8.0 FISHES

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The apparent absence of a commercially exploitable offshore fishery resource has limited research on the fishes in Hudson Bay and James Bay. Few studies have been conducted offshore or in winter, few have been repeated in subsequent years, and sampling techniques have varied in their selectivity and efficiency. Because many marine fish species have only been caught at a few locations, little is known of population structure and dynamics or of ecosystem interrelationships. Research has focussed primarily on estuarine habitats that have been, or may be, affected by hydroelectric developments, and on anadromous salmonids that are harvested for food. Concern about the impact of altering the under-ice plume from rivers affected by hydroelectric development has spurred detailed research on the ecology of fish larvae offshore the mouth of the Grande rivière de la Baleine. There are important subsistence and commercial fisheries for anadromous Arctic charr along both the Nunavut and Nunavik coasts (see Section 14.4).

Traditional knowledge of the marine fishes is also limited. It consists largely of observations from shallow nearshore waters and from examinations of the stomach contents of harvested biota (Fleming and Newton 2003). Some of these observations are difficult to interpret, as hunters often do not differentiate between similar species of whitefishes, ciscos, cods or sculpins, or between capelin and sand lance. The “good, large size” cod reported near Lake Harbour by Fleming and Newton (2003:4), for example, are likely Greenland cod from Soper Lake and not Arctic cod (see Stewart and Bernier 1988). And, the Inuktitut name for capelin meaning “the ones that hide in the sand” (Fleming and Newton 2003:8)—likely refers to sand lance, which burrow into the sand, rather than capelin. Similar interpretation problems exist in the region’s scientific literature.

This Chapter summarizes knowledge of fishes that use waters of the Hudson Bay marine ecosystem. Rather than present detailed discussions of the species based on literature from other regions, it concentrates on information from studies within Hudson Bay and James Bay.

8.1 ZOOGEOGRAPHY

At least 61 species of fish use waters of the Hudson Bay marine ecosystem, which includes the James Bay and Hudson Bay marine regions (Figure 1-1). Their scientific names are provided in Appendix 3, which includes a brief summary of each species' depth, salinity, and substrate preferences, movements and utilization. None of these fishes is unique to this ecosystem but the estuarine fish communities are unusual. Two other species, Greenland halibut and shorthead redhorse, may also be present. The former may have been collected from Richmond Gulf (Hunter et al. 1984); the latter will enter brackish water on rare occasions and is present in river systems along the coast of James Bay and southern Hudson Bay (Scott and Crossman 1973), suggesting that it may enter the estuaries. In 1955-56, eggs and fingerlings of the chum salmon (*Oncorhynchus keta*) and pink salmon (*O. gorbuscha*) were introduced to three rivers of the Hudson-James Bay basin (Hunter 1968). The object was to supplement the basin's anadromous fish resources. There was no known survival of fish from these experiments. Data from the Hudson Strait marine region, immediately to the north, are provided for comparative purposes. Too few data are available from the Foxe Basin marine region for useful comparison.

Despite the limited sampling, a few generalizations with regard to the ecosystem's fish fauna are possible: 1) the number of Arctic marine fish species increases moving northward from the relatively warm, shallow, dilute waters of southern James Bay; 2) the ability of freshwater species to withstand salt water is an important ecological adaptation for this region; and, 3) the relatively shallow depths may exclude many of the deepwater fishes that occur in Hudson Strait (Morin et al. 1980; Morin and Dodson 1986).

Of the species reported from Hudson Bay and/or James Bay: 25 stay in the marine environment throughout their lives; 10 are marine but use the estuaries seasonally or as nursery grounds; 9 spawn and overwinter in fresh water but enter the brackish coastal waters for varying periods during the summer to feed (anadromous); 16 are freshwater species with varying salt tolerances that occasionally enter the weakly brackish estuaries or coastal waters (semi-anadromous); one, the fourhorn sculpin, lives in the brackish estuaries year-round (estuarine); and another, the Atlantic salmon, spawns in freshwater but can winter in salt water (diadromous). The number of species reported is low relative to Hudson Strait (Table 8-1), and to other marine regions along the Atlantic coast of Canada (Scott and Scott 1988). The extent to which this reflects differences in sampling efforts is unknown.

Table 8-1. Habitat use by fish species reported from the James Bay, Hudson Bay, and Hudson Strait marine regions (see also Appendix 3).

Species' habitat use	**Marine Region**		
	James Bay*	**Hudson Bay**	**Hudson Strait**
marine (M)	22	22	64
typically marine but make seasonal use of brackish water (B)	10	9	10
estuarine (E)	1	1	1
anadromous (A)	7	8	7
diadromous (D)	1	1	1
typically freshwater but occasionally enter brackish water (S)	12	8	6
TOTAL	53	49	89

*Note: James Bay Marine Region includes southeastern Hudson Bay, see Figure 1-1.

Anadromous and semi-anadromous fishes are less common in the more saline coastal waters of western and northern Hudson Bay than in the relatively dilute waters of James Bay and southern Hudson Bay (Table 8-1). Lake trout, lake cisco, lake whitefish, round whitefish, and burbot, which are common anadromous fishes in the estuaries and coastal waters of James Bay and southeastern Hudson Bay (Morin et al. 1980; Fleming and Newton 2003), are not common in the brackish coastal waters of western Hudson Bay (D. McGowan and G. Carder, DFO, Winnipeg, pers. comm. 1991). One anadromous species that is more common in the coastal waters of western and northern Hudson Bay is the Arctic charr. Hudson Bay and James Bay are both relatively shallow and lack the deepwater species that inhabit Hudson Strait.

Two recent developments in the zoogeography are of particular ecological interest, apparent changes in the species composition in northern Hudson Bay and the introduction of rainbow smelt.

Fisheries survey data are insufficient to identify changes in species composition but proxy data are available from Canadian Wildlife Service studies of seabird diets. The species composition of marine fishes in the diet of thick-billed murre (*Uria lomvia*) nestlings in northern Hudson Bay shifted over the period 1980 to 2002 (Gaston et al. 2003). The occurrence of Arctic cod, sculpins, and benthic Zoarcidae decreased while that of capelin and sand lance increased Figure 8-1). Arctic cod fell from a mean of 43% of deliveries in the mid-1980s to 15% in the late 1990s; sculpins and zoarcids fell from 36% to 15%. Deliveries of capelin increased from 15% to 50% over the same period. These changes were associated with a halving of the July ice cover in Evans Strait over the period 1981-99, and may reflect the effects of a general warming of Hudson Bay waters on the relative abundance of these fish species (Gaston et al. 2003).

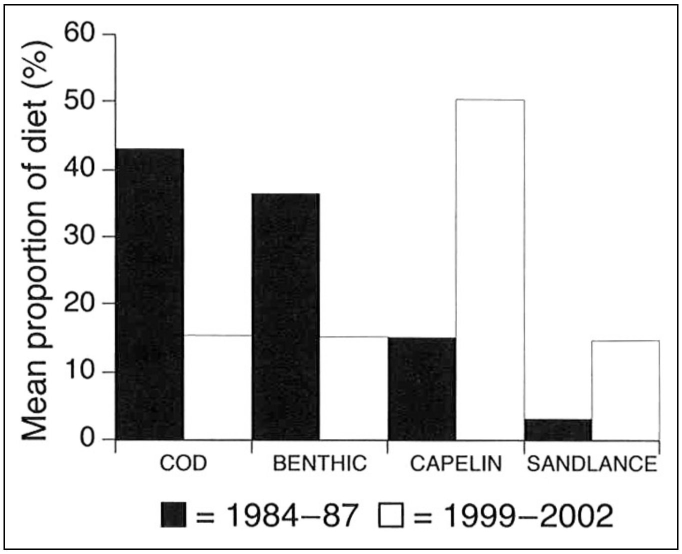

Figure 8-1. Proportion of fish prey types delivered to thick-billed murre chicks in 1984-87 and 1999-2002 (benthic = sculpins + zoarcids)(from Gaston et al. 2003, p.231). Values are means of annual proportions. Differences between periods for each prey type were significant at p<0.01.

Rainbow smelts (*Osmerus mordax*), presumably from the Atlantic population, have been illegally introduced into the Hudson Bay drainage at lakes in the Rainy and English/Wabigoon river systems of northwest Ontario (Campbell et al. 1991; Franzin et al. 1994; Stewart et al. 2001). They were first reported from the south basin of Lake Winnipeg in 1991 and by 1998 had spread down the Nelson River to the estuary (Figure 8-2; Remnant et al. 1997; Zrum 1999). In 2002 they were taken 15 km upstream from the mouth of the Churchill River, having ventured along the Hudson Bay coast against the prevailing currents (D. Remnant, North/South Cons. Inc., Winnipeg, pers. comm. 2003). There is evidence for spawning of the species in the lower Nelson River basin (Zrum 1999).

The spread of this small, predatory anadromous fish is a concern for commercial fisheries (Franzin et al. 1994; Stewart and Watkinson 2004). Rainbow smelts are voracious predators of invertebrates. They compete directly for food with various commercially harvested species, particularly whitefishes and ciscos, and prey upon their eggs and larvae. Rainbow smelts are in turn eaten by other harvested fish species such as walleye and lake trout. Walleye that have rainbow smelts in their stomachs when they are captured in gillnets deteriorate very quickly (D. Remnant, North/South Cons. Inc., Winnipeg, pers. comm. 2003). If they are not cleaned immediately on capture their flesh is unmarketable within hours.

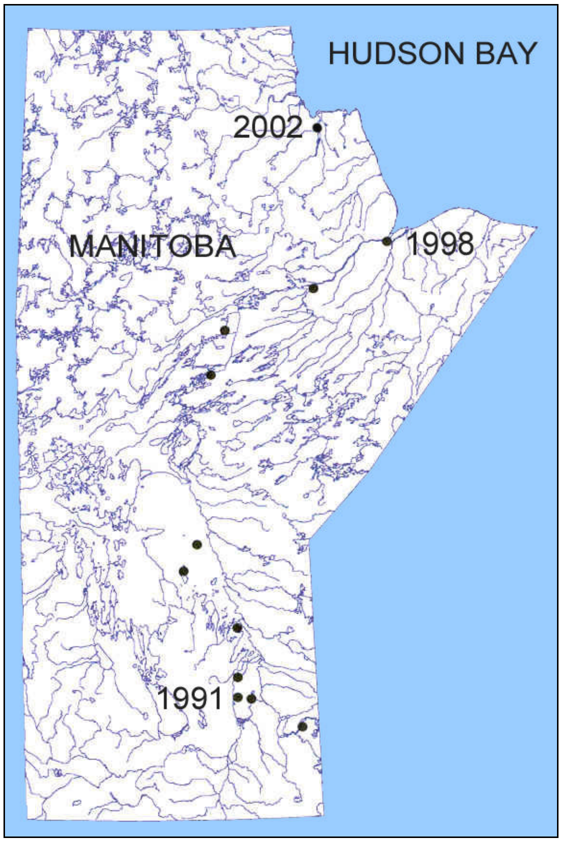

Figure 8-2. **Spread of rainbow smelt in the Hudson Bay drainage (adapted from Stewart and Watkinson 2004).**

The potential impact of the spread of this species along the coasts of Hudson and James bays and into other river systems has not been examined. Elsewhere, its introduction has reduced the populations of pelagic and benthic planktivores and increased the growth and fat content of game and commercial fish that begin eating it Stewart and Watkinson 2004). This increases mercury content of the latter and reduces their quality for human consumption. However, the rainbow smelt is also an excellent food fish in its own right and supports both commercial and recreational fisheries in the Great Lakes and Atlantic Canada. The potential effects of this introduced species on commercially harvested salmonid species in the Hudson Bay ecosystem merits close and immediate examination.

8.2 MARINE FISHES

The paucity of marine fisheries research in the region limits what can be said of its' marine fishes. Indeed, the offshore fisheries resources are virtually unknown. Some aspects of the ecology of capelin, Arctic cod, Greenland cod, and sand lance have been studied, and will be discussed further.

8.2.1 Capelin

The capelin is an important food for Arctic cod, anadromous Arctic charr, seals, beluga whales, and fish-eating birds (Fleming and Newton 2003). It has a circumpolar distribution that extends along the mainland coast of Canada and into the southernmost Arctic islands (McAllister 1963b; Hunter et al. 1984). The species is common in summer at estuaries along the Quebec coast (Morin and Dodson 1986; Fleming and Newton 2003) and west to at least the Nelson and Churchill estuaries (Watts and Draper 1986; Baker 1989).

Large numbers of capelin spawn on shingle beaches in the Belchers in July-September (Dunbar 1988; Fleming and Newton 2003) and on beaches in the vicinity of Port Nelson, near the mouth of the Nelson River estuary, in June (Comeau 1915). Larvae with yolk sacs (4-6 mm) are abundant and widespread in the Nelson River estuary in July, suggesting that they hatch in late June or early July (Baker 1996; Horne 1997; Horne and Bretecher 1998; Zrum 1999, 2000). They are most common in the Nelson River estuary at high tide, when densities of >100 individuals$\cdot$m^{-3} are not uncommon, particularly in deeper water. In July, larvae with yolk sacs are also present in concentrations of up to 3.2 individuals$\cdot$m^{-3} in the Churchill River estuary and offshore, suggesting that capelin spawn in and near the estuary in June or early July (Lawrence and Baker 1995). Little is known of the ecology of adult capelin in the region. However, dietary studies of thick-billed murre suggest that they have become more abundant in northern Hudson Bay over the past two decades (Gaston et al. 2003).

8.2.2 Arctic Cod

Arctic cod are a vital link in the food chain of the Hudson Bay marine ecosystem, where they can occur in vast schools (Morrison and Gaston 1986; Fleming and Newton 2003). These small pelagic cod have a circumpolar Arctic distribution and are distributed widely in Hudson Bay (Hunter et al. 1984; Scott and Scott 1988). Many fishes, seals, whales, and marine birds eat them. Arctic cod in turn eat a variety of smaller fishes, crustaceans, and polychaetes. Their ecology has been studied in detail in the High Arctic (e.g., Bradstreet et al.

1986) but is poorly known in Hudson Bay. In the High Arctic, juvenile and adult fish are found either dispersed throughout the water column or in large, dense schools. They are smaller and shorter-lived than Greenland cod, seldom attaining a length of more than 300 mm or an age of 7 years. They are often associated with ice cracks or edges and move inshore in late summer. Larval Arctic cod are very common in the coastal waters of southeastern Hudson Bay (Ponton and Fortier 1992; Ponton et al. 1993; Fortier et al. 1995, 1996). Their ecology is discussed in the section that follows on estuarine communities.

Little is known of the ecology of adult Arctic cod in the region. However, dietary studies of thick-billed murre suggest that they have become less abundant in northern Hudson Bay over the past two decades (Gaston et al. 2003). Inuit from Repulse Bay and Akulivik also report that they are less abundant than in the past (Fleming and Newton 2003).

8.2.3 Greenland Cod

Greenland cod are demersal, non-schooling fish (Mikhail and Welch 1989). This Arctic and cold temperate species is distributed in coastal inlets and estuaries along the east coast of Hudson Bay south to at least the Eastmain River estuary in James Bay and along the west coast of Hudson Bay south to Arviat (Ochman and Dodson 1982; Hunter et al. 1984). Studies at Saqvaqjuac Inlet in northwestern Hudson Bay (63ºN) did not capture them on the open coast (Mikhail and Welch 1989). This, coupled with the lack of species reports, suggests that the species may avoid the relatively shallow and exposed coasts of southwestern Hudson Bay and western James Bay. There is no evidence that they undertake large-scale migrations. In James Bay individuals seem to move offshore in the summer as the temperature of coastal waters increases and inshore into estuaries in winter (Morin et al. 1991). They may be more sedentary at Saqvaqjuac, where gradients in temperature and food concentrations are smaller.

These cod can tolerate salinities as low as 4 ppt (≈psu) (Ochman and Dodson 1982) and temperatures up to 20ºC (Morin et al. 1991). In eastern James Bay, they occupy shallow (2-5 m) coastal waters that have a belt of eelgrass at 1-3 m depth in summer. At Saqvaqjuac, they are evenly distributed near the bottom to 35 m depth (Mikhail and Welch 1989). Spawning occurs between April and June in James Bay and in March and early April at Saqvaqjuac, possibly in estuaries. Little is known about the early life stages of the species. Individuals can grow to 700 mm in length and live 12 years (Mikhail 1985; Morin and Dodson 1986; Mikhail and Welch 1989; Morin et al. 1991). They mature at 2-4 years, spawn annually thereafter, and have a high fecundity. Greenland cod eat a variety of fishes and benthic crustaceans. They grow larger than Arctic cod and may be less common prey for marine mammals and birds.

8.2.4 American Sand Lance

These small fishes are common in the inshore waters of Hudson Bay. They typically occur over sandy bottom in large schools and, when not schooling, will burrow into sandy bottom where they may remain above the low tide level between tides (Scott and Scott 1988). They are one of the most abundant species in the Nelson River estuary in summer, occurring at densities of up to 10 individuals$\cdot$m^{-3} at high tide, and are most common in the stratified offshore estuarine zones (Baker 1989, 1996; Horne and Bretecher 1998; Zrum 1999, 2000). Their distribution within the estuary is patchy but they are captured consistently in shallow water (3-6 m) of intermediate salinity (15-20 ppt [≈psu]). Adults, juveniles, and larvae, some with an egg sac, frequent the estuary. The larvae are planktonic until they grow to about 30 mm in length, and primarily benthic thereafter. Sand lance larvae are also common in the coastal waters of southeastern Hudson Bay (Ponton and Fortier 1992; Ponton et al. 1993; Fortier et al. 1995, 1996). Their ecology is discussed further in the following section.

8.3 ESTUARINE FISH COMMUNITIES

The relative importance of the freshwater species that exploit the extensive brackish zone is characteristic of the fish fauna of James Bay and southern Hudson Bay (Morin and Dodson 1986; Schneider-Vieira et al. 1993). Lake trout, lake cisco, lake whitefish, round whitefish and burbot, which commonly inhabit fresh water, frequent the mainland estuaries from the Nelson River south and east to the Innuksuak River to the extent that they are considered to be anadromous. These species make similar use of the Mackenzie River estuary (Stewart et al. 1993b) and/or the Chantrey Inlet-Rasmussen Basin area (Stewart and Bernier 1983) but are not common in brackish coastal waters elsewhere in Hudson Bay. The estuaries of southern James Bay also support a number of other freshwater species that are seldom reported from brackish water, including white sucker, walleye, slimy sculpin, spoonhead sculpin, and brook stickleback.

The Salmonidae, Catastomidae, and Cottidae dominate fish communities in the estuaries of Rupert's Bay and of the Eastmain, Maquatua, La Grande, Grande Baleine, Petite Baleine, Innuksuac, Nelson, and Churchill rivers (Morin et al. 1980, 1992; Morin and Dodson 1986; Kemp et al. 1989; SEBJ 1990; Schneider-Vieira et al. 1993). The species composition of these fish communities changes with latitude. Arctic and Subarctic species such as Arctic charr, Greenland cod, and shorthorn sculpin are rare or absent in the estuaries of southern James Bay, while there are fewer freshwater species in the northern estuaries (Morin et al. 1980; Schneider-Vieira et al. 1993). These differences are likely related to a variety of physical and biological factors, such as post-glacial dispersion, competition, habitat availability, climate, and/or oceanography. Resistance to freezing in sub-zero coastal waters is one important determinant of the fishes’ seasonal movements. Marine species such as Greenland cod and shorthorn sculpin are freeze-resistant, so their winter movements are unlikely to be restricted by low temperature (Whoriskey et al. 1994). Anadromous species such as lake cisco and brook trout are less resistant to sub-zero temperatures and shift their winter distributions into areas where their blood plasma will not freeze—typically closer to river mouths or into fresh water.

Seasonal movements of fishes that frequent the estuaries can be complex and are influenced by variations in temperature and salinity and by species' biological requirements (Lambert and Dodson 1982a; Kemp et al. 1989). Indeed, estuaries may serve as refugia from the winter stresses of both marine and riverine (lotic) environments (Roy 1989). The life cycles of anadromous lake cisco and lake whitefish are perhaps best known and serve to illustrate these complexities (Figure 8-3). Differences in the energetic costs of these migrations may play an important role in determining the reproductive strategy followed by each species (Dodson et al. 1985; Lambert and Dodson 1990a+b). Both of these anadromous salmonids exhibit reduced fecundity moving northward, largely due to later maturity and less frequent spawning (Morin et al. 1982). The life cycles of other fish that use James Bay and southern Hudson Bay are likely equally complex (see also Dutil and Power 1980).

Brackish waters of the Nelson River estuary provide important summer feeding and nursery habitat for juvenile lake cisco, lake whitefish, and longnose sucker from the lower Nelson River (Baker 1989, 1990). While a range of other typically freshwater species use the estuary in summer, few adults of these species have been caught there. Adult lake cisco are seldom caught in the Nelson River mainstem in summer (Remnant and Baker 1993) but are taken in the fall when they move into its’ tributaries to spawn (MacDonell et al. 1992; MacDonell 1993). Their apparent rarity in the Nelson River and its estuary suggests that many adults move along the coast of Hudson Bay in summer. These summer sojourns can be extensive, as tagged fish do move between the Churchill and Nelson rivers (Lawrence and Baker 1994). They appear to winter near the mouth of the Nelson River or within the estuary (MacDonell et al. 1992). In contrast, adult lake whitefish may forage occasionally in the estuary but appear to conduct most of their activities in the Nelson or its’ tributaries (Baker 1990; MacDonell and Bernhardt 1992). Whitefish (which likely includes the lake cisco), capelin and suckers have been found in the stomachs of beluga whales taken from the Nelson River area (Comeau 1915).

In contrast to the Nelson River estuary, the abundance of fish in the Churchill River estuary in summer is low (Baker et al. 1994). This may be related to the very low density of zooplankton. Sampling at the surface and

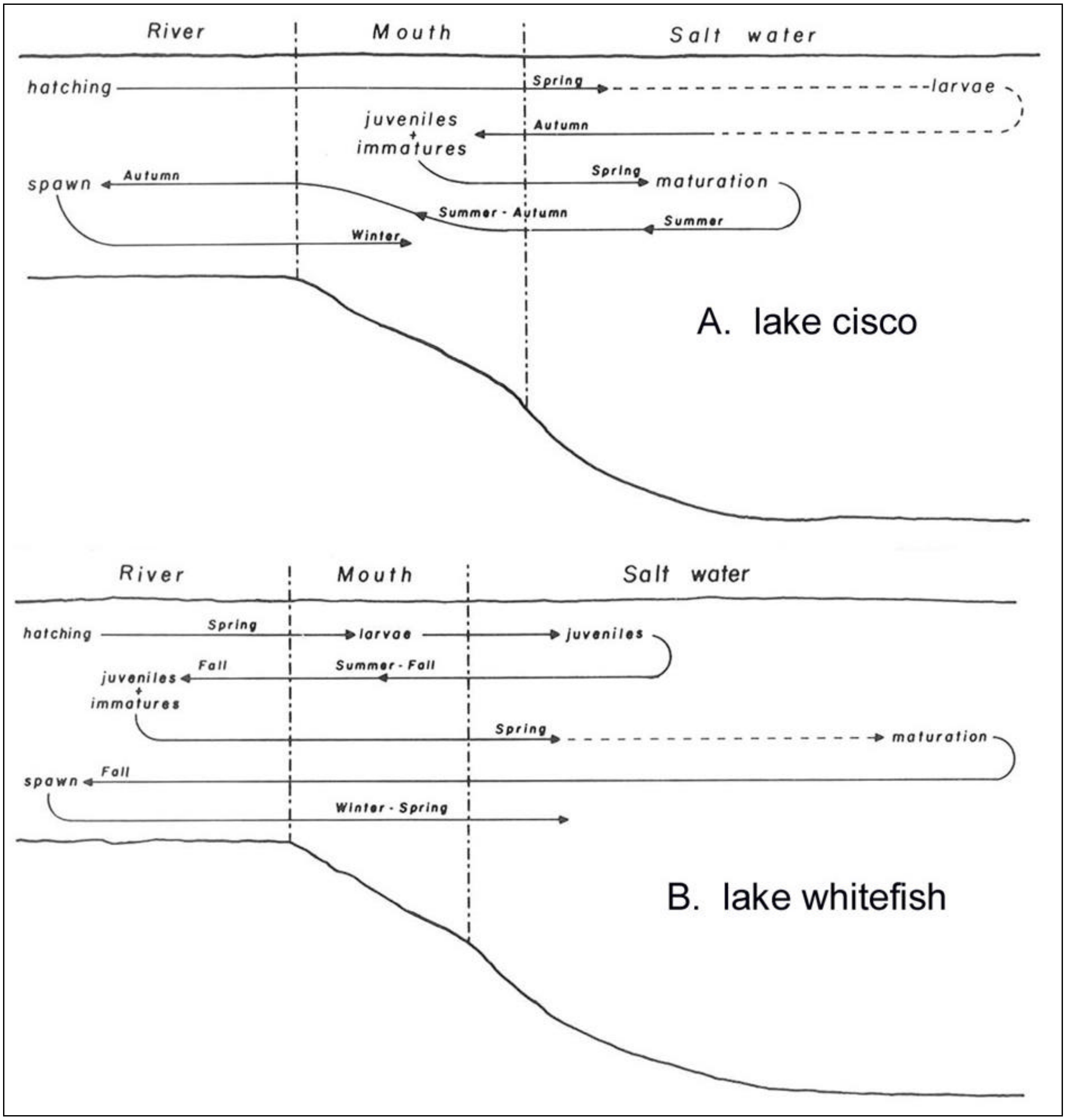

Figure 8-3. **The life cycles of anadromous (A) lake cisco (*Coregonus artedi*) and (B) lake whitefish (*C. clupeaformis*) in coastal James Bay (adapted from Morin et al. 1981, p. 1605). Horizontal lines indicate movements of the fishes through the freshwater, river mouth, and saltwater zones from hatching to postspawning. Arrows indicate the direction of movement and collection locations; dashed lines indicate speculative movements. The vertical arrangement of the lines is not related to the depth distribution of the fish.**

in deep water using Isaacs-Kidd trawls during August 1993, yielded few large invertebrates and no adult fishes. Most fish, primarily young-of-the-year capelin and sand lance, were captured in zooplankton nets.

Stocks of lake cisco in the rivers of eastern Hudson Bay may be reproductively isolated, perhaps by salinity or temperature barriers, whereas those to the south in eastern James Bay appear to constitute a single reproductive unit (Bernatchez and Dodson 1990). This is supported by the apparent absence of larval retention and demonstration of straying among rivers in James Bay. Similar straying occurs between the Nelson and

Churchill rivers in southwest Hudson Bay (Lawrence and Baker 1994). It has important implications for stock management.

The estuaries also provide important nursery habitat for larval fishes. The larval communities of the Eastmain (Ochman and Dodson 1982) and Grande Baleine (Drolet et al. 1991; Gilbert et al. 1992; Ponton and Fortier 1992; Ponton et al. 1993; Fortier et al. 1995, 1996) estuaries are highly structured both spatially by salinity and temporally by date of hatch; many of the larval taxa emerge before ice breakup (Figure 8-4). This separation probably limits interspecific competition. The estuaries support larvae that hatch upstream in fresh water and are swept downstream by spring runoff, and those of marine and estuarine spawning species. The timing and extent of the freshet influences the distribution of the marine larvae and determines when larvae of anadromous and freshwater species enter the Bay (Ponton et al. 1993).

In the spring and summer of 1988-90, Arctic cod and sand lance were the most abundant larvae in and around the plume of Grande rivière de la Baleine (Ponton et al. 1993). The larval densities of Arctic cod, sand lance, slender eelblenny, and gelatinous snailfish were greatest in salinities >25 psu; Arctic shanny, sculpins, and capelin larvae were more abundant at salinities between 1 and 25 psu; and burbot and coregonine larvae were associated with fresh or brackish water even in Hudson Bay.

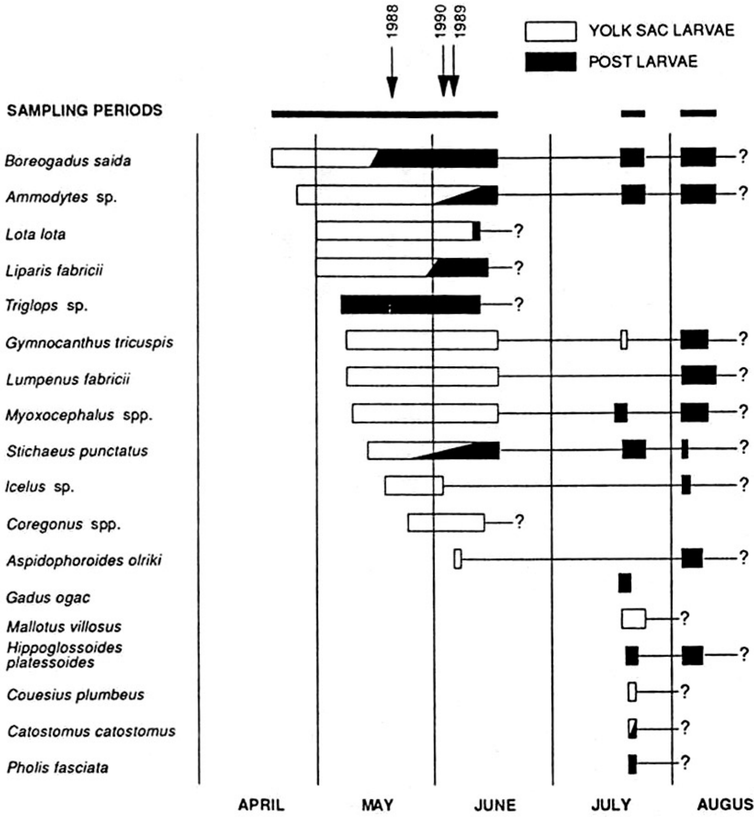

Figure 8-4. **Seasonal occurrence of the larval fish species caught during 1988-90 in Hudson Bay offshore Kuujjuarapik (from Ponton et al. 1993, p.325). Arrows indicate the start of ice breakup in the Bay offshore Kuujjuarapik. Ice breakup in Grande rivière de la Baleine generally occurred 10 days earlier.**

Larvae at the Grande Baleine estuary exhibit two survival strategies; sand lance and Arctic cod produce many, small larvae that hatch before ice breakup and feed on relatively small prey, while shannies (Stichaeidae) and sculpins (Cottidae) produce fewer, relatively large larvae that emerge after breakup and prey on larger items (Drolet et al. 1991). Before the spring freshet the sand lance and Arctic cod larvae are marginally more abundant offshore, where porous sea ice supports the development of ice algae, than inshore where freshwater inhibits algal growth (Gilbert et al. 1992).

Estuarine habitats provide important food resources for freshwater and anadromous species. Important foods for anadromous salmonids include: freshwater insect larvae that are carried downstream into the estuaries; small marine fishes such as capelin, eelblenny and sand lance; marine molluscs and amphipods (Hunter et al. 1976; Greendale and Hunter 1978; St.-Arsenault et al. 1982); and catostomids (Magnin and Clement 1979).

The estuaries also provide important food resources for marine species and for some, such as capelin (see above), important reproductive habitat. First-feeding larval Arctic cod and sand lance, for example, accumulate under the spring ice at the pycnocline below the brackish plume of Grande rivière de la Baleine (Figure 8-5; Ponton and Fortier 1992). This habitat offers them salinities they can tolerate and the optimal combination of prey density and visibility. If the plume becomes too thick (i.e., depth of 25 ppt [≈psu] isohaline >9 m) the larvae stop feeding (Fortier et al. 1996). Outside the plume area, where the surface meltwater layer is less turbid than the river plume, the under-ice distribution of larval Arctic cod and sand lance is less stratified and may be less constrained by light penetration and salinity. Their feeding success and growth also depends upon how well the timing of their hatch matches the reproductive cycle of the copepods they prey upon (Fortier et al. 1993). While the fish species hatch at about the same time each year, the copepod lifecycle is not always in synchrony so the nauplii they eat are not always available at the right time. Their dependence on the timing of the freshet and plume dynamics suggests a direct link between climate and survival of these species' larvae in the area affected by the plume (Fortier et al. 1996).

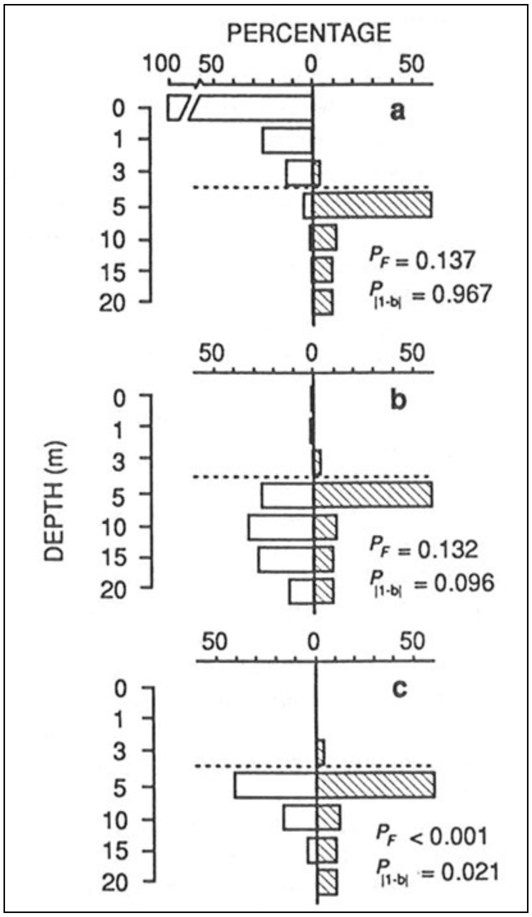

Figure 8-5. Vertical distribution of Arctic cod (*Boreogadus saida*) larvae =7 mm (hatched histograms) offshore Grande rivière de la Baleine relative to (a) percent irradiance at depth, (b) percent food density at depth, and (c) percent food availability at depth (i.e., % food density x % irradiance) (from Ponton and Fortier 1992, p.223). Dotted line indicates pycnocline. Note the compressed vertical scale.

8.3.1 Anadromous Arctic Charr

Arctic charr are discussed here at greater length than the other anadromous species because of their importance to the Inuit of Hudson Bay, who harvest them for subsistence and commercial sale (see also Section 14.4).

The Arctic charr has a circumpolar distribution that is the most northerly of any freshwater fish. Its populations can be anadromous or landlocked (McPhail 1961; McPhail and Lindsey 1970; Scott and Crossman 1973; Johnson 1980). The anadromous form is abundant in coastal areas of the Canadian Arctic but is not usually distributed far inland, except in the larger rivers. It is common in coastal areas of northern Quebec and Nunavut but less so in Ontario and Manitoba.

Anadromous charr migrate downstream during ice break-up from mid June to early July to spend the summer feeding in Hudson Bay and James Bay, and return upstream from mid August to mid September to overwinter in fresh water (Sprules 1952; Johnson 1980; McGowan 1987). They have been captured in salinities of up to 32 ppt (≈psu) in the Beaufort Sea (Craig 1984; Bond and Erickson 1987) but have not been reported from saline water in winter. This supports the belief that they leave the sea and overwinter in fresh waters to avoid sub-zero marine waters.

During the summer anadromous Arctic charr range widely along the Hudson Bay coast (Figure 8-6). Indeed, one charr tagged at Sandy Point, Nunavut was recaptured at Winisk, Ontario--a distance of over 800 km (G.W. Carder, DFO, Winnipeg, pers. comm.), while another tagged at Maguse River, Nunavut travelled northward at a rate of 33 km per day to the Ferguson River (MacDonell 1989). Migrants do not always return to their natal river systems to overwinter, but generally do so during spawning years (Johnson 1980; McBride 1980; Gyselman 1984).

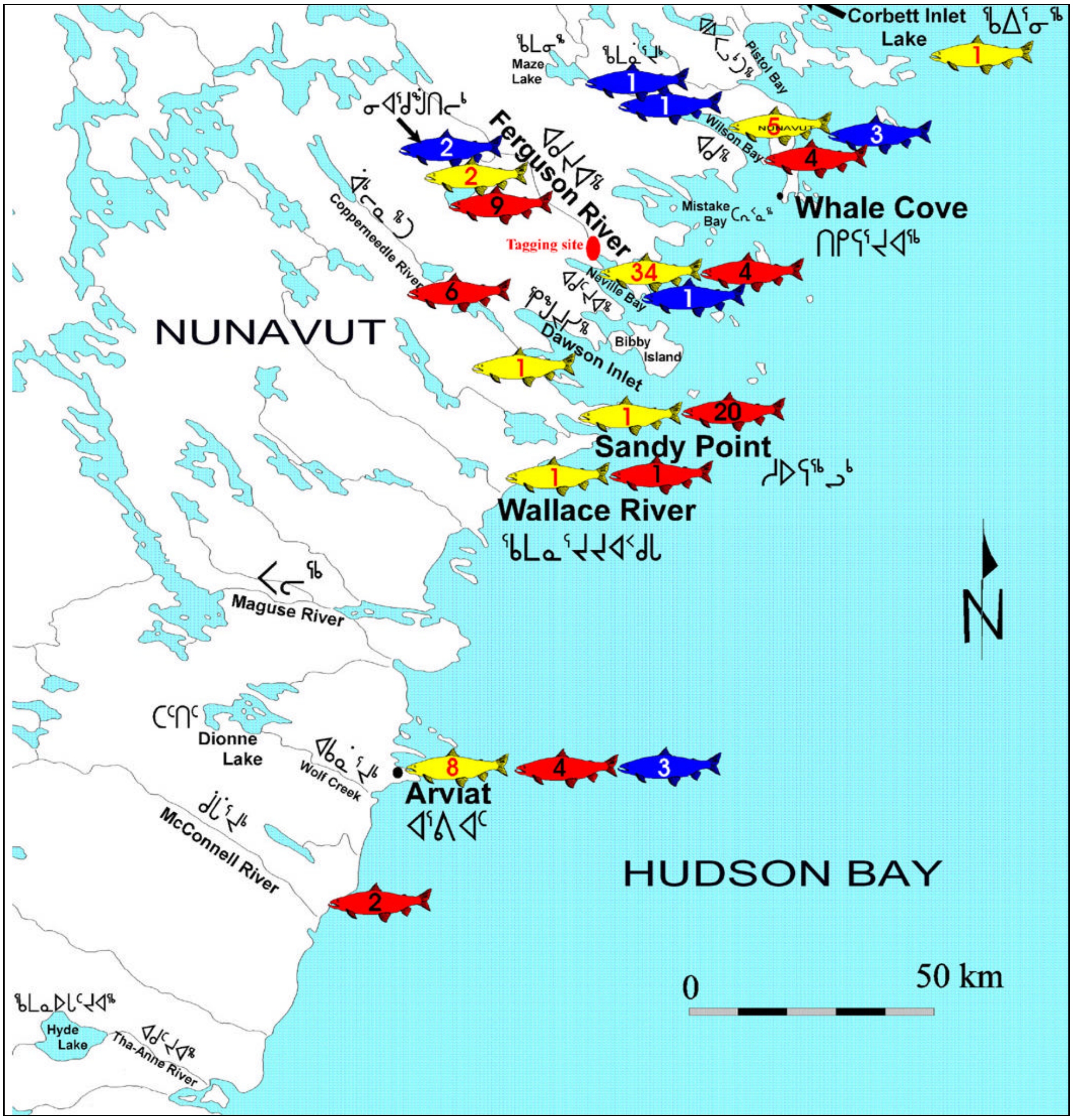

Figure 8-6. **Movement of anadromous Arctic charr along the Kivaliq coast of Hudson Bay (adapted from McGowan 1998, p. 39). In June 1995, 493 Arctic charr were tagged during the downstream run at the Ferguson River. This map shows the number of charr recaptured by fishermen at different locations in 1995 (yellow), 1996 (red) and 1997 (blue).**

Arctic charr in the Hudson Bay region spawn in fresh water during late August, September, and early October (Sprules 1952; Johnson 1980; Stewart and Bernier 1984; K. Martin-Bergmann, DFO, Winnipeg, pers. comm.), generally over gravel bottom in an area where current is sufficient to keep the eggs detritus-free and deep enough to protect them from freezing (Moore 1975; Johnson 1980). Eggs hatch in April or May and young pre-anadromous charr spend several years in fresh water, followed by 2 to 4 seasons of migrations to sea for feeding, before reaching sexual maturity. Maturity for both sexes is reached between ages 5 and 12 years and mature fish seldom spawn in consecutive years (Grainger 1953; Johnson 1980; Stewart and Bernier 1984).

Arctic charr in Hudson Bay eat predominately amphipods, mysids, and fish (Sprules 1952; Stewart and Bernier 1984). Because food is more abundant at sea they generally grow faster and larger than charr that remain in fresh water but are shorter-lived. Along the Kivalliq coast anadromous charr can grow to a fork length of 880 mm and live 23 y (Carder and Peet 1983).

Anadromous Arctic charr are attractive fish to subsistence, commercial, and sport fishers because they are available spring and fall in quantity at known locations. They grow faster and generally larger than landlocked charr, and are almost always in better condition--having higher coefficients of condition and fewer *Diphyllobothrium* spp. parasites encysted in the body cavity (Johnson 1980; Stewart and Bernier 1984).

8.4 SUMMARY

Knowledge of fishes in the Hudson Bay marine ecosystem is scant except for harvested anadromous species, and in the vicinity of estuaries that have been or may be affected by hydroelectric development. Lack of a proven, commercially viable offshore fisheries resource has limited offshore fisheries research, and ice conditions have limited seasonal research. Relatively little is known of fishes along the Ontario coast or offshore.

At least 61 species of fish use waters of the Hudson Bay marine ecosystem—fewer than are present in Hudson Strait and along the Atlantic coast. James Bay and southern Hudson Bay support characteristic and unusual estuarine fish communities that consist of a mixture of Arctic marine, estuarine, and freshwater species. These communities include more freshwater and anadromous species and fewer Arctic and deepwater species than those in western and northern Hudson Bay. The entire ecosystem is relatively shallow and lacks the deepwater species that inhabit Hudson Strait.

The composition of the estuarine fish communities changes with latitude. To the south the Arctic marine species are poorly represented, and to the north and offshore there are fewer freshwater species. Freshwater species make particular use of the estuaries along the Quebec coast, from the Eastmain River estuary northward to and including Richmond Gulf, where the waters are relatively warm, shallow, and dilute. The ability to exploit the extensive brackish zone is an important ecological adaptation for both the freshwater and Arctic marine species. Their seasonal movements are often complex and are influenced by variations in temperature and salinity, and in their biological requirements. The estuaries provide important seasonal foraging and nursery habitat for many species, spawning habitat for some, and year-round habitat for fourhorn sculpin.

Two recent changes in the zoogeography are of particular ecological interest. First, species composition in northern Hudson Bay may have shifted over the past two decades, with a decrease in the relative abundance of Arctic cod and an increase in that of American sand lance—possibly related to warming. Second, recent introduction of rainbow smelt (*Osmerus mordax*) into coastal river systems of Hudson Bay has the potential to damage coastal fisheries. The species is actively invading systems along the Hudson Bay coast and, elsewhere, has been implicated in the decline of native lake whitefish and cisco populations. Both of these developments merit further study.

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