

H. Bornemann⁽¹⁾, M. Schröder⁽¹⁾, A.R. Carlini⁽²⁾, P.J.N. de Bruyn⁽³⁾, R.R. Reisinger⁽³⁾, T. McIntyre⁽³⁾, C.A. Tosh⁽³⁾, M.N. Bester⁽³⁾, S. Frickenhaus⁽¹⁾ & J. Plötz⁽¹⁾

Hot spot foraging depths of southern elephant seal males at the Filchner Trough outflow, Southern Weddell Sea

Background & Objectives

The Filchner Trough outflow (77°S, 36°W) is considered a “hot spot” in terms of biology and oceanography. The factors contributing to this area of dependable food supply and its relation to physical processes are yet unknown. Satellite telemetry data of adult male southern elephant seals, tagged in 2000 provided new insights into the seals' foraging depths at the Filchner Trough and elucidated the distribution of potential prey in relation to oceanographic features on-site. A follow-up study in 2010 is presently investigating if males continue exploring the same area. The project involves scientists from South Africa, Argentina, and Germany in synoptic tasks at Marion Island and King George Island / Isla 25 de Mayo.

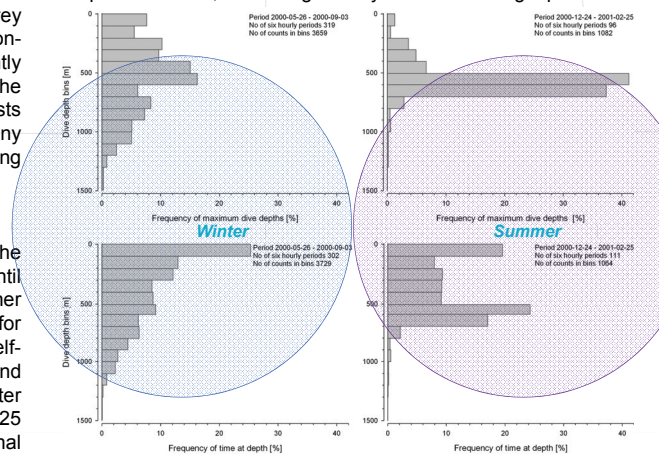
Movements

Three post-moult males travelled along the eastern shelf margin of the Peninsula until they reached the region of the Filchner Trough at around 75°S. **Male 09** stayed for 102 days in a localized 100km-wide shelf-slope area flanked by Berkner Bank and Akademik Fedorov Canyon, facing winter sea ice concentrations of up to 100%. On 25 Aug **Male 09** headed again to the north; final locations were fixed at South Georgia on 23 Oct. **Male 10** moved more off-shelf to the South, matching the return path of **Male 14**; transmissions stopped prematurely on 30 May. The route of **Male 14** appeared to be quite similar to that of **Male 09**; it arrived 26 May, and remained for 100 days before heading back to King George Island on 3 Sep. It embarked on a post-breeding trip on 24 Nov remaining for 63 days (24 Dec - 25 Feb) in a coastal polynya easterly of its post-moult trip. Transmissions ended on 20 Mar 2001^{a)}. Preliminary results from tags deployed on adult males on King George Island in April 2010 indicate that some seals have reached the area off Larsen Ice Shelf yet, exploring water masses there and along the South Orkneys originating from both, the Larsen Ice Shelf and Filchner Trough.

Dive depths

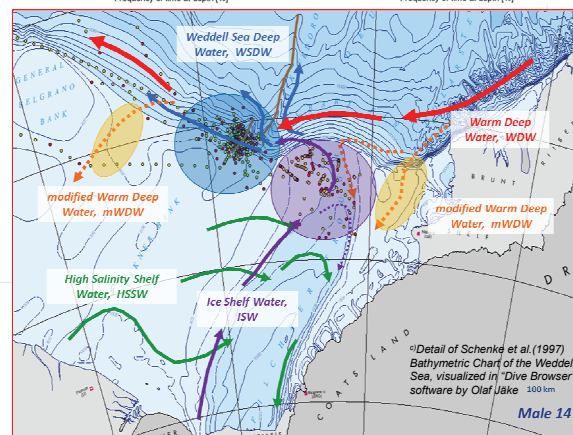
Hot spot foraging depths of **Male 14** are spread over the full capacity of the satellite tag's pressure transducer (0 - 1500 m). The frequency distributions indicate a slight mode at depths between 400 and 600 m in winter, and a dominating mode between 500 and 700 m in summer. Both distributions reflect the spectrum of seafloor depths in the respective areas, indicating mainly benthic-

demersal feeding. Winter dive depths correspond with varying slope depths, and are thus more evenly distributed. The stronger mode in summer dive depths results from the trough-shaped bottom topography, with dives being concentrated at sill depths. Deeper dives (> 800 m) are mainly seen in winter; shallower dives (< 300 m) show a night preference throughout the year^{b)}.



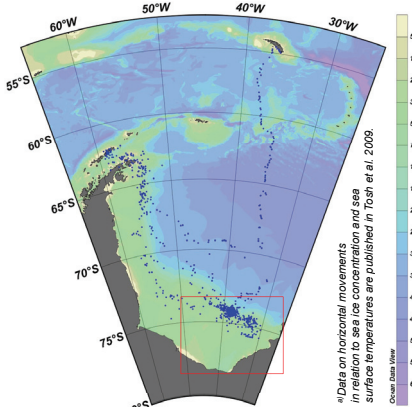
Distribution of maximum dive depths (above) and exploited depths (below – as proportion of time spent at these depths) in winter (left) and summer (right) of **Male 14** equipped with WildLife Computers SDR T-6 at King George Island / Isla 25 de Mayo in April 2000.

Colouring corresponds with the circled areas on the bathymetric chart^{c)} below, denoting winter and summer foraging of elephant seal **Male 14** at two neighbouring areas along the outflow of the Filchner Trough. Adjacent ellipsoids indicate movements of Weddell seals tracked by Nicholls et al. 2008.



^{b)}Results from Canonical Correspondence Analyses (CCA)

Weddell Sea Deep Water as a result of mixing of **WDW**, **mWDW**, **ISW**, **HSSW**
Warm Deep Water, cold, relatively low in salinity – freezing of sea ice, low amount of ice shelf water
modified Warm Deep Water warm, salty – part of the ACC, heat source
Ice Shelf Water very cold, relatively salty – meltwater of the ice shelves
High Salinity Shelf Water cold, very salty – freezing of sea water, salt accumulation
WDW, **mWDW**, **ISW**, **HSSW** contribute generating **WSDW**, **WSBW**, **AABW** (see text).



ARGOS locations of three adult male southern elephant seals highlight the region of the Filchner Trough outflow (□), Southern Weddell Sea, 2000.

Oceanography

Three seals preferred the steep continental slope areas far south in the Weddell basin. Here the southern branch of the Weddell Gyre meets the Filchner Trough outflow, which, together with the uneven bathymetry, causes intensive mixing of the contributing water masses. The particular region utilized by the males corresponds closely with the region identified by Foldvik et al. (2004) as being important for the production of dense water masses of the Weddell Sea. The production of both Weddell Sea Deep Water (WSDW) and Weddell Sea Bottom Water (WSBW) is of substantial importance for the export of Antarctic Bottom Water (AABW), the water body along which cold, dense and oxygenated water is exported from the Antarctic into the world oceans. This area is also characterized by elevated trace element

concentrations dissolved from the shelf ice into the Ice Shelf Water (ISW). This water mass is transported to the north through the Filchner Trough into the Weddell Gyre circulation system where it is heavily mixed within the Antarctic Slope Front.

The Filchner Trough outflow is one of, if not the only, steady annual source of dense shelf waters that is responsible for the deep and bottom water formation in the Weddell Sea. The results indicate relationships between physical and biological processes, and show that not all parts of the shelf are biologically similar. An enhanced availability of nutrients supplied by the Filchner outflow and, in turn, a dependable supply of prey for seals is hypothesized.

(1) Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft www.awi.de

(2) Instituto Antártico Argentino Dirección Nacional del Antártico www.dna.gov.ar

(3) Mammal Research Institute University of Pretoria www.up.ac.za

References
Foldvik A, Gammelsrød T, Østerhus S, Fahrbach E, Rohardt G, Schröder M, Nicholls K W, Padman L, Woodgate RA (2004) Ice shelf water overflow and bottom water formation in the southern Weddell Sea. *Journal of geophysical research*, 109, C02015, doi:10.1029/2003JC002008
Nicholls KW, Boehme L, Bluw M, Fedak MA (2008) Wintertime ocean conditions over the southern Weddell Sea continental shelf, Antarctica. *Geophysical Research Letters* 35, L21605, doi:10.1029/2008GL035742
Schenke HW, Dijkstra SJ, Niederjasser F, Schöne T, Hirze H, Hippmann B (1997) Bathymetric Chart of the Weddell Sea. doi:10.1594/PANGAEA.708891
Tosh CA, Bornemann H, Ramdohr S, Schröder M, Martin T, Carlini AR, Plötz J, Bester MN (2009) Adult male southern elephant seals from King George Island utilize the Weddell Sea. *Antarctic Science*, 21 (2), 113-121, doi:10.1017/S0954102008001557