at all, aware of. In the mysterious case of the disappearing salmon it is very hard to get a conviction with so many likely suspects, so many unknowns and largely circumstantial evidence. This makes it difficult to know what needs to be done to save the wild Atlantic salmon.

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Coping with Crisis

If salmon stocks are down because of natural changes in their ocean habitat then our hands may be tied. We simply have to wait for things to run their course and for stocks to rebound naturally. However, while waiting we need to ensure that the endangered stocks don't become extinct before they even get a chance to recover. Many groups are cooperating to try and stem the collapse and conserve remnant populations. Leading the way are groups such as the Atlantic Salmon Federation (ASF), government agencies such as the Department of Fisheries and Oceans (DFO) and Environment Canada (EC), and international organizations such as the North Atlantic Salmon Conservation Organization (NASCO) and the International Council for the Exploration of the Sea (ICES). Details about their conservation efforts are available on the web sites listed in "Further Reading". Let's briefly consider a few of the more promising initiatives.

Canada's salmon are protected under the Fisheries Act and the quality of their habitats under the Canadian Environment Protection Act. However, there is a growing feeling that further protective measures are urgently needed. Scientists and conservation groups are urging the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to designate the inner Bay of Fundy populations of Atlantic salmon as a "species at risk". Listing might impress on the public the seriousness of the problem and attract additional interest and funding for research and conservation. Commendably, the US Government recently placed the hundred or so wild salmon remaining in Maine rivers on its endangered species list. The aquaculture industry and some agricultural interests opposed this, arguing that regulations to protect wild salmon would hamper their operations. The Atlantic Salmon Federation hopes that this bold step will prompt similar designation of some Canadian salmon stocks.

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Progress has been made in the past decade in improving water quality and restoring habitats in some Fundy rivers. Most are still far from pristine, but there may be cause for cautious optimism. All around the Bay, community groups such as the Clean Annapolis River Project (CARP) and the St. Croix Estuary Project have been protecting and restoring local waterways. Projects have ranged from replanting streamside buffer vegetation to restoring the silted-over gravel substrate in salmon spawning areas. Responding to public demands for healthy aquatic environments, government agencies are more vigilant in monitoring and protecting water quality. The kinds and amounts of wastes that industries and municipalities flush into waterways are better regulated. Past excesses in pesticide use by agriculture and forestry have largely been curtailed. Limestone is being placed in some rivers to try to neutralize the effects of acid rain. Consideration is being given to removing or modifying obsolete, ecologically harmful barriers on some rivers. These, and many similar activities, are slowly rejuvenating aquatic habitats and raising hopes that someday salmon might return in abundance. Students in many schools are also doing their part, with assistance from the Atlantic Salmon Federation. They are learning about salmon biology by hatching and raising them in aquaria and releasing the young fish into nearby streams.

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Fish hatcheries on a much larger scale have long been used to raise freshwater fish such as salmon and trout. Eggs and milt carefully stripped from mature adults are mixed, the fertilized eggs hatched and the young grown in large tanks before being set free. Untold millions of salmon smolts have been released from many Maritime hatcheries since Confederation. Although this has been successful in enhancing populations of some game fish, the role of hatcheries in salmon conservation is being reconsidered. There is concern that hatcheries typically mixed fish stocks from several sources. When a population was wiped out in one river it was often replaced with a hatchery reared strain from another river. This tends to eliminate the unique genetic differences that evolved in different waters over many millennia. The long-term ecological consequences of this are not fully understood. It is known that wild salmon are four times better at finding their way back to a river than are hatchery reared ones. The concern about genetics has been further sharpened by the aquaculture industry demands for "improved" (*i.e.* more suitable for salmon farming) hatchery stock and by the introduction of foreign strains of salmon. Many salmon being farmed in Maine are from a European strain genetically modified to grow faster. Some wild salmon stocks have

been mixed and "mongrelized" so much that a Maine fisheries biologist quipped that "if they were dogs they wouldn't be recognized by the kennel club". Opponents of listing salmon as an endangered species argue that there may no longer be a real species to protect, just hatchery created hybrids. Peter Amiro suggests that smolt production in hatcheries might buy more time for scientists to study the threats to salmon stocks. There are just too few wild fish remaining in some waters to carry out meaningful scientific research. Hatcheries are also being used as "gene banks" to preserve unique genetic strains until conditions in the wild improve and they can be reintroduced. This involves keeping the strains of fish separate and raising them to maturity in order to produce eggs and continue the lineages.

"Opponents of listing salmon as an endangered species argue that there may no longer be a real species to protect, just hatchery created hybrids."

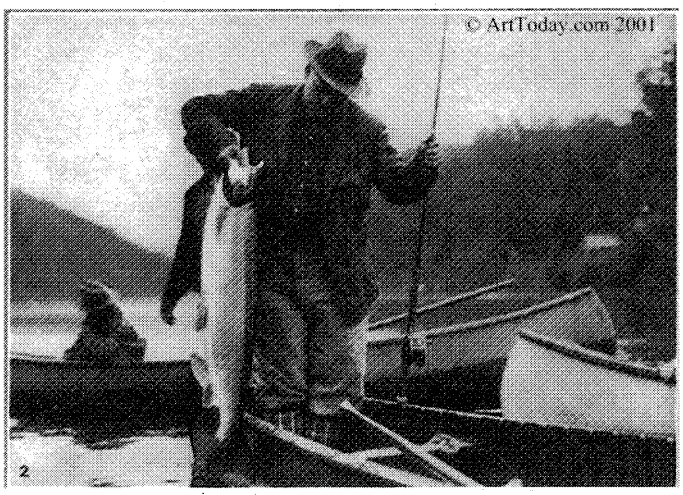
Sea Search

Until we know what is happening to the salmon at sea it is not certain what additional conservation measures should be undertaken. Conservation groups such as the Atlantic Salmon Federation are adamant that "more research is vitally important to determine what is happening in the ocean". They are urging DFO to spend at least $10 million a year over the next five years on research, including an ambitious program to tag and track the fish as they leave rivers and disperse in the sea. The Federation and DFO are already conducting a joint project that uses a sonic tag inserted in a fish's body cavity to follow it in the wild. Early models, with a short transmitter life and limited detection range, were only useful within an estuary. Smaller, more powerful tags with longer life now allow fish to be tracked for six months or more. In 1999, a smolt tagged in the Big Salmon River was followed for 26 miles as it wended its way across the Bay of Fundy. Researchers found that tagged fish avoided predators in the estuary and nearby coastal waters and headed out into the Bay along specific routes. They are hoping to track them eventually all the way to their winter feeding grounds at the mouth of the Bay. Automatic receivers are now being developed that can detect tagged salmon up to a half a mile away. An array of such receivers moored in different places in the ocean could provide valuable information about the movements and behaviour of migrating salmon. However, John Anderson cautions that "tracking itself will not likely reveal why mortality occurs, but it should indicate where and when it occurs". Once the "scene of the crime" is known, efforts can then be made to find out why they are dying. To aid in this, researchers from ASF and DFO are testing a Norwegian trawl net designed to capture young fish alive. This is being used in the Bay of Fundy to catch young salmon to examine them for parasites, diseases or other clues about what is killing them. But it is a study that demands infinite patience: "There are so few [salmon] left that we are now looking for a needle in a hay stack".

"it is a study that demands infinite patience: 'There are so few [salmon] left that we are now looking for a needle in a hay stack'."

In spite of these dedicated research and conservation efforts, the fate of wild salmon in the rivers of the Bay of Fundy and Gulf of Maine still hangs in the balance. An editorial in a New England newspaper asked rhetorically "Does it matter if wild Atlantic salmon disappear?"After all there are still huge numbers penned in the floating cages of the salmon farms. It concluded that wild salmon do indeed matter and "their loss would strike a blow both to the world's ecosystem and to the New England soul". Salmon are just as much a part of the Maritime soul. Perhaps even more importantly they are a powerful, evocative symbol of healthy, productive aquatic and marine ecosystems. If we are unable to mobilize our science, technology and community spirit to save something as tenacious, majestic, and awe inspiring as the Atlantic salmon, then the prospects for the rest

of our precious natural heritage appear very bleak indeed.



An angler proudly displays his trophy salmon caught in a New Brunswick River in the 1930s. Are such scenes destined to remain forever just fond memories?

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Further Reading

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Informative Web Sites:

ICES: http://www.ices.dk/

ASF: http://www.asf.ca

NASCO: http://www.nasco.org.uk/

DFO: http://www.dfo-mpo.gc.ca/index.htm

EC: http://www.ns.ec.gc.ca/

COSEWIC: http://www.cosewic.gc.ca/

The Fundy Issues Series is an initiative of the Bay of Fundy Ecosystem Partnership. These publications describe our present scientific understanding of some of the environmental issues confronting the Bay. We hope that they will enhance your understanding of the biological richness and complexity of this unique marine area and the problems confronting it. Such awareness may encourage you to help in protecting it for the use and enjoyment of all, so that future generations may also share and appreciate its bounty and rare beauty.