Palmer Area User's Committee

Pre-Meeting information
September 2, 2009
8:30am - 1 pm MDT

Dial-in instructions:

1. Dial In Number: 1.877.336.1275
2. Access Code: 1274113

(International Dial in: 1.404.443.6391 - use Access Code above)

Should you need assistance during your conference, please press * # for a list of menu options
and *0 to obtain Specialist assistance.

Facilities Update

2009 existing projects

- ✓ Aquarium Power (outlets for Kristen O’Brien's Project)
- ✓ Raise the Boat House Garage Door
- ✓ GWR Boiler Replacement
- ✓ Inspect the Station Fire Sprinkler Heads
- ✓ Install Filters in the BioLab and GWR heating Loops
- ✓ Replace the Galley Sink
- ✓ Replace the Kitchen Stove Hood Exhaust Fan
- ✓ Pier Repair
- ✓ BioLab Mechanical Room Water Sensors
- ✓ Staircase Over Fuel Oil Line
- ✓ Improve the ventilation in the VHF Hut
- ✓ Walkway Test Section
- ✓ Replace the BioLab Fireplace Floor tile
- ✓ Replace the GWR and BioLab Bathroom Plumbing

Facilities Update

2010 proposed projects

- 5th Gamage Point Bollard
- NOC Cooling
- Bat Cave Electrical Panel Replacement
- Boathouse Deck Expansion
- Earth Station Cooling Expansion
- Hand Held Fire Extinguisher Revision
- Carp Shop Ventilation Installation
- Haz Van Lighting
- On Going Pier Repair
- Haz Van Exhaust
- GWR Bathroom Exhaust Fan
- Relocate the GWR Exhaust Stack
- Seismic Hut Power Relocation
- Rec Hut Rebuild

Facilities Update

PAUC Recommendations for future projects

- Your recommendations go here

IT Updates

- Webcam
- Armed Forces Radio Television Service
- Information Security

Information Technology
Information Security Update

- Federal Policy
  - USAP enterprise is a Federal network; includes stations and vessels
  - Federal policies apply to all systems that connect to the USAP
  - Done in order to protect science, the general research environment and federal resources
- USAP Policy
  - NSF/OPP Division of Antarctic Science fully supports OPP requirements that grantees comply with OPP information security requirements and initiatives
  - OPP has been continually refining and improving the USAP information security program to bring it into compliance with guidance from the NSF CIO
  - Grantee compliance with USAP information security management requirements is mandatory - to include:
    - **Awareness training, compliance with Rules of Behavior**
    - **Laptop computer screening for transient computing equipment**
    - **AND grantee instrumentation attached to USAP IT infrastructure (e.g. - local area networks)**
  - OPP has identified that the general integration of grantees within the USAP information security program is weak and lagging behind progress made with USAP operational IT systems

Information Technology
Information Security Update – Cont'd

- OPP has observed that grantee systems need improvement in compliance with mandatory operational information security requirements
  - Keeping operating systems updated to currently supported vendor versions
  - Staying current with vendor operating system/application security patches
  - Staying current with anti-viral scans and anti-virus signature files
  - Implementing mandatory operating systems standard configurations; or providing mandatory hard evidence for OPP review for justification of exemption from a configuration setting
  - Timely response to addressing problems noted and forwarded to the grantee system manager for resolution
  - Maintaining proper technical expertise on a routine basis within the grantee's staff to keep deployed instrumentation system compliant and respond to discrepancies or incidents (or - failing the availability of grantee staffing with required expertise, grantees are not formally requesting and negotiating that RPSC Research Associates, supported by RPSC IT staff, provide managed information security services to achieve the same results)
  - Providing sufficient advanced information (ORW, SIPs) regarding technical systems descriptions and detail of the IT/computing infrastructure that they bring to Antarctica for interconnection with USAP IT systems

Information Technology
Information Security Update – Cont'd

- OPP is escalating its efforts to bring the science grant community into improved compliance
  - Due to increasing emphasis by the Federal government on cyber security backed by annual OIG technical audits of USAP information security posture
  - Grantees can expect greater attention and increasing performance expectations by OPP in the coming months
- Prime contractor is tasked with scanning all systems and reporting findings to owner for remediation and findings/status to NSF
  - Guidelines require a response within 7 days to vulnerability notice
  - Remediation of the identified vulnerabilities within 30 days, or if remediation must be delayed, a reason for delay
- NSF is arbitrator on reject/accept participant remediation plan-failure to respond/remediate can lead to NSF order to disconnect

Information Technology
Skype

- Skype is a peer-to-peer network application which has inherent vulnerabilities that put the USAP enterprise at risk
  - Skype can transmit infected files that bypass current USAP security defenses
  - USAP currently has no infrastructure to supervise Skype connections to mitigate these vulnerabilities
  - Bandwidth utilization remains a major concern especially when used by a large concentrated population over limited station bandwidth
- But, Skype is a growing business application with high user demand, improving security capabilities and stability
- USAP is investigating providing this capability as a secure Managed Service
  - Centralized Skype management with secure configuration settings
  - Assessment of impacts of voice and video services on station infrastructure; file sharing TBD
  - Initial deployment may be in 2010-2011 season if testing reveals no major security concerns

The Antarctic Geospatial Information Center:

Promoting Antarctic Science Through Geospatial Data

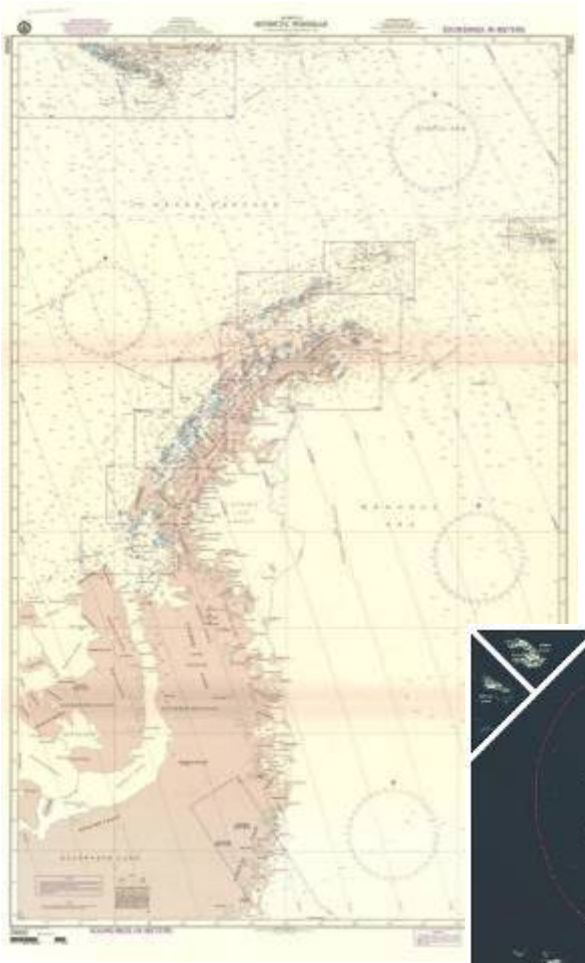
MISSION:

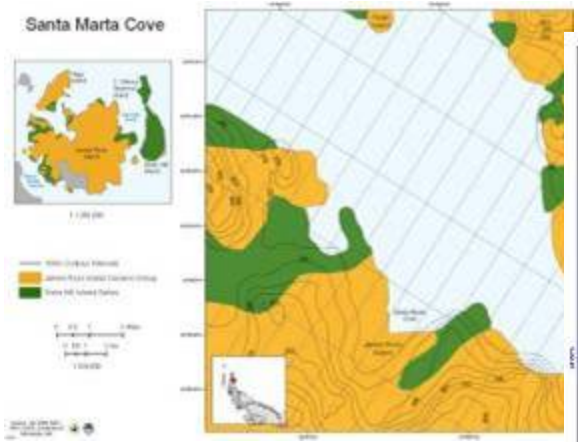
- Support the geospatial needs of science and operations in Antarctica
- Collect existing geospatial data
- Provide cartographic services
- Archive and serve geospatial data
- Develop specialized software

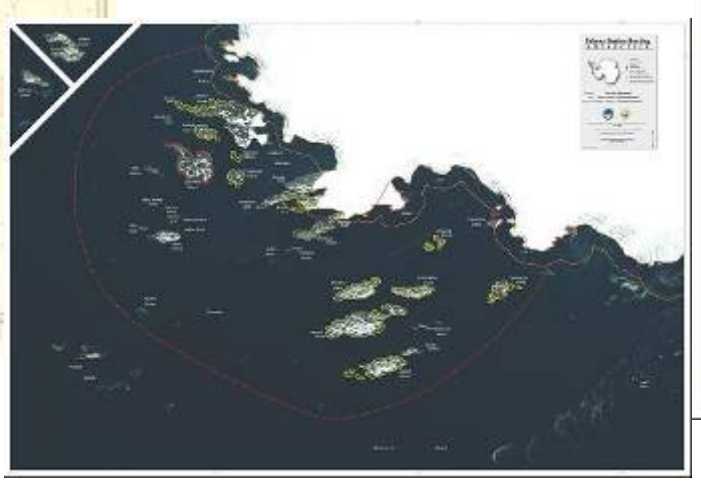
Michelle LaRue and Paul Morin

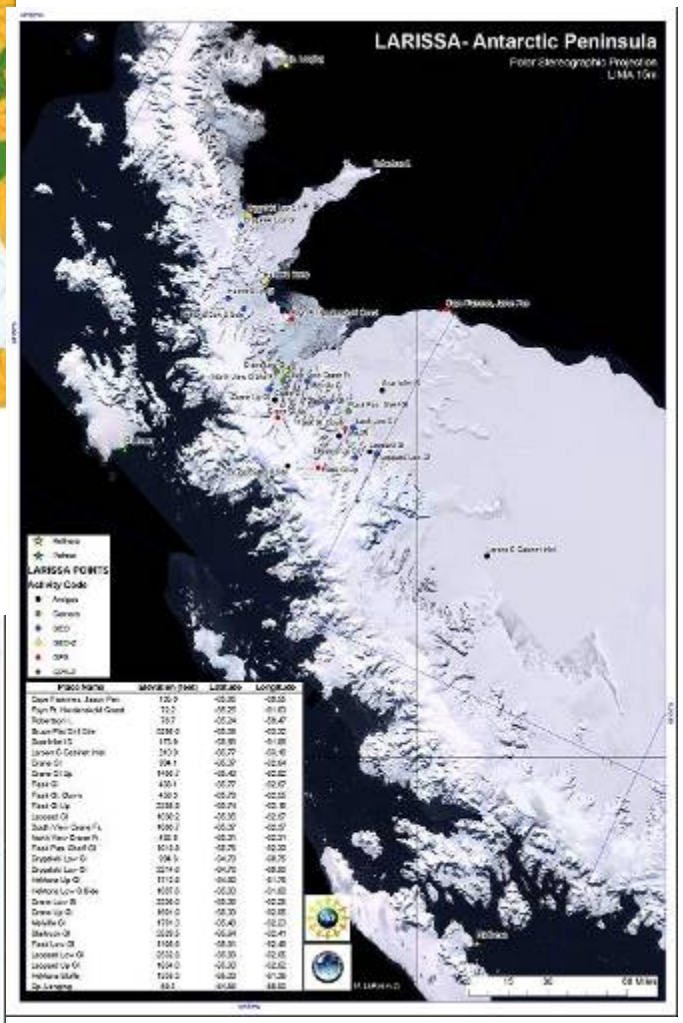
University of Minnesota

Maps/Nautical Charts

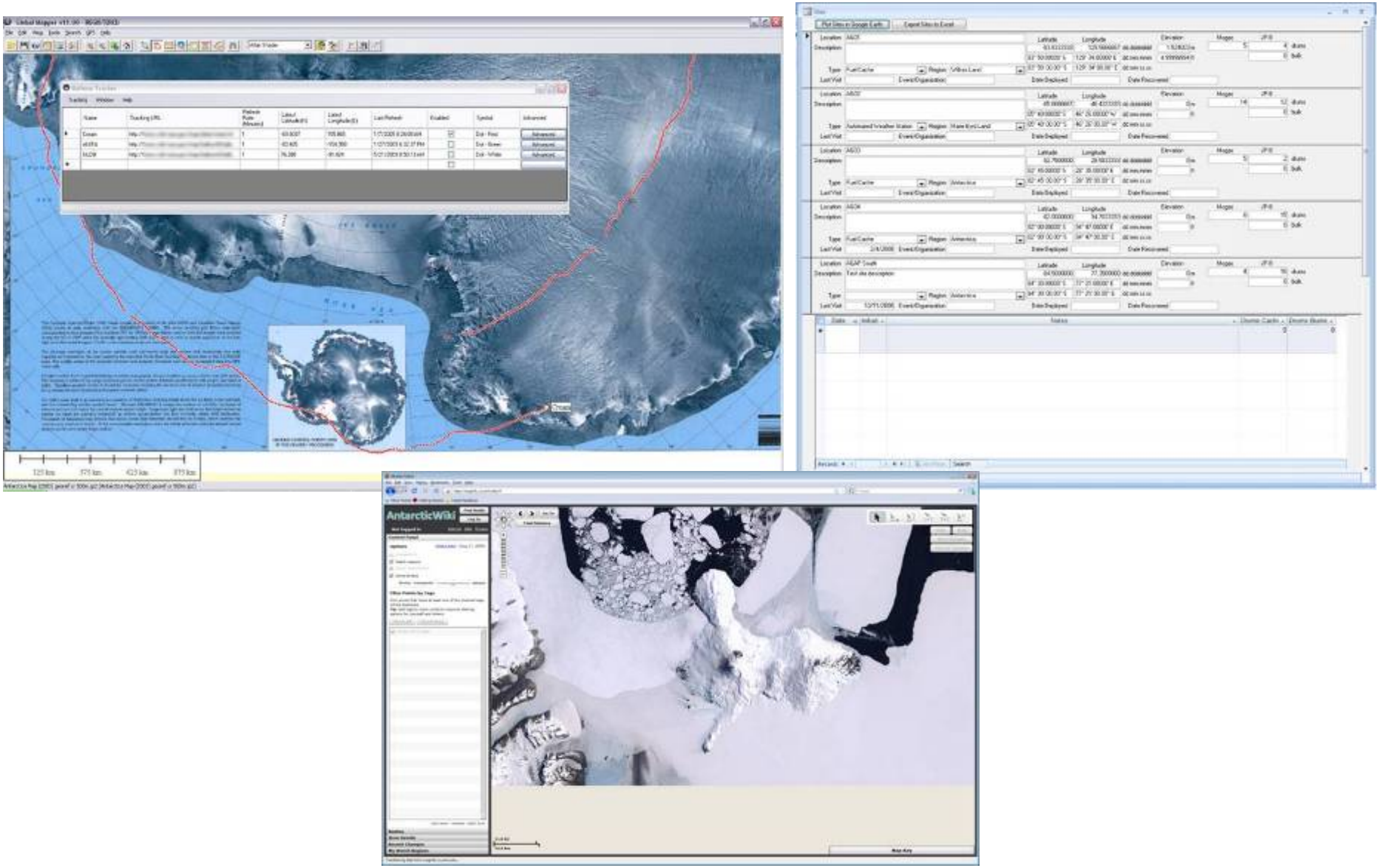




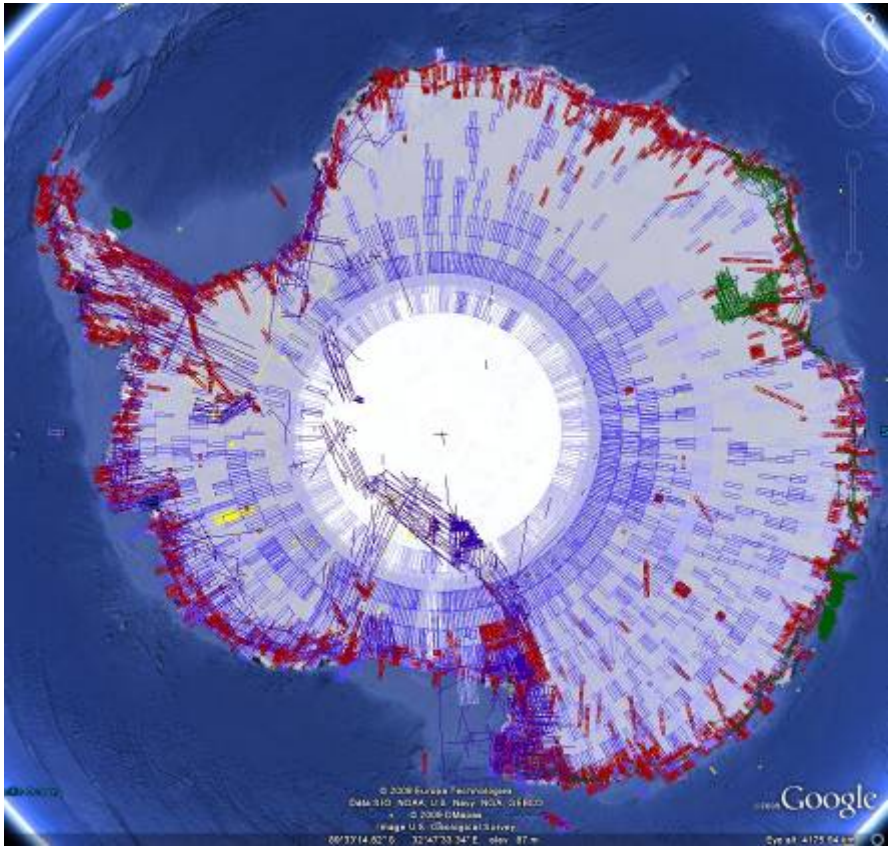




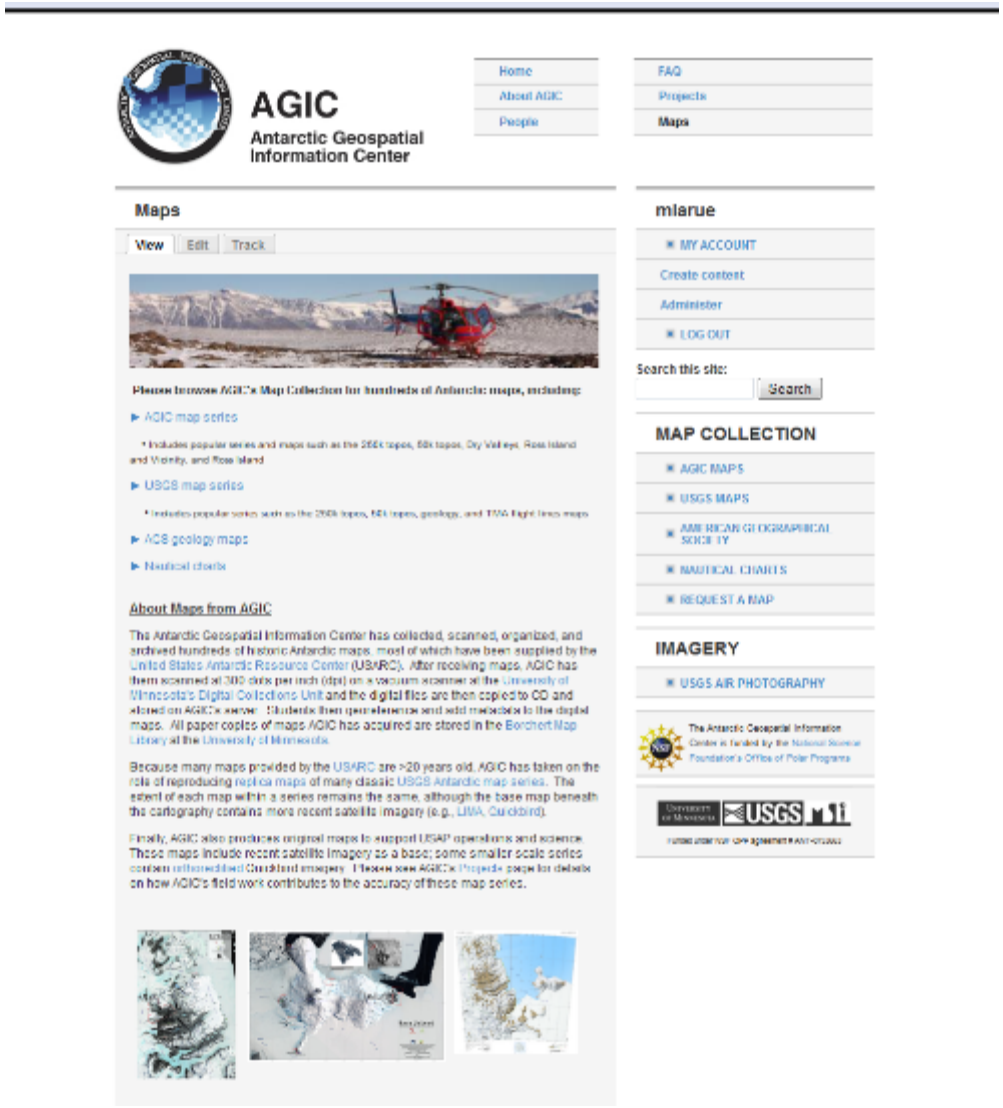
Software and Applications



Imagery



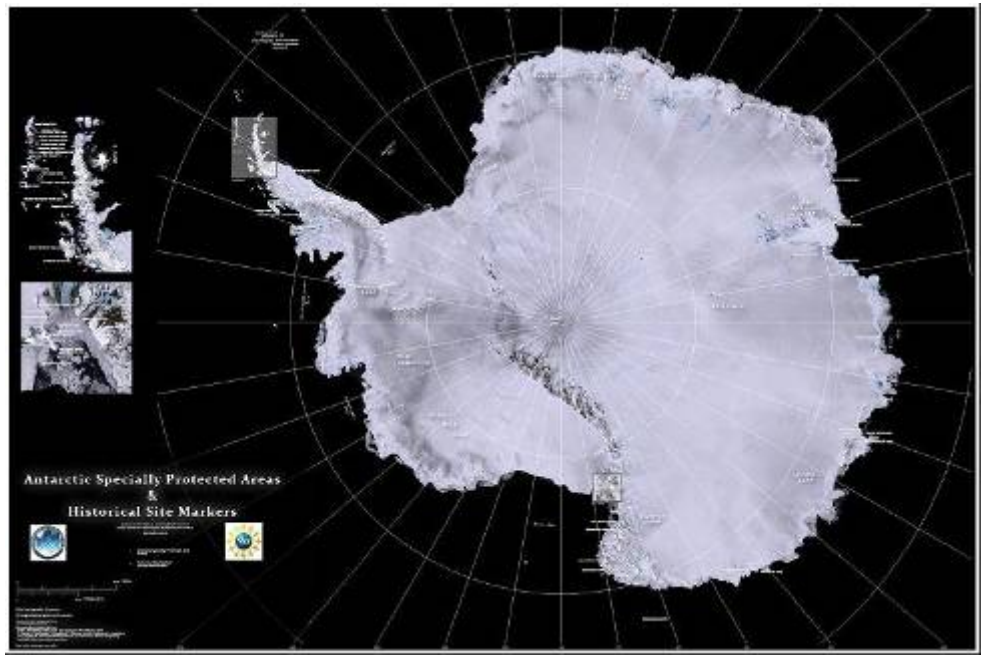
Website



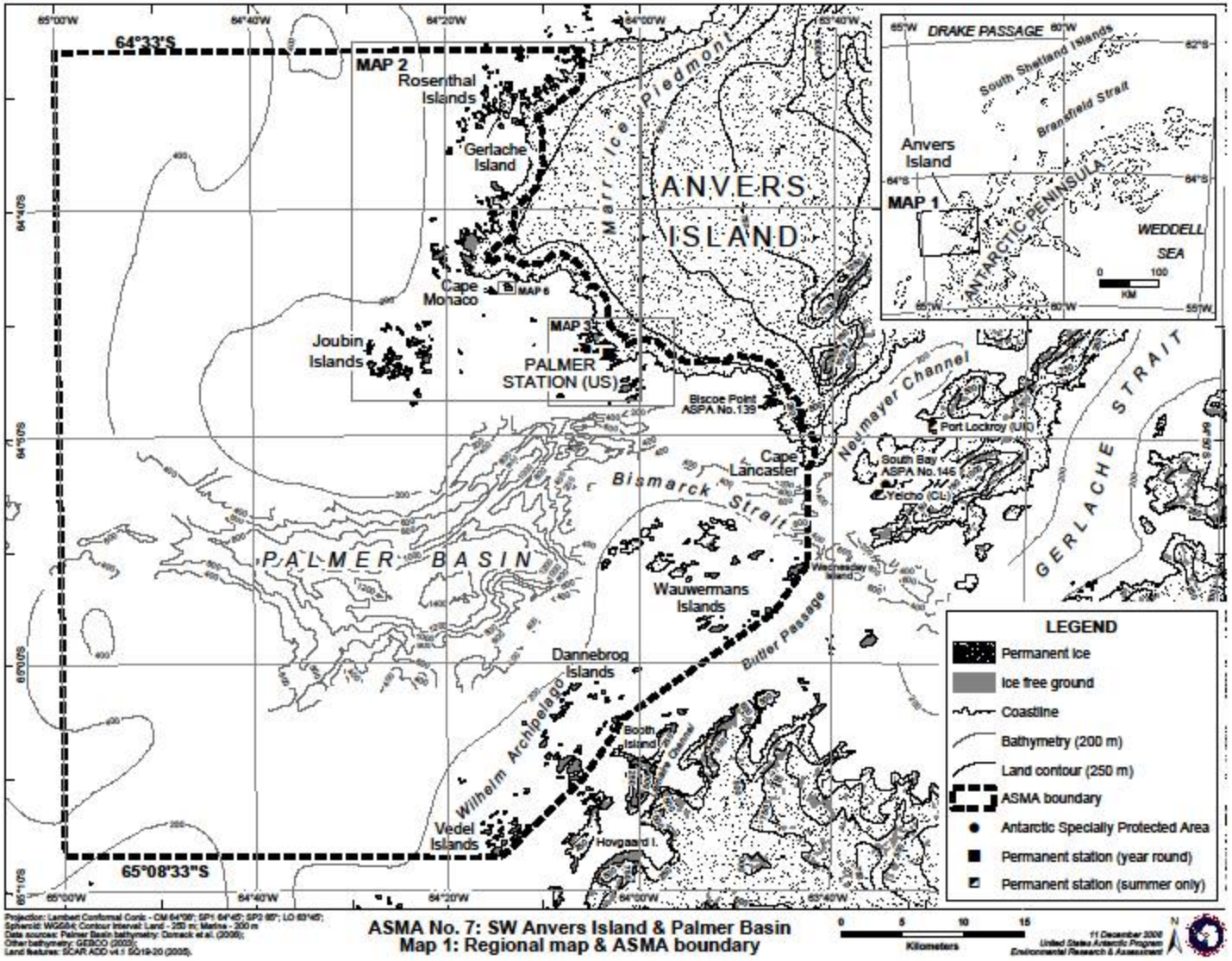
- Download Maps
  - AGIC originals
  - USGS topos
  - Nautical Charts
  - Geologic
- Software/Applications
  - AntarcticWiki
  - Balloon Tracker
  - Database Manager
- Contact us for imagery

Tell Us What You Need!

- POC: Michelle LaRue
  - larue010@umn.edu
  - 612-626-0505
- Director: Paul Morin
  - lpaul@umn.edu
- PIs can contact us directly

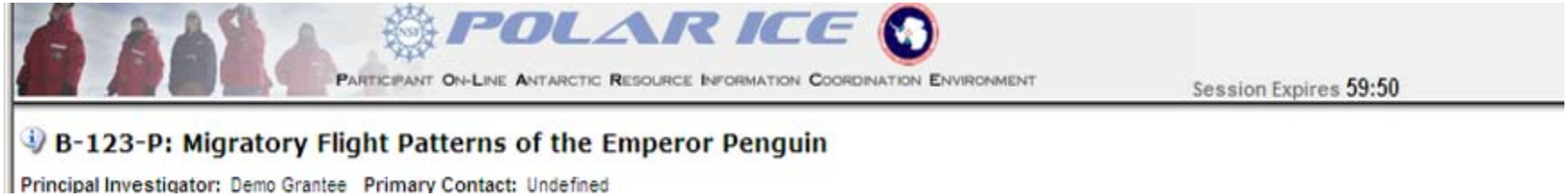


ASMA Management

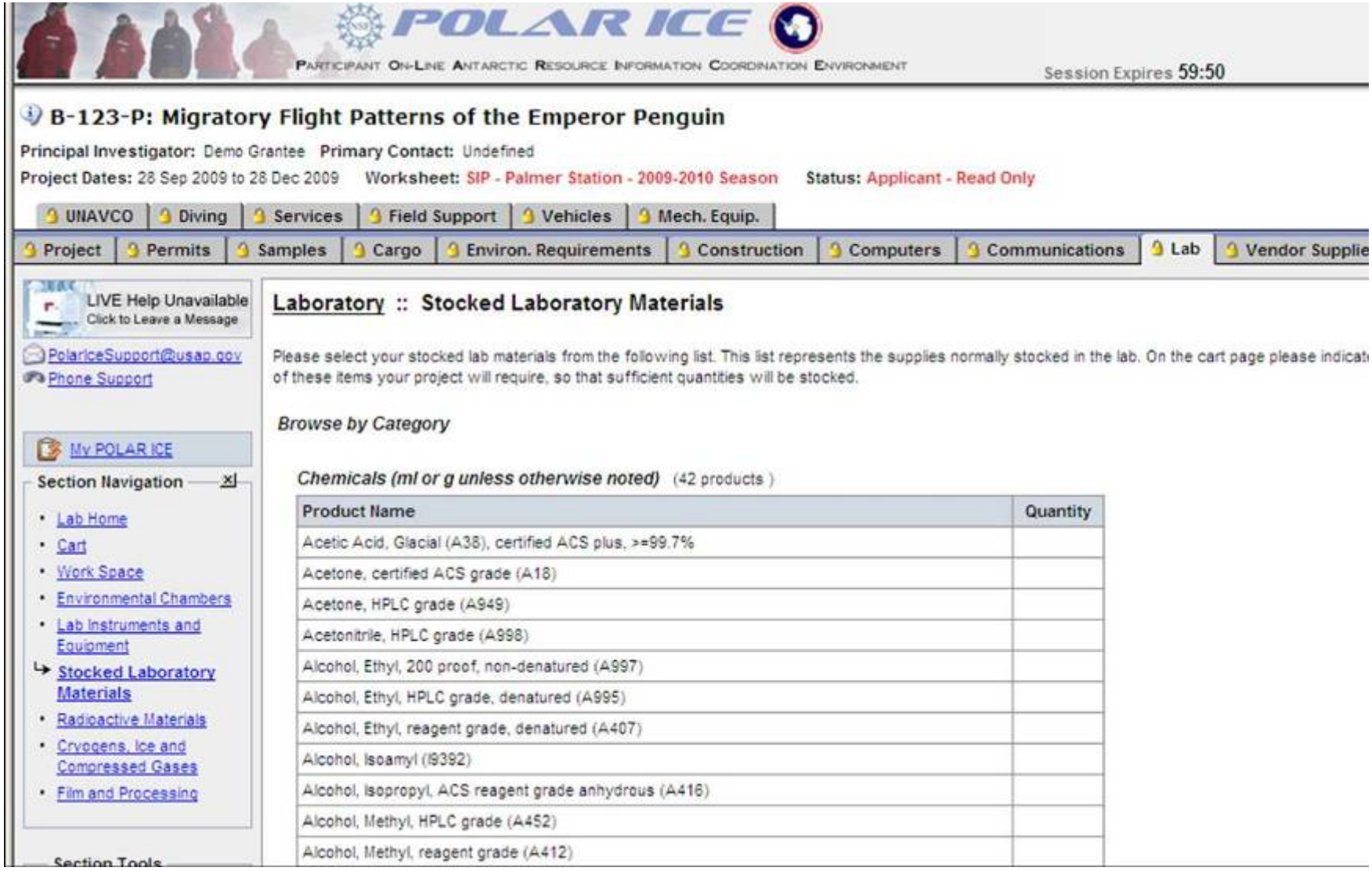


Lab Services

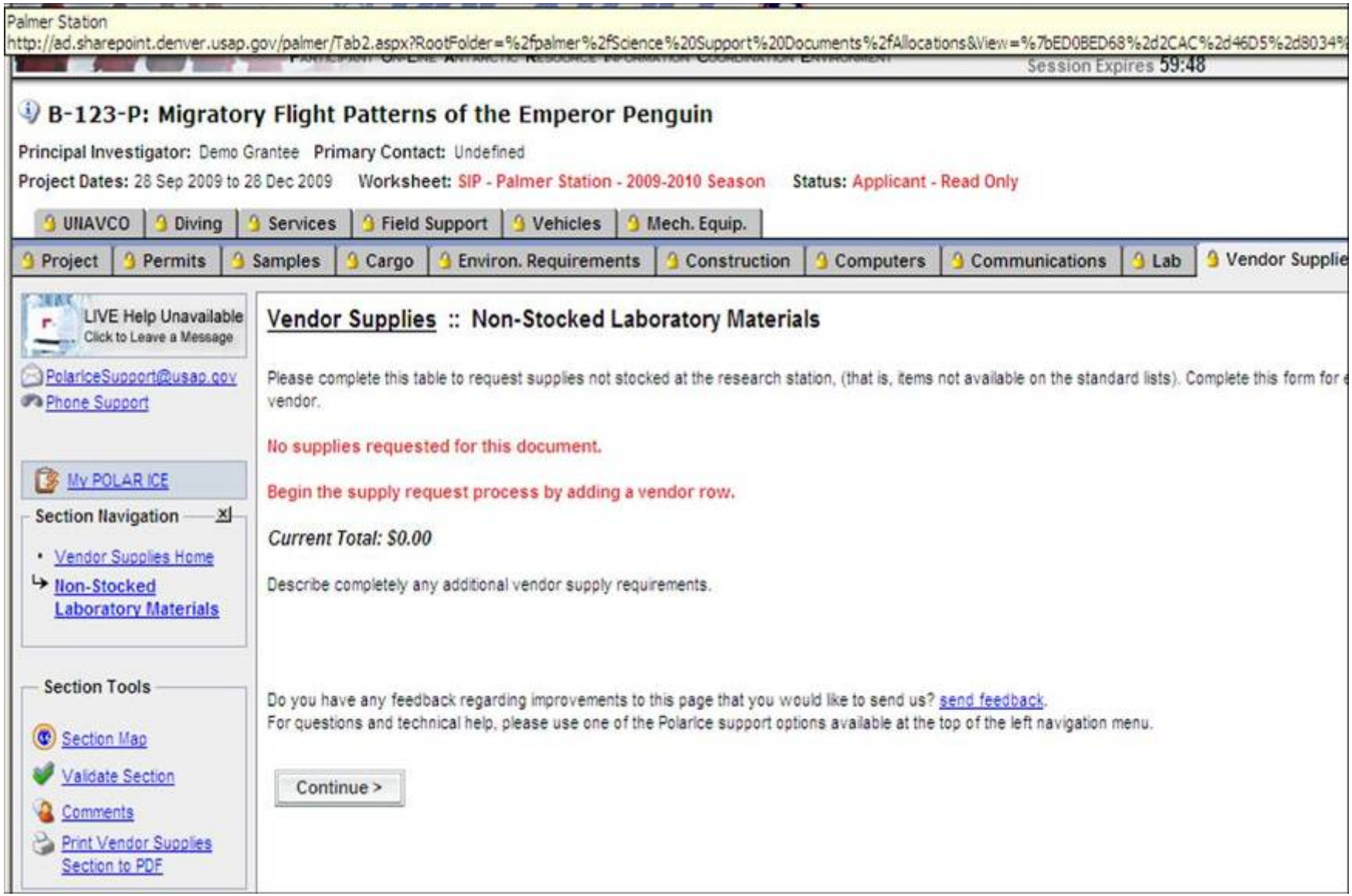
PolarIce: Who Buys What?!?
Depends on your grant structure and the proposal solicitation. General delineation is within the SIP.
The following two slides are screen shots from PolarIce.



RPSC buys standard consumable items



Grant pays for “Vendor Supplies”- these are things we do not normally stock on station



Instruments and Equipment- current lifecycle priority

Rank within Science Support	Description	QTY
3	Autoclave, Amsco 2021M, 240-270 deg F	1
7	Freezer, -70C REVCO	2
11	Freeze Dryer, Virtis Freezemobiles	1
15	Freeze Dryer, Virtis Feezemobiles	2
19	SPOT Diagnostic digital camera, Model 1.3.0	1
23	Water system, Nanopure	1
25	Oven, Fisher Forced air Iso-Temp, Model 615F, 1.5cu.ft	4
26	Binoculars, Leica, 8x42	1
27	Refrigerator, underbench, general purpose	1
28	Freeze Dryer, Virtis Feezemobiles	2
29	Waterbath replacements	8
30	Scotsman icemaker	2
31	PE Lambda 40	1
32	Wescor 5500 vapor pressure osmometer	2

Journal List 2009-10

Nature

www.nature.com (no log-in necessary)

- Access is available courtesy the NSF

Science (only available through specifically designated computers with a permanent IP address- username and password are administrator functions and do not allow access to articles)

- www.sciencemag.org
- 2002 through current issue (use JSTOR for older articles)

Limnology and Oceanography

- www.aslo.org/lo (no log-in necessary)
- 1956 through current issue

Antarctic Science

- www.journals.cambridge.org/jid_ANS

Indexes

Science Citation Index

- http://www.thomsonisi.com/cgi-bin/jrnlst/jloptions.cgi?PC=D

EBSCO Arctic and Antarctic Regions Abstracts

http://search.ebscohost.com

Arctic & Antarctic Regions **(AAR) Some articles/abstracts are available online through a hyperlink in the full citation, or may be on microfiche here on station: click on the record and pull up the full citation; if the Record ID (towards the bottom) begins with ANTA, look up the number in our collection.**

JSTOR

http://www.jstor.org/search (no log-in necessary)

This index has over 250 journals and articles are available. However, the most recent years of each journal are unavailable. Some of the more popular journals include: *Ecology* 1920-1998, *Science* 1880-1997, *Limnology and Oceanography* 1956-1999, *Paleobiology* 1975-1998

Blackwell Publishing

http://www.blackwellpublishing.com/search.asp (no log-in necessary)

Almost 700 journals are available in this index. At the moment, only abstracts are available, not the full articles

NISC Arctic & Antarctic Regions Abstracts and **Cold Regions Bibliography Project**

http://biblioline.nisc.com/scripts/login.dll?BiblioLine (no log-in necessary)

Cold Regions Bibliography Project

http://www.coldregions.org

These indices are a multidisciplinary collection of international polar databases, from 1800 – present. Some articles are only available as a citation, others include an abstract. We have microfiche available on station with the full articles cited here through 1999.

Some explanation of the microfiche limitations:

Funding for the bibliography compilation transferred from the NSF/Library of Congress to the American Geological Institute (AGI) in 1999. Microfiche updates are no longer being made as most publishers make their articles available on their own websites and the AGI has a Document Delivery Service which provides the full text articles. This service charges per article and does not support electronic document delivery.

WorldCat

www.worldcat.org

Scientific Journals- MAUC recommendations

- There is no need for hard copies of journals that are available online (Science and Nature).
- Limnology and Oceanography is a useful journal but not worth the cost of a subscription in McMurdo. If it can be made available through the NSF, we strongly encourage that (and other journal access as well)
- Please request to maintain subscriptions to Antarctic-specific journals (Antarctic Science), as many libraries do not provide access to it. Online-only subscription would be fine and is perhaps part of what NSF can make available.
- Online access to EBSCO Arctic and Antarctic Regions Abstract is valuable and we would like to see it continued if possible.

Data Products

- Uv Monitoring System is currently operational but unfunded.

- PalMos has reached it’s lifecycle and we need to replace it. Relocation to TerraLab would be best location for longer lifecycle.- Recommendations from PAUC.

Peninsula Automatic Weather Station Briefing

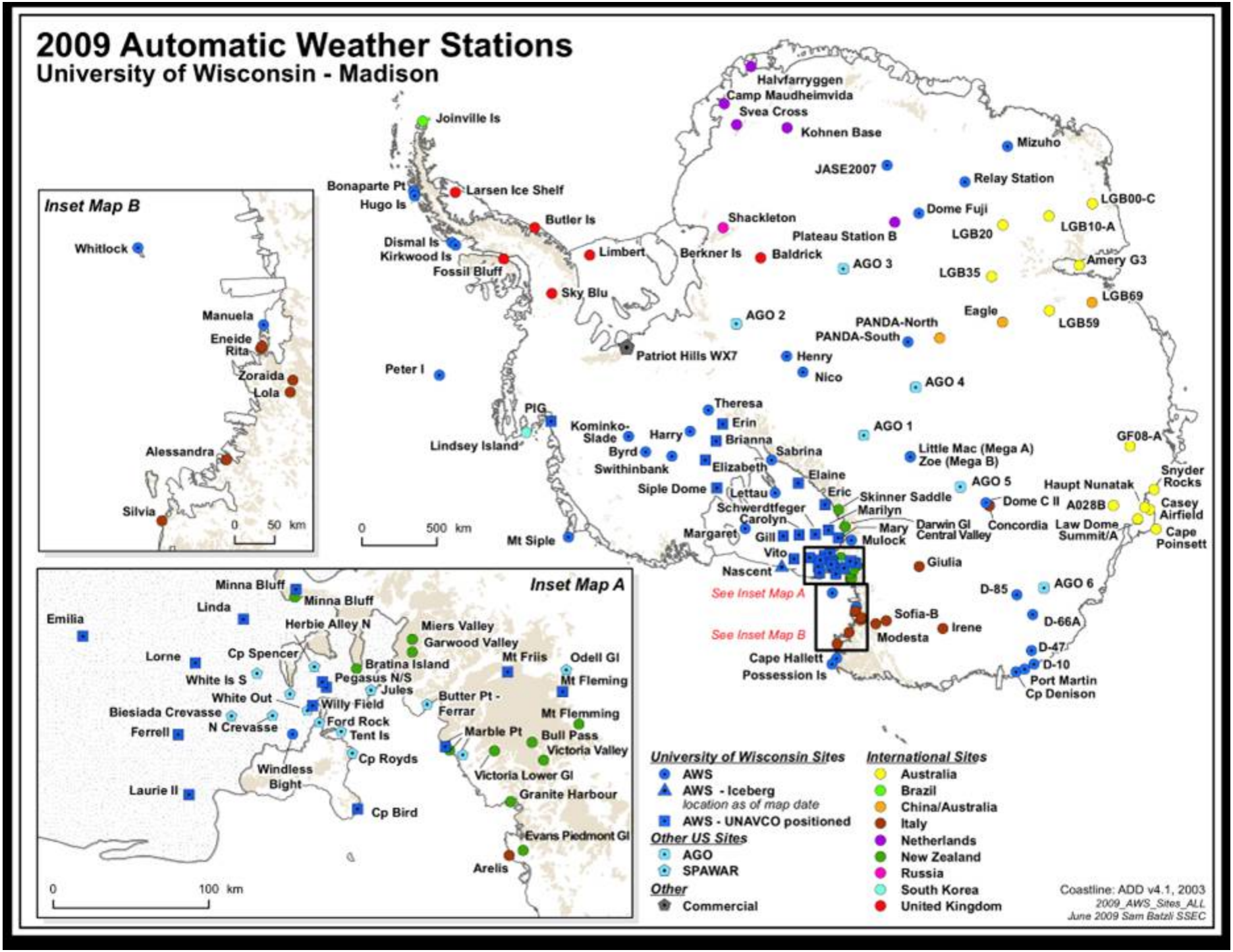
Dr. Matthew Lazzara

Antarctic Meteorological Research Center

Space Science and Engineering Center

University of Wisconsin-Madison

W. Kevin Pedigo
(Sr. Marine Computer and Instrument Specialist)
on the ARSV Laurence M. Gould
installing AWS at Hugo Island


2009 Automatic Weather Stations
University of Wisconsin - Madison
Halvfarryggen
Camp Maudheimvida
Svea Cross
Kohnen Base
Mizuho
JASE2007
Relay Station
Joinville Is
Bonaparte Pt
Hugo Is
Larsen Ice Shelf
Butler Is
Dismal Is
Kirkwood Is
Fossil Bluff
Limbert
Berkner Is
Shackleton
Baldrick
Dome Fuji
Plateau Station B
LGB20
LGB00-C
LGB10-A
AGO 3
LGB35
Amery G3
LGB69
Sky Blu
AGO 2
Eagle
LGB59
PANDA-North
PANDA-South
Patriot Hills WX7
Henry
Nico
AGO 4
Peter I
PIG
Theresa
Erin
Brianna
Sabrina
Elizabeth
Elaine
Eric
Skinner Saddle
Marilyn
Darwin Gl
Central Valley
Mary
Mulock
Gill
Margaret
Carolyn
Schwerdtfeger
Lettau
Siple Dome
Swithinbank
Byrd
Harry
Kominko-Slade
Lindsey Island
Mt Siple
AGO 1
Little Mac (Mega A)
Zoe (Mega B)
AGO 5
Dome C II
Concordia
GF08-A
Haupt Nunatak
A028B
Snyder Rocks
Casey Airfield
Law Dome Summit/A
Cape Poinsett
Vito
Nascent
Giulia
See Inset Map A
See Inset Map B
D-85
AGO 6
D-66A
Sofia-B
Irene
Modesta
D-47
D-10
Port Martin
Cp Denison
Cape Hallett
Possession Is
Manuela
Eneide
Rita
Zoraida
Lola
Alessandra
Silvia
Whitlock
Inset Map B
0 50 km
0 500 km
Inset Map A
Minna Bluff
Minna Bluff
Linda
Emilia
Herbie Alley N
Miers Valley
Garwood Valley
Lorne
Cp Spencer
Bratina Island
Mt Friis
Odell Gl
Mt Fleming
White Is S
Pegasus N/S
Jules
White Out
Willy Field
Butter Pt -
Ferrar
Biesiada Crevasse
N Crevasse
Ford Rock
Tent Is
Mt Flemming
Ferrell
Marble Pt
Bull Pass
Victoria Valley
Cp Royds
Windless Bight
Victoria Lower Gl
Granite Harbour
Laurie II
Cp Bird
Evans Piedmont Gl
Arelis
0 100 km
University of Wisconsin Sites
AWS
AWS - Iceberg
location as of map date
AWS - UNAVCO positioned
Other US Sites
AGO
SPAWAR
Other
Commercial
International Sites
Australia
Brazil
China/Australia
Italy
Netherlands
New Zealand
Russia
South Korea
United Kingdom
Coastline: ADD v4.1, 2003
2009_AWS_Sites_ALL
June 2009 Sam Batzli SSEC

Peninsula AWS Status

- Wisconsin AWS:
  - Bonaparte Point - Serviced
  - Hugo Island – New install
  - Racer Rock – Not installed
  - Dismal Island
    - Sort of working (to be serviced/taken over by BAS?)
  - Kirkwood Island – Off air
  - Proposal & Collaboration Policy
- Brazil AWS:
  - 2 AWS (?)
  - Joinsville Is. and Biscoe Is.
    - Unclear/not well (but

SITE	ARGOS ID / AWS _ type	Action 08/09	Lat.	Long.	Alt.(m)	Date STARTED	WMO#
	Antarctic Peninsula						
Larsen Ice	8926 CR1000	BAS	66.949°S	60.897°W	17	Oct-85	89262
Butler Island	8902 CR1000	BAS	72.207°S	60.160°W	91	Mar-86	89266
Fossil Bluff	8920 CR1000	BAS	71.33°S	68.283°W	63	Dec-01	89065
Limbert	8925 CR1000	BAS	75.422°S	59.851°W	40	Dec-95	89257
Ski-Hi	8917 CR1000	BAS	74.792°S	70.488°W	1395	Feb-94	89272
Bonaparte Point	8921 CR10X	Serviced	64.778°S	64.067°W	8	Jan-92	89269
Hugo Is	8935 CR1000	Installed	64.964°S	65.670°W	25	Dec-94	
Racer Rock	Not active		64.067°S	61.613°W	17	Nov-89	89261
Kirkwood Island	8930 CR10X	Off	68.340°S	69.007°W	30	May-01	
Dismal Island	8932 CR10X	Works summer	68.087°S	68.825°W	10	May-01	

- BAS-"Wisconsin" AWS
  - Formerly Wisconsin AWS
  - Proposed BAS complete take over within 2 years
    - May impact real-time data
  - All AWS visited and functioning
- BAS-Chile
  - 1 AWS at Fleming Glacier
    - Not transmitting
    - Will be serviced 2009/2010
    - Dr. Wendt
    - Dr. Casassa
- Larissa Project
  - AWS on Larsen Ice Shelf
  - 3 AWS - US – Dr. Konrad Steffan
  - 2 AWS - Dutch – Dr. Michiel van den Broeke

(Various transmission means)

New Topic Recommendations

- Open discussions to identify topics not previously discussed.

Closing Remarks and PAUC business

Management Plan for

Antarctic Specially Managed Area No. 7

SOUTHWEST ANVERS ISLAND AND PALMER BASIN

Introduction

The region that includes southwest Anvers Island and the Palmer Basin and its fringing island groups has a wide range of important natural, scientific and educational values and is an area of considerable and increasing scientific, tourist and logistic activities. The importance of these values and the need to provide an effective means to manage the range of activities was recognised with adoption of the area as a Multiple-Use Planning Area for voluntary observance at the XVIth Antarctic Treaty Consultative Meeting (1991). With the acquisition of new data and information and changes to logistics and the pressures arising from human activities in the region, the original plan has been comprehensively revised and updated to meet current needs as an Antarctic Specially Managed Area (ASMA).

In particular, scientific research being undertaken within the Area is important for considering ecosystem interactions and long-term environmental changes in the region, and how these relate to Antarctica and the global environment more generally. This research is important to the work of the Committee for Environmental Protection, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the Antarctic Treaty System as a whole. There is a risk that these globally important research programs and long-term datasets could be compromised if activities were to occur in the marine area that were not appropriately managed to avoid potential conflicts and possible interference. While marine harvesting activities are not currently being conducted within the Area, and the marine component of the Area represents only 0.5% of CCAMLR Subarea 48.1, it is important that should harvesting be undertaken within the Area then it should be carried out in such a way that it would not impact on the important scientific and other values present within the Area.

Important values present in the proposed ASMA in the vicinity of Palmer Station and key activities to be managed are summarised as follows:

1. Values to be protected and activities to be managed

(i) Scientific values

The diverse and easily accessible assemblages of marine and terrestrial flora and fauna in the southwest Anvers Island and Palmer Basin area are particularly valuable for science, with some datasets spanning the past 100 years and intensive scientific interest beginning in the 1950s. Studies have been carried out on a wide variety of topics, including long-term monitoring of seal and bird populations, surveys of plants and animals in both the terrestrial and sub-tidal environments, investigations of the physiology and biochemistry of birds, seals, terrestrial invertebrates and zooplankton, the behaviour and ecology of planktonic marine species, physical oceanography, and marine sedimentology and geomophology. While the United States (US) maintains the only permanent research station within the Area, research in these fields has been undertaken by scientists from a broad range of Antarctic Treaty Parties, often as collaborative projects with US scientists. Some important recent examples from the Palmer Long Term Ecological Research (LTER) program are described below.

The southwest Anvers Island and Palmer Basin area has exceptional importance for long-term studies of the natural variability in Antarctic ecosystems, the impact of world-wide human activities on Antarctica and on the physiology, populations and behaviour of its plants and animals. Research in this region is essential for understanding the linkages among avifauna, krill dynamics and the changing marine habitat.

In particular, the United States Antarctic Program (USAP) has a major and ongoing commitment to ecosystem research in the Antarctic Peninsula region, which was formalized through the designation in 1990 of the area around Palmer Station (US) as a Long Term Ecological Research (LTER) site. The Palmer LTER (PAL-LTER) site is part of a wider network of LTER sites, and one of only two in the Antarctic, designed specifically to address important research questions related to environmental change over a sustained period spanning more than several decades. Since 1991, the PAL-LTER program has included spatial sampling during annual and seasonal cruises within a large-scale (200,000km^2) regional grid along the west coast of the Antarctic Peninsula, as well as temporal sampling from October to March in the local area adjacent to Palmer Station. The Palmer LTER and the British Antarctic Survey are collaborating on research comparing the marine ecosystem in the Palmer Basin region with that in Marguerite Bay approximately 400km further to the south. In the Palmer region, the ecosystem is changing in response to the rapid regional warming first documented by BAS scientists. In addition, recent collaboration has been established as part of the International Polar Year with scientists from France and Australia using metagenomic tools to understand microbial community adaptations to the polar winter.

A major theme in the PAL-LTER is the study of sea-ice dynamics and related impacts on all aspects of the ecosystem (Smith *et al.* 1995). The annual advance and retreat of sea-ice is a major physical determinant of spatial and temporal changes in the structure and function of the Antarctic marine ecosystem, from total and annual primary production to breeding success in seabirds. The Western Antarctic Peninsula (WAP) is a premier example of a region experiencing major changes in species abundance, range and distribution, in response to regional climate change. This change is manifested primarily as a southern migration of regional climate characteristics (Smith *et al.* 1999, 2001). Paleoecological records on sea-ice, diatom stratigraphy and penguin colonization have also placed the current LTER data into a longer-term context (Smith *et al.* 1999, 2001). In particular, the Palmer Basin has been the site of extensive paleoecological and climate change studies. The Palmer Basin also exhibits a variety of geomorphological features of value.

Extensive seabird research has focused on the ecology of Adélie penguins and their avian predators and scavengers within the inshore 50km^2 PAL-LTER grid close to Palmer Station. Colonies on 18 islands in this area are visited every 2-7 days in the summer season, and three more distant control sites within the ASMA are also visited infrequently to assess the extent of possible disturbance from activities around Palmer Station. Sea ice forms a critical winter habitat for Adélie penguins, and interdisciplinary research has focused on the impacts of changes in the frequency, timing and duration of sea-ice on the life histories of this and other bird species, as well as on prey populations.

Torgersen Island is the site of a study on the impacts of tourism, and has been divided into two areas, one open to visitors and the other closed as a site for scientific reference. This site together with other nearby islands not visited by tourists provide a unique experimental setting to examine the relative effects of natural versus human-induced variability on Adélie penguin populations. The long-term data sets obtained from this site are of particular value in understanding the impacts of tourism on birds.

The southwest Anvers Island and Palmer Basin region also hold particular scientific interest in terms of newly-exposed terrestrial areas that have been subject to vegetation colonization after glacial retreat. With continuing trends of glacial retreat, these areas are likely to be of increasing scientific value.

Seismic monitoring at Palmer Station contributes to a global seismic monitoring network, and the remote location of the station also makes it a valuable site for long-term monitoring of global levels of radionuclides.

It is important that the region is carefully managed so that these scientific values can be maintained and the results of the long-term research programs are not compromised.

(ii) Flora and fauna values

The southwest Anvers Island and Palmer Basin region is one of the most biologically diverse in Antarctica, with numerous species of bryophytes, lichens, birds, marine mammals and invertebrates (Appendix C). These organisms are dependent on both the marine and terrestrial ecosystems for food and habitat requirements, with the Palmer Basin exerting a substantial influence on regional ecological processes.

Breeding colonies of birds and seals are present on ice-free areas along the coast of Anvers Island, as well as on many of the offshore islands within the region. Eleven species of birds breed in the Area, with Adélie penguins (*Pygoscelis adeliae*) the most abundant, and several other species are frequent non-breeding visitors. Five species of seals are commonly found in the Area, but are not known to breed there. Palmer Basin is an important foraging area for birds, seals and cetaceans.

The two native Antarctic vascular plants, *Deschampsia antarctica* and *Colobanthus quitensis*, are commonly found on surfaces with fine soil in the area around Arthur Harbor, although they are relatively rare along the Antarctic Peninsula (Komárková *et al.* 1985). The vascular plant communities found at Biscoe Point (ASPA No. 139) and on the Stepping Stones are some of the largest and most extensive in the Anvers Island region, and are particularly abundant for such a southerly location. Dense communities of mosses and lichens are also found on Litchfield Island (ASPA No. 113) – a site specially protected for exceptional vegetation values – and at several other locations around Arthur Harbor.

The soils and plant communities provide an important habitat for invertebrates, and the ice-free islands and promontories close to Palmer Station are particularly valuable for their abundant populations of the endemic wingless midge *Belgica antarctica*, the southernmost, free-living true insect. This is also of significant value for scientific studies, since this species has not been found to the same extent close to other research stations on the Antarctic Peninsula.

(iii) Educational and visitor values

The southwest Anvers Island area holds a special attraction to tourists because of its biological diversity, accessibility and the presence of Palmer Station. These features offer tourists the opportunity to observe wildlife, and gain an appreciation of Antarctic environments and scientific operations. Outreach to tourists via local tours and shipboard lectures given by scientists is a valuable educational tool, and information is also made available to high school students in the US by initiatives through the LTER program.

2. Aims and objectives

The aim of this Management Plan is to conserve and protect the unique and outstanding environment of the southwest Anvers Island and Palmer Basin region by managing the variety of activities and interests in the Area. The Area requires special management to ensure that these important values are protected and sustained in the long-term, especially the extensive scientific data sets collected over the last 100 years. Increasing human activity and potentially conflicting interests have made it necessary to manage and coordinate activities more effectively within the Area.

The specific objectives of management in the Palmer Basin region are to:

- Facilitate scientific research while maintaining stewardship of the environment;
- Assist with the planning and coordination of human activities in the region, managing potential or actual conflicts of interest among different values, activities and operators, including between different areas of scientific research;
- Ensure that any marine harvesting activities are coordinated with scientific research and other activities taking place within the Area. This coordination could include the development of a plan for harvesting within the Area in advance of any such activities taking place.
- Ensure the long-term protection of scientific, ecological, and other values of the Area through the minimization of disturbance to or degradation of these values, including disturbance to fauna and flora, and to minimize the cumulative environmental impacts of human activities;

- Minimize the footprint of all facilities and scientific experiments established in the Area, including the proliferation of field camps and boat landing sites;
- Promote the use of energy systems and modes of transport that have the least environmental impact, and minimize the use of fossil fuels for the conduct of activities in the Area;
- Encourage communication and co-operation between users of the Area, in particular through dissemination of information on the Area and the provisions that apply.

3. Management activities

To achieve the aims and objectives of this Management Plan, the following management activities are to be undertaken:

- National Programs operating within the Area should establish a Southwest Anvers Island and Palmer Basin Management Group to oversee coordination of activities in the ASMA. The Management Group is established to:
    - facilitate and ensure effective communication among those working in or visiting the Area;
    - provide a forum to resolve any potential conflicts in uses;
    - maintain a record of activities and, where practical, impacts in the Area;
    - develop strategies to detect and address cumulative impacts;
    - evaluate the effectiveness of management activities; and
    - disseminate information on the values and objectives of the ASMA to those working in or visiting the Area.

The Management Group should convene on an annual basis to review past, existing, and future activities and to make recommendations on the implementation of this Management Plan, including its revision when necessary.

- To guide activities in the Area, a general Code of Conduct for activities is included in this Management Plan (see Section 7) and further Guidelines relating to specific activities and zones are included in the Appendices.
- National Programs operating within the Area and tour operators visiting should ensure that their personnel (including staff, crew, visiting scientists and passengers) are briefed on, and are aware of, the requirements of this Management Plan;
- The USAP determines annually the number of tourist vessel visits to Palmer Station (approximately 12 per season) through a pre-season scheduling and approval process;
- Signs and markers shall be erected where necessary and appropriate to show the boundaries of Antarctic Specially Protected Areas (ASPAs) and other zones within the Area. Signs shall be secured and maintained in good condition, and removed when no longer necessary;
- Copies of this Management Plan and supporting documentation will be made available at Palmer Station (US). In addition, the Management Group shall make this information freely available in electronic form to enable visitors to consult plan requirements in advance and to enable them to carry a copy when visiting;
- Visits should be made to the Area as necessary (no less than once every 5 years) to evaluate the effectiveness of the Management Plan, and to ensure that management and maintenance measures are adequate. The Management Plan, Code of Conduct and Guidelines will be revised and updated as necessary.

Note: any activity planned inside an ASPA within the Area requires a permit and must refer to the appropriate management plan for guidance.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

Map 1. Regional map and ASMA boundary.

Map 2. SW Anvers Island Restricted Zones: Rosenthal, Joubin and Dream islands.

Map 3. Arthur Harbor & Palmer Station access.

Map 4. Palmer Station Operations Zone.

Map 5. Torgersen Island Zones.

Map 6. Dream Island Restricted Zone.

Map 7. Litchfield Island, ASPA No.113.

Map 8. Biscoe Point, ASPA No.139.

6. Description of the Area

(i) Geographical co-ordinates, boundary markers and natural features

General description

Anvers Island is the largest and most southerly island in the Palmer Archipelago, located approximately 25km west of the Antarctic Peninsula. It is bounded by Neumayer Channel and Gerlache Strait in the southeast and Bismarck Strait to the south (Map 1). Anvers Island is heavily glaciated, the southwestern half being dominated by the Marr Ice Piedmont, a broad expanse of permanent ice rising gently from the coast to around 1000m elevation. The southern and western coastlines of Anvers Island within the Area comprise mainly ice cliffs on the edge of the Marr Ice Piedmont, punctuated by small rocky outcrops, ice-free promontories and numerous small near-shore islands. Other prominent land features within the Area include ice-free Cape Monaco at the southwestern extremity of Anvers Island, and Cape Lancaster in the southeast. These ice-free areas form important sites for animal and plant colonisation.

Six main island groups exist within the Area: in the north are the Rosenthal Islands (~22km NW of Palmer Station). Fringing the Palmer Basin are the Joubin Islands, the Arthur Harbor island group (location of Palmer Station), the Wauwermans Islands, the Dannebrog Islands and the Vedel Islands. These island groups are of low relief, generally of less than 100m in elevation, although local topography can be rocky and rugged together with small relict ice-caps.

Palmer Station (US) (64°46'27"S, 64°03'15"W) is located within Arthur Harbor on Gamage Point, an ice-free promontory on the southwestern coast of Anvers Island at the edge of the Marr Ice Piedmont (Maps 3 & 4). Immediately to the south of the station are Hero Inlet and Bonaparte Point. Norsel Point lies 2.7km from Palmer Station at the NW extremity of the largest island in Arthur Harbor, which until recently was joined to Anvers Island by an ice-bridge. Other islands within a few km west of the station include Torgersen (Map 5), Humble, Breaker and Litchfield (Map 7) islands, the latter designated as ASPA No. 113. Those nearby to the southeast include Shortcut, Christine, Hermit, Limitrophe, Laggard and Cormorant islands (Map 3). More distant, Biscoe Point, ASPA No. 136, lies on a small island ~14km to the southeast that was until recently also joined by an ice-bridge to Anvers Island (Map 8). To the west, Fraser, Halfway (Map 2) and Dream (Map 6) islands lie 5.9, 6.4 and 9.4km respectively NW of Palmer Station in Wylie Bay.

There are three dominant marine features in the Palmer Basin region:

Shallow shelves: extend from Anvers Island and the adjacent island groups to depths of 90-140m.

Bismarck Strait: located south of Palmer Station and north of the Wauwermans Islands on an east–west axis, with depths generally between 360 to 600 m, connecting the southern entrances to Gerlache Strait and Neumayer Channel to Palmer Basin.

Palmer Basin: the only deep basin in the area, located 22km southwest of Palmer Station and with a maximum depth of ~1400m. It is bordered by the Joubin Islands to the north, the Wauwermans

Islands to the east, and the Dannebrog and Vedel island groups in the southeast, and is surrounded by shelves shallower than 165m. A channel of ~460m depth connects Palmer Basin to the continental shelf edge west of the Area.

Boundaries of the Area

The Southwest Anvers Island and Palmer Basin ASMA encompasses an area of approximately 3275km^2, including both terrestrial and marine components. For ease of navigation, the boundaries of the Area follow geographic features where practical and latitude/longitude lines in open ocean areas remote from prominent land features. The northeastern boundary of the Area is defined as a line extending parallel to and approximately one kilometer inland from the southwest Anvers Island coastline. This terrestrial boundary extends from a northerly location at 64°33'S, 64°06'03"W, ~3.1km north of Gerlache Island, to 64°51'21"S, 63°42'36"W at Cape Lancaster in the south. From Cape Lancaster, the eastern boundary is defined as the 63°42'36"W line of longitude extending 7.9km across Bismarck Strait to 64°55'36"S on Wednesday Island, the most easterly of the Wauwermans Islands. The boundary then follows a general southwesterly direction to 65°08'33"S, 64°14'22"W at the southern extremity of the Vedel Islands, following the eastern coastlines of the Wauwermans, Dannebrog and Vedel island groups. The southern boundary of the area is defined as the 65°08'33"S line of latitude extending due west from 64°14'22"W in the Vedel Islands to 65°00'W.

The northern boundary is defined as the line of latitude extending from 64°33'S, 64°06'03"W to the coast (~3.1km north of Gerlache Island) and thence due west to the 65°00'W line of longitude. The western boundary of the Area is defined as the 65°00'W line of longitude, extending between 64°33'S in the north and 65°08'33"S in the south.

The boundaries of the Area have been designed to include areas of high ecological value while also maintaining a practical configuration for ease of use and navigation. The original Multiple-use Planning Area boundary has been extended northwards to include the Rosenthal Islands, which contain several large colonies of chinstrap and gentoo penguins that may function as source populations for other colonies in the southwest Anvers Island region (W. Fraser *pers. comm.* 2006). The original boundary has also been extended westwards and southwards to include the full extent of the Palmer Basin, because of the biological, palaeoecological and oceanographic importance of this feature.

The extent of the terrestrial component has been revised from the original Multiple-use Planning Area boundary to exclude extensive ice fields on the Marr Ice Piedmont, which do not possess values related to the core objectives of the management plan. The boundary encompasses all ice-free coastal areas, the Palmer Basin which plays a key role in regional ecosystem processes, and the nearby associated island groups, which are biologically important and also the focus of most human activity in the region.

Climate

The western Antarctic Peninsula is experiencing the most rapid warming of any marine ecosystem on the planet (Ducklow *et al.* 2007). The mean annual temperature at Palmer Station between 1974-96 was –2.29° C, with an average minimum monthly air temperature over this period of –7.76° C in August, and a maximum of 2.51° C in January (Baker 1996). Data from Faraday / Vernadsky Station 53km to the south demonstrate a statistically significant trend of annual average temperature rise, from –4.4º in 1951 to –2.0º in 2001, an average rate of 0.057º C per annum (Smith *et al.* 2003). The minimum recorded temperature at Palmer Station as of 2006 is –31° C, and the maximum is 9° C. Storms and precipitation are frequent, with approximately 35-50 cm water equivalent of precipitation received annually in the form of snow and rain (Smith *et al.* 1996). Winds are persistent but generally light to moderate in strength, prevailing from the northeast.

Glaciology, geology and geomorphology

The dominant glacial feature within the Area is the Marr Ice Piedmont. Smaller glaciers and ice-caps are found on many of the islands and promontories, the largest of which is located on Gerlache Island in the Rosenthal Islands (Map 2). Recent observations show the local glaciers to be retreating by

approximately 10m annually, with a number of ice-bridges between the Marr Ice Piedmont and offshore islands having collapsed.

Anvers Island and the numerous small islands and rocky peninsulas along its southwestern coast are composed of late-Cretaceous to early-Tertiary age granitic and volcanic rocks belonging to the Andean Intrusive Suite. These rocks dominate the Anvers Island area (Hooper 1962) and similar rock types extend into the island groups further south.

The main marine geomorphological feature within the Area is Palmer Basin, an erosional, inner-shelf trough located at the convergence of former ice-flows that once drained across the continental shelf from three distinct accumulation centers on the Antarctic Peninsula and Anvers Island (Domack *et al.* 2006). Seafloor features include relict terraces, sub-glacial lake deltas, channels, debris slopes and morainal banks. These remain as evidence of the development of a sub-glacial lake within the Palmer Basin during, or prior, to the last glacial maximum, its subsequent drainage, and the recession of the Palmer Basin ice stream system (Domack *et al*. 2006).

Freshwater habitat

Throughout the Area there are no significant lakes or streams, although there are numerous small ponds and temporary summer melt streams (Lewis Smith 1996). These are mainly on Norsel Point and some of the offshore islands in Arthur Harbor: notably on Humble Island, and also found on Breaker, Shortcut, Laggard, Litchfield and Hermit islands, and at Biscoe Point (W. Fraser, *pers. comm.* 2006), although many are heavily contaminated by neighboring penguin colonies and groups of non-breeding skuas. The streams possess few biota other than marginal mosses (e.g. *Brachythecium austrosalebrosum*, *Sanionia uncinata*), which are a favored habitat for the larvae of the Antarctic wingless midge, *Belgica antarctica*. However, the ponds support a diverse micro-algal and cyanobacterial flora, with over 100 taxa being recorded, although numbers vary considerably between ponds (Parker 1972, Parker & Samsel 1972). Of the freshwater fauna there are numerous species of protozoans, tardigrades, rotifers, and nematodes, and a few free-swimming crustaceans of which the anostracan *Branchinecta gaini* (Antarctic fairy shrimp) and copepods *Parabroteus sarsi* and *Pseudoboeckella poppii* are the largest and most conspicuous (Heywood 1984).

Flora

The Area lies within the cold maritime Antarctic environment of the western Antarctic Peninsula, where conditions of temperature and moisture availability are suitable to support a high diversity of plant species, including the two native flowering plants Antarctic hairgrass (*Deschampsia antarctica*) and Antarctic pearlwort (*Colobanthus quitensis*) (Longton 1967; Lewis Smith 1996, 2003). In Antarctica these flowering plants occur only in the western Peninsula region, South Shetland and South Orkney Islands, occurring most frequently on sheltered, north-facing slopes, especially in gullies and on ledges near sea level. In a few favourable sites the grass has developed locally extensive closed swards (Lewis Smith 1996), notably at Biscoe Point (ASPA No. 139), where closed swards cover up to 6500 m^2. Throughout the maritime Antarctic, and especially in the Arthur Harbor area, the warming trend since the early 1980s has resulted in populations of both species rapidly increasing in number and extent, and numerous new colonies becoming established (Fowbert & Lewis Smith 1994; Day *et al*. 1999).

Vegetation within the Area is otherwise almost entirely cryptogamic (Lewis Smith 1979), with bryophytes dominating moist to wet habitats and lichens and some cushion-forming mosses occupying the drier soils, gravels and rock surfaces (Komárková *et al.* 1985). Dense communities of mosses and lichens are found at several locations around Arthur Harbor, including Norsel Point, Bonaparte Point and Litchfield Island, as well as some of the outer islands and Cape Monaco. In particular, sheltered north-facing slopes support locally extensive communities of the moss turf sub-formations up to 30 cm in depth, with stands of the *Polytrichum strictum–Chorisodontium aciphyllum* association predominating (Lewis Smith 1982). In Arthur Harbor large banks of these mosses can be found overlying an accumulation of peat exceeding a meter in depth and radio-carbon dated at almost 1000 years old. These are particularly apparent on Litchfield Island (ASPA No. 113), which is

protected principally because of its outstanding vegetation values. Smaller examples are found on Laggard Island, Hermit Island and on Norsel Point, with small banks occurring on coastal promontories and islands throughout the Area. The largest of the Joubin Islands has a peat bank composed solely of *Chorisodontium* (Fenton & Lewis Smith 1982). From the late 1970s relictual patches of centuries-old peat formed by these mosses became exposed below the receding ice cliffs of Marr Ice Piedmont, notably on Bonaparte Point (Lewis Smith 1982). Wet level areas and seepage slopes usually support communities of the moss carpet and mat sub-formation in which *Sanionia uncinata, Brachythecium austrosalebrosum* and *Warnstorfia* spp. are usually dominant. One exceptionally extensive stand on Litchfield Island was destroyed by the increasing summer influx of fur seals during the 1980s.

Lichen-dominated (e.g. species of *Usnea*, *Pseudephebe*, *Umbilicaria* and many crustose forms) communities of the fruticose and foliose lichen sub-formation (often referred to as fellfield) are widespread on most stable, dry stony ground and exposed rock surfaces, often with associated cushion-forming mosses (e.g. species of *Andreaea*, *Hymenoloma*, *Orthogrimmia* and *Schistidium*) (Lewis Smith & Corner 1973). Rocks and boulders close to the shore, especially where influenced by nutrient (nitrogen) input from nearby penguin and petrel colonies, usually support various communities of the crustose and foliose lichen sub-formation. Many of the species (e.g. *Acarospora*, *Amandinea*, *Buellia*, *Caloplaca*, *Haematomma*, *Lecanora*, *Lecidea*, *Xanthoria*) are brightly coloured (orange, yellow, gray-green, brown, white).

The green foliose alga *Prasiola crispa* develops a conspicuous zone on the highly nutrient enriched soil and gravel around penguin colonies. In late summer melting ice fields and permanent snow patches develop a reddish hue as huge aggregations of unicellular snow algae accumulate in the melting firn. Elsewhere, green snow algae give the surface a distinctive coloration.

A checklist of flora observed in the Area is included in Appendix C.

Invertebrates

The vegetation communities found within the Area serve as important habitat for invertebrate fauna. As is common elsewhere on the Antarctic Peninsula, springtails and mites are especially prominent. Colonies of the mite *Alaskozetes antarcticus* are frequently observed on the sides of dry rocks, while other species are associated with mosses, fruticose lichens and Antarctic hairgrass. The most common springtail, *Cryptopygus antarcticus*, is found in moss beds and under rocks. Springtails and mites are also found in other habitats, including bird nests and limpet accumulations (Lewis Smith 1966).

The islands near Palmer Station are notable for their abundant populations of the wingless midge *Belgica antarctica*, a feature not found to the same extent close to other research stations on the Antarctic Peninsula. This endemic species is significant because it is the southernmost, free-living true insect. It inhabits a wide range of habitats including moss, the terrestrial alga *Prasiola crispa* and nutrient-enriched microhabitats adjacent to elephant seal wallows and penguin colonies. Larvae are exceptionally tolerant of freezing, anoxia, osmotic stress and desiccation.

Colonies of the seabird tick *Ixodes uriae* are frequently found beneath well-drained rocks adjacent to seabird nests and especially Adélie penguin colonies. This tick has a circumpolar distribution in both hemispheres and exhibits the greatest range of thermal tolerance (-30 to 40°C) of any Antarctic terrestrial arthropod. The abundance of this tick has decreased during the past three decades concomitantly with observed decreases in Adélie penguin populations (R. Lee *pers. comm.* 2007).

Birds

Three species of penguins, Adélie (*Pygoscelis adeliae*), chinstrap (*P. antarctica*) and gentoo (*P. papua*), breed in the southwest Anvers Island area (Parmelee & Parmelee 1987, Poncet & Poncet 1987, Woehler 1993). The most abundant species is the Adélie penguin, which breeds on Biscoe Point, Christine, Cormorant, Dream, Humble, Litchfield and Torgersen islands, as well as the Joubin and Rosenthal islands (Maps 2-8). Numbers of Adélie penguins have declined significantly over the last 30 years, thought to be linked to the effects of the changing climate on sea-ice conditions, snow

accumulation and prey availability (Fraser & Trivelpiece 1996, Fraser & Hofmann 2003, Fraser & Patterson 1997, Trivelpiece & Fraser 1996). Numbers of Adélie penguins breeding on Litchfield Island declined from 884 pairs to 143 pairs between 1974/75 and 2002/03, with no pairs breeding in 2006/07 (W. Fraser *pers. comm.* 2007). Chinstrap penguins are present on Dream Island, on small islands near Gerlache Island, and on the Joubin Islands. The Rosenthal Islands contain source populations of chinstrap and gentoo penguins that are likely to be closely linked to other colonies in the southwest Anvers Island region. Gentoo penguins are thought to be increasing in the region in response to the regional warming, and may be colonising new sites in recently deglaciated areas or sites vacated by Adélie penguins. In particular, small glaciers on the Wauwermans Islands are retreating and may provide important habitat for new gentoo colonies (W. Fraser *pers. comm.* 2006).

Southern giant petrels (*Macronectes giganteus*) breed at numerous locations within the Area. Blue-eyed shags (*Phalacrocorax* [atriceps] *bransfieldensis*) breed on Cormorant Island, Elephant Rocks and in the Joubin Islands. Other breeding bird species occurring in the Area include kelp gulls (*Larus dominicanus*), Wilson's storm petrels (*Oceanites oceanicus*), sheathbills (*Chionis alba*), south polar skuas (*Catharacta maccormicki*), brown skuas (*C. loennbergi*) and Antarctic terns (*Sterna vittata*). Common non-breeding visitors include southern fulmars (*Fulmarus glacialoides*), Antarctic petrels (*Thalassoica antarctica*), cape petrels (*Daption capense*) and snow petrels (*Pagadroma nivea*). A full list of breeding, frequent and less common or transient visitors recorded in the Area is provided in Appendix C.

Marine mammals

There are few published data on the marine mammals within the area. Cruises conducted in Gerlache Strait have observed fin (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*) and southern bottlenose (*Hyperoodon planifrons*) whales (Thiele 2004). Anecdotal observations by Palmer Station personnel and visitors have noted fin, humpback, sei (*Balaenoptera borealis*), southern right (*Eubalaena australis*), minke (*Balaenoptera bonaerensis*) and killer (*Orcinus orca*) whales within the Area, as well as hourglass dolphins (*Lagenorhynchus cruciger*) (W. Fraser *pers. comm.* 2007). Non-breeding Weddell (*Leptonychotes weddellii*) and southern elephant seals (*Mirounga leonina*) haul out on accessible beaches, and crabeater (*Lobodon carcinophagus*) and leopard seals (*Leptonyx hydrurga*) are also commonly seen at sea and on ice floes within the Area. Numbers of non-breeding Antarctic fur seals (*Arctocephalus gazella*), mainly juvenile males, have increased in recent years, and depending on the time of year hundreds to thousands of individuals may be found on local beaches throughout the Area. Their increasing abundance is damaging vegetation at lower elevations (Lewis Smith 1996, Harris 2001). Despite the lack of published data concerning marine mammals within the Area, their presence is likely to be related to foraging for Antarctic krill, which forms an important component in their diets (Ducklow *et al.* 2007). A list of marine mammals observed within the Area is provided in Appendix C.

Oceanography

The Western Antarctic Peninsula is unique as the only region where the Antarctic Circumpolar Current (ACC) is adjacent to the continental shelf. The ACC flows in a northeasterly direction off the shelf, and there is also some southward flow on the inner part of the shelf (Smith *et al*. 1995). Circumpolar Deep Water (CDW) transports macronutrients and warmer, more saline water onto the shelf, which has significant implications for heat and salt budgets in the southwest Anvers Island and Palmer Basin region. Circulation patterns and the presence of the CDW water mass may also affect the timing and extent of sea ice (Smith *et al*. 1995). The extent of sea ice cover and the timing of the appearance of the marginal ice zone (MIZ) in relation to specific geographic areas have high interannual variability (Smith *et al*. 1995), although Smith and Stammerjohn (2001) have shown a statistically significant reduction in overall sea-ice extent in the Western Antarctic Peninsula region over the period for which satellite observations are available. The ice edge and the MIZ form major ecological boundaries, and are of particular interest in the region because of their interaction with many aspects of the marine ecosystem, including phytoplankton blooms and seabird habitat. Within

the Area, the Palmer Basin is a focal point of biological and biogeochemical activity and an important area of upwelling.

Marine ecology

The marine ecosystem west of the Antarctic Peninsula is highly productive, with dynamics that are strongly coupled to the seasonal and interannual variations in sea ice. The rapid climate changes occurring on the western Antarctic Peninsula, with resultant changes in sea ice, is affecting all levels of the food web (Ducklow *et al.* 2007). Marine flora and fauna within the Area are strongly influenced by factors including low temperatures, a short growing season, high winds influencing the depth of the mixed layer, proximity to land with the potential for input of micronutrients, and the varying sea-ice coverage. It is a high-nutrient, low-biomass environment.

High levels of primary production are observed within the region, maintained by topography-induced upwellings and stratification by fresh water input from glaciers (Prézelin *et al.* 2000, 2004; Dierssen *et al.* 2002). In terms of biomass, the phytoplankton communities are dominated by diatoms and cryptomonads (Moline & Prezelin 1996). Species distribution and composition varies with water masses, fronts and the changing position of the ice edge.

Salps and Antarctic krill (*Euphausia* sp.) often dominate the total zooplankton biomass (Moline & Prezelin 1996). Dominant organisms in the neritic province on the shelf southwest of Anvers Island are *E. superba, E. crystallorophias,* and fish larvae (Ross *et al.* 1996). The distribution and abundance of zooplankton is variable over time, and Spiridonov (1995) found krill in the Palmer Archipelago to exhibit a highly variable life cycle as compared with other areas of the western Antarctic Peninsula.

There is a high level of endemism among fish species sampled on the Antarctic continental shelf as compared with other isolated marine communities, with new species still being regularly discovered (Eastman 2005). Examples of fish collected within the Area are six species of Nototheniidae (*Notothenia coriiceps neglecta, N. gibberifrons, N. nudifrons, Trematomus bernachii, T. hansoni* and *T. newnesi*), one of Bathydraconidae (*Parachaenichthys charcoti*) and one of Channichthydae (*Chaenocephalus aceratus*) (De Witt & Hureau 1979, Detrich 1987, McDonald *et al.* 1992).

The soft-bottomed macrobenthic community of Arthur Harbor is characterised by high species diversity and abundance, being dominated by polychaetes, peracarid crustaceans and molluscs (Lowry 1975, Richardson & Hedgpeth 1977, Hyland *et al.* 1994). Samples collected during a study of UV effects on marine organisms carried out close to Palmer Station during the austral spring (Karentz *et al.* 1991) yielded 57 species (1 fish, 48 invertebrates, and 8 algae). Sampling was from a combination of rocky intertidal areas (yielding 72% of organisms), subtidal and planktonic habitats. Of the marine invertebrates collected, the greatest number of species was found in the phylum Arthropoda (12 species). The Antarctic limpet (*Nacella concinna*) is common in Arthur Harbor (Kennicutt *et al*. 1992b).

Human activities and impact

‘Base N’ (UK) was built on Norsel Point (Map 3) in 1955 and operated continuously until 1958. The United States established ‘Old Palmer’ Station nearby on Norsel Point in 1965, although in 1968 transferred the main US operations to the present site of Palmer Station on Gamage Point. ‘Base N’ was used as a biological laboratory by US scientists from 1965-71, although this burnt to the ground in 1971. ‘Old Palmer’ station was removed by the US in 1991, and all that remains of both ‘Old Palmer’ and ‘Base N’ are the original concrete footings.

On 28 January 1989, the Argentine vessel *Bahia Paraiso* ran aground 750m south of Litchfield Island, releasing more than 600,000 liters (150,000 gallons) of petroleum into the surrounding environment (Kennicutt 1990, Penhale *et al.* 1997). Contamination was lethal to some of the local biota including krill, intertidal invertebrates and seabirds, particularly Adélie penguins and blue-eyed shags (Hyland *et al.* 1994, Kennicutt *et al.* 1992a&b, Kennicutt & Sweet 1992). A summary of the spill, research on the environmental impact, and the joint 1992/1993 clean-up by Argentina –and The Netherlands can be found in Penhale *et al.* (1997).

All fin-fishing is currently prohibited in the western Antarctic Peninsula region (CCAMLR Statistical Subarea 48.1) under CCAMLR Conservation Measure 32-02 (1998) (CCAMLR 2006a). Krill fishing occurs in the offshore region to the northwest of the Palmer Archipelago, and is currently concentrated mainly around the South Shetland Islands further to the north. The total krill catch for Subarea 48.1 was reported at 7095 tonnes in the 2004/05 season (CCAMLR 2006b), and there has been some limited historical activity in the vicinity of the ASMA. However, fine-scale data show krill catches in the southwest Anvers Island region during only one 3-month period between 2000 and 2005, with a total catch of less than 4 tonnes (Q2, 2002/03)(CCAMLR 2006b: 187). CCAMLR-related activities are therefore occurring within or close to the Area, but are currently minimal.

Current human activities in the Area are mainly related to science and associated logistic activities, and tourism. Palmer Station (US) serves as the base for scientific research and associated logistic operations conducted in the western Antarctic Peninsula and Palmer Archipelago by the United States Antarctic Program (USAP) and collaborators from a number of other Antarctic Treaty Parties. Scientific and logistic support is received from ships operated or chartered by the USAP, which visit the station approximately 15 times per year. Aircraft are not operated routinely from Palmer Station, although helicopters may visit occasionally in summer. Local scientific transport and support is provided using small inflatable boats, which are operated throughout the 3-mile (~5km) 'safe boating limit' area during the summer season (Map 3). Frequent visits are made to islands within the safe boating limit for scientific research, and also for recreation by base personnel.

Published information on the impacts of science (for example from sampling, disturbance or installations) within the Area is limited. However, numerous welding rods inserted into soil to mark vegetation study sites (Komárková 1983) were abandoned at Biscoe Point (ASPA No. 139) and Litchfield Island (ASPA No. 113) in 1982. Where these remained, surrounding vegetation had been killed as an apparent result of highly localised contamination by chemicals from the rods (Harris 2001).

Between 1984/85 and 1990/91, the number of tour ship visits each season at Palmer Station increased from 4 visits (340 visitors) to 12 (1300 visitors). Since 1991 the number of tour ship visits to Palmer Station has been maintained at approximately 12 vessels annually, with visits arranged prior to the start of the season. Tourists typically land at the station itself for a tour of the facilities, visit the Visitor Zone on Torgersen Island (Map 5), and make short cruises around the nearshore islands using inflatable boats. Yachts also visit Palmer Station and the surrounding area, with 17 vessels visiting during the 2007/08 season. Studies of changes in penguin populations on Torgersen Island and nearby islands suggest that the impacts of visits by tourists, base personnel, and scientists on breeding performance have been small compared to longer-term climate-related forcing factors (Fraser & Patterson 1997, Emslie *et al.* 1998, Patterson 2001).

(ii) Structures within the Area

Modern Palmer Station (Map 4) consists of two main buildings, a laboratory facility and several ancillary structures including an aquarium, small boathouse, workshops, storage and communications facilities. The station is powered by one diesel-electric generator, the fuel for which is stored in two double-walled tanks. A pier has been constructed adjacent to the station at the entrance to Hero Inlet, which may accommodate medium-sized scientific and logistic support ships. The station is operated year-round and can accommodate approximately 44 people, with a summer occupancy of at least 40, and a winter complement of around 10.

(iii) Restricted and managed zones within the Area

Three types of management zones (Restricted, Visitor and Operations) are designated within the Area. Two ASPAs are also located within the Area.

(a) Restricted Zones

Sixteen sites of special ecological and scientific value are designated as Restricted Zones (Maps 2-6). These sites are particularly sensitive to disturbance during the summer months, and are listed as follows:

Table 1: Restricted Zones within the Southwest Anvers Island and Palmer Basin ASMA

Bonaparte Point (incl. 'Diana's Island' and 'Kristie Cove')	Laggard Island
Christine Island	Limitrophe Island
Cormorant Island	Norsel Point
Dream Island	Rosenthal Islands
Elephant Rocks	Shortcut Island
Hermit Island	Shortcut Point
Humble Island	Stepping Stones
Joubin Islands	Torgersen Island (SW half of island)

The Restricted Zones include a buffer extending 50m from the shore into any adjacent marine area (Map 2). A 50m Restricted Zone buffer also extends around Litchfield Island (ASPA No. 113). In order to protect sensitive bird colonies throughout the breeding season to the maximum extent possible, and also plant communities, access to Restricted Zones between 1 October to 15 April inclusive is restricted to those conducting essential scientific research, monitoring or maintenance. All non-essential small boat traffic should avoid transit of or cruising within the 50m marine buffers of Restricted Zones.

Specific guidelines for scientific research activities within Restricted Zones are included in the Scientific Guidelines for the ASMA (Appendix A).

(b) Visitor Zone

The northeastern half of Torgersen Island is designated as a Visitor Zone (Map 5). Visitors are currently directed to this part of the island, while access to the Restricted Zone in the southwest part of the island, which is set aside as a scientific reference area, is restricted to those conducting essential scientific research, monitoring or maintenance. Specific guidelines for activities within the Visitor Zone are included in the Visitor Guidelines for the ASMA (Appendix B).

(c) Operations Zone

Palmer Station facilities are largely concentrated within a small area on Gamage Point. The Operations Zone is designated as the area of Gamage Point encompassing the station buildings, together with adjacent masts, aerials fuel storage facilities and other structures and extending to the permanent ice edge of the Marr Ice Piedmont (Map 4).

(d) Antarctic Specially Protected Areas (ASPAs)

Two Antarctic Specially Protected Areas, ASPA No. 113 Litchfield Island and ASPA No. 139 Biscoe Point, are located within the ASMA (Maps 7 and 8). Revised management plans for both sites were adopted by the Antarctic Treaty Parties in 2004. All entry is prohibited unless in accordance with a Permit issued by an appropriate national authority.

(iv) Location of other protected areas within close proximity of the Area

In addition to ASPA No. 113 and ASPA No. 139 within the Area, the only other protected area within close proximity is ASPA No. 146, South Bay, Doumer Island, 25km southeast of Palmer Station (Map

1). There are no Historic Sites and Monuments within the Area, with the nearest being HSM No. 61, Base A, Port Lockroy, Goudier Island, 30km east of Palmer Station (Map 1).

7. General code of conduct

The Code of Conduct in this section is the main instrument for the management of activities in the Area. It outlines the overall management and operational principles for the Area. More specific environmental, scientific and visitor guidelines are provided in the appendices.

(i) Access to and movement within the Area

Access to the Area is generally by ship (Map 4), with occasional access by helicopter. There are no special restrictions on the transit of vessels through the Area, with the exception of seasonal buffer zones extending 50m from the shore at a small number of islands designated as Restricted Zones (see Section 6(iii)(a)). Prior to visiting Palmer Station, radio contact should always be made to obtain guidance on local activities being conducted in the region (Map 3).

Tour ships, yachts and National Program vessels may stand offshore and access Palmer Station and the surrounding coast and islands by small boat, taking into account the access restrictions applying within designated zones. The region of safe small boat operations and preferred small boat landing sites within the area local to Palmer Station are shown on Map 3 (see also Appendix A).

Access to Restricted Zones between 1 October – 15 April inclusive is restricted to those conducting essential scientific research, monitoring or maintenance, including the nearshore marine area within 50m of the coast of these zones (see Section 6(iii)(a) for details). Access to ASPAs is prohibited except in accordance with a Permit issued by an appropriate national authority.

Aircraft operating within the Area should follow the 'Guidelines for the operation of aircraft near concentrations of birds in Antarctica' (Resolution 4, XXVII Antarctic Treaty Consultative Meeting). The primary helicopter landing site at Palmer Station is a flat, rocky area approximately 400m east of Palmer Station. Helicopter approach should be high over the peninsula east of Palmer Station or up the channel from SE (refer to Palmer Station page in the Anvers Island section of the *Wildlife Awareness Manual* (Harris 2006)). Overflight of wildlife colonies should be avoided throughout the Area, and specific overflight restrictions apply at Litchfield Island (ASPA No.113) and Biscoe Point (ASPA No.139) (Maps 7 & 8 and specific provisions in the ASPA management plans).

Movement on land within the Area is generally on foot, although vehicles are used in the Operations Zone. A route leading from Palmer Station up onto the Marr Ice Piedmont is marked by flags to avoid crevassed areas. The precise route varies according to conditions and visitors should obtain the latest information on the route from Palmer Station. In the winter, snowmobiles are sometimes used on this route. All movement should be undertaken carefully to minimise disturbance to animals, soil and vegetated areas.

(ii) Activities that are or may be conducted within the Area

Activities that may be conducted in the Area include:

- scientific research, or the logistical support of scientific research, that will not jeopardise the values of the Area;
- management activities, including the maintenance or removal of facilities, clean-up of abandoned work-sites, and monitoring the implementation of this Management Plan; and
- tourist or private expedition visits consistent with the provisions of this Management Plan and the Visitor Guidelines (Appendix B);
- media, arts, education or other official national program visitors;
- harvesting of marine living resources, which should be conducted in accordance with the provisions of this Management Plan and with due recognition of the important scientific and environmental values of the Area. Any such activities should be conducted in coordination with research and other activities taking place, and could include development of a plan and guidelines

that would help to ensure that harvesting activities did not pose a significant risk to the other important values of the Area.

All activities in the Area should be conducted in such a manner so as to minimize environmental impacts. Specific guidelines on the conduct of activities within the Area, including within specific zones, can be found in the Appendices.

(iii) Installation, modification or removal of structures

Site selection, installation, modification or removal of temporary refuges or tents should be undertaken in a manner that does not compromise the values of the Area. Installation sites should be re-used to the greatest extent possible and the location recorded. The footprint of installations should be kept to the minimum practical.

Scientific equipment installed in the Area should be clearly identified by country, name of principal investigator, contact details, and date of installation. All such items should be made of materials that pose minimal risk of contamination to the area. All equipment and associated materials should be removed when no longer in use.

(iv) Location of field camps

Temporary field camps may be made where required for research, and in accordance with the Restricted Zone and ASPA provisions. Field camps should be located on non-vegetated sites, or on thick snow or ice cover when practical, and should avoid concentrations of mammals or breeding birds. The location of field camps should be recorded, and previously occupied campsites should be re-used where appropriate. The footprint of campsites should be kept to the minimum practical.

Emergency caches are located on several islands within the Area for safety purposes, and are identified on Map 3. Please respect the caches and only use them in a genuine emergency, reporting any such use to Palmer Station so the cache can be restocked.

(v) Taking or harmful interference with native flora and fauna

Taking (including killing or capturing) or harmful interference with native flora or fauna is prohibited, except by Permit issued in accordance with Annex II to the *Protocol on Environmental Protection to the Antarctic Treaty* (1998).

(vi) Collection or removal of anything not brought into the Area

Material not covered by 7(v) above should only be removed from the area for scientific and associated educational purposes or essential management or conservation purposes, and should be limited to the minimum necessary to fulfill those needs. Material of human origin likely to compromise the values of the Area may be removed unless the impact of removal is likely to be greater than leaving the material in place. If this is the case the appropriate authority should be notified. Do not disturb experimental sites or scientific equipment.

(vii) Restrictions on materials and organisms which can be brought into the Area

Visitors should seek to minimize the risk of introduction of non-native species to the maximum extent practical.

(viii) Waste disposal / management

All wastes other than human wastes and domestic liquid waste shall be removed from the Area. Human and domestic liquid wastes from stations or field camps may be disposed of into the sea below the high water mark. In accordance with Article 4, Annex III of the Protocol on Environmental Protection, wastes shall not be disposed of into freshwater streams or lakes, onto ice-free areas, or onto areas of snow or ice which terminate in such areas or have high ablation.

(ix) Requirements for Reports

Reports of activities in the Area should be maintained by the Management Group to the greatest extent possible, and made available to all Parties. In accordance with Article 10 of Annex V of the Protocol on Environmental Protection, arrangements should be made for collection and exchange of reports of inspection visits and on any significant changes or damage within the Area.

Tour operators should record their visits to the Area, including the number of visitors, dates, and any incidents in the Area.

8. Exchange of information

In addition to the normal exchange of information by means of the annual national reports to the Parties of the Antarctic Treaty, and to SCAR and COMNAP, Parties operating in the Area should exchange information through the Management Group. All National Antarctic Programs planning to conduct scientific activities within the Area should, as far as practical, notify the Management Group in advance of their nature, location and expected duration, and any special considerations related to the deployment of field parties or scientific instrumentation within the Area.

All tour ships and yachts should, as far as practical, provide the Management Group with details of scheduled visits in advance.

All those planning to conduct marine harvesting activities within the Area should, as far as practical, notify the Management Group in advance of their nature, location and expected duration, and of any special considerations related to how these activities could impact on scientific investigations being carried out within the Area.

Information on the location of scientific activities within the Area should be disseminated as far as practical.

9. Supporting documentation

This Management Plan includes the following supporting documents as appendices:

- Appendix A: Scientific and Environmental Guidelines (including guidelines for Restricted Zones);
- Appendix B: Visitor Guidelines (including guidelines for the Visitor Zone);
- Appendix C: Plant, bird and mammal species recorded within the Southwest Anvers Island and Palmer Basin ASMA;
- Appendix D: References.

Appendices

Appendix A - Supporting Guidelines and Data

Scientific and Environmental Guidelines (including guidelines for Restricted Zones)

The coastal marine environmental of the West Antarctic Peninsula has become an important site for scientific research, with a history of study going back some fifty years. This code suggests how you can help to protect the values of the area for future generations and ensure that your presence in the region will have as little impact as possible.

- Everything taken into the field must be removed. Do not dump any unwanted material on the ground or in the water.
- Do not collect specimens or any natural material of any kind, including fossils, except for approved scientific and educational purposes.
- For those based at Palmer Station, stay within the safe boating limits: these are approximately 5km (3 miles) from the station and no closer than 300m from the glacier front along the Anvers Island coastline (Map 3).
- Visit only approved islands at approved times. Do not harass wildlife. Do not disturb mummified seals or penguins.
- When traveling on foot, stay on established trails whenever possible. Do not walk on vegetated areas or rock formations. Some of the biological communities in them have taken several thousand years to develop.
- Ensure that equipment and supplies are properly secured at all times to avoid dispersion by high winds. High velocity winds can arrive suddenly and with little warning.
- Avoid any activities that would result in the dispersal of foreign substances (e.g., food, fuel, reagents, litter). Do not leave any travel equipment behind.

Fuel and chemicals:

- Take steps to prevent the accidental release of chemicals such as laboratory reagents and isotopes (stable or radioactive). When permitted to use radioisotopes, precisely follow all instructions provided.
- Ensure you have spill kits appropriate to the volume of fuel or chemicals you have and are familiar with their use.

Sampling and experimental sites:

- All sampling equipment should be clean before being brought into the field.
- Once you have drilled a sampling hole in sea ice or dug a soil pit, keep it clean and make sure all your sampling equipment is securely tethered.
- Avoid leaving markers (e.g. flags) and other equipment for more than one season without marking them clearly with your event number and duration of your project.

Glaciers:

- Minimize the use of liquid water (e.g., with hot water drills) which could contaminate the isotopic and chemical record within the glacier ice.
- Avoid the use of chemical-based fluids on the ice.
- If stakes or other markers are placed on a glacier, use the minimum number of stakes required to meet the needs of the research; where possible, label these with event number and project duration.

Restricted Zones:

- Research in Restricted Zones should be carried out with particular care to avoid or minimize trampling of vegetation and disturbance of wildlife;
- Minimize any disturbance to birds during the breeding season (1 October to 15 April) except for compelling scientific reasons;

All visits to and activities within Restricted Zones should be recorded, in particular records should be kept of the type and quantity of all sampling.

- ***Appendix B - Visitor Guidelines (including guidelines for the Visitor Zone)***
- These guidelines are for commercial tour operators and private expeditions, as well as for National Antarctic Program staff when undertaking recreational activities within the Area.

- Visitor activities should be undertaken in a manner so as to minimize adverse impacts on the southwest Anvers Island and Palmer Basin ecosystem and/or on the scientific activities in the Area;
- Tour operators should provide visit schedules to National Programs operating in the Area in advance of their visits, which should be circulated to the Management Group as soon as they become available;
- In addition to the above, tour vessels and yachts planning to visit Palmer Station should make contact with the station at least 24 hours before arrival to confirm details of the visit;
- At Palmer Station, no more than 40 passengers should be ashore at any time;
- Small boat cruising should avoid any disturbance of birds and seals, and take account of the 50m operation limit around Restricted Zones;
- Visitors should maintain a distance of 5 meters from birds or seals, to avoid causing them disturbance. Where practical, keep at least 15 meters away from fur seals;
- Visitors should avoid walking on any vegetation including mosses and lichens;
- Visitors should not touch or disturb scientific equipment, research areas, or any other facilities or equipment;
- Visitors should not take any biological, geological or other souvenirs, or leave behind any litter;
- Within the group of islands in Arthur Harbor, tourist landings should be confined to the designated Visitor Zone.

- **Visitor Zone (Torgersen Island)**
- Visits to Torgersen Island should be undertaken in accordance with the general visitor guidelines outlined above. Further site-specific guidelines are as follows:

- Landings on Torgersen Island should be made at the designated small boat landing site at 64°46'17.8"S, 64°04'31"W on the northern shore of the island;
- No more than 40 passengers should be ashore at any time;
- Visitors should limit their visit to the Visitor Zone portion of the island, as the Restricted Zone is a control site for scientific research (Map 5).

- ***Appendix C - Plant, bird and mammal species recorded within the Southwest Anvers Island and Palmer Basin ASMA***

- Table C.1: Plant species recorded within the Area (extracted from British Antarctic Survey Plant Database (2007)).

Flowering plants	**Lichens**
Colobanthus quitensis *Deschampsia antarctica*	*Acarospora macrocyclos* *Amandinea petermannii* *Buellia anisomera, B. melanostola, B. perlata, B. russa* *Catillaria corymbosa* *Cetraria aculeata* *Cladonia carneola, C. deformis, C. fimbriata, C. galindezii, C. merochlorophaea var. novochloro, C. pleurota, C. pocillum, C. sarmentosa, C. squamosa* *Coelopogon epiphorellus* *Haematomma erythromma* *Himantormia lugubris* *Lecania brialmontii* *Lecanora polytropa, L. skottsbergii* *Leptogium puberulum* *Massalongia carnosa* *Mastodia tessellata* *Melanelia ushuaiensis* *Ochrolechia frigida* *Parmelia cunninghamii, P. saxatilis* *Physcia caesia, P. dubia* *Physconia muscigena* *Pseudephebe minuscula, P. pubescens* *Psoroma cinnamomeum, P. hypnorum* *Rhizoplaca aspidophora* *Rinodina turfacea* *Sphaerophorus globosus* *Stereocaulon alpinum* *Umbilicaria antarctica, U. decussata* *Usnea antarctica, U. aurantiaco-atra* *Xanthoria candelaria* *Xanthoria elegans*
Liverworts	
Barbilophozia hatcheri *Cephaloziella varians* *Lophozia excisa*	
Mosses	
Andreaea depressinervis, A. gainii var. gainii, A. regularis M *Bartramia patens* *Brachythecium austrosalebrosum* *Bryum archangelicum, B. argenteum, B. boreale, B. pseudotriquetrum* *Ceratodon purpureus* *Chorisodontium aciphyllum* *Dicranoweisia crispula, D. dryptodontoides* *Grimmia reflexidens* *Hymenoloma grimmiaceum* *Kiaeria pumila* *Platydictya jungermannioides* *Pohlia cruda, P. nutans* *Polytrichastrum alpinum* *Polytrichum juniperinum, P.piliferum, P. strictum* *Sanionia uncinata* *Sarconeurum glaciale* *Schistidium antarctici, S. urnulaceum* *Syntrichia magellanica* *Syntrichia princeps, S. sarconeurum* *Warnstorfia laculosa*	

Notes: The number of species recorded within the Area = 83

- Table C.2: Bird and mammal species recorded within the Area (Parmelee et al. 1977; W. Fraser pers. comm. 2007).

Common name	Scientific name	Status within Area
Birds		
chinstrap penguin	*Pygoscelis antarctica*	Confirmed breeder
Adélie penguin	*Pygoscelis adeliae*	Confirmed breeder
gentoo penguin	*Pygoscelis papua*	Confirmed breeder
southern giant petrel	*Macronectes giganteus*	Confirmed breeder
blue-eyed shag	*Phalacrocorax* [atriceps] *bransfieldensis*	Confirmed breeder
kelp gull	*Larus dominicanus*	Confirmed breeder
Wilson's storm petrel	*Oceanites oceanites*	Confirmed breeder
sheathbill	*Chionis alba*	Confirmed breeder
south polar skua	*Catharacta maccormicki*	Confirmed breeder
brown skua	*Catharacta loennbergi*	Confirmed breeder
Antarctic tern	*Sterna vittata*	Confirmed breeder
southern fulmar	*Fulmarus glacialoides*	Frequent visitor
Antarctic petrel	*Thalassoica antarctica*	Frequent visitor
cape petrel	*Daption capense*	Frequent visitor
snow petrel	*Pagadroma nivea*	Frequent visitor
emperor penguin	*Aptenodytes forsteri*	Occasional visitor
king penguin	*A. patagonicus*	Occasional visitor
macaroni penguin	*Eudyptes chrysolophus*	Occasional visitor
rockhopper penguin	*Eudyptes chrysocome*	Occasional visitor
Magellanic penguin	*Spheniscus magellanicus*	Occasional visitor
black-browed albatross	*Diomedea melanophris*	Occasional visitor
gray-headed albatross	*D. chrystosoma*	Occasional visitor
northern giant petrel	*Macronectes halli*	Occasional visitor
black-bellied storm petrel	*Fregetta tropica*	Occasional visitor
red phalarope	*Phalaropus fulicarius*	Occasional visitor
South Georgia pintails	*Anas georgica*	Occasional visitor
black-necked swan	*Cygnus melancoryphus*	Occasional visitor
sandpiper	(sp. unknown)	Occasional visitor
cattle egret	*Bubulcus ibis*	Occasional visitor
Arctic tern	*Sterna paradisaea*	Occasional visitor
Seals (no data on breeding or numbers available)		
Weddell seal	*Leptonychotes weddellii*	Frequent visitor
southern elephant seal	*Mirounga leonina*	Frequent visitor
crabeater seal	*Lobodon carcinophagus*	Frequent visitor
leopard seal	*Leptonyx hydrurga*	Frequent visitor
Antarctic fur seals	*Arctocephalus gazella*	Frequent visitor
Whales and dolphins (no data on breeding or numbers available)		
fin whale	*Balaenoptera physalus*	Observed
humpback whale	*Megaptera novaeangliae*	Observed
sei whale	*Balaenoptera borealis*	Observed
southern right whale	*Eubalaena australis*	Observed
minke whale	*Balaenoptera bonaerensis*	Observed
killer whale	*Orcinus orca*	Observed
hourglass dolphins	*Lagenorhynchus cruciger*	Observed

- *Appendix D - References*

- Baker, K.S. 1996. Palmer LTER: Palmer Station air temperature 1974 to 1996. *Antarctic Journal of the United States* **31**(2): 162-64.
- CCAMLR 2006a. Schedule of Conservation Measures in force 2006/07 season. CCAMLR, Hobart, Australia.
- CCAMLR 2006b. Statistical Bulletin, Vol. 18 (1996*2005). CCAMLR, Hobart, Australia.
- Day, T.A., C.T. Ruhland, C.W. Grobe & F. Xiong 1999. Growth and reproduction of Antarctic vascular plants in response to warming and UV radiation reductions in the field. *Oecologia* **119**: 24-35.
- Detrich III, H.W. 1987. Formation of cold-stable microtubules by tubulins and microtubule associated proteins from Antarctic fishes. *Antarctic Journal of the United States* **22**(5): 217-19.
- Domack E., D. Amblàs, R. Gilbert, S. Brachfeld, A. Camerlenghi, M. Rebesco, M. Canals & R. Urgeles 2006. Subglacial morphology and glacial evolution of the Palmer deep outlet system, Antarctic Peninsula. *Geomorphology* **75**(1-2): 125-42.
- Ducklow, H.W., K.S. Baker, D.G. Martinson, L.B. Quetin, R.M. Ross, R.C. Smith, S.E. Stammerjohn, M. Vernet & W. Fraser 2007. Marine pelagic ecosystems: The West Antarctic Peninsula. Special Theme Issue, Antarctic Ecology: From Genes to Ecosystems. *Philosophical Transactions of the Royal Society of London* **362**: 67-94.
- Eastman, J.T. 2005. The nature and diversity of Antarctic fishes. *Polar Biology* **28**(2): 93-107.
- Emslie, S.D., W.R. Fraser, R.C. Smith & W. Walker 1998. Abandoned penguin colonies and environmental change in the Palmer Station area, Anvers Island, Antarctic Peninsula. *Antarctic Science* **10**(3): 257-68.
- Fraser, W.R. & Trivelpiece, W.Z. 1996. Factors controlling the distribution of seabirds: winter-summer heterogeneity in the distribution of Adélie penguin populations. In: R. Ross, E. Hofmann, & L. Quetin (eds) *Foundations for ecological research west of the Antarctic Peninsula*. *Antarctic Research Series* **70**. American Geophysical Union, Washington, DC: 257-52.
- Fraser, W.R. & Hofmann, E.E. 2003. A predator's perspective on causal links between climate change, physical forcing and ecosystem response. *Marine Ecology Progress Series* **265**: 1-15.
- Fraser, W.R. & Patterson, D.L. 1997. Human disturbance and long-term changes in Adélie penguin populations: a natural experiment at Palmer Station, Antarctic Peninsula. In: B. Battaglia, J. Valencia & D. Walton (eds) *Antarctic communities: species, structure and survival*. Cambridge University Press, Cambridge: 445-52.
- Fraser, W.R., W.Z. Trivelpiece, D.G. Ainley & S.G. Trivelpiece 1992**.** Increases in Antarctic penguin populations: reduced competition with whales or a loss of sea ice due to global warming? *Polar Biology* **11**: 525-31.
- Fenton, J.H.C. & Lewis Smith, R.I. 1982. Distribution, composition and general characteristics of the moss banks of the maritime Antarctic. *British Antarctic Survey Bulletin* **51**: 215-36.
- Fowbert, J.A. & Lewis Smith, R.I. 1994. Rapid population increases in native vascular plants in the Argentine Islands, Antarctic Peninsula. *Arctic and Alpine Research* **26**: 290-96.

- Harris, C.M. 2001. Revision of management plans for Antarctic Protected Areas originally proposed by the United Kingdom and the United States of America: 2001 field visit report. Unpublished report, Environmental Research & Assessment, Cambridge.
- Harris, C.M. (ed) 2006. *Wildlife Awareness Manual: Antarctic Peninsula, South Shetland Islands, South Orkney Islands*. First Edition. Wildlife Information Publication No. 1. Prepared for the UK Foreign & Commonwealth Office and HMS *Endurance*. Environmental Research & Assessment, Cambridge.
- Heywood, R.B. 1984. Antarctic inland waters. In: R. Laws (ed) *Antarctic ecology* (Volume 1). Academic Press, London: 279-344.
- Hooper, P.R. 1962. The petrology of Anvers Island and adjacent islands. *FIDS Scientific Reports* **34**.
- Huiskes, A.H.L., D. Lud, T.C.W. Moerdijk-Poortviet, & J. Rozema 1999. Impact of UV-B radiation on Antarctic terrestrial vegetation. In: J. Rozema (ed) *Stratospheric ozone depletion; the effects of enhancing UV-B radiation on terrestrial ecosystems*. Blackhuys Publishers, Leiden: 313-37.
- Kennicutt II, M.C. 1990. Oil spillage in Antarctica: initial report of the National Science Foundation-sponsored quick response team on the grounding of the *Bahia Paraiso*. *Environmental Science and Technology* **24**: 620-24.
- Kennicutt II, M.C., T.J. McDonald, G.J. Denoux & S.J. McDonald 1992a. Hydrocarbon contamination on the Antarctic Peninsula I. Arthur Harbor – subtidal sediments. *Marine Pollution Bulletin* **24**(10): 499-506.
- Kennicutt II, M.C., T.J. McDonald, G.J. Denoux & S.J. McDonald 1992b. Hydrocarbon contamination on the Antarctic Peninsula I. Arthur Harbor – inter- and subtidal limpets (*Nacella concinna*). *Marine Pollution Bulletin* **24**(10): 506-11.
- Kennicutt II, M.C & Sweet, S.T. 1992. Hydrocarbon contamination on the Antarctic Peninsula III. The *Bahia Paraiso* – two years after the spill. *Marine Pollution Bulletin* **24**(9-12): 303-06.
- Komárková, V. 1983. Plant communities of the Antarctic Peninsula near Palmer Station. *Antarctic Journal of the United States* **18**: 216-18.
- Komárková, V. 1984. Studies of plant communities of the Antarctic Peninsula near Palmer Station. *Antarctic Journal of the United States* **19**: 180-82.
- Komárková, V., S. Poncet & J. Poncet 1985. Two native Antarctic vascular plants, *Deschampsia antarctica* and *Colobanthus quitensis*: a new southernmost locality and other localities in the Antarctic Peninsula area. *Arctic and Alpine Research* **17**(4): 401-16.
- Lascara, C.M., E.E. Hofmann, R.M. Ross & L.B. Quetin 1999. Seasonal variability in the distribution of Antarctic krill, *Euphausia superba*, west of the Antarctic Peninsula. *Deep Sea Research Part I: Oceanographic Research Papers* **46**(6): 951-84.
- Lewis Smith, R.I. & Corner, R.W.M. 1973. Vegetation of the Arthur Harbour-Argentine Islands region of the Antarctic Peninsula. *British Antarctic Survey Bulletin* **33-34**: 89-122.
- Lewis Smith, R.I. 1979. Peat forming vegetation in the Antarctic. In: E. Kivinen, L. Heikurainen & P. Pakarinen (eds), *Classification of peat and peatlands*. University of Helsinki, Helsinki: 58-67.
- Lewis Smith, R.I. 1982. Plant succession and re-exposed moss banks on a deglaciated headland in Arthur Harbour, Anvers Island. *British Antarctic Survey Bulletin* **51**: 193-99.
- Lewis Smith, R.I. 1996. Terrestrial and freshwater biotic components of the western Antarctic Peninsula. In: R. Ross, E. Hofmann, & L. Quetin (eds) *Foundations for*

ecological research west of the Antarctic Peninsula. *Antarctic Research Series* **70**. American Geophysical Union, Washington, DC: 15-59.

- Lewis Smith, R.I. 2003. The enigma of *Colobanthus quitensis* and *Deschampsia antarctica* in Antarctica. In A. Huiskes, W. Gieskes, J. Rozema, R. Schorno, S. van der Vies & W. Wolff (eds) *Antarctic biology in a global context*. Backhuys Publishers, Leiden: 234-39.
- Longton, R.E. 1967. Vegetation in the maritime Antarctic. In: J. Smith (ed) A discussion on the terrestrial Antarctic ecosystem. *Philosophical Transactions of the Royal Society of London* **252B**(777): 213-35.
- McDonald, S., M. Kennicutt II, K. Foster-Springer & M. Krahn 1992. Polynuclear aromatic hydrocarbon exposure in Antarctic fish. *Antarctic Journal of the United States* **27**(5): 333-35.
- Moline, M.A. & Prezelin, B.B. 1996. Palmer LTER 1991-1994: long term monitoring and analysis of physical factors regulating variability in coastal Antarctic phytoplankton biomass, in situ productivity and taxanomic composition over subseasonal, seasonal and interannual time scales phytoplankton dynamics. *Marine Ecology Progress Series* **145**: 143-60.
- Parker, B.C. 1972. Conservation of freshwater habitats on the Antarctic Peninsula. In: B. Parker (ed) *Conservation problems in Antarctica*. Allen Press Inc., Lawrence, Kansas: 143-162.
- Parker, B.C. & Samsel, G.L. 1972. Fresh-water algae of the Antarctic Peninsula. 1. Systematics and ecology in the U.S. Palmer Station area. In: G. Llano (ed) *Antarctic terrestrial biology*. *Antarctic Research Series* **20**. American Geophysical Union, Washington, DC: 69-81.
- Parmelee, D.F., W.R. Fraser & D.R. Neilson 1977. Birds of the Palmer Station area. *Antarctic Journal of the United States* **12**(1-2): 15-21.
- Parmelee, D.F. & Parmelee, J.M. 1987. Revised penguin numbers and distribution for Anvers Island, Antarctica. *British Antarctic Survey Bulletin* **76**: 65-73.
- Patterson, D.L. 2001. The effects of human activity and environmental variability on long-term changes in Adélie penguin populations at Palmer Station, Antarctica. Unpublished MSc thesis in Fish & Wildlife Management, Montana State University, Bozeman.
- Patterson, D.L., E.H. Woehler, J.P. Croxall, J. Cooper, S. Poncet & W.R. Fraser (in press). Breeding distribution and population status of the northern giant petrel *Macronectes halli* and the southern giant petrel *M. giganteus*. *Marine Ornithology* (submitted).
- Penhale, P.A., J. Coosen & E.R. Marshcoff 1997. The *Bahai Paraiso*: a case study in environmental impact, remediation and monitoring. In: B. Battaglia, J. Valencia & D. Walton (eds) *Antarctic Communities: species, structure and survival*. Cambridge University Press, Cambridge: 437-44.
- Poncet, S. & Poncet, J. 1987. Censuses of penguin populations of the Antarctic Peninsula 1983-87. *British Antarctic Survey Bulletin* **77**: 109-29.
- Smith, R.C. & Stammerjohn, S.E. 2001. Variations of surface air temperature and sea-ice extent in the western Antarctic Peninsula (WAP) region. *Annals of Glaciology* **33**(1): 493-500.
- Smith, R.C., K.S. Baker, W.R. Fraser, E.E. Hofmann, D.M. Karl, J.M. Klinck, L.B. Quetin, B.B. Prézelin, R.M. Ross, W.Z. Trivelpiece & M. Vernet 1995. The Palmer

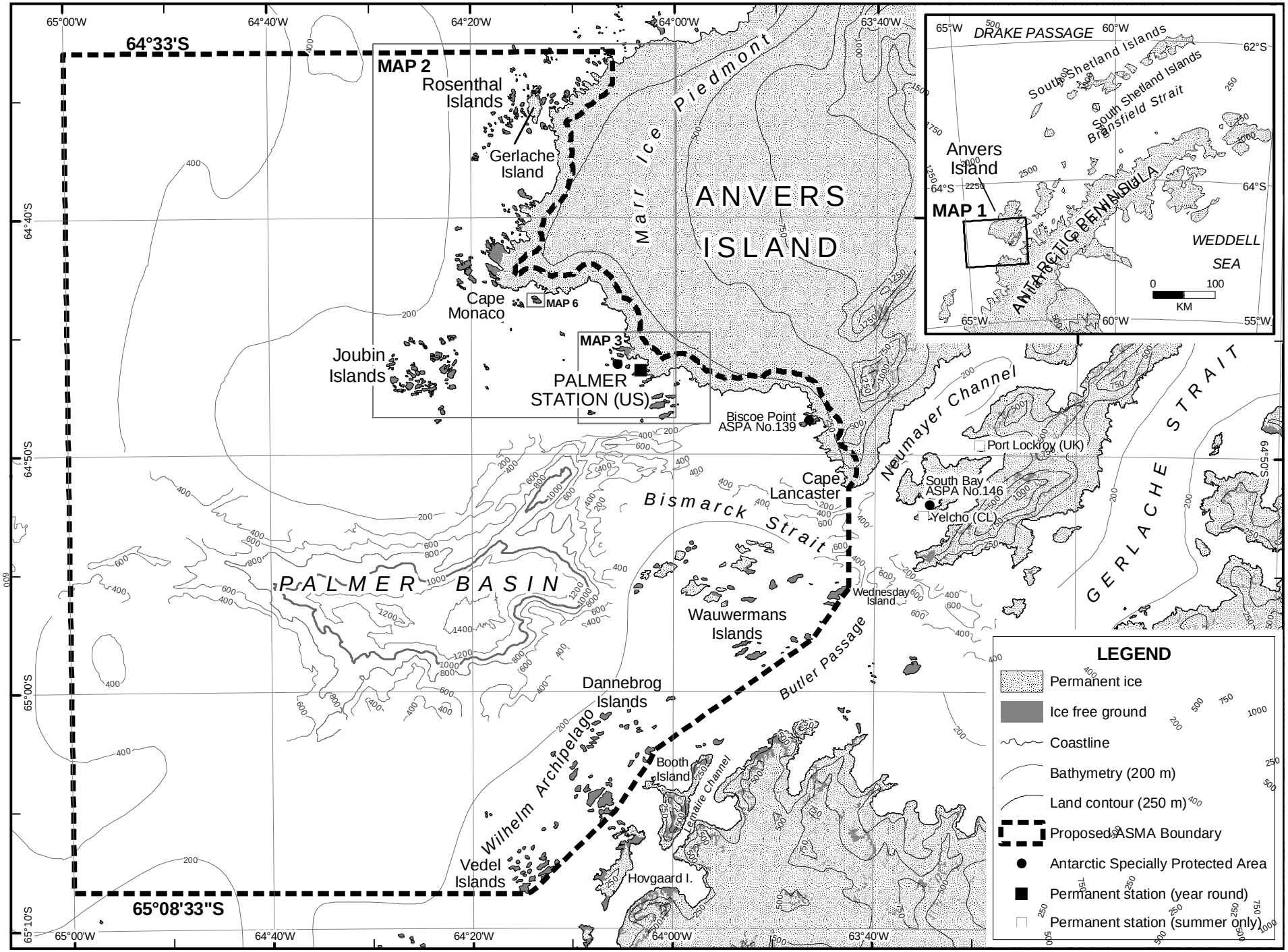
LTER: A long-term ecological research program at Palmer Station, Antarctica. *Oceanography* **8**(3): 77-86.

- Smith, R.C., S.E. Stammerjohn & K.S. Baker. 1996. Surface air temperature variations in the western Antarctic Peninsula region. In: R. Ross, E. Hofmann, & L. Quetin (eds) *Foundations for ecological research west of the Antarctic Peninsula*. *Antarctic Research Series* **70**. American Geophysical Union, Washington, DC: 105-12.
- Smith, R.C., K.S. Baker & S.E. Stammerjohn. 1998. Exploring sea ice indexes for polar ecosystem studies. *BioScience* **48**: 83-93.
- Smith, R.C., D. Ainley, K.S. Baker, E. Domack, S. Emslie, W.R. Fraser, J. Kennett, A. Leventer, E. Mosley-Thompson, S.E. Stammerjohn & M. Vernet. 1999. Marine Ecosystem Sensitivity to Climate Change. *BioScience* **49**(5): 393-404.
- Smith, R.C., K.S. Baker, H.M. Dierssen, S.E. Stammerjohn, & M. Vernet 2001. Variability of primary production in an Antarctic marine ecosystem as estimated using a multi-scale sampling strategy. *American Zoologist* **41**(1): 40-56.
- Smith, R.C., W.R. Fraser, S.E. Stammerjohn & M. Vernet 2003. Palmer Long-Term Ecological Research on the Antarctic marine ecosystem. In: E. Domack, A. Leventer, A. Burnett, R. Bindschadler, P. Convey & M. Kirby (eds) *Antarctic Peninsula climate variability: historical and paleoenvironmental perspectives. Antarctic Research Series* **79**. American Geophysical Union, Washington, DC: 131-44.
- Stammerjohn, S.E. & Smith, R.C. 1996. Spatial and temporal variability of western Antarctic Peninsula sea ice coverage. In: R. Ross, E. Hofmann, & L. Quetin (eds) *Foundations for ecological research west of the Antarctic Peninsula*. *Antarctic Research Series* **70**. American Geophysical Union, Washington, DC: 81-104.
- Stammerjohn, S.E. & Smith, R.C. 1997. Opposing Southern Ocean climate patterns as revealed by trends in regional sea ice coverage. *Climatic Change* **37**: 617-39.
- Stammerjohn, S.E., M.R. Drinkwater, R.C. Smith & X. Liu 2003. Ice-atmosphere interactions during sea-ice advance and retreat in the western Antarctic Peninsula region. *Journal of Geophysical Research* **108** (C10) 10: 1029/2002JC001543.
- Thiele D., K. Asmus, S. Dolman, C.D. Falkenberg, D. Glasgow, P. Hodda, M. McDonald, E. Oleson, A. Širovic, A. Souter, S. Moore & J. Hildebrand 2004. International Whaling Commission – Southern Ocean GLOBEC/CCAMLR collaboration: Cruise Report 2003-2004. *Journal of Cetacean Research & Management* SC/56/E24.
- Trivelpiece W.Z. & Fraser, W.R. 1996. The breeding biology and distribution of Adélie penguins: adaptations to environmental variability. In: R. Ross, E. Hofmann, & L. Quetin (eds) *Foundations for ecological research west of the Antarctic Peninsula*. *Antarctic Research Series* **70**. American Geophysical Union, Washington, DC: 273-85.
- Woehler, E.J. (ed) 1993. *The distribution and abundance of Antarctic and Subantarctic penguins.* SCAR, Cambridge.

-

- **Personal communications**

- Fraser, W. various personal communications 2003-08;
- Patterson, D. 2006;
- Lee, R. 2007;
- Lewis Smith, R. 2007.



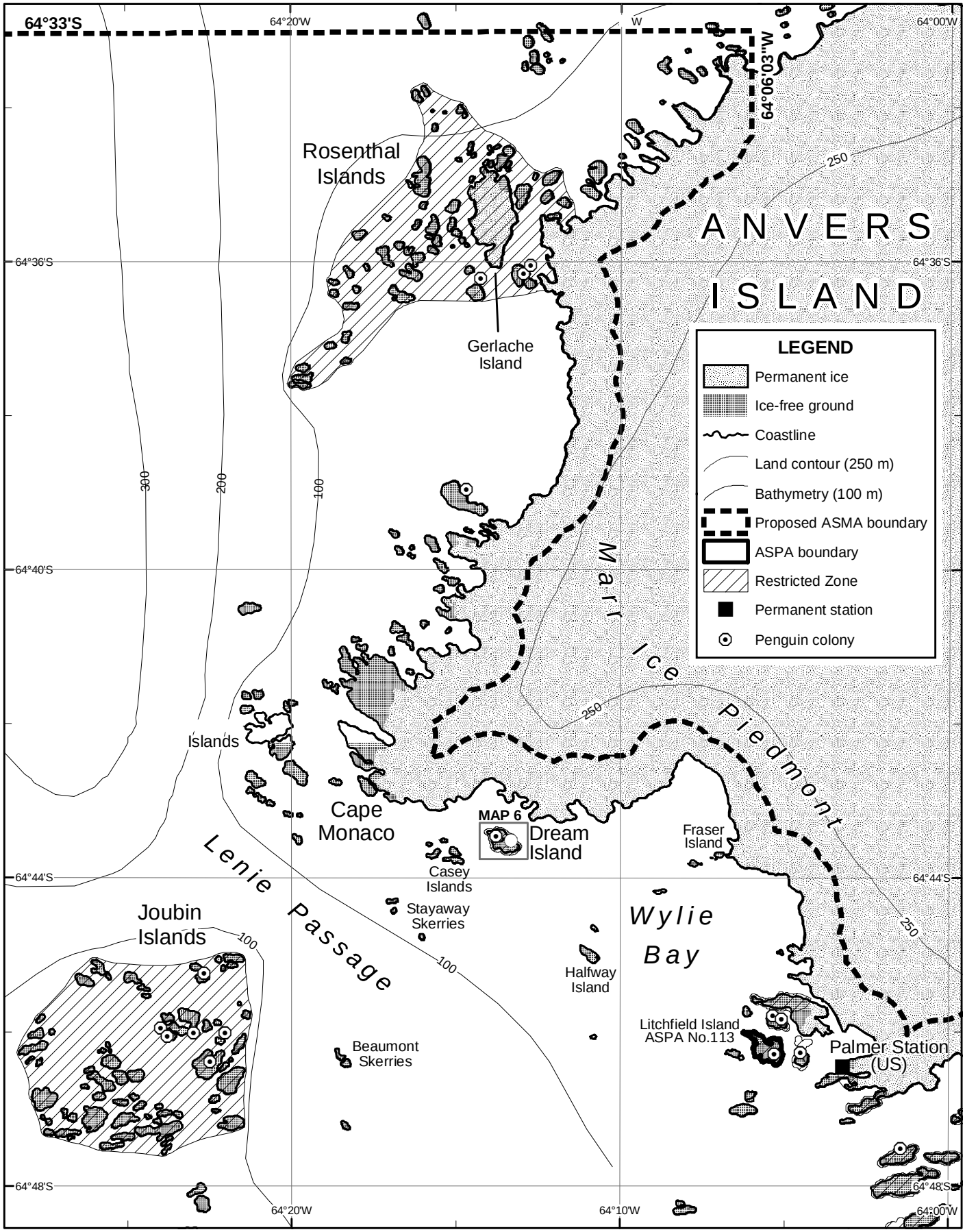
Projection: Lambert Conformal Conic - CM 64°06'; SP1 64°45'; SP2 65°; LO 63°45';
Spheroid: WGS84; Contour interval: Land - 250 m; Marine - 200 m
Data sources: Palmer Basin bathymetry: Domack et al. (2006);
Other bathymetry: GEBCO (2003);
Land features: SCAR ADD v4.1 SQ19-20 (2005).

ASMA No. 7: SW Anvers Island & Palmer Basin
Map 1: Regional map & ASMA boundary

0 5 10 15
Kilometers

N

25 March 2008
United States Antarctic Program
Environmental Research & Assessment



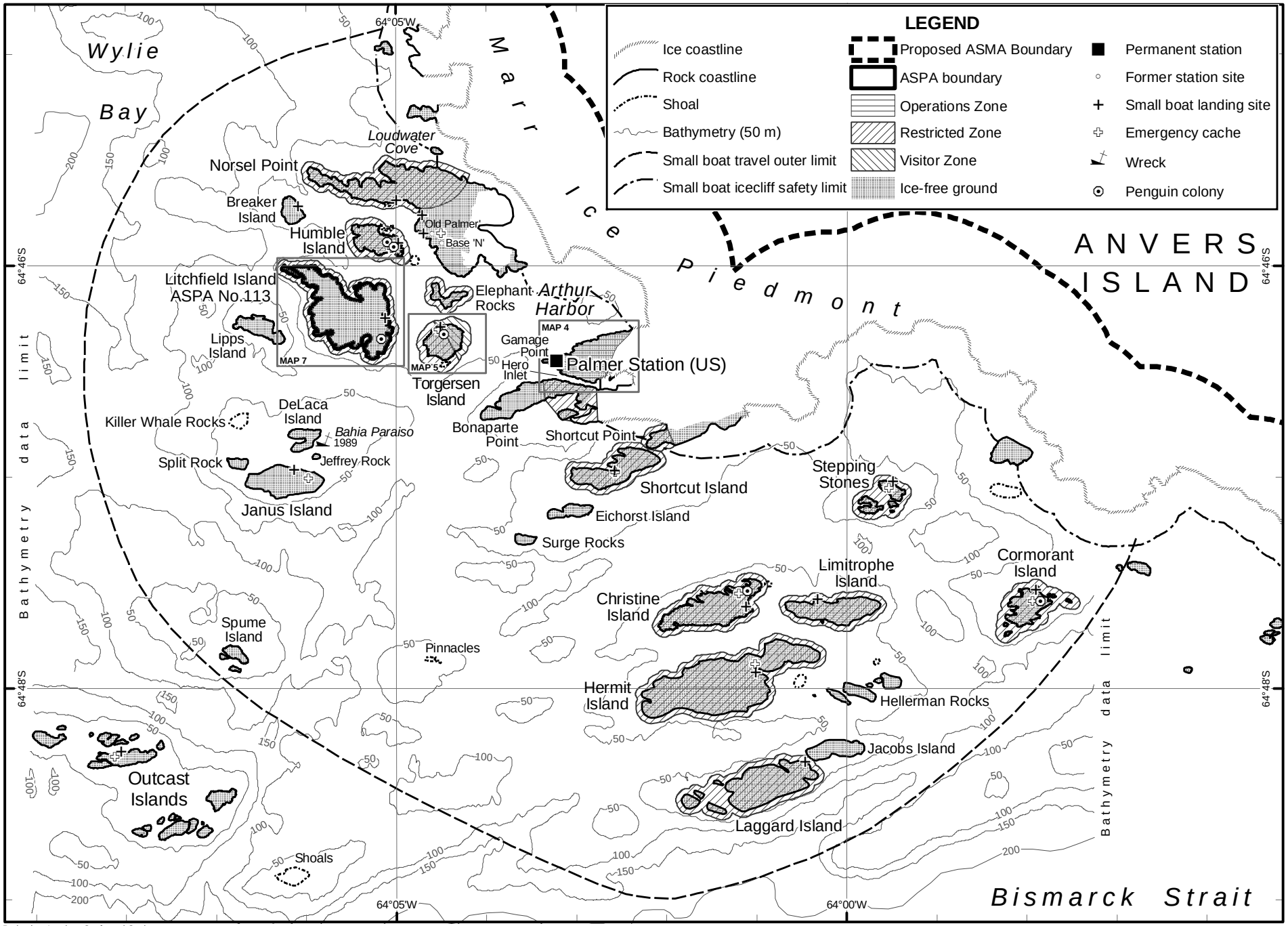
Projection: Lambert Conformal Conic
Central Meridian: 64°15'W;
Standard parallels: 64°38'S, 64°44'S; Spheroid: WGS84
Contour interval: Land - 250 m; Marine - 100 m
Data sources: Base map - SCAR ADD v4.1 (2005) (horizontally adjusted to USGS orthophotos along SW Anvers Island coastline; Ice coastline in Wylie Bay from BAS SQ19-20 3&4 (2005)); Bathymetry - GEBCO (2003); Penguin colonies - Harris (2006)

ASMA No. 7: SW Anvers Island & Palmer Basin
Map 2: SW Anvers Island Restricted Zones
Rosenthal, Joubin & Dream islands

0 1 2 3 4 5
Kilometers

N

25 March 2008
United States Antarctic Program
Environmental Research & Assessment



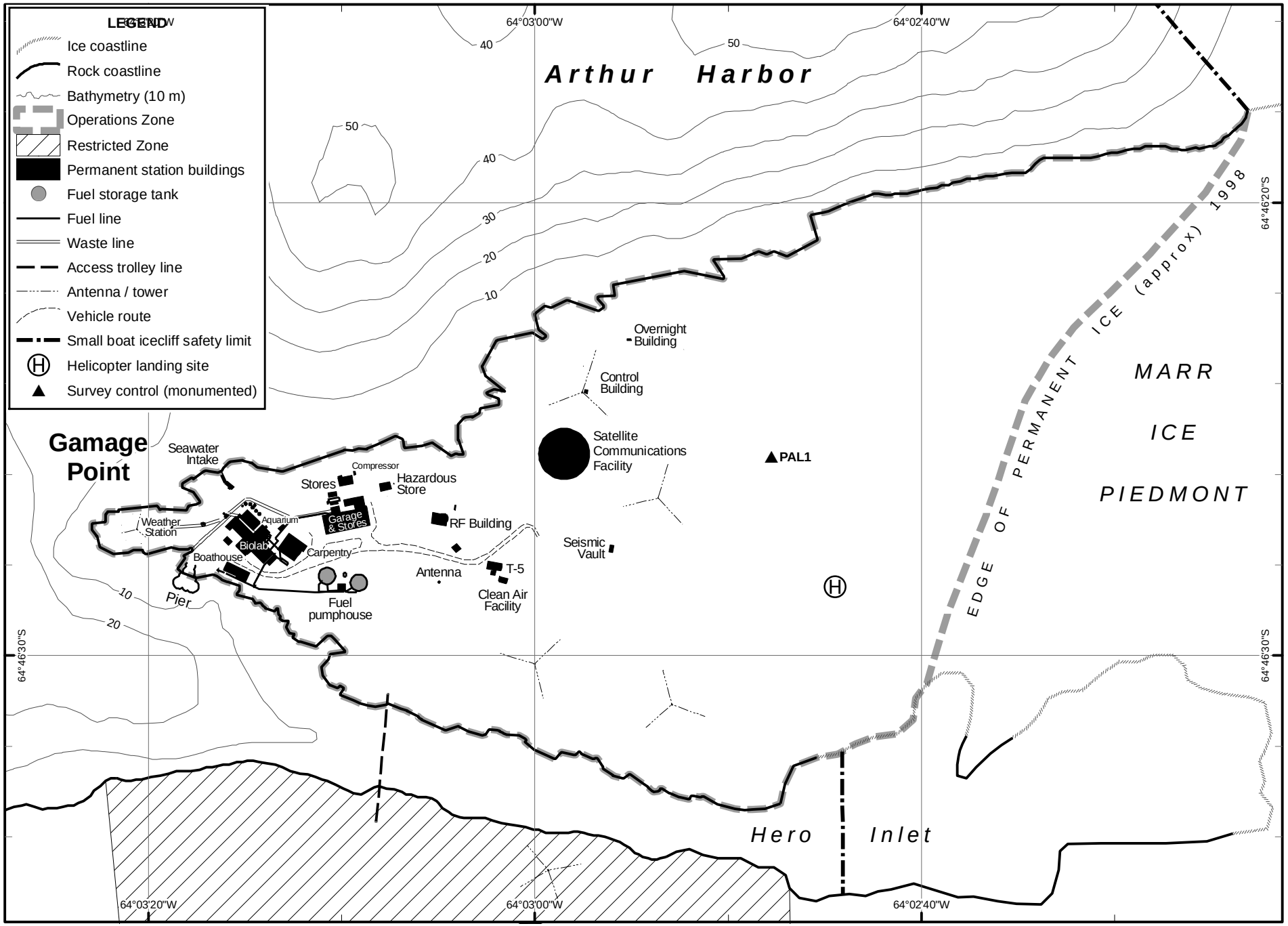
Projection: Lambert Conformal Conic
Central Meridian: 64°02'W; Standard parallels: 64°46'S, 64°48'S;
Spheroid: WGS84; Contour interval: Marine - 50 m;
Data sources: Coast: USGS orthophotos, RPSC Survey & CAD (Gamage Point) & GPS boat surveys (2004); TMA3210 24v rectified image (BAS/USGS 1998); Asper & Gallagher PRIMO bathymetric survey (2004); BAS SQ19-20 3&4 (2005) & SCAR ADD 4.1 (horizontally adjusted); Bathymetric contours derived from Asper & Gallagher PRIMO survey data.

ASMA No. 7: SW Anvers Island & Palmer Basin
Map 3: Arthur Harbor & Palmer Station access

0 500 1000 1500 2000
Meters

N

25 March 2008
United States Antarctic Program
Environmental Research & Assessment



Projection: Lambert Conformal Conic
Central Meridian: 64°03'W; Standard parallels: 64°46'S, 64°48'S;
Datum: USGS PAL1; Spheroid: WGS84;
Bathymetry contour interval: 10 m
Data sources: Infrastructure RPSC CAD & Survey (2007);
Coastline: RPSC CAD & Survey (2004) & TMA3210 24v rectified image (1998);
Ice edge: TMA3210 24v rectified image (1998);
Bathymetry derived from Asper & Gallagher PRIMO survey (2004).

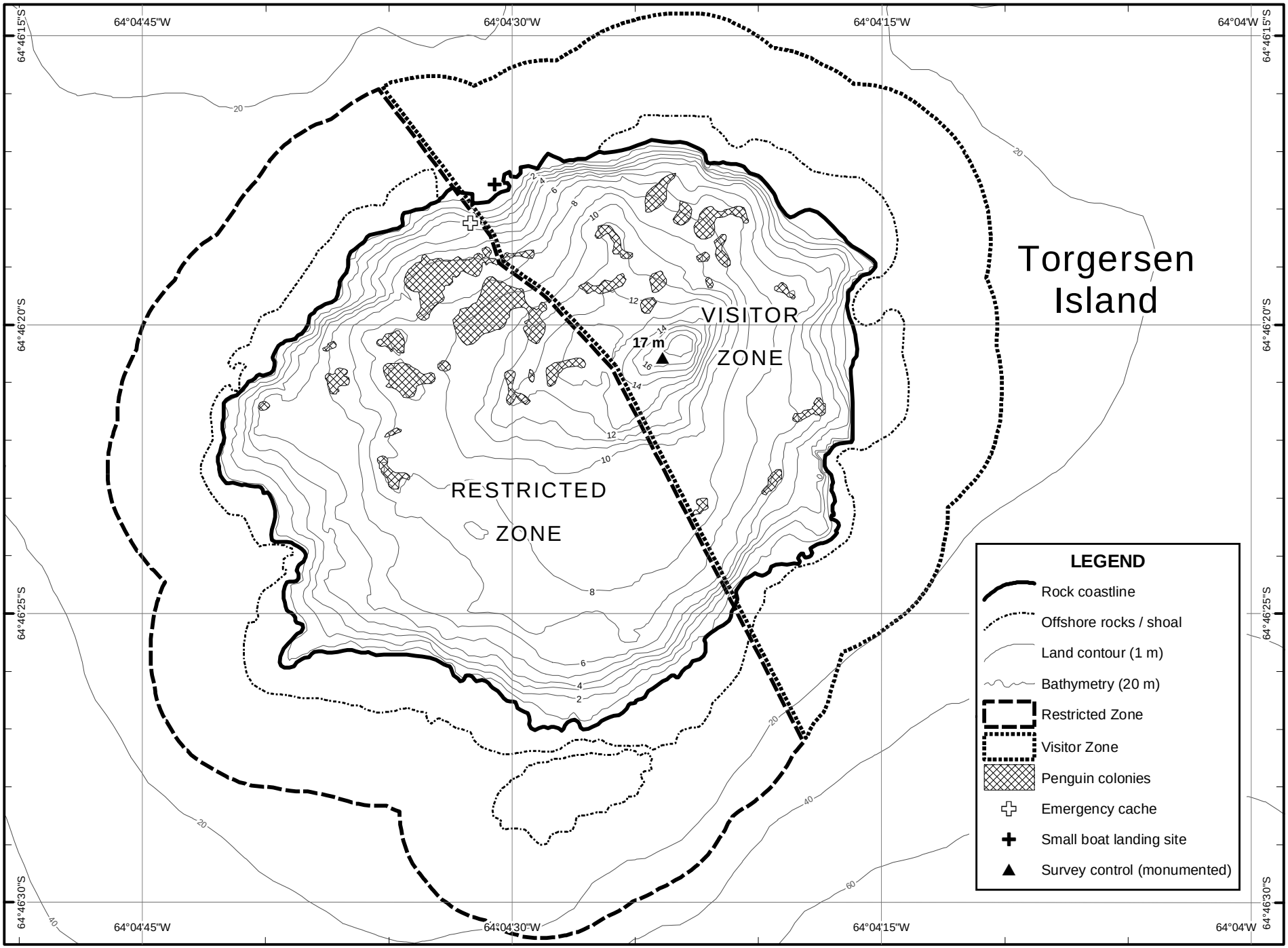
ASMA No. 7: SW Anvers Island & Palmer Basin

Map 4: Palmer Station Operations Zone

0 50 100 150
Meters

N

25 March 2008
United States Antarctic Program
Environmental Research & Assessment



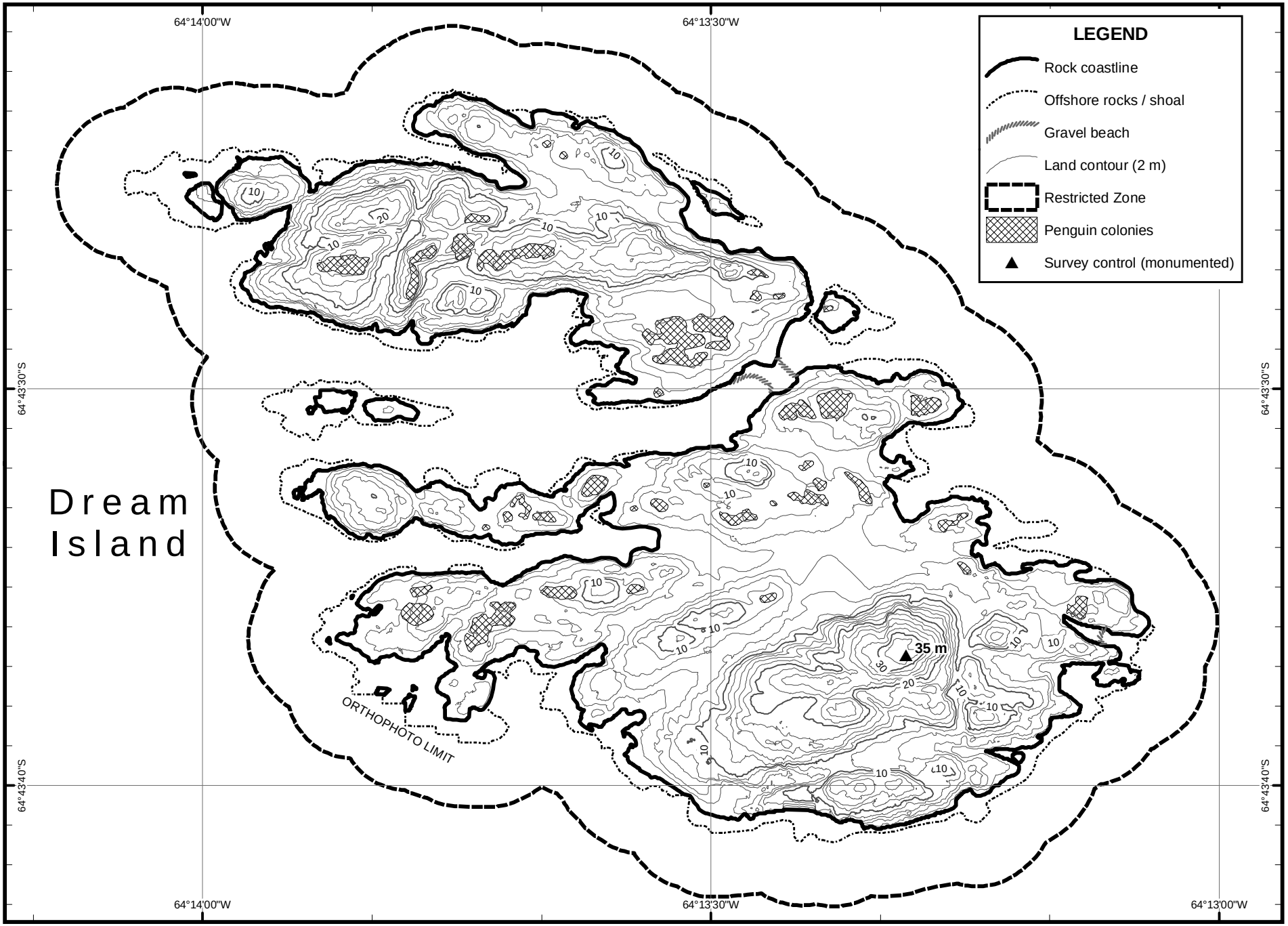
Projection: Lambert Conformal Conic; Central Meridian: 64°04'30"W;
Standard parallels: 64°46'S, 64°48'S; Datum: USGS TOR1; Spheroid: WGS84;
Contour interval: Land - 1 m; Marine - 20 m
Data sources: Coastline & penguin colonies derived from USGS orthophoto (2001) & Patterson (2001);
Bathymetry derived from Asper & Gallagher PRIMO survey (2004).

ASMA No. 7: SW Anvers Island & Palmer Basin
Map 5: Torgersen Island Zones

0 50 100
Meters

N

25 March 2008
United States Antarctic Program
Environmental Research & Assessment



Projection: Lambert Conformal Conic
Central Meridian: 64°13'30"W; Standard parallels: 64°43'S, 64°44'S;
Datum: USGS DRE1 (1999); Spheroid: WGS84;
Contour interval: 2 m
Data sources:
Coastline & penguin colonies derived from USGS orthophoto (2001).

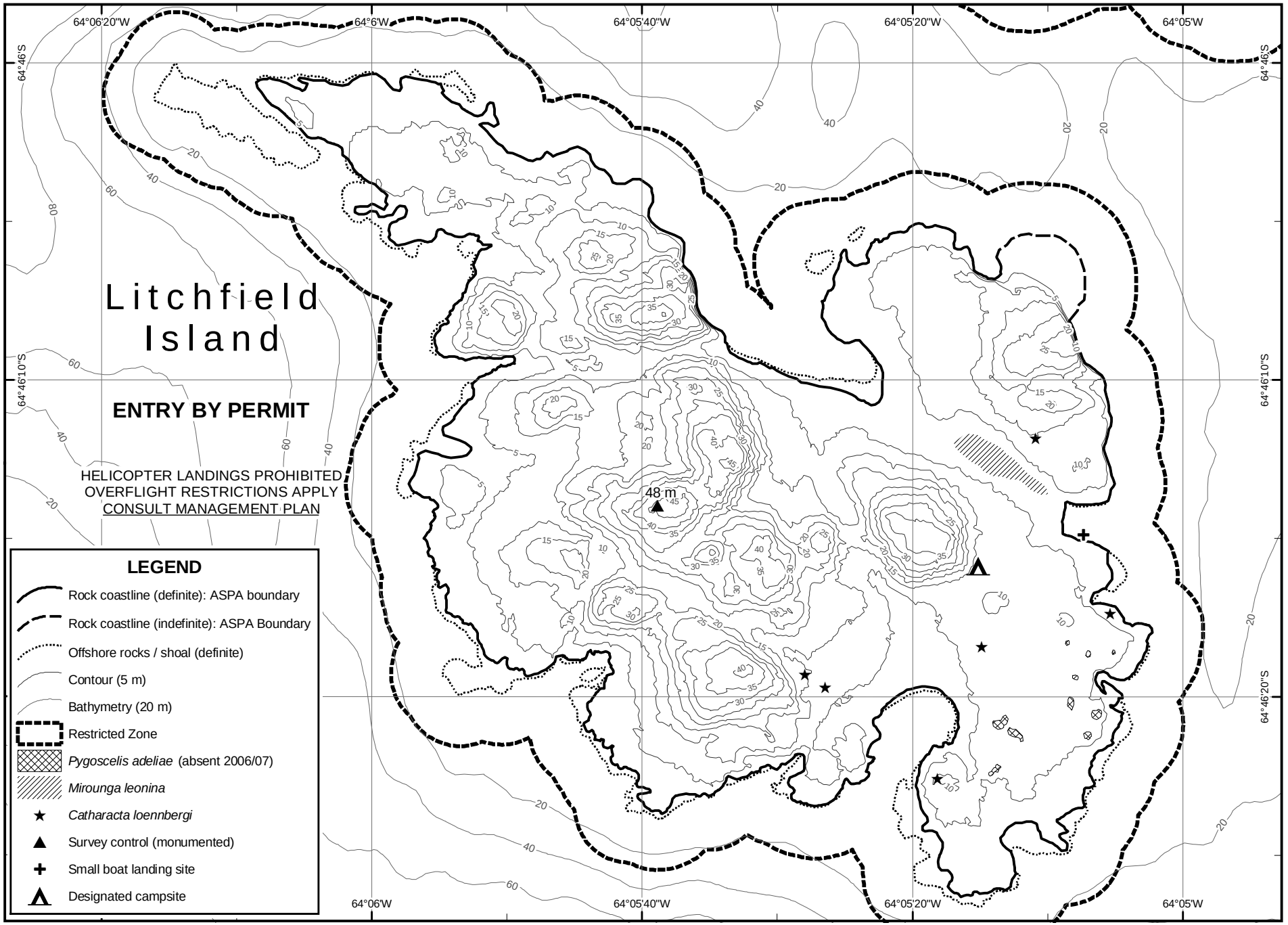
ASMA No. 7: SW Anvers Island & Palmer Basin

Map 6: Dream Island Restricted Zone

0 50 100 150
Meters

N

25 March 2008
United States Antarctic Program
Environmental Research & Assessment



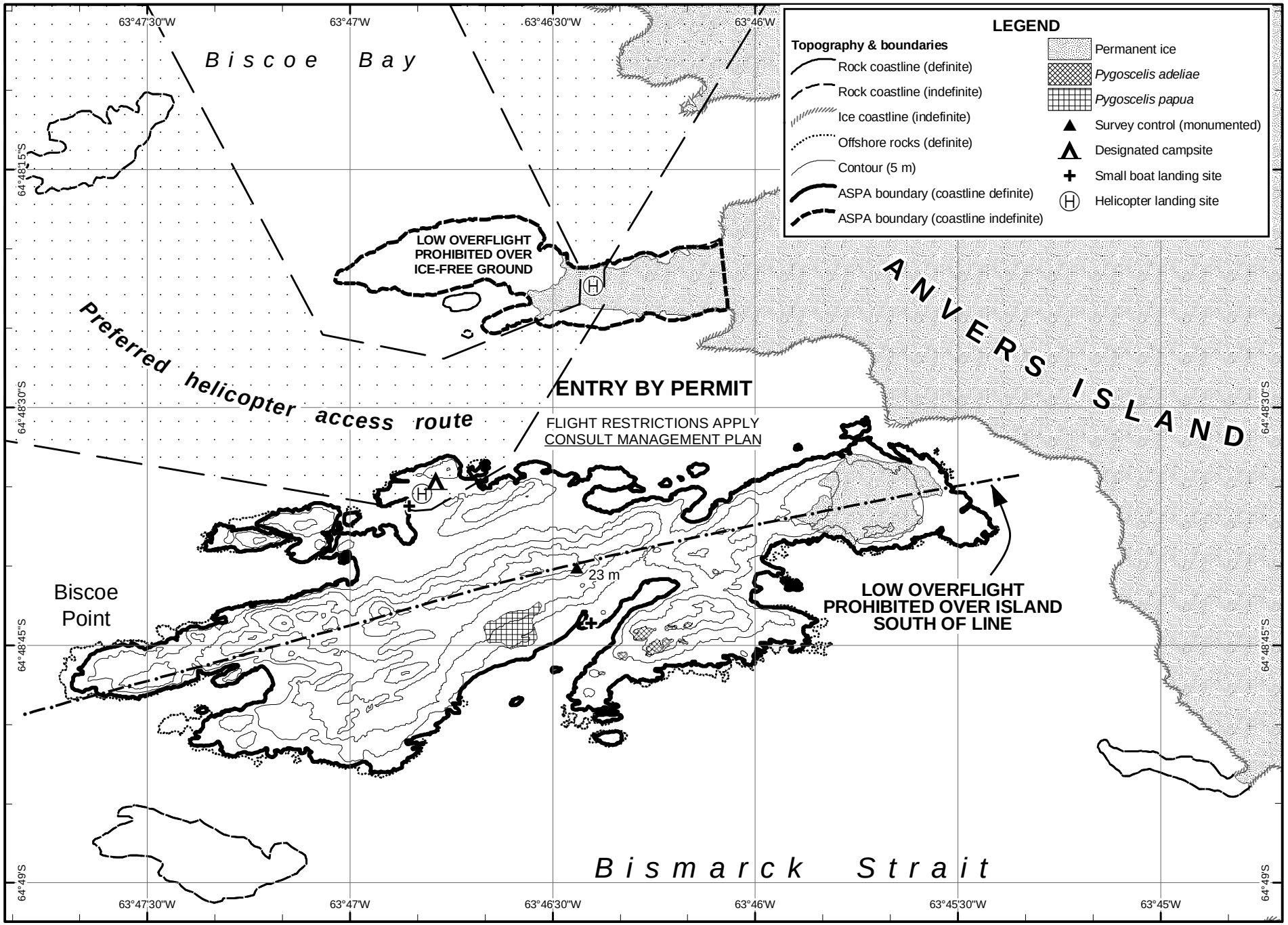
Projection: Lambert Conformal Conic
Central Meridian: 64°06'W; Standard parallels: 64°46'S, 64°48'S;
Datum: USGS LIT1 (1999); Spheroid: WGS84;
Contour interval: Land - 5 m; Marine - 20 m
Data sources: Map updated from ASPA management plan (2004).
Definite coastline & seal colony derived from USGS orthophoto (2001);
Indefinite coastline from TMA3210 24V rectified image (1998);
Bathymetry derived from Asper & Gallgher PRIMO survey (2004);
Bird data W. Fraser (2001/2007).

ASMA No. 7: SW Anvers Island & Palmer Basin
Map 7: Litchfield Island, ASPA No.113

0 50 100 150 200
Meters

N

25 March 2008
United States Antarctic Program
Environmental Research & Assessment



Projection: Lambert Conformal Conic
Central Meridian: 63°46'W; Standard parallels: 64°48'S, 64°50'S;
Datum: USGS BIS1 (1999); Spheroid: WGS84; Contour interval: Land - 5 m;
Data sources: Map updated from ASPA management plan (2004).
Definite coastline derived from USGS orthophoto (2001);
Indefinite coastline derived from TMA3208 006V rectified image (1998);
Penguin colonies & other features from orthophoto & GPS survey (ERA 2001).

ASMA No. 7: SW Anvers Island & Palmer Basin
Map 8: Biscoe Point, ASPA No.139

0 100 200 300 400
Meters

N

25 March 2008
United States Antarctic Program
Environmental Research & Assessment