

SCOR Panel on New Technologies for Observing Marine Life
Meeting #3

Kobe, Japan
18-20 October 2006

Meeting Summary

Panel Members Attending: Geoff Arnold, Elgar de Sa, Gaby Gorsky, John Gunn, and Bob Ward

Regrets: David Farmer, Antonio Pascoal, Alex Rogers, Heidi Sosik, and Song Sun

Others Attending: Simon Allen (CSIRO), Jesse Ausubel (Sloan Foundation), Mark Hindell (Univ. of Tasmania), Ron O'Dor (CoML Secretariat), and Ed Urban (SCOR)

Objectives of the Meeting, Review of Agenda, and Actions Since Last Meeting

The Panel chair, Elgar de Sa, opened the meeting by asking participants to introduce themselves. De Sa reviewed the agenda and Ed Urban reviewed the actions since the last meeting and action items remaining. Urban also showed the Panel the PowerPoint presentation that he made to the Census of Marine Life (CoML) Scientific Steering Committee (SSC) the previous week. Jesse Ausubel, from the Sloan Foundation, which provides support for the Panel, stated that he wants the Panel to feel free to stimulate the projects to use new technologies, including technology that will be standardized to make technology less expensive and/or easier to use. The Panel's tasks may evolve over time. It should follow the paths that it thinks will have the maximum benefit to CoML projects and CoML's legacy. The Panel could challenge CoML projects to provide feedback on their technology needs each year. It would be useful for scientists providing different kinds of observations to push together for new measurements. Ausubel suggested that GOOS could prepare a timeline for each year from 2011 to 2025 to identify what biological measurements could be included in GOOS. Ed Urban responded that the Panel and the GOOS Scientific Steering Committee could work together on this. There is already a precedent for the GOOS physical measurements, in terms of the percentage implementation of planned measurements by year.

Special Joint Session with Techno-Ocean 2006

The Panel co-sponsored a special session with Techno-Ocean 2006 on technologies related to CoML and spent time beforehand preparing for the presentations. This session was chaired by Jesse Ausubel, who introduced CoML to the audience and related the importance of new technologies to CoML. The first presentation was on electronic tag technologies and was given by John Gunn and Geoff Arnold. Gunn pointed out that satellite technologies only work with tags for animals that spend a significant amount of time at the surface each day, such as salmon sharks. He added that there is a great need to link tag data with oceanographic data; Argo floats are too far apart and spend too much time in the deep ocean to be useful for understanding marine life. Arnold noted that tidal data can help in geolocation for tagged animals that sit stationary on the bottom in tidally influenced areas.

The second presentation, on potential applications of autonomous underwater vehicles (AUVs) to CoML projects, was given by Elgar De Sa and Simon Allen. De Sa spoke about “Application of AUVs with Optics to CoML projects.” He noted that there are 58 different AUVs that have been developed or are under development (see www.ausi.org/auvs/auvs.html). They range in size from very large ones to small ones that can be deployed by one or two people. Users of AUVs include remote sensing users (for sea-truthing measurements), oceanographic institutions, municipal corporations in coastal states, navy and defense laboratories, archaeological departments, the shipping industry, the offshore oil industry (for rig inspection), and rapid environmental impact assessment for e-governance. De Sa presented the technical specifications of the AUV (Maya) that he has been developing at the Indian National Institute of Oceanography. Maya is a small AUV that can carry the following science payloads: CTD, oxygen optode, radiometers, camera, and fluorometer. De Sa showed vertical dive profiles of dissolved oxygen, chlorophyll, turbidity, and temperature from Maya diving at Idukki Dam.

AUVs can dive to programmed depths, measure sensor variables while in motion, yo yo in the water column to map in three dimensions, perform mission transects below the sea surface, and avoid obstacles. AUVs use the following types of navigation:

- Open-ocean navigation with fixed long baseline transponders
- Navigation with ultra-short baseline localization: noise and alignment are problems
- Terrain-based navigation using SLAM (Simultaneous Localization and Mapping). SLAM uses AUV sensors, for example, sonar and camera, to fix unique features in an underwater environment. SLAM then attempts to “close the loops” on dead reckoned errors by recognizing these features through correspondence matching. SLAM uses loop closures and minimization criteria to continuously improve localization and mapping. SLAM works in real time and is the key to true autonomous navigation. Applications of SLAM include monitoring of coral reefs, study of hydrothermal vents and seamounts, and seabed photography.
- Low-cost navigation with Doppler Log, GPS, and Compass
- Inertial Navigation – too expensive

The types of optical instruments deployed on AUVs to date include cytometers, dissolved oxygen optodes, nutrient sensors, optical radiometers, Flowcams, turbidity sensors, and fluorometers. Examples of the use of optics on AUVs include

- the deployment of a cytometer on Autosub¹
- deployment of an optical phytoplankton discriminator on REMUS to detect harmful algal blooms²
- the Shadowed Image Particle Profiling Evaluation Recorder (SIPPER) is being deployed on a 21-inch diameter AUV. SIPPER includes two line-scan cameras and two collimated laser light sheets. This allows a resolution of 4,096 pixels per line and

¹ Cunningham, A., D. McKee, S. Craig, G. Tarran, and C. Widdicombe. 2003. Fine-scale variability in phytoplankton community structure and inherent optical properties measured from an autonomous underwater vehicle by JMS 43:51-59.

² Improved monitoring of HABs using autonomous underwater vehicles (AUV) (I.C. Robbins et al, Center of Coastal Marine Science, California Polytechnic State University)

23,000 lines scanned/sec. Objects are back-illuminated for better depth of field, higher f number, and lower power consumption. A shadowed image is captured in two dimensions; computers reconstruct a 3-D image. The resolution is a 15-25 um particle size.

AUVs can also carry non-optical imaging instruments, such as acoustic devices. For example, AutoSub has been used to map krill under sea ice in the Antarctic.³

Drawbacks of AUVs include their present inability to conduct long-distance navigation (but this is under development), power constraints that limit long missions, acoustic communications are difficult in shallow waters, hovering is difficult (except for specialized UUVs like ABE, Woods Hole), and they are unstable cruising just below the sea surface.

De Sa concluded by noting how AUVs could benefit CoML projects. Already, AUVs can be used to monitor blooms of phytoplankton and zooplankton with fluorometers and cytometers, and other environmental factors with Doppler Sonar Navigation, GPS and Compass. Zooplankton can be imaged by large AUVs like AUTOSUB, which could be applied by CMarZ. Remaining challenges for AUVs include perfection of terrain-based navigation (SLAM), which will open up new opportunities for CoML projects to apply optical and other sensing to coral reefs (CReefs), seeps and vents (ChEss), and seamounts (CenSeam). The development of long-endurance AUVs with new power sources is another challenge that, when solved, will present new opportunities for observing marine organisms. Another new potential is the use of multiple coordinated AUVs, which could be used for mapping the distribution of organisms, and associated chemical and physical properties.

Simon Allen entitled his presentation “The Need—Building Smaller Pyramids”. He noted that AUVs are important because more observations of the global ocean are needed for a variety of purposes. The key to deploying more AUVs is to make them less expensive to build and deploy, including capital, logistical, and information development costs. Deploying low-cost AUVs will require taking the many steps from observing something for the first time to being able to afford to undertake those observations routinely, as well as managing the disconnect between observational science and the science of observing. Recent marine technology and equipment successes at CSIRO include

- **Redesign of deployment and attachment methods for whale shark tagging**—The results are 100% deployment success (6/6), which has never before been achieved. 5 of the 6 tags are still transmitting after 5 weeks. The longest tag attachment has been 3 months, which also was never achieved previously. One of the 6 tags was recovered and all archived data were recovered. This should prove to be a remarkable data set, although it has not yet been analysed.

³A.S. **Brierley**, P.G. Fernandes, M.A. Brandon, F. Armstrong, N.W. Millard, S.D. McPhail, P. Stevenson, M. Pebody, J. Perrett, M. Squires, D.G. Bone, and G. Griffiths. 2002. Antarctic Krill Under Sea Ice: Elevated Abundance in a Narrow Band Just South of Ice Edge. *Science* 8 March 2002 295: 1890-1892 [DOI: 10.1126/science.1068574].

- **MUFTI (Multi Frequency Towed Instrument)**—This instrument contained repackaged commercial instruments for deployment underwater. They have increased the sensitivity of measurements compared with previously available instruments, yielding better fish stock analysis.
- **Benthic Laboratories**—Used for *in situ* benthic respiration analysis.

Existing towed systems used by CSIRO have the following features:

- Fiber optic cabling (provides real-time imagery for the ROV pilot)
- Digital stereo video (surface recorded, calibrated)
- Digital stills (trigger, instant preview)
- USBL: geolocation of data
- Navigation camera
- Remote electronic control
- Telemetry: depth, altitude, wire out
- Data: CTD, fluorometer

CSIRO deploys two ROV versions: (1) a “shallow system”—portable system – fishing vessels; wire to operate at ~500 m and (2) a “deep system” –large vessel platform; wire to operate at ~1500 m. WHOI has developed an ROV that can operate to 11,000m.

The majority of marine research technology development has been point or small area focused. However, the greatest advances in understanding in terms of impact in recent years have been made by broad area technologies. CSIRO has tested an AUV called NUI Explorer. It is estimated that it can perform surveys 10 times faster than a comparable ROV, although this AUV was damaged by the ship in the first day and the full testing could not be accomplished. Allen showed video of a low-cost AUV they are developing. It has stereo vision-based navigation and data collection, and is designed to hover and work close to the seabed.

Following these presentations, there was an opportunity to view the poster session and displays of ocean equipment at the Techno-Ocean meeting. Following this break, two presentations were given by industry representatives:

1. Outline of Microfocus X-ray CT and Its Application for Ocean Technology
Dr. Akira HIRAKIMOTO and Mr. Satoru IGUCHI (Shimadzu Corp. Kyoto, Japan)
2. Current technologies of oceanographic data sensors
Dr. Shoichirou Konashi (Alec Electronics, Kobe, Japan)

This session was chaired by Yoshihisa Shirayama, the chair of the CoML Natural Geography in Shore Areas (NaGISA) project. Shirayama opened the session by presenting the technical challenge of describing the large number of species that are being discovered in some CoML projects.

Following the presentations, there was a panel discussion, with questions from the panel members to each other and from the audience. The panel included Allen, Arnold, Ausubel, De Sa, Gunn, Hirakimoto, Konashi, and Urban.

Encyclopedia of Life

Jesse Ausubel described to the panel his work on developing a proposal for an Encyclopedia of Life, which is planned to be a Web page for each known species (there are approximately 200,000 marine species). This idea was first proposed by E.O. Wilson. There were several workshops and conferences to explore the idea, but it didn't take off. Perhaps the Internet was not quite ready at that time. In 2005, Wilson contacted the MacArthur Foundation, which contacted Ausubel in his Rockefeller University capacity. Ausubel told his MacArthur Foundation contact that he thought the vision was good and the timing was right, given the success of the Wikipedia. Anyone with an interest in a species could start a thread, which could be improved later. Ausubel is chairing a small planning group to develop a proposal for the MacArthur Foundation. This group involves CoML people and some natural history museum leaders. They have prepared a short concept paper, technical specifications, and a mock-up Web site (see http://names.ubio.org/pleary/EOL/EOL_demo.html). The proposal would be for US\$40 million over five years.

More recently, aggregation technology (also known as “mash-up technology”) has been developed. The proposed activity would use a combination of Wiki and aggregation technologies. The species pages would be user configured. An initial activity would be to scan scholarly literature from the past, which is being done by the Biodiversity Heritage Library (BHL; see <http://www.bhl.si.edu/>). They are trying to form a “union catalog” that would allow a rationale scheme for digitizing literature. Intellectual property rules differ by countries, but many of the BHL institutions hold the copyrights to the original articles. CoML would like to create the provisional Web pages for all 200,000 of the known marine species, and then would encourage experts to improve the pages. They have negotiated an agreement with Google and GenBank that if a nucleotide sequence is put into Google, it will automatically search GenBank. Ausubel asked for the Panel's support of the concept and help in developing support for it.

Simon Allen stated that if the pages would be machine readable, an image acquired by an AUV/ROV could be checked against pages for help in identifying species. Gaby Gorsky asked how aggregation technology deals with junk literature. Jesse Ausubel responded that the Wiki approach allows quality control and improvement of information.

Data Visualization

Jesse Ausubel reported on CoML plans for a workshop on data visualization. Communicating information visually is important and now includes screens from normal size to personal digital assistant (PDA) size. The Framework Group for the CoML 2010 report has recommended that CoML should consider producing many short animations. There are a variety of standardization issues related to colors, icons, ways to use buttons/sliders, map projections, how passage of time is shown, etc. Ausubel noted that the visualization of ocean data could attract an industry audience. Ron O'Dor added that a large challenge, because of the limits of geolocation capabilities, is to figure out how to turn individual profiles, such as from marine mammals, into models of the ocean. John Gunn noted that computer game developers have a lot of tools that we don't know about, which Ausubel confirmed, and offered his contacts in that industry.

The following information was received from Pat Halpin for the meeting, based on discussions initiated at the last CoML2010 meeting:

At the last CoML2010 Framework committee meeting (9/18-19/2006 at St. Johns, Newfoundland), Jesse Ausubel asked Mike Fedak and Pat Halpin to take the lead on organizing an upcoming workshop on visualization technologies for CoML. The general charge is to organize a focused workshop highlighting emerging mapping, computer graphics and visualization technologies that would be directly useful for communicating CoML activities and findings to the public. The goal is to hold the workshop within the next year.

Participants in the workshop would include key individuals from a variety of CoML projects involved in a range of data visualization and communications media issues. Halpin would like to expand the participation in the workshop to bring in resources from outside of the existing CoML community, specifically inviting experts from the computer graphics, scientific publications and media industries to help us further develop our visualization products. The most useful outcomes of a workshop would be:

- (1) identify high-impact visualization methods already in use by CoML projects;
- (2) acquire critical reviews from external visualization, publications and multimedia experts;
- (3) identify common technologies, protocols, visualization formats to help standardize CoML products; and
- (4) develop a plan to coordinate the development of visualization efforts for 2010

Halpin has begun making contacts in the data visualization field (see <http://vis.duke.edu/> and http://vis.duke.edu/Facilities/visroom/visualization_room.html, and <http://vis.computer.org/vis2006/>). The meeting could be hosted at the data visualization laboratory at Duke University. The Scripps Institution of Oceanography also has a 3D visualization center and the University of British Columbia has a new ocean modeling visualization center that could be involved in the activity. Halpin has had contacts with TOPP already and would like to gain inputs from a variety of CoML projects as the initiative is developed.

The Panel offered help on planning and conduct of the workshop and will contact Pat Halpin to offer assistance. Jesse Ausubel stated that he hopes some Panel members would attend the workshop. John Gunn will contact Fedak and Halpin about Panel interest in the workshop. Gaby Gorsky emphasized that data visualizations must be able to show the uncertainty in our knowledge, rather than just trying to present attractive pictures that ignore or misrepresent uncertainty.

Mark Hindell added that the St. Andrews data visualization system is geared toward Argo, but is now setting up the ability to use it with Google Earth. Elgar de Sa asked if OBIS has visualization tools. Ausubel answered that the main job of OBIS is to collect spatially referenced data, although it does have a simple mapping tool built in.⁴

⁴Comment from Alex Rogers: It strikes me that the visualization and tagging areas have overlap. If we could generate a 3d GIS map of the oceans with excellent 3D visualization then positioning of tags from temperature and other data as well as lat / long fix may improve positioning. It is also likely to reveal a lot about animal distributions

Panel Web site

Ed Urban presented the existing Web site and a potential (simpler) new front page to it. He stated his opinion that the main audience of the Web site is the CoML projects and the main purpose to help inform them of technologies that could be useful to them and to share technologies among them. Urban expressed that the existing CoML Technology Web site (see <http://www.coml.org/edu/tech/t1.htm>) is quite informative and geared toward the public, and there is no reason to duplicate that site. Elgar de Sa stated that the existing Panel Web site is very advanced (more so than an HTML-coded Web site) and has a lot of useful features. He has an instruction sheet for uploading files, images, and URLs. Urban suggested that we get the code from the Web site developers and move it to University of Rhode Island or elsewhere, since the Web site developer has been so reluctant to make the changes that we have been asking for for the past 1.5 years. De Sa suggested that we give them until the end of the year to make the requested changes and to change the managers of the Web site after that, if necessary. The Panel Web site could be a clearinghouse for information for other related groups, such as all the tagging groups, listing upcoming conferences, manufacturers, etc.

Panel Terms of Reference

Panel members and Jesse Ausubel agreed that the existing Panel terms of reference are still valid.

Panel Connections with GOOS and GEO

Ausubel reported that David Farmer, a member of the Panel has volunteered to advance ocean issues in the Global Earth Observing System of Systems (GEOSS) process. Jim Baker is working with Farmer to accomplish this goal through personal meetings and changes to GEOSS documents. Ausubel explained the Global Earth Observations (GEO) initiative and its relationship to the Global Ocean Observing System (GOOS). Ed Urban reminded the Panel that one legacy of its work could be to help GOOS develop its biological aspects. John Gunn reported that he is now a member of the GOOS SSC and he thinks it would be useful for the Panel to put some effort into helping GOOS with its biological activities. The Panel agreed and will address this issue at its meeting in Auckland, New Zealand in conjunction with the CoML All Program meeting (see below).

Panel Focus Areas

The Panel continues to focus its activities in a few specific areas, including molecular techniques, electronic tags, and AUVs. In addition to the information presented in the special session with Techno-Ocean, there were two presentations at the Panel meeting on these focus areas.

Mark Hindell made a presentation about emerging statistical and data issues with electronic tags and how to approach these problems:

- Data integration—This is the issue of integrating tag data with environmental data

if combined with modeling of environmental preferences (e.g through ENFA). Such a map would required detailed bathymetry and depth-stratified physical data including temp, salinity, oxygen, aragonite saturation state etc.

- Problems with location—This is the largest problem with electronic tags, how to geolocate the animal position and represent the uncertainty in the location appropriately.
 - “The location problem”—Uncertainty in location occurs at all space scales for most animals that spend most of their time below the water surface, because the locations are inferred from sparse communications with satellites. In between these known locations, it is necessary to make inferences about the path of the animal through time. At least a partial solution can be achieved by using all of the data available, including supplied uncertainty (e.g., from ARGOS communications), ancillary data sources, and behavioural models that predict the most likely path of an animal based on what is known about their behaviour at certain times of the year, certain phases of their feeding and reproductive cycles, their genders, how fast they can swim, do they avoid (or are attracted to) certain environmental conditions, etc. The combination of these data can be best achieved under a Bayesian framework. Ed Urban added that it would be helpful to provide an “envelop of uncertainty” to express statistical uncertainties, as is done sometimes when presenting regression lines.
 - Geo-location—The problems related to geo-location are unquantified uncertainty, the tendency to have only one location per day, and problems that arise with using sun angle on the equinoxes (latitudes are particularly difficult to determine). Again, data of different types can be used together, including light data. Each twilight section can be used as an independent source of data, integrated with all other sources of data. ARGOS data provide an animal’s location to within about 5 km.
 - Detection of areas of concentration of marine species is an important application of tagging. The most common approach is to use simple overlays of the tracks of tagged animals to see what areas feature the high density of tracks. Using this method still raises the issue of how to deal with spatial uncertainty. A slightly more sophisticated method is to show the time spent in various areas, using raster-based analysis. Finally, identification of hotspots can be improved using behavioural models and employing fractal analysis, first passage time, and state-space models
 - Visualisation—An increasingly common approach is to plot animal tracks on Google Earth maps.

John Gunn noted that taggers are focusing on patterns now, but need to understand how tagged animals can help us understand their basic biology. We can’t deploy enough tags to answer some kinds of questions. Emergent properties of compiled individual data are now important. We need to use complex system models, without driving a result with Bayesian priors. We tend to look at sea-surface temperature and think the situation is simple, that is, that temperature is the primary control on the distribution of organisms. When we look at three-dimensional temperatures, however, we see that the temperatures that animals experience are very different.

Gaby Gorsky presented a review of the application of vision systems to AUVs. He presented a list of AUVs and gliders, including those with vision/optics:

Bio-optical Sensors

- Slocum gliders (<http://www.webbresearch.com/slocum.htm>)--has optical sensors, but not yet cameras.

- Video Plankton Recorder (VPR: <http://www.who.edu/instruments/viewInstrument.do?id=1007>)—The VPR collects digital images, but they are difficult to use for taxonomic purposes.
- ASTER^x—This is a French AUV capable to 3000 m. It can include a camera, including a digital “smart camera” to visualize zooplankton in blue water.
- Gavia (<http://www.gavia.is/>)--has a camera and light, but not high definition.
- Cytosub (<http://www.cytobuoy.com/>)—has *in situ* video and fluorescence analysis of particles. It includes scanning flow cytometry. High-definition television (HDTV) is beginning to be used on such vehicles, as very small HDTV cameras are being developed.
- HAB Buoy (<http://www.cis.plym.ac.uk/cis/projects/HABBuoy.html>)--could be put into mid-sized AUV
- DIDSON (Dual Frequency Identification Sonar: <http://www.apl.washington.edu/programs/DIDSON/DIDSON.html>)-- can be used in turbid water.

In the near future, the NEREUS will be deployed, which can be used in AUV and ROV mode. The bio-optical profiler will probably include a video camera in a few years. Dave Checkley has put a laser optical plankton counter (LOPC) on a profiler. Stereovision of individual organisms may not be possible. Holography may be applicable on AUVs. The visual capabilities on ROVs and AUVs is moving from 2-D to 3-D (x-ray and confocal). And, finally, intelligent AUVs are being developed, that can adapt their sampling and route based on analysis of conditions and events. The miniaturization of sensors will allow more sensor deployments.

Jesse Ausubel stated that it is important for relevant CoML projects to be aware of these developments. Ron O’Dor asked about the application of gliders for observing marine life. Simon Allen responded that gliders are mostly for ocean basin-scale applications. The Office of Naval Research is purchasing 300 of them. They can be used for passive detection of marine mammals and can be used in depths as shallow as 50 m.

Panel Publications Under Development

The Panel has two types of publications. The first is exclusively for the Web site and these publications can be updated periodically, if desired. The first of these is on “Is Molecular Biology the Magic Bullet for Tackling Marine Biodiversity?”, by Alex Rogers and Bob Ward. A second article is on “Electronic tagging of marine animals”, by John Gunn and Geoff Arnold is being developed.

A second type of article are those published in hard copy. The first of these is an article on “Potential of AUVs as new generation ocean data platforms” by Elgar Desa, R. Madhan, and P. Maurya, published in *Current Science* Vol 90, No. 9, 10 May 2006. Another article is under development by Gaby Gorsky on “Optical profilers for marine ecology.” This article is being targeted for publication in *Sea Technology*.

Finally, Ed Urban is developing an article on satellite communications options for oceanographic applications, including animal tagging. Urban shared the draft with the Panel. It

will either be published on the Panel Web site or will be submitted to *EOS* or *Sea Technology*, depending on reactions to it by friendly reviewers. Urban will circulate the document to the Panel again when it is closer to completion.

Review of Research Proposals/Plans

The Panel discussed four CoML project research plans that had been submitted to the CoML Scientific Steering Committee and approved earlier in the year, to attempt to provide technology advice to the projects. Jesse Ausubel emphasized that the purpose was not to review the plans, because they had already been reviewed and accepted. In general, there was not enough detail in the documents to know exactly what technologies are being used and how, making it difficult to review the plans. But the Panel provides a few comments below. It would be useful to find out what technological innovations or breakthroughs each project has achieved. Also needed are methods to do species identifications without collecting every organism. CoML has requested that the Panel review the Technologies document in preparation for its revision for the 2007 CoML All Program Meeting and the Panel has started this review.

Census of Marine Zooplankton—The Census of Marine Zooplankton (CMarZ) project was presented by Gaby Gorsky. (Sun Song is a member of the CMarZ steering group, but was not at the Kobe meeting.) Gorsky presented the goals and main aspects of CMarZ. A recent CMarZ-dedicated cruise used a Moccuss net to deep water. No imaging systems were used. (The necessity of at-sea barcoding depends on the taxon involved. The morphology of some groups is destroyed by acetone, although in these cases, more tissue-friendly DNA preservatives can be used. There was an advantage that freshly collected organisms could be identified and barcoded without being put in preservative first. Gorsky stated that optical methods could be useful to increase the information gathered by CMarZ and for the study of gelatinous organisms, which do not fare well in nets. Bob Ward wondered why CMarZ is not using the Barcode of Life Database (BOLD) to store their COI data, because BOLD has a lot of tools that can be used with data stored there. There should be a list of recommended sequences for different taxa. Bob Ward will contact Ann Bucklin about this.

Census of Diversity of Abyssal Marine Life (CeDAMar)—CeDAMar is using the Nautilie submersible. John Gunn asked whether baited cameras might be used by CeDAMar in some areas. Alex Rogers responded by email that baited cameras have been deployed in the abyssal ocean and are useful for attracting and estimating the density of scavengers. Also, video surveys could be a good adjunct to actual collections.

Census of Antarctic Marine Life (CAML)—CAML is still organizing, particularly for IPY. It looks like the project is going to have a significant barcoding activity. The proposal is a bit thin on technical details. Panel members suggested that CAML could use ROVs, AUVs, and gliders. If this is of interest to CAML, the Panel could gather information about platforms that can be used in the Antarctic. Will tagging be done in CAML or through TOPP? Elgar de Sa noted that CAML should be aware of the video observations being made by Italian scientists through holes in the ice. Simon Allen suggested that the ALESTAR platform can operate in AUV model. Other options for Antarctic use are ROVs that are cabled to the ship for data transfer, but have their own power supplies. These ROVs allow use of fiber optic cables, which make it possible

to decouple ROV movements from movements of the mother ship to a greater degree than is possible when an ROV is powered from the ship also.⁵

Continental Margin Ecosystems on a Global Scale (CoMARGE)—The panel suggested that specimens could be collected by ROV for barcoding and voucher specimens.⁶

Census of Seamounts (CenSeam)—Alex Rogers reviewed the CenSeam renewal proposal between the meetings of the Panel and provided comments to the Sloan Foundation. He found that the most significant weakness of the programme that has come to light over the last year is the lack of shiptime for CenSeam researchers to expand their research activities into areas of the ocean in which seamounts are poorly studied. We need to ask CenSeam if they implemented the previous Panel recommendations.

Proposal for SCOR Working Group on Automatic Plankton Visual Identification

Ed Urban distributed to the Panel a proposal for a new SCOR working group on Automatic Plankton Visual Identification, and asked for Panel comments. Gaby Gorsky explained why such a project would be desirable. He stated that this is a good idea, in general, although it is probably too early to settle on the ZOOIMAGE system. It would be better to have some kind of objective analysis of the 4-6 existing systems before settling on one. Having a common system would avoid the problem of losing samples before they are analyzed, because they can be analyzed quickly. It will be important in this activity to assemble information from other fields that use image analysis, such as security and medicine.⁷

Reports on Meetings Attended by Panel Members

Between annual Panel meetings, members attend associated meetings on behalf of the Panel and are expected to report back to the panel on relevant information gathered and any actions that the Panel should take.

International Underwater Robotics Workshop (8-12 Nov. 2005 in Genoa, Italy)—Elgar de Sa and Antonio Pascoal attended this meeting and de Sa gave a report about it. There is a lot of activity on coordinating motions of AUVs and gliders, from groups at MIT, in Portugal, and at the Naval Postgraduate School in Monterey, California, USA. The marine robotics community has two groups, both of which were represented at the meeting:

- Implementation of vehicle technology and applications to bathymetry mapping of coastal zones, marine life in hydrothermal vents, seamount mapping, and in inspection and surveillance of ports and harbors.
- The other group works on the mathematical theory of AUV coordination and control, neural network based control theory, terrain navigation and extended Kalman filter applications.

⁵ Comment from Alex Rogers: The ROV ISIS will be deployed in the Antarctic off the Peninsula in January 2007.

⁶ Comment from Alex Rogers: They could also be collected by surface-deployed sample gears such as trawls, dredges and corers. Note that for infauna it may be desirable to divide samples and preserve in DNA-friendly and morphology-friendly ways.

⁷ Comment from Alex Rogers: I agree this is a useful project. However, surely we should also consider ways in which to gain meaningful data on fast-movers in the oceans such as squid. This could link up with AUV technology.

There is a special issue of a journal coming out of this workshop.

7th IFAC Conference on Maneuvering and Control of Marine Craft (20-22 September 2006 in Lisbon, Portugal)—Elgar De Sa attended this meeting and Antonio Pascoal was the convener. It focused on the future of AUVs and ROVs. The plenary sessions focused on marine robots as advanced tools for marine science, coordination and control of multiple vehicles, underwater navigation, future developments and applications of marine robotics, and control of design models of marine vessels.

CoML Barcoding Meeting (15-16 May 2006 in Amsterdam, Netherlands)—Panel members Bob Ward and Sun Song attended this meeting and Ward was on the planning committee for it. Ed Urban also attended. CMarZ acknowledged the Panel's contribution to the barcoding meeting in its annual report to the CoML SSC.

11th Deep-Sea Biology Symposium (9-14 July 2006 at Southampton, UK)—Alex Rogers attended this meeting and provided a written report about it. There was no suggested actions for the Panel from this meeting.

CoML SSC Meeting (13-14 October 2006, Nara, Japan)—Ed Urban attended this meeting and reported on SCOR activities of interest to CoML (CoML is affiliated to SCOR). As part of this presentation, he gave the CoML SSC an update about Panel activities. The SSC seemed pleased with the Panel's work. They asked that the Panel give some attention to the problem of geo-location for electronic tags and asked that the Panel add an expert on data visualization. Urban suggested that the Panel should be involved in planning the technology session at the CoML All Program meeting in New Zealand in November 2007.

Panel Representation at Future Meetings

International Marine Acoustic Telemetry 2006 (5-9 November 2006 in Leigh, New Zealand)—John Gunn reported that this meeting has been cancelled or postponed.

CMarZ Steering Group meeting (5-8 November 2006 in Tokyo, Japan)—Sun Song is a member of the CMarZ Steering Group and will attend this meeting.

Tagging Meeting in Monterey (7-9 March 2007)—John Gunn and Geoff Arnold will participate in this meeting. One of the purposes will be to get tagging scientists and tag manufacturers together.

Second International Symposium on Tagging and Tracking Marine Fish with Electronic Devices (8-12 October 2007, in San Sebastián, Guipúzcoa, País Vasco, Spain)—The Panel will offer to help with this meeting, either as a co-sponsor, by having a session, or by some other means.

Microbiology Meeting in Cochin, India—Bob Ward will attend, as there is a session on barcoding.

4th International Zooplankton Production Symposium (May 28, 2007 - Jun 01, 2007 in Hiroshima, Japan)—Gaby Gorsky will be attending this meeting.

Additions/Replacements to Panel

As mentioned earlier, the CoML SSC asked the Panel to add a data visualization expert. There was also some uncertainty about whether Heidi Sosik is interested in remaining on the Panel. Ed Urban will check on this. Other ideas included someone who works on gliders, someone from MBARI, and Marsh Youngbluth from the Harbor Branch Oceanographic Institution,

Members Assigned to CoML Projects

Jesse Ausubel suggested that Ron O'Dor and Ed Urban be more proactive about building linkages between the panel and projects, including appointing project liaisons. The project liaisons were updated, although some projects still need a liaison.

ArCOD:

CAML: Bob Ward

ChEss: ??

CeDAMar: Alex Rogers

CenSeam: Alex Rogers

CmarZ: Sun Song, Gaby Gorsky

CoMarge: Simon Allen (not a panel member)

CReefs: Elgar Desa, Bob Ward

GOMA: David Farmer

ICoMM: Heidi Sosik

MAR-ECO: Gaby Gorsky

NaGISA: Ed Urban (not a panel member, but willing to liaise with this group)

POST: David Farmer

TOPP: John Gunn, Geoff Arnold

Plans for Next Panel Meeting

The next panel meeting will be held in conjunction with the [Census of Marine Life 3rd All Program Meeting](#), in Auckland, New Zealand in November 2007. Panel members will participate in project meetings before the main CoML meeting and will meet afterward to discuss contributions of biological measurements to GOOS and other Panel business:

- Attend meetings of CoML projects on 12-13 Nov.
- Attend public event on 14 Nov.
- Attend All Program Meeting on 15-16 Nov.
- Hold Panel meeting on 17 Nov.

Action Items

Actions Items Left Over from Frankfurt Meeting

Actions	Who	By when
Update de Sa PowerPoint slides to include all 14 CoML projects	Urban	In progress
Make suggestions of new Panel members: industry, acoustics, satellite technology, visualizations	Panel	Jan. 31
Look for a nanotechnology meeting to send a Panel member or two to.	All	Continuing
Investigate what panel could do in terms of advancing image analysis applications	Gaby	
Web site actions: <ul style="list-style-type: none"> • List all the CoML projects on the top navigation bar • Work on copyrights for materials on site • Still need to populate the site. Panel members can load information themselves or can ask Ed or Elgar to do it. 	Elgar Ed Panel	ASAP In progress
New Action Items from Kobe Meeting		
Provide feedback to Jesse Ausubel on Encyclopedia of Life Plan, when ready to review	All	
Contact Pat Halpin to offer Panel help with the data visualization workshop	John Gunn	ASAP
Synergy Web site developers to make all the requested changes	Elgar	By Dec. 31
Panel Web site <ul style="list-style-type: none"> • Make sure that the Rogers/Ward article is posted correctly • Are there usage statistics for the site? Add Google Analytics? • Link barcoding site to Panel Web site 	Elgar Elgar	ASAP
Publications Under Development <ul style="list-style-type: none"> • Gorsky paper on optical technologies • Gunn paper on tags • Urban paper on satellite communications 		
Advice to CoML Projects <ul style="list-style-type: none"> • Panel members to review new assignments of project liaisons • Panel members to read the CoML Methodologies report and original research plan for their assigned project(s) • Contact Ron O'Dor about technology people on the individual projects 	All All Ed	ASAP Feb. 15 Done, awaiting a response
Panel Membership		

<ul style="list-style-type: none"> • Determine Heidi Sosik's interest in remaining on Panel • Add expert in data visualization 	Ed Ed to consult with Ausubel and O'Dor	Done, awaiting a response By Dec. 31
<p>Upcoming Meetings</p> <ul style="list-style-type: none"> • Will Sun Song be attending the CMarZ Steering Group meeting in November? • Second International Symposium on Tagging and Tracking Marine Fish with Electronic Devices – Offer Panel assistance 	Ed, Sun John, Geoff	Report received
<p>All Program Meeting in New Zealand</p> <ul style="list-style-type: none"> • Offer Panel Assistance with Technology Session 	Elgar, Ed	ASAP
<p>Panel Meeting in New Zealand</p> <ul style="list-style-type: none"> • Plan a session on biological obs. for GOOS. John Gunn will write up a short description of a proposal for a brainstorming session. 	John	
Add Keith Alverson and John Field (GOOS) to Panel email list	Ed	Done
Contact Ann Buckin about putting together a list of recommended sequences for different taxa	Bob	
Ask CenSeam if they have implemented Panel recommendations	Ed? Or Alex?	