

Bornemann, H., Steinhage, D., Oosthuizen, W.C., Bester, M.N. (2015). Seal survey at the Filchner Outflow System (SEAFOS) with research aircraft *Polar 6* during campaign FIL2014

<b>Aircraft</b>	Basler BT-67 <i>Polar 6</i>
<b>Altitude</b>	600 feet
<b>Speed</b>	140 knots
<b>Ground speed</b>	72 m s <sup>-1</sup>
<b>Transect spacing</b>	37 km between survey boxes

*SEAFOS census strip-widths*

<b>Flight</b>	<b>Flight transect</b>	<b>Direction</b>	<b>Census strip-widths</b>
2013-11-15	Transit Halley-Z	West	296.02 – 1020.13
	Transect Z-A	North	308.66 – 373.64
	Connect A-B	East	350.70 – 363.03
	Transect B-C	South	308.68 – 376.09
	Connect C-D	East	318.03 – 402.29
	Transect D-E	North	329.03 – 378.31
	Connect E-F	East	360.70 – 372.79
	Transect F-G	South	347.85 – 376.96
	Connect G-H	East	358.47 – 359.41
	Transect H-I	North	361.28 – 382.25
	Connect I-K	East	363.87
	Transect K-L	South	348.04 – 396.79
	Transit L-Halley	East	No seal images
2013-11-16	Transit Halley-1	West	605.32 – 1031.63
	Transect 1-2	South	349.01 – 417.24
	Connect 2-3	East	349.78 – 368.16
	Transect 3-4	North	347.80 – 445.88
	Connect 4-5	East	352.22 – 417.68
	Transect 5-6	South	351.61 – 385.65
	Connect 6-7	East	358.77 – 365.51
	Transect 7-8	North	364.28 – 384.95
	Connect 8-9	East	343.66 – 363.98
	Transect 9-10	South	328.80 – 362.18
Transit 10-Halley	East	806.03 – 1057.35	

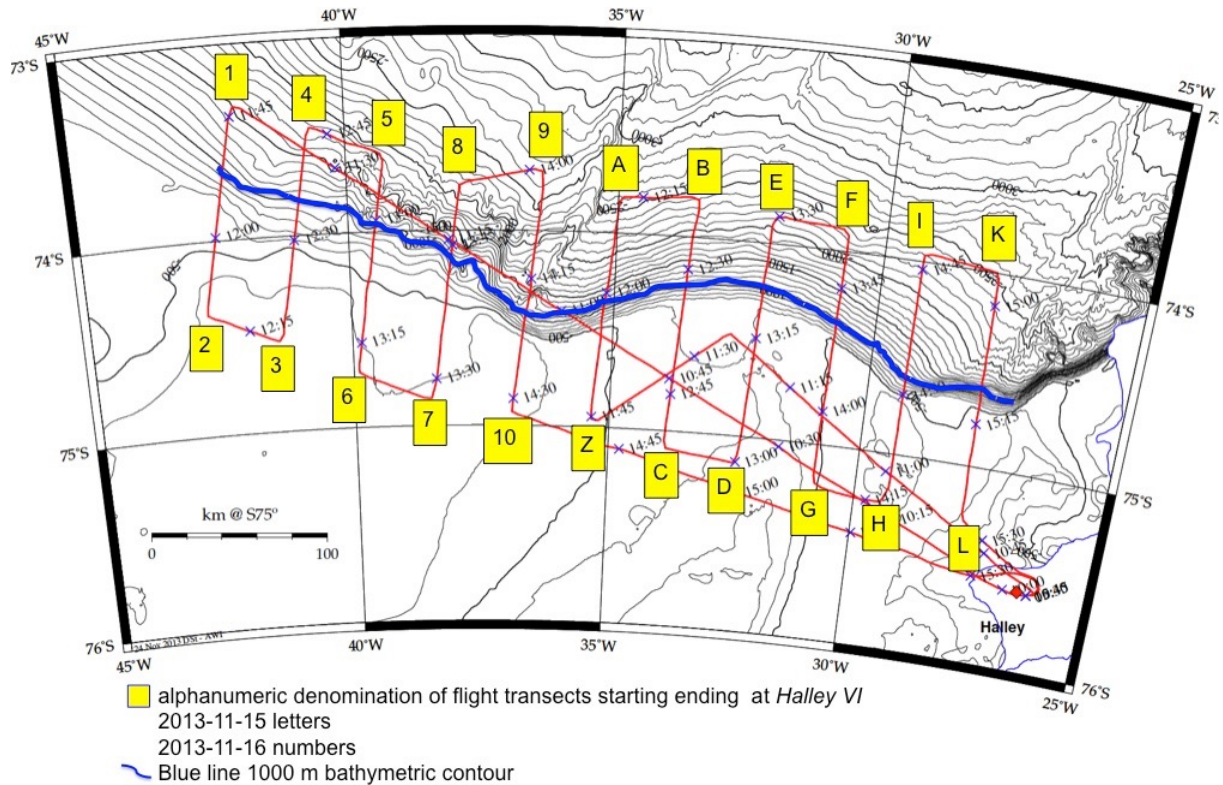


Fig. 1: Flight plan of transects flown by *Polar 6* on 15 and 16 November 2013

#### Labelling of special parameters

The following formulas were used to calculate special parameters (Excel):

**Strip width [m]**  $((\text{TAN}(40.5 \cdot \text{PI}()/180)) \cdot \text{Altitude}) \cdot 2$

**Distance [km]**  $\text{ARCCOS}(\text{SIN}(\text{Lat\_start\_transect} \cdot \text{PI}()/180) \cdot \text{SIN}(\text{Lat\_end\_transect} \cdot \text{PI}()/180) + \text{COS}(\text{Lat\_start\_transect} \cdot \text{PI}()/180) \cdot \text{COS}(\text{Lat\_end\_transect} \cdot \text{PI}()/180) \cdot \text{COS}(\text{Lon\_start\_transect} \cdot \text{PI}()/180 - \text{Lon\_end\_transect} \cdot \text{PI}()/180)) \cdot 6366.70$

**Distance [nm]** Distance [km]/1.852

#### Comments on SEAFOS during FIL2014

RA *Polar 6* conducted a systematic digital photographic aerial survey of the area of the Filchner Outflow System during two survey flights from *Halley VI* on 15 and 16 November 2013. The total survey distance covered 3,000 km each on 15 (eastern section) and 16 (western section) November 2013. Due to a low cloud ceiling on 15 November, the first flight operation was terminated prematurely and thus the westernmost track could not be flown. This track was flown on 16 November, and the total number of tracks numbered 11 instead of 12 as had been planned originally.

The aircraft was equipped with nadir mounted vertically built in Canon Mark III 1Ds photo (sensor-ID 724) and a video camera (710) with recording unit (B835) for still pictures and video footage respectively. The camera has a 24 x 36 mm full frame sensor with 3888 x 2592 pixel resolution, and was equipped with a 14 mm wide-angle f 2.8 lens (81° vertical and 104° horizontal angle of view). In addition, the aircraft's zenith video camera (710), the laser scanner RIEGL VG580 (B832), the laser altimeter RIEGL LD90 (705), and the infrared radiation thermometer KT19 (B839) and the hygrometer CR2 (722) were successfully operated. During the flights, a total of 7,213 nadir camera images (stored as .jpg and as Canon specific raw .CR2 formats) and 13 files of parallel video footage (stored as .mpg) were taken. The total data set is complemented by report files that contain GMT scripts for

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documenting the flight tracks relative to bathymetry, and GPS files containing the coordinates of the flight tracks in relation to time stamps (UTC) and altitude flown (WGS84). Approaches to the tracks were flown at 660 m (2,000 ft), and the tracks at 200 m (600 ft) altitude. The survey design comprised 11 parallel transects with 37 km (20 nm) separation between successive transects. Transects were placed perpendicular to the 1,000 m bathymetric contour to effectively sample the pack-ice habitat along a bathymetric gradient. Images were continuously recorded and successive photographs taken along the trackline overlapped to cover the entire length of transects.

Digital video footage recorded in parallel was not analysed, as still images were of superior resolution (archived via /hs/dms/aircraft/DMS\_Archive/Aircraft/ANTR\_2014/1311150701-dms1 and /hs/dms/aircraft/DMS\_Archive/Aircraft/ANTR\_2014/1311160801-dms1). Seal density was estimated using strip transect sampling. Strip-width (the width of the observation area perpendicular to flight direction) was derived using simple trigonometry, using the flight altitude and field of view angle of the lens. Because the mean flight altitude varied somewhat between transects (194 to 221 m asl), strip-width was calculated separately for each transect (331 m to 378 m). Transect length summed to a total distance of 1,148.44 km. The total area covered by images taken at ~200 m asl, including the area surveyed when flying between two transects (lines connecting two transects; total distance 367.51 km), was 656.62 km<sup>2</sup>. Strip transect sampling assumes that all objects in the covered strip are detected (in our case, always detecting a seal when present in an image). In theory, detectability does not fall away with distance from the trackline for digital aerial surveys; though our personal experience was that objects near the edge of an image required more searching and may have a greater probability of non-detection. To control for incomplete detection, three trained observers independently examined all images on high definition LCD screens and annotated the presence or absence of seals in each image. All seals in an image were counted and the coordinates of the image tagged in a GIS layer.

All images with detections were validated after selection to ensure the correct identification of seals and removal of any images considered to be false positive identifications (e.g., shadows, cracks in ice, melt pools). Detected seals could, however, not be classified to species level. To estimate detection probability detections were split into those found by one, two or three observers. We assume that all seals located in each strip were counted when individual observer data was collated. We additionally searched for seals on images taken during flights to and from the transect grid and *Halley VI*. Approach and return flights were flown up to a height of 660 m asl, allowing us to assess how detection probability falls away with altitude and if detections were still reliable at higher altitudes. If detection remained reliable at higher altitudes, such altitudes have the advantage of having a wider strip-width, increasing the covered area.

A total of 3,511 photos amounting to 42 GB storage volume together with 11 GB video footage was recorded on 15 November, and another 3,702 photos (46 GB) and video footage (12,5 GB) on 16 November 2013. In total, 389 seals were counted on 272 images across the entire flight profile, including transit flights to and from the transect grid. Detection probability varied by observer, decreasing and becoming more variable with increasing altitude.

Images file numbers denote date and time and the running number of the image since the aircraft started, e.g. 20131115\_152854,844\_0303 = Image of 2013 November 15 taken at 15:28:54,844 and image number 303 since the aircraft started on that survey day. Images are available as high resolution raw data (\*.CR2) and low resolution JPGs (\*.JPG). Video file names (not archived here) denote start time e.g. 1115103913[\_n].mpg = Video taken on November 15 2013 start at 10:39:13. In case more than one file was created, the extension „\_n“ with n=1, etc. denotes the number of consecutive footage sequences.

For further information see cruise report Knust and Schröder (2014) <http://hdl.handle.net/10013/epic.44292.d001>

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*SEAFOS seal images during POLAR 6 campaign FIL2014*, <http://doi.pangaea.de/10.1594/PANGAEA.843395> contain:

- Event label = Transect ID e.g. SEAFOS\_Transit\_Halley-Z
- Image Date/Time [UTC]
- Image Latitude
- Image Longitude
- Altitude [m]
- Census strip-width [m]
- No of seals counted by observer 1
- No of seals counted by observer 2
- No of seals counted by observer 3
- No of seals on image validated
- Height bin
- Image number
- Links to images in CR2 format
- Links to images in JPEG format

*SEAFOS flight profile in 1 min resolution during POLAR 6 campaign FIL2014*, <http://doi.pangaea.de/10.1594/PANGAEA.843392>

- Event label = Transect ID e.g. SEAFOS\_Transit\_Halley-Z
- Date/Time
- Latitude
- Longitude
- Altitude [m]
- Census strip-width [m]

*Raw data files*

- [http://epic.awi.de/37448/6/GPS\\_SEA\\_20131115.zip](http://epic.awi.de/37448/6/GPS_SEA_20131115.zip)
- [http://epic.awi.de/37448/7/GPS\\_SEA\\_20131116.zip](http://epic.awi.de/37448/7/GPS_SEA_20131116.zip)
  - Date/Time
  - Latitude
  - Longitude
  - Altitude [m]