

THIS PAPER NOT TO BE CITED WITHOUT PRIOR REFERENCE TO THE AUTHOR

International Council for
the Exploration of the Sea

CM 1980/M: 15
Anadromous and Catadromous
Fish Committee

PACIFIC SALMON IN THE NORTH ATLANTIC;
A HISTORY AND ASSESSMENT OF CURRENT STATUS

D. J. Solomon,
Ministry of Agriculture, Fisheries and Food,
Directorate of Fisheries Research,
Fisheries Laboratory, Lowestoft,
Suffolk NR33 0HT, England



ABSTRACT

The history of attempts to establish or to introduce for other purposes the seven species of Oncorhynchus are briefly described. Fuller details are given of recent experiments, especially those which have led to natural spawning.

1. INTRODUCTION

The purpose of this review is to give a brief history of introductions and escapes of Pacific salmon to the N. Atlantic area, with emphasis on recent and existing stocks. It also gives references for more extensive information. The area covered is the N. Atlantic Ocean, Baltic Sea, and Barents Sea, and rivers draining to these seas. The Mediterranean Sea and Great Lakes of North America are not included.

There are several reasons why Pacific salmon have been transferred outside their natural range. Perhaps the most usual has been to attempt establishment of natural self-sustaining populations, for sport or commercial fisheries. More recently, several attempts have been made to utilize salmon on an ocean ranching basis for sport or food, with stocks maintained by hatchery production. Another reason has been for fish cultivation, particularly with the development of net cage culture. Finally, introductions for hatchery rearing for put-and-take fisheries in fresh water have been undertaken. Although these last two developments need not involve intentional release to river systems or the sea, escapes appear to be almost unavoidable, and these developments should be considered along with release projects in evaluating possible environmental impact.

Information on several dozen separate introductions is given here; from the poor published records of many of them it can be inferred that there are others unrecorded. A full record is important, in order that developments can be carefully watched. It is hoped that member countries will make every

attempt to submit details of developments involving Pacific salmon to the Working Group on the Introduction of Non-Indigenous Marine Organisms.

2. EARLY EXPERIMENTS (Up to 1930)

Numerous attempts were made during Victorian times to introduce a wide range of fish species to new areas, and rather fewer during the early years of this century. Davidson and Hutchinson (1938) list: chinook salmon to seventeen U.S. Atlantic and Gulf states, Canada, the U.K. (between 1872 and 1880), France (1872-1900), Germany (1872-1900), Ireland (1891-1900), and the Netherlands (1872-1930); sockeye salmon to Maine, pink salmon to four U.S. Atlantic states, and coho salmon to six U.S. Atlantic states. All these transplants were made to streams with the intent of establishing sea-going runs. All failed, though pinks in Maine (see 4.1 below) succeeded to the extent of achieving significant returns in the short term. Many of the other introductions were of small numbers of eggs to unsuitable habitats by enthusiastic amateurs, and little can be learned from detailed consideration of the projects.

3. COHO SALMON (O. kisutch)

3.1 New England States

Following early attempts (Section 2), numerous introductions have been made for sport and commercial fisheries and for cultivation. Joyner (1973) gives the recent history and rationale behind the projects. Eggs were shipped from Washington and Oregon, the fish were reared to the smolt stage, and released. Subsequently eggs have been stripped from returning fish. The National Marine Fisheries Service (Anon., 1975) lists the following figures:

		No. of smolts	Total adult returns	%
New Hampshire	1969-72	264,000	5,650	2.14
Massachusetts	1971-73	192,000	1,000	0.52
Rhode Island	1971-73	110,000	411	
Connecticut	1968-71	309,000	3	

Stolte (1974) gives details of the New Hampshire venture, including evidence of some natural spawning, with low survival, limited straying and a small sport fishery. NEMRIP (1975) describes cage rearing enterprises on the Maine coast.

3.2 New Brunswick and Nova Scotia, Canada

It is likely that one of the New England projects (Section 3.1) has given rise to two small breeding populations in New Brunswick and Nova Scotia. Symons and Martin (1978) describe a population of juvenile coho in Frost Fish Creek (Digdeguash River, N.B), estimated at 24 fish, in 1976. Anon. (1980) reports finding three juveniles in a tributary of the Cornwallis River, N.S. in October 1979. An adult had been reported in the same system in January, 1976. This suggests that the young in 1979 may be the second generation supported by the stream.

3.3 France

The development of cage rearing of coho in France has been well documented by Harache and Novotny (1976), and Harache (1979a and b). Eggs have been imported from the U.S. each year since 1971; local broodstock development has proven difficult. Several escapes have taken place from cages and from freshwater farms rearing smolts (Harache, 1979b; Solomon, 1979), which in at least one case led to smolts migrating to sea, returning to the river as adults and successfully spawning to produce young fish in the river. However, this population appears to have died out. The cage rearing is continuing and is likely to expand as long as eggs are available. There are also reports of intentional releases.

3.4 Federal Republic of Germany

A small stock of coho was imported in 1974 from the U.S. for evaluation of angling potential (Welcomme, 1979), but few details are available. R. Meixner (personal communication) reports that they are held in enclosed waters in the Elbe watershed, but one or two have escaped and have been recaptured in streams downstream of the ponds.

3.5 United Kingdom

Twenty thousand eggs were imported to Scotland in late 1976 by a commercial company to evaluate cultivation potential. They were reared under conditions of strict quarantine and confinement as stipulated by law, and their offspring are also legally confined (Munro, 1979). No further imports have taken place. Munro et al. (1980) give details of the quarantine arrangements.

3.6 Spain

Munro (1979) refers to cage rearing developments in Spain, but gives no details.

3.7 Latvian, SSR

Munro (1979) records that cage rearing experiments have involved up to 100,000 coho. Many thousands have escaped during storms.

4. PINK SALMON (O. gorbuscha)

4.1. Maine, USA

Although falling within the early period (Section 1), further details are given as the experiment was well recorded and produced some interesting results. Bigelow and Schroeder (1953) record large scale releases of fry from the autumn of 1913 to 1917, peaking at over 6 million in 1916, in several rivers. Large numbers of adults were seen and caught in 1915 and in subsequent years. Eggs were collected from returning fish and the fry released between 1922 and 1926. As runs appeared to be established propagation was discontinued, but the stock rapidly declined and none had been reported for 'some years' in 1953.

4.2. Newfoundland, Canada

This project, involving transfer of eggs from British Columbia between 1959 and 1966, has been described by Lear (1975). Up to 5.9 million eggs were planted out each year. Returns of up to 8,500 adults were recorded, most to the area of release. Some natural spawning occurred, producing over 4 million eggs in 1967. However, after transplants were ceased, runs declined rapidly, with only 18 being recorded in the river in 1972. In 1976, eight were recorded (Lear and Day, 1977), and a few the year after (Reddin, personal communication). Reddin suggests that a population may still remain and attempts will be made to check this. Rowell (1980) reports that a number of pink salmon held in a net enclosure for cultivation research escaped in 1979 when the net was damaged by ice.

4.3. Northern Russian and Northern Norway

In most years between 1957 and 1977 large numbers (up to 36 million per year) of pink salmon eggs were transferred from the Pacific to the Kola Peninsula area (White and Barents Seas). A total of over 220 million eggs was involved, resulting in the release of 187 million fry. In the early years returns were very poor. However, as transfer and release techniques have improved, eggs were taken from returning fish, and some natural spawning populations built-up; numbers of returning adults have increased considerably. The odd-year-class gave the best results, as was the case with the donor Pacific stock. Details and further references are given by Grinyuk et al. (1978a) and Berg (1961, 1977).

Fish strayed from the area of introduction particularly to the adjacent coasts of Northern Norway (Finnmark), and a few fish were caught in W. Norway, Iceland and the U.K. (Williamson, 1974). Berg (1961, 1977) describes the occurrence of fish in Norway. Many thousands were caught in some years, and

it appeared that self-sustaining populations may have developed in some rivers (Bjerknes, 1977). However, there is some doubt whether the populations can survive without continued enhancement with hatchery fry (V Bjerknes, personal communication). Bjerknes and Vaag (1980) give details of the migration and fishery in N. Norway.

4.4 Southern Norway

In 1963, 100,000 pink salmon eggs were imported from Washington to Hardanger Fiord, near Bergen, but all died of vibriosis in their first year (Berg, 1977). In 1973 eggs from Finnmark (see ^{Section} 4.3) were distributed to several hatcheries in S. Norway. Many were successfully reared and a second generation established. In 1976, 10,000 fry were released in the River Søgne (Berg, 1977); recaptures in the neighbouring Mandal River in 1977 probably originated from this release (V Bjerknes, personal communication).

4.5 Latvian SSR and German Democratic Republic

This project has been under way for some years but is poorly reported in publications in English. Rimsh (1977) gives some details. Between 1973 and 1976 fish were released to rivers of the Bay of Riga, Latvia. Rimsh admits very poor husbandry, and survival was low ('coefficients of commercial returns' were 0.005 to 0.04%). The fish fed widely in the Baltic, and shoals were reported in the coastal waters of Finland, Sweden, Poland, German Democratic Republic and USSR. An adult fish was recorded in fresh water in Poland in 1974 (Radziun and Stankowska-Radziun, 1976); these authors also make passing reference to release of pink salmon by the German Democratic Republic.

4.6 New Brunswick, Canada

Rowell (1980) reports that pink salmon eggs were imported to the St Andrews area for research purposes in late 1977 (5000) and 1978 (50,000). They are reared in net enclosures, but an estimated 1230 of the 1977 group escaped when a net was damaged.

4.7 Labrador, Canada

There appears to be a self-sustaining population of pink salmon in the area of Saglek Fiord (D Reddin, personal communication). Fishermen have reported catches in the river each year since 1970. Identification was confirmed in 1973, 1974 and 1976. The origin of this stock is uncertain; possibilities are Newfoundland (section 4.2) and Russian (Section 4.3).

5. CHINOOK SALMON (O. tshawytscha)

5.1 New England States

Following numerous early introductions (Section 2) an attempt was made to establish chinook salmon at Mousam Pong, Maine from 1934 onwards (Cooper, 1939). The attempt appears to have had no success. Meade (1974) gives details of cultivation experiments in Rhode Island using eggs from Washington. The fish were reared to adults in an enclosed system.

5.2 Finland

Davidson and Hutchinson (1938) reported that at that time attempts were being made to establish self-sustaining runs of chinook in Finnish rivers. No further observations appear to have been published.

6. OTHER SPECIES

6.1 Chum salmon (O. keta) in USSR

Berg (1961) records that between 1933 and 1939 about 10 million chum eggs were transferred to the Rivers Onega and Kola (Kola Peninsula), but with very few returns. The attempts were resumed in 1956 at the same time as the pink salmon project (Section 4.3), and in four years a total of 12.7 million fry were released. Only a very few adults were recaptured (Grinyuk et al., 1978b).

Munro (1979) records that 1 million chum eggs have been reared in Latvia between 1972 and 1978 to produce 700,000 fry, which were released to the Baltic. Again there are no details of returns.

6.2 Sockeye (O. nerka) in USSR

Between 1966 and 1969 760,000 sockeye were released into Lake Maksim on the Kola Peninsula (Grinyuk et al., 1978b). No adults were recaptured.

6.3 Sockeye (O. nerka) in Sweden

It is understood that sockeye are being stocked into lakes in Sweden, but no further details are available.

6.4 O. masou and O. rhodurus in the Federal Republic of Germany

Welcomme (1979) briefly records that these two species were imported from Japan in 1976 and 1977 for assessment of angling potential.

REFERENCES

- ANON., 1975. Salmon for New England; draft environmental impact statement. Nat. Mar. Fish. Serv., N.E. Region, 22 pp.
- ANON., 1980. Pacific coho salmon have been found in Nova Scotia. Fisheries, 5: 41.
- BERG, M., 1961. Pink salmon (Oncorhynchus gorbuscha) in Northern Norway in the year 1960. Acta Borealia, A. Scientia, 17: 24 pp.
- BERG, M., 1977. Pink salmon Oncorhynchus gorbuscha (Walbaum) in Norway. Rep. Inst. Freshwat. Res., Drottningholm (56), 12-17.
- BIGELOW, H. B. and SCHROEDER, W. C., 1953. Fishes of the Gulf of Maine. Fishery Bull., Fish Wildl. Serv. U.S., (53), 577 pp.
- BJERKNES, V.. 1977. Evidence of natural production of pink salmon fry (Oncorhynchus gorbuscha Walbaum) in Finnmark, North Norway. Astarte, 10: 5-7.
- BJERKNES, V. and VAAG, A., 1980. Migration and capture of pink salmon Oncorhynchus gorbuscha Walbaum in Finnmark, North Norway. J. Fish. Biol., 16: 291-298.
- COOPER, G. P., 1939. A biological survey of the Waters of York County and the southern part of Cumberland County, Maine. Fish survey report No. 1. Maine Department of Inland Fisheries and Game, 58 pp.
- DAVIDSON, F. A. and HUTCHINSON, S. J., 1938. The geographic distribution and environmental limitations of the Pacific salmon (genus Oncorhynchus). Bull. Bur. Fish., Wash., 48: 667-692.
- GRINYUK, I. N., KANEP, S. V., SALMOV, V. Z. and YAKOVENKO, M. Ya., 1978a. Effects of ecological factors upon pink salmon population in basins of the White and Barents Seas. ICES, C.M. 1978/M:6, 8 pp. (mimeo).
- GRINYUK, I. N., KANEP, S. V. and YAKOVENKO, M. Ya., 1978b. On the acclimatisation of the Pacific salmon Oncorhynchus in the White and Barents seas. With Soviet -Japanese Symposium on Questions of Aquaculture and Raising the Bioproductivity of the Worldwide Ocean, Moscow 1977, 124-128.
- HARACHE, Y., 1979a. Coho salmon farming in France. Part I. The reasons for the choice. Part II Technical aspects and results. Fish Farmer, 2(1), 6-7, 2(3) 40-44.
- HARACHE, Y., 1979b. Coho salmon and environment in Brittany. Proceedings of the 10th Annual Study Course, Institute of Fisheries Management, 272-289.

- HARACHE, Y., and NOVOTNY, A. J., 1976. Coho salmon farming in France. Mar. Fish. Rev., 38(8), 1-8.
- JOYNER, T., 1973. Salmon for New England fisheries. Part I: Historical background. Mar. Fish. Rev., 35: 1-3.
- LEAR, W. H., 1975. Evaluation of the transplant of Pacific pink salmon (Oncorhynchus gorbuscha) from British Columbia to Newfoundland. J. Fish. Res. Bd Can., 32: 2343-2356.
- LEAR, W. H. and DAY, F. A., 1977. An analysis of biological and environmental data collected at North Harbour River, Newfoundland, during 1959-75. Environment Canada; Tech. Rep., Fish. Mar. Serv., (697), 61 pp.
- MEADE, T. L., 1974. The technology of closed system culture of salmonids. Mar. Tech. Rep., Univ. Rhode Island, (30), 30 pp.
- MUNRO, A. L. S., 1979. Introduction of Pacific salmon to Europe. ICES, C.M. 1979/F:28, 6 pp. (mimeo).
- MUNRO, A. L. S., ELSON, K. G. R., NEEDHAM, E. A., NORRIS, R. J. and McGRATH, E. J., 1980. ICES code of practice for the introduction of non-indigenous species - the quarantine of coho salmon for a whole life cycle. ICES, 1980.
- NEMRIP, 1975. Pacific salmon flourishing in Maine. New England Marine Resources Information Program. Information 76, 1-2, University of Rhode Island.
- RADZIUN, K. and STANKOWSKA-RUDZIUN, M., 1976. Pink salmon caught in Polish waters. ICES, C.M. 1976/M:5, 4 pp. (mimeo).
- RIMSH, E. Ya., 1977. Results of acclimatization of hump-backed salmon in the Baltic. Proc. Soviet/American Conference on Aquaculture, Tallin, 24-28 October 1977, 97-99.
- ROWELL, T. W., 1980. ICES Working Group on Introduction of non-indigenous marine organisms; Report for Canada, 1973-1979 (unpublished).
- SOLOMON, D. J., 1979. Coho salmon in north-west Europe; possible effects on native salmonids. Lab. Leaflet, MAFF Direct. Fish. Res., Lowestoft, (49), 21 pp.
- STOLTE, L. W., 1974. Introduction of coho salmon into coastal waters of New Hampshire. Progve Fish. Cult., 36: 29-32.
- SYMONS, P. E. K. and MARTIN, J. D., 1978. Discovery of juvenile Pacific salmon (coho) in a small coastal stream of New Brunswick. Fishery Bull., Fish. Wildl. Serv. U.S., 76: 487-489.

WELCOMME, R. L., 1979. Preliminary record of international transfers of fish species. FAO Fish. Circ., (715) (draft).

WILLIAMSON, R. B., 1974. Further captures of Pacific salmon in Scottish waters. Scott. Fish. Bull., (41), 28-30.