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Pink Salmon East

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ABSTRACT

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Cannibalism by adult on young likely contributed to the failure of a recent attempt to introduce pink salmon to a Newfoundland stream, which suggests another attempt should be considered.

Key words: pink salmon; east coast; interaction

RÉSUMÉ

Barber, F. G. 1981. Pink salmon east. Can. Tech. Rep. Fish. Aquat. Sci. 986: iii + 8 p.

Les interactions entre les classes d'années ont vraisemblablement contribué à l'échec d'une récente tentative d'introduction de saumon rose dans un cours d'eau de Terre-Neuve; il faudrait donc tenter un autre essai.

Mots clés: saumon rose, côte est, interaction

This essay was prompted by recent suggestions that transplants of Pacific salmon (*Oncorhynchus*) to our east coast should again be attempted (Larkin 1978) and that where acid rain is a problem (e.g. Power 1980; Jensen and Snekvik 1972) pink salmon (*O. gorbuscha*) might be introduced (Berg 1977, p. 16; Bjerknes and Vaag 1980a; Sutterlin and Merrill 1978, p. 28), and by evidence of interaction in transplanted populations of pink salmon. Interaction, as exercised through predation by adult on young, can lead to dominance, as recognized in the existence of disparity in abundance, occasionally extreme disparity (Neave 1952), and by a geographical cline in size of returning adults, at least to streams in British Columbia and Alaska (Ricker et al. 1978; Barber 1980). The odd-year dominance seen in the number of adults returning from experimental releases of hatchery fry to the Barents Sea (Grinyuk et al. 1978, p. 2, 7) is likely also due to interaction between adult and fry (Note 1), although the outcome of the experiment there remains uncertain (Kossov et al. 1960; Neave 1965; Berg 1961; Sutterlin and Merrill 1978; Munro 1979). Fry observed leaving streams in northern Norway are believed progeny of fish used in the Soviet experiments (Berg 1977; Bjerknes 1977; Bjerknes and Vaag 1980a,b); of these streams in Norway, Berg (1977, p. 17) remarked, "the stock in some of the rivers may be self-producing."

Hope was initially high that pink salmon had been successfully introduced to a stream in Newfoundland (Quigley 1965; Blair 1968; Ricker and Loftus 1968), but eventually returns showed a steady decline to near extinction (Scott and Crossman 1973; Lear 1975; Lear and Day 1977). Lear (1975) did not discuss the possibility that interaction between year classes caused the failure, although he remarked (p. 2355) "the use of even year stocks could also be a contributory factor." Of the returns to Newfoundland:

1) there was a trend to decreasing length,
2) odd-year fish were larger than even and
3) eventually the stream, North Harbour River, became barren in both years (Lear 1975).

These three facts suggest interaction between year classes which, with the near success of the experiment, leads me to propose another attempt should be made there but with a single year class. While the proposal is narrowly based on the three results and while "only trials are likely to supply the final answer" (Ricker 1954), I deem it useful to review the experience. I follow the consideration that the progeny of transplants could "become progressively better adapted to Atlantic conditions" (Ricker and Loftus 1968, p. 39) and introduce the notion that a degree of conditioning of the surface layer there is necessary for this increasing adaptation.

Paine and Zaret (1975) believed predator-prey relationships are important factors in species introductions and remarked, "Maximal benefits from fish introductions will be conferred where the invader is ecologically matched with its prey." Present understanding of the food of Pacific salmon while in the ocean indicates a wide diet (e.g. Andrievskya 1958; LeBrasseur 1972), one likely as wide as that of Atlantic salmon (*Salmo salar*) and likely not limited over the ocean there (Lear 1972; 1980) however, as the fish has not

been successfully introduced the possibility cannot be rejected. Competition in the ocean may occur between Atlantic salmon and pink salmon, but this would require that pink salmon eventually develop a similar migration pattern (Fig. 1; Note 2); this is another possibility that cannot now be rejected even though density-dependent limitation of either species while in the ocean is unlikely (Barber 1979b; Note 3). Competition for the freshwater resource would be small as the dependence of each is quite different (Ricker 1954), but some interaction could occur in coastal inshore areas between pink and Atlantic salmon, i.e. between young and adult, which could prove limiting (e.g. Barber 1980; Note 4).

I assume pink salmon originated from the charr (*Salvelinus alpinus*) in the northern North Pacific, specifically in the Bering Sea (Barber 1978), where they gradually became tuned to the structure and content of the Langmuir circulations; a structure caused by interaction of wind and wave and a content partly residue from the earlier passage of the salmon (Barber 1979b; Note 5). That this first occurred in a relatively small ocean area with some internal circulation was critical in that the residue likely had significant residence time, at least two years, and so conditioned the surface layer. This provided for the establishment of a self-sustaining population and for the subsequent expansion of range over the subarctic North Pacific Ocean. Transplants of pink salmon have not been attempted to streams of the Gulf of St. Lawrence (Davidson and Hutchinson 1938; Huntsman and Dymond 1940; Neave 1965; Ricker and Loftus 1968; Ricker 1972), a region rather similar to the Bering Sea and so one with potential.

In a review of "current understanding of the Gulf of St. Lawrence" it was described as a "large complex estuary" with a characteristic surface layer of low salinity and a "flushing time of freshwater somewhat less than one year" (Trites and Walton 1975). The gulf is smaller than the Bering Sea and may on average have a greater proportion of ice cover each winter with an associated deep (100 m) and cold (-1.5°C) surface layer (Note 6). The salinity structure resembles that of the subarctic North Pacific (Tully and Barber 1961) with which Pacific salmon have been associated (Tully and Dodimead 1956; see also Ingraham 1979). The structure is not characteristic of the North Atlantic, but as it does occur in adjacent areas like the gulf, a population established in North Harbour River might gradually come to utilize the food resource of the gulf.

Reviews of transplants emphasize other factors (Neave 1965; Ricker 1972; Lear 1975), though there is reference to the possibility that the fish simply get lost (Stewart 1977). I speculated that guidance is provided by Langmuir circulations and that dispersal over the ocean in winter is important to the optimum use of the ocean food resource; dispersal was seen to be directed by the Langmuir cells sensed by the fish (Barber 1979b). Without the particular salinity structure these cells may be rather larger in the Atlantic than in the Pacific and not as available to the fish as a guidance mechanism. In time a population of pink salmon could become tuned to the particular character of the North Atlantic surface layer, as has *S. salar*, and so develop a characteristic migration. This possibility would be enhanced were a self-sustaining population established somewhere within that ocean system, e.g. at North Harbour River.

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NOTES

1) The report of Grinyuk et al. (1978) refers specifically to returns from releases in the area of the Kola River and Inlet. Interaction in this experiment could be removed by restricting fry release to one or the other of odd or even years and, while releases there have not been carried out in some years, the purpose apparently was "to check the course of acclimatization" (Grinyuk et al. 1978). Other evidence for dominance, i.e. for year-class interaction, in these transplant experiments includes that provided by Williamson (1974, p. 29) who showed that up to 1973 around Scotland adult fish were generally only caught in odd years and that of Bjerknes and Vaag (1980b) in which both abundance and average size are smaller in even years; both suggest odd-year dominance. V. Bjerknes (personal communication) drew attention to a number of other factors which might influence statistics there, including the present net fishery which probably selects for large size.

2) Many Atlantic salmon travel to a particular area off Greenland (Fig. 1) which has been termed a "centralized feeding ground" (Power 1958, p. 88) and "communal feeding ground" (Payne et al. 1971); however, the proportion of North American salmon there may vary markedly from year to year (e.g. Lear 1976, p. 35 and references therein). It has been argued, e.g. Dunbar and Thomson (1979), that the location of this area varies somewhat in response to hydrographic conditions (see also Christensen and Lear 1980, p. 34).

3) Huntsman and Dymond (1940) in a brief review of earlier attempts to establish *Oncorhynchus* in some streams of the North American Atlantic coast appear to have concluded that the ocean was not limiting. They remarked, "The facts show that the pink salmon will pass successfully through its sea stage on certain parts of the Maine coast, but evidence fails of there having been a second generation produced by natural spawning."

4) Whether interspecific interaction, as in predation by adult on young in inshore areas (Barber 1980), would be significant is uncertain, but likely both grilse and adult would prey on pink fry. Huntsman (1941, p. 234) believed that when abundant parr could eat younger fish and so establish a dominant year-class, although Christensen and Larsson (1979) believed cannibalism by adult salmon of the Baltic to be "very rare." In a recent review of marine survival of young, interaction was not considered (Wedemeyer et al. 1980).

5) This is the conditioning of the surface layer I see necessary to adaptation and to eventual range expansion. Man could likely contribute to the process by injecting appropriate material into the surface layer of the transplant region.

6) Consideration of the way pink salmon might cope with this layer of cold water is rather remiscent of the Hudson Bay transplant attempt

wherein it was anticipated the fish would move eastward through Hudson Strait to overwinter elsewhere (Ricker and Loftus 1978, p. 37); not anticipated was the introduction of pink salmon to the Great Lakes (e.g. Johnstone 1977, p. 232-3). Pink salmon could move out of the gulf in winter, but as many commercial species overwinter there (Trites and Walton 1975, p. 16) pink salmon might as well. Atlantic salmon likely are not in the gulf in winter, but perhaps rainbow trout (*Salmo gairdneri*) are as they sea run to Prince Edward Island; MacCrimmon (1971, p. 669) remarked:

> Rainbow trout in Prince Edward Island were first introduced in 1924...A modest sea-run fishery does exist in the Northumberland Strait area... but rainbow trout are not taken from any waters tributary to the Gulf of St. Lawrence...

Those rainbows, without a winter in the ocean, taken recently on the north and south shore of the estuary of the St. Lawrence River could have originated from several sources (Whoriskey et al. 1981), perhaps including those in a cage-rearing experiment in Trinity Bay (Jamieson 1980) and from earlier introductions in Newfoundland (MacCrimmon 1971, p. 666; Scott and Crossman 1964).

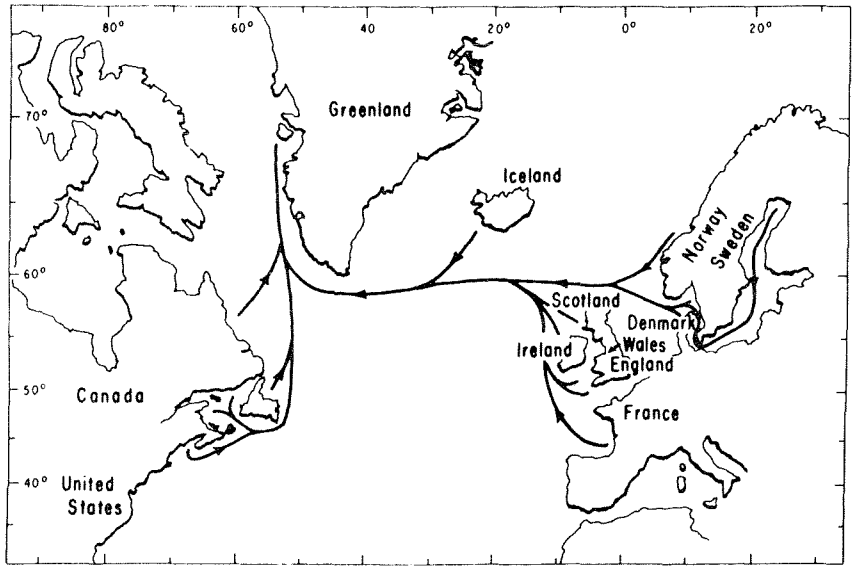

Fig. 1. An illustration from MacKenzie (1972) where it is captioned, "State-of-origin of tagged Atlantic salmon (natural smolts, hatchery reared smolts, kelt) recaptured at west Greenland to March, 1971." Reproduced by permission of The International Atlantic Salmon Foundation.