VOLUME TWENTY SEVEN FEBRUARY 2014 NUMBER ONE

The Lobster NEWSLETTER

ANNOUNCEMENTS

10th International Conference and Workshop on Lobster Biology and Management

Lobsters in a Changing Climate

May 18-23, 2014

Iberostar Cancún Hotel

Cancún, México

www.dmc-cancun.com/icwl2014

The 10th International Conference and Workshop on Lobster Biology and Management "Lobsters in a Changing Climate" (10th ICWL) is being hosted by the Institute of Marine Sciences and Limnology of the National Autonomous University of Mexico. The conference will be held from Sunday May 18 to Friday May 23, 2014 in Cancún, México. The venue (the all-inclusive Iberostar Cancún Hotel) is offering very competitive rates for participants to the conference. (For details visit the conference website: www.dmc-cancun.com/icwl2014)

All presentations and posters will be in English. The deadline for abstract submission was extended until 15 February to match the deadline for the early-bird registration. Regular registration will continue to be open until 31 April, but if you miss this date you can ask to register on site. We have already received many abstracts from participants from Australia, Belize, Brazil, Canada, Ecuador, Israel, Mexico, New Zealand, Nicaragua, Norway, South Africa, Sweden, and the United States, but we also expect abstracts from participants from Chile, Costa Rica, Cuba, France, India, Italy, Japan, Panama, Spain, Switzerland, the United Kingdom and Venezuela.

Our five invited keynote speakers (Bruce Phillips, Australia; Ehud Spanier, Israel; Juan Carlos Seijo, Mexico; Jim Penn, Australia; Rick Wahle, USA) have confirmed their participation. We thank them all for taking the time to prepare what will surely be very interesting and exciting key presentations.

Several colleagues kindly volunteered to coordinate sessions on the following topics: Climate Change (Nick Caputi and Simon de Lestang, Australia), Connectivity and Larval Studies (Mark Butler, USA), Reproduction, Development and Physiology (Jason Goldstein, USA), Diseases and Parasites (Don Behringer, USA and Grant Stentiford, UK), Aquaculture, Nutrition and Population Enhancement (Andrew Jeffs, New Zealand, Carly Daniels, UK, and Greg Smith, Australia), Lobsters in Antiquity (Kari Lavalli, USA and Ehud Spanier, Israel), Habitat and Ecosystem Issues for Fisheries Management (Lynda Bellchambers, Australia), Stock Assessment (Nelson Ehrhardt, USA), and Management (Jim Penn, Australia). Additional sessions include Genetics, Population and Community Ecology, Behavioral Ecology and Neurobiology, Marine Protected Areas, and Fisheries and Fisheries Technology.

We are happy to announce that the proceedings of the 10th ICWL will be published as a special issue in the *ICES Journal of Marine Science*. Manuscripts will be submitted online through the Journal's website and will be handled in the same manner as regular-issue Journal manuscripts. The deadline for manuscript submission is being arranged with the journal, but will likely be around 2 to 3 months after the conference. For more information, please visit the conference website regularly.

The conference is a great opportunity for students to present their works and interact with lobster specialists from all over the world. One of our students (Alí Espinosa-Magaña) recently launched a conference page in Facebook (www.Facebook.com/10thICWL) so that people –especially students– from all over the world can request or exchange information on various subjects, look for potential roommates at the venue in order to reduce costs, etc.

Students who are without sufficient financial support to attend the conference may wish to apply for "The Paul Kanciruk Student Travel Award for the International Lobster Conference and Workshop". Look for the announcement in this Lobster Newsletter. In order to help replenish the Paul Kanciruk Student Travel Award for the next ICWL, we are planning on continuing the custom established in the 9th ICWL: having a raffle with items donated by the conference attendees. Two copies of the 2013 book "*Lobsters: Biology, Management, Aquaculture and Fisheries (2nd. Edition)*", kindly donated by

Wiley-Blackwell, will be awarded to the best student oral and poster presentations at the end of the conference.

Apart from the scientific program and to provide conference attendees an opportunity to socialize in a different scenario than the venue and to see some Caribbean marine life in action (hopefully including spiny lobsters), we are preparing a special treat for the mid-conference free afternoon (Wednesday, 21 May): an exclusive snorkeling tour to the Puerto Morelos coral reef and dinner on a beautiful beachside facility in Bahía Petempich. The company has offered a reduced rate for conference attendees and their companions/families.

Also on the web site you will find several options for tours and activities that range from a few-hours shopping trip to Playa del Carmen to a full-day tour including a visit to Chichén Itzá or to the less known but beautiful Ek-Balám archaeological site. Remember that the special room rates at the venue apply from 3 days before to 3 days after the conference, so consider taking advantage of your stay to enjoy some of these tours. You won't regret it.

Again, this and more information is already or will soon be available at www.dmc-cancun.com/icwl2014 and www.Facebook.com/10thICWL, so be sure to visit these sites regularly. But if you have any doubts, particular requests, or require additional information, feel free to send us an email anytime.

We are truly looking forward to welcoming you in Cancun!

Patricia Briones-Fourzán
Enrique Lozano-Álvarez
Conveners, 10th ICWL
icwl2014@gmail.com

Student Travel Award for ICWL

The Paul Kanciruk Student Travel Award for the International Lobster Conference and Workshop

The Paul Kanciruk Student Travel Award is available to promising graduate students or recent doctoral degree recipients who are without sufficient financial support to attend the International Conference and Workshop on Lobsters (ICWL). The award honors the late Paul Kanciruk (1947-2006), who received his Ph.D. in 1976 under the directorship of Professor William Herrnkind, and from whose estate funds were made available to found this award. Dr. Kanciruk spent most of his professional career as a respected scientist in the area of climate change research and large database management, yet his doctoral research in lobster biology contributed substantially to our understanding of lobster behavior. Paul was unable to present his dissertation research results at the first ICWL held in 1977 in Perth, Australia because of lack of funding. Thus, it is fitting that this award be used for this purpose and in his memory.

To apply: Students who wish to apply for the award to attend the upcoming ICWL in Cancun, Mexico in May 2014 should complete the application form available on the ICWL conference website (http://www.dmc-cancun.com/icwl2014/). The form is also available by email from the Chair of the award committee: Dr. Mark Butler (mbutler@odu.edu). **The completed application form must be emailed to the Chair of the award committee by March 1st, 2014. Recipients of the award will be announced by March 31st, 2014.**

The Award Committee:

Dr. Mark Butler (Chair), Old Dominion University (USA)
Dr. Alison MacDiarmid, National Institute for Water & Atmospheric Research (New Zealand)
Dr. Raquel Goni, Instituto Español de Oceanografía, (Spain)

Contributions: Members of the international community with interests in lobster fisheries, management, and science who would like to contribute to this award fund to ensure its existence for future conferences should contact Mark Butler (mbutler@odu.edu).

November 27-30, 2012, Portland, Maine, USA

Symposium Convener:
University of Maine Sea Grant Program
www.seagrant.umaine.edu/lobster-symposium

Coordinators:
Rick Wahle, University of Maine
Andrea Battison, University of Prince Edward Island
Paul Anderson, Maine Sea Grant Program

Proceeding of this Symposium now in a Special Issue of

Canadian Journal of Fisheries & Aquatic Sciences

November 2013, vol. 70 no. 11

http://nrcresearchpress.com/toc/cjfas/70/11

Symposium themes:

- Foodweb Dynamics
- Anthropogenic & Environmental Stressors
- Metapopulation Dynamics & Connectivity
- Coupled Human-Natural Systems & Ecosystem-Based Management

RESEARCH NEWS

Successful pilot of project investigating cost-effective methods of monitoring puerulus settlement

From: Graeme Ewing

For over two decades the Institute of Marine and Antarctic Studies (IMAS) has been monitoring puerulus in shallow inshore waters on the east coast of Tasmania. The Fisheries Research and Development Corporation (FRDC) funded IMAS project *Developing cost-effective industry-based techniques for monitoring puerulus settlement in all conditions: trials in southern and western Tasmania* is investigating ways to enhance puerulus monitoring in Tasmania. Trials conducted under the first phase of this project have successfully shown proof-of-concept for a collector design for use by commercial fishers in deeper exposed waters, and a camera system for observing puerulus settlement behaviour.

Puerulus DO settle in deep water!

In Tasmania, puerulus collectors have been successfully deployed on the east coast, but have not stood up to the harsh sea conditions on the south and west coast where the majority of the Tasmanian lobster catch comes from. Consequently, IMAS has designed and built a fleet of "pot collectors" in which the collector substrate is housed and located in a standard steel lobster trap suitable for deployment and servicing by vessels from the commercial fleet (Fig. 1 and 2). The substrate housing incorporates a sieve to minimise loss of puerulus on hauling. Twelve pot collectors deployed adjacent to existing shallow water collectors on the Tasmanian east coast yielded similar numbers of puerulus.

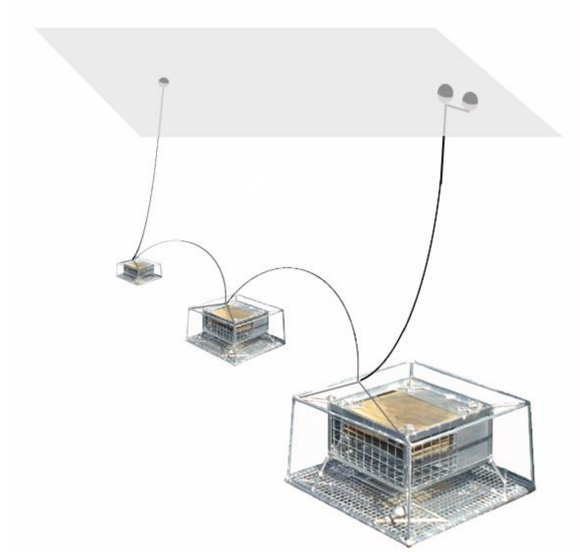

Figure 1. One string of three pot collectors

Twenty-four pot collectors were deployed by commercial fishers in September 2012 into depths from 57 to 102 m. on the Tasmanian south and southwest coasts. They were serviced by commercial fishers on 3 occasions after soak times of 6 to 8 weeks. Servicing of each string (3 pot collectors) was accomplished in around one hour and feedback from both skippers and crew was positive regarding the ease of servicing. Catch rates of puerulus were higher in the shallower depths (57 to 68 m), but puerulus were also encountered in collectors at depths of up to 102 m. Collectors also yielded other invertebrates (particularly shrimps and isopods) and juvenile red cod, gurnard perch and butterfly perch.

This is the first direct evidence of puerulus settlement in deep water.

Figure 2. Deploying the collectors

This trial has successfully demonstrated that:

- the puerulus pot collectors can be serviced easily by commercial lobster vessels;
- puerulus are retained in the pot collector during hauling to the surface;
- puerulus settle in deeper water
- collection rates between pot collectors and routine inshore collectors are comparable;
- our pot collector design can withstand the adverse conditions typical of the south and southwest coasts of Tasmania.

Puerulus cam – monitoring puerulus settlement from the comfort of your office!
IMAS scientists, in collaboration with CSIRO, have developed a prototype camera system for monitoring puerulus settlement and post-settlement behaviour. The camera system captures images at a pre-determined interval and transmits them in real time, using the 4G network, to a web server where they can be viewed on any computer with internet access.

The system is comprised of cameras and lights (Fig. 3) attached to the puerulus collector on the sea-floor, and connected to a surface buoy which houses a battery, solar charging system, single board computer, wireless 4G modem, analogue camera server, analogue to digital converter and relays. The computer can be accessed through the internet to adjust capture intervals, spontaneously capture images, and update or troubleshoot software. In an effort to reduce costs and simplify repairs and modification, the majority of the components in the camera system are inexpensive and readily available.

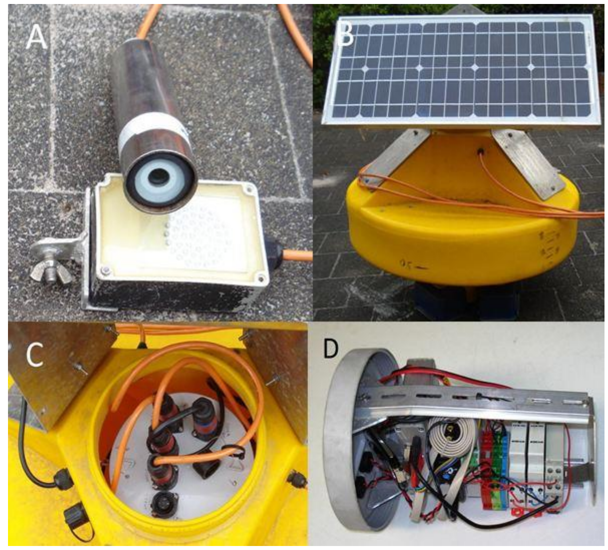

Figure 3. Components of the puerulus monitoring camera system. A: underwater bullet video camera and LED infra-red light array; B: buoy to house electronics and power systems; C: electronics pod mounted in the buoy; and D: electronics pod.

In field trials the camera system delivered discernable images of southern rock lobster puerulus on artificial habitats (Fig. 4), and the battery and charger system was able to support round the clock hourly capture and transmission of images. The camera system offers a cost-effective means to monitor puerulus settlement and, because of the frequency of images, allows us to monitor more precisely the timing of settlement, the retention of puerulus on the artificial habitat and the behaviour of newly settled puerulus, more comprehensively than the monthly diver-based servicing of the collectors.

On the basis of the success of these trials, IMAS has submitted a FRDC application to fund the 2nd and 3rd phases of this project. This will see the deep water collectors deployed at a number

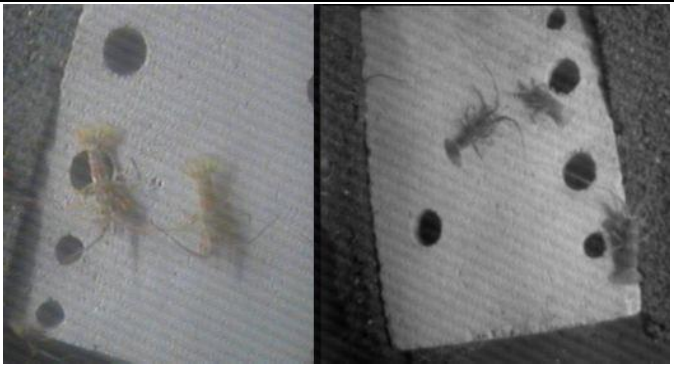

Figure 4. Images of puerulus captured by the camera system.

of locations around Tasmania (Fig. 5) which over time should provide state-wide insights into recruitment patterns and trends. It would also entail deployment of the camera system at routine puerulus monitoring sites which will allow assessment of the representativeness of monthly indices of settlement on existing shallow water collectors.

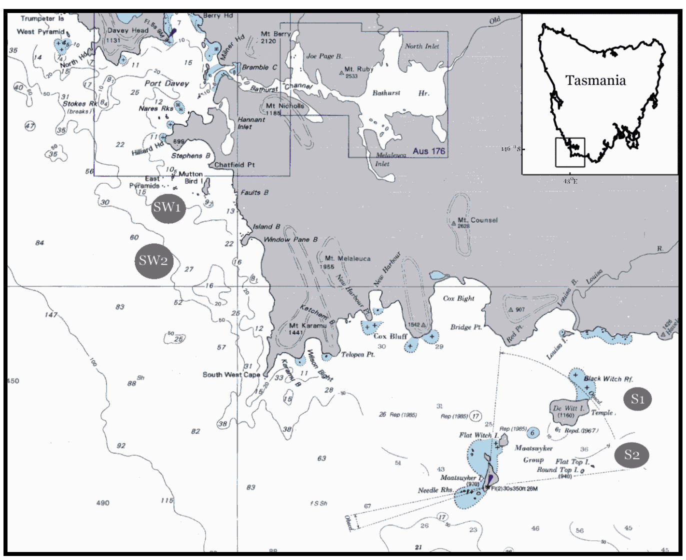

Figure 5. Map showing the areas on the south (S1 and S2) the south west (SW1 and SW2) coasts of Tasmania where prototype deep water puerulus collectors were deployed.

This project aims to provide industry and government with an increased ability to forecast fluctuations in future lobster catches around the state, allowing management to improve the economic and biological sustainability of the Tasmanian lobster fishery. It also enables the fishing community to become actively involved in monitoring their future.

Graeme Ewing
Institute for Marine & Antarctic Studies
Taroona
Tasmania
Australia
Email: Graeme.Ewing@utas.edu.au

Accelerometry as a tool for studying lobster behavior: Preliminary results from the Florida Keys, FL (USA)

From: Benjamin C. Gutzler and Mark J. Butler IV

Understanding the behavior of animals as they interact with each other and their environment is a key goal of ecology. However, this is often easier said than done, especially for marine animals that spend their time in an environment where it is difficult for researchers to follow or observe them for long periods of time. Acoustic telemetry is one widely used means of tracking animal movements and although modern autonomous telemetry systems have immense capabilities, they are expensive and their cost may be a barrier to many researchers. Accelerometry has emerged as another tool for investigating animal behavior, and may serve as a lower-cost alternative to full-scale acoustic telemetry arrays.

As part of a project examining the movement of Caribbean spiny lobsters (*Panulirus argus*) in the Florida Keys, we have been investigating the viability of accelerometry as a tool for studying the behavior of lobsters in the wild. We used both accelerometer dataloggers (HOBO Pendant G, Onset Computer Corp.) and remote telemetry accelerometer tags (AT-82 tag and miniSUR receiver, Sonotronics Inc.) attached to the carapace with an acoustic tracking pinger in a "backpack" configuration to compare activity patterns of lobsters found in natural and artificial shelters (Fig. 1). In the lab, we used closed-circuit camera monitoring systems to validate our methods and developed a MATLAB function to identify periods of lobster activity from accelerometer data with >90% accuracy.

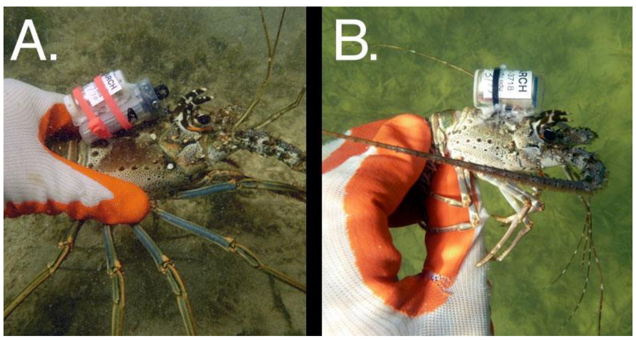

Figure 1. Accelerometer "backpack" configurations. A is the HOBO datalogger with tracking pinger attached; B is the Sonotronics AT tag with integral pinger.

In the field, we tagged and released lobsters (ranging in size from 22 mm to 94 mm in carapace length) and used the pinger's signal to recapture them 24 hrs later to retrieve the tags. From the tag data we determined periods of maximum activity and estimated how far each animal had moved overnight. Most activity occurred in the middle of the night, generally with another period of high activity shortly before dawn, possibly as the animals searched for shelter for the day (Fig. 2). Small lobsters released in artificial shelters were almost invariably recaptured in the same shelter the next day, but similar sized animals released in natural shelters were seldom relocated in the same shelter, suggesting that shelter fidelity is higher for small lobsters in artificial shelters than in natural shelters. Large animals were never recaptured in the same shelter, regardless of whether they were released in natural or artificial shelters.

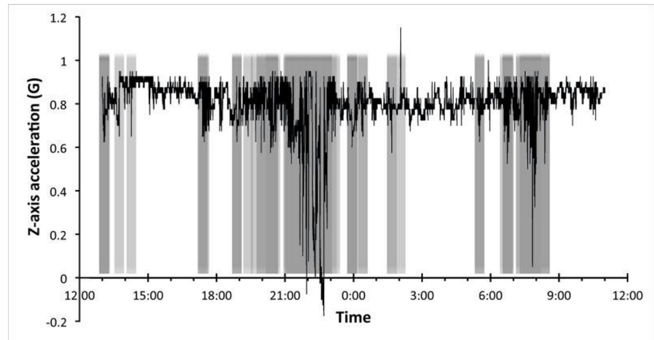

Figure 2. An example of accelerometer output. Shaded areas indicate times of activity as identified by the MATLAB analysis function, with darker shading representing more intense activity.

Accelerometry has the potential to be an effective tool for studies where long-term monitoring of movement is not as important as information on activity patterns, and further development of the technology involved is likely to improve its utility in the years ahead. Currently, we are working to improve our ability to discriminate between various types of movement and activity from the accelerometer signal; however, it is already clear that accelerometry is capable of providing usable information for studies of lobsters in the wild.

Acknowledgements
Funding for this project was provided by a grant from Florida Sea Grant and an equipment grant from Sonotronics, Inc.

Benjamin C. Gutzler and Mark J. Butler IV
Old Dominion University
Norfolk VA
USA
Email: bgutz001@odu.edu

Fluctuations in tissue glycogen concentrations in the American lobster, *Homarus americanus*, during the moult cycle.

From: Michael Ciaramella, Andrea Battison, and Barbara Horney

Glycogen is considered important for maintaining normal physiological function and growth. The physiological changes that occur during the moult are poorly understood and could give insight into the physiological mechanisms behind the moulting process and lobster nutrition. Glycogen concentrations in the hepatopancreas, pincher claw muscle, crusher claw muscle and tail muscle of 88 lobsters, *Homarus americanus*, were determined indirectly by enzymatic digestion to glucose with amyloglucosidase (*Rhizopus sp*, Sigma Aldrich). A colorimetric hexokinase based assay was used for measurement of glucose. The glucose concentrations were then converted to oyster glycogen equivalents by comparison to a similarly digested oyster glycogen reference curve. To normalize for the size of lobster and percent water content, the calculated glycogen concentrations were converted to index values using the following equation,

$$Glycogen\ Index\ (GIn) = \left(\frac{(\%W * G)}{CL}\right) * 10^4$$

where %W represents percent water content of the tissue, G is mg of glycogen per mg of tissue, and CL is the carapace length of the lobster with units of mg glycogen (mg tissue)$^{-1}$ mm^{-1}.

These data revealed significant variations among tissues in stored glycogen content at different stages of the moult cycle. The overall trend was a significant decrease in the post-moult period (Fig. 1), while tissue specific variations were observed in the inter-moult and pre-moult stages. On average, the hepatopancreas had a higher glycogen concentration than the muscle tissues and exhibited a significant increase during the late pre-moult period – a time when food intake is markedly reduced. The increased pre-moult HP glycogen content could represent a storage pool of scavenged material from cuticular chitin to be reused for chitin synthesis in the post-moult.

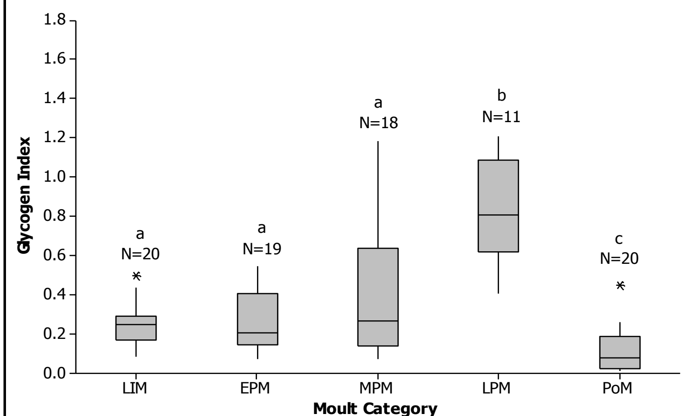

Figure 1. Standardized hepatopancreas glycogen content, expressed as Glycogen Index in *Homarus americanus* over five moult categories**.** Statistically significant differences were observed in groups with different letters ($p < 0.01$, Mann-Whitney). Asterisks represent outliers within groups. Abbreviations: late inter-moult (LIM), early pre-moult (EPM), mid pre-moult (MPM), late pre-moult (LPM) and post-moult (PoM).

Michael Ciaramella[abd]; Andrea Battison[bc]; Barbara Horney[d]

[a] Departments of Food Science Nutrition and Health Promotion and Wildlife Fisheries and Aquaculture, Mississippi State University, 945 Stone Boulevard, Mississippi State, MS, 39762

[b] Lobster Science Centre, Atlantic Veterinary College, University of Prince Edward Island, Prince Edward Island, Canada, 550 University Avenue Charlottetown, PE, C1A 4P3

[c]Crustipath, PO Box 682, Charlottetown, PE C1A 7L3

[d] Department of Pathology and Microbiology, Atlantic Veterinary College, University of Prince Edward Island, Prince Edward Island, Canada, 550 University Avenue Charlottetown, PE, C1A 4P3

FRDC Project 2008/13 Assessing the ecological impact of the western rock lobster fishery in fished and unfished areas

From: Lynda Bellchambers and Matt Pember

The initial certification process for the Western Rock Lobster Fishery (WRLF) to obtain accreditation by the Marine Stewardship Council (MSC) in 2000 required an ecological risk assessment (ERA) to be undertaken. Among a range of priority information gaps identified was the need to collect basic ecological information to determine if changes in lobster density and size structure, due to fishing, had caused significant changes in habitat structure and benthic community composition in deep water. Subsequent research undertaken using existing gradients in the lobster density along the coast of Western Australia increased the understanding of the relationship between lobster and their deep water habitats (Bellchambers 2010). However, the approach was ineffective in addressing MSC requirements and it was concluded that there was a need for future research in deep water to use research closures.

Therefore, an essential component of the current project was to identify an appropriate deep water area to close to lobster fishing so the potential impacts of lobster fishing on deep water (>40m) ecosystems could be assessed by comparing the closed area with nearby fished areas. The first step in identifying potential areas for closure was the creation of an industry-based closed area working group. Initially, the working group nominated and assessed a number of potential areas using selection criteria established by the Ecosystem Scientific Reference Group (EcoSRG). Two areas were short-listed as potential closed areas i.e. the south eastern corner of the Abrolhos zone and the 30°S latitude line offshore from Leeman. After extensive negotiations with industry an area *ca.* 3900 ha (6 nm x 2 nm) that straddles the 30°S latitude line offshore from Leeman, Western Australia, being officially closed to western rock lobster fishing on the 15 March 2011

With an area closed to lobster fishing in place, the next step was to construct detailed habitat maps of the terrain, substrates and biota, using data from hydroacoustic and towed video surveys, of the fished (Jurien) and unfished (Leeman) areas (Figure 1). These three data sets were then used for: comparing the fished and unfished areas to ensure that the two areas were comparable, to assist with the design of the sampling programs and to predict the distribution of western rock lobster.

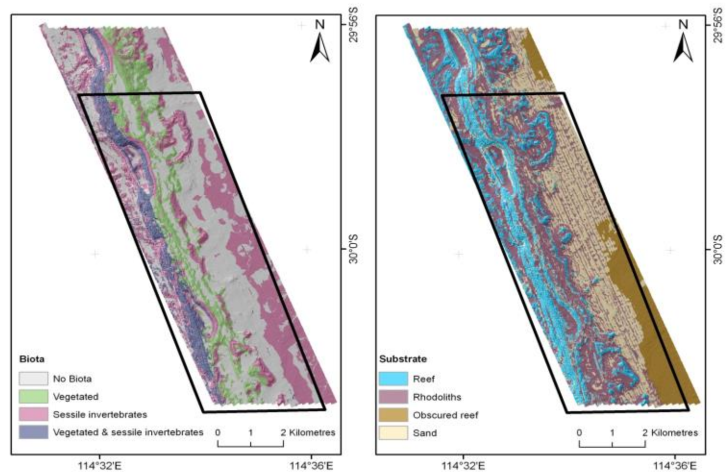

Figure 1. Substrate and biota types modelled at Leeman (closed area) using hydroacoustic data and ground truthed with towed video. Closed area is designated by black box.

This project tested different sampling methods to assess their ability to detect change due to fishing and to developed a cost effective long-term monitoring program. To establish ecosystem baselines and devise a cost-effective strategy for long-term monitoring, the ecosystem components to be monitored were divided into three categories: target species (lobsters), benthic habitats and indirect ecosystem indicators (small fish)

There was an increase in the abundance of lobsters in both fished and closed areas in deep water areas over the five years of this study (Figure 2). The sampling period (2008-2012) corresponds to a period of below average recruitment and substantial management changes in the fishery. Therefore, the increase in lobster abundance in deep water illustrates the effectiveness of management measures implemented during this period. While there was an increase in both fished and unfished areas the increase in abundance was larger in the closed area with a significant increase evident after only 18 months of closure. The increase in abundance in the closed area was most pronounced in legal sized lobsters, particularly males (Figure 2).

In addition to detailed habitat maps, an autonomous underwater vehicle (AUV) was used to sample benthic assemblages in fished (Jurien) and closed (Leeman) areas. The use of the AUV enabled the collection of benthic information at different scales and the ability to precisely re-sample geo-referenced areas so that each site can be followed through time to determine the impacts of fishing on the benthic assemblages. The first year of data has been collected providing a baseline for each of the sites against which any future changes can be quantified.

To assist with the process of determining what other aspects of the ecosystem to monitor qualitative models were used. Qualitative modelling can be used to increase the understanding of ecosystem dynamics by simplifying trophic systems. The models predicted that fishing for rock lobster may positively impact small fish, such as old wife (*Enoplosus armatus*), footballer sweep (*Neatypus obliquus*), and king wrasse (*Coris auricularis*) as they compete for the same food source. Therefore, these small fish were identified as potential indicators of the effects of rock lobster fishing. Small crustaceans (amphipods and isopods) were identified as potential indicators of bait effects.

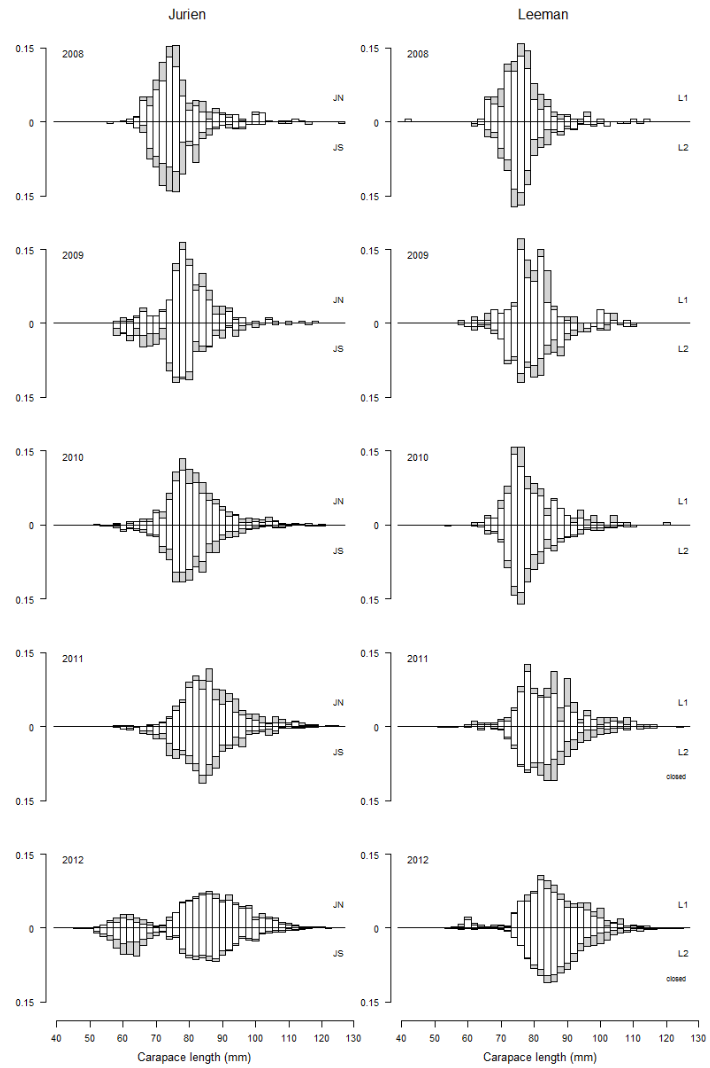

Figure 2. Size composition (CL mm) of male (filled bars) and female (un-filled bars) lobsters at Jurien (fished, left) and Leeman (unfished, right) between 2008 and 2012. In each year the two sites at each location (i.e JN and JS or L1 and L2) have been plotted above or below the x axis. Note that L2 became closed to fishing prior to sampling in 2011.

The small fish, which were suggested by qualitative modelling as potential indicators of ecosystem effects of fishing for lobster, were sampled along with the rest of the fish assemblage using baited remote underwater videos (stereo BRUVs) in fished (Jurien) and closed (Leeman) areas. The fish assemblages of the fished and closed areas were comparable and a number of small fish were observed at abundances high enough to use as possible indicators. In all cases, sampling of macroalgal habitats provided the most statistical power to detect change. Limiting fish sampling to macroalgal habitats would therefore provide the most cost effective monitoring scenario.

The results of this project indicate that all three components (target species, benthic habitats and indirect ecosystem indicators (such as fish) and the sampling methods used have the capacity to detect ecosystem changes. Despite changes in lobster abundance detected 18 months after the implementation of the closed area it is important to note that the full impact of fishing on the ecosystem may take an extended period to manifest (i.e. >10 years). Establishing a baseline, as done by this study, and implementing a long term monitoring program for a range of different ecosystem components increases the likelihood that any potential changes will be detected.

The real value of this research is the increased understanding of the deep water ecosystem which will allow future assessments of the risk to the ecosystem of the removal of lobster biomass by fishing to be based on scientific research. In addition, the capacity to detect change in the ecosystem that may be driven or influenced by fishing in a timely manner allows for adaptive management and if required allows mitigation measures to be implemented to minimise the potential impacts. An area closed to lobster fishing also allows the research of lobster populations in an unexploited state to investigate factors such as carrying capacity, density dependent growth and natural mortality. The refinement of these aspects of lobster biology and ecology can improve existing stock assessments and modelling. for adaptive management and if required allows mitigation measures to be implemented to minimise the potential impacts. An area closed to lobster fishing also allows the research of lobster populations in an unexploited state to investigate factors such as carrying capacity, density dependent growth and natural mortality. The refinement of these aspects of lobster biology and ecology can improve existing stock assessments and modelling.

Literature cited

Bellchambers L.M. 2010. The effect of western rock lobster fishing on the deep water ecosystems of the west coast of Western Australia. Fisheries Research Report 199. Department of Fisheries, Western Australia. 96 p. http://www.fish.wa.gov.au/Documents/research_reports/frr199.pdf

L.M. Bellchambers and M.B. Pember
Marine Ecology and Monitoring Section (MEMs), Western Australian Fisheries and Marine Research Laboratories, Department of Fisheries, Government of Western Australia, PO Box 20, North Beach, WA 6920, Australia

Linking puerulus settlement and recruitment in southern rock lobster fisheries.

From: Adrian Linnane, Richard McGarvey, Caleb Gardner, Terence I. Walker, Janet Matthews, Bridget Green and André E. Punt

Southern rock lobster (*Jasus edwardsii*) puerulus monitoring has been undertaken in south eastern Australia since the early 1970s but quantified settlement estimates did not develop until the 1990s. Across South Australia, Victoria and Tasmania puerulus settlement is highest during the winter months of June, July and August, with peak settlement generally observed in July (Linnane et al., 2010). The collectors are similar in design to those described by Booth and Tarring (1986), consisting of angled wooden slats that mimic natural crevice habitat (Figure 1).

Figure 1. The collectors are serviced monthly by research teams who count newly settled puerulus to provide an index of puerulus abundance.

Firstly, this study examined spatial trends in puerulus settlement from the three States using annual settlement indices from a number of fisheries. Settlement were found to be closely correlated across four fishing areas in Victoria and South Australia implying that common oceanographic factors control settlement in this region. Tasmanian sites were not correlated with any of the South Australian or Victorian regions, but within Tasmania, settlement on the north-east coast was strongly distinct from sites further south.

Secondly, annual indices were correlated with lagged estimates of recruitment to examine the potential of puerulus settlement as a predictor of future fishery recruitment (Figure 2). In South Australia, the strongest correlations between settlement and recruitment to legal size were observed using a 4–5 year time–lag. Within Victoria and Tasmania, the period from settlement to recruitment at 60 mm carapace length (CL) was 2 and 3 years respectively. The period from 60 mm CL to legal size is approximately another 2–3 years, suggesting that the total time from settlement to the fishery ranges from 4–6 years in these regions.

This is the first time that the recruitment/settlement relationship has been quantified across a large spatial scale in *J. edwardsii*. It is considered to be a significant break-through in the understanding of southern rock lobster dynamics and has the potential to substantially improve fishery stock assessment outputs. Specifically, the relationship can be utilized to project forward estimates of lobster biomass, thereby providing a short to medium term window-to-the-future in relation to fishery performance at various levels of catch.

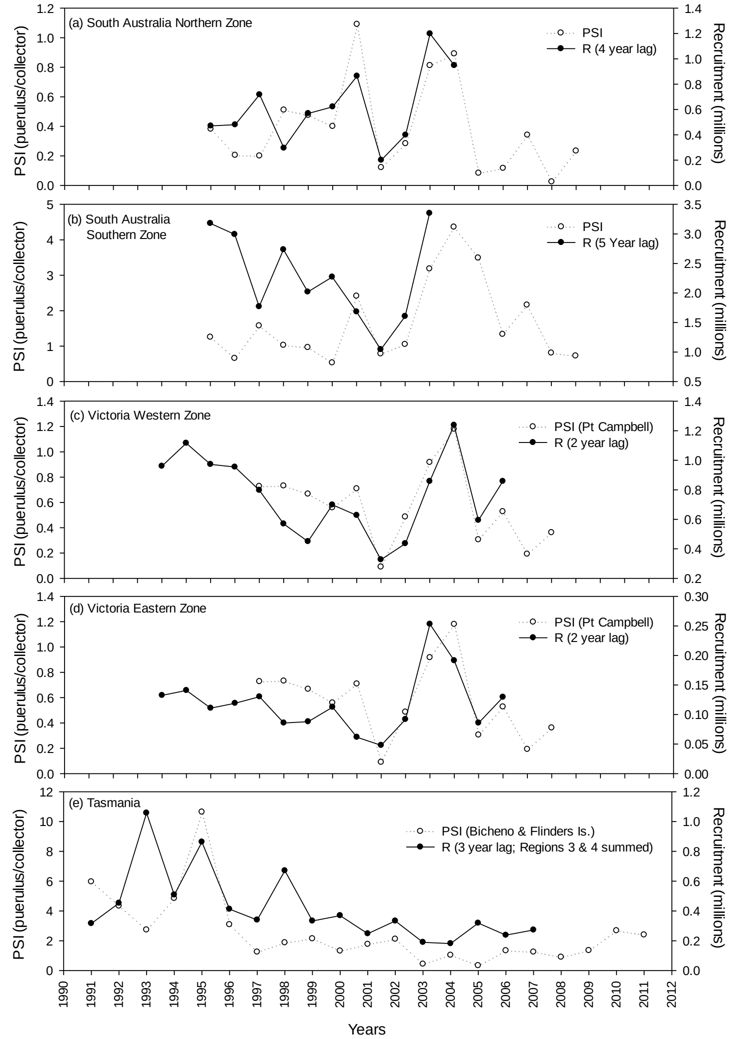

Figure 2. Relationship between puerulus settlement indices (PSI) and lagged model estimated recruitment (R) across South Australia, Victoria and Tasmania. Note that recruitment is to minimum legal size in South Australia and to 60 mm carapace length (CL) in Victoria and Tasmania. The period from 60 mm CL to legal size is approximately another 2–3 years, suggesting that the total time from settlement to the fishery ranges from 4–6 years in these regions.

Acknowledgements

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Adrian Linnane

SARDI, South Australian Aquatic Sciences Centre, 2 Hamra Ave, West Beach, SA 5024 AUSTRALIA

Email: Adrian.Linnane@sa.gov.au

Whale Entanglements in the western rock lobster fishery

From: Jason How

The population of humpback whales (*Megaptera novaeangliae*; Breeding Stock 'D') migrates along the west coast of Australia and is the largest population of humpbacks whales in the southern hemisphere (Leaper et al. 2008). The current population size is likely to be above 30,000 (Branch 2006) and estimated to continue to grow until 2020 where it is predicted to return to pre-whaling levels (Johnston and Butterworth 2009). The population migrates north along the coast starting around the southwest corner of the state (34°S) in June, continuing north through until August. By the end of August (Jenner et al. 2001), the majority of whales surveyed off Ningaloo (22°S) were undertaking their southern migration (Chittleborough 1953), which extends through to November.

The western rock lobster fishery (WRLF), which targets *Panulirus cygnus* off the west coast of Australia, fishes these same waters during the humpback whale migration. Under previous effort controls, the season for rock lobster fishing operated between November and June which resulted in between zero and four entanglements annually. This level (0-4 entanglements) was set as a performance indicator for the fishery, though it was recognised that the rate of whale interactions was likely to increase through time given the increasing numbers of whales migrating along the west coast. However in recent seasons, there has been an increase in the number of reported whale entanglements with commercial fishing gear, and WRLF gear in particular (Figure 1). The increase in whale entanglements is a likely result of a shift in fishing effort to more winter fishing.

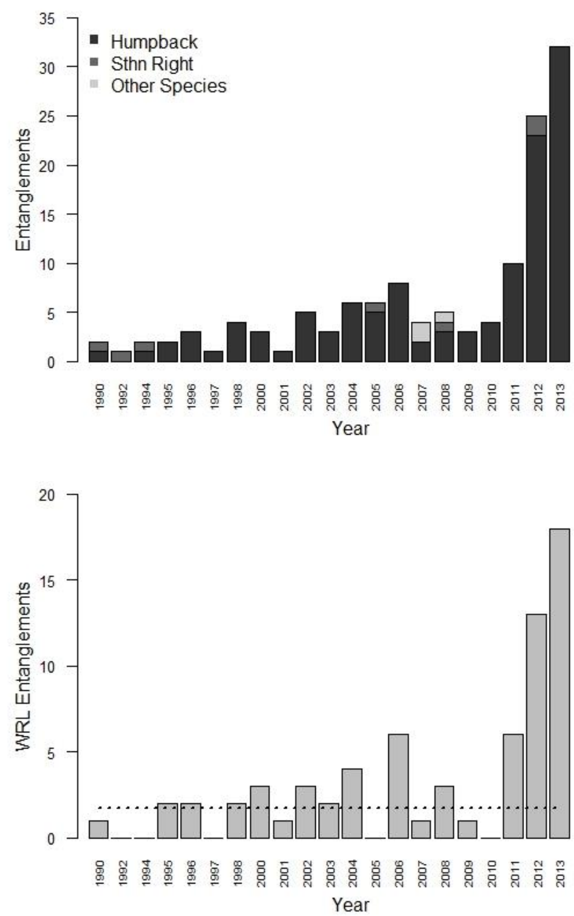

Figure 1 Timeline of entanglements of a) all entanglements by year and species and b) in western rock lobster gear by year with dotted line indicating long term average of whale entanglements in western rock lobster gear prior to 2011

Over the last few seasons (2010/11 and 2011/13) there have been significant changes to the management arrangements for the western rock lobster fishery. The move to quota-based management has included a change to season length with the season extending until the end of August in 2011 and September in 2012. The 2013/14 season was the first season with no temporal closure, allowing fishing to occur year round. The extension of the season has led to a movement of fishing effort more into months when the humpback migration occurs, resulting in a significant increase in the number of whale entanglements.

To address this issue, two Fisheries Research and Development Corporation projects have begun. They primarily are dealing with two aspects of the issue; 1) where and when entanglements are most likely to occur, and 2) potential mitigation measures to reduce whale entanglements. With mandatory gear modifications required for the 2014 whale migration season, there has been considerable testing of possible gear modifications. This includes biodegradable rope, negatively buoyant ropes, acoustic pingers and remote releases. The results of fisher and research trials will assist fishers and managers to determine which mitigation measures may be most successful in reducing whale entanglements.

Future work in collaboration with researchers from the Australian Antarctic Division, Department of Parks and Wildlife (Western Australia), Murdoch University and industry will assess the actual effectiveness of these measures in reducing whale entanglements as well as improving our spatial and temporal understanding of whale migrations through smart phone applications logging whale sightings and satellite tracking.

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Jason How
Western Australian Fisheries and Marine Research Laboratories, Department of Fisheries, Government of Western Australia, PO Box 20, North Beach, WA 6920, Australia

Environmental effects associated with cold fronts increase catch rates of *Panulirus argus* in a Mexican Caribbean Biosphere Reserve

From: Kim Ley-Cooper, Simon de Lestang, Bruce F. Phillips, Enrique Lozano-Álvarez, Patricia Briones-Fourzán, Ravi Fotedar

Bahía de la Ascensión (Sian Ka'an Biosphere Reserve, Mexico) is a large, shallow bay located on the eastern margin of the Yucatan peninsula that sustains a productive fishery for *Panulirus argus*.

Fishers extract legal-sized lobsters by hand from casitas distributed in fishing areas within the bay and from shallow coral reef habitats (≤15 m in depth) along the mouth of the bay. Although catch rates tend to decline from high values at the beginning of the fishing season (July) to low values at the end of the season (February), catch rates usually exhibit a secondary peak within the autumn. We analysed environmental and catch data sets from 1985 to 2012 to test whether this secondary autumnal peak was linked to the passage of northerly cold fronts ("Nortes"). Results showed that catch rates tend to increase 5 to 15 days after the passage of a Norte, but only when the strength of northerly winds reaches or surpasses a threshold value of ~2.0 m s^{-1}. The autumnal peak in catch rates reflects an increased abundance of legal-sized lobsters over the outermost bay fishing areas adjacent to the coral reef (Fig. 1). These lobsters include subadults moving out from shallow, inner bay areas and large adults moving in from deeper (>20 m) areas off the bay where lobsters are not subject to fishing. Our results suggest that local production of *P. argus* may be significantly influenced by biological and behavioural responses of lobsters to environmental effects associated with strong Nortes.

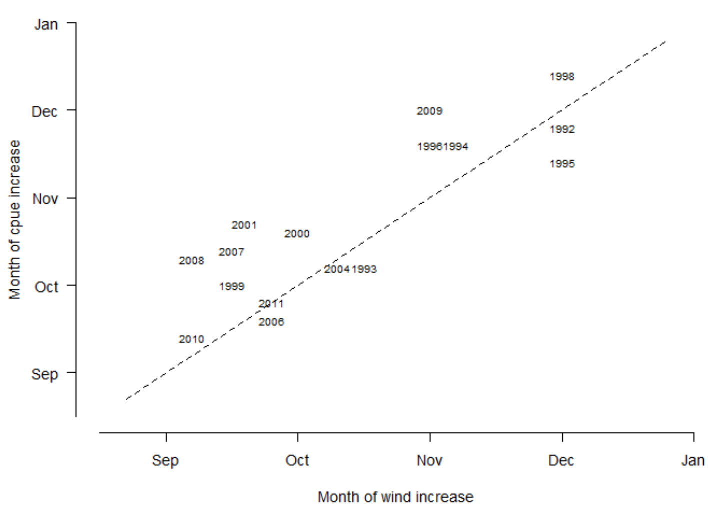

Figure 1. The strong positive relationship between the timing of northerly winds reaching or exceeding 2 ms^{-1} and the timing of marked increases in CPUE within the commercial fishery of Bahía de la Ascensión, Sian Ka'an.

Kim Ley-Cooper[1], Simon de Lestang[2], Bruce F. Phillips[1], Enrique Lozano-Álvarez[3], Patricia Briones-Fourzán[3], Ravi Fotedar[1]
[1] Department of Environment and Agriculture, Curtin University, Perth, Australia.
[2] Western Australia Fisheries Department, Perth, Australia
[3] Unidad Académica de Sistemas Arrecifales, Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Puerto Morelos, México
Email: kim.ley@postgrad.curtin.edu.au

OPINION

Ruminations on Managing American Lobster Fisheries

From: Bob Miller

The editors have generously provided me with a soap box to share personal opinions on management of American lobster fisheries. My experience is with the Canadian fishery.

1. *Fishery scientists desperately need MEAs (Marine Experimental Areas).*

Several no-take areas have shown increases in lobster biomass and egg production. For four reserves in New Zealand, Kelly *et al*. (2000) reported that benefits to *Jasus edwardsii* increased with age of the reserves. Biomass increased 5-10% and egg production 5-9% per year of existence. In a reserve off Western Australia density of legal sized *Panulirus cygnus* increased 50 times and egg production 100 times compared to adjacent fished areas (Babcock *et al*. 2007). *Homarus gammarus* density off SW England was 5 times higher in a reserve than in fished areas after 4-years (Haskin *et al.* 2011) and off southern Norway 2.8 times greater in a reserve than a fished area after 3 years (Moland 2013). These areas were all very small at <1 to a few km^2. Assuming these areas provide minimum estimates of habitat carrying capacity, with guestimates of growth and mortality rates, one could estimate potential annual yields.

Even better, one could conduct real experiments with controls, replication, and random assignment of treatments to areas. How populations respond to controlled harvests of set sizes, sexes, or quantities could be measured directly. These results would inform the choice of a harvest strategy and would be an improvement over modeling an outcome using a host of assumptions.

How effective would an agricultural scientist be if he/she could not run field trials to compare seed varieties, fertilizer applications, weed controls, soil types, etc.? How reliable would the results be if several farmers harvested the experimental plots at different rates, at different times, using different equipment, and kept poor records? What if drug manufacturers were not allowed to test the effectiveness of new drugs against placebos or established drugs?

Fishery scientists should demand MEAs to reduce guessing and to provide a better return on science investment. Let's put more science into fishery science.

2. *The need to understand causes of population change is overrated.*

The precautionary approach advises us that incomplete information is no excuse for inaction on resource management. A corollary is that more complete information may not help.

Probable causes of falling recruitment, falling spawning stock, or falling landings include benthic predation, pelagic predation on larvae, increased fishing mortality, and a less favorable physical environment. It is highly unlikely that fishery managers would regulate for fishing down benthic or pelagic stocks even if these were identified as agents of lobster population control. Of several possible ways to adjust fishing mortality nearly all are intended to increase egg production. We can rarely regulate change to the physical environment. The above symptoms of stock health can all be treated with increased egg production. Thus, identifying the cause is less important than applying the cure. Exceptions are identifying man-made habitat destruction, correcting unreported catches, and reducing wasteful fishing practices such as discard and ghost fishing mortalities. Disease is a cause that may defy solution.

3. *Does modeling larval drift improve lobster fishery management?*

The principal question is; how many larvae are transported from the area of hatch to the area of settlement and survive initial settlement? Components of the question are: number produced at source, dilution during drift, duration of the larval stage(s), larval survival, settlement survival, and effect of larval swimming behavior. Identifying the sources of larvae that support local components of the fishery would be an obvious benefit to fishery management.

Mortality and dilution (i.e. dispersion) around the mean drift can reduce settlement to an insignificant contribution to the population. Unsuitable habitat at settlement can also negate settlement success. For lobster habitat north of the Gulf of Maine, I hypothesize the most important consideration is the number of larvae retained near the hatch area and near shore versus the number not retained. If transported even a few km the probability of settling in an area with favorable temperature and substrate would be low (ignoring swimming behavior). The band of suitable bottom temperature (MacKenzie 1988) is limited to about 30 m depth and rocky substrate usually to a few km. Annis *et al*. (2013) provide evidence of a narrow zone of suitable temperature on the coast of eastern Maine, but they believe drift and swimming can supply larvae from a distant source. Near-shore releases of many drifters or neutrally buoyant particles could give an empirical test of passive dispersion. The release of 10^9 magnetically attractive particles and deployment of dozens of magnetic collectors looks promising for measurement of particle drift (Hrycik *et al*. 2013). I doubt that modeling mean drift, with unknown survival, and without larval swimming will provide useful predictions of transport from source to settlement. A study group on source-settlement of marine populations concluded that local retention was greater than indicated by most drift models (Swearer *et al*. 2002; Warner and Cowan 2002)

4. *Manage by direction rather than destination.*

In fisheries we are chasing an unclear and moving target for optimum management. Incomplete stock information clouds our crystal ball. Changes to the environment, fishery, and markets move the target. Therefore, better we ask how we can improve on the *status quo* rather than how we are managing relative to a fixed reference point.

Landings are a good report card for management but a fixed value is not a good target. In SW Nova Scotia during 1990 to 2005 lobster landings increased by a factor of four over an earlier 80-year average. In eastern Nova Scotia during the last decade they increased by a factor of eight over a 90-year average. In eastern Nova Scotia fishermen argued for many years that any attempt to increase landings would be futile because of the historical average and because of a long list of supposedly limiting factors. The limiting factors are still in place; the fishery was underachieving, perhaps for a century (Miller and Breen 2010).

Total allowable catches (TACs) are usually adjusted over time, but are uncommon in lobster fisheries. In other fisheries they usually support a fixed reference point. This can address the changing environment and maybe a changing fishery, but not a changing market.

Changing targets requires more effort than the *status quo*. Change also requires courage to make educated guesses, and to accept mistakes. We should keep our targets moving; they will never be exactly right, but moving them will make them less wrong.

The reader can make a list of targets (reference points) for his/her own fishery. Much has been published on this topic. Some of my favorites are:
-an index of egg production, catch per unit effort, or recruit abundance;
-ghost fishing mortalities plus by-catch mortalities in other fisheries are less than X % of landed catch;
-an increased landed price by $ X/kg by making sizes and seasons more compatible with market demand;
-and in one case, the depth of a sea urchin feeding front.

5. *Fishermen's observations are better for hypothesis formation than hypothesis testing.*

Fishermen's involvement in planning, data collection, and implementing a management plan can increase their support of the plan (Pomeroy and Berkes 1997). However, misjudging their potential can be expensive – a few personal experiences. Fishermen were quick to draw conclusions on cause-effect. Others, e.g. fish draggers, poachers, government, and bad weather were blamed for their problems. Thus, they were absolved from making improvements. In long-term larval and juvenile monitoring programs they wanted to periodically change the sampling locations and gear to satisfy their curiosity, but reduce the quality of the time series. They missed sampling dates because of personal inconvenience. In a large tag-recapture study they were provided with personal instruction, plus the name of a fisherman in each port, plus a science representative to consult regarding any difficulty. However, 60% filled in the data sheets incorrectly (Miller 2010). In summary, fishermen need careful oversight when monitoring and testing hypotheses.

I apologize to authors who should have been acknowledged; we old guys are forgetful and a little lazy.

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R.J. Miller
Bedford Inst. Oceanography
Dartmouth, N.S.
Canada B2Y 4A2
Email: Robert.miller@dfo-mpo.gc.ca

The Lobster NEWSLETTER

Editors:

Nick Caputi
Western Australian Fisheries and Marine Research Laboratories
PO Box 20
North Beach WA 6920 AUSTRALIA
FAX: (618) 9203 0199
Nick.Caputi@fish.wa.gov.au

Richard A. Wahle
Research Professor
School of Marine Sciences
University of Maine
Darling Marine Center
Walpole, Maine 04573 USA
Richard.Wahle@maine.edu

Assistant Editor – This Issue:
Jenny Moore
Western Australian Fisheries and Marine Research Laboratories
PO Box 20
North Beach WA 6920 AUSTRALIA
jenny.moore@fish.wa.gov.au

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Contact Nick Caputi (southern hemisphere) or Rick Wahle (northern hemisphere) about article submissions and inquiries or corrections to the Lobster Newsletter mailing list.