A planned aerial survey for minke whales in east Antarctica during summer 2009/10

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Abstract

Continuing on from a small-scale aerial survey for minke whales undertaken in east Antarctica during the summer of 2008/09, the Australian Antarctic Division is planning another aerial survey in the 2009/10 summer season. As in previous seasons, this aerial survey will be flown using fixed-wing CASA-212 aircraft and will be double-platform on each side of the aircraft. The survey has two aims: first, to test the hypothesis that Antarctic minke whales occur in significant numbers within sea ice inaccessible to research vessels; second, to provide data in order to model their distribution relative to sea ice habitat.

It is planned that the 2009/10 aerial survey will be split into three phases in order to address a number of different hypotheses about the relationship of Antarctic minke whales and sea ice in east Antarctica; this survey will also span nearly 20° of longitude. The first phase, scheduled for December, 2009, will be a repeat of the aerial survey undertaken in Vincennes Bay December, 2008 (near 66° S 110°E) and will cover around 5,000 kilometres of transect effort. This first phase will allow a between-year comparison of whale abundance and distribution in the Vincennes Bay area. The second phase, scheduled from late December 2009 to mid-January, 2010, will shift survey effort north of the Shackleton Ice Shelf and into the eastern section Davis Sea (near 64° S 100°E) and will cover around 4,700 kilometres of transect effort. Historically, whale research voyages such as IDCR/SOWER have surveyed in this area but have not been able to access the Davis Sea or the polynyas that open up around the Shackleton Ice Shelf. In the third phase, scheduled to run from mid-January to early February, 2010, survey effort will return to the Vincennes Bay area and will cover around 5,500 kilometres. This last phase will allow an intra-season comparison of whale abundance and distribution.

Background

Progressing from a successful small-scale aerial survey focussing on minke whales in east Antarctica last season (Kelly *et al.* 2009; SC/61/IA3), another aerial survey, extended across a broader range of longitudes, is planned for the 2009/10 season. During last season's small-scale aerial survey (using fixed-wing aircraft), a total on-effort length of 5,500 km was realised, covering an area of 60,600 km^2 (see Kelly *et al.* (2009; SC/61/IA3) for more details). This survey effort yielded sightings of approximately 76 individual Antarctic minke whales (another 27 individuals were of unknown species). The successful completion of last season's aerial survey is matched by another recent aerial survey (helicopter-based) in December, 2008 near Atka Bay in the Haakon VII Sea (Kock *et al.* 2009; SC/61/IA11); both of which bode well for the future aerial surveys in the Southern Ocean. Our minke whale aerial survey programme is now ready to attempt a large-scale survey over sea ice. The Australian Antarctic Division has allocated around six weeks of flying time within a nine week window: from early December, 2009 to early February, 2010. After a series of survey test flights flown near Casey station in the summer of 2007/08 (Kelly *et al.* 2008; SC/60/IA4), this will be the third season in a row that aerial surveys for minke whales in east Antarctica will have been attempted/completed.

Survey aims

The aims of the planned large-scale aerial survey stay the same as those reported for previous years (i.e., Hedley *et al.* (2007; SC/59/IA2)). Debates concerning conventional line transect estimation methods aside; the Scientific Committee of the IWC has noted an apparent decline the minke whale abundance estimates between the second and third circumpolar IDCR/SOWER ship-based surveys. One theory, reported in Branch (2006; SC/58/IA4), is that changes in the ice edge boundary each year, and changes in the number of minke whales present in the pack ice beyond this boundary, could be responsible for the differences in abundance estimates of whales in open water. In other words, could there be many more minke whales within pack ice (and open areas within pack ice), where the research ships can't search? The aerial survey programme aims to estimate relative abundance of minke whales in sea ice and also in adjacent open water to test this hypothesis. Of course, the proportion of minke whales within the sea ice may vary substantially across the Antarctic, and we are only able to test the hypothesis within a limited area; as noted below, though, we are substantially increasing the longitudinal range of the survey this year. Our survey programme also aims to collect environmental data along side whale distribution data in order to study pack ice habitat relationships.

Extended survey area

A number of factors influenced the decision as to where to extend the survey area from its current extent: both operational/logistical and environmental. Operationally, the aerial survey is confined to operating out of skiways with fuel depots. Within areas of coastline adjacent to the current survey extent, this limits survey bases to two locations: the presently used Casey station (66° 16' 54"S 110° 31' 39"E) and an Australian Antarctic Division summer camp at Bunger Hills (66° 10'S 100° 53'E), around 450 km west of Casey. Aerial survey flights from Bunger Hills would allow access to pack ice-open water gradients around the Shackleton Ice Shelf and into the east Davis Sea. An original survey plan included running a portion of the proposed survey from the Australian Davis station (68° 34' 37"S 77° 58' 21"E), which would allow access to Prydz Bay. However, it is only logistically reasonable to base a fixed-wing aerial survey at Davis station in December, before pack ice supporting a nearby skiway melts. Further, it is not known if enough minke whales have moved into Prydz Bay by early December to justify such survey effort. From a logistical point of view, it is also possible to extend the existing survey edge east from Casey station, north of Totten Glacier (67° 00'S 116° 20'E) and over towards 120°E. A reasonable density of minke whales sightings from a number of voyages have been observed east of 113°E (i.e., IDCR/SOWER and BROKE (Thiele *et al.* 2000)). However, this would place sections of the survey area inside and out of a gyre that circulates clockwise between 90° and 115°E (Bindoff *et al.* 2000; Nicol *et al.* 2000). To avoid possible complications in interpreting data collected from very different water masses, the Cape Poinsette polynya remains the eastern boundary of the planned aerial survey.

In addition to two dominant polynya features—Vincennes Bay and the Cape Poinsette polynya—that the current survey extent covers, expanding westwards would allow the inclusion of two more polynyas: the Shackleton polynya and the Davis Sea. In various IDCR/SOWER surveys (CPII and

CPIII), a reasonable number of minke whales have been observed around the Shackleton Ice Shelf. Unfortunately, the IDCR/SOWER voyages have largely been denied access to the Davis Sea due to heavy sea ice conditions; the most recent attempt was the 2008/09 summer season (Ensor *et al.* 2009). During a multidisciplinary survey between 80° and 150°E (BROKE; Nicol *et al.* (2000)), very few whales of any species were observed in the east Davis Sea, although a spike in primary production was measured in the area (Strutton *et al.* 2000). Therefore, despite a lack of historical observations of whales in the area, a small amount of effort in the Davis Sea is still justified.

The process of shifting survey base from Casey station to Bunger Hills creates natural divisions or phases in the planned survey progression. The first phase, scheduled for December, 2009, will be a repeat of the aerial survey undertaken in Vincennes Bay December, 2008 and will cover around 5,000 kilometres of transect effort. Planned transect spacing will be around 28 km (15 nautical miles). This first phase will allow a between-year comparison of whale abundance and distribution in the Vincennes Bay area. Details of all phases are given in *Figure 1*; but actual survey boundaries, particularly the northern extents, will be a function of prevailing pack ice conditions. The second phase, scheduled to run from late December 2009 to mid-January, 2010, will shift survey effort north of the Shackleton Ice Shelf and into the eastern section of the Davis Sea (near 64°S 100°E) and will cover around 4,700 kilometres of transect effort. Planned transect spacing of the second phase will be around 37 km (20 nautical miles). Historically, whale research voyages such as IDCR/SOWER have surveyed in this area but have not been able to access the Davis Sea or the polynyas that open up around the Shackleton Ice Shelf. Effort will not be placed over the heavy fast ice just north of the Shackleton Ice Shelf. Furthermore, the northern extent of the second survey phase will be decided based on pack ice dynamics in late December so as to include the pack ice-open water gradient. In the third phase, scheduled from mid-January to early February, 2010, survey effort will return to the Vincennes Bay area and will cover around 5,500 kilometres. This last phase will allow an intra-season comparison of whale abundance and distribution. In this last phase, the northern extent of the survey area will be placed to include a substantial area (maybe around a quarter of the area covered by the first survey phase) of open water that is accessible to vessels such as those used by IDCR/SOWER voyages. The total area of all three survey phases (not double counting overlapping areas in phases one and three) is approximately 267,320 km^2: an area that spans nearly 20° of longitude and represents around 7.4% of the total area between the east Antarctic coast line (which includes permanent ice sheets) and the 62°S line, between 30° and 160°E.

The planned total lengths of transects for each of the phases are based on minke whale encounter rates from last season; estimated bad weather (which will ground the aerial survey, on average, every second day; similar rates expected at Bunger Hills (*pers. comm*. Gronset[1])); and a maximum flying range of the aircraft of 1100km. Furthermore, the total transect length to be flown out of Bunger Hills is greatly constrained by the amount of fuel that can be cached there. These planned total transect lengths are maximum values and substantial decreases in actual distances flown may result from unforeseen logistical constraints. A back-of-the-envelope estimate of encounter rate is 0.014 minke whales per kilometre of survey effort (from last season: total number of minke whales observed divided by total survey effort). Under the assumption of a set spatial distribution of minke whales within various pack ice concentrations throughout the extended survey area, it is estimated that around 212 animals may be observed with this planned survey design.

Survey protocols and photographic equipment

Survey protocols remain the same as per last season: double-platform observer configuration (two on each side of aircraft) and a flight leader. Observations will be recorded on digital voice recording system and declination angles of animals perpendicular to observer will be measured with Suunto inclinometers. Digital stills and high-definition video cameras will continue to play an important role in collecting pack ice data and photographing/videoing animals. Our current infrared camera (FLIR Photon 320) does not perform as well as was hoped in identifying whale blows in pack ice. The infrared camera does, however, identify hauled out seals and penguins; it is likely, therefore, infrared footage will continue to be collected for the benefit of other research programmes. We are currently seeking capability/equipment to be placed in the aircraft to provide accurate pitch and roll angles; these values coupled with radar altimeter data will allow approximate estimates of whale body lengths from still and video images. Finally, due to some persistent issues with species-ID (Kelly *et al.* 2009;

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SC/61/IA3), we are currently testing extra digital stills cameras to cover more area to aid to *post hoc* confirmations.

Risks to survey success

As per last season, there is a risk that the observing team won't be able to travel to Antarctica at or around the planned departure date (see Kelly *et al.* (2008; SC/60/IA4)). There have been, however, great improvements in reliability of the flight service between Hobart and Wilkins Runway, near Casey station, and there is only a moderate risk that this will fail in the coming summer. However, given the reasonably long period of flying allocated to the survey programme, even a truncated survey effort is likely to return valuable minke whale distribution and abundance data.

Preliminary results of this aerial survey will be presented to the Scientific Committee of the IWC in 2010.

References

Bindoff, N. L., Rosenberg, M. A. and Warner, M. J. (2000). On the circulation and water masses over the Antarctic continental slope and rise between 80 and 150 degrees E. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* **47**, 2299-2326.

Branch, T. A. (2006). Possible reasons for the appreciable decrease in abundance estimates for Antarctic minke whales from the IDCR/SOWER surveys between the second and third circumpolar sets of surveys. *Scientific Committee of the International Whaling Commission, St Kitts* **SC/58/IA4**, 8 pp.

Ensor, P., Komiya, H., Kumagai, S., Kuningas, S., Olson, P. and Tsuda, Y. (2009). 2008-2009 International Whaling Commission-Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Cruise. *Scientific Committee of the International Whaling Commission, Madeira, Portugal* **SC/61/AI**.

Hedley, S. L., Bravington, M. V., Gales, N., Kelly, N. and Peel, D. (2007). Aerial survey for minke whales off eastern Antarctica. *Scientific Committee of the International Whaling Commission, Anchorage, Alaska* **SC/59/IA2**, 47 pp.

Kelly, N., Peel, D., Pike, D., Bravington, M. V. and Gales, N. (2008). Aerial survey of minke whales off East Antarctica: report on 2007/08 test survey and future plans. *Scientific Committee of the International Whaling Commission, Santiago, Chile* **SC/60/IA4**, 8 pp.

Kelly, N., Peel, D., Pike, D., Bravington, M. V. and Gales, N. (2009). An aerial survey for Antarctic minke whales in sea ice off east Antarctica: a pilot study. *Scientific Committee of the International Whaling Commission, Madeira, Portugal* **SC/61/IA3**.

Kock, K. H., Scheidat, M., Boebel, O., Bräger, S., Herr, H., Lehnert, K., Lehnert, L. S., Verdaat, H. and Williams, R. (2009). The occurrence of cetaceans along two transects from 57°S to Atka Bay (70°29.6`S/ 07°57.6`W). *Scientific Committee of the International Whaling Commission, Madeira, Portugal* **SC/61/IA11**.

Nicol, S., Pauly, T., Bindoff, N. L. and Strutton, P. G. (2000). "BROKE" a biological/oceanographic survey off the coast of East Antarctica (80-150 degrees E) carried out in January-March 1996. *Deep-Sea Research Part II-Topical Studies in Oceanography* **47**, 2281-2298.

Strutton, P. G., Griffiths, F. B., Waters, R. L., Wright, S. W. and Bindoff, N. L. (2000). Primary productivity off the coast of East Antarctica (80-150 degrees E): January to March 1996. *Deep-Sea Research Part II-Topical Studies in Oceanography* **47**, 2327-2362.

Thiele, D., Chester, E. T. and Gill, P. C. (2000). Cetacean distribution off Eastern Antarctica (80-150 degrees E) during the Austral summer of 1995/1996. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* **47**, 2543-2572.

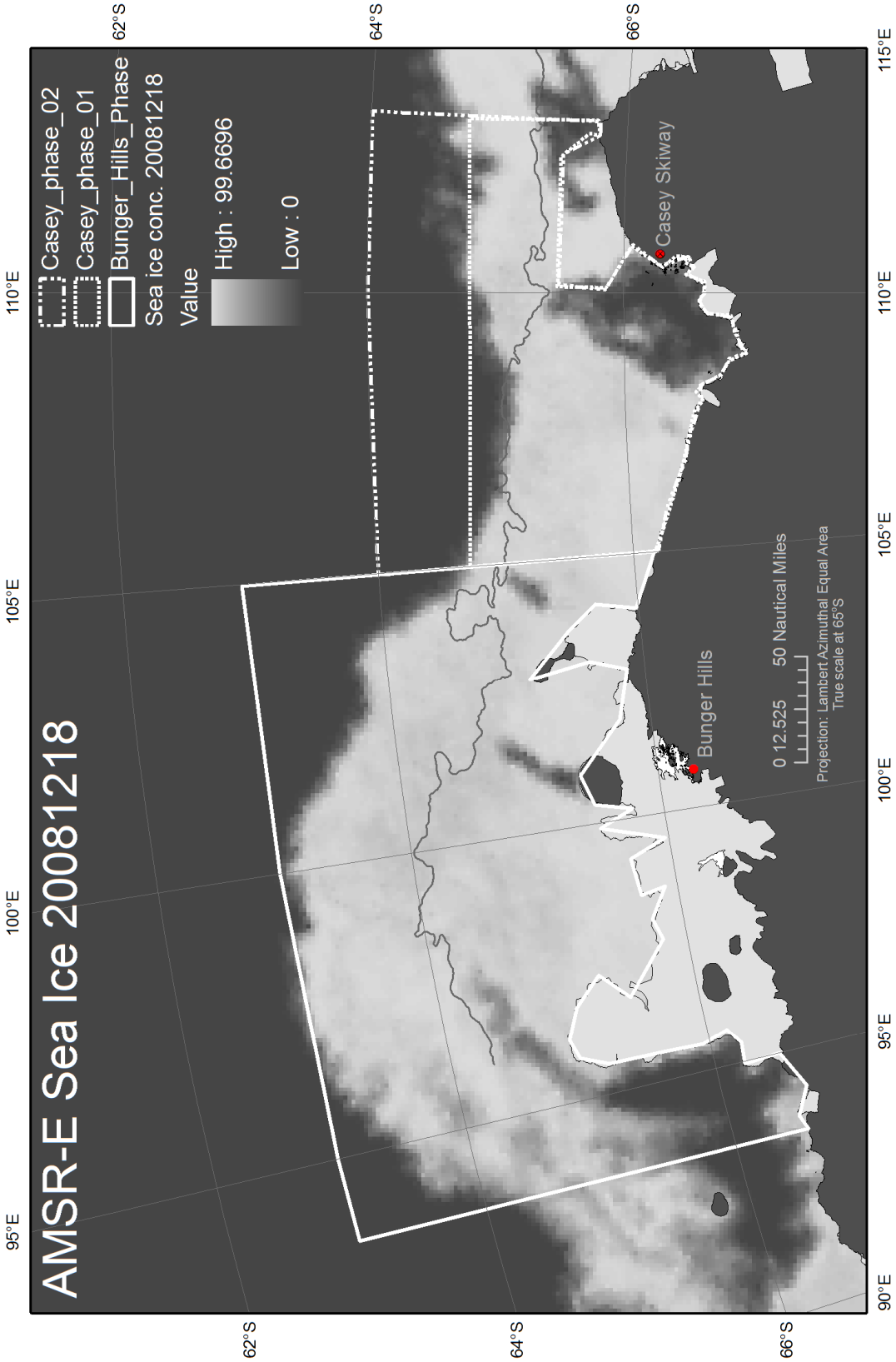

Figure 1 Phases one-three of the planned fixed-wing aerial survey for Antarctic minke whales over the 2009/10 summer period in east Antarctica. The pack ice distribution on 18 December, 2008 was selected as it represents a fairly typical distribution for that time of year.