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Preliminary results from DST tagging of salmon in the Norwegian Sea

by

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Introduction

An inter-Nordic tagging study including Norway, Faroes and Iceland has been carried out in the sea in 2002- 2004. The study has been supported by the Nordic Council of Ministers, the Research Councils of the Faroes and Iceland, as well as the Marine Research Institutes of Faroes, Iceland and Norway. The aim of the study has been to study various marine life history traits such as, winter habitats, diurnal patterns of vertical migration and feeding activities, and in addition to gather information allowing the risk of being intercepted by pelagic fishing gear to be assessed.

Material and methods

A specially designed "salmon trawl" with extra flotation on the head line and bridles was used together with a device for live fish capture (modified from Fish Lifter, Holst and McDonald, 2000) attached to the cod end of the trawl. This technique allows the majority of the fish to pass through the cod-end of the trawl with very little damage and loss of scales and external parasites (Holst and McDonald 2000; ICES 2000/ACFM:13). The mean towing speed with this trawl was 4.8 kt (SD ±0.4) and the wire length was 290 – 340 m depending on the condition of the waves. The trawl was towed in large arcs to avoid the wake of the ship. The modified "Fish Lifter" allows most of the salmon to be taken with little or no external damage, making the catch fit for tagging and release. Possibly because of the higher trawling speed (mean ~ 3.5 kt. previously) and maybe also due to lower sea temperatures, the captures have been good when trawling was performed temperatures of 6 – 9 C. Mean CPUEs between 2.9 – 5+ have been registered in the autumn north of the Faroes and in April 2004 when the Norwegian research vessel was fishing in the mid part of the Norwegian Sea. In June –July 2002-03 in the Norwegian Sea the catches of adult salmon stayed low and mostly comprised fish farm escapees, although a large number of post-smolts were taken. In the summer, however, the post-smolts were too small to be tagged with the DSTs available (38.4 x 12.5 mm). The areas fished are shown in Figure 1 and the launching of a load of fish in figure 2.

.Post-capture the fish were placed in a recovery tank for and observed for 30 min- 1 day . Fish showing normal reactions (circulating close to the bottom of the tank when cover was removed) and stable swimming behaviour were chosen for tagging unless smaller than 400g or , in general , if scal los was less than 30/ of the integument. The tags were placed in the body cavity of the salmon through a small incision above the pelvic fins. Two types of tags were used, an "I- button" tag (Dallas Semiconductor) recording only temperature (memory capacity approx. 12,000 recordings) and a depth and temperature recording tag with a memory capacity of 21,738 measurements per parameter (Star Oddi "Milli"). Each Milli- tag can be set to log at fourteen sequences with different measurement intervals varying from seconds to weeks. In this experiment sequences of 1, 5 30, 60 and 120 min were used. The tags will record these parameters for two years during the time lapse from tagging to retrieval of the tags. Each fish got an additional bright coloured numbered external tag to facilitate detection. A few scales and the adipose fin were removed for biological analyses, length and weight of all fish were recorded and the stomach content of dead fish removed for further analyse. In 2004 a special trough that could contain 4-5 fish recovering from anaesthesia and that could be hoisted over the ship's side by a crane was used for releasing the fish on the Norwegian ship. The salmon thus didn't have to be touched post-operation, which greatly reduced handling stress.

Results

Table 1 summarises the Nordic taggings. During the study some differences in the environment where the recaptures were made could be observed over the years. E.g. most fish in the Faroes' tagging in 2002 and 2003 were captured north-west, close to the border of the EEZ between Faroes and Iceland, in the relatively cool waters of the front between the cold Icelandic current and the warmer Atlantic water In 2004, however, the highest catch per trawl hours, CPUE, were obtained further south in waters between 8 – 9 C (Figures 3 and 4). Most of the catches in the central Norwegian Sea in April 2004 were also occurring in the warmer Atlantic water. When temperatures were less than 7 C no salmon were captured.
Table 2 shows an example of the differences in mean length between discards and tagged fish.

Altogether five DSTs fish have been returned from the releases in central Norwegian Sea. One I-button tag (out of four released) was returned from R. Namsen, Mid-Norway and in 2004 four DSTs were returned from R. Namsen, R. Børsa estuary, R. Surna (all in Mid-Norway) and from r. Ätran in SW-Sweden. The assumed migration routes of these fish are presented in Figure 1. Data records from these tags are presented in Figure 5 on the time scale 24.04 – 30.08. which were the date of first records after release in the sea respectively the last of data recorded in river before capture. Individual data records are presented in Figures 6 – 10 and a detail of the records made with 1 minute intervals from the R. Ätran data set is shown in figure 11.

439 days of observation mostly on an hourly basis, but mixed with periods with shorter observation intervals is obtained from these recaptures. Common for all four is a period of relative inactivity for the first 14 – 20 days after release. Preliminary analyses of the data records show that after the initial period the patterns are fairly different, but all have a period of rather extensive diving activity although the maximum diving depths (85 - ~ 280m) and the number of dives per time unit seem to vary considerably from fish to fish. The salmon probably are progressing towards the coast and feeding at the same time during this phase. All fish stay mostly in the

uppermost 5 - 10 m which seems to be the starting point for excursions into deeper layers. When approaching the end point different patterns can be discerned, probably depending on the nature of the fjord, the estuary and finally the river where the salmon arrive. E.g. the River Ätran in Sweden is small, shallow and warm (Figure 10), while the River Surna is a large regulated river with some parts draining cold water from high in the mountains. This can be seen as a fall in temperature when the fish ascends into the river (Figure 9) while the temperature rises in R.Ätran. Further recaptures from the tagging north of Faroes in November 2004 and possibly also 2 SW fish from the tagging in April 2004 in the Norwegian Sea might turn up during the 2005 fishing season.

One salmon carrying an external tag from the releases at Faroes in 2003 was reported in September 2004 from the R.Urie in Eastern Scotland (possible route indicated in Figure 1). Unfortunately the DST was not returned from this fish. The DST might have been lost with the viscera when gutting the salmon. It could also have grown out through the body wall during the passing year and lost, which has been observed from DST tagged Pacific salmon returning to the home rivers on US west coast (Nielsen, pers com.).

Conclusions

The results so far are a breakthrough in marine tagging of pre-adults and adult salmon. The conclusions from the preliminary analyses are that a) DSTs are an invaluable tool for studying marine life history traits of the salmon, b) the relatively frequent dives below 20 – 50m might make the salmon more vulnerable previously believed to interception by mid- water trawls in some areas, and c) the relatively high costs involved are balanced by the number of observation days obtained from each tag.

References

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Molm, M. Holst, J.C. and Hansen, L.P. 2000. Spatial and temporal distribution of post-smolts of Atlantic salmon (*Salmo salar* L.) in the Norwegian Sea and adjacent areas. - *ICES J. Mar. Sci*., 57:955 – 964.

Holst, J.C. and McDonald, A. 2000. FISH-LIFT: A device for sampling live fish with trawls. *Fisheries Research*, 48:87-91.

Table 1 Summary of DST tagging of salmon carried out by Norway, Faroes and Iceland in 2002 – 2004.

CRUISE	AREA	TIME	NO. CAPTURED	NO. TAGGED
Norway- 2002-04	Norwegian Sea	June/July 2002 & 2003; April 2004	224	107*
Faroes- 2002 - 04	Faroes' EEZ, north	October 2002-03 November 2004	482	293**
Iceland – 2002 - 03	Iceland's EEZ, west & east; east	November/ December 2002 January 2003	28	6
Total			734	406

* five tag recaptures ** recapture of an externally tagged salmon- the DST was lost

Table 2. Mean lengths of tagged salmon and dead/discarded fish in 2003 – 2004.

	Mean L, cm Tagged fish	Mean L, cm Discards
Faroes, 2003	39.8	37.7
Norwegian Sea 2004	46.8	41.7

Figure 2 Recovery / release trough and release of two salmon from R/V "Johan Hjort", Norwegian Sea April 2004.

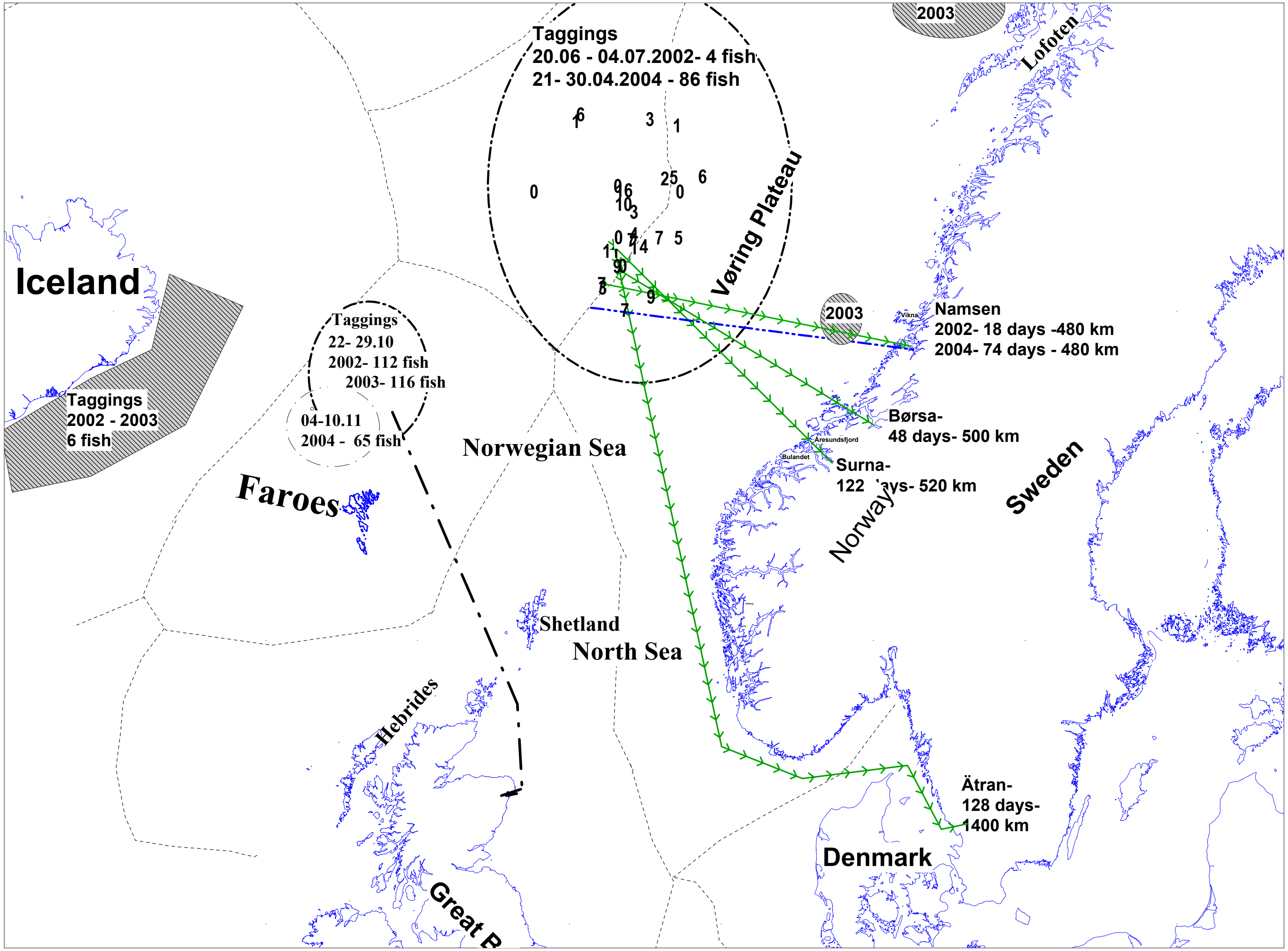

Figure 1 Areas where DST tagging was carried out 2002 – 2004 by The Faroes, Iceland and Norway. Possible migration routes of 4 recaptured salmon from the 2004 releases in the central Norwegian Sea indicated by arrows. Recapture in 2002 marked with hyphens and dots. Same legend indicates the recapture in Scotland of a salmon from the Faroes' 2003 release that had lost its DST. Other legends in the figure.

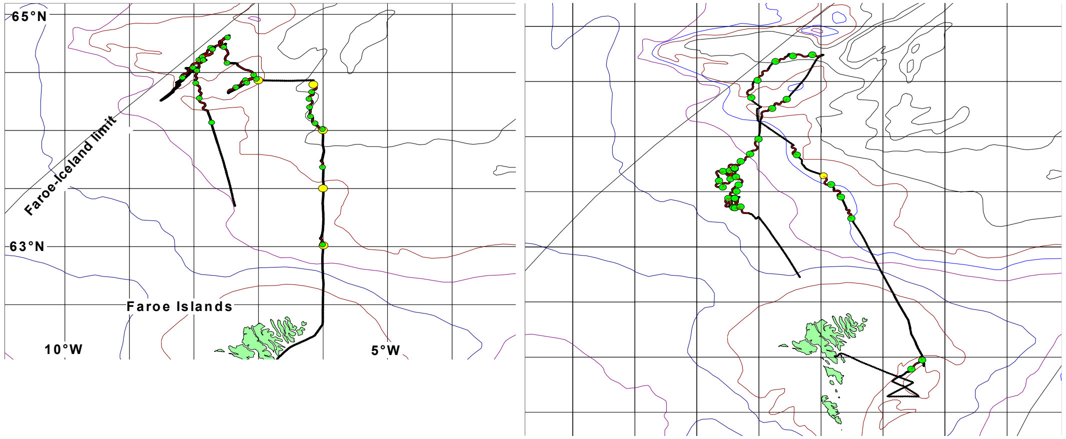

Figure 3 Cruise tracks for the Faroese tagging expeditions in 2003 (left) and 2004 (right).

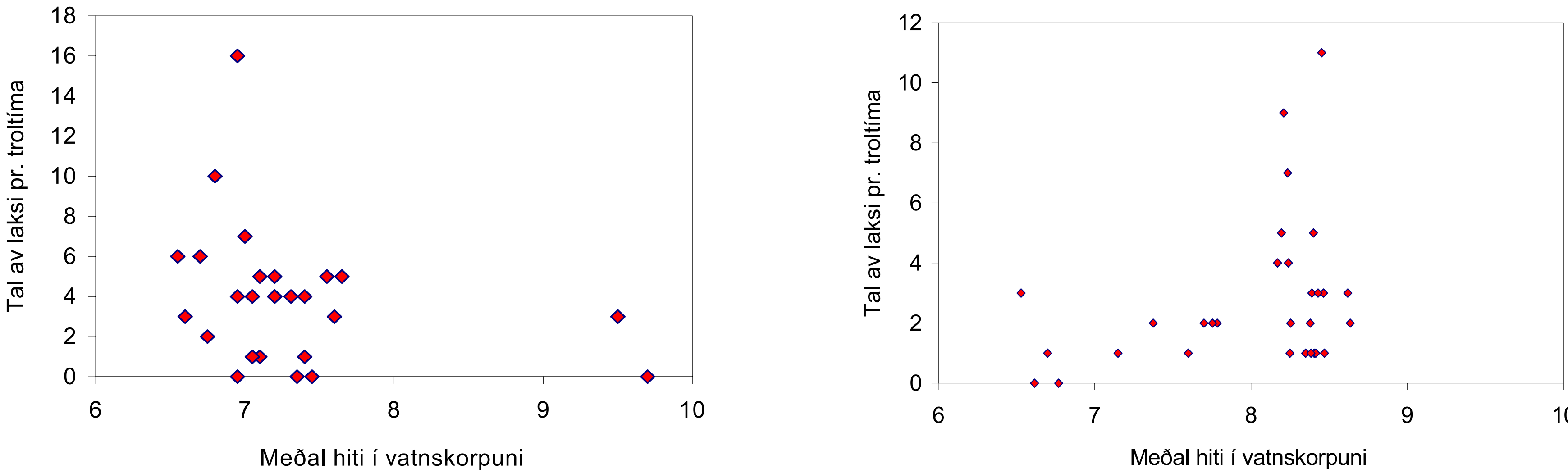

Figure 4 Catch per unit of effort (trawl hours) in relation to the surface temperatures north of Faroes in 2003 (left) and 2004 (right). Number of salmon on the vertical axis and temperatures on the horizontal axis

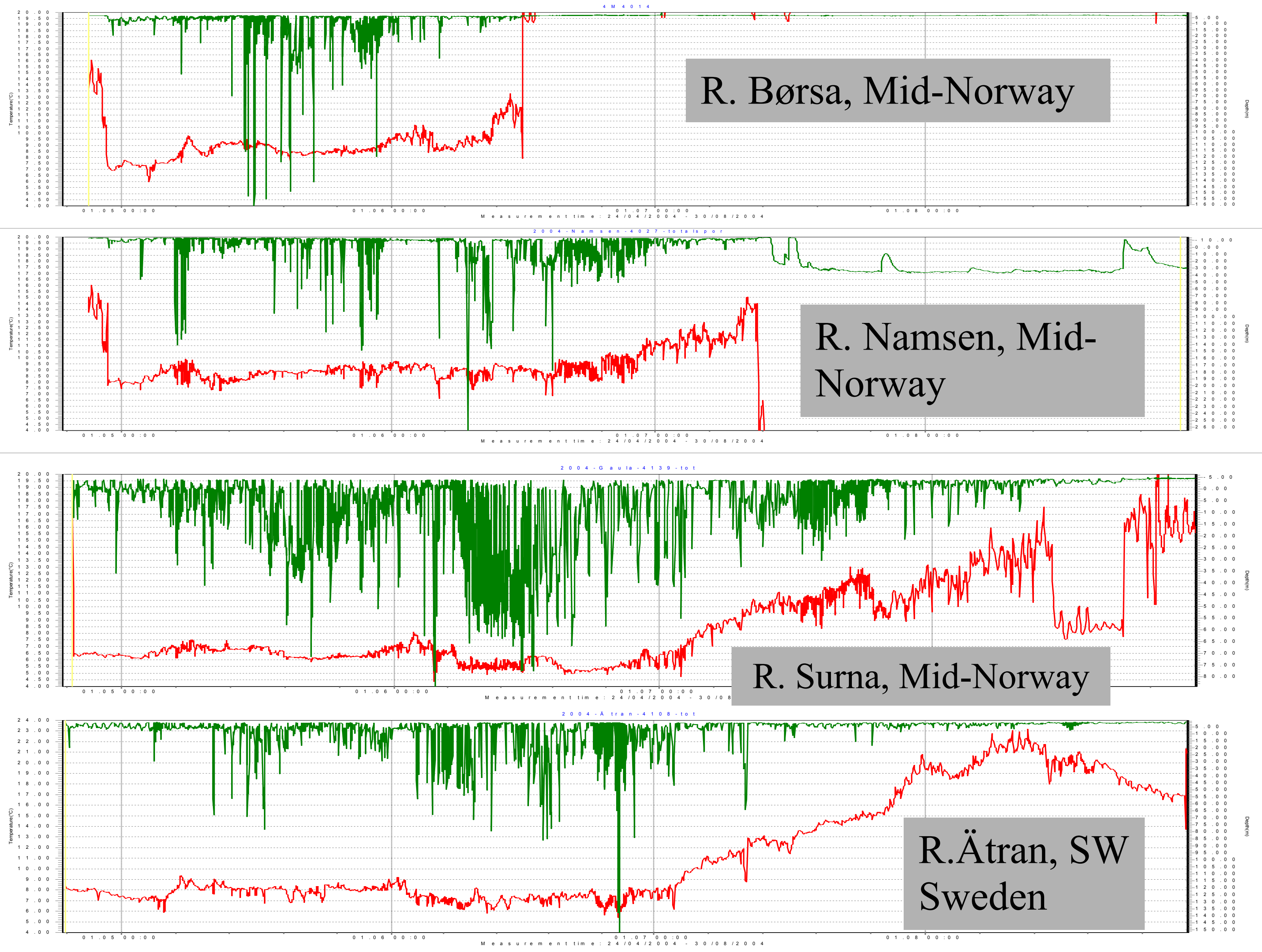

Figure 5 Four data records from returned tags arranged on the same time scale. Start 24.04.04 and end 03.08.04.

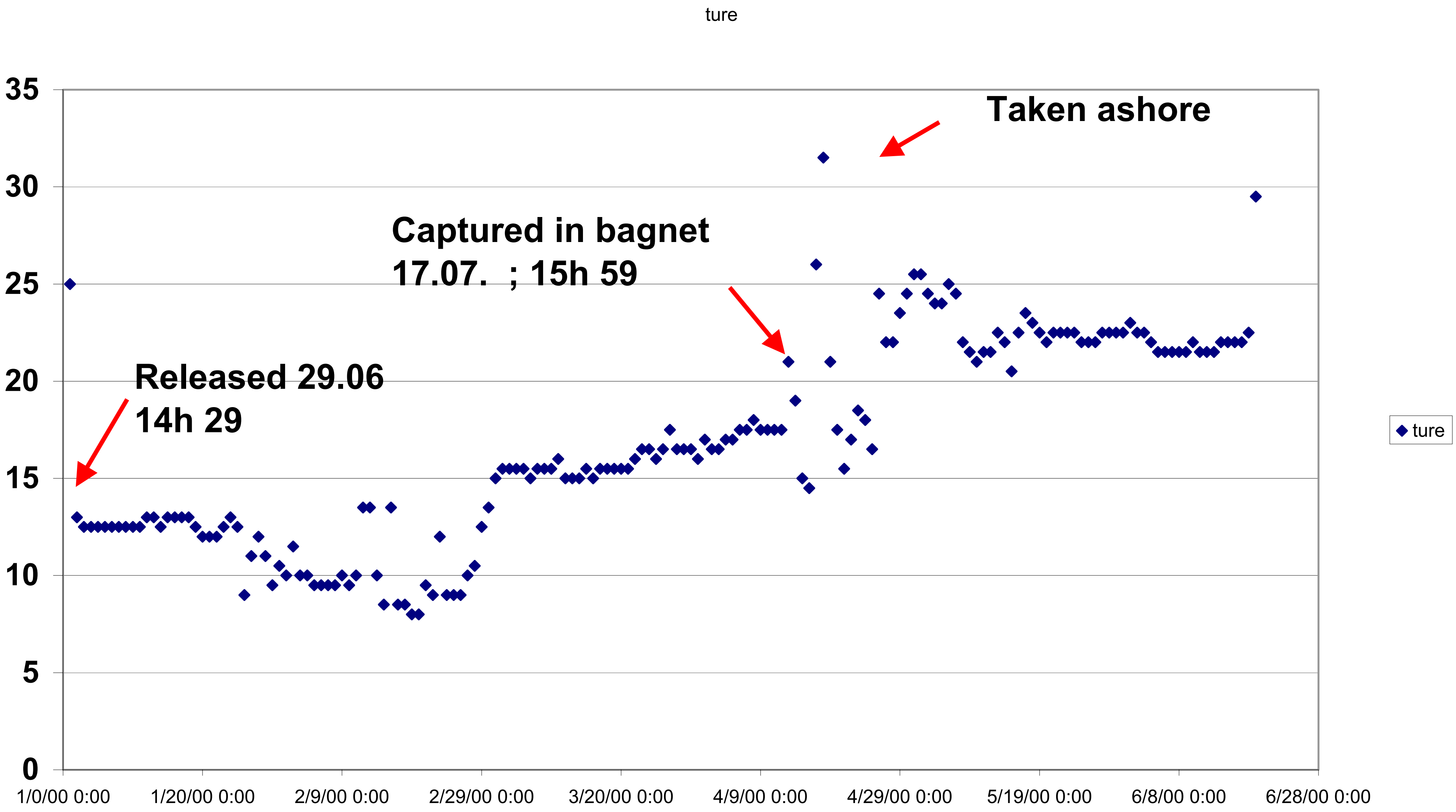

Figure 6 Temperature records from I-buttontag returned from R. Namsen in 2002.

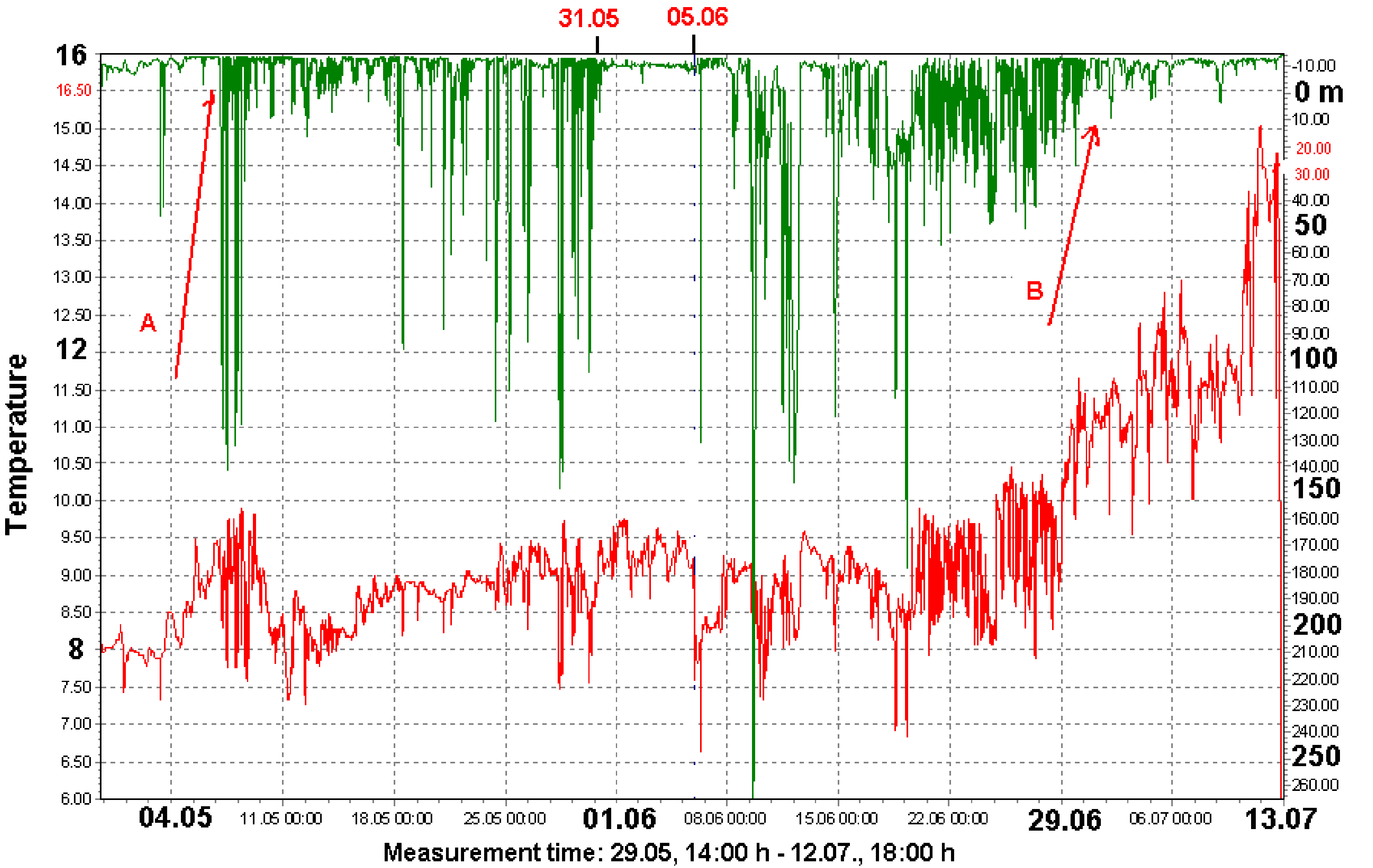

Figure 7 Data records of a salmon recovered in the ***Namsen fjord***, Mid- Norway. Depth above and temperature graph below. **A)** post-relese period , and probable periods of and **B)** feeding and migration activity,. Thereafter coastal/fjord migration (rising temperature and ceasing diving activity) until the fish is captured in a bag net.

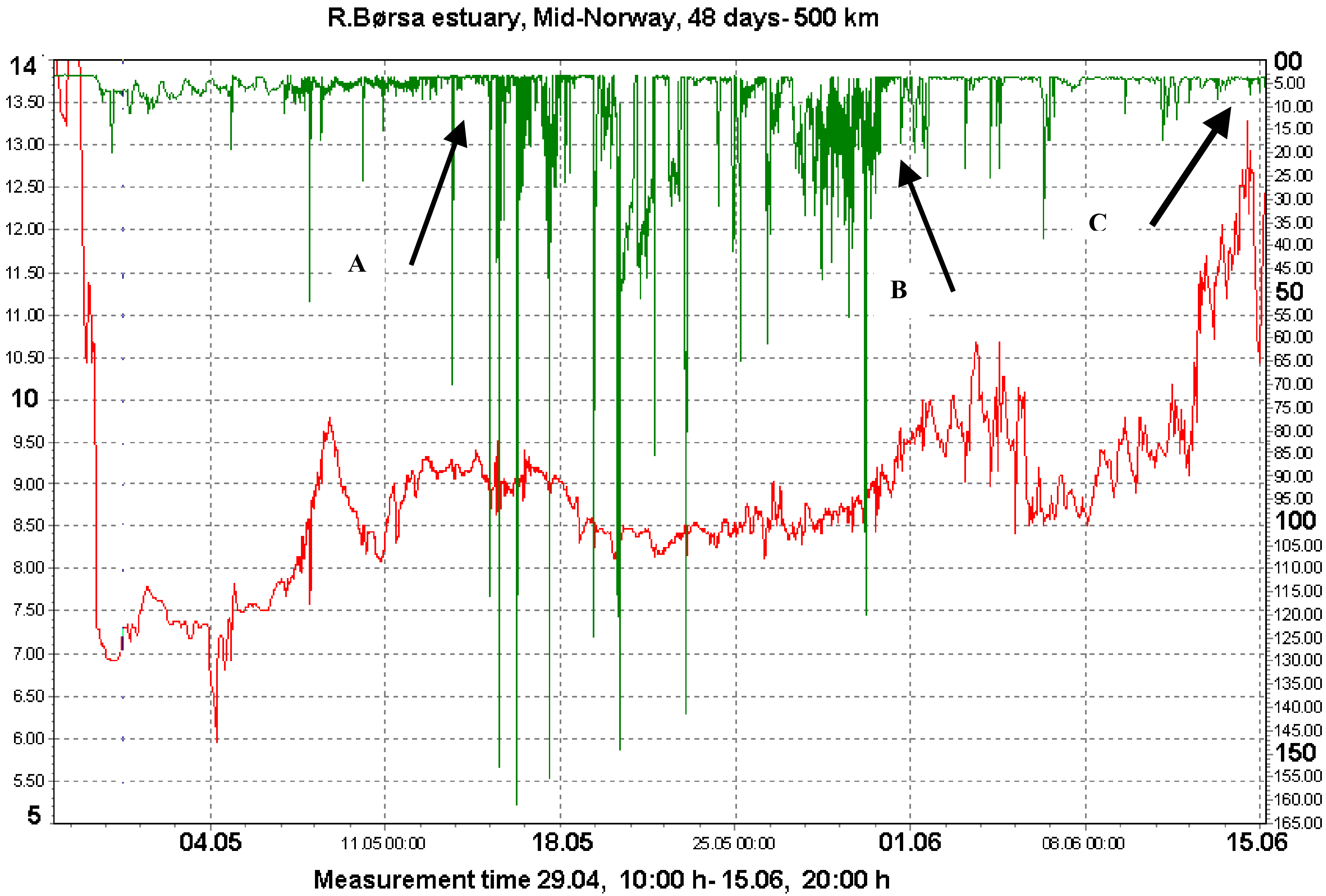

Figure 8 Data records of a salmon recovered in R. Børsa estuary , Mid- Norway. Depth above and temperature graph below. **A)** post-release period , and probable periods of **B)** feeding and migration activity, **C)** Coastal migration and estuarine dwelling (diving activity ceases and temperature rises) until captured.

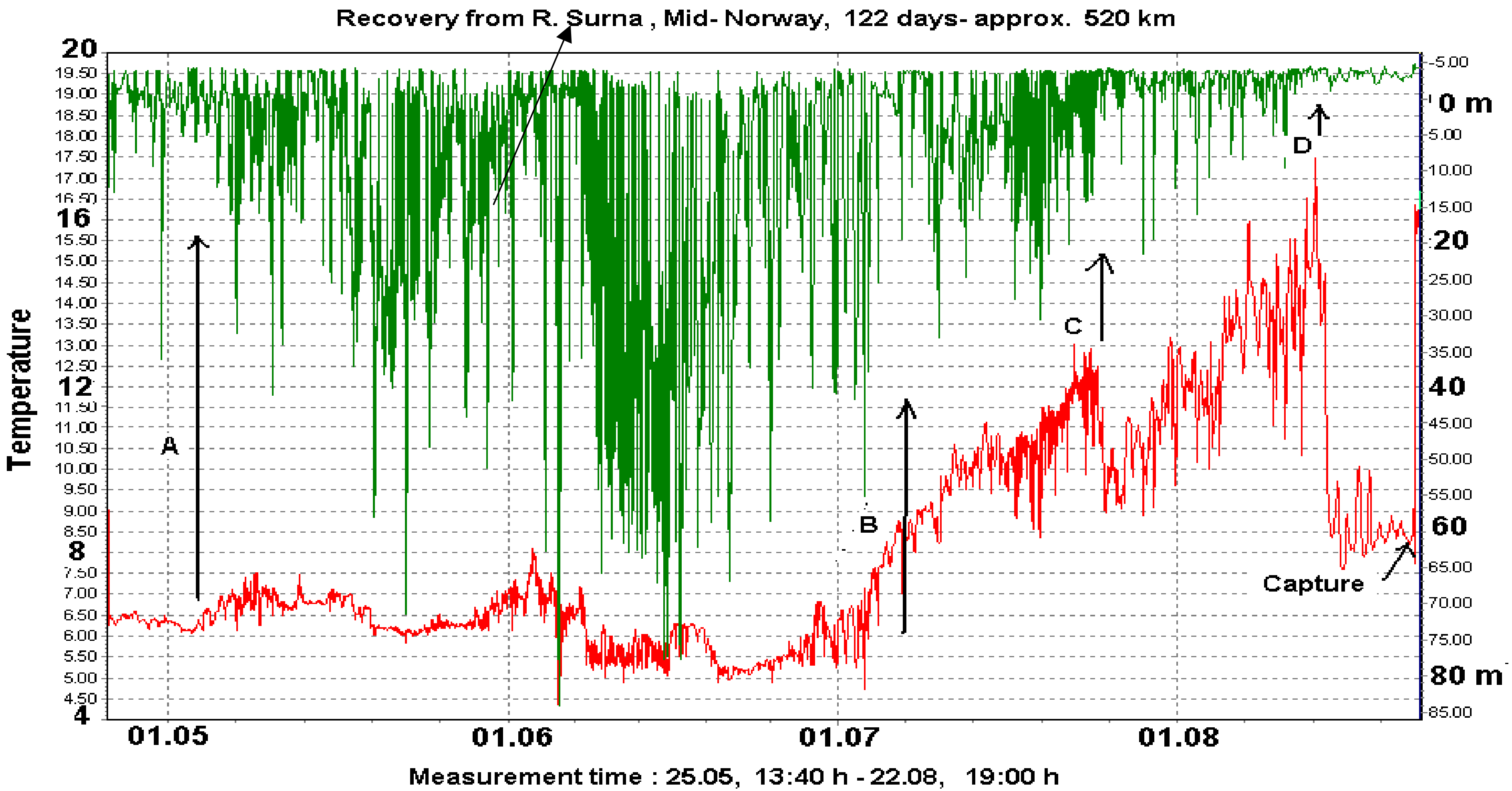

Figure 9 Data records of a salmon recovered in R. Surna , Mid- Norway. Depth above and temperature graph below. **A)** post-release period , and probable periods of **B)** feeding and migration activity, **C)** Coastal migration (rising temperature), **D)** Estuarine dwelling and migration followed by in-river dwelling when the diving activity ceases. The R.Surna is draining from high mountains and is regulated by power dams. The flushing of water from the dams may have caused the large fall in temperature observed in the graph.

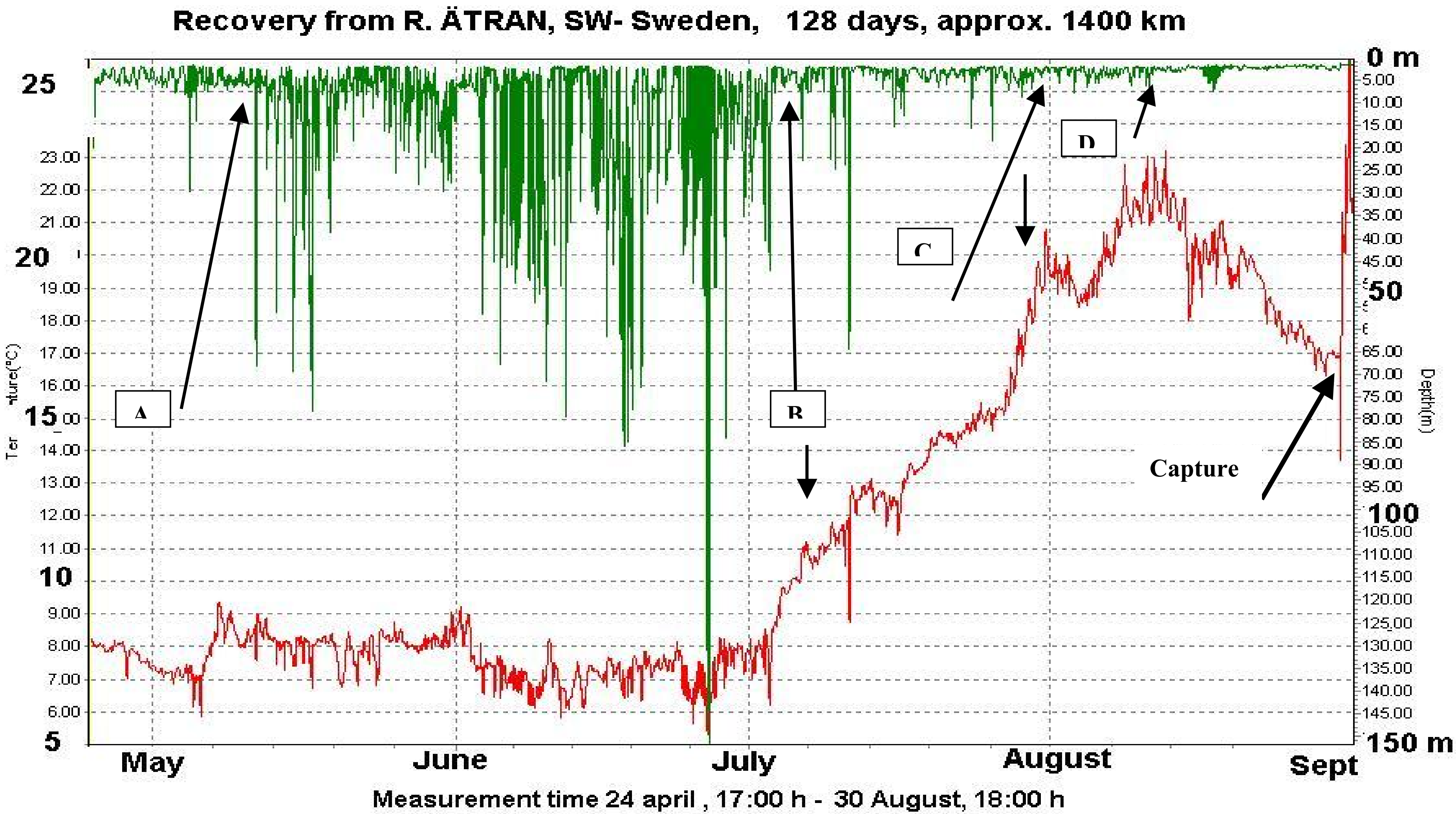

Figure 10 Track of a salmon recovered in R. Ätran, Sweden. Depth above and temperature graph below. **A)** Post-release period **B)** Probable periods of feeding and migration activity, **C)** Coastal migration (rising temperature), **D)** Estuarine dwelling and migration followed by in-river dwelling when the diving activity ceases.

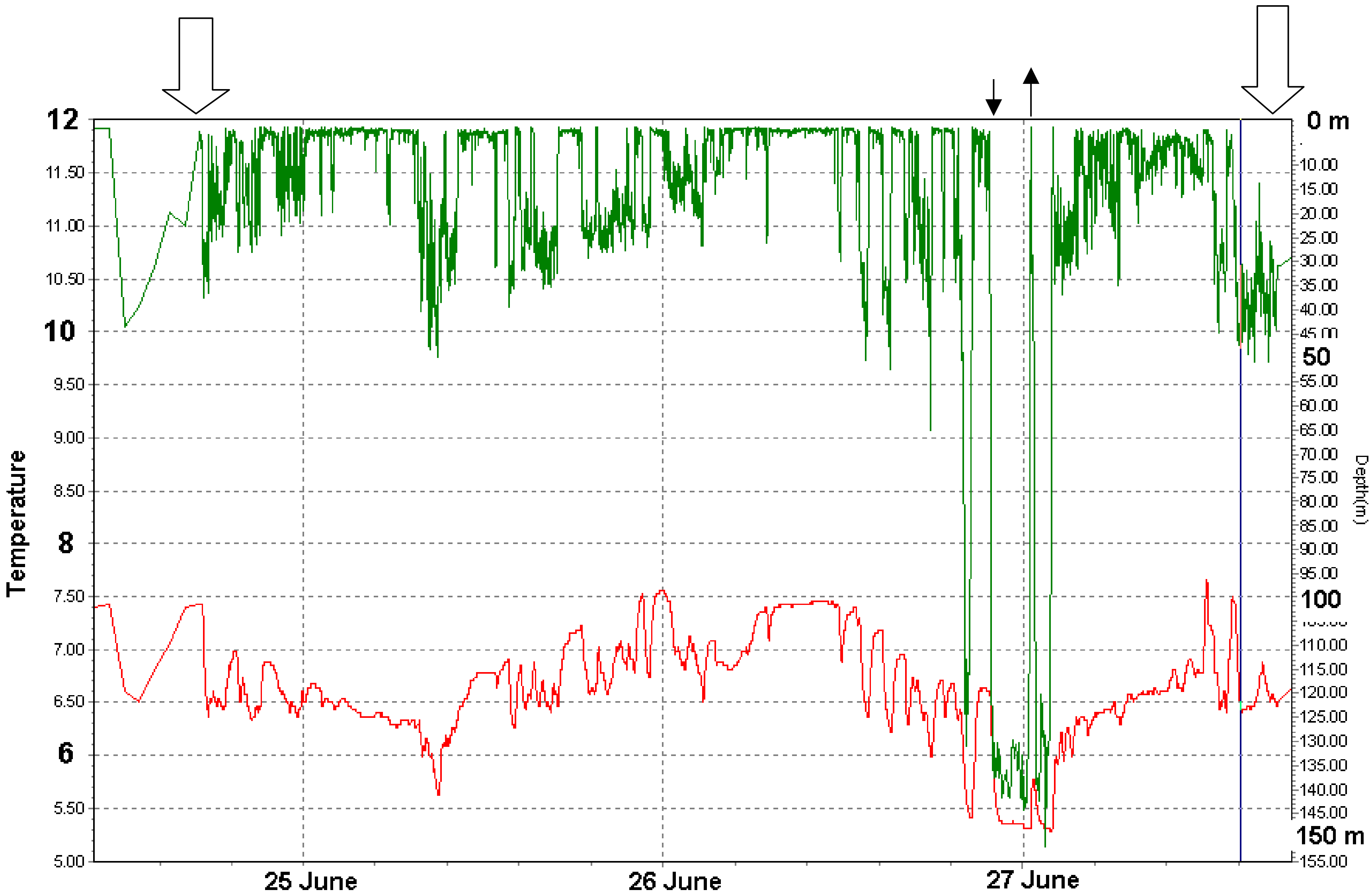

Figure 11 Detail from data records from R. Ätran. Data logged at 1 minute intervals between 24 June, 17:00 h- 27 June, 17:00 h (broad arrows). Before and after data were logged at 60 min intervals. Time for 3 h dive down to 145 m indicated in the graph. Other legends like previous graphs.