What I did on my summer vacation:
R/V Atlantis Cruise AT15-8

As the academic year was winding down in July, I was getting ready for a different sort of vacation – participating in a research cruise to the central Pacific to study the ecology of the deep sea floor. This is the trip log.

ORIENTATION TO THE RESEARCH CRUISE
3 AUGUST 2006 THURSDAY

I arrived at the ship about 2230 on Wednesday night, after a long trip from Miami and a busy day finishing up last minute work. I am pleasantly surprised to find out the ship has a satellite internet system, so I can be in touch throughout the trip! The R/V ***Atlantis*** is BIG; my cabin is on the 03 deck with the senior scientists – that's about 40 feet about the water line!

This cruise leaves from San Francisco for 14 dive days in the north Pacific research site, "Station M", on deep sea benthic energetics with Dr. K.L. Smith, Jr. The ship will return to Astoria, Oregon on 20 August 2006.

Ken Smith was my graduate adviser at the Scripps Institute of Oceanography at the University of California at San Diego from 1978 until I graduated in 1982. The first deep-sea submersible dive I made was in 1979. The DSV ***Alvin*** seemed much smaller then, and on a mother ship called the ***R/V Lulu.*** The ship was pretty cramped, but the trip to the bottom of the ocean was as exciting as trip to deep space. The dive was in a deep basin off southern California, and that dive lasted about 11 hours. That dive to the bottom of the ocean at 3400 meters changed my thinking about the scale of the ecosystems in the ocean. Even back in the late 1970's, man has already left a trail of garbage on the deep sea floor, no place on the planet is untouched. My entire graduate research focused on questions of how fish feed and survive at great depths in the ocean.

So this cruise is a rare opportunity for me to return to deep sea ecology, and catch up with colleagues from around the world. During the day we will be conducting DSV ***Alvin dives***, I have the honor of being on the first dive tomorrow – we will be setting out video cameras and doing video transects of the deep sea floor. At night, we will be making good use of the ship time setting Free Vehicles on the deep ocean floor to measure sediment respiration rates. We also plan deep trawls and fish traps deployments.

ORIENTATION TO THE R/V Atlantis

Built:	1997	**ALVIN Conversion:**	1997
Length:	274 feet	**Beam:**	52.5 feet
Draft:	17 feet	**Gross Tonnage:**	3,200 T
Displ. Tonnage:	3,510 LT	**Endurance:**	60 days
Range:	17,280 NM	**Fuel Capacity:**	296,470 gallons
Laboratories:	3,710 sq. feet		

Speeds:	**Complement:**
Cruising - 12.0 knots	Crew - 23
Maximum - 15.0 knots	Scientists - 23
Minimum - 0 knots	DSOG/Tech - 13

Other Features:

Dynamic positioning system, ROV and submersible hangars, fully equipped machine shop, fume hoods, uninterruptable power supply, air conditioning, library/lounge, copy machine, laundry, two rigid-hull inflatable rescue/work boats

The R/V Atlantis has more lab space that the entire College of The Bahamas, and likely more computing capacity! The power plant on the ship rivals most small islands, and it takes almost a million US dollars to fuel this ship. This ship is owned by the United States Navy but leased to the Woods Hole Oceanographic Institute in Massachusetts as part of the UNOLS fleet. (UNOLS – University National Oceanographic Laboratory System funded through the National Science Foundation).

The afternoon on the ship was consumed with safety orientation and drills, there is certainly much more emphasis on safety since the last time I was at sea, but this is good. We have 19 in the scientific party, and all types of people need to be hearing a common message in terms of safety procedures. We try on and operate the EBA's (Emergency Breathing Apparatus) for the submersible – that is a comforting thought!

The bow of the R/V Atlantis, tied at the pier by Giants Stadium in San Francisco.

The DSV Alvin in its hanger on the R/V Atlantis. The ship was especially fitted to house and launch the submersible. The DSV Alvin will soon be retired for a new generation of deep research submersibles that can work at depths of 6000m, The DSV Alvin can work to 4500 m.

FIRST DAY OF WORK
04 August 2006, Friday

The scientific party and sub crew started out well before 6 AM getting gear ready for the submarine dive. The night before, I was able to look over an identification book of the common invertebrate benthos at abyssal depths in the central Pacific. The original idea of placing the camera tripods was scrapped as the cameras malfunctioned as they were being tested on the sub. This was a bit disappointing, but there was a quick scramble to move on coring equipment and collection boxes. WE reorganized our task list to include

1.) Coring in the fecal trail and around the area where we found the ***Enchinocrepis*** urchins.
2.) Collection the ***Enchinocrepis*** urchins, separating the purple, white and tan color morphs into different collection boxes
3.) Look for and photograph fishes, and
4.) Conduct a video transect

I am diving with a graduate school colleague, Dr. Ray Wilson. He is an expert on deep sea fishes, and has even dove in the Russian deep sea research submersibles in the

northern Atlantic. Ray and I felt comfortable that we could accomplish the work objectives with 3 -4 hours of work time on the bottom at 4100 meters. This was as deep as the submersible had dove since its overhaul at the beginning of the year. We loaded the sub and began the dive at 0800. The seas had long-period 8-10 ft swells, with wind about 16 knots from the northeast. Conditions were fine for launching, though a bumpy ride for the time the sub was on the surface.

Notes from Dive 4219 Starboard side observer

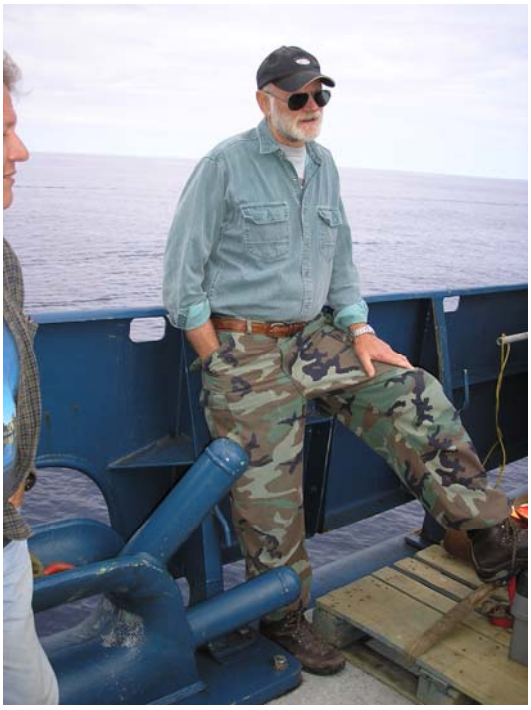
TIME (local)	Depth (meters)	Description	Water Temperature
0755	Deploy	Enter sub for dive 4219, begin deployment	
0806	Surface	Sub free of ship	
0811	Surface	Sub begins descent	16°
0814	200	Already rapidly changing light levels	
0816	272	Descent rate about 30 m/ minute	
0819	365	Beginning of bioluminescence	
0820	393	Intense bioluminescence	
0824	500	Intense bioluminescence	
00832	815	Intense bioluminescence, large salps or other gelatinous zooplankton	
0837	981	Intense bioluminescence, large salps or other gelatinous zooplankton	3.7°
0918	2268	Intense bioluminescence	2.0°
0936	2831	Less bioluminescence	2.0°
0939	2918	Sparse bioluminescence	1.6 °
0945	3081	Detect problems with the port robotic arm, test the ability to reach cores with the starboard arm,	1.6 °
1015	3921	Approaching bottom, appears flat, little bioluminescence visible	1.6 °
1025	4118	Reach the bottom – clear view of the bottom as we approach, lots of invertebrates clearly visible. We move forward slowly and see a good variety of benthos in the visual field including crinoids and urchins. TARGET position X = 7475, Y = 7370	1.5 °
1034	4118	Abort dive after malfunction of the ballast system	
1141	1953	On ascent testing systems for ground faults and other trouble shooting	2.0°
1248	surface	On the surface again, sub recovery goes smoothly, seas are calm and wind is down	16.6°

After the submersible is recovered, the Alvin engineer group begins to take the sub apart to check out the problems. Obviously, the scientists are very disappointed and the crew is a bit perturbed that systems did not operate as planned. The problems seem to be linked to the depth of the dive – right at the limit of the submersible capacity. The next

generation of deep sea submersibles to be commissioned in 2009 will be designed to work at 6000 meters.

The rest of the day we spend getting the “Free Vehicle Grab Respirometer” (FVGR) and “Free Vehicle Fish Trap” (FVFT) deployed on timed mooring devices. These arrays go down to the bottom of the ocean for a few days, then an acoustic release is used to drop descent weights and allow the equipment to return to the ocean surface. From there, the ship picks up a radio transponder to recover the samples. This takes plenty of people and coordination to get big pieces of heavy equipment safely over the side of the ship and deployed.

All this equipment is due up in a few days, so after tonight we will go to operations for day (submersible dives) and nights (free vehicle recovery and deployment).



The chief scientist, Dr. Ken Smith, Jr. has worked over 35 years in deep sea biology. He has more ship time on research vessels than any other biological oceanographer in the country. His passion for deep sea studies has lead to the development of new research instrumentation such as the ROVER and the Free Vehicle cameras and respirometry systems.

*The DSV Alvin being launched from the large A-frame crane off the stern of the R/V **Atlantis.** Inside is a very cramped space for three people, a pilot and two scientists.*

DOWN AGAIN
05 August 2006, Saturday
0800 The submersible goes down as planned, with Jeff and Tasios as observers, they have the4 same task list we had yesterday, so we are all hopeful that the submersible is in good working order now. The weather is calm, and there are pods of dolphins swimming off the port side of the boat. The water is the deep sapphire blue color of the open ocean.

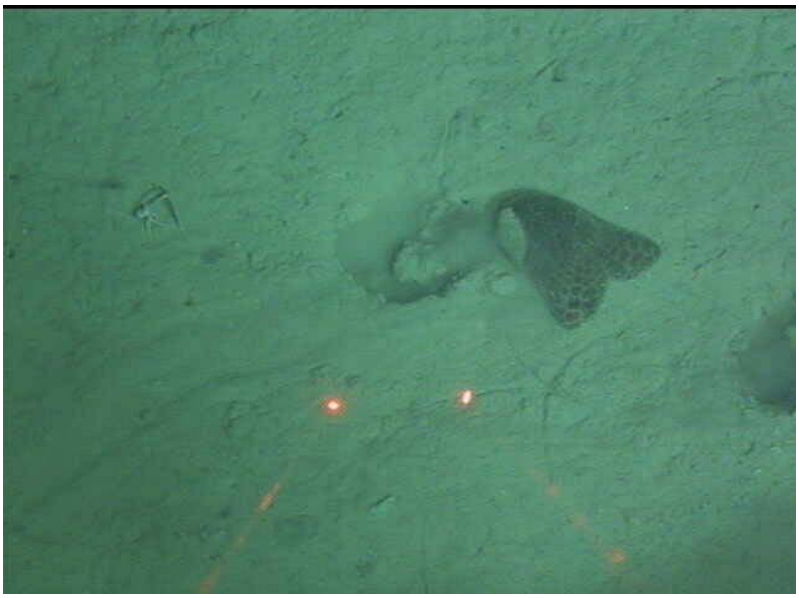
After the submersible launch, there is plenty of time to get some work done – I finish up my trip report from Abaco field work LAST month, and thanks to my graduate students, have some music to listen to on my laptop. I am learning so much from the people on the cruise. I have a great discussion with Larry Lowell about invertebrate taxonomy and what types of microscope with camera system I might need for the Nassau Harbour monitoring project. I am really charge to get that proposal outlined while at sea. The cruise has just reminded me how much being involved in scientific research matters.

1700 The submersible is up and the dive has been a great success. The ship has an amazing intranet system where we can download the navigation and photographic survey

data from the submersible a few hours after the recovery. I am charged with keeping the ship event log. Throughout the ship there in an internal internet where all the navigation, meteorological and research data is posted, one can even see the pictures and videos from each dive. There are plenty of samples to process, such as invertebrates to freeze or dissect. The sub also brought up 21 sediment cores that need to be extruded and frozen for later chemical analyses.

2000 The fish trap is up. The sun is just setting and the sea is flat calm. The dolphins are a common sight now, small Pacific white-sided and common dolphins. They circle the boat but keep their distance. The fish trap has three large rattails *Coryphaenoides armatus* and maybe a hundred small amphipods. The smell of the rattail fish is very distinctive and not appealing. I never never want to be buried in the sea and be an episodic bait fall for these creatures. I spend my time helping Jeff and Ray with the fish dissecting then doing invertebrate identification with Larry. The samples are really interesting, even a solitary coral comes up with some of the benthic samples.

We start an inventory of the animals brought up from the trap and submersible and it is a late night for many people processing samples, then doing a CTD (water sampling cast) at 0100. Every night the ship has to run about 10 miles from our work area to dump out the sewage and biodegradable garbage. Even at sea we sort the garbage in to plastics (to incinerate) and the paper/ biodegradable (to dump). It is like the ship is our own little sustainable island system. I find it interesting we have to dump sewage from the bilges 10 miles away for fear of contaminating experiments 4000 meters below us!



*The deep sea urchin **Echinocrepis** is related to the sea biscuit found on the Bahama banks. The populations of these urchins in the deep sea fluctuate with climate cycles (determining their food supply).*

The basket on the front of the submersible holds a box for collecting organisms and cores manipulated by the robotic arms.

THE ROVER GOES DOWN
06 August 2006, Sunday

This is getting routine, but still exciting. The pattern is to get up at 0600, get coffee, and get out on deck. The "Rover II" is ready to deploy. This is a small mobile vehicle built by a team of engineers at MBARI (Monterrey Bay Aquarium Research Institute). The Rover is being tested with the submersible to test the various engineering components. Ultimately, the ROVER will be equipped to do deep sea sediment respirometry. The rate that animals grow, eat and reproduce in the deep ocean is an important theme for this cruise; the key to that is the amount of food energy that falls to the ocean floor from surface waters. Much of that food energy is broken down by bacteria and meiofauna in the sediment. The lead engineers, Paul and Alana, will be able to see the movement of the rover on the sea floor and evaluate the performance as well as release mechanisms with some options for manual recovery with the sub. This is always a challenge to engineer and build reliable equipment up to the job of working in the cold and high pressure of the deep sea.

After the Rover is safely away, the submersible is prepared for launch on Dive #4221. Once the submarine is down, there is not much to do on board the ship until it returns. No operations can be carried out while the ship is tending the sub. You can go up to the bridge and see the communications and navigation center; a display will show exactly where the submarine is in relation to the ship.

1600 Rover returns after a successful test. The submersible was able to film the movement of the Rover, but the programmed releases did not work, and the sub had to manually liberate the Rover from its sacrificial descent weights. All is well as long as the equipment makes it back on the deck of the ship

1700 Submarine back like clock work, with samples to process. There are a few sea urchins and holothurians, and more cores to process. Processing samples takes several

hours. I go to bed early, but the late team waits for the retrieval of deep water sediment traps that have been in place since LAST NOVEMBER! They finish work about 4 AM.

	*The ROVER being launched over the side of the ship. The ROVER is being developed to carry out experiments on the sea floor remotely over a three to four month period.*
	*A close up photo of the **Echinocrepis** urchins. Five years ago, these urchins were very rare, but now populations are booming. Long term ecological cycles in the deep sea are poorly understood.*

MONDAY MORNING AT SEA
07 August 2006

Up about 0630 to a ghost ship, most people are asleep from the late night work, but the submersible crew is busy getting ready for the day's dive. Imagine an 8AM to 5PM job where you spend your day at the bottom of the ocean. There are check lists and tests to perform every day for the dive's success. Today, a pilot-in-training will be going down with Tim Shaw, a marine chemist. The weather is unusually calm, a glassy, smooth, endless sapphire blue ocean. We see small common dolphins every day passing the boat is small groups. The deck and the lab is littered with big pieces of equipment brought up from the sea floor – a titanium frame camera system, sediment traps and big pressure housing for instruments. All of this has to be cleaned, re-serviced and put back in the ocean for another 6 months!

0830 Submarine is launched; Tim Shaw is off with a pilot-in-training. I am off to do some work on the computer to complete a few outstanding letters and reports to be sent off…I work all morning at a happy pace, keep up with the ship log and inventory of specimens brought up. At lunch, the night crew is back up and there is a big agenda for the afternoon. We spend the day repairing a huge 40' otter trawl – we will deploy this right after the submarine recovery, and drag the trawl on 4100 m with over 8500 m of hydrographic wire out behind the ship.

The trawl deployment was an engineering feat to get the trawl down with the large crane, lots of people and a big hydraulic winch. I stand winch watch until 21:30 then crash and set my alarm for 0300 to be on deck for trawl recovery! That will be like Christmas to see what animals come up.

	*Pressure effects on Styrofoam illustrate the challenge to engineers to design systems that are pressure resistant.*
	*Rattails look elegant and streamlined while swimming over the bottom. These fish are attracted to any disturbance on the sea floor as a potential food source.*

TUESDAY TRAWLING
08 AUGUST 2006

Up at 0300 to bring in the big trawl. There was a core team of four of us responsible for the trawl deployment and recovery. Ray Wilson, Jeff Drazen, Larry Lowell and I have been baby-sitting the deployment of the wire, and now the whole mess is back up on deck. There is literally a few hundred pounds of mud, fish and worm-like things sitting

on the deck. Deep sea fauna is not well known, but many species are already described, and people are looking at more sophisticated questions than, "What's down there?" Now the focus is on population genetics, recruitment and reproduction as well as trophic interactions. The deep sea is a continuum from the coastal oceans, and thus general ecological processes will be similar, but likely there are some new adaptations to the scale, physical extremes of pressure and temperatures as well as the limitations of food sources. People are definitely impacting the deep sea – even the ship dumps its sewage and compacted biodegradable trash in the ocean. We trawl up from 4100 meters plastics, pieces of lumber, and some odd pieces of machine debris (looks like a fan belt!)

The sorting of the invertebrates and dissecting of the fish takes several hours of team work.

I go to sleep about 10AM and sleep until 3 PM. The rest of the day is a bit disorienting, still some material to sort – and I photograph the rocks brought up from the trawl, not Manganese nodules as one would expect in the deep sea, but light ovoid pumice stones! These rocks were formed in volcanic eruptions, and were ejected and maybe floated to the deep sea and sunk to the deep ocean floor. I do not know how old some of these rocks can be; the deep sea floor is this settlement plane collecting the planet's history over millennium. The weather is definitely picking up and getting rougher, the report is for rough weather this weekend.

Up through the night sorting invertebrates in the deep trawl was really fun. It was amazing to see the variety of species coming up from 4000 m.

An assortment of deep sea starfish collected in the trawl.

WINDY WEDNESDAY WITH NEW DISCOVERY
Wednesday, 9 August 2006

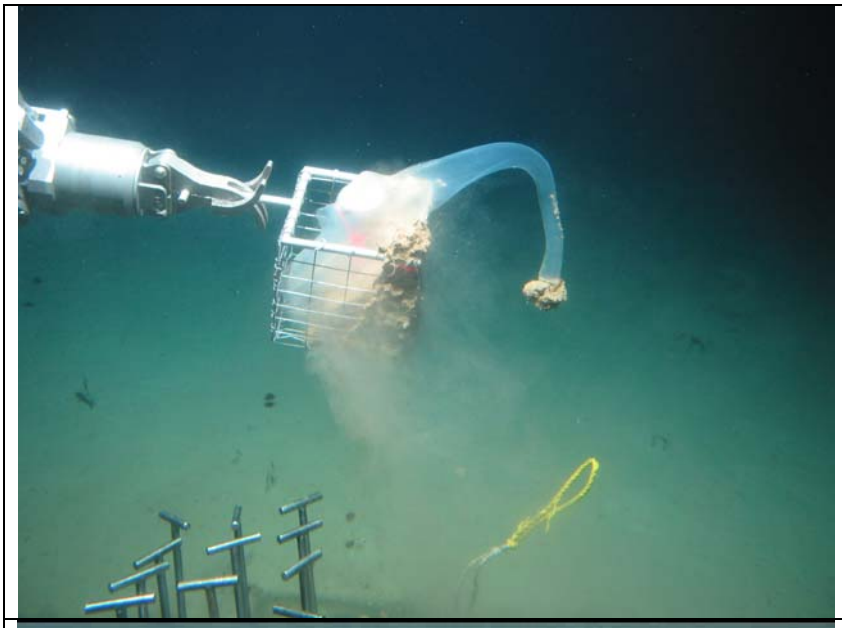
The weather is picking up; there is a noticeable roll in my bunk. The ship is amazing with the way the bow can be maintained into the wind and swell, so in the laboratory and work spaces you can hardly notice the 8-10 ft waves rolling by. Today is a spent maintaining records for the push cores. There is a high demand for small (30 cm) cores from the deep sea sediments. Several scientists are processing these sediment (mud) samples to look at

- What animals live in the mud (meiofauna invertebrates)
- What is the organic content of the mud, and thus what types of biotic energy reaches the sea floor, and
- What is the diversity of deep sea biota by examining the DNA finger print of the surface microbial community?

Larry and Jake go down for the Alvin dive, and have an excellent time. They bring back a real discovery – a new species of tunicate. Tunicates are our closest invertebrate relatives, and occur all over the world's oceans. Usually, they are small, grape-size animals clinging to rocks and pier pilings that filter water to trap small organisms in the water column. This deep-sea predatory tunicate is over 50 cm high with a thick transparent tunic and hood that slurps in unsuspecting animals over the sea floor at 4100 m. There is quite a contract of the elegance of the animals in photographs from the sub and the big blob of tissue that comes up in the biology box on the front of the submarine at the end of the dive.

This Station M at the eastern edge of the Pacific is a well-studied site with decades of collection data and oceanographic studies. There are many parts of the ocean, including much of the deep water in The Bahamas that we know relatively little about. There were Alvin dives in the Tongue of the Ocean in the 1960's but those records and reports are

long scattered in dusty corners of museums and libraries. What is happening today, and how the deep sea has changed with all the ocean dumping that occurs is just not known. The deep water is just down stream from inputs to the shallow water and banks. While we are doing research on this remote Pacific site, we are very careful about sorting trash and restricting what is dumped over the side of the ship. Too bad that same care does not carry over to our everyday habits.

	*The sub arm collects a large predatory tunicate from the sea floor*
	*A deep sea sponge looks like a flower, this sponge secrets glass (silica) spicules to keep its body elevated about the mud bottom on a stalk.*

DIVE DAY, ALVIN DIVE #4225
Thursday, 10 August 2006

My rotation comes up again, and it is a relatively calm day. I am going to dive as the senior observer with Andrew Chase, the software engineer from MBARI. We are charged with ROVER observations and collecting more urchins and cores. There are two groups of scientists on the cruise – one group is primarily engineers who are designing

and developing the deep ROVER. This is a mobile instrument that can go to the deep sea floor for up to seven months, and take all sorts of measurements and samples. Right now, the ROVER is in the development stage where it is just being tested for software routines that allow it to go down, wake up, travel a few meters, turn, and then come back to the surface. There is a team of engineers that put this together in collaboration with the ecologists. This instrumentation development is funded by a National Science Foundation grant to Ken Smith, and new instruments are the key to asking more sophisticated research questions in the deep sea.

Dive days are hectic, the observers need to be up early, have all the warm clothing necessary for a 9 hour dive to 1.5 degree Celsius waters packed, get a briefing on task priorities from the chief scientist, and then use the head for the last time (unless you can urinate in a bottle under a blanket in a sphere only 6' in diameter.)

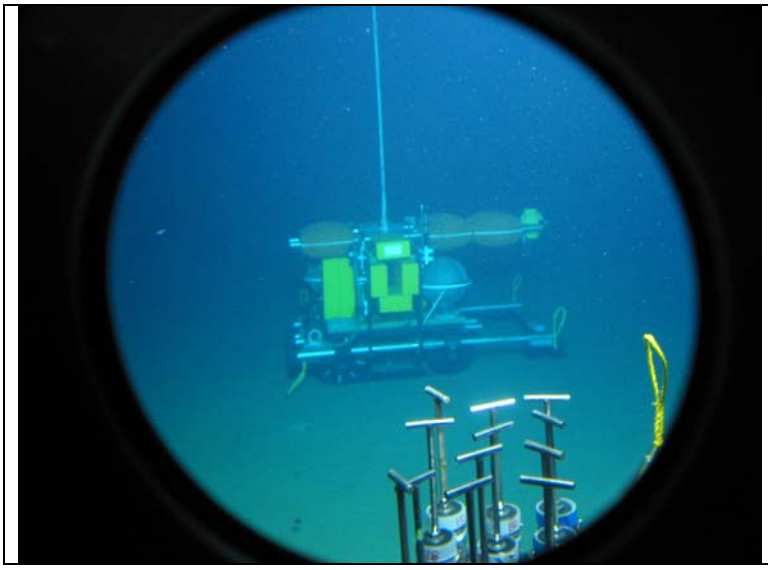
The dive is very exciting, and the 4 hours you have the bottom go by in a flash. There is always something to see out the observation ports, video recording equipment to use, notes to take, and a task list to complete. We are able to locate the camera tripod, and attach flotation to that to send it back to the surface. Next we collect some sponges, and core near and away from the stalk of the sponges. The cores are fairly small, and researchers want to know what controls the distribution of benthos (bottom-dwelling organisms) on the deep sea floor.

After the dive, there is still the night work to do, deploying the Free Vehicle Grad Respirometer and the fish trap (again).

Log from Dive 4225 Port side observer

TIME (GMT)	Depth (meters)	Description	Water Temperature
1503	Deploy	Enter sub for dive 4219, begin deployment	17.3°
1507	Surface	Sub free of ship	17°
1508	17	Sub begins descent	17°
1510	110	Already rapidly changing light levels	10°
1511	152	Descent rate about 30 m/ minute	9.4°
1513	222	Beginning of bioluminescence	8.2°
1553	1633	Descent	2.6°
1650	3396	Checking out camera systems, approaching bottom	1.5°
1736	4117	Camera hooked up to floats to send to surface	1.5°
1741	4118 m	Camera away	1.5°
1743	4118 m	Two rattails already around the arms	1.5°
1749	4118 m	Dropped excess weight from the sub to adjust buoyancy	1.5°
1754	4118 m	First sponge cored near and away from stalk, collect sponge (Hexactinellidae)	1.5°
1805	4118 m	Move towards ROVER, locate another sponge	1.5°
1806	4118 m	Core near stalk and away from second sponge	1.5°
1850	4118 m	Found ROVER	1.5°

1906	4118 m	ROVER moves slowly forward, lots of fish around	1.5°
1912	4118 m	ROVER moving forward, track is smooth	1.5°
1931	4118 m	ROVER stops and moves backwards, 5 + fish in immediately vicinity	1.5°
1953	4118 m	ROVER turns then stops, acoustic release signaled from the surface, See small gray eels, small mouth, swimming near arm of submersible.	1.5°
2021	4118 m	ROVER did not respond to surface signal, sub pulls manual weight release, and ROVER is away from bottom	1.5°
2023	4118 m	Bottom is dense with red medusae, lots of benthos and bioturbation tracks. Core sponge #3	1.5°
2040	4118 m	Core in and out of trail of holothurian ***Echinocrepis***	1.5°
2046	4118 m	Core in and out of trail of second urchin	1.5°
2053	4118 m	Core around the fourth sponge	1.5°
2100	4118 m	Find a large holdfast from kelp that washed out from shore	1.5°
2132	4118 m	End dive, drop weights and head up	1.5°
0032	surface	Sub back on the ship after a rocky recovery	17.5°



The ROVER is observed through the sub window as it creeps along the bottom.

A deep sea medusa drifts past the sub observation port.

WEATHER DAY
Friday, 11 August 2006

I can tell when I get up in the morning that the seas are rough. My bunk is three levels about the main deck, so there is quite a bit of motion with the rolling of the ship. The students and technicians have rooms below the main deck, which might have less rolling, but considerably more noise from the bow thrusters and anti-roll tanks. Below deck it is really noisy! When the submarine is not diving, there is much less activity on board the ship, and people are a bit lost for what to do. With the increase in the wave activity we recall the fish trap early in the afternoon. The trap has an acoustic release like many of the instrumentation packages. The release listens for a signal from the surface and then drops the weights at the bottom of the trap. It still takes 2 hours for the trap to reach the surface.

We have great success with the fish trap, and the baited hooks on the outside of the trap. There are a dozen rattails outside and inside the trap. This time we get two species of rattails, ***Coryphaenoides armatus*** and ***C. yaquinae***. We look closely at the fish, examining the fins and the teeth to distinguish the two species, but they are indistinguishable on the video tapes. Two species that look very similar, and are found in the same habitat usually doesn't make sense ecologically, but ***C. armatus*** is at the very edge of its depth limit, while ***C. yaquinae*** extends out deeper than 6000 m over the abyssal plains. Probably is we could really observe the behavior of these fishes on the bottom, the differences between the two species might be more apparent. Any time researchers work in the deep sea, a disturbance is created, and fish are attracted to disturbances so it is a challenge to decipher what would be a normal pattern of behavior.

Some of the fish on hooks come up badly eaten by amphipods or squid on the sea floor. The viscera (guts and intestines) are eaten away, leaving only the head and skeletal musculature. Rattails are the ubiquitous scavengers of the deep sea floor – Jeff and Ray study the energetics and population dynamics of these fishes. Rattails or "grenadiers" are attracted to any disturbance on the bottom, and seem to circle around the submarine or

equipment. They appear to float above the bottom with a shimmer of dark brownish blue. This is quite a contract to the hideous mess that comes up on the hooks and in the fish trap. The fish have bulging eyes and exploded swim bladders, with a smell that is distinct and unpleasant. These have to be the least appetizing fish to consider eating! We hear from the Japanese computer technician, Kazumi that rattails are eaten, but I can not get past the smell!

All afternoon is spent dissecting fish. In the evening, the crew starts a round of "Texas Hold 'Em" poker, while most people watched a movie.

Free Vehicle Grab Respirometer (FVGR) deployed to spend two days on the deep sea floor looking a sediment metabolism – or how fast oxygen is consumed by bacteria and small organisms in the deep sea floor mud.

SECOND WEATHER DAY
Saturday, 12 August 2006

All night long, the ship was running multi-bean surveys to create a very detailed map of the bottom bathymetry. This technology used to only available to the military, but now we can create very detailed maps of the abyssal plain below us, with the small hills and ridges. When the weather is too rough for anything else, we can always do the bottom mapping.

It is rough in the morning, and again the ALVIN dives are cancelled at 0700. This puts people into a bit of depression. The schedule is revised to allow for multi-coring – a large tripod with cores is dropped to the ocean floor to take a set of 15 sediment samples. Unfortunately, the coring does not go well. The first attempt does not produce any sediment samples (the cores come up clean). On the second deployment, a bad metal-to-metal scrapping sound comes from the winch. The core is eventually recovered, but the bearings for the winch sheave are gone. This takes all day – by the time the core is back on deck, it is dinner time and the deck crew is not going to take it apart until tomorrow.

There is still some clean up of samples to do, and jobs preparing the cores for tomorrow. The weather calls for calmer seas. The evening crew spends time doing two CTD casts (CTD = Conductivity-Temperature-Density – a water sampling system really at the heart

of all oceanography that can define the water quality characteristics at depth, and thus the water masses in the ocean)

The CTD – an oceanographic workhorse for sampling water throughout the water column.

BACK TO DIVING
Sunday, 13 August 2006
The seas are noticeable calmer, so Ray finally gets down on his dive. The student intern, Ashley Booth, gets to go as the second observer – she has got to be the luckiest intern on the planet today. All her hard work on the cruise and in the lab over the past year has paid off; and she is obviously thrilled to see the invertebrates up close and in real life compared to the mangled samples that return to the surface.

While the submersible is down, I am up on the bridge and discover that there are the vessel logs from ALL the ***Alvin*** dives back to the 1970's. The second mate, Craig, is telling me that the ***Alvin*** did extensive work in the Tongue of the Ocean (TOTO) and the Northwest Passage north of New Providence. These deep sea canyons in The Bahamas have to be very vulnerable environments with all the garbage dumped off Nassau, not to mention the US Navy operations at AUTEC.

The submarine is on the surface at 5PM, and there is a rush of activity. Everyone is on deck to see the sub recovery. Ray and Ashley have taken some great fish photos while the sub was sitting in one place deploying the tripod cameras.

The evening is busy with the recovery of the Free Vehicle Grab Respirometer (FVGR). This is the last deployment for this piece of equipment, so after the sediment samples are processed, the team starts breaking down and storing the pieces. Jeff starts fishing for squid again. Tonight is dark with no moon and overcast, so the only lights are the lights on the ship. Jeff brings up a Humboldt squid – a large 2-ft long squid.

Jeff Drazen is from the University of Hawaii and looks at the energetics of deep sea fish. He is starting to look at the food sources that support the deep sea fishes. These pelagic

squid have large eyes and formidable beaks for biting and grasping prey. The colors pulsing down their bodies are metallic iridescent colors. The night is very dark, no moon, so the squid are drawn up from the deep to the bright lights on the fantail of the ship. The photographs don't really do justice to these animals. We are catching immature individuals, the adults range over 6 feet in length, and have been reported to kill fishermen. This is the same species found all along the coast of California (one of many squid species), commonly called "Diablo Rojo" or red devil by the Mexican fishers.

There have been lots of interesting discussions about the origin and ecology of deep water fauna. The HMS ***Challenger*** expeditions in the 1870's shocked the scientific community with the collection of over 13,000 specimens of deep sea fauna. Prior to that expedition, zoologists hypothesized that the deep sea was an "azoid zone", or lifeless void. After over 140 years of deep water exploration, oceanographers now understand the connection through the water column of large marine systems from the surface through the midwater to the abyssal plains. The vast areas of deep water environments is at a scale that ecologists struggle to understand, but these environments still respond to climate cycles and disturbances. The deep water likely also is degraded and impacted by human activities as well. One has to just look at the reports on the Gulf of Mexico to understand the scope and severity of changes humans can initiate in deep basins.

So far on these sets of dives, observers have only seen one Coke can on the sea floor at 4000m. I hope we did not drop it off this ship.

This was the photo of the trip – a rattail resting its head on one of the submersible cameras, taken by the other camera! These fish live in a totally dark world, and their eyes are not responsive to the bright lights on the sub – instead the pits along the jaw and head help the fish feel vibrations in the water.

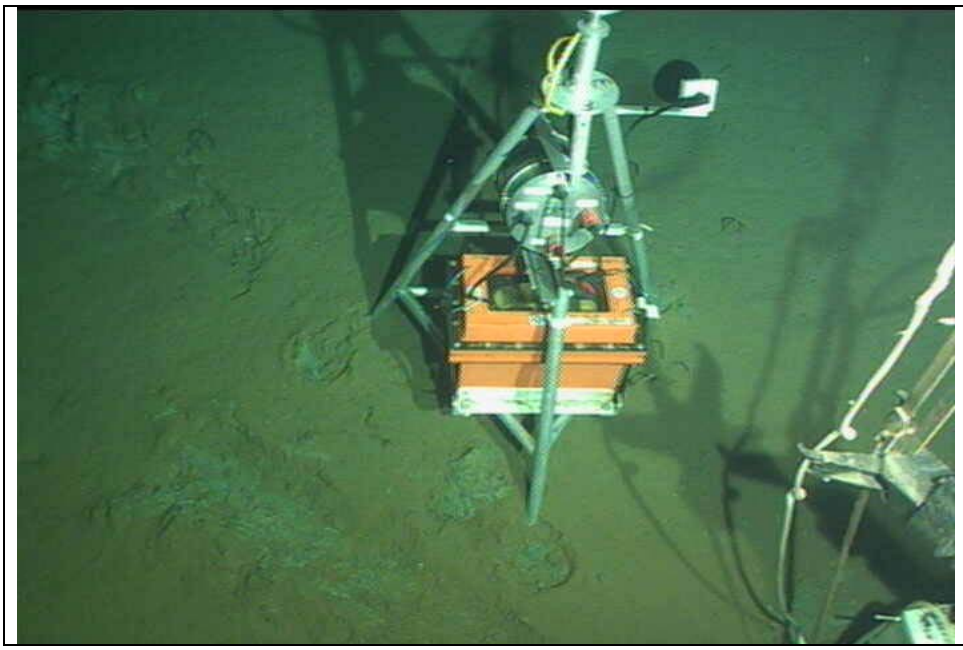
Juvenile Humboldt squid caught off the ship on a dark moonless night. The squid were attracted to the bright lights on the ship.

ANOTHER MONDAY AT SEA
Monday, 14 August 2006

The submarine is in normal operations mode. Today the sub mission will focus on the camera tripods and getting another photo transect. The camera tripods have been in place overnight photographing the movement of the ***Echinocrepis*** urchins. Like many urchin species, these urchins are apparently going through a rapid growth in population size. Urchins on coral reefs and apparently, in the deep sea go through periods of rapid growth, then rapid decline in population size as a response to changing food supplies or environmental conditions.

Mike is looking at the energetics of these urchins, and collecting specimens to dissect out their guts for chemical analyses back on shore. He will compare the organic component of the sediment around the urchin, in the urchin's gut, and behind the urchin (the urchin trail is presumably some component of sediment that has already passed through the urchin's gut).

During the day, we spend our time getting another great giant piece of equipment ready for deployment: the camera sled. This is a large metal sled that is towed on the bottom with a forward-pointing camera and strobe. There is a small 16' otter trawl towed behind the sled. This survey method of the benthos can be compared to the submersible transects. The camera sled can be towed from any large research ship.



Camera tripod placed by the submarine to track the movement of the benthic animals.

PHOTOTRANSECT DIVE
Tuesday, 15 August 2006

Submarine goes down for Dive #4228, Henry and Jeff go on the dive to focus on getting the photo transects complete. This takes time to set up the downward pointing camera and ballast the sub about 2 meters off the bottom. A close-up examination of the sea floor shows a maze of bioturbation from the urchins, starfish and other invertebrates. It is interesting to compare the soft mud floor of the deep sea to the oolite sand banks of the Bahamas. Both environments are limited in food energy, but there seems much more visible benthic activity here in the darkness of 4000 m than on the sun-drenched shallow banks. The animals in the deep sea live at cold temperatures with slow metabolic rates, and long life-cycles.

The day is occupied with getting the camera sled ready for deployment. As soon as the submarine is recovered, the sled will be deployed. Everyone is thinking about getting into Astoria, Oregon, and getting this cruise wrapped up. The weather turning rough and it is not certain we will be able to get in the last two submarine dives on Wednesday and Thursday. I keep myself busy with reviewing the dive tapes and files to maintain a log of the cores and other collections made during the cruise.

After the camera sled is deployed by about 15 people, I go to sleep and set my alarm for 2 AM to get up and help sort the fish and invertebrates that are collected in the small trawl attached to the back of the sled.

A close up photo of the deep sea floor showing all the biological activity – notice the sunken starfish that feed under the surface of the mud.

ROUGH WEATHER AGAIN
Wednesday, 16 August 2006

I get up at 2 AM to see the sled recovered. The weather has picked up, and the wind is cold! I find out that I do not have enough warm clothes on this trip, so just wear many layers as possible. The camera sled is recovered, the cameras appeared to work, but the trawl was tangled and never opened on the bottom. This is disappointing to put in all the time and effort for about a dozen small worms caught on the net, but this is the nature of research.

I go back to sleep for a few hours, but then get up in time to see the submarine launch. The seas have picked up and the dive with another test of ROVER is cancelled. My job on the cruise is putting together the metadata files for the cruise, which includes the inventory of specimens, fate of the cores taken, and update of the event or station log. Most of the other people on the cruise work full time on deep sea biology research questions, so this is a fantastic chance for me to both catch up with this field but also draw the obvious parallels with shallow water marine ecology. All of the researchers have worked together in the past to some degree that there is a good deal of collaborations. There are discussion on grant-writing, the latest results from meetings, and ideas for future papers and projects. This is what being a scientist is supposed to be about, but it is not inexpensive. The ship has a state of the art navigation and communications system and each submarine dive costs about fifty thousand US dollars! The National Science Foundation awards ship days and Alvin dives on a competitive evaluation of research proposals. Tasios (Dr. Tasios Tselepidis) works for the Institute of Marine Sciences in Crete, and goes through a similar proposal process to get funding through the European Union.

Where does this put research funding for a small country like The Bahamas? Scientific research is viewed as a luxury of developed countries, but may be even more necessary in developing countries where the issues of pollution and resource management are even

more acute. Obviously to do world-class research on the marine environment, one needs money, resources and talented people. The most important tools would be research vessels, but judging from the challenges of just getting the **R/V Guanahani** out for 10 days in July, we need a new approach to the importance of studying the oceans in The Bahamas.

Time is not wasted on the ship; most of the day is spent doing deep CTD casts. Dr. Time Shaw, a chemist from University of South Carolina are collecting the water, filtering the water from depth to look at extracting radio-nuclides. They use about 225 liters for water to extract down to a gram of material. This material is taken back to the laboratory to read on an alpha counter and gamma counter to detect the amount of isotopes in the water column at various depths. Researchers know when atomic weapons first released these radio-nuclides into the atmosphere and on to the surface of the ocean. Tim is testing new materials used to extract these isotopes from sea water over a broad depth range. The evening is spent getting the metadata files in order, and starting to pack specimens. The talk has started to shift to what people will do in port.

LAST SUBMARINE DIVE
17 August 2006

The submarine dive is put on a one-hour hold this morning, the wind and waves are still up but the wind is dropping. The ROVER is on hold for deployment as well; the purpose of the dive will be to run another set of tests on the ROVER. It has been programmed to take a current direction from its current meter, then turn into the current and move about 10 meters. This is a big test of both of the programming and the mechanical engineering of the ROVER. The ROVER has to go into the water about an hour ahead of the sub. It takes two hours to sink to the bottom – just like the submarine. 4000 m is a long way down at 30 m per minute.

The launch goes smoothly, the wind is down, but swell is up. During the day, we already start to break down equipment and get gear moved into baskets for offloading. There is quite a bit of work to do reviewing the submersible dive tapes. The ship has an elaborate data logging system. For each submersible dive, there are still photos and three video tapes to review and catalog. The ship has an intranet system between the shipboard data processing systems, so I can download files to review on my laptop while working in the lab. There is plenty of laboratory and work space on the ship; almost the ideal work environment (no phones) but you don't get to go home in the evening.

The dive is successful, and the prototype ROVER is very successful. The engineers are ecstatic, and ready to get back to the lab on shore to make modifications and improvement. There are lots of interesting invertebrates in the collection, Larry gets these identified and into preservative. There is a big effort to get some of the clean up done and prepare the specimens for shipment. I am getting a nice collection of the gonadal (ovaries and testes) tissue from rattails, so hopefully I can get the histology done, and look at the slides to continue my studies on energetics and life history strategies of

fishes. These rattails can live for a hundred years, so no body knows much about when they reproduce.

	*Cores of the sediment around a large piece of kelp that has drifted several hundred miles off the coast of California to sink to the deep sea floor.* *The red dots are lasers from the camera system for scaling, and are 10 cm apart.*
	*Scientists and sub engineers talking about the research results.*

PACKING UP, SHIP HEADING TO ASTORIA
Friday, 18 August 2006

There is a steady stream of work completing the review of dive photos and video tapes. The ship is underway making 10 knots with 750 nautical miles to the port of Astoria, Oregon. I was last in Astoria in 1979. This was an important fishing and lumber port at the mouth of the Columbia River. Since 1979, the lumber and fishing industries of the Pacific Northwest have collapsed and re-organized, so it should be interesting to see what has happened here.

The real work just starts at the end of the cruise – the follow up analyses and writing of manuscripts will take months to years to complete. The team hopes to have some significant papers and summaries of the past 25 years of work for the next Deep Sea Biology International Conference in Goa, India in 2008. Plans and responsibilities are discussed. Everyone is very happy with the success of the research, even with a few

days of bad weather. The ROVER was a big success, with three separate tests of its ability to travel and orient to the current on the sea floor.

STEAMING THROUGH FOG
Saturday, 19 August 2006
As the ship steams north into the cold water flowing south from the Arctic, the warm air over cold water creates fog. I wake up to the fog horn sounding every 10 minutes as the visibility drops to less than mile. The bridge is closed and crew are posted to watch for small coastal fishing boats that might be in the way of a large, fast moving steel-hulled ship.

By late afternoon, the sun is out, and there is a faint outline of a coast against the horizon, the first sight of land in 14 days. We have spent the day cleaning; it is the responsibility of the science party to clean the labs and the cabins used in preparation for the next research group meeting the boat in Astoria for submersible work in the Straits of Juan de Fuca off the state of Washington.

ARRIVAL IN PORT
20 August 2006, Sunday
The morning is again foggy as we approach the sea buoy off the coast of Oregon. A fast pilot boat speeds along side the R/V ***Atlantis***, and the bar pilot makes an impressive leap on to the ship. The bar pilot has local knowledge of the sand bars at the mouth of the Columbia River, and will guide the ship into port.

We are surrounded by literally hundreds of small recreational fishing boats out line fishing for salmon at the mouth of river. Fishermen are crowded together in small and large boats with lots of lines over the side to catch salmon trying to return upriver to spawn. The trip into the mouth of the river is spectacular, as the Columbia must be several miles wide at this point. We go up to a major bend in the river channel to Astoria, a port wedged between the river and coastal hills. It certainly smells like a fishing port, but most of the fishing boats I saw 25 years ago are gone, and many piers abandoned.

As soon as the ship is tied to the dock, there is a flurry of activity to get equipment offloaded to waiting trucks, and everyone is celebrating cell phone service with phone call homes. I have to thank everyone for a fantastic voyage, and lots of food for thought to stimulate more research interest in the Bahamas, particularly with a focus on our entire ecological system from the islands to the bottom of Tongue of the Ocean. The new innovations in navigation, technology and scientific theory are as amazing as they are accessible to a motivated research effort. I got plenty to think about during the upcoming academic year; I think I am going to be day-dreaming during those long Academic Board meetings this fall about submersibles and undersea ROV's (remote operated vehicles) working along the platform margins off Nassau.

	*The scientific party on the cruise consisting of ecologists, engineers and chemists.*
	*Astoria, Oregon, land at last*