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**Do Norwegian Atlantic salmon feed in the northern Barents Sea?**

**– Tag recoveries from 70 - 78° N**

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1 Three tagged Atlantic salmon *Salmo salar* were recaptured as subadults/adults (1.4 - 3 kg)  
2 between 70.5° - 78° N in the western Barents Sea; two of the fish originated from the Alta  
3 Fjord region in northern Norway and one from the Drammen River, south-eastern Norway.  
4 An additional tag was recovered from the stomach of a Greenland halibut captured south-west  
5 of Bear Island at >600m depth; this tag was from a smolt released in the River Alta one month  
6 earlier. These are the northernmost tag recoveries reported for Atlantic salmon, and indicate  
7 that Norwegian salmon, especially the fish from northern populations, may use the northern  
8 Barents Sea as a feeding area during part of their life cycle.

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**Key words:** *Salmo salar*, sea migration, ocean distribution, tag and recapture, Barents Sea

1 Atlantic salmon *Salmo salar* are distributed over large areas of the North Atlantic, and the  
2 species is known to undertake long sea migrations (Klemetsen *et al.*, 2003). The distribution  
3 of salmon in the sea probably depends on a combination of environmental factors, such as  
4 food availability, water temperature and currents, along with genetic components that govern  
5 population specific navigation systems.

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7 The distribution of salmon at sea is not even (Holst *et al.*, 2000; Hansen & Jacobsen, 2000;  
8 Holm *et al.*, 2003), and salmon originating from several rivers may be caught in the same  
9 oceanic areas at the same time (Hansen & Jacobsen, 2003). Tagging experiments have shown  
10 that salmon from North America remain mainly in the western North Atlantic (Ritter, 1989),  
11 whereas fish from European and southern Norwegian populations are believed to feed mostly  
12 in the Norwegian Sea and the North-East Atlantic (Holm *et al.*, 2003). European fish,  
13 particularly those from southern Europe, UK and Ireland, are also abundant at West  
14 Greenland (Swain 1980), and there is evidence that some migration of salmon occurs between  
15 North America and Europe (Reddin and Friedland, 1999; Hansen & Jacobsen, 2003).

16

17 In contrast, very little information exists about the oceanic migrations and distributions of  
18 Atlantic salmon stocks from Northern Norway and Russia. A few fish of Russian origin have  
19 been captured north of the Faroe Islands (Hansen & Jacobsen, 2000; Holm *et al.*, 2003) and  
20 salmon from the White Sea basin may utilize different feeding areas from those populations  
21 that migrate directly into the Barents Sea (Jensen *et al.*, 1999). A few Atlantic salmon post-  
22 smolts have been caught at 70 - 75° N in the Norwegian and Barents Sea in July (Holm *et al.*,  
23 2004), but the origin of these fish is not known.

24

1 In recent years, three tagged subadult/adult Atlantic salmon have been recaptured in the  
2 western Barents Sea (Table I). The fish were released as smolts in River Alta, River Hals  
3 (close to the River Alta) and River Drammen. Two of the fish were taken as by-catch in  
4 herring surface trawls (15 m deep), and the third was captured in a littoral floating gillnet. The  
5 first salmon, captured in early August 2002 on the west side of Bear Island, weighed 2.2 kg. It  
6 had been released in the River Drammen, southern Norway, 15 months earlier as a 170 mm  
7 long smolt. The second fish, weighing 1.4 kg, was captured in late August 2004 in the south-  
8 western part of the Barents Sea opening (Fig. 1). It had been released as a 190 mm smolt in  
9 the River Alta 14 months earlier (Table I). The third salmon was taken in early October 2006  
10 in a gillnet set by a fisherman outside Longyearbyen, Spitsbergen (Table I and Fig. 1). This  
11 fisherman observed several jumping salmon within the area and the gillnet was therefore  
12 targeted for these. This fish, weighing 3.0 kg, was taken together with about 20 untagged  
13 similar sized salmon. The fish had been released as a 181 mm smolt in the River Hals, Alta  
14 Fjord, 15 months earlier (Table 1).

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16 In early August 2005, a Carlin tag was found together with fish remains in the stomach of a  
17 60 cm long Greenland halibut *Reinhardtius hippoglossoides* caught close to Bear Island  
18 (Table I and Fig. 1). This tag originated from an Atlantic salmon that had been released as a  
19 187 mm smolt in the Alta River one month earlier (Table I).

20

21 Three of the four salmon originated from rivers that drain into Alta fjord (Rivers Alta and  
22 Hals). A total of 250 000 hatchery-reared Atlantic salmon smolts of local origin have been  
23 tagged and released into the rivers in the period from 1986 - 2006. During the period 2002-  
24 2005, a total of 40 000 smolts were Carlin tagged. Until now, only 0.38% are recaptured,  
25 respectively 0.14% in the river and 0.18% in the sea and almost exclusively in coastal bag- and

1 gillnet fisheries (Strand and Finstad, 2007). The three fish that form the basis of this  
2 communication are the only salmon from these taggings that have been reported recaptured in  
3 the open ocean. In the River Drammen, about 100 000 hatchery-reared salmon smolts of local  
4 origin have been tagged with Carlin tags and released since 1984 (4000 each year), and the  
5 fish reported here is the northernmost recapture from these taggings. The estimated survival  
6 of these fish until they enter the Norwegian coast has varied between 1-8% (pre fishery  
7 survival). Before the ban of flouting drifting nets in 1989, 65% of the returning salmon from  
8 River Drammen was estimated to be captured in gillnets at the Norwegian coast. After the  
9 ban, the average sea fishery capture was reduced to about 20% (Hansen *et al.*, 2006). The  
10 number of tags recovered from the Barents Sea opening is admittedly small, compared to  
11 recaptures along the coast of northern Norway and in the area around the Alta Fjord. One  
12 reason for this may be the lack of targeted fisheries for salmon in the Barents Sea in contrast  
13 to the extensive fishing that occurs along the coast in Northern Norway, and the open ocean  
14 fisheries that have been carried out in the Northern Norwegian Sea, especially north of the  
15 Faroe Islands. Large numbers of tagged salmon have been taken in these fisheries (Hansen *et*  
16 *al.*, 1999; Jacobsen, 2000; Jensen *et al.*, unpubl. data). In addition, the waters around  
17 Spitsbergen have been regarded to be outside the area for natural distribution of Atlantic  
18 salmon and no systematic registrations of salmon catches in the marine fisheries have been  
19 done in this area.

20

21 The Atlantic salmon captured outside Longyearbyen in October 2006, is the most northern  
22 tagged salmon documented. This, together with reports of recaptures of untagged salmon in  
23 the same fjord in 2002 (Berge *et al.*, 2005), may indicate that Atlantic salmon can feed further  
24 north than earlier believed, and that this could be mainly fish from the northernmost  
25 populations. An interesting observation is also that several Pink salmon *Oncorhynchus*

1 *gorbuscha* have, in recent years been captured in rivers and gillnets as far north as  
2 Nordaustlandet (north of 80° N) on Svalbard (pers. com. B. Gulliksen, Univ. of Tromsø,  
3 Norway). These were untagged fish that probably originate from Russian rivers at the Kola  
4 Peninsula where they were first introduced in the 1950'es (Berg, 1977), and shows that also  
5 this salmon species may use the northern Barents Sea as feeding area.

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7 It is somewhat surprising that a tag from an Atlantic salmon postsmolt was found in the  
8 stomach of a Greenland halibut caught at 667 m depth south west of Bear Island. Atlantic  
9 salmon are thought to swim mostly in surface waters (Rikardsen *et al.*, 2004; Thorstad *et al.*,  
10 2004; Finstad *et al.*, 2005), whereas the Greenland halibut is found mostly at 500 - 800 m  
11 along the continental slope between the Norwegian mainland and Svalbard (Godø & Haug,  
12 1989). Greenland halibut may feed on pelagic and mesopelagic fish (Michaelsen & Nedreaas,  
13 1998; Bjelland *et al.*, 2000; Hovde *et al.*, 2002) and have been documented pelagically up to  
14 200 m depth by experimental fishing and data storage tag recordings (Vollen, T. *et al.*,  
15 unpubl. data). Results from similar studies conducted on hatchery reared Atlantic salmon  
16 postsmolts have revealed that salmon may sometimes perform short-duration dives to depths  
17 of several hundred meters, but these dives are almost exclusively seen when the salmon has  
18 grown to subadult/adult fish (Gudjonsson, S. & Einarsson, S., pers. com., Institute of  
19 Freshwater Fishes in Iceland). Other possible explanations could be that the fish died and the  
20 tag or the whole fish sunk into deeper waters, or that it was passed to the Greenland halibut  
21 through another prey, for example cod (*Gadus morhua*). However, the latter is less probable,  
22 given the size of the postsmolt at tagging (19 cm) which imply that the cod would then  
23 probably have been too big to be eaten by the Greenland halibut. Hence, the exact location  
24 where the Greenland halibut consumed the Atlantic salmon, or its tag, remains unknown.

25

1 Holst *et al.*, (2000) hypothesized that post-smolts originating from the Norwegian coast north  
2 of 70° N may make an anticlockwise turn north-east into the Barents Sea before swimming  
3 westwards in the more northerly parts of the Barents sea. Further, they suggested that the fish  
4 might either leave the Barents Sea close to Bear Island or feed in the Polar Front area close to  
5 Bear Island during their first summer. The fact that the 1SW salmon from the Alta River and  
6 the salmon from the River Drammen were captured in the southwestern and western part of  
7 the Barents Sea, respectively, may lend support to this. The salmon captured at 78° N at  
8 Svalbard may also have migrated the same direction during its first year at sea, but then  
9 followed the Atlantic current north and into the Isfjorden at Spitsbergen. However, and the tag  
10 recovered from the Greenland halibut derive from these explanations as the postsmolt with  
11 this tag could have been maximum one month at sea, and must have migrated north-west in  
12 the Barents Sea if it was eaten within the same area as the Greenland Halibut was recaptured.

13  
14 In recent years sea surface temperatures in the Barents Sea have been higher than previously  
15 (Ingvaldsen *et al.*, 2006) and this may have resulted in a more northern oceanic distribution of  
16 salmon, thereby providing an explanation for the capture of the salmon as far north as 78° N.  
17 At the site this fish was captured, the seawater temperature was 2.5° C, a temperature much  
18 higher than normal in this area, probably as a result of an influx of Atlantic water along the  
19 west coast of Spitsbergen and into Isfjorden during autumn in 2006 (pers. com. Jørgen Berge,  
20 UNIS, Svalbard, Norway). As an apropos, several untagged Atlantic salmon were captured in  
21 the same area in 2002, a year when the seawater temperature also was unusually high and  
22 with an influx of warmer Atlantic water (Berge *et al.* 2005).

23  
24 Our findings could indicate that some Atlantic salmon, especially the fish from northern  
25 populations, utilize the Barents Sea as a feeding area. If fish from northern and southern

1 European salmon populations feed in different areas at sea, this could explain why the marine  
2 production of such populations cycle differently (Anon. 1999). As such, more knowledge is  
3 needed about the migration route of northern Atlantic salmon populations, their main feeding  
4 areas and the factors underlying fluctuations in their marine production. This will be  
5 especially important in the light of potential changes in the Barents Sea ecosystem, in relation  
6 to climate change, the effects of over-fishing of the marine stocks, and the development of the  
7 petroleum industry in this area.

8

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11 the University of Tromsø.

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1 **Legends to figures**

2 Fig. 1. Map of the release (marked with arrows) and recapture sites (marked with stars) of the  
3 tagged Atlantic salmon and the main currents in the Barents Sea. The number of the recapture  
4 sites (1-4) refers to the fish number given in Table I.

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1 Table I. Atlantic salmon tagged as smolts and recaptured in the Barents Sea opening (fish no.  
 2 1, 2 and 4) and at Svalbard (fish no. 3).

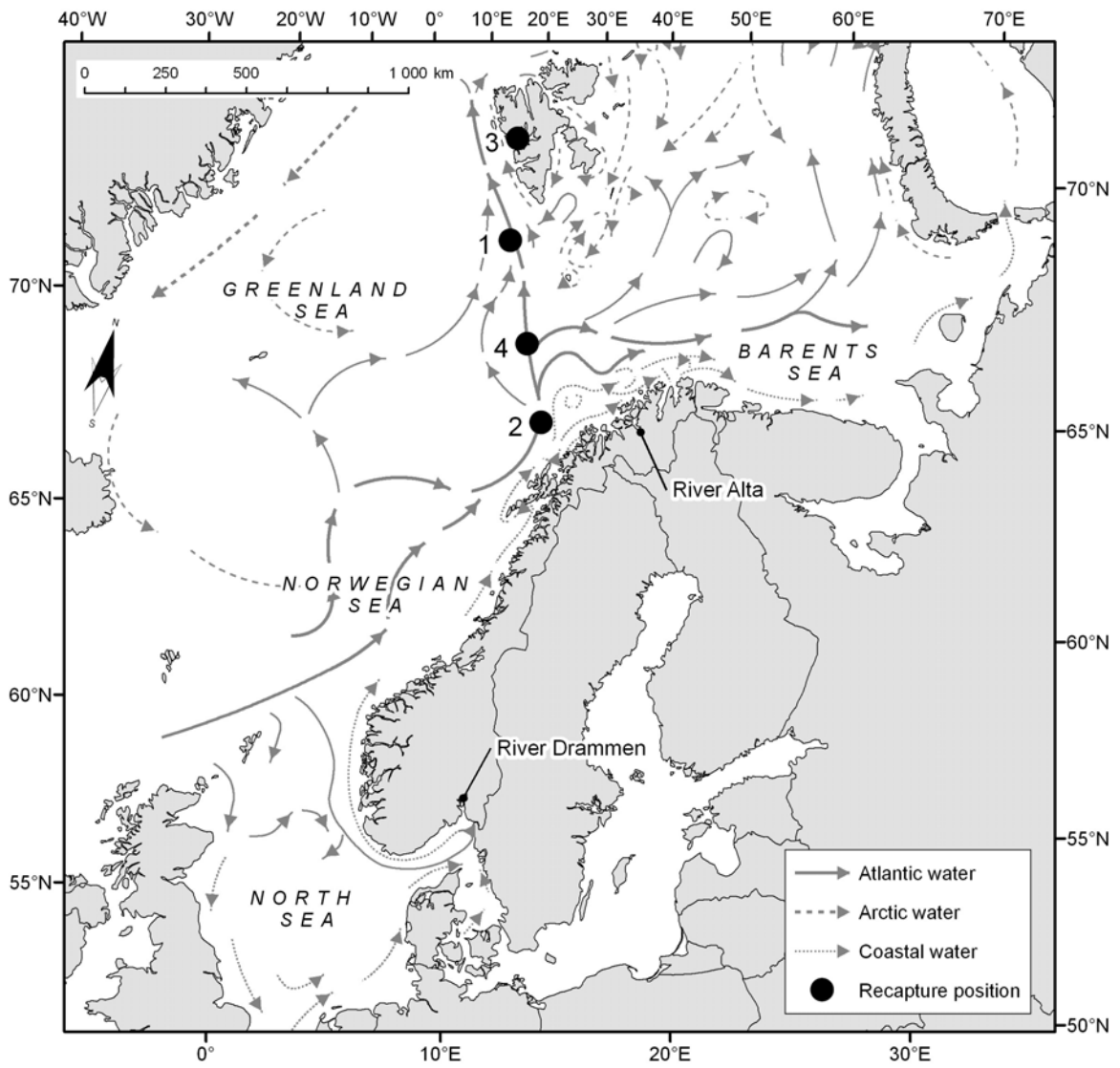
<b>Fish no.</b>	<b>Tagged</b>	<b>River origin</b>	<b>Recaptured</b>	<b>Capture gear</b>	<b>Site of recapture</b>	<b>Size at recapture</b>
1	15 May 2001	Drammen	9 Aug. 2002	Pelagic herring trawl	75° 40' N; 9° 20'E	2.2 kg
2	30 June 2003	Alta	19 Aug. 2004	Pelagic herring trawl	70° 46' N; 16° 14' E	1.4 kg
3	15 July 2005	Hals	5 Oct. 2006	Littoral floating gillnet	78° 15' N; 15° 40'E	3.0 kg
4	4 July 2005	Alta	9 Aug. 2005	-	72° 50' N; 14° 49'E	Not known*

3 \* = Tag was found inside stomach of a Greenland halibut captured on a deepwater long line

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