Logistics Planning Outline for the 2010/2011 NBP/ODEN 2-boat Operation

In an attempt to coordinate the science between the ODEN and the NBP for next year's 2-boat operation, the information below will be compiled and passed out during the planning meeting in November.

Principal Investigators: Patricia Yager, Hugh Ducklow, Rob Sherrell, Sharon Stammerjohn, Oscar Schofield
Project leader onboard NBP/ODEN (if other than P.I.): **Yager**
ASPIRE: Amundsen Sea Polynya International Research Expedition
Participants onboard (tentative): Total: 14 US scientists (including one K-12 teacher) Name and function: **P. Yager** (PI-microheterotrophy and net community production), K. Sines (tech-micro), B. Heimlich (student-DIC), L. Garay (PolarTREC teacher); **R. Sherrell** (PI-trace metals), Sherrell-2, Sherrell-3, Sherrell-4 (S. Silverman); **S. Stammerjohn** (PI – atm/oce/ice interactions), Stammerjohn student; **O. Schofield** (PI-primary production), Schofield-2, Schofield -3 **H. Ducklow** (PI-particle flux) or Ducklow tech Contractor staff will be 10: Marine Projects Coordinator (1), Marine Science Tech (2), Electronics Tech (2), Marine Tech (3), IT Tech (2) We anticipate that our Swedish collaborators will need approximately 12 additional berths.

Please give a brief cruise synopsis. Include the following: research objectives and proposed cruise track.

FROM OPS REVIEW: The overall objective of ASPIRE is to study the dynamics of primary production, physical oceanography, phytoplankton, zooplankton and microbial ecology and biogeochemical processes in the Amundsen Sea Polynya. ASPIRE seeks to investigate why and how the Amundsen Sea Polynya is so much more productive than other Polynyas. The ASPIRE PIs will utilize the USAP research vessel the *RV/IB Nathaniel B. Palmer* from Nov. 26, 2010-Jan. 5, 2011 for 40 science days during a transit from Punta Arenas, Chile to McMurdo Station in the Ross Sea.

Because of its thick ice cover and location far from any human population center in the central Pacific sector of the Southern Ocean, the Amundsen Sea has rarely been studied by oceanographers at sea. Yet, remote sensing suggests that it hosts on average the most productive (per m^2) but highly variable summertime polynya in the Antarctic: the **Amundsen Sea Polynya (ASP)**, which is the focus of our project. Glaciologists also report that the nearby Pine Island and Thwaites Glaciers (two of Antarctica's five largest) are undergoing significant acceleration and thinning, perhaps because of increased upwelling of warm ocean water beneath the ice shelf. Of key interest is whether this melt is influencing the productivity of the ASP through its impact on either the iron concentration or the stability of the water column. Members of our team went to the ASP onboard *Oden* in December 2007 and in just a few days confirmed very high levels of chlorophyll a (up to 10.4 μg/L at 10 m depth) and rates of pelagic bacterial production higher than any ever measured during years of research in the Ross Sea Polynya. For this proposal, we have assembled an international team of trace metal and carbon chemists, phytoplankton physiologists,

microbial and zooplankton ecologists, and physical oceanographers, to investigate why and how the Amundsen Sea Polynya is so much more productive than other polynyas.

Our groups would join the NBP and Oden in Punta Arenas in November. Upon departure, we expect the ships to transit the Drake Passage and enter the sea ice of the Amundsen Sea region. Our proposed cruise track would take us to the ASP along the most time efficient, sea ice conducive, route across the Amundsen continental shelf. Brief hydrographic stations on the way into the polynya, across the eastern side of the shelf, as close to the deep troughs as possible (see eastern white track on map below) are desirable, but our priority is to get into the open waters of the polynya region as soon as possible. If ice is heavy, we anticipate entering as we did in 2008 and then aim directly for the sediment trap station. We then anticipate 14 days of open water station occupations and sampling.

Once in the ASP, our priorities would be:

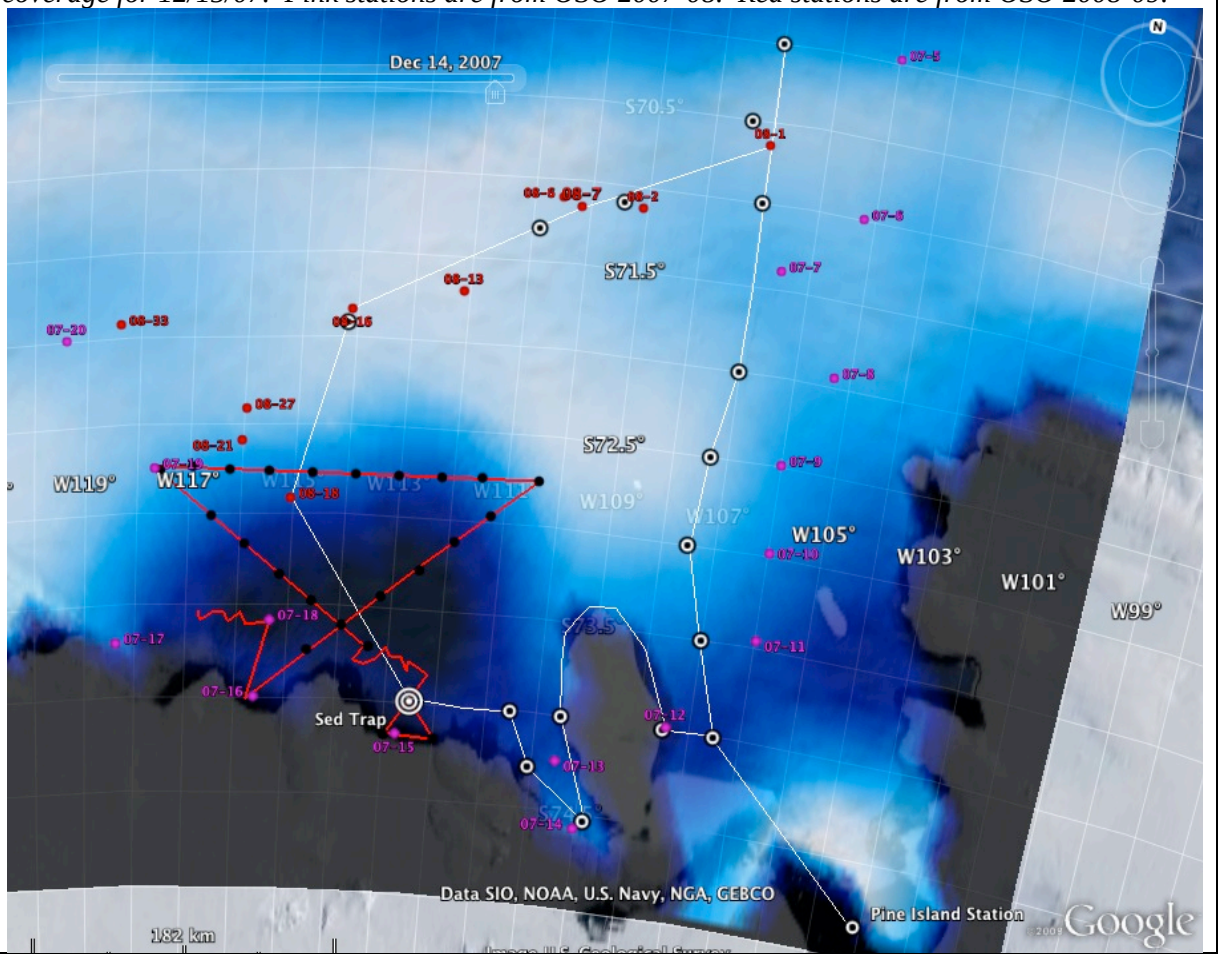
1) Deployment of **instruments** (glider and moored sediment trap: see large white circle symbol on map below);

2) 3 pre-planned high-resolution hydrographic **transects** through the open water (straight red lines on map below), to detect within-polynya gradients; and

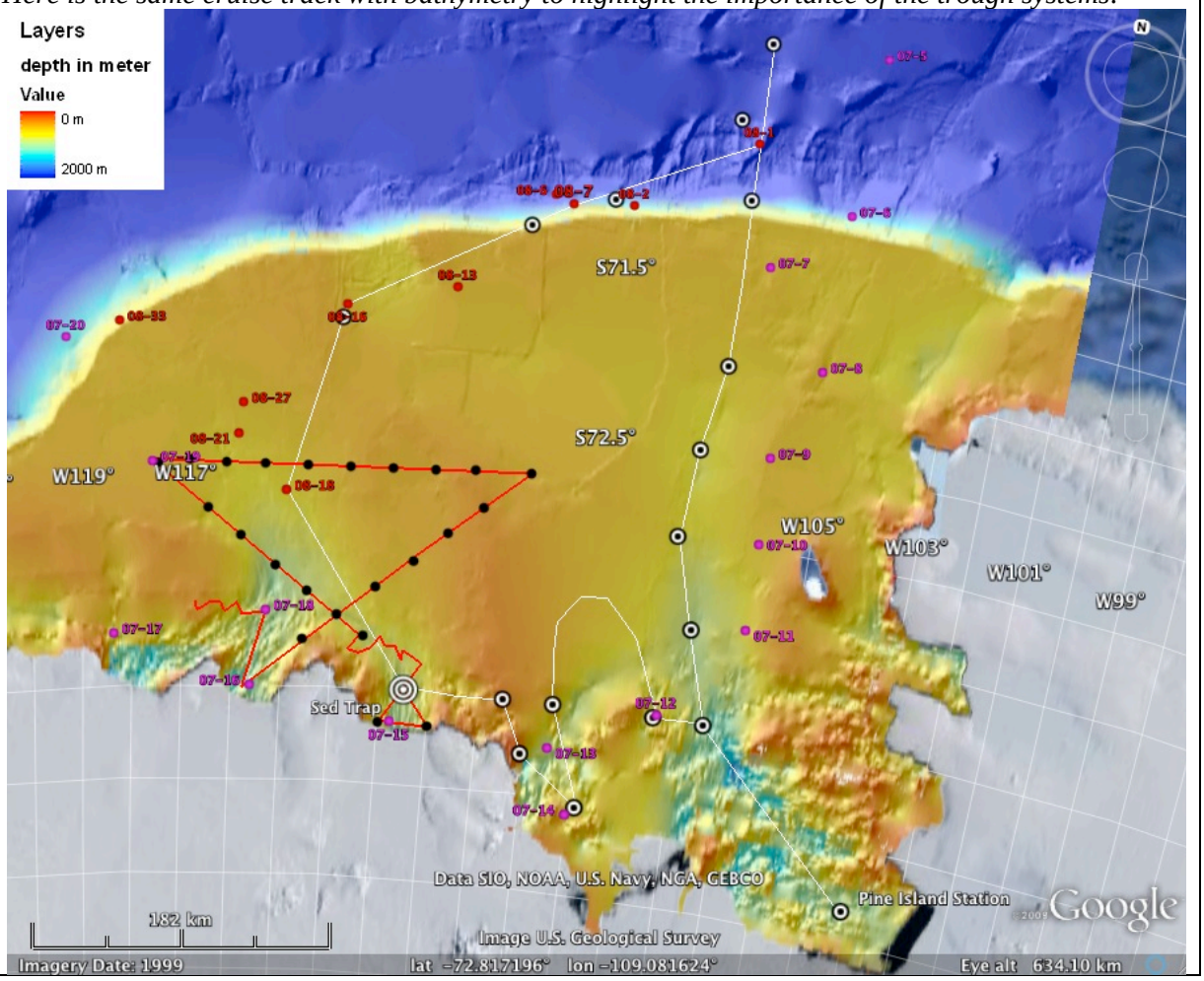
3) two efforts of opportunistic "**pseudo-Lagrangian**" sampling (2-3 days each) while following drifting sediment traps (squiggly red lines on map below).

If sea ice conditions allow, and the Pine Island Polynya is open, any extra time should be spent there. Sampling along the ice shelf is also desirable if time allows.

Given that we will only have one cruise to the region instead of the originally proposed three cruises (with interannual variability), we have modified our proposed cruise track to better sample within polynya gradients as follows (red = high priority, white = lower priority), shown with sea ice coverage for 12/15/07. Pink stations are from OSO 2007-08. Red stations are from OSO 2008-09.



Here is the same cruise track with bathymetry to highlight the importance of the trough systems:



Briefly describe sampling methods and major systems and equipment (collection method (i.e standard CTD, plankton nets, MOCness Nets, etc…)

FROM OPS REVIEW: Major logistic considerations for this project are:

- Vessel equipment requested for this project includes: 3-VHF radio location beacons, underway water sampling system, standard CTD, hydrowinch and wire for deployment of self-contained in situ pumps, autosal, two deck incubators, Langdon O_2 titrator, TSE mooring winch, acoustic release deck units, nutrient analyzer, shared rad van (for C^{14}), rad van (for ^{3}H) , trace metal clean van, liquid scintillation counter, FIRe System and two sets 24 in. Bongo plankton nets with 200um mesh nets codends, small electric winch to aid in vertical net tows through the upper 100m, boom to support starboard side ”fish” towing. Compressed air to power metal-clean seawater pump.
- A trace metal clean CTD/rosette system (trace metal clean winch, cable, and rosette) is to be purchased via Rob Sherrell's award. This system will be owned by the government and maintained by the science support contractor for future USAP projects.
- Contractor vessel staff will deploy the grantee-provided McLane sediment trap mooring and floating sediment traps
- Contractor vessel staff will provide a technician to operate the nutrient analyzer
- Contractor vessel staff will provide zodiac support for small boat operations
- Contractor will provide concrete mooring weights for deployment of the sediment trap mooring

- The PIs request use of the portable FIRe system, contractor will provide system, grantees will provide a tech to set up system aboard the NBP
- Grantees will provide the following equipment and supplies from their grant:
  - Mooring hardware, line and floats to deploy moorings
  - McLane Sediment trap to be deployed on a mooring
  - Acoustic release for sediment trap mooring
  - Floating sediment traps to be deployed from a float
  - Trace metal clean water sample bottles (Niskin-X or GoFlo) for trace metal clean CTD casts
  - Slocum Webb Gliders with spares
  - Trace metal clean surface water sampling towed fish and ancillary supplies
  - Trace metal clean system (trace metal clean winch, cable, and rosette)
  - In situ pumps for large volume filtration (battery powered, self contained)

One of our primary objectives is to determine the sources of iron to the phytoplankton of the Amundsen Sea. This requires sampling seawater both in and outside the ASP in a way that will not contaminate the samples with iron (using a **Trace Metal Clean (TMC) CTD/rosette system with Kevlar cable and clean winch**). In addition to the ASP, we will sample key water masses across the continental shelf and along ice shelf fronts. We also will deploy a **TMC *in situ* pump** / **towed fish** that requires a boom extending at least 15 ft off the rail to support the PI-supplied sheave, line, and tube.

We will be measuring and collecting water from the **continuous, underway seawater system**. We will need access to ship's nav, met and underway seawater data. If possible, we will use the ship's underway pCO2 system (otherwise we are willing to install one of our own).

To increase our spatial coverage, we will deploy a **Slocum Webb glider** as soon as possible once we arrive in the ASP. This autonomous instrument descends and rises through the water column, sending data and receiving instructions via the Iridium satellite system. It should not go into areas of significant sea ice, and it should avoid Iridium blackout areas.

We will be deploying trace metal clean sediment traps (**moored McLane** trap and **floating PIT** traps). We will need a winch or A−frame on the fantail to deploy the mooring. The floating traps will need to be tracked by radio beacon.

We will need **on-deck incubators** for a large number of experimental samples. At minimum, we will need space for two on-deck incubators, one for productivity incubations of profile samples, and the other for various bioassay experiments.

Sampling methods and sites when ship in motion

Site/area/transect	Type of sampling to be performed, volume of H_2O collected
Transect to/from/in Amundsen Sea Polynya	Underway seawater intake
Transect across the Drake Passage	Underway seawater intake
Throughout entire cruise	Atmospheric pCO2, T, and S, underway surface seawater pCO2, T, and S, shipboard weather data

Sampling methods and sites from stationary ship

Sampling site	Type of sampling, weight/volume of samples and equipment, etc.	Time per station
Transect to/from/in Amundsen Sea Polynya	CTD Rosette 10 liter Niskin conventional ship's rosette and TMC rosette, in situ pumps	3-6 hr
Amundsen Sea Polynya only	Ship's bongo nets or PI-supplied TMC plankton net	1-2 hr

Sampling method and sites away from the ship, on ice: **NA**

Sampling site	No. of persons	Type of sampling, weight/ volume of samples and equipment, etc.	Time per station

Deployment/retrieval of equipment

Site	Type of equipment, weight/ volume, procedure, etc.	Time per station
Amundsen Polynya	Moored sediment trap (75 kg) weight 300 kg	6 hours
Amundsen Polynya	Drifting sediment trap array (100kg)	2 hours
Amundsen Polynya	Slocum Glider, 50kg	1 hour

Which are the most prioritized sampling areas/methods?

Site/area	Method/type of sample	Other info
Amundsen Sea Polynya	Glider deployment	
Amundsen Sea Polynya	Trap mooring	
Amundsen Sea Polynya	CTD Rosette, pumps, nets	Multiple hydro stations (10-20)
Amundsen Sea Polynya	Floating trap deployment	Following drogue, sampling every ~6 hours for 2-3 days
Eastern trough	CTD Rosette	
Ice shelf edge	CTD Rosette	
Pine Island Polynya	CTD Rosette	

The following equipment needs to be installed onboard
(describe in detail, also needed connections to electricity, water, gas etc):

The PIs request use of the portable FIRe system, contractor will provide system, grantees will provide a tech to set up system aboard the NBP
Contractor vessel staff will provide a technician to operate the nutrient analyzer
Flow-through automated pCO2 system provided by ship (otherwise PI can install hers); PIs will set up carbonate system instrumentation (SOMMA/coulometer, alkalinity titrator) which has gas lines and significant stable power requirements (110V)
Standard UV-vis spectrophotometer (Sherrell colorimetric Fe)
Coulter counter
Microscope for phytoplankton counts and taxonomy

Back-up air compressor unless ship has two capable of running the air-powered SW pump
Fluorometer
Scintillation counters inside rad vans; cold incubators inside rad vans if possible
On-deck, flow through incubators

Vessel space needed for this project includes dry lab, wet lab, hydro lab, bio lab and microscope lab

Lab space	Wet lab	Dry lab	Bio Lab
Meters of bench space	10	15	10
Power needs (VA) 220/380 V			
Cold water (yes/no)	yes	yes	yes
Hot water (yes/no)	yes	yes	yes
Sewage (yes/no)	yes	yes	yes
Compressed air (yes/no)	yes	yes	
Gas (yes/no)	Yes	No	Yes
Fume hood (yes/no)	yes	yes	yes
Sea water intake (yes/no)	yes	yes	yes
Other (specify)			

Special lab areas needed:

Clean air room	TMC ”tent” will be constructed in forward portion of wet lab
Other (specify)	14C – rad van 3H – rad van
Cold lab	1 m of lab bench space in the cold room, set at 2°C

Storage of equipment and samples:

	Space needed (m^2/m^3)
Container	
Cold +2°C	4 refrigerators
Freezer -20°C	2 large freezers
Freezer -80 C	3 large freezers

The following chemicals, gases or other hazardous substances will be used, including radioisotopes or other substances which may constitute a threat of contamination for sensitive analyses:

Substance	Weight/vol.	To be used for:
Radioactive materials: 14C, 3H	5 mCi	Bacterial production, Primary production
Fixatives: formalin 5%, 37%; glutaraldehyde	10, 1, 1 L	Sediment trap cups, plankton sample preservation
Acids (Hydrochloric, TCA, sulfuric, phosphoric)	15 liters	trace metal sampling, cleaning, bacterial production, CO2
Alcohol (ETOH)	15 liters	Chlorophyll, sterilization
Acetone	10 liters	Chlorophyll
Mercuric chloride	<50 g	Poison for CO2 samples
Coulometer fluids (DMSO)	5 liters	UIC Coulometer

Hazardous waste:

Substance	Weight/vol.	Comments
Radioactive materials	50 L	Liquid
Radioactive materials	50 L	Dry
Fixatives	60 L	Liquid
Acids	20L	SW diluted HCl
Acidic seawater with dilute mercury	200L	CO2 waste
Alcohol (ETOH)	50 L	Mixed with seawater

Disturbance to or sampling of organisms: **NA**

1. Species (scientific and English name)	
2. Handling/sampling method	
3. Storage or handling onboard	
4. Possible risks to health or environment	
5. Consideration required from the ship/other researchers	Oden – Benthic sampling can be incompatible with trace metal clean sampling.

Cargo to be taken onboard the ship:

The RV/IB Nathaniel B. Palmer will sail from Punta Arenas, Chile to McMurdo Station, Antarctica. All cargo will travel through Pt. Hueneme in the USAP cargo systems. Once the vessel arrives at McMurdo Station, all cargo including samples will be shipped back via the cargo vessel the *M/V Tern,* unless specific requests are made for -80C samples that require COMAIR shipments due to the lack of -80C freezers on the *M/V tern.*

Type, handling/storage	Weight (kg)	Volume (m3)
Cargo Weight SB	5000 lbs	
Sediment trap (includes crate)	150 kg	4
Trap mooring hardware	150 kg	2
Trap anchor weight	200 kg	1
Trap releases	100 kg	1

Cargo and samples to be taken off the ship:

Type, handling/storage	Weight (kg)	Volume (m3)
Cargo Weight NB	7000 lbs	
Some frozen (-80) samples for COMAIR	25 lbs	0.5
Some cool or DNF samples for Tern	100 lbs	1
Some -20C frozen samples for Tern	25 lbs	1

Other support needed onboard Oden(NBP), or in preparation phase:

Cryogen/Nitrogen	20L
Zodiac Support	Yes

Data transfers and email
Request transfers for glider data to NBP as part of enhanced bandwidth protocol