SC/59/RMP 6

Update on available data on surfacing rates of Northeastern Atlantic minke whales

NILS ØIEN, GJERMUND BØTHUN & LARS KLEIVANE

Institute of Marine Research, P.O.Box 1870 Nordnes, N-5817 Bergen, Norway
nils@imr.no

ABSTRACT

We present results from radio tagging of five minke whales in the Norwegian Sea and Svalbard areas and compare them to earlier radio-tagging and visual experiments to determine surfacing rates for use in estimation of abundance of minke whales in the Northeast Atlantic. While one of the whales was followed for less than 3 hours, the other four were followed over periods of 19-40 hours. They showed large individual variation in hourly blow rates, which is of the same order as variation between individuals, which spans the range 33-72 blows/whale/hour. The mean intersurfacing interval of 18 minke whales radio-tagged in Norwegian waters is 77.31 s, corresponding to a blow rate of 46.6 blows/whale/hour.

MINKE WHALES, RADIO-TAGGING, DIVING, SURFACING RATE, NORTHEAST ATLANTIC

INTRODUCTION

The methods used in Schweder et al. (1997) and Skaug et al. (2004) depend on availability of data on surfacing patterns of minke whales. Limited amounts of dive time data are available, and even these have been collected in several ways. In 1991 the *Ad Hoc Working Group on g(0)* discussed the use of dive time data (IWC, 1992) and expressed a preference for such data as collected from radiotracking experiments. While the group recognised that dive sequences from VHF tracking could include surfacings that would not normally be visible to an observer and thus result in a positive bias in estimates of g(0), this was prefered to visually derived dive time data. Problems with the latter could involve missed surfacings, combining surfacings from two or more whales and the short time period over which visual data usually have been collected (selection bias).

The Norwegian survey program to collect data for new abundance estimates of minke whales in regular intervals has materialized in annual partial surveys, which over six-year periods cover the relevant management areas in the Northeast Atlantic. The intention of collecting dive time data has been an integral part, as is also the intention during the current six-year program 2002-2007. Originally the hope was to use satellite linked instruments attached to minke whales with the potential to collect surfacing patterns over wider time frames, geographical areas and other covariates than is usually possible with VHF tracking. This proved to be an unsuccessful approach and therefore in 2000 and following years efforts have been directed to collecting surfacing data by means of VHF tracking only. Over the period 2003-2006 five minke whales have been VHF tracked.

METHODS

The tracking equipment was a combined solution of ATS (Applications Technology Satellites) instruments, and a line transect PC-GPS unit for downloading of signals. The ATS device included a receiver (R2100), a direction finder (Direction indicating display) and an antenna (Yagia antennas), while the PC-GPS unit was a special designed kit developed during the Norwegian line transect survey program. The radio-tags were built waterproof, with a frequency-range between 142,00 mHz and 143,00 mHz, and with a power supply of two times 3.2 V lithium batteries. The total weight of these units is approximately 120 grams each. The attachment of tags has been continuously modified during the surveys from two flies, to an umbrella design in order to function as an anchor-attachment to the blubber layer. All arrows were pre-creamed with an anti-bacterial substance, basimysin. The radio units were applied with the launching system ARTS (Arial rocket transmission system, Heide-Jørgensen *et al.* 2001).

VHF TAGGING OVER THE PERIOD 2003-2006

In Table 1 are summarised all VHF data collected in connection with the Norwegian marine mammal program, and Figure 1 shows the sampling localities. While data collected in 2002 and earlier have been presented and used in the estimation of minke whale abundance in the Northeast Atlantic, five new series collected over the period 2003-2006 are presented here.

In 2003, one minke whale, *mi-2003-01*, was VHF tagged on 5 August during the sightings survey west off Spitsbergen within loose ice belts forming bays which probably offered good feeding opportunities. The whale was followed for 24 hours and during this period the whale moved around within a circle of about 10 nautical miles.

In 2004 two minke whales were VHF tagged in the Vestfjorden area, northern Norway, on 2 and 3 September. The first whale, *mi-2004-01*was followed for nearly 3 hours, while the other whale, *mi-2004-02*, was followed for about 11 hours.

In 2006 two minke whales were tagged during the sightings survey. One, *mi-2006-01*, was tagged on 27 July off Storegga, western Norway, and followed for 16 hours over a distance of about 50 nautical miles. This individual seemed to be stressed by the tagging and appeared very active for the first 6 hours. The other, *mi-2006-02*, was tagged 4 August in Vestfjorden, northern Norway and followed for about 40 hours, and during that period moved around 80 nautical miles. This whale did not show any sign of disturbance under the tag attachment operation.

Characteristics like movement pattern, dive time frequencies and mean dive time over half-hour intervals throughout the tracking period are given in Figure 2.

DISCUSSION

Mean blow rates

In general, the mean blow rates calculated from the recent 2003-2006 data are not aberrant from those presented from previous radio tagging experiments in the northeast Atlantic (Table 1), although the blow rates calculated from *mi-2006-01* is at the upper end of the range. This animal was however evidently stressed through the tagging and may therefore not be representative for normal diving behaviour.

Joyce et al. (1990) describes radio tracking of a minke whale in coastal waters of Faxafloi, Iceland. This whale showed a surfacing rate of 66.59 blows/hour which is at the higher end of the range of the overall individual variation given in Table 1, which is 33-72 blows/hour.

If we look at visually derived blow rates, a mean surfacing rate for minke whales in Icelandic waters of 52.8 blows/hour have been found (Gunnlaugsson, 1989). For experiments in Norwegian waters, mean surfacing rates of 52.4 (Joyce et al. 1989) and 42.0 blows/hour (Øien et al. 1990) have been calculated. The range of individual blow rates was 16-66 blows/hour for the Norwegian data (Øien et al. 1990). This range compares well with the VHF data.

In addition to problems with visually collected dive time data mentioned earlier (IWC 1992), it has also been shown that minke whales may show responsive movements to survey vessels even at distances of several hundred meters (Palka and Hammond 2001).

Diurnal patterns

Folkow and Blix (1993) found that surfacing rates were significantly higher during day than night, when the whales appeared to sleep for approximately 3 hours. Their conclusions were based on data from the four whales mi-1991-01/02/03/04 in Table 1. A radio-tracked minke whale in coastal waters of Iceland also showed a significant difference between day and night; 60.35 blows/hour for daytime and 74.44 blows/hour for night time (Joyce et al. 1990). Our analyses indicate that there are structures in the data, for example that hour may affect dive times, however, the signals are not clear and analyses would probably benefit from having more covariate information like behaviour.

From experiments based on visual recording of dive patterns, Stockin et al. (2001) conclude that there are significant differences in surfacing rates both throughout the day (0900-1800) and throughout the year with the shortest surfacing intervals at noon and in the months of June and July. They found a total mean surfacing interval of 66.1 (SD 96.7, range 1-806s) which corresponds to a blow rate of 54.5 blows/hour which falls within the ranges from similar experiments. Stockin et al. (2001) do not give numbers for monthly surfacing intervals, but from their Figure 1 it may be derived that there is an approximate increase in their data of 10% in dive duration from July to August, but then a decrease of say 5% to September. They ascribed differences in surfacing intervals to be result of ecological changes such as different foraging strategies. It should be mentioned in this context that all the Norwegian dive time series, both VHF and visually recorded data, have been collected in waters also surveyed, while the study area of Stockin et al. (2001) appears to be non-representative of the habitats surveyed by Norwegian vessels as it is a rather shallow water habitat.

As mentioned above, the visually derived blow rates collected during and as part of the Norwegian sighting surveys both in time and location, do not show different patterns from those derived from VHF radio tracking experiments conducted in May, July, August and in early September.

ACKNOWLEDGMENT

We would like to thank RESTECH for an excellent cooperation during the development of the launching and instrumentation system ARTS (Arial Rocket Transmitter System). This research has received funding from the Norwegian Research Council.

REFERENCES

Folkow, L.P. and Blix, A.S. 1993. Daily changes in surfacing rates of minke whales (*Balaenoptera acutorostrata*) in Norwegian waters. *Rep.int.Whal.Commn 43:311-314.*

Gunnlaugsson, Th. 1989. Report on Icelandic minke whale surfacing rate experiments in 1987. *Rep.int.Whal.Commn 39:435-436*.

Heide-Jørgensen, M.-P., Kleivane, L., Øien, N., Laidre, K.L. and Jensen, M.V. 2001. A new technique for deploying satellite transmitters on baleen whales: Tracking a blue whale (*Balaenoptera musculus*) in the North

Atlantic. *Marine Mammal Science 17(4):949-954.*

International Whaling Commission. 1992. Annex L. Report of the *Ad Hoc* Working Group on g(0). *Rep.int.Whal.Commn 42: 252-258*.

Joyce, G.G., Øien,N., Calambokidis, J. and Cubbage, C. 1989. Surfacing rates of minke whales in Norwegian waters. *Rep.int.Whal.Commn 39:431-434.*

Joyce, G.G., Sigurjónsson, J. and Vikingsson, G. 1990. Radio tracking a minke whale (Balaenoptera acutorostrata) in Icelandic waters for the examination of dive-time patterns. *Rep.int.Whal.Commn 40:357-361*.

Øien, N., Folkow, L. and Lydersen, Chr. 1990. Dive time experiments on minke whales in Norwegian waters during the 1988 season. *Rep.int.Whal.Commn 40:337-341*.

Palka, D.L. and Hammond, P.S. 2001. Accounting for responsive movement in line transect estimates of abundance. *Can.J.Fish.Aquat.Sci. 58:777-787*.

Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep.int.Whal.Commn 47:* 453-483.

Skaug, H.J., Øien, N., Bøthun, G. And Schweder, T. 2002. Abundance of northeastern Atlantic minke whales for the survey period 1996-2001. *Paper SC/54/RMP5, IWC Scientific Committee, April 2002.*

Skaug, H.J., Øien, N., Schweder, T. and Bøthun, G. 2004. Abundance of minke whales (*Balaenoptera acutorostrata*) in the Northeastern Atlantic. C*anadian Journal of Fisheries and Aquatic Sciences, 61:*870-886

Stockin, K.A., Fairbairns, R.S., Parsons, E.C.M. and Sims, D.W. 2001. Effects of diel and seasonal cycles on the dive duration of the minke whale (Balaenoptera acutorostrata). *J.Mar.Biol.Ass.U.K. 81:189-190.*

Table 1

Mean intersurfacing intervals and blow rates for the VHF radio tracking data collected in connection with the program for abundance estimation of Northeast Atlantic minke whales. The mid part of the ID number indicates the year of collection of the data. Total mean is based on data collected in Beaufort ≤ 4, where applicable. *Small Management Area* locations for the VHF experiments are given in the last column (*SMA*).

ID	*Intersurfacing interval, s*	*SD*	*Min*	*Max*	*Blows/whale/hour*	*SMA*
mi-1989-01	83.47	9.64	10	404	43.13	EW
mi-1989-02	72.08	2.56	7	505	49.94	EW
mi-1991-01	63.03	7.92	7	381	57.12	EW
mi-1991-02	84.12	3.66	7	394	42.8	EW
mi-1991-03	89.43	5.54	5	550	40.25	EW
mi-1991-04	75.51	10.20	10	340	47.68	EW
mi-1992-01	54.66	3.47	6	230	65.86	ES
mi-1992-02	81.41	2.10	7	463	44.22	ES
mi-2001-01	66.85	5.5	4	385	53.85	EW
mi-2001-02	99.21	2.09	4	480	36.29	EW
mi-2002-01	58.88	4.6	2	262	61.14	EN
mi-2002-02, all data	71.56	1.8	4	502	50.31	EW
mi-2002-02, Beau ≤ 4	72.9	1.8	1	502	49.91	EW
mi-2002-03	122.67	3.6	4	534	29.35	EW
mi-2002-03, Beau ≤ 4	107.5	9.9	9	410	33.49	EW
mi-2003-01	**59.40**	**2.09**	**1**	**398**	**60.61**	**ES**
mi-2004-01, all data	**77.10**	**7.51**	**5**	**335**	**46.69**	**EW**
mi-2004-02	**88.17**	**5.13**	**1**	**572**	**40.83**	**EW**
mi-2006-01	**50.10**	**1.75**	**1**	**372**	**71.86**	**EW**
mi-2006-02, all data	81.92	2.13	3	602	43.94	EW
mi-2006-02, Beau ≤ 4	**88.30**	**2.69**	**3**	**560**	**40.77**	**EW**
MEAN of estimates	**77.31**	**1.6**			**46.57**	

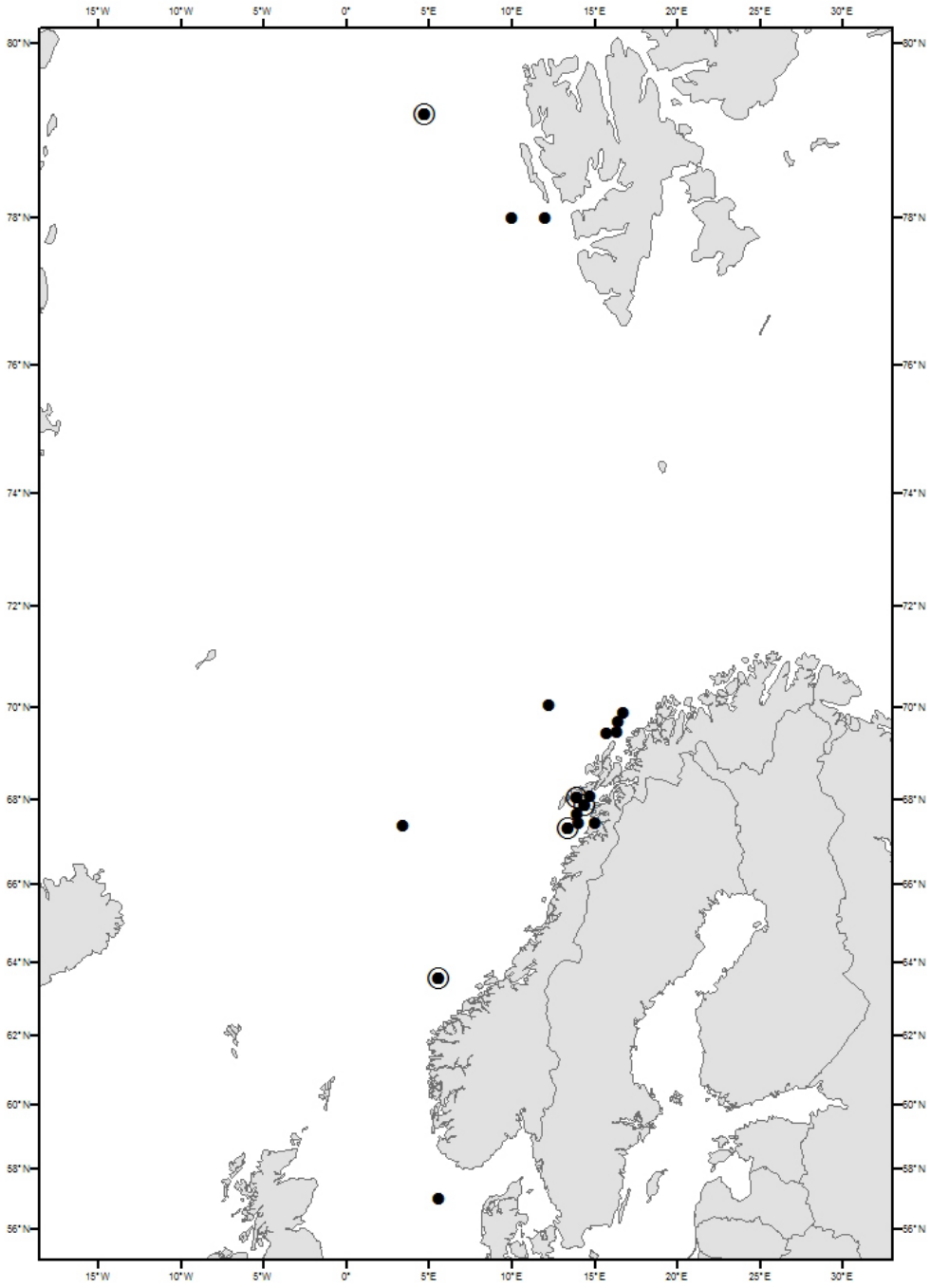
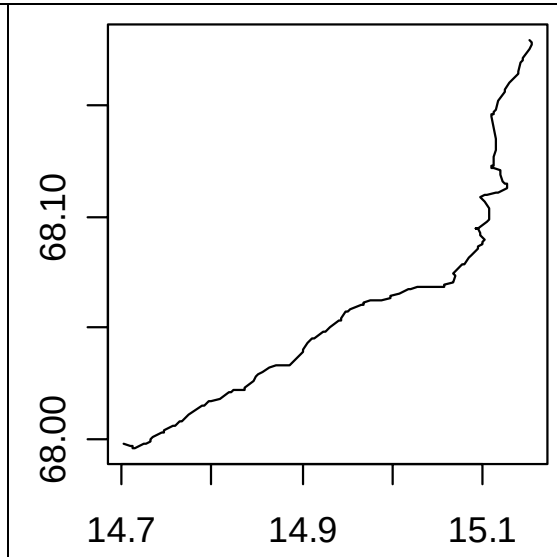
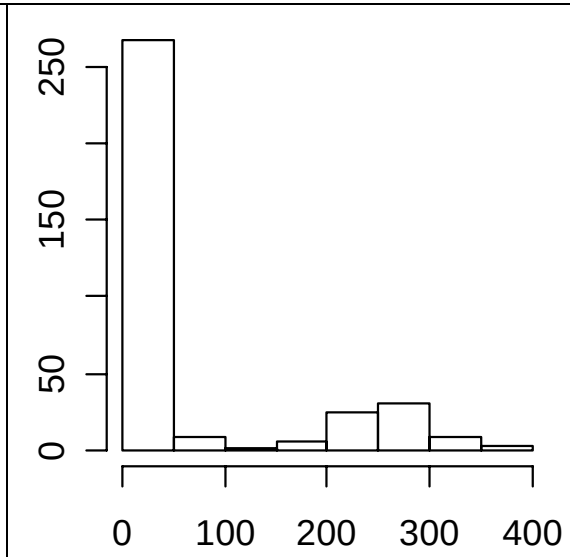
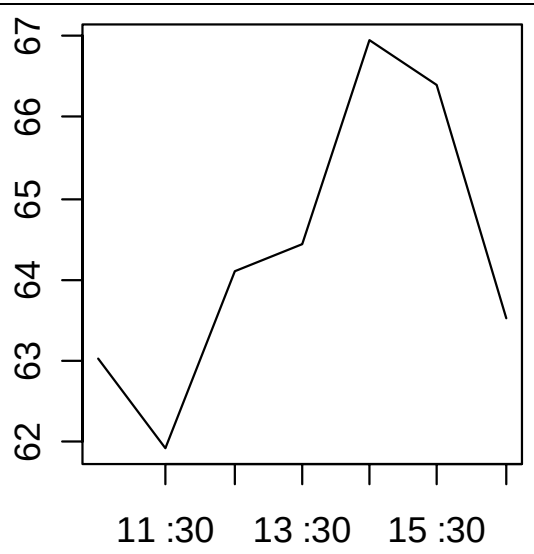
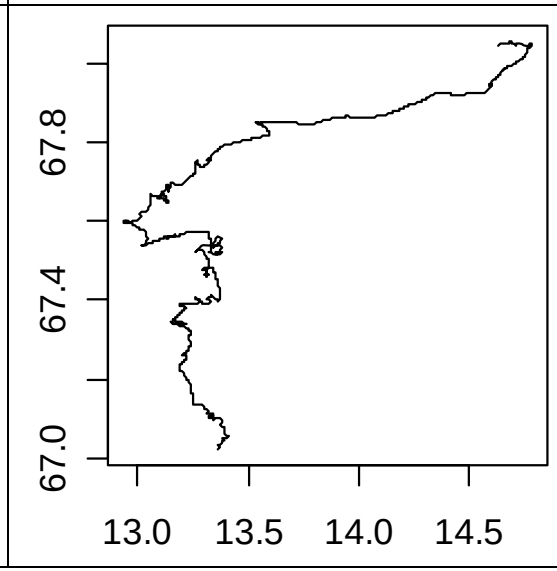
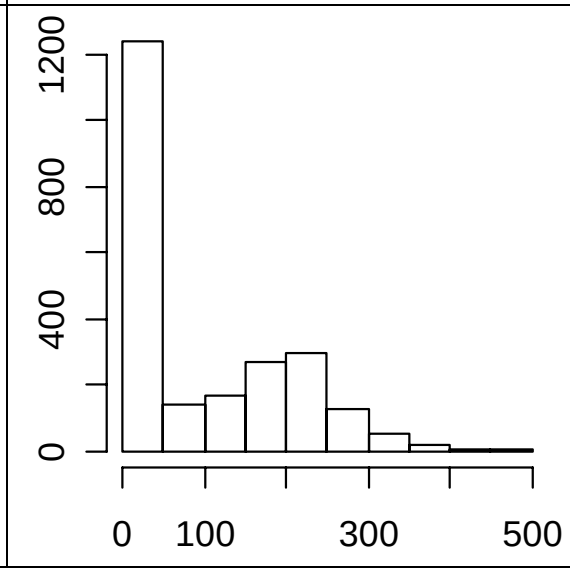
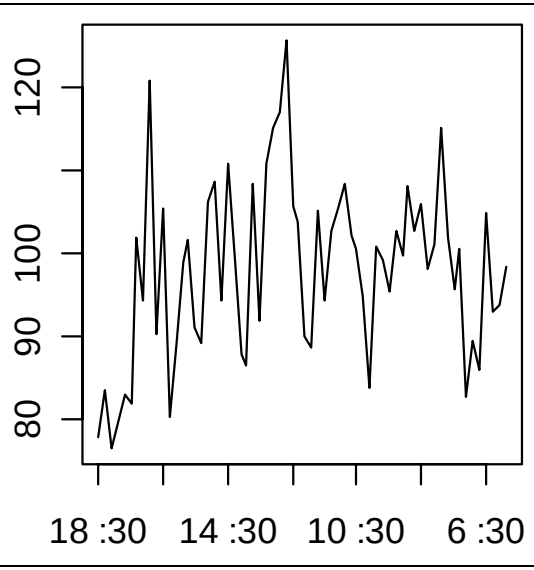
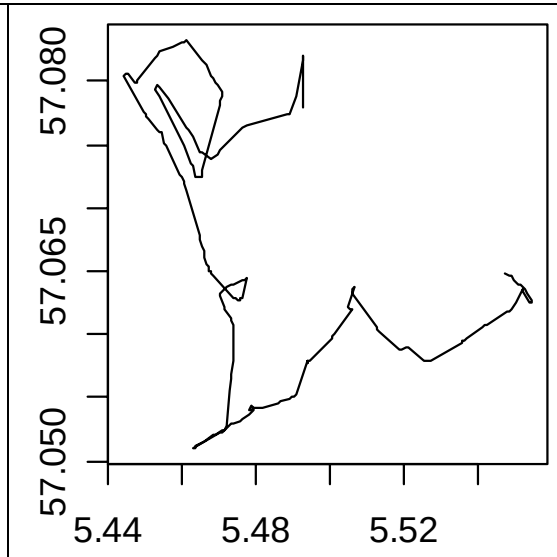
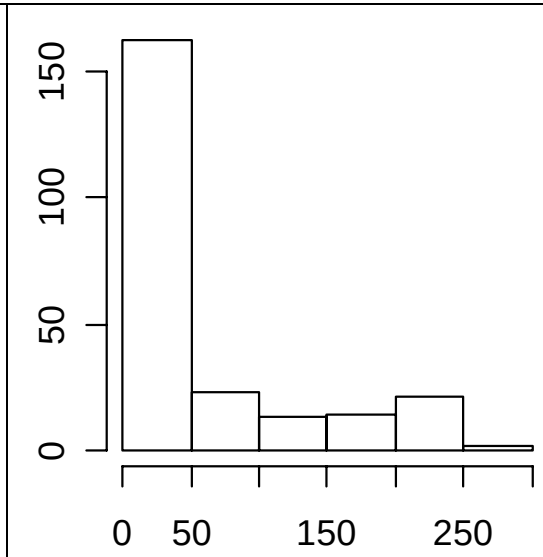
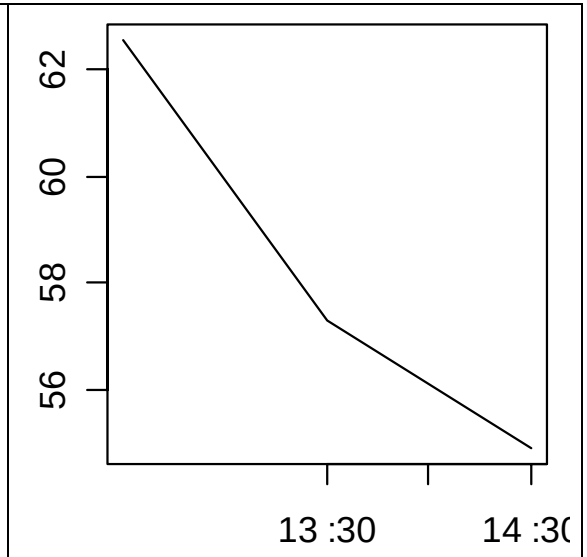
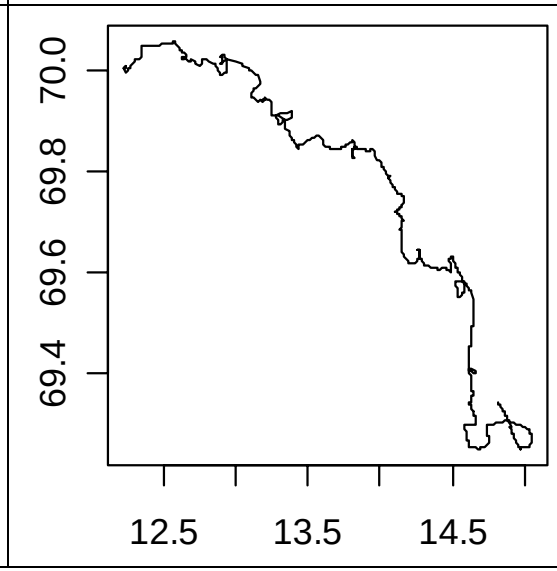
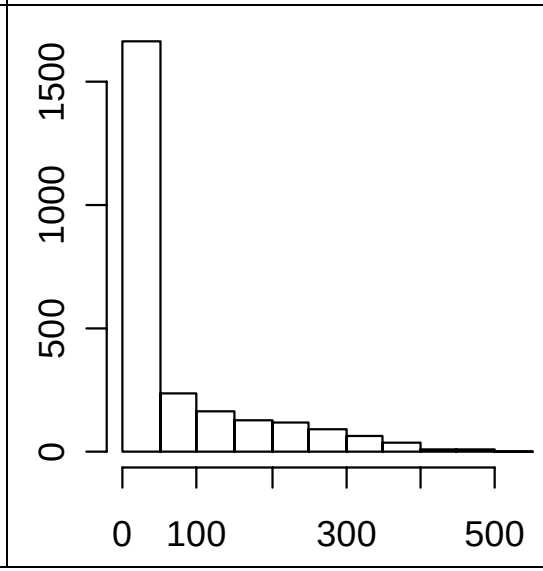
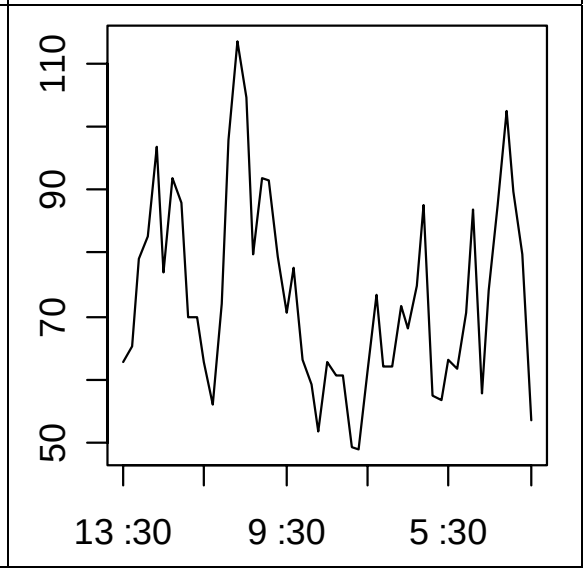
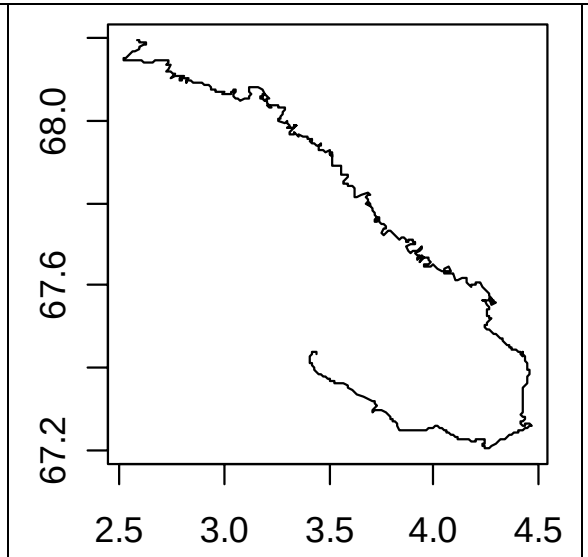
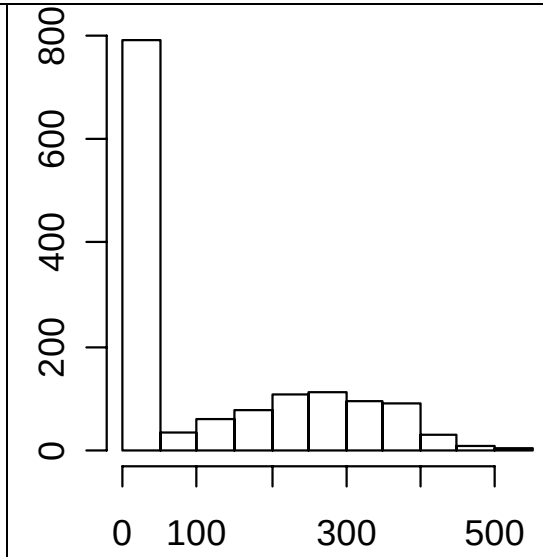
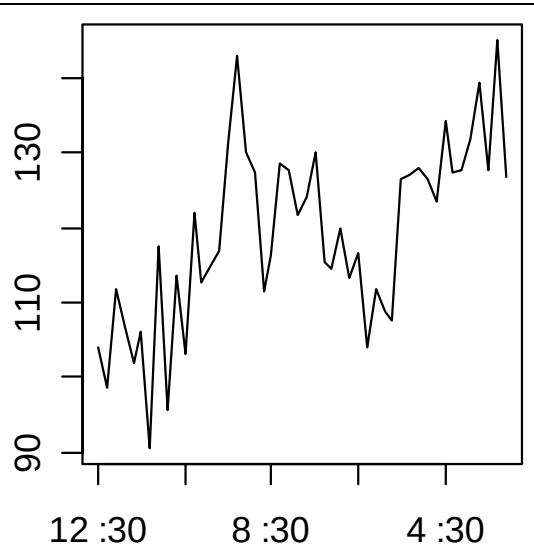
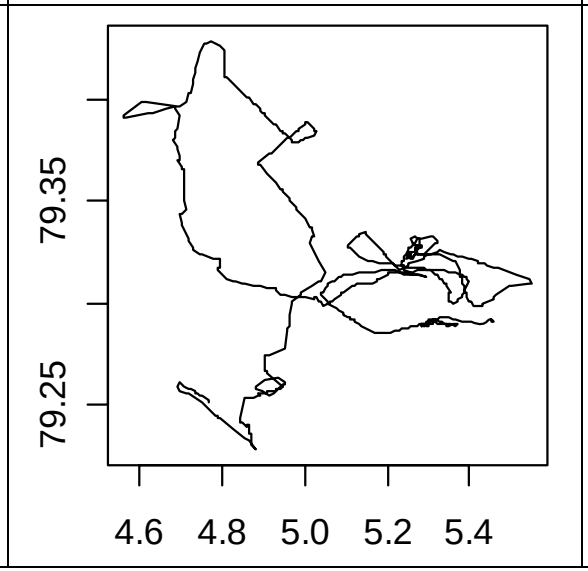
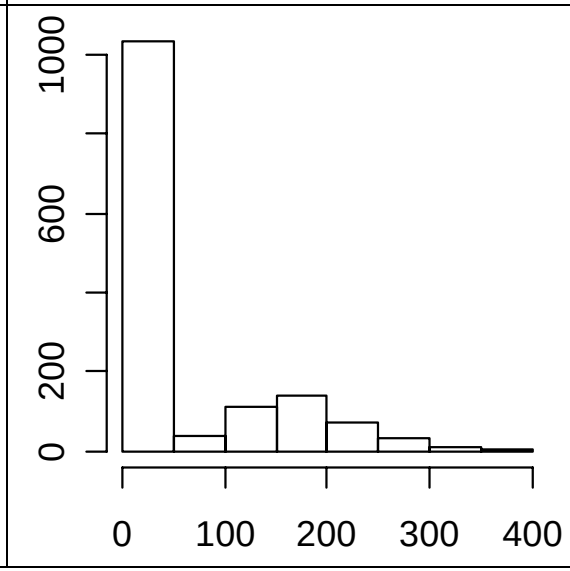
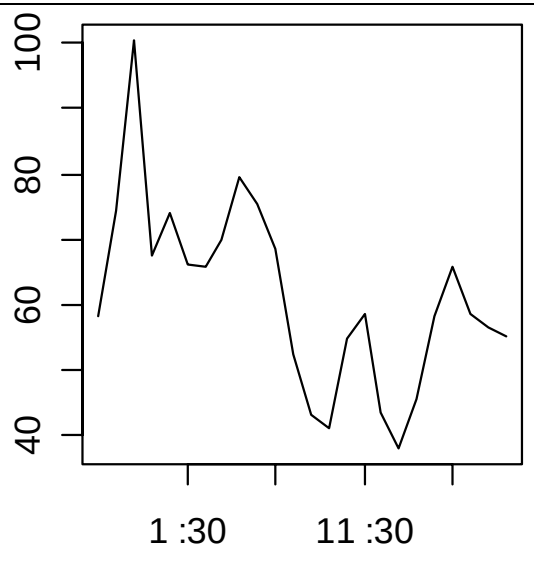


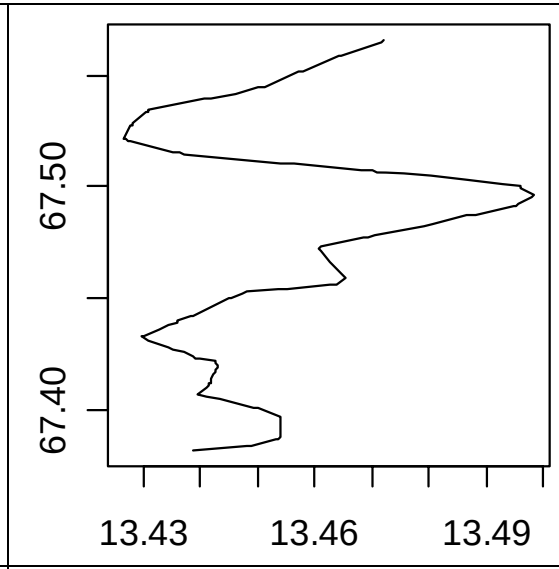
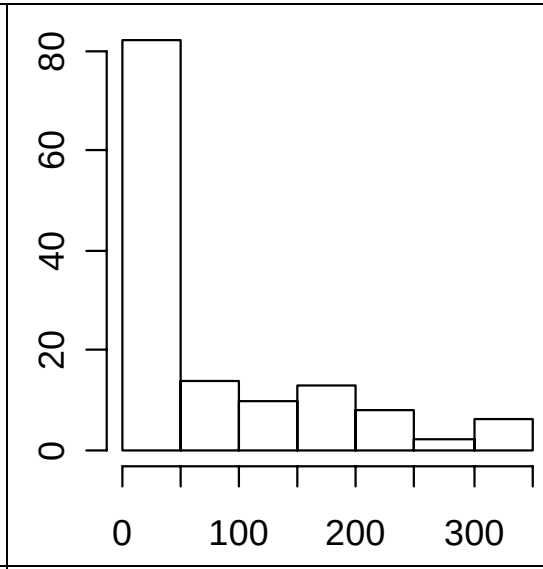
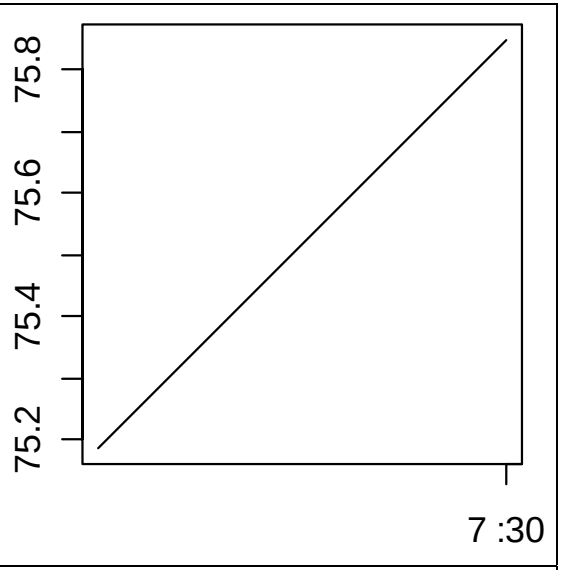
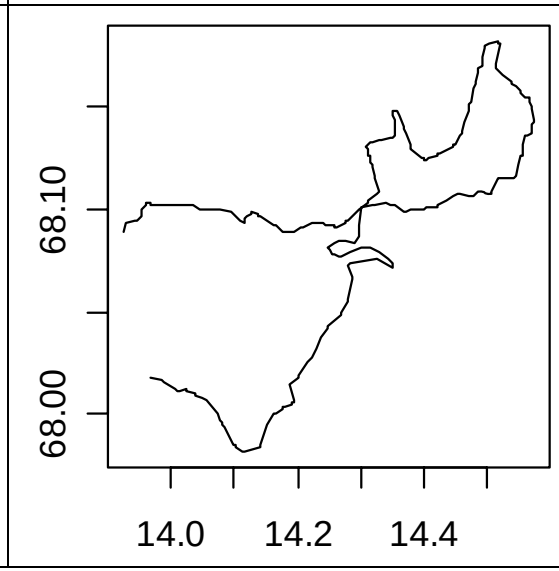
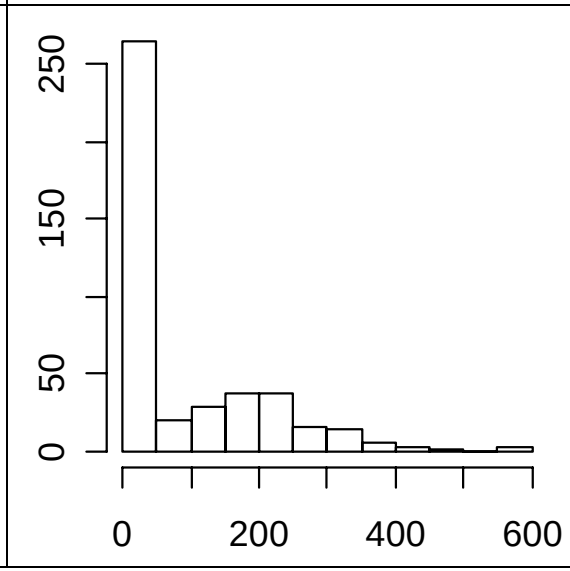
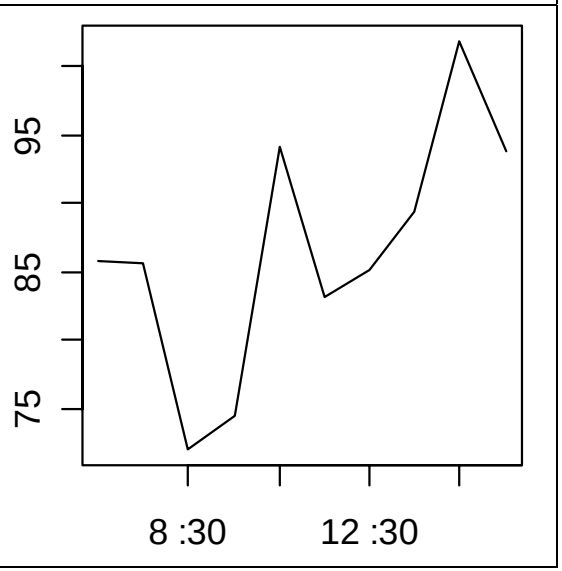
Figure 1. Sampling locations for all minke whales listed in Table 1. The large circles represent the minke whales VHF tagged over the period 2003-2006.

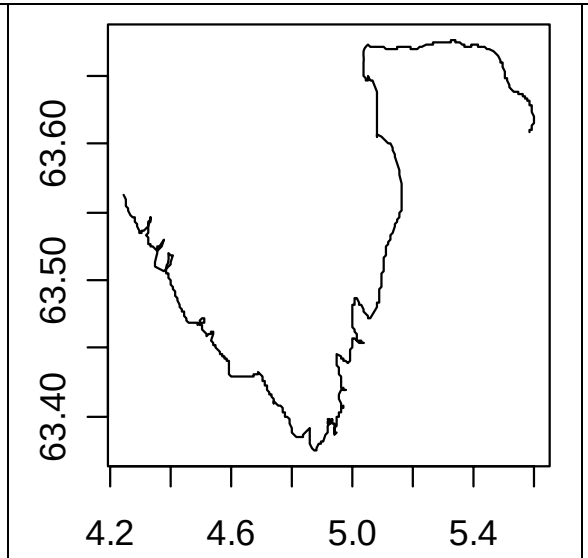
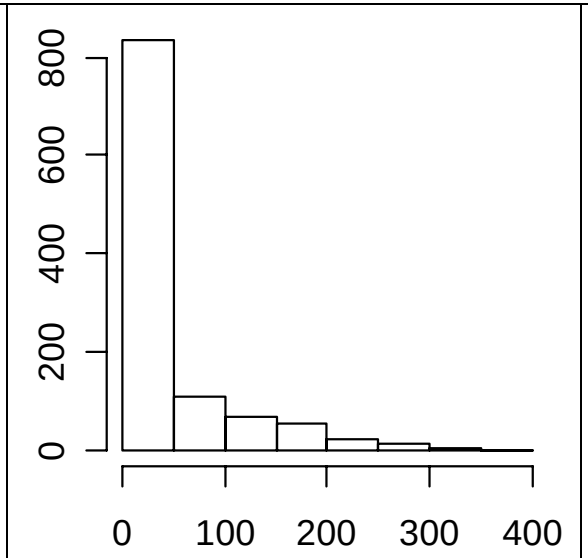
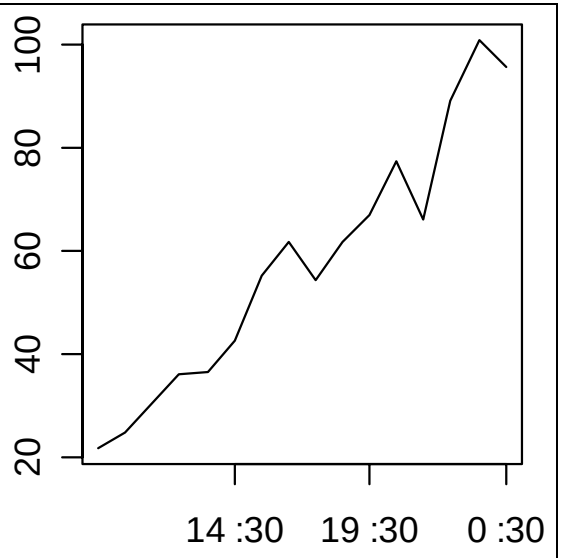
Figure 2. The following panels show for each of the ten minke whales VHF tagged over the years 2001-2006: The track of the vessel which followed the radio tagged minke whale (*left panel*); The frequency distribution of dive times (*mid panel*); and Mean dive times calculated over half-hour intervals (*right panel*).

Mi2001-01 Jarl2			
Mi2001-02 Jarl3			

Mi2002-01 Senet			
Mi2002-02 Art1			

Mi2002-03 Art2			
Mi2003-01 Wirko			

Mi2004-01 Zeta			
Mi2004-02 Boy			

Mi2006-01 Tuva			
Mi2006-02 Marie