Appendix A: SMRU phone tag overview

Background

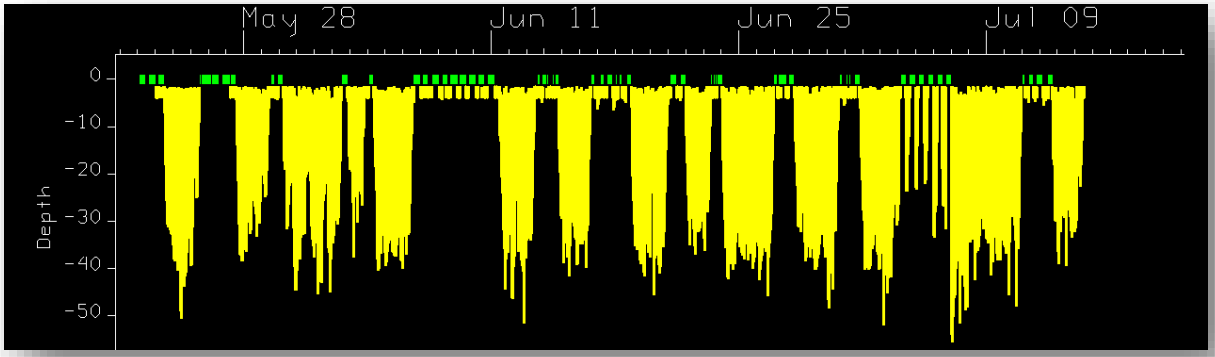
The Sea Mammal Research Unit began making tagging devices to relay data about the position of marine mammals in the late eighties. The first tags used the Argos satellite system, which offers global coverage but extremely low bandwidth (one 32-byte messages per minute, simplex). Finding out where an animal goes quickly raises more questions about why it has gone there and what it is doing, so several sensors have been added to the package over the years (depth, temperature, salinity, chlorophyll, acceleration, etc.).

We began to use the mobile phone system in 2004, in partnership with Vodafone and Siemens Mobile. Many marine mammals do not spend enough time in mobile coverage for these tags to be suitable, but for animals which are expected to range within about 30 km of populated coastal areas these tags offer much greater data throughput. We now supply about 150 such tags per year to researchers in many countries:

- UK / Ireland
- Netherlands / Germany
- Denmark / Sweden
- USA (Hawaii, Oregon, California)
- France
- Norway
- Estonia
- Australia
- Finland
- Kazakhstan (Caspian Sea)
- Brazil
- Canada (Newfoundland)

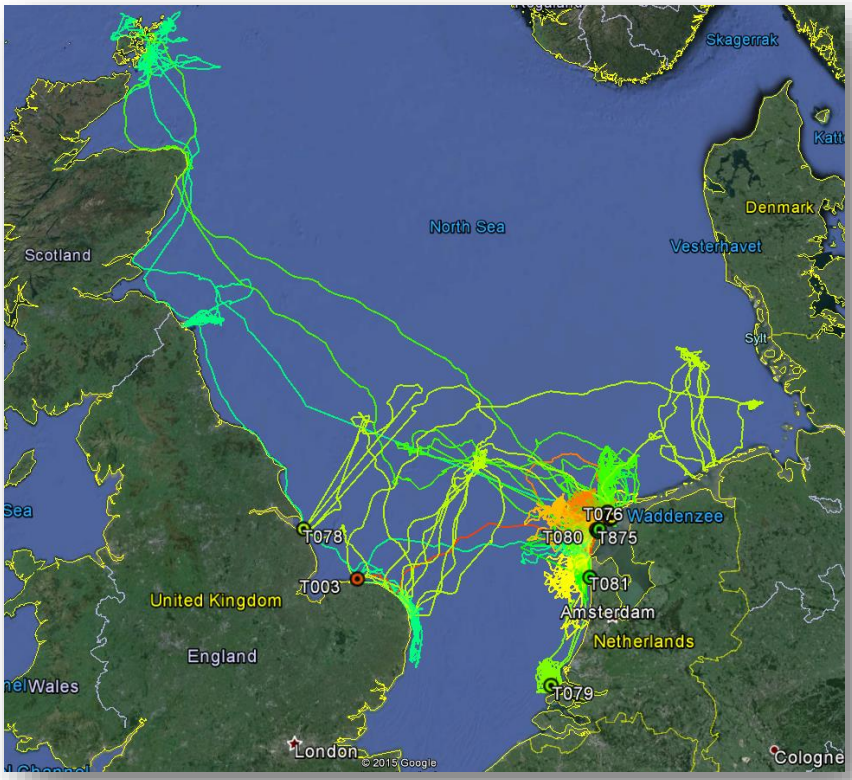
Movement

Seal behavior varies according to the species, life stage and gender of the animal, but can be summarized as a sequence of trips to the open sea interspersed with shorter intervals spent on land (“haulouts”).



Typical depth vs time profile: yellow lines show diving, green blocks are haulouts (>10 mins dry)

The characteristics of these trips vary: on a typical foraging trip a seal may spend five days at sea and then return to the coast for a few hours; there is also directed travel from A->B, e.g. many seals tagged on the UK North Sea coast make long trips to the Netherlands/German coast; juvenile seals may spend much longer periods at sea, visiting several different coastal sites in succession.

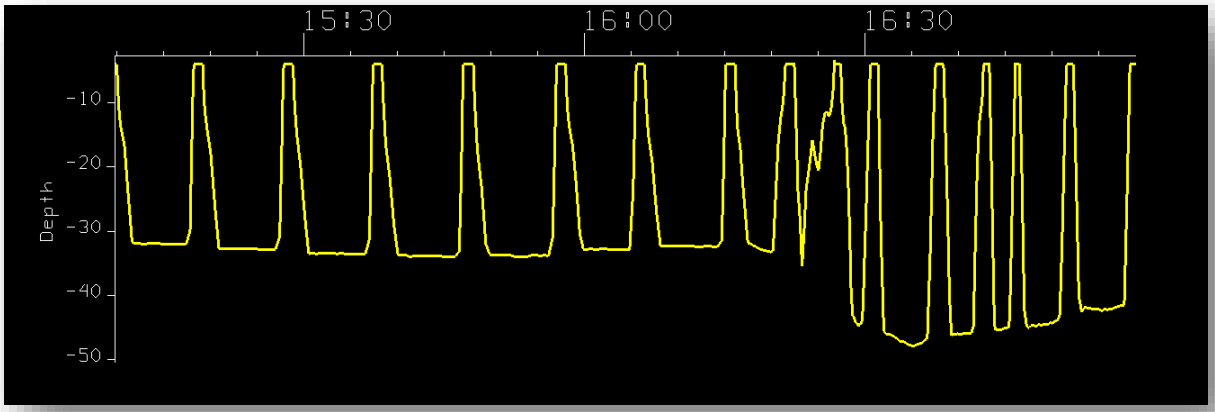


Seals' annual cycle also tends to include a period of a few weeks where they spend much longer periods hauled out on land for moulting or breeding. Tags fall off with the fur at the annual moult.

At sea behaviour

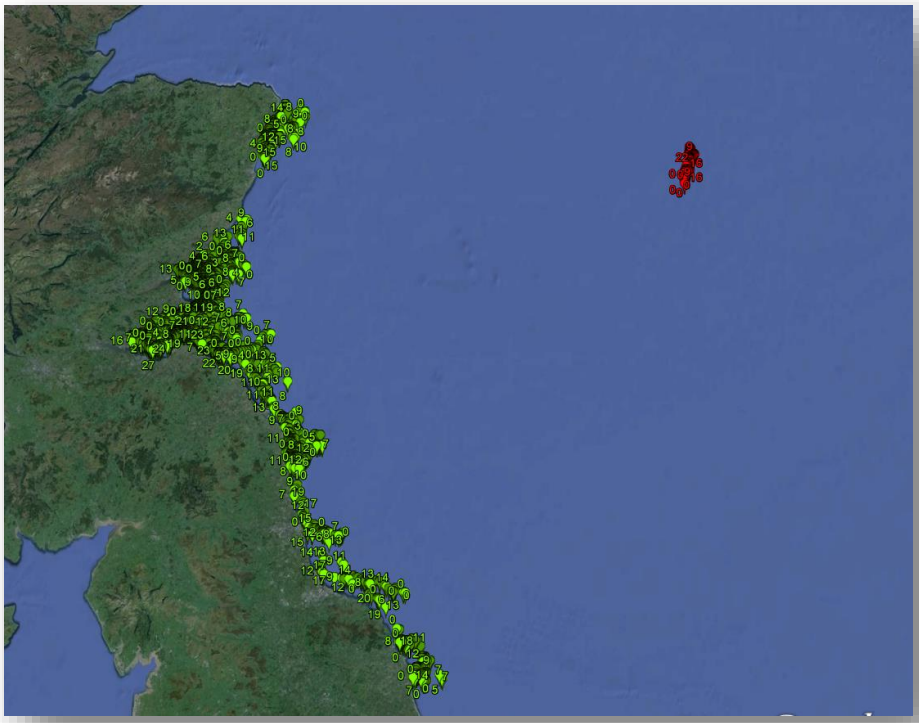
Seals spend most of the time underwater, descending to a depth of 20 – 500m and returning to the surface every 5-40 minutes to breathe. The surface period typically

lasts a few minutes, during which time the antenna is subject to wave wash.



Seals spend little time at the surface

We have found that it is possible to connect and send SMS messages during these surface intervals, but more substantial data relay is very rarely successful.



SMS messages received from 10 tags deployed at the Firth of Forth. The messages shown in red are from a Telenor station on a Norwegian oil rig.

Current GSM system

Components: Gemalto/Cinterion BGS2 module; custom GPS module (post-processed snapshot – tag does not know where it is); depth, temperature, wet/dry sensors GSM/GPRS (2G only).

Quad-band antenna (850/950/1800/1900 MHz).

Lithium primary cell 3.6V for maximum energy density. Requires HLC (hybrid layer capacitor) to deliver pulse currents without voltage sag.

Microcontroller samples approx. 120kB of sensor data per day. This is compressed to approximately 60 kB per week which is stored for subsequent transmission. SMS provide opportunistic position update and diagnostics information. FTP is used for bulk data transfer (120kB per fortnight). Maximum call duration is about 5 minutes – the primary cell requires several hours' recovery time between calls. However, the main constraint on data volume is cell capacity (6Ah). About 25% of the available energy is used on transmission, the remainder on data collection (mostly GPS). The target lifetime is 6-10 months.

SIMs

M2M Vodafone. Whilst official support is available from Vodafone, it is necessary to understand how data are routed using 2, 3, and 4G systems to assist in tackling problems, especially when roaming.

Future system

Module: Sierra Wireless Airprime HL8548 (3G, LTE– simulation of foreign systems?)
Penta-band antenna (enclosure design tools? - simulation of foreign frequencies?)

Other developments

FTP to be replaced with HTTP POST; SIM-on-chip; Portable basestation; Conventional A-GPS (SirfStarV – requires 11kB per day upload); Non-standard/multiple systems (Japan, Canada).