ARCTIC
VOL. 59, NO. 1 (MARCH 2006) P. 37–46

A Review of the Occurrence of Pacific Salmon (*Oncorhynchus* spp.) in the Canadian Western Arctic

S.A. STEPHENSON[1]

(*Received 21 March 2005; accepted in revised form 29 June 2005*)

ABSTRACT. This manuscript summarizes all known captures of Pacific salmon (*Oncorhynchus* spp.) in the Canadian western Arctic up to the end of 2003. Historic information on Pacific salmon distribution in the Canadian western Arctic is limited, and some older identifications are suspect. It is difficult to determine whether salmon numbers are actually increasing, or whether a recently established program to gather information on Pacific salmon abundance has only made them appear more abundant than historically. However, there is no evidence of newly established populations and overall not enough information to state definitively that salmon are increasing in frequency in the Canadian western Arctic as a direct result of climate change.

Key words: Pacific salmon, *Oncorhynchus* spp., western Arctic, Northwest Territories, harvest, climate change

RÉSUMÉ. Ce manuscrit résume toutes les captures connues de saumon du Pacifique (*Oncorhynchus* spp.) dans l'ouest de l'Arctique canadien jusqu'à la fin de 2003. Les données historiques portant sur la répartition du saumon du Pacifique sont restreintes, et certaines identifications plus anciennes sont douteuses. Il est difficile de déterminer si le nombre de saumons augmente réellement ou si le programme récemment mis sur pied pour recueillir de l'information sur l'abondance du saumon du Pacifique les fait paraître plus abondants qu'ils ne l'étaient historiquement. Toutefois, il n'existe aucune preuve de populations nouvellement établies et dans l'ensemble, il n'y a pas assez d'information pour affirmer de manière définitive que la fréquence du saumon augmente dans l'ouest de l'Arctique canadien directement en raison du changement climatique.

Mots clés : saumon du Pacifique, *Oncorhynchus* spp., ouest de l'Arctique, Territoires du Nord-Ouest, capture, changement climatique

Traduit pour la revue *Arctic* par Nicole Giguère.

INTRODUCTION

Climate change in the form of global warming is predicted to bring about changes that will appear first and be especially severe in Arctic and Subarctic areas, including the nearshore Beaufort Sea and Mackenzie River Valley (Dyke and Brooks, 2000). Although many of these changes (e.g., the presence of southern bird species) will be observed earliest and most easily in the terrestrial setting, similar, gradual changes will occur in the aquatic environment. Northern species will find their historic ranges shrinking as habitat changes and temperatures exceed their tolerances. In some cases, their negative interactions with recently arrived southern species may affect their long-term survival as increased predation on young and competition for food and spawning areas occur. The Mackenzie River and its tributaries may act as a corridor for southern freshwater fish to move northward as these waters warm. An increase in ocean temperature will weaken the cold water barrier in the Bering Strait and may assist in the movement of primarily anadromous or entirely marine Pacific fish species into the nearshore Beaufort Sea and the Mackenzie River Delta.

The current interest in Pacific salmon in Canadian western Arctic waters is due largely to the belief that a perceived increase in their abundance is a confirmation of climate change. However, we need proof that salmon have increased from former levels of abundance, or that individuals captured today represent membership in Arctic stocks established over the past 10–20 years, before we can state conclusively that the current distribution of Pacific salmon in the Arctic is a direct result of climate change. With recent renewal in oil and gas exploration in the Mackenzie River Valley and nearshore Beaufort Sea, established or establishing populations of Pacific salmon and strays in the area could be extremely sensitive to anthropogenic perturbations. Thus, identifying the salmon species present and their distribution in the Arctic and determining if and where spawning populations exist may be useful for monitoring the effects of climate change and screening proposed industrial activities near waterways.

Although the first records of Pacific salmon in the Arctic date back to fish captured in Alaska in the late 1880s (Hunter, 1974), some salmon species were unquestionably present in the Beaufort Sea and the Mackenzie River Valley before that time. The frequency of their capture will

[1] Fisheries and Oceans Canada, Resource Management and Aboriginal Affairs, 501 University Crescent, Winnipeg, Manitoba R3T 2N6, Canada; stephensons@dfo-mpo.gc.ca

always remain unknown; however, Pacific salmon would have been identified as "different" from the local lake trout (*Salvelinus namaycush*), arctic char (*S. alpinus*), and Dolly Varden (*S. malma*) well known to and regularly captured by Aboriginal people. It was only during the 1930s, as people from the South began to inhabit the Arctic, that voucher specimens were first sent to museums, interested individuals began to keep records of the capture of Pacific salmon, and Aboriginal people began taking specimens to authorities for identification (Dymond, 1940; Hunter, 1974).

While Inuit of the western Arctic have names for all large and several of the smaller fish species that they have traditionally harvested, Inuktitut (Inuit) names do not exist for most Pacific salmon in the area (McAllister et al., 1987; this study). An Inuktitut name is known for only the most common Pacific salmon in the area: the chum salmon (*Oncorhynchus keta*) (Coad and Reist, 2004). Similarly, in the Mackenzie River Valley area, a Dene name is known only for the chum salmon (Bayha and Snortland, 2002). This lack of names suggests that historically, the overall frequency of capture of Pacific salmon in the Canadian Arctic was low (i.e., Dymond, 1940), as the regular capture of such species would have given rise to names for them. As only a single species is named, it is fair to state that except for the long-known stock(s) of chum salmon that spawn in areas of the upper Mackenzie River drainage (e.g., McPhail and Lindsey, 1970), we have no historical evidence for other established Pacific salmon stocks in the area, and that the capture of other Pacific salmon, if noted as different species, must have been infrequent.

This paper summarizes all known captures of Pacific salmon from waters of the Canadian western Arctic—including the Beaufort Sea, Coronation Gulf, the westernmost islands of the Arctic Archipelago, the Mackenzie River Valley, and Mackenzie River tributaries—up to the end of 2003. By adding to and updating the work of Hunter (1974), this work provides the necessary background to determine 1) whether Pacific salmon have increased in abundance since records were first kept, and 2) whether evidence exists to suggest the recent establishment of self-sustaining Arctic salmon populations.

METHODS

Records of Pacific salmon in the Canadian western Arctic were gathered by searching published and unpublished literature, regional harvest studies, and museum databases from the Royal Ontario Museum (ROM) and Canadian Museum of Nature (CMN), as well as through discussions with scientists, researchers, regional fisheries biologists, and area fishers. These sources provided information on salmon captured by area fishers during subsistence or commercial harvesting and reported or unreported in regional harvest studies or commercial fishing information returns; salmon captured by government, university researchers, or consultants; and those fish purchased through a program set up by Fisheries and Oceans Canada (DFO) to record the capture of salmon by Aboriginal and non-Aboriginal fishers. Any fish reported only as "salmon" by any of these sources were excluded from further consideration.

Because they appear sporadically and unpredictably, Pacific salmon in the Canadian western Arctic have not been captured by any directed scientific research program. Rather, the majority of salmon have been captured by Aboriginal subsistence and commercial fishers in isolated locations. Thus, reports of captures often come to light only long after the specimen can no longer be examined (e.g., Gwich'in Renewable Resource Board [GRRB], unpubl. data). To better document the frequency of appearance of Pacific salmon, and to secure specimens for positive identification and additional study, the DFO established a salmon collection program for the entire Northwest Territories in 2000. The program offers a monetary reward for the delivery of salmon carcasses and basic information such as the date and location of capture. This program has been extensively advertised, on posters and by word of mouth during conversations with fishers, and promoted through area harvest studies and during radio and newspaper interviews. As the collection program is equally applicable to subsistence, commercial, and recreational fishers, information and specimens can and have been obtained from a diverse group of participants. However, despite three years of promotion, some fishers insist they have not heard of the program, prefer not to sell their salmon to DFO, or consider involvement in the program too time-consuming. Therefore, despite the intention of the collection program, all salmon captured in the Canadian western Arctic are undoubtedly not reported to or seen by DFO.

The specimens discussed herein are presented as 1) those verified to species by knowledgeable personnel (e.g., biologists and other individuals familiar with the species) examining the fish or, in rare cases, using only photographs, 2) those reported through harvest studies, or 3) those reported through conversation with fishers or biologists. Identification may be uncertain or suspect for some specimens reported by the last two methods, as there was no opportunity for an expert to examine the specimens. In recent years (1995–2003), all verified species identifications were made using keys of external characteristics (e.g., Scott and Crossman, 1973). Whenever possible, the specimen was secured for additional examination, including internal/external meristic counts and possible future genetic analysis. Because of the experience of personnel and the availability of identification keys, salmon examined by resource managers over the past 20 years were given a higher probability of being properly identified than those not seen by resource managers.

On the basis of the above methods, the identification of each specimen listed in Tables 1 and 2 was accorded a

reliability ranking of good, fair, or poor. Good identifications were those in which the fish was identified using a taxonomic key, or identified by a person with prior experience with Pacific salmon, or both. A fair rating was given to those species that have widely known and readily identifiable characteristics, or those which have been seen in large numbers regularly (i.e., annually or semi-annually) so that many people had familiarity with them. This ranking holds true for chum salmon, which are common in the Canadian western Arctic, have been seen by many fishers, and possess obvious characteristics (e.g., rosy colour with dark vertical bars) when entering the spawning phase. A rank of poor was given to those specimens for which limited information was recorded (e.g., no mention of length, weight, or coloration) and to those fish captured in a silver (ocean) phase, when they had not yet taken on the reproductive characteristics that aid identification. Fish identifications were ranked as "poor" when other fishers did not confirm the capturer's identification, or when it was known that this fish was unique in the fisher's experience. In many cases, conversation with the fisher clarified whether recent captures had been correctly identified. When this was not possible, or if the harvests had occurred in the past, the possibility of a correct identification was conservatively ranked.

SALMON DISTRIBUTION

Chum Salmon

Chum salmon are the most common of the Pacific salmon found in the western Arctic, with spawning populations known in the Colville River, Alaska (Fig. 1), and the Mackenzie River drainage (Salo, 1991).

Chum salmon have been harvested from the Mackenzie River in 21 of the last 40 years (Table 1). The wide geographic area (along the entire length of the Mackenzie River) and regular frequency with which captures occur suggests that most chum salmon in the western Arctic are en route to known spawning areas at the rapids below Fort Smith in the Slave River (McPhail and Lindsey, 1970) and possibly to areas of the upper Liard River, British Columbia (McLeod and O'Neil, 1983). Although Johnson (1975) noted the occasional reports of chum salmon from Great Bear Lake, he felt that it was unlikely that an established population existed within the lake, since almost continual fishing by residents of Deline near the outlet to the Great Bear River resulted in infrequent captures. It is possible that chum salmon populations established in northern Alaskan rivers may sometimes contribute to fish captured in the Mackenzie River, especially in those years when very large numbers are reported (Table 1).

Chum salmon have been infrequently reported east of the Mackenzie River. Hunter (1974) reported a possible capture in the Anderson River, and a single specimen was taken much farther to the east, near Kugluktuk, in 1981 (CMN, CMNFI 1981-0959.1) (Fig. 2). Fishers in Paulatuk reported chum salmon from the Hornaday River in 1978, 1979 (Corkum and McCart, 1981), and 2003 (this study). However, the general paucity of chum salmon captures east of the Mackenzie Delta supports a strong homing sense among these fish to natal streams in the Mackenzie drainage.

Pink Salmon

Although pink salmon (*O. gorbuscha*) are confirmed to spawn between Point Hope and Point Barrow, Alaska (Fig. 1), it is uncertain if those sometimes captured to the east in the Colville River also represent a spawning population (Craig and Haldorson, 1986). The proximity of the Colville River to the Mackenzie River may explain the presence of pink salmon in the Canadian Arctic in some years.

Pink salmon have been reported infrequently in the Canadian Arctic, and in almost all cases, only single specimens have been captured (Table 2). Although Craig and Haldorson (1986) suggested that in western Alaska pink salmon were more abundant in even-numbered than in odd-numbered years, the available data suggest there may be no similar trend in the Canadian western Arctic. To date, all pink salmon captures have taken place either in August or in early September. The farthest inland captures have been made in the Peel River, approximately 120 km from the coast (Hunter, 1974). Half of all captures have been reported from brackish water at coastal locations, with the remainder mainly from the lower reaches of rivers (Fig. 3). The majority of pink salmon have been captured in or near the Mackenzie Delta, and except for a single capture on Banks Island (Babaluk et al., 2000), no pink salmon have been taken farther east or north.

Coho Salmon

The northernmost known population of spawning coho salmon (*O. kisutch*) is near Point Hope, Alaska, although coho salmon have occasionally been captured in marine waters farther east, near Prudhoe Bay (Craig and Haldorson, 1986).

Coho salmon are the rarest of all Pacific salmon in the Canadian western Arctic. Babaluk et al. (2000) reported the capture of a single coho salmon in Great Bear Lake in September 1987 (Fig. 4). A second capture was made through the ice of the Mackenzie Delta near Inuvik in October 1998 (this study) (Table 2). While the Inuvialuit Harvest Study reported the harvest of six coho salmon at Sachs Harbour in 1993 (Fabijan, 1995a), these fish were misidentified by local people and actually represent some of the same fish identified as sockeye salmon (*O. nerka*) by Babaluk et al. (2000). The rarity of verified coho salmon captures suggests that established populations of this species do not exist in the Canadian Arctic, and that both verified captures represent stray fish.

TABLE 1. Number, location, and year of capture of chum salmon reported from the Canadian western Arctic. Reliability of identification (G = good, F = fair, P = poor) is based on available information about the knowledge of the person who made the identification.

Year	Location	Number	Reliability	Reference
Chum Salmon:				
1914	Mackenzie River	a "notable" run	G	Dymond, 1940
1931	Slave River	1	G	Dymond, 1940
1931	Mackenzie Delta	10+?	F	Dymond, 1940
1937	Peel River	1	G	Dymond, 1940
1938	Yukon coast	30	G	Dymond, 1940
1938	near Kigtluit (probably Kidluit Bay)	6	G	Dymond, 1940
1938	Whitefish Station (Mackenzie Delta)	3	G	ROM #10883, #10884, #10860
1947	Peel River	1	G	Hunter, 1974
?	Anderson River	1+	F	Hunter, 1974
1956	Hay River	1+	G	Hunter, 1974
1957	Peel River	2	G	Hunter, 1974
1957	Big Buffalo River	1	G	Hunter, 1974
1957	Hay River	2	G	Hunter, 1974
1957	Tuktoyaktuk	2	G	CMN, CMNFI 1963-0077.1, 1963-0078.1
1958	Great Slave Lake	6	G	Hunter, 1974
1957–59	Slave River	3	G–F	Hunter, 1974
1958	Talston Bay, Great Slave Lake	1	G–F	Hunter, 1974
1966	Great Slave Lake	1	G	Hunter, 1974
1968	Great Bear Lake	1	G	Hunter, 1974
1971	Mackenzie Delta	1	G	Stein et al., 1973
1972	Tsiigehtchic	8	G	Stein et al., 1973
1972	Peel River	1	G	Stein et al., 1973
1972	Norman Wells	1	G	Stein et al., 1973
1974?	Great Bear Lake	1+	G	Johnson, 1975
1978	Mackenzie Delta area	7[1]	G–F	Corkum and McCart, 1981
1978	Tsiigehtchic	3[1]	G–F	Stewart, 1996
1978	Paulatuk	7[1]	G–F	Corkum and McCart, 1981
1978	Fort McPherson	21	G–F	Stewart, 1996
1978	Fort Good Hope	100–200	G	G. Low, DFO, pers. comm. 2004
1978	Hay River	10–15	G	G. Low, DFO, pers. comm. 2004
1978	Fort Smith	10–15	G	G. Low, DFO, pers. comm. 2004
1979	Paulatuk	121	G–F	Corkum and McCart, 1981
1979	Aklavik	2000–3000	G	G. Low, DFO, pers. comm. 2004
1979	Inuvik	2[1]	G–F	Stewart, 1996
1979	Tsiigehtchic	500	G	G. Low, DFO, pers. comm. 2004
1979	Fort McPherson	1500–2000	G	G. Low, DFO, pers. comm. 2004
1979	Fort Good Hope	5000	G	G. Low, DFO, pers. comm. 2004
1979	Fort Simpson	100–200	G	G. Low, DFO, pers. comm. 2004
1979	Fort Providence	80–120	G	G. Low, DFO, pers. comm. 2004
1979	Hay River	50–100	G	G. Low, DFO, pers. comm. 2004
1979	Fort Resolution	100–150	G	G. Low, DFO, pers. comm. 2004
1979	Little Buffalo River	3	G	G. Low, DFO, pers. comm. 2004
1979	Lutsel K'e	2	G	G. Low, DFO, pers. comm. 2004
1979	Fort Smith	50–100	G	G. Low, DFO, pers. comm. 2004
1979	Slave River (Fort Smith)	3+	G	Tripp et al., 1981
1979–80	Liard River	246	G	McLeod and O'Neil, 1983
1980	Aklavik	5–10	G–F	G. Low, DFO, pers. comm. 2004
1980	Mackenzie Delta	87[1]	G–F	Corkum and McCart, 1981
1980	Fort McPherson	10–20	G–F	G. Low, DFO, pers. comm. 2004
1980	Tsiigehtchic	67	G	G. Low, DFO, pers. comm. 2004
1980	Tsiigehtchic	10[1]	G–F	Corkum and McCart, 1981
1980	80 km below Fort Good Hope	1	G	RL&L, 1980
1980	Fort Good Hope	1000	G	G. Low, DFO, pers. comm. 2004
1980	Fort Simpson	10–20	G	G. Low, DFO, pers. comm. 2004
1980	Fort Providence	10–20	G	G. Low, DFO, pers. comm. 2004
1980	Hay River	5–10	G	G. Low, DFO, pers. comm. 2004
1980	Fort Smith	10–15	G	G. Low, DFO, pers. comm. 2004
1981	Hay River	2	G	G. Low, DFO, pers. comm. 2004
1981	Fort Liard	1–5	G	G. Low, DFO, pers. comm. 2004
1981	Kugluktuk	1	G	CMN, CMNFI 1981-0950.1
1984	Fort Smith	2	G	RL&L/EMA Slave River Joint Venture, 1985
1986	Cache Creek (Aklavik)	1	G	Babaluk et al., 2000
1987	Aklavik	103	G	Fabijan, 1991a
1988	Aklavik	2	G–F	Fabijan, 1991a
1988	Inuvik	6	G–F	DFO, 1991
1989	Aklavik	7	G–F	Fabijan, 1991b
1993	Shingle Point	9	F	this study
1993	Tsiigehtchic area	2	G	K. Howland, DFO, pers. comm. 2005
1997	Peel River	2	F	McDonald, 1998

TABLE 1. *(continued)*

Year	Location	Number	Reliability	Reference
1998	Peel River	40	G	R. Tallman, DFO, pers. comm. 2004
1998	Norman Wells	1	F	Bayha and Snortland, 2002
1998	Fort Good Hope	219	G	Bayha and Snortland, 2002
1998	Paulatuk	1	G–F	Fabijan, 2000
1999	Fort Good Hope	51	G	Bayha and Snortland, 2002
1999	Tsiigehtchic	2	G	this study
1999	Inuvik	4	G	this study
1999	Fort McPherson	4	G	this study
2000	Peel River	2	F	GRRB, unpubl. data
2000	Aklavik	1	G	this study
2000	Tsiigehtchic	1	F	GRRB, unpubl. data
2000	Tsiigehtchic	2	G	this study
2000	Fort Good Hope	14	G–F	Bayha and Snortland, 2003
2001	Deline (Great Bear Lake)	1	P	this study
2001	Peel River	4	G–F	GRRB, unpubl. data
2001	Fort Good Hope	12	G–F	Bayha and Snortland, 2003
2002	Tsiigehtchic	10	G–F	GRRB, unpubl. data
2002	Fort McPherson	1	G	this study
2002	Fort Good Hope	1	F	this study
2002	Liard River	1	G	this study
2003	Hornaday River (Paulatuk)	1	G–F	this study
2003	Great Bear Lake	1	G	this study
2003	Aklavik	12	G	this study
2003	Norman Wells	5+	G–F	this study
2003	Great Slave Lake	3	G	G. Low, DFO, pers. comm. 2003
2003	Fort Good Hope	15+	G–F	this study
2003	Fort Providence	1	G	G. Low, DFO, pers. comm. 2004
2003	Aklavik	40	G–F	GRRB, unpubl. data
2003	Peel River	65	G–F	GRRB, unpubl. data
2003	Tsiigehtchic	8	G–F	GRRB, unpubl. data
2003	Tree River (Mackenzie River)	34	G–F	GRRB, unpubl. data

[1] Numbers calculated from fish weights based on 3 kg per fish.

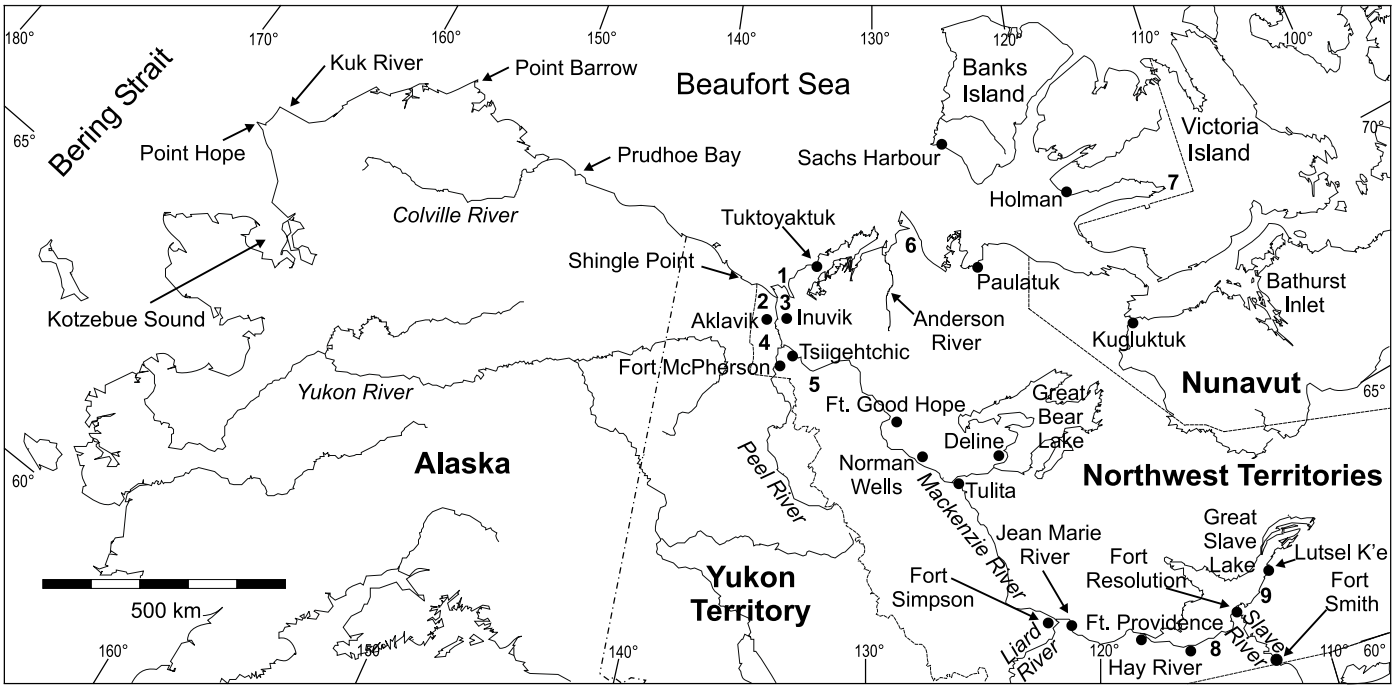

FIG. 1. Map showing locations discussed in text. Numbers indicate the following: **1**: Kidluit and Kittigasuit bays; **2**: Cache Creek (Big Fish River); **3**: Whitefish Station; **4**: Rat River; **5**: Tree River; **6**: Horton River; **7**: Kagloryuak River; **8**: Big and Little Buffalo rivers; and **9**: Talston Bay.

TABLE 2. Number, location, and year of capture of pink, coho, sockeye, and Chinook salmon reported from the Canadian western Arctic. Reliability of identification (G = good, F = fair, P = poor) is based on available information about the knowledge of the person who made the identification.

Year	Location	Number	Reliability	Reference
Pink Salmon:				
1936	Kigtluit (probably Kidluit Bay)	1	G	Dymond, 1940
1938	Kittigasuit Bay	1	G	Dymond, 1940
1945 or 1947	Kidluit Bay	1 or 2	G	Hunter, 1974
1945 or 1947	Peel River	1	G	Hunter, 1974
?	Peel River	?	F	Hunter, 1974
1956	Rat River	> 1	F	Hunter, 1974
1957	Peel River	1	G	Hunter, 1974
1957	Tuktoyaktak Harbour	1	G	CMN, CMNFI 1963-0074.1
1958	Tuktoyaktuk Harbour	1	G	Riske, 1960
1959	Aklavik	1	G–F	Hunter, 1974
1992	Cache Creek (Aklavik area)	1	G	Babaluk et al., 2000
1993	Sachs Harbour	1	G	Babaluk et al., 2000
1997?	Mackenzie Delta	1	G	this study
Coho Salmon:				
1987	Great Bear Lake	1	G	Babaluk et al., 2000
1998	Mackenzie Delta	1	G	this study
Sockeye Salmon:				
1908	Fort Providence	1	P	Hunter, 1974
1965	Bathurst Inlet	11	G	Hunter, 1974
1966	Holman	30–40	G	Hunter, 1974
1993	Sachs Harbour	8	G	Babaluk et al., 2000
1993	Tsiigehtchic area	8	G	R. Tallman, DFO, pers. comm. 2004
1994	Tuktoyaktuk	1	F–P	Fabijan, 1995b
1994	Horton River[1]	1	F–P	Fabijan, 1995b
1995	Slave River (Fort Smith)	1	G	Little, 1997; (A. Smith, Golder Assoc. Ltd., pers. comm. 2005)
1997	Kagloryuak River	1	G	this study
1998	Tuktoyaktuk	3	F–P	Fabijan, 2000
2000	Holman	1	F–P	this study
2003	Norman Wells	1	G	this study
2003	Fort Good Hope	1+	F	this study
2003	Jean Marie River	1	G	this study
Chinook Salmon:				
1914	Peel River (Tsiigehtchic area)	?	F	Dymond, 1940
1950	Kugluktuk	1	G	Hunter, 1974
1961 or 1962	Kugluktuk	13	G	Hunter, 1974
1979	Fort Liard	1	G	McLeod and O'Neil, 1983
1993	Shingle Point	1	F–P	this study
1993	Shingle Point[2]	2	F–P	Fabijan, 1995a
1995	Slave River (Fort Smith)	1	G	Little, 1997; (A. Smith, Golder Assoc. Ltd., pers. comm. 2005)
1997	Shingle Point	20+	F	D.A. Gordon, Aklavik HTC, pers. comm. 2001
2001	Norman Wells	1	P	this study
2001	Aklavik	1	G–F	this study
2002	Aklavik	1	G	this study

[1] Location given as "Tuktoyaktuk" in Fabijan (1995b).

[2] Location given as "Aklavik" in Fabijan (1995b).

Sockeye Salmon

Like several other Pacific salmon, sockeye salmon have their northernmost known spawning population south of Point Hope, Alaska, in Kotzebue Sound (Burgner, 1991).

Hunter (1974) reported the unverified identification of a sockeye salmon captured at Fort Providence on the Mackenzie River in 1908—not so unbelievable a report in view of subsequent captures. Hunter (1974) also reported the first verified Canadian Arctic captures of 11 sockeye salmon in the marine waters of Bathurst Inlet in 1965, as well as captures of up to 40 additional fish in marine waters near Holman on Victoria Island in 1966 (Fig. 5). Babaluk et al. (2000) reported the capture of eight sockeye salmon from the Sachs River estuary near Sachs Harbour, Banks Island, in 1993 (Table 2). An additional eight fish, the first verified from the Mackenzie River, were captured in and near the Arctic Red River at Tsiigehtchic in 1993 (R. Tallman, DFO, pers. comm. 2004).

The southernmost capture site for sockeye salmon is in the Slave River near Fort Smith. Although Tallman et al. (1996a, 2005) reported that Tallman et al. (1996b) captured sockeye salmon in the Slave River in 1995, a review of Tallman et al. (1996b) reveals that the species is not

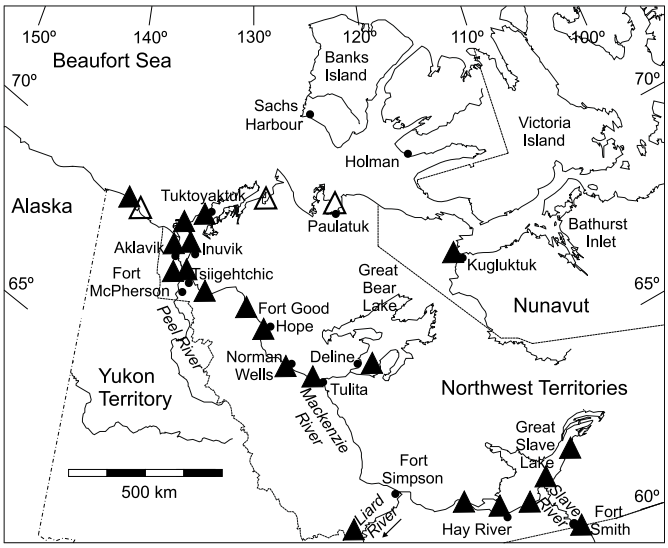

FIG. 2. Chum salmon capture distribution in the Canadian western Arctic. Closed triangles indicate verified identification, and open triangles, suspected identification. Each symbol may represent the capture of more than one fish over several years.

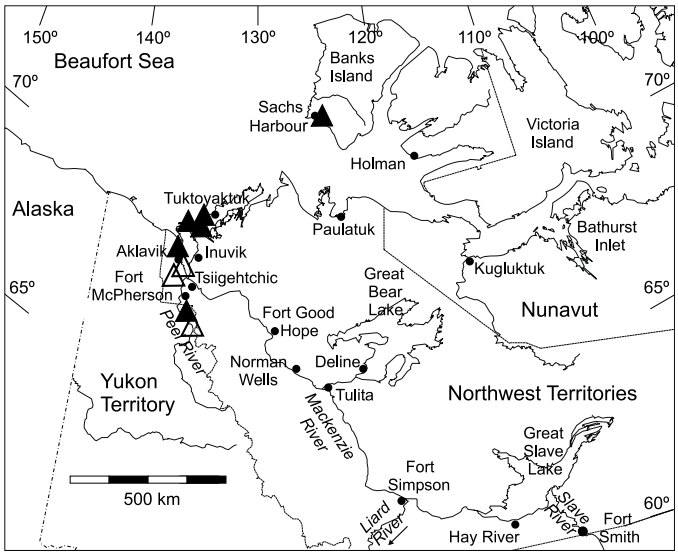

FIG. 3. Pink salmon capture distribution in the Canadian western Arctic. Closed triangles indicate verified identification, and open triangles, suspected identification. Each symbol may represent the capture of more than one fish over several years.

among those listed. Tallman (DFO, pers. comm. 2005) stated that the sockeye salmon reported by Little (1997) was the same one that had inadvertently been left off the list of captured species presented in Tallman et al. (1996b). Therefore, there has been only a single sockeye salmon captured in the Slave River.

A single sockeye salmon was captured in the Kagloryuak River east of Holman on Victoria Island in 1997 (this study). In 2003, single specimens of sockeye salmon were captured in the Mackenzie River at Norman Wells and Jean Marie River. Unverified, but probable, sockeye captures were also reported from the Mackenzie River at Fort Good Hope in the fall of 2003. Overall, sockeye salmon have the widest geographic distribution of all Pacific salmon species in the Canadian western Arctic (Fig. 5).

Chinook Salmon

The northernmost known spawning population of Chinook salmon (*O. tshawytscha*) is believed to be in Kotzebue Sound, Alaska (Healey, 1991). Craig and Haldorson (1986) have reported strays captured in the Kuk and Colville rivers along the northern coast of Alaska (Fig. 1).

Verified records of Chinook salmon are rare in the Canadian Arctic. Hunter (1974) reported the species from marine waters near the mouth of the Coppermine River at Kugluktuk in 1950 and again in 1961 or 1962 (Fig. 4). Chinook salmon then went unreported until an individual was captured in the Liard River near the British Columbia border in 1979 (McLeod and O'Neil, 1983). McCart (1986) reported Chinook salmon from the Slave River prior to 1986, but did not provide details on numbers or dates of capture, and two of the references he cited to support the reported captures did not deal with the Slave River. Assuming that the third reference referred to in McCart (1986) as RL&L Environmental Services Ltd. files, there is still a problem, as RL&L/EMA Slave River Joint Venture (1985) does not mention the capture of any Chinook salmon during the 1983–85 survey. Similarly, although Tallman et al. (1996a, 2005) reported that Tallman et al. (1996b) had captured Chinook salmon from the Slave River, examination of Tallman et al. (1996b) shows that Chinook salmon was not among the 18 fish species listed as captured. Little (1997) reported the capture of Chinook salmon from the Slave River near Fort Smith in 1995. As with the sockeye salmon, Tallman (DFO, pers. comm. 2005) stated that the Chinook salmon reported by Little (1997) was the same one that had inadvertently been left off the list of species captured in Tallman et al. (1996b). Therefore, the single Chinook salmon captured from the Slave River in 1995 is the only known capture/record of this species in the Slave River.

Although fishers from Aklavik reported the capture of several Chinook salmon in marine waters of the Yukon North Slope in August of 1993 (Fabijan, 1995a; this study) and one fisher reported the capture of dozens of Chinook in the same area in 1997 (D.A. Gordon, Aklavik Hunters and Trappers Committee, pers. comm. 2001), the next verified capture was not made until the fall of 2002, when a 7.9 kg female was captured near Aklavik (this study). The fisher who made the 2002 capture reported that he had captured a similar fish at the same location in 2001 (Table 2).

Large salmon, some up to 11 kg in weight, reportedly captured near the Arctic Red River and in the Peel River in 1914 (Dymond, 1940) are thought to have possibly been Chinook salmon (Hunter, 1974). The large salmon seen in this run were apparently not seen again in the ensuing 26 years, although some Aboriginals had reportedly seen similar fish in the Yukon River (Dymond, 1940), which

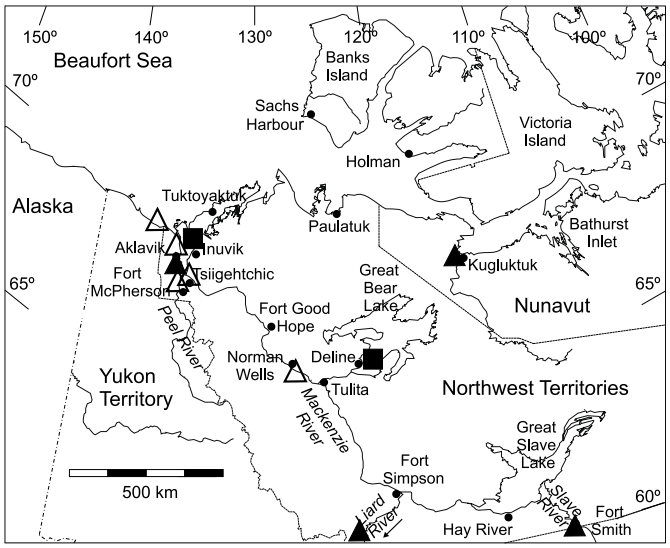

FIG. 4. Coho salmon (squares) and Chinook salmon (triangles) capture distribution in the Canadian western Arctic. Closed symbols indicate verified identification, and open symbols, suspected identification. Each symbol may represent the capture of more than one fish over several years.

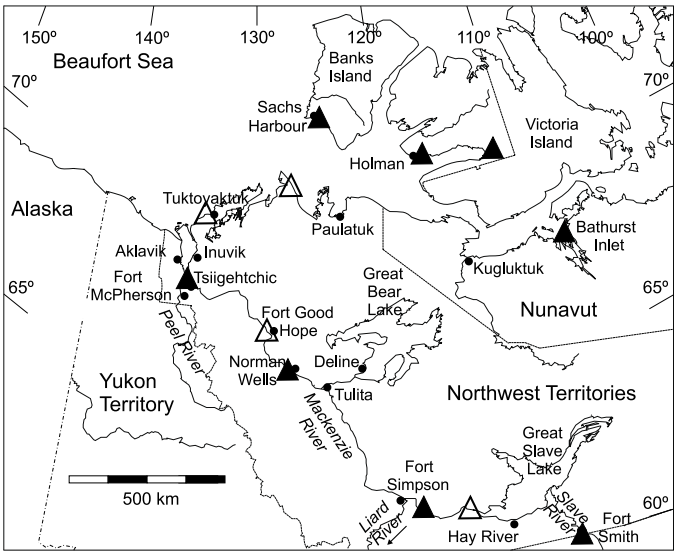

FIG. 5. Sockeye salmon capture distribution in the Canadian western Arctic. Closed triangles indicate verified identification, and open triangles, suspected identification. Each symbol may represent the capture of more than one fish over several years.

does have a run of Chinook salmon. Their reported large size, and their rarity to Aboriginals who were at least somewhat familiar with chum salmon, makes it plausible that these fish were Chinook salmon.

Trends in Salmon Sightings

Excluding some exceptional years reported in Table 1, such as the "notable run" of salmon in the Mackenzie River in 1914 (Dymond, 1940), several of the last 25 years stand out either for the number of species recorded or for the total number of salmon captured. The most unusual year was 1979, for the sheer number of salmon harvested. In a "normal" year, a few to dozens of chum salmon are captured in several locations along the Mackenzie River Valley (Table 1). In 1979, however, thousands of chum salmon were reported to harvest surveys carried out in late fall in communities along the Mackenzie River and the shores of Great Slave Lake (G. Low, DFO, pers. comm. 2004), and the first verified Chinook salmon was captured in the Mackenzie drainage (McLeod and O'Neil, 1983).

In 1993, sockeye salmon and pink salmon were captured at Sachs Harbour, sockeye salmon were captured in the Tsiigehtchic area and Chinook salmon were reported, although not confirmed, from the Beaufort Sea off the Yukon North Slope near Shingle Point (Fig. 1). Oddly, chum salmon were not reported as particularly abundant that year, although poor reporting to harvest studies may have been partly responsible for this finding.

In 1998, large numbers of chum salmon were reported from the Peel River and in the Mackenzie River, at Fort Good Hope (Table 1); the second authenticated capture of a coho salmon in the Canadian western Arctic was made in the Mackenzie Delta; and sockeye salmon were reported at the community of Tuktoyaktuk.

Finally, 2003 saw a large increase in both the number of salmon and the number of species of salmon captured, especially within the Mackenzie River. Chum salmon were recorded in large numbers in many Mackenzie River Valley communities, including several in which they had formerly been rare. The presence of sockeye salmon far up the Mackenzie River suggests that a greater-than-average number of Pacific salmon may have strayed north of their usual ranges.

The above demonstrates that exceptional years, judged either by total numbers captured or by number of species present, seem as common now as they were in the past. However, because it is unlikely that all species were properly identified in the past (and some may still be incorrectly identified), it is those years of overall high salmon abundance, rather than the number of species present, that are most useful as a possible indicator of climate change. However, there seems little evidence to suggest that Pacific salmon are more common in the Canadian western Arctic today than they have been over the past 90 years.

THE FUTURE OF PACIFIC SALMON IN THE CANADIAN ARCTIC

The absence of confirmed spawning populations of pink, coho, sockeye, and Chinook salmon east of Point Hope, Alaska, suggests that the captures of these species in the Beaufort Sea and adjacent inland waters represent straying individuals whose final destination remains unknown. As several reports of large numbers of Chinook and sockeye salmon in the Canadian western Arctic exist from as far back as 40 years ago, the infrequent capture of a few more of these fish represents neither the stable

presence (as would be indicated by more regular captures) nor the consistent increase in abundance required to characterize established or establishing populations in Canadian waters. Thus, the infrequent capture of all species of Pacific salmon (except chum salmon) in the Canadian western Arctic supports a hypothesis of continued straying, often by small schools of fish.

An end to most harvest studies, along with a gradually declining subsistence fishery harvest (Stephenson, 2004) and a small, widely distributed human population in the Canadian western Arctic, suggests that the above results represent only a small percentage of the salmon actually present in the area. Many salmon are not reported, and in many cases, those reported are not verified to species. As a result, if salmon abundance increases in the future, the chances of having all captures reported will be low, and accurate estimates of the distribution and abundance of salmon will remain unknown. The continued promotion and expansion of the salmon collection program will therefore be a vital way—and in many cases, the only way—of recording the distribution of salmon in the Canadian Arctic. The DFO should consider expanding the program to western Nunavut communities, such as Kugluktuk, where chum and Chinook salmon have been captured.

Although coho salmon has only recently been verified in the Canadian western Arctic, and the frequency of capture of sockeye, a formerly rare species, has increased, albeit sporadically, over the past 20 years, the basic question remains difficult to answer. Have Pacific salmon been recorded in increasing numbers in recent years because there has been an increased interest and effort to identify and document them, or are they actually increasing in abundance? Only continued efforts to document and verify harvests of these species and to record catch-per-unit-effort data on a wide scale will provide a definitive answer. However, the results above suggest that, excluding some exceptional years, which occurred in the past as well as in recent times, there is little evidence to suggest that Pacific salmon are more common in the Canadian western Arctic today than they have been over the past 90 years. Ultimately, the abundance and distribution of Pacific salmon in the Canadian Arctic will depend on their response to continually changing environmental conditions over a wide area and their ability to find habitats suitable for long-term colonization.

ACKNOWLEDGEMENTS

I wish to acknowledge the assistance of J. Babaluk, D. Chiperzak, K. Howland, G. Low, D. McGowan, R. Tallman, F. Taptuna, and J. Reist in the DFO Central and Arctic Region, who provided information on salmon captures or offered suggestions to improve the information contained herein. John Babaluk provided the base map used for all figures. George Low provided access to salmon harvest numbers collected during the late 1970s. Alison Smith (née Little) provided additional information on the Slave River salmon captures of 1995. Janet Winbourne of the Gwich'in Renewable Resource Board provided unpublished information from the Gwich'in Harvest Study. Charles McNeely of Fort Good Hope, Northwest Territories, provided information and a discussion on his 2003 harvest. Erling Holm (Royal Ontario Museum) provided additional data on salmon captures from the 1930s. Information on holdings at the Canadian Museum of Nature was drawn from the distributed data network entitled Species Analyst, a project of the North American Biodiversity Information Network, and participating institutions. The assistance of Ian McLeod (Department of Environment and Natural Resources, Government of the Northwest Territories, Aklavik) in securing specimens of salmon from the Aklavik area from 2000–03 is especially acknowledged. The quality of this manuscript was immeasurably improved by thorough reviews of an early draft by J. Babaluk and D. Watkinson.

REFERENCES

BABALUK, J.A., REIST, J.D., JOHNSON, J.D., and JOHNSON, L. 2000. First records of sockeye (*Oncorhynchus nerka*) and pink salmon (*O. gorbuscha*) from Banks Island and other records of Pacific salmon in Northwest Territories, Canada. Arctic 53(2):161–164.

BAYHA, J., and SNORTLAND, J. 2002. Sahtu settlement harvest study data report 1998 and 1999. Report prepared for Sahtu Renewable Resources Board. Available from Sahtu Renewable Resources Board, PO Box 134, Tulita, Northwest Territories X0E 0K0.

———. 2003. Sahtu settlement harvest study data report 2000 and 2001. Report prepared for Sahtu Renewable Resources Board. Available from Sahtu Renewable Resources Board, PO Box 134, Tulita, Northwest Territories X0E 0K0.

BURGNER, R.L. 1991. Life history of sockeye salmon (*Oncorhynchus nerka*). In: Groot, C., and Margolis, L., eds. Pacific salmon life histories. Vancouver: UBC Press. 1–117.

COAD, B.W., and REIST, J.R. 2004. Annotated list of the Arctic marine fishes of Canada. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2674. 112 p.

CORKUM, L.D., and McCART, P.J. 1981. A review of the fisheries of the Mackenzie Delta and nearshore Beaufort Sea. Canadian Manuscript Report of Fisheries and Aquatic Sciences 1613. 55 p.

CRAIG, P., and HALDORSON, L. 1986. Pacific salmon in the North American Arctic. Arctic 39(1):2–7.

DEPARTMENT OF FISHERIES AND OCEANS (DFO). 1991. Annual summary of fish and marine mammal harvest data for the Northwest Territories, 1988–1989, Vol. 1. 59 p.

DYKE, L.D., and BROOKS, G.R. 2000. Introduction. In: Dyke, L.D., and Brooks, G.R., eds. The physical environment of the Mackenzie Valley, Northwest Territories: A base line for the assessment of environmental change. Geological Survey of Canada Bulletin 547. 7–10.

DYMOND, J.R. 1940. Pacific salmon in the Arctic Ocean. Proceedings of the Sixth Pacific Science Congress, San Francisco, 1939. Vol. 3:435.

FABIJAN, M. 1991a. Inuvialuit harvest study final data report: July 1986 – December 1988. Report prepared for the Fisheries Joint Management Committee. Available from Inuvialuit Harvest Study, Box 2120, Inuvik, Northwest Territories X0E 0T0.

——. 1991b. Inuvialuit harvest study final data report: January 1989–December 1989. Report prepared for the Fisheries Joint Management Committee. Available from Inuvialuit Harvest Study, Box 2120, Inuvik, Northwest Territories X0E 0T0.

——. 1995a. Inuvialuit harvest study final data report: January 1993–December 1993. Report prepared for the Fisheries Joint Management Committee. Available from Inuvialuit Harvest Study, Box 2120, Inuvik, Northwest Territories X0E 0T0.

——. 1995b. Inuvialuit harvest study final data report: January 1994 – December 1994. Report prepared for the Fisheries Joint Management Committee. Available from Inuvialuit Harvest Study, Box 2120, Inuvik, Northwest Territories X0E 0T0.

——. 2000. Inuvialuit harvest study final data report: January 1998 – December 1998. Report prepared for the Fisheries Joint Management Committee. Available from Inuvialuit Harvest Study, Box 2120, Inuvik, Northwest Territories X0E 0T0.

HEALEY, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). In: Groot, C., and Margolis, L., eds. Pacific salmon life histories. Vancouver: UBC Press. 311 – 393.

HUNTER, J.G. 1974. Pacific salmon in Arctic Canada. Fisheries Research Board of Canada, Manuscript Report Series 1319. 12 p.

JOHNSON, L. 1975. Distribution of fish species in Great Bear Lake, Northwest Territories, with reference to zooplankton, benthic invertebrates, and environmental conditions. Journal of the Fisheries Research Board of Canada 32:1989 – 2004.

LITTLE, A.S. 1997. Food and habitat use within the fish assemblages of the lower Slave River, Northwest Territories. M.Sc. Thesis, Dept. of Biological Sciences, University of Alberta, Edmonton, Alberta. 117 p.

McALLISTER, D.E., LEGENDRE, V., and HUNTER, J.G. 1987. Liste des noms inuktitut (esquimaux), français, anglais et scientifiques des poissons marins du Canada arctique; List of Inuktitut (Eskimo), French, English and scientific names of marine fishes of Arctic Canada. Canadian Manuscript Report of Fisheries and Aquatic Sciences 1932. 106 p.

McCART, P.J. 1986. Fish and fisheries of the Mackenzie system. In: Davies, B.R., and Walker, K.F., eds. The ecology of river systems. Dordrecht, The Netherlands: Dr. W. Junk. 493 – 515.

McDONALD, I. 1998. Gwich'in harvest study data report: 1997. Report prepared for Gwich'in Renewable Resource Board. Available from Gwich'in Renewable Resource Board, Box 2240, Inuvik, Northwest Territories X0E 0T0.

McLEOD, C.L., and O'NEIL, J.P. 1983. Major range extensions of anadromous Salmonids and first record of Chinook salmon in the Mackenzie River. Canadian Journal of Zoology 61: 2183 – 2184.

McPHAIL, J.D., and LINDSEY, C.C. 1970. Freshwater fishes of northwestern Canada and Alaska. Fisheries Research Board of Canada Bulletin 173. 381 p.

RISKE, M.E. 1960. A comparative study of north Pacific and Canadian arctic herring (*Clupea*). M.Sc. Thesis, University of Alberta, Edmonton, Alberta. 151 p.

RL&L. 1980. Downstream aquatic impact studies in the mainstem Mackenzie and Liard rivers. Interim report. Available from Golder Associates, #300, 10525 – 170 Street, Edmonton, Alberta T5P 4W2. 20 p.

RL&L/EMA SLAVE RIVER JOINT VENTURE. 1985. Fall fish spawning habitat survey 1983–1985. Prepared for the Slave River Hydro Study Group by RL&L/EMA Slave River Joint Venture, Edmonton, AB. Available from the Cameron Library, University of Alberta, Edmonton, Alberta T6G 2J8.

SALO, E.O. 1991. Life history of chum salmon (*Oncorhynchus keta*). In: Groot, C., and Margolis, L., eds. Pacific salmon life histories. Vancouver: UBC Press. 231 – 309.

SCOTT, W.B., and CROSSMAN, E.J. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184. 966 p.

STEIN, J.N., JESSOP, C.S., PORTER, T.R., and CHANG-KUE, K.T.J. 1973. Fish resources of the Mackenzie River valley: Interim report II. Fisheries Service, Canada Department of the Environment. 260 p.

STEPHENSON, S.A. 2004. Harvest studies in the Inuvialuit Settlement Region, Northwest Territories, Canada: 1999 and 2001–2003. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2700. 34 p.

STEWART, D.B. 1996. A review of the status and harvest of fish stocks in the Gwich'in Settlement Area. Canadian Manuscript Report of Fisheries and Aquatic Sciences. 2336 p.

TALLMAN, R.F., TONN, W., HOWLAND, K.J., and LITTLE, A. 1996a. Synthesis of fish distribution, movements, critical habitat and food web for the lower Slave River north of the 60th parallel: A food chain perspective. Northern River Basins Study, Synthesis Report No 13. Edmonton: Government of Alberta. 152 p.

TALLMAN, R.F., TONN, W., and LITTLE, A. 1996b. Diet, food web and structure of the fish community, lower Slave River, June to December, 1994 and May to August, 1995. Northern River Basins Study, Project Report No. 119. Edmonton: Government of Alberta. 91 p.

TALLMAN, R.F., HOWLAND, K.L., LOW, G., TONN, W.M., and LITTLE, A. 2005. Composition and changes to the fish assemblage in a large sub-arctic drainage: The Lower Slave River. In: Rinne, J.N, Hughes, R.M., and Calamusso, B., eds. Historical changes in large river fish assemblages of the Americas. American Fisheries Society Symposium 45, Bethesda, Maryland. 23 – 39.

TRIPP, D.B., McCART, P.J., SAUNDERS, R.D., and HUGHES, G.W. 1981. Fisheries studies in the Slave River Delta, NWT: Final report. Prepared for Mackenzie River Basin Study by Aquatic Environments Limited, Calgary, Alberta. Available from the Cameron Library, University of Alberta, Edmonton, Alberta T6G 2J8. 262 p.