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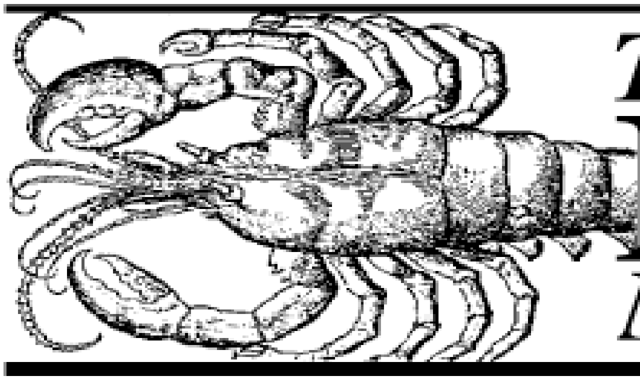

The Lobster NEWSLETTER

ANNOUNCEMENTS

INTERNATIONAL CONFERENCE: "RECENT ADVANCES IN LOBSTER BIOLOGY, AQUACULTURE AND MANAGEMENT (RALBAM 2010)" INDIA, JANUARY 5th-8th 2010

From: M. Vijaykumaran and R. Kirubagaran

Themes: Fishery; Conservation and management; Ecosystem interactions; larval distribution / settlement / larval studies; Aquaculture and enhancement; Post harvest practices; Physiology, Nutrition and Health: Biotechnological innovations.

Registration: Registered participants will have the privilege of attending all scientific sessions, tea, lunch, dinners and local tour, and will receive conference materials. The registration fees for various categories are:

Foreign Delegates:
Early Registration (31 Oct. 09): US $ 250
Late Registration (after 31 Oct.09): US $ 300
Registration fee for spouse: US $ 100
Student registration fee: US $ 100

Indian Delegates:
Registration fee: Rs. 5000
Student Registration fee: Rs. 2000


Photo Credit : NIOT

Call for abstracts: All contributors for oral and poster presentations are required to submit abstracts in English. The abstract should be clear, descriptive and not longer than 400 words saved in MS Word. (12 point, Times New Roman, single-column format). Last date for receipt of abstract is **15 November 2009**. The acceptance of abstract would be intimated to the authors by **30 November 2009.** Full paper has to be submitted at the time of the conference before presentation.

The Venue: The Conference will be conducted at the conference Centre of NIOT in the outskirts of Chennai, India (15 km away from the City Centre). A local sight seeing tour will be arranged for all registered delegates and post conference tours can be arranged to various parts of South India through the department of tourism.

Travel and Accommodation: Chennai city has a number of Hotels and restaurants providing decent accommodation to suit the requirements of varied interests. Local transport will be provided for all delegates staying in Hotels in City Centre to attend the conference.

For more details, visit the website www.niot.res.in/ralbam/home.htm.


Photo Credit : Wikipedia

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**To keep you reminded of
the 9th International Conference and Workshop
on Lobster Biology and management
in Bergen, Norway, June 2011**


Photo: Bergen Tourist Board/Per Eide

We are getting on with the preparations.
In the mean time check out the city:

http://www.visitbergen.com/default.asp?sp=GB

More information will come later
We look forward to see you all here for a great conference

REGIONAL WORKSHOP:
THE AMERICAN LOBSTER SETTLEMENT INDEX AT 20 YEARS
LOOKING BACK / LOOKING AHEAD

*Sponsored by Bigelow Laboratory for Ocean Sciences and
Maine Department of Marine Resources (DMR)*

A workshop celebrating the 20th anniversary of collaborative lobster settlement monitoring in New England and Atlantic Canada, will be held **June 19 - 21, 2009.** Workshop goals are to review the accomplishments of the settlement index to date and to set priorities for the collaboration, sampling and data analysis over the next 5 years. Two half-day workshop sessions, a lobster bake, and plenty of time to explore and kayak. Maine DMR will host the event at Burnt Island Light Station in Boothbay Harbor, a 5-acre island with meeting and dining hall, dorm accommodations, and tent platforms. Off-island accommodations available. For details and registration information, contact Rick Wahle.


Photo credit: V. Bourdett-Coutts

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RESEARCH NEWS

California: The Land of Surf, Sun, and… Lobsters? An introduction to research on the California spiny lobster (*Panulirus interruptus*)

From: Kira R. Withy-Allen and Kevin A. Hovel

California spiny lobsters (*Panulirus interruptus*) may not be in high demand in the global market, but they are an ecologically important, heavily fished species in Southern California and Baja California, Mexico. California spiny lobsters range from Monterey Bay, CA to Magdalena Bay, Mexico, with greatest population densities in central Baja California (Figure 1). California spiny lobsters have been the target of intense commercial and recreational fishing in Southern California for over a century, and lobster abundance and mean size have declined dramatically over this time period. California spiny lobsters are thought to be important predators of herbivorous urchins, thereby helping to maintain biodiversity in California kelp forest ecosystems (Tegner and Levin 1983, Lafferty 2004). Their top-down control of community structure also occurs in the rocky intertidal and soft-sediment seagrass habitat.

The State of California presently is implementing the Marine Life Protection Act (MLPA), which mandates the establishment of new marine protected areas (MPAs) along the California coast. Planning for new MPAs in the Southern California region has just begun. Spiny lobsters are a priority species of the MLPA, but planning may be hindered by the fact that far less is known about California spiny lobster ecology than about American lobster or Caribbean spiny lobster ecology. In this article we highlight research being performed on the California spiny lobster, and how it applies to the management of this important species.

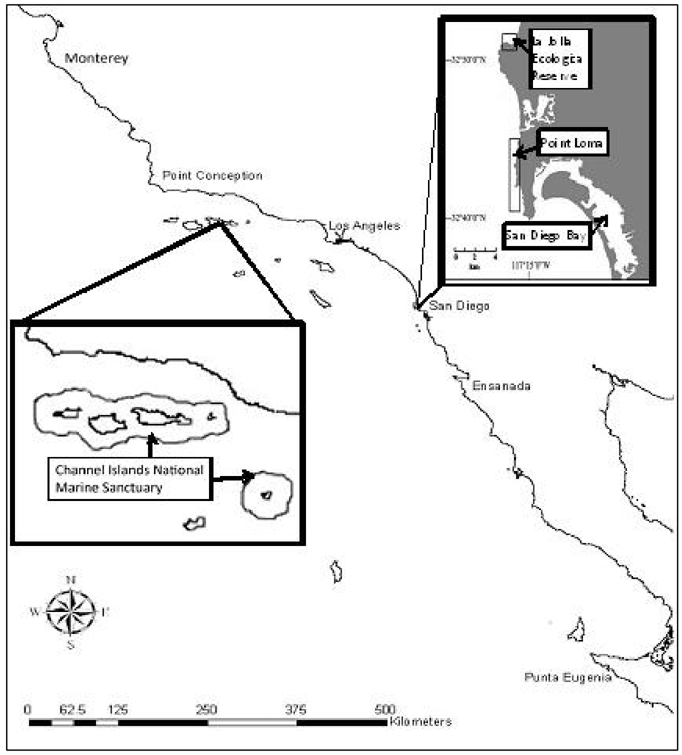

Figure 1. Locations of lobster research along the California coast, including the Channel Islands National Marine Sanctuary and three sites in San Diego (La Jolla Ecological Reserve, San Diego Bay and Point Loma).California Spiny lobsters range from Monterey, CA to Magdalena Bay, Baja, Mexico, with highest densities near Punta Eugenia, Baja, Mexico.

Fisheries Research

Spiny lobsters are one of the most exploited marine invertebrates in California. The commercial fishery has traditionally been monitored by logbooks, but researchers are now investigating the direct impacts of the fishery on lobster populations for management purposes. One such effort is the Collaborative Lobster and Fishery Research Project (CALobster), established by H.A. Lenihan at the University of California, Santa Barbara (UCSB). CALobster faculty and students collaborate with local lobster fishermen and the California Department of Fish and Game (CDFG) to monitor lobster populations and catch rates in the Northern Channel Islands using trapping and tag-recapture techniques. Resource managers at the CDFG also have begun to monitor the recreational fishery by requiring catch report cards and by conducting studies on catch efficiency of hoop nets, one of two ways that lobsters can legally be captured by recreational fishermen (lobsters also may be taken by hand).

Movement behavior and habitat use

With the ongoing implementation of the MLPA, lobster home range, habitat use and movement patterns are critical to determine. Kevin Hovel and his students at San Diego State University have been studying California spiny lobster habitat use and movement since 2001. With funding from California Sea Grant and the San Diego Foundation, they have addressed questions about lobster preferences for particular habitats and shelters, and why these preferences exist. In collaboration with Dr. Christopher Lowe at California State University Long Beach (CSULB), they also have used acoustic tagging technology to determine lobster movement patterns and foraging behavior in Southern California kelp forests. Their work in the Point Loma and La Jolla kelp forests near San Diego is revealing that California spiny lobsters display a combination of homing and nomadic behavior, which may be altered by factors such as predation risk, habitat selection, and food availability. Lobsters that were tracked nightly with acoustic tags in the heavily fished Point Loma kelp forest moved an average of 600m per night, and unlike some other spiny lobster species, homed to the same shelter only a small fraction of the time. In fact, at dawn after foraging, lobsters more often preferred to remain within a new landscape than to return to the proximity of their previous shelter. Lobsters did not display extreme vigilance to predators and typical defensive behaviors (e.g. forming large aggregations, selection of smaller shelters that restrict predator access). This may be due to removal of most large finfish from Point Loma; in a subsequent study, when lobsters were acoustically tracked within and near an MPA where fish predators are abundant, lobsters rarely moved more than 30m per night, remained in kelp forest habitat, formed larger aggregations and selected shelters more closely scaled to body size.

Research on MPAs

Both long-established and new MPAs in California appear to enhance lobster densities. In the MPA near Santa Catalina Island, lobsters were 8% larger and 70% more abundant within the MPA than at adjacent commercially fished sites (Iacchei et al. 2005), a trend also seen in the La Jolla Ecological Reserve (Parnell et al. 2005), the recently established Channel Islands reserves, and in San Diego Bay, in which commercial lobster fishing is prohibited. Long-term monitoring of lobster movement within and near the La Jolla Ecological Reserve by K. Withy-Allen using moored acoustic receivers is revealing that lobsters within this MPA establish small home ranges and do not often cross the boundary of the reserve. A larger study encompassing multiple MPAs, presently being planned, will help further elucidate the factors that dictate lobster movement behavior and shelter selection.

Population Connectivity

In addition to applied research, there are still many large-scale questions about spiny lobsters that have yet to be answered. One of the most important factors in overall management of this species is to understand how these organisms are distributed along the coast, and in particular to identify population sources and sinks. Although it has been speculated that lobster populations within the Southern California Bight are periodically populated by larvae from lobsters in dense regions in Baja California, Mexico, perhaps during El Nino events, there is little evidence to support this theory. To help determine how populations are maintained throughout the Southern California Bight, researchers at UCSB and the University of Hawaii at Manoa are using microsatellites and MtDNA, respectively, to explore population connectivity across the California-Mexico international border. Stronger management strategies can be implemented if sources and sinks along the coast can be identified.

Regulating Prey

A controversial suggestion has been that in the absence of sea otters, California spiny lobsters are one of the primary species maintaining biodiversity in kelp forest ecosystems by regulating urchin populations (Tegner and Levin 1983, Lafferty 2004). However, there have been few studies that have manipulated urchin and lobster abundances to determine direct effects of this predator-prey relationship. K.D. Nichols and K.A. Hovel have conducted tests of how lobsters and other predators may dictate urchin populations in Southern California. Their experiments show that lobsters are important nocturnal predators of urchins, and that along with daytime fish predators, urchins are rapidly eaten in the kelp forest, even when provided with habitat cover. This indicates that if lobsters are overfished, there may be an increase in urchin abundance, which could negatively affect the kelp forest ecosystem. In a companion study, B. Cheng and K. Hovel found that spiny lobsters can have a profound impact on invasive species in an estuarine system (Cheng 2008). In this study, distribution of the introduced Asian mussel was dictated by spiny lobster predation. The findings from this study are similar to those of Carolos Robles, who found that spiny lobsters regulated mussel prey in the intertidal zone, thereby increasing diversity in areas with high lobster abundance.

Future Research

Although these studies have greatly contributed to our current knowledge of spiny lobster ecology, behavior and distribution, there is still much more information needed to efficiently manage lobsters along the West Coast. Therefore, California researchers, including Dr. Kevin Hovel (SDSU), Dr. Hunter Lenihan (UCSB), Dr. Douglas Neilson (CDFG), and Dr. Christopher Lowe (CSULB) are building a collaborative partnership to study lobsters. The next few years will be critical in determining management strategies to protect spiny lobsters so that California can remain a place for surf, sun, and lobsters.

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Double tagging experiments and tag loss in *Palinurus elephas*

From: Lucía González-Vicente, David Díaz, Sandra Mallol and Raquel Goñi

Figure 1. *Palinurus elephas*. (Photo credit: D. Diaz)

In the framework of a long-term monitoring of *Palinurus elephas* (Figure 1) in the Columbretes Islands marine reserve (CIMR) (Western Mediterranean), we carried out annual tag-recapture experiments to estimate natural mortality, population size and emigration rates from the CIMR towards the adjacent fishery (Goñi et al., 2006). In addition to emigration, the loss of organisms from a tagged population may be due to: (1) natural mortality M, (2) fishing mortality F, (3) mortality related to the presence of the tag G, and (4) tag loss L. While M and F are presumably similar in tagged and untagged individuals, G and L are artifacts of the tagging method that can not be distinguished from M or F and may hinder interpretation of tag-recapture data. Tag loss in monitoring studies of *P. elephas* is not known as this species is routinely single-tagged. Here we report on the results of a double tagging experiment to estimate tag shedding rates in *P. elephas,* and explore the possible effects of timing of tagging in relation to moulting.

We double tagged 2,484 lobsters inside the CIMR during four tagging events: September 1999 and June 2000 through 2002. We used T-bar anchor tags (Hallprint®, Australia) inserted dorso-laterally on both sides of the first abdominal intersegmental membrane. A total of 1,056 lobsters were recaptured during the period 2000-2008 in the course of experimental fishing surveys inside the CIMR and commercial fishing operations outside. To estimate tag loss rates we used only data from recoveries up to three years-at-liberty, as recapture rates beyond that time were low and highly variable. In order to select recoveries having undergone a similar number of moults, we used recaptures from lobsters with times at liberty of 12 months or multiples of this period. For lobsters recaptured several times, only the first recapture was taken into account to assure data independence. The final analysis contained a total of 377 double tagged and 112 single tagged recaptured lobsters.

To estimate tag loss parameters we employed the method of Chapman et al. (1965) which was later extended by Bayliff & Mobrand (1972). Taking ρ as the immediate tag loss or Type I loss, and $\hat{L}$ as the instantaneous rate of tag loss or Type II tag loss (frequency of tag loss per unit of time), which is constant in these models (Equation 1), the probability of tag loss $\hat{P}$ (relative frequency of occurrence) was calculated with: (1) Chapman et al. model (1965) allowing only for long term tag loss, and (2) Bayliff & Mobrand model (1972) allowing for both immediate and long term tag loss (Equation 2).

$$\ln \frac{2\text{N double tag}_{ij}}{\text{N single tag}_{ij} + 2\text{N double tag}_{ij}} = -\ln \rho - \hat{L}t \quad \text{(Eq.1)}$$

where $i = 1, 2, 3$: years at liberty
$j = 1, 2, 3, 4$: tagging events

$$\hat{P} = 1 - \rho\, e^{-\hat{L}t} \quad \text{(Eq.2)}$$

where $1-\rho$ = immediate tag loss or Type I loss
$\hat{L}$ = instantaneous rate of tag loss or Type II loss

The probability of tag loss $\hat{P}$ was used to calculate the multinomial probabilities of the different tag-combinations: retaining two-tags $p_{DD}^{DD} = (1-\hat{P}_{ij})^2$, one-tag $p_{D}^{DD} = 2 \cdot (1-\hat{P}_{ij}) \cdot \hat{P}_{ij}$ and zero-tags $p_{0}^{DD} = (\hat{P}_{ij})^2$, and subsequently to estimate the expected probability of recapture of a lobster with two tags ($p_{DD}^{DD} / 1 - p_{0}^{DD}$), or one tag ($p_{D}^{DD} / 1 - p_{0}^{DD}$) (Adam & Kirkwood, 2001). The expected values from the fitted models with and without immediate tag loss were compared with the observed values, to decide which model produced the best fit. We explored possible differences in tag shedding related to the timing of tagging relative to moulting by comparing the observed proportions of single-tag recoveries from the September (1999) tagging event, close to moulting for males, with those observed from the June tagging events.

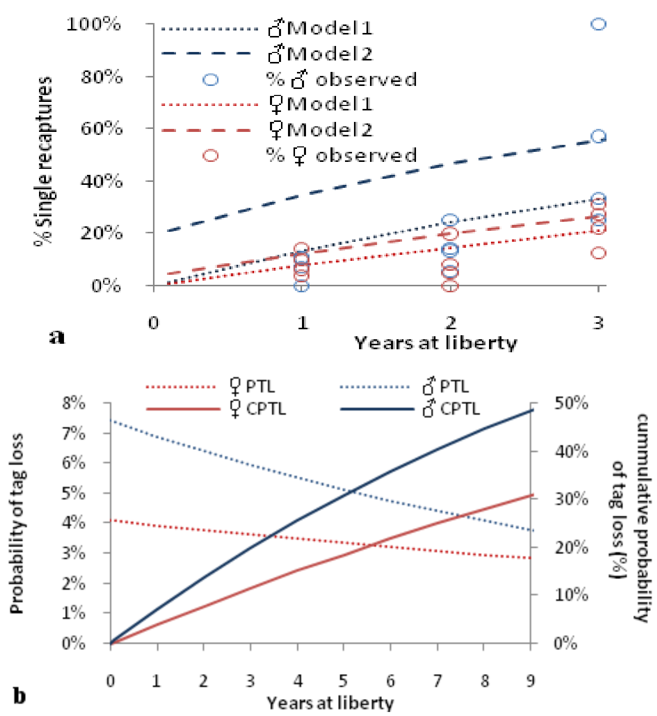

Figure 2. (a) Expected probability of recapture of single-tagged male and female *P. elephas* according to Chapman et al. (Model 1, dotted lines) and Bayliff & Mobrand (Model 2, dashed lines) and the observed percentage of single recaptures (% single/total, circles). (b) Modeled trend of the probability of tag loss (PTL,(%), dotted lines) and cumulative probability of tag loss (CPTL (%), solid lines) for both sexes.

For both sexes the model with best fit to the data over the first three-years-at-liberty was Chapman's model which assumes no immediate tag loss (Figure 2a). The estimated rate of tag loss $\hat{L}$ from that model was 7.4% year^{-1} for males and 4.1% year^{-1} for females (Table 1). Males are therefore almost twice as likely to lose a tag as females, probably mainly due to their greater growth rate. At this rate we forecast that 20% of male tags would be lost after 3 years, while in that period females would lose 12% of their tags (Figure 2b).

Results found for other lobster species show higher immediate mortality and shedding in those individuals tagged during the late pre-moult (Comeau & Mallet, 2003; Moriyasu et al., 1995). However, we did not observe greater tag loss one year after the autumn tagging event relative to the June tagging groups, in spite of its proximity to a male moulting period (Goñi & Latrouite, 2005) (Figure 3).

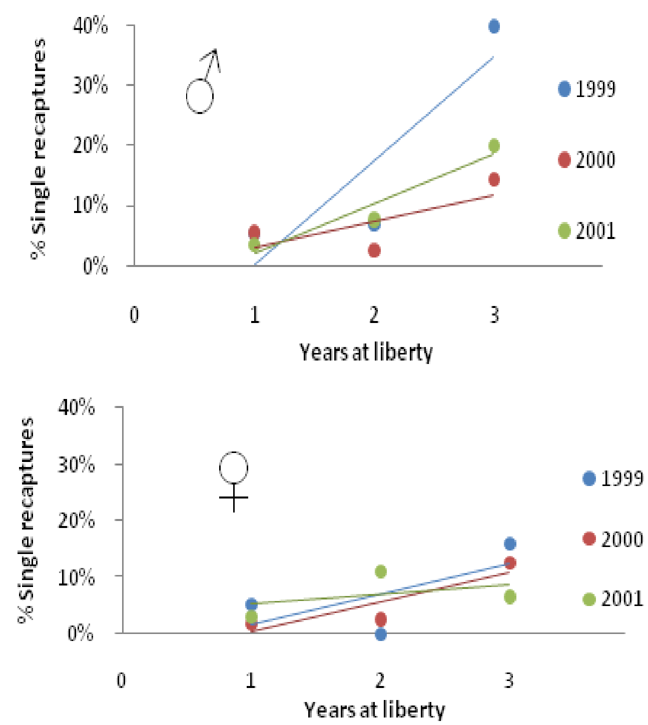

Figure 3. Observed proportion of single-tag recaptures (% single/total) for male (top) and female (bottom) *P. elephas* as a function of time at liberty for surveys 1999 to 2001; 2002 data not presented due to low recapture rates and high variability.

Our findings demonstrate that the rate of loss of T-bar anchor tags inserted dorsally in *P. elephas* in the natural environment is lower than expected on the basis of studies on other spiny lobster species (mean for sexes combined for the Chapman et al. model: 5.7% year^{-1}). In previous experiments with T-bar anchor tags inserted ventrally on *Jasus edwardsii* in the field, the tag loss was estimated at between 6-6.1% year^{-1}(♀) and 12-13.8% year^{-1}(♂) (Xiao, 2003 *cited by* McGarvey, 2004; Frusher et al.; 2008).

Also laboratory experiments on *J. verreauxi* with the same tag type inserted dorsally reached 8% year^{-1} (sex unspecified, Montgomery & Brett; 1996) (Table 2). Results of this study, when compared with previous work, suggest that tag loss may fluctuate greatly depending on species, tag type, experiment conditions, time of tagging or tagging position (Scarrat, 1970; Melville-Smith & Chubb, 1997).

Aknowledgements

We thank B. Stobart and J. Luscombe for their comments.

Table 1. Estimates of the instantaneous rate of tag loss $\hat{L}$ ± standard error, immediate tag retention ρ and probability of tag loss $\hat{P}$. Data from the four tagging events combined. Models with the best fit to the observed data are marked with an asterisk (*).

	Model		$\hat{L}$	intercept	r^2	inmediate tag retention ρ	probability tag loss year^{-1}	$\hat{P}$
♂	Bayliff & Mobrand	$\hat{P} = 1 - \rho e^{-\hat{L}t}$	0.125 ± 0.04	0.113 ± 0.08	0.52	89.30%	11.7%	
	Chapman et al	$\hat{P} = 1 - e^{-\hat{L}t}$	0.074 ± 0.02		0.42	100%	7.2%	*
♀	Bayliff & Mobrand	$\hat{P} = 1 - \rho e^{-\hat{L}t}$	0.050 ± 0.02	0.019 ± 0.04	0.43	98.08%	4.8%	
	Chapman et al	$\hat{P} = 1 - e^{-\hat{L}t}$	0.041 ± 0.01		0.41	100%	4.0%	*

Table 2. Tag loss rate estimates (year^{-1}) for various tag types on spiny lobsters species found in the literature. D- dorsally inserted; V- ventrally inserted.

Species	Author		Tag type	Tag loss	Tag location	Data source
Panulirus cygnus	Chittleborough, RG.	1974	Sphyrion tag	27%	D	Field
			Western rock lobster tag	30%	D	Field
Panulirus argus (juvenile)	Davis, GE.	1978	Floy FD-68B tag	45%	D	Field
Panulirus marginatus	O'Malley, JM.	2008	Streamer tag	54%	D	Field
Jasus novaehollandiae	Winstanley, RH.	1976	Dart tag	56%♂	V	Field
				41%♀	V	Field
Jasus verreauxi	Montgomery, SS. & Brett, P.A.	1996	Toggle tag	6%	D	Laboratory
			T-anchor tag	8%	D	Laboratory
			Dart tag	8%	D	Laboratory
Jasus edwardsii	McGarvey, R.	2004	T-anchor tag	12%♂	V	Field
				6%♀	V	Field
Jasus edwardsii	Frusher et al.	2008	T-anchor tag	14%♂	V	Field
				6%♀	V	Field

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"Not all those who wander are lost": Phyllosoma behavior may help unravel connectivity in the Caribbean spiny lobster, *Panulirus argus*.

From: Jason Goldstein and Mark Butler

The quote by the English writer and poet J.R.R. Tolkien may be true in the case of dispersing phyllosoma larvae, for there is increasing evidence that larval behavior (*e.g.,* swimming, diel vertical migration, sensory capabilities) can influence their ultimate destination. This important paradigm shift in the way we think about lobster larval dispersal and the potential for larval retention and localized recruitment has been well documented among those working with marine larval reef fishes as well as other marine decapod larvae such as crabs (Pineda et al. 2007). Evidence from genetic studies, novel mark-recapture experiments using natural or artifical chemical markers, and biophysical models that incorporate larval behavior all suggest that populations are more "closed" than previously believed and larval behavior is crucial to local retention and thus high degrees of population connectivity (Cowen et al. 2000).

It is well known that spiny lobsters are among those marine taxa with extended PLDs (pelagic larval durations) representing the upper limit of known PLDs (Phillips et al. 2006). Like many other types of zooplankton, phyllosoma of all the palinurid species studied thus far engage in both DVM (diurnal vertical migration) and OVM (ontogenic vertical migration) during their protracted pelagic period (reviewed in Bradford et al. 2005). Both DVM and OVM enhance the retention of meroplanktonic larvae in coastal zones and therefore increase their probability of self-recruitment (reviewed by Werner et al 2007). Because many of the existing techniques devised for studying the connectivity of marine species are not applicable to spiny lobsters (e.g., permanent chemical marking of internal structures), researchers have relied on biophysical modeling as a tool to examine larval dispersal in spiny lobsters, including: *P. marginatus* in Hawaii (Polovina et al. 1999), *P. argus* in the Bahamas (Stockhausen and Lipicius 2001) and southern Atlantic (Rudorff et al. 2009), *P. cygnus* in Western Australia (Griffin et al. 2001), and *J. edwardsii* in New Zealand (Chiswell and Booth 2008).

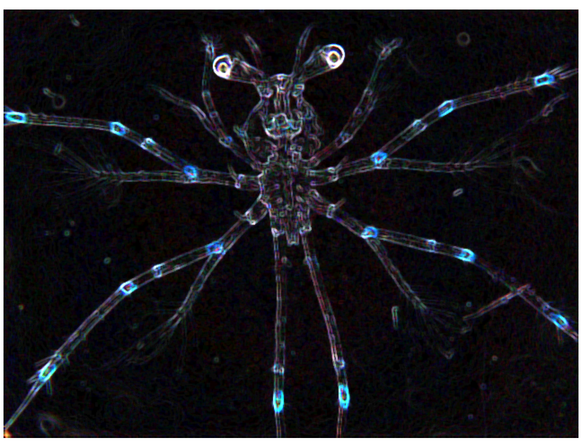

Figure 1. Early-stage *P. argus* phyllosoma (Photo credit: H. Matsuda and J. Goldstein)

For the past few years, we have employed a multi-disciplinary approach to investigate if the behavior of the Caribbean spiny lobster (*P. argus*) phyllosoma (Figure 1) affect its dispersal and therefore connectivity among coastal areas throughout the Caribbean basin. Based on our recent success at culturing *P. argus* phyllosomas (Goldstein et al. 2008), we first documented stage-specific phyllosoma responses to light that are indicative of OVM in laboratory experiments. Secondly, we quantified stage-specific phyllosoma depth distributions from plankton sampling in the Straits of Florida and compared these results to our findings in the lab. Third, we used a coupled three-dimensional bio-physical oceanographic model to explore the effect of OVM on larval dispersal from sites distributed throughout the Caribbean Sea. Because our intention was to mimic larval behavior as closely as possible, our model simulations incorporated both DVM and OVM as well as larval mortality estimates. The details of our findings appear in a manuscript soon to be submitted for publication, but here we highlight a few of our results:

- The response of laboratory-reared phyllosoma to light regimes similar in intensity and wavelength to those at various depths in the sea, changed abruptly after about three months post-hatch. Early stage phyllosoma were positively phototactic—later stage phyllosoma became negatively phototactic after 3 months.

- Early stage phyllosoma do not engage in DVM, whereas late stage ones probably do, a pattern also observed in *P. cygnus* from Western Australia.

- The age and size of phyllosoma at the time this change in behavior occurred corresponded with a shift in the vertical distribution of animals that we observed in the plankton; smaller phyllosoma (< 10mm CW) were found mostly in surface waters (< 25m) compared to larger ones (> 10mm CW) that were numerous at depths exceeding 75m.

- Incorporating OVM changes in photobehavior into biophysical model simulations, reduced larval dispersal to about 25% of that predicted for passive phyllosoma and more than doubled their settlement in habitable coastal areas.

- Our simulations suggest that the average dispersal of *P. argus* phyllosoma in the Caribbean is an order of magnitude less than previously believed, on the scale of a few hundred kilometers rather than thousands of kilometers. However, long distance dispersal of phyllosoma still occurs in regions where currents are highly advective.

In this study, we capitalized on our successes at rearing spiny lobster phyllosoma to investigate behaviors such as OVM, the absence of which has limited advances in biophysical modeling of larval dispersal. Most estimates of spiny lobster phyllosoma dispersal have relied on simple advection-diffusion or passive particle models that may oversimplify oceanographic conditions and, along with the absence of larval behavior, cannot accurately depict larval dispersal.

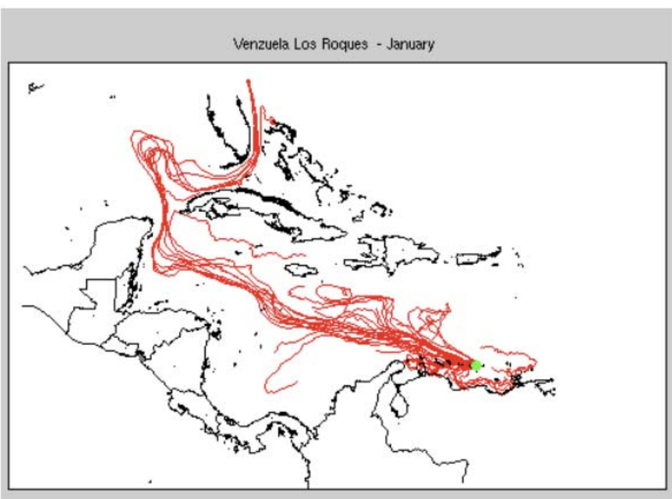

Figure 2. One example of a representative spawning location in the Caribbean (Los Roques, Venezuela) for *P. argus* phyllosomas and the predicted larval trajectories modeled from both the local oceanography of the area and predictions of phyllosomas exhibiting ontogenetic vertical migration.

We have not yet explored the extent that seasonality in spawning or oceanographic conditions may alter the dispersal of long-lived spiny lobster larvae. Nor do we imply that the predicted supply of spiny lobster postlarvae to particular coasts foretells recruitment. Larval dispersal is not the only factor relevant to recruitment. Currently, we are working with our colleagues to model and validate *P. argus* dispersal from numerous locations and time periods throughout the Caribbean using geo-referenced spawning biomass data (Figure 2). Those simulations will permit us to generate probability distributions (dispersal kernels) describing the most likely origin and destination of larvae, which is a crucial product for multi-national management of Caribbean spiny lobster stocks. Our work efforts are part of a global initiative through the Coral Reef Targeted Research & Capacity Building for Management (CRTR) Program and the Connectivity Working Group (see http://www.gefcoral.org).

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Revealing the Robinson Crusoe Island Lobster

From: Alvaro Palma and Rick Wahle

An ambitious research project has just been launched to reveal the ecology of the virtually unstudied spiny lobster endemic to the Juan Fernández Archipelago in the southeast Pacific some 650 km west of central Chile. Drs. Alvaro T. Palma, Universidad Católica, Santiago, and Carlos Gaymer, Universidad Católica del Norte, Coquimbo, are co-investigators of the project to document the demography and recruitment processes of the Robinson Crusoe lobster, *Jasus frontalis*. The four-year project, supported by FONDECYT, the Chilean Fund for Science and Technology, started in the austral spring of 2008.

Of the three islands comprising the Juan Fernandez Archipelago, Robinson Crusoe is the largest at 15 km long and only a few km wide. The island's jagged peaks rise as high as 1000 m almost vertically from the shore, enclosing hidden valleys of ferns and other plants, 20% of which are endemic to the archipelago. In 1704 Scottish seaman Alexander Selkirk jumped ship here and lived as a castaway on the island for more than four years. His journals became the inspiration for Daniel Defoe's novel, *Robinson Crusoe*.

With about 500 residents, Robinson Crusoe is the only island with a year-round community. Its 60 artisanal fishermen use small dories powered by 20 hp outboard motors. They use locally handcrafted wooden traps made of the introduced eucalyptus wood logged on the island. Harvesters fish their 30 traps from October to May over a depth range of a few to 100 meters. In recent years landings have varied between 40 and 50 metric tons. The catch is flown to Chile, and from there to markets as far away as Europe where Robinson Crusoe Island lobster is an exotic delicacy.

Figure 1. Alvaro Palma with his students, Pedro Santilices, Maria Jesus Montes and Florian Schneider (from left to right), on board the 8-m rigid bottom inflatable. (Photo credit: R. Wahle)

Despite the fact that the harvest of this species by local fishermen represents one of the economic pillars of Robinson Crusoe Island, to date little or nothing is known about the species' *in situ* ecology and population dynamics. The commercial value of *J. frontalis* has mandated monitoring of the catch and considerable research on the fishery (e.g., Arana & Vega 2000). A single recent oceanographic survey has given a one-time snapshot of patterns of larval abundance around the islands (Mujica 2006). Still, there have been no comprehensive ecological studies that would answer even basic questions about larval dynamics, postlarval settlement, benthic nurseries, migrations, social behavior or processes driving changes in landings.

The goal of Palma and Gaymer's study, therefore, is to quantify the distribution and abundance of the different ontogenetic phases, to understand the functional linkages among them, and to better understand both the pre- and post-settlement processes influencing recruitment. In order to achieve this, for five months of the spring and summer the co-investigators and their students have set up a field station on the island (Figure 1). Logistics are challenging to say the least. All their gear, including boat, fuel, scuba tanks, compressor, food and personal belongings were shipped from the continent by a Chilean Navy transport vessel that supplies the island monthly. A local dive shop rents dive locker and air station, and a mooring has been set in the harbor for their 8-m rigid bottom inflatable. They set up a weather station and deployed moorings around the island for oceanographic instruments and passive postlarval collectors (Figure 2). The accumulating time series of ocean-atmosphere data will be correlated with larval and postlarval data from both collectors and larval tows. Benthic juveniles and adults are also being quantified through dive surveys of lobster dens where a few to several dozen lobsters aggregate during the day. Lobsters are also being tagged with PIT tags injected into the base of the last walking leg to evaluate movements among dens. To characterize population genetic structure specimens will be collected by fishermen from the three islands of the archipelago, as well as the miniscule Desventuradas Islands 600 km to the north, the only other islands where *J. frontalis* is found.

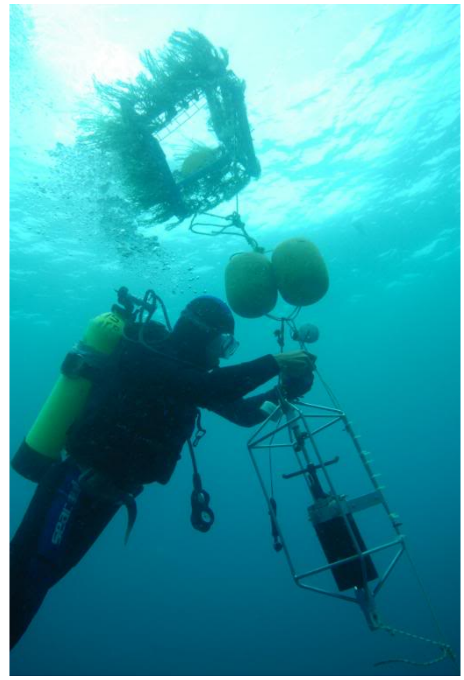

Figure 2. SCUBA diver attaching current meter to one design of a passive post-larval collector for *Jasus frontalis.* (Photo credit: R. Wahle).

To broaden the scope of the project, FONDECYT support has made it possible for other lobster specialists to assist with the project. In December, 2008, Rick Wahle (Bigelow Laboratory for Ocean Sciences) was the first of three visiting scientists to come to the island during the project. Wahle and Palma have had a long-standing mutual interest and collaboration in recruitment processes of lobsters and crabs going back to Palma's graduate school days at the University of Maine where he completed his PhD in 1998. During his three-week visit to the island, Wahle assisted with dive surveys and the first deployment of several designs of passive postlarval collectors modeled after those used for *Jasus* species in Australia, New Zealand and South Africa, but never before tested with *J. frontalis*. As of March of this year, early stage phyllosoma larvae were just appearing in plankton tows. In daytime tows, larvae were concentrated at 5-10 m depth, whereas at night they were distributed more evenly to the surface, the first suggestion of vertical migration for this species. Although no peurulus postlarvae had yet appeared on the collectors, the presence of larvae may bode well for postlarvae and early benthic recruits in the coming weeks and months.

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American Lobster Shell Disease Research Intensifies

From: Barbara Somers

Research on lobster health is paramount to understanding the causes and consequences of shell disease in the American lobster, *Homarus americanus*. In 2006, the United States Congress appropriated $3 million to establish a cooperative research program—*The New England Lobster Research Initiative*—to study shell disease. The goal of this program is to describe the disease agent and how it works, and to determine the extent and severity of the disease in New England waters. This initiative combines the strengths of 11 institutions, two state agencies, and over 35 scientists and graduate students. A unique feature of this program is the "*100 Lobster Study*" in which some of the world's foremost crustacean disease researchers are working with material from the same 100 lobsters. Expectations are that this collaborative approach will allow for groundbreaking analysis of a complex problem. This article gives a brief overview of the program which started in March 2007 and concludes in 2009.

Several researchers are looking for changes in the structure of the exoskeleton that would make the lobster vulnerable to shell disease. Michael Tlusty (New England Aquarium) and his group of researchers are examining the hypothesis that diet and water temperatures affect the structure of the shell. Joseph Kunkel (University of Massachusetts, Amherst) and his team are looking at detailed shell morphology and chemistry under the hypothesis that climate change induced ocean acidification is altering the chemistry at the interface of the shell and seawater, ultimately weakening the shell (Figure 1).

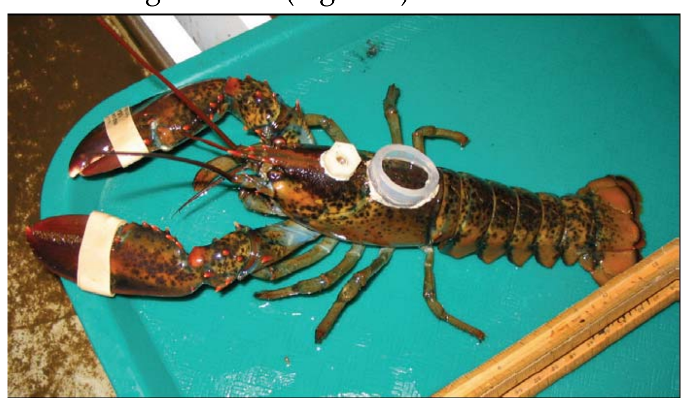

Figure 1. Joseph Kunkel places a lobster in specially designed stereotactic holder. Lobster cuticle is scanned by two ion probes, one for calcium and one for protons, to detect differences between the ions coming out of normal versus shell diseased cuticle. (Photo credit: J. Kunkel)

Hans Laufer (University of Connecticut), and his colleagues hypothesize that chemicals known as alkylphenols may inhibit the shell hardening process after molting, perhaps by interfering with calcium binding in the chitin matrix that forms the exoskeleton. Alkylphenols are organic compounds that result from the breakdown of hard plastics. They are also found in detergents, paints and lubricants that enter the ocean through wastewater and septic system effluent, as well as road run-off Similarly, Lawrence LeBlanc, Deanna Prince and their research partners at the University of Maine, Orono) are examining whether other environmental contaminants may contribute to lobster shell disease by determining if specific organic and trace metal contaminants such as nickel, chromium and arsenic consistently co-occur with shell-diseased lobsters. Bassem Allam (Stony Brook University) and his team of researchers are assessing immune response capability and the microbial community associated with shells from lobsters with and without epizootic shell disease. In their study, they are comparing lobsters from western Long Island Sound (LIS) where disease prevalence is low with those from eastern LIS where disease prevalence is high. Both populations are being compared to reference lobsters from Maine. Results show striking differences between animals from the diseased and healthy lobster populations with respect to immune system response and microbe activity on the shells. Work is continuing to better characterize the composition of the microbial community living on the outside of healthy and diseased lobsters, and to explore the defense factors associated with the lobster's shells. Tim Verslycke and his associates at Woods Hole Oceanographic Institution are investigating the relationships between lobster shell disease and expression of genes related to the hormone and immune systems, molting, energetic and xenobiotic metabolism, and shell formation.

Jelle Atema, (Boston University) and his colleagues are investigating whether healthy lobsters avoid lobsters with shell disease, and whether females prefer to mate with lobsters from their own population. Such selective mating might have consequences for genetic structure of lobster populations. Preliminary results suggest genetic differences among lobsters within close proximity, a finding consistent with selective mating due to behavioral barriers.

Three research teams are trying to identify which pathogens degrade the shell. Andrei Chistoserdov, (Louisiana State University) and his collaborators are evaluating the bacterial interaction with the shells in lobsters, crabs and shrimp, all of which suffer from some form of shell disease. The question is whether they are all affected by the same bacteria. The bacteria *Aquimarina* is a strong candidate. Furthermore, Patrick Gillevet, (George Mason University) is applying a molecular technique called pyrosequencing to identify bacterial communities on the shell.

Jeffrey Shields, (Virginia Institute of Marine Science) and his lab are examining how shell disease affects mortality and molting. He is also managing the *100 Lobster Study* and putting together the database of results from the studies thirty-nine collaborators. All the researchers are getting pieces of the same 100 lobsters, some with, some without shell disease, from the same location in Narragansett Bay, Rhode Island. Hopes are that the intensive parallel analyses of blood, shell, and tissue from the same lobsters will point to the causative agent of shell disease. Preliminary results suggest that many of the factors studied contribute to the disease. However, it is most likely that in the wild multiple interacting agents are causing the shell disease epizootic. For more details about the projects and updated results visit http://seagrant.gso.uri.edu/fisheries/lobster_initiative/updates.html

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Samples Needed to Complete Phylogenetic Analysis of Achelate Lobsters

From: Ferran Palero, Marta Pascual, Keith Crandall, Pere Abelló, Enrique Macpherson, Kari L. Lavalli and Ehud Spanier

We would like to direct the attention of readers of *The Lobster Newsletter* to our recently published research on Achelata phylogenetics (Palero et al, 2009), and ask their help in completing our analysis.

The lobster Infraorder Achelata contains three main families: Palinuridae (spiny lobsters), Scyllaridae (slipper lobsters), and Synaxidae (furry or coral lobsters). Members of these groups lack chelae on their first pair of pereiopods and have a phyllosoma larva (Scholtz and Richter, 1995; Dixon et al., 2003). As one of the most commercially important groups of decapod crustaceans (Holthuis, 1991; George, 2006) spiny lobsters have received great attention for many years, including numerous studies on their ecology, phylogeography and systematics (Patek and Oakley, 2003; Phillips, 2006). Far less is known about slipper and coral lobsters, despite much recent research (Lavalli and Spanier, 2007).

For the last few years, molecular DNA analysis has emerged as a helpful tool to resolve conflicting hypotheses generated through interpretation of morphological data and an incomplete fossil record. The reconstruction of phylogenetic relationships using molecular data may help to trace the origin of morphological innovations which had a major impact on the radiation of the Achelata. In our phylogenetics work, different nuclear (18S, 28S, and H3) and mitochondrial (16S and COI) gene regions were sequenced in a total of 35 achelate species to test conflicting hypotheses of evolutionary relationships within the infraorder and to solve taxonomic disagreements in the group.

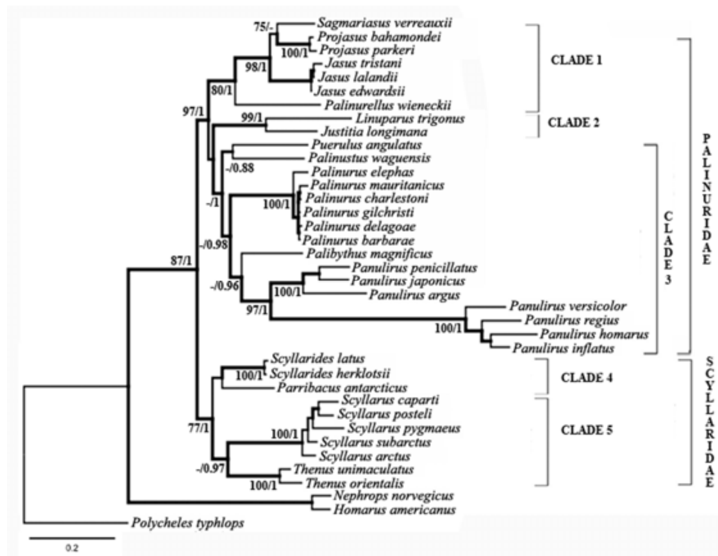

Figure 1. Topology obtained using BI after alignment with muscle and pruning with Gblocks. Bootstrap branch support for ML analysis (before slash) and Bayesian posterior probabilities (after slash) are indicated above a cut off value of 70 and 0.70, respectively.

The results of combined molecular data analysis strongly support the hypothesis that the Achelata is a monophyletic group composed of two main families: Palinuridae and Scyllaridae. Synaxidae is found to be a polyphyletic group, which should be included within the Palinuridae, as previously proposed by Davie (1990). Consequently, our results indicate that the origin of the sound-generating stridulating organ occurred only once during Achelata evolution. Within the Palinuridae/Synaxidae clade, phylogenetic reconstruction methods support clustering the Silentes palinurid clade (*Projasus, Sagmariasus, Jasus*) with the synaxid genus *Palinurellus*, as well as a *Linuparus/ Justitia* clade (Figure 1). Most surprisingly, the genera *Palinurus, Panulirus* and *Palybithus* clustered together under Bayesian inference. Finally, dating the divergence of Achelata with a relaxed-clock method (Welch and Bromham, 2005) has given results that are compatible with previous hypotheses of a Triassic origin of the group (George, 2006). The origin of the main clades within families was located in the period spanning from the end of the Lower Cretaceous to the beginning of the Upper Cretaceous (Cenomanian, approx. 100 Mya). Interestingly, this was the period with the highest sea level observed in the past 600 million years (approximately 150 m above present levels) (Hancock and Kauffman, 1979).

In the same study, the two main clades found within the Scyllaridae agreed with previous inferences from adult morphological data. By our phylogenetic analysis, two subfamilies lacking flagella on maxillipeds 1 and 3, the Theninae and Scyllarinae, grouped together, while two subfamilies sharing multiarticulated maxillipeds 1-3, the Arctidinae and Ibacinae, clustered separately, albeit more weakly. Therefore, we are not yet able to resolve phylogenetic relationships among slipper lobster genera primarily because of the lack of samples for some genera.

Even though our samples to date include the genera *Scyllarides, Parribacus, Thenus* and *Scyllarus*, we still need representatives of *Arctides, Ibacus, Evibacus Parribacus* and *Scyllarus*-related genera. We therefore, seek preferentially fresh or ethanol-fixed specimens. Please contact any one of the co-authors (Ferran Palero, preferably) at their email address to make arrangements.

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FISHERIES & AQUACULTURE UPDATES

Assessment of the *Panulirus argus* Lobster Resource, and Culturing Tests in the Region of Santa Marta, Colombia

From: Juan Carlos Jaimes-Martínez, Carlos Trujillo, Ybeth Pinzón and Ramón Nieto Juan Carlos Jaimes-Martínez

Three species of the lobster Family Palinuridae are found in the Colombian Caribbean: *Panulirus argus, P. guttatus* and *P. laevicauda*. Over the last decade these species have collectively accounted for an annual average harvest of 217 tons (CCI, 2006; Cruz et al., 2007). *P. argus* comprises the vast majority of the landings (97%, INPA, 2001). The major areas of extraction in Columbia are the San Andres Archipelago, where industrial and artisanal fisheries are practiced, and the Guajira coasts where only artisanal methods are used (CCI, 2006; Cruz et al., 2007; Jaimes et al., 2004). Colombia accounts for 3.6% of the total Caribbean lobster production, and most of the Caribbean lobsters are exported to the United States and Europe (CCI, 2006; Cruz et al., 2007).

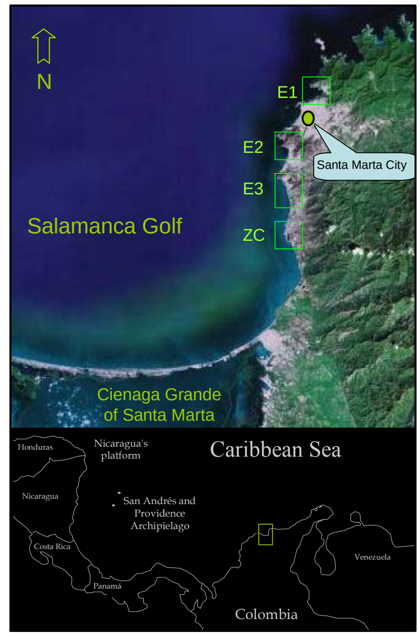

Figure 1. Sampling stations (E1, E2, E3) in Columbia's Santa Marta region of the Caribbean Sea (inset), where suspended collectors were anchored and on-growing tests developed (ZC). (Photo credit: Google maps modified by Juan C. Jaimes M.)

Between 2002 and 2007 in the Santa Marta region (Figure 1), two projects focusing on the evaluation of the lobster resource were developed by Sila Kangama Foundation, Encuentro Corporation and Rancheria Foundation with financial support from ECOFONDO (Colombia) and ACDI (Canada)-ECOFONDO. The aim of the first project was to determine natural variability in postlarval settlement and to implement artificial shelters for management of the spiny lobster in the Santa Marta region. The second project actively involved artisanal fishermen in a productive management process, as support for social security and sustainable development in the middle watershed of Toribio River and its coastal zone in Santa Marta's district, Magdalena Department. Here we give an update on our ecological studies of *P. argus* in the area, and the results of culture experiments in floating cages.

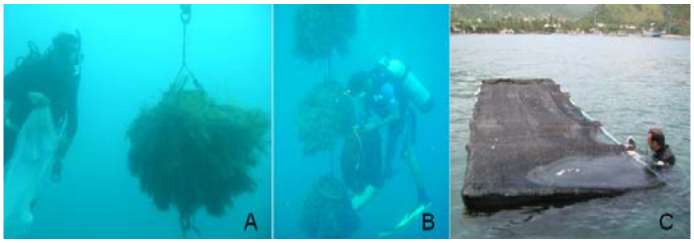

Figure 2. A. GuSi collectors; B. Column collectors; C. First floating cage used during field activities (2002-07). (Photo credit: Guillermo Díaz Pulido (2A) and Juan C. Jaimes M. (2B&C))

During the first project, postlarval settlement was assessed, using so called "GuSi" collectors developed by Gutierez *et al*. (1992; Figure 2A), at a depth of 10-11 m, while older juveniles and adults were quantified using concrete blocks and artificial shelters (Casitas cubanas) at 3 and 15 m, respectively (Cruz, 2002). During the second project, a series of collectors was suspended as a vertical column (Jaimes and Nieto in prep; Figure 2B). Culturing tests were also initiated in floating cages (Figure 2C).

This new model of floating "column type" collector consists of a series of six plastic disks 32 cm in diameter to which eight 45-cm synthetic tassels are tied; all the disks are secured to a vertical line. In Taganga Bay station, an array of 10 vertical lines were installed, interspersed with horizontally oriented GuSi collectors, all separated by about 3 m, covering an area of 300 m^2, and ranging in depth from 4.5 to 15 m. At Pelican Island four lines were installed covering an approximate area of 90 m. In addition, with local fishermen, a system of floating culturing cages was built, deployed and anchored to the seabed (Figure 3), The frame was made of recycled "plastic wood", within which a net surrounding an internal structure js held. This set covers an area of approximately 20 m^2. Postlarvae were obtained from the suspended collectors. This represents the first test of a small scale spiny lobster culture in Colombia.

Postlarval assessment: Between December 2002 and January 2007 18,520, *Panulirus argus* postlarvae were captured. We observed puerulus settlement in the collectors with an average size (±1SE) of 6.2 ± 0.4 mm carapace length. During the first project, the average (±1SE) number of postlarvae per collector for the region was 36 ± 33. This is high compared to existing data from the region (Cruz, 2001). Maximum numbers were observed near the end of the relatively cool, dry season in March and April 2003 (114 ± 13 and 111 ± 12, respectively). Smaller pulses were measured during the rainy season in August and October (78 ± 34, 75 ± 33, respectively; Figure 5). We are currently evaluating this assessment variation in relation to oceanographic and other environmental conditions in the south-west Caribbean during the study period.

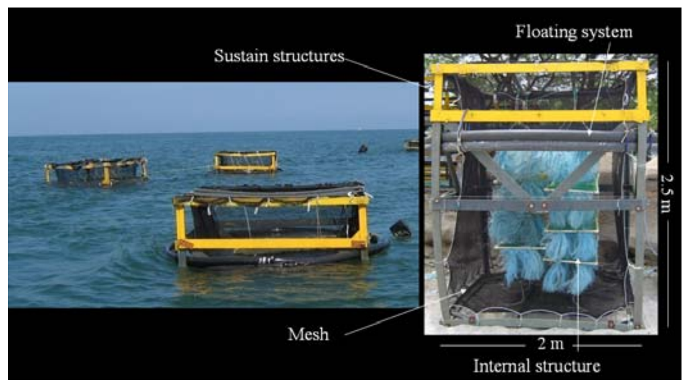

Figure 3. General assembly of the farming unit. A total of 23 floating cages were installed during the two projects. (Photo credit: Juan C. Jaimes M.)

Juvenile and Adult Recruitment: Contrary to expectations, we observed very low recruitment of juveniles and adults during shelter assessment. A possible cause may be the few natural areas that provide shelter for newly settled postlarvae, resulting in the survival of only those that can reach the few areas suitable for their development (Jaimes et al., 2004).

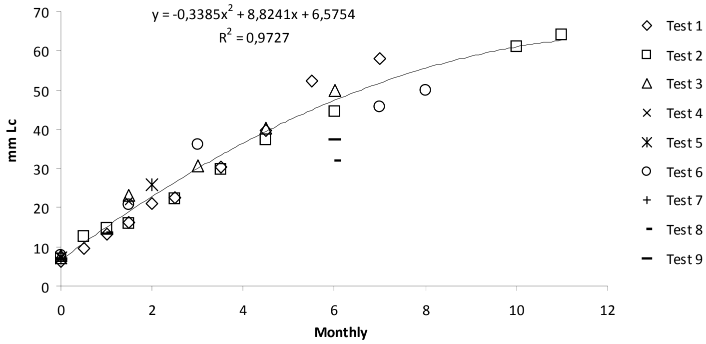

Figure 4. Size at age data and fitted growth polynomial function for *P. argus* grown in floating cages.

On-growing tests: Floating cages were designed and built with recycled plastic, presenting as innovative system a series of trays (internal structure), which have synthetic tassels similar to the ones used for the suspended collectors, which gives a wider surface area inside the cage, shelter, feeding opportunity and shade (Jaimes and Nieto in prep). During the on-growing tests, postlarvae were fed daily with fish entrails from local fisheries (~10 g/d/animal). Preliminary data from several cage trials infer the general growth rate under local conditions (Figure 4). Observed sizes at age produced a good fit to a linear growth model (R^2= 0.97; Jaimes and Nieto in prep). At this growth rate lobsters would be expected to enter the harvestable size of 70 mm carapace length within 14 months.

During both projects, the supply of postlarvae to the coast of the Santa Marta region, was abundant and continuous, but varied spatially and temporally. Previous research elsewhere indicates that this variation depends on the distribution, reproductive dynamics, and size of the breeding stock, as well as by large scale and local geography and oceanography (Briones and Gutiérrez, 1991; Briones, 1994; Cruz 2001; Keulder, 2005). Benthic juvenile and adult populations, and in turn harvests, appear to be limited by the few areas suitable for survival (Jaimes *et al*., 2004). Given the success with collectors and relatively high growth rates attained in floating cages, lobster farming may be a productive alternative. Still, it is necessary to continue studies to optimize these collecting and culture systems to maximize production.

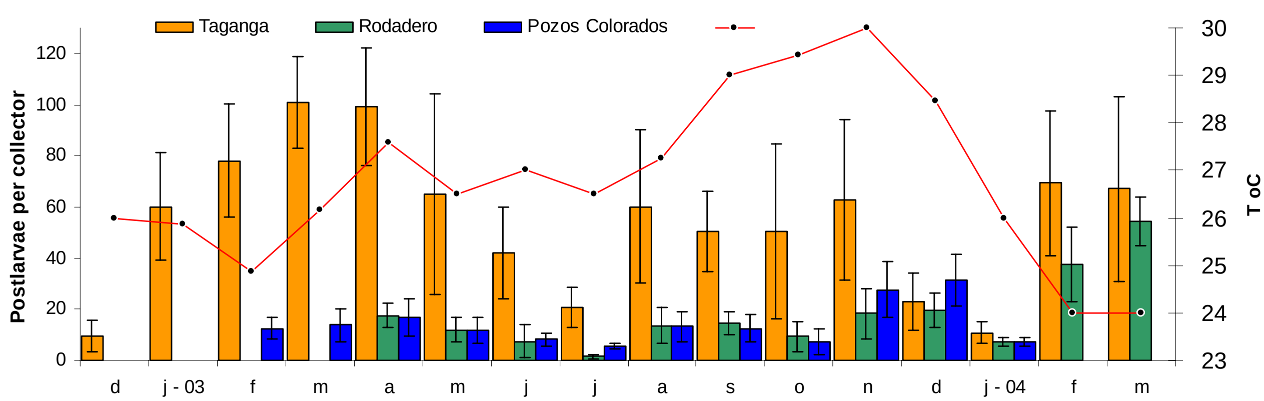

Figure 5. Spatiotemporal variation in postlarval assessment, 2002 – 2004.

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Using Research Traps To Monitor Nova Scotia Lobster Fishery Recruitment— Season Update 2007/2008

From: Shannon Scott-Tibbetts

The Fishermen and Scientists Research Society (FSRS) is a non- profit organization specializing in promoting effective communication between fishermen, scientists and the general public. Based in Halifax, Nova Scotia, the FSRS maintains a network of fishermen and scientists capable of conducting collaborative research and collecting information relevant and necessary to the long term sustainability of the marine fisheries. In the spring of 1999, the FSRS launched a Lobster Recruitment Index Project. During the regular commercial season, fishermen use a particular number of standardized, ventless lobster traps (Figure 1a) to gather information about undersize lobsters in their area. Volunteer fishermen count, sex and measure the size of lobsters from their science traps and record them in a logbook. They also indicate if lobsters are berried, tagged, and/or v-notched. Participants also monitor bottom temperatures by placing a computerized temperature recorder in one of their project traps for the entire lobster season.

The project has participants in all Lobster Fishing Areas (LFAs) along the Atlantic coast of Nova Scotia, from LFA 27 to LFA 35 (ranging from Cape Breton to the Bay of Fundy) (Figure 2). Each participant fishes two to five project traps, depending on the LFA. The project traps are ideally fished in the same locations each year to minimize the effects of spatial variation.

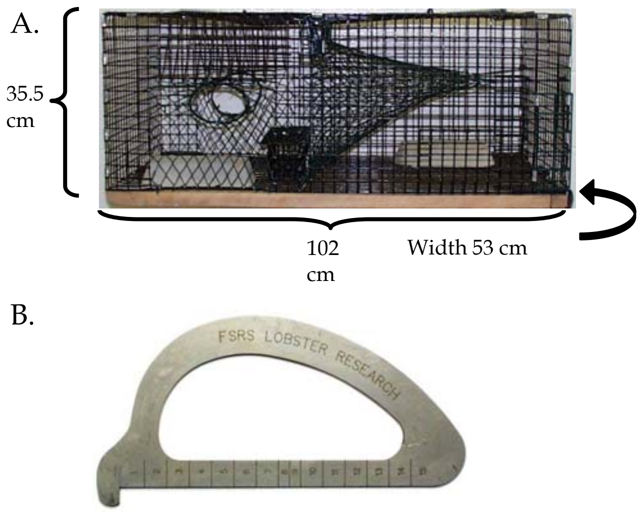


Figure 1. Standardized trap (a) and gauge (b) used in the FSRS lobster recruitment study. (Photo credit: Carl MacDonald)

The project is designed to study changes in the abundance of juvenile lobsters that will be recruited into the lobster fishery in the upcoming seasons and, as the project continues, allow an index of recruitment to be developed. Lobster fisheries in Atlantic Canada rely heavily on newly-recruited lobsters. Hence, we hope to be able to predict, with some certainty, if there will be increases or declines for the commercial lobster fishery.

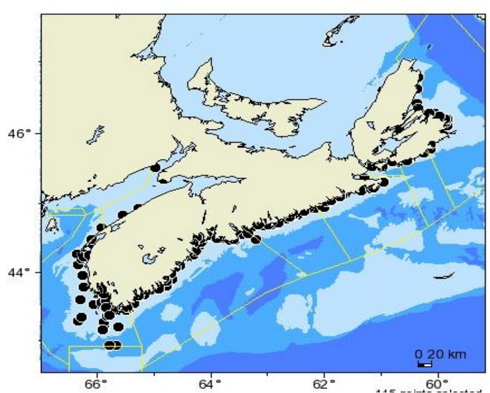


Figure 2. Location of participants in recruitment study during Fall 2007 Spring 2008 .

As of 2002, the Fishermen and Scientists Research Society has been in collaboration with the Gulf of Maine Lobster Foundation. This development has meant an expansion of the standardized trap study to the New England Coast, and enabled us to have a more complete picture of the lobster industry. This is an ongoing collaboration and has resulted in various workshops and meetings on both sides of the border.

Fall 2007/Spring 2008 Summary of Results

In the Fall 2007 season, 71 fishermen took part in the project in LFAs 33, 34 and 35. That year 183 project traps were fished. There was a total of 3,845 project hauls and a total of 13,290 lobsters captured. During the Spring 2008 season a total of 444 science traps were fished . All LFA's combined for a total of 17,367 project trap hauls. A total of 59,441 lobsters were captured, sexed, measured and recorded by fishermen. Fishermen captured an average of 3.5 lobsters per trap haul. Overall catch composition remains approximately 50% female and 50% male. There are large differences in catch rates across LFAs (Table 1).

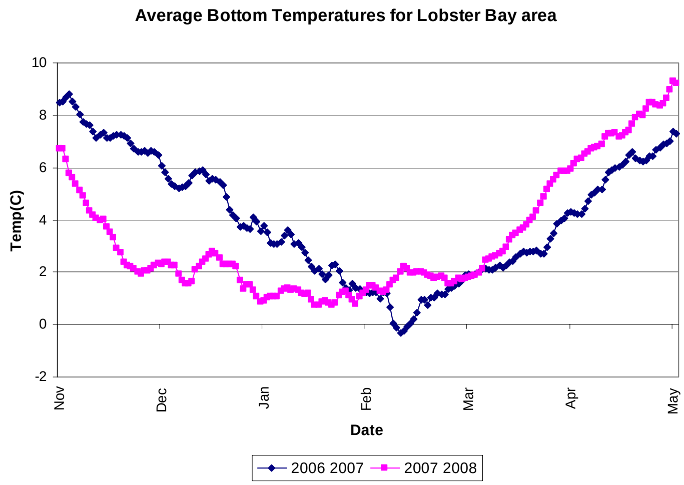
Table 1. Catch rates of lobster in research traps by carapace length and LFA for Fall 2007 and Spring 2008

Fall 2007 Results (Nov-Feb)

LFA	# Fishermen	Trap Hauls	Total	Lobsters / Trap Haul
33	35	2229	5879	2.64
34	34	1531	6841	4.47
35	2	85	570	6.71
	71	3845	13290	3.46

Spring 2008 Results (Mar-May)

LFA	# Fishermen	Trap Hauls	Total	Lobsters/ Trap Haul
27	28	4371	16173	3.70
28	1	139	336	2.42
29	8	2089	9621	4.61
30	6	1304	6235	4.78
31A	6	641	2628	4.10
31B	11	1213	3465	2.86
32	17	1687	2571	1.52
33	39	3255	7187	2.21
34	33	2314	9802	4.24
35	3	354	1423	4.02
	152	17367	59441	3.42



Temperatures were recorded by a data logger

Figure 3. Example of bottom temperature graph from two research traps in LFA 34. November through May for 2006 to 2007 (Blue) and 2007-2008 (Pink).

placed in one of the fisherman's standardized traps and then returned to the FSRS office to be downloaded (Figure 3). Each fisherman receives personalized temperature and catch results from their traps.

All the lobster recruitment data have been summarized and presented at regional lobster advisory meetings and at the FSRS Annual Conference in Truro, NS. Please visit the FSRS website (www.fsrs.ns.ca) and download the newsletter, Hook Line and Thinker, to learn more about this and other projects with which the Society is involved.

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Meeting Summary: Roundtable on American Lobster Enhancement

From: Dounia Daoud, Michel Richard and Martin Mallet

On November 6th, 2008 the Coastal Zones Research Institute (CZRI) and the Atlantic Veterinary College Lobster Science Centre (AVCLSC) at the University of Prince Edward Island, Canada, co-hosted a half-day roundtable on lobster seeding in Atlantic Canada and New England as part of their 4th Annual Lobster Science Workshop. The meeting was held in Moncton, New Brunswick with support from the Natural Sciences and Engineering Research Council of Canada-Atlantic Regional Opportunities Fund. The theme was "*Growing the resource – Lobster enhancement and health strategies*". This roundtable continued discussions begun at a meeting held at the New England Aquarium, Boston, in December 2007. That meeting examined new developments in the field of lobster enhancement in the region (Tlusty and Wahle, 2008). Industry, government and scientific representatives from all four Atlantic provinces, Quebec and the United States were brought together to focus on the question: "How do we measure the success of seeding initiatives." A discussion on seeded lobster quality and health was also initiated. The roundtable was co-chaired by Gastien Godin (CZRI) and Martin Mallet (Homarus Inc.).

The CZRI is responsible for the science associated with hatchery optimization within the Homarus Inc. initiative. Being situated in the heart of lobster fishing communities in northern New Brunswick, the Institute sees first hand the importance of lobster fishing for small coastal communities, and thus has made long-term sustainability a priority. Since the 2007 Boston meeting, the research focus has been adjusted to incorporate studies of lobster behavior as an additional indicator of lobster quality and overall health.

A decade ago, in 1998, Orion Seafood International initiated lobster stakeholder meetings, including Darden Restaurants Inc., the federal Minister of Fisheries and Oceans (then, David Anderson), his Provincial counterparts from all four Atlantic Canada provinces, as well as AVCLSC, Clearwater Seafoods Limited Partnership, Paturel International Co., and the fishing sector. The Lobster Sustainability Trust Fund was created in July, 2008, to establish a fishery enhancement network in the region. The aim of the fund is to preserve and enhance the viability of the lobster industry and its communities through the promotion of scientific research, stock and habitat enhancement, environmental and ecological protection and the sustainability of the industry. The constitution and guidelines for the Trust Fund should be complete before the end of 2009.

Last year's Boston meeting gave a refreshed look at lobster enhancement efforts under way in Atlantic Canada and New England (Tlusty and Wahle, 2008). In particular, recent successes of the Homarus Inc. group in New Brunswick had offered renewed optimism that hatchery-reared stage IV (postlarval) lobster could be released and survive in the wild. However, it was also mentioned that *"…optimism should be tempered by the large number of questions still surrounding this body of work. It is unknown whether these efforts will be successful everywhere…"* Lobster seeding has been pondered for over 100 years. Efforts to enhance lobster populations for increasing harvest through the addition of hatchery-reared larvae/juvenile lobsters had been widespread worldwide and controversial (Bannister and Addison, 1998). The main reason for this controversy is the lack of measurable data to show an increase in the adult lobster population that can be attributed to larvae/juvenile release programs (Van der Meeren, 2005). Through the Homarus Inc. project we have seen the first results showing that stage IV lobsters can survive in the wild after seeding. The new optimism is generating more research and collaborations to answer these century-old questions. In particular, a high priority is to define the criteria of success and how to measure it.

The roundtable resulted in several propositions on how to measure the success of seeding:

- The before-after control-impact (BACI) approach as used by the Homarus Inc. and Maine groups was considered a valid approach to evaluate initial success of seeding. However, this approach should be duplicated and Homarus Inc. is planning other experimental seeding sites in this direction.
- Genetic work (fingerprinting in Maine and Nova Scotia) and the use of microwire tags (Nova Scotia) were only briefly discussed, since the advantages and limitations of these techniques have already been addressed in Boston in 2007.
- The Maine Lobster Institute's efforts to use tidal pounds as hatcheries for producing massive seedings (millions of larvae) in a natural environment was explained. They have developed the use of juvenile sampling traps to look for population changes after release. The Institute envisions a comparative analysis of lobster densities pre- and post-seeding. Fishermen could easily buy into and participate in this program by doing some field monitoring.
- Behavioral studies should be conducted that examine larval dispersal behavior after release relative to the presence of predators. In the coming years CZRI-Homarus Inc. plans to evaluate escape from predators and cryptic behavior of hatchery-produced larvae in controlled conditions.
- Site assessments should be undertaken prior to releases. Releases should be focused on areas where seeding will have the maximum impact. For example, seeding in an area where there is already a large amount of natural larval production (northern Prince Edward Island, for example) would make enhancement almost futile.

- A significant portion of the roundtable was also devoted to the health status of seeded larvae. The AVCLSC is developing research on health levels of different stages of larvae. The Lobster Institute informed the group that a North American Lobster Health Coalition had recently been federally funded in the US. Quality of the hatchery-produced larvae is being assessed at the CZRI, using indicators such as developmental abnormalities, nutritional status, metabolic rates, and biochemistry. Nutritional deficiencies at the developing egg stage could strongly affect larval quality. More information should be collected about egg quality in relation to rearing conditions. Wild larvae should be used as a benchmark for quality and health standards.

In summary, while the meeting resulted in no definite answers to the question of how we measure success, it was agreed that North American lobster enhancement initiatives need to increase communication and begin working together towards the common goal of effective lobster seeding as a tool to enhance or stabilize the lobster resource. Establishing baseline characteristics of the quality and health of larval and postlarval lobster should be a priority. Meanwhile, it would be wise to establish codes of conduct or a best practices manual that would serve fishery enhancement initiatives. A hatchery consortium could be the basis for developing such a tool, and would develop common research goals into an integrated program. The inherent benefits of sharing information are obvious; however, it is still unclear how interested parties will join forces in this endeavor.


Photo credit: Coastal Zones Research Institute

In attendance: D. Basti (Lobster Institute), A. Battison (AVCLSC), B. Bayer (Lobster Institute), C. Billings (Lobster Institute), D. Bouchard (Lobster Institute), L. Clancey (NS Fisheries & Aquaculture), M. Comeau (DFO Moncton), P. Cormier (NB Fisheries), D. Daoud (CZRI), L. Darling (Paturel International Co.), B. Darling (Paturel International Co.), J. Feehan (Northumberland Fisheries Museum), G. Godin (CZRI), L. Greening (NS Fisheries & Aquaculture), S. Greenwood (AVCLSC), K. Hill (Darden Restaurants), J. Lavallée (AVCLSC), D. Losier (Cape Bald Packers), R. MacMillan (PEI Fisheries, Aquaculture & Rural Developments), M. Mallet (MFU-Homarus Inc.), S. Motnikar (Quebec Ministry of Agriculture, Fisheries & Food), M. Richard (MFU), J. Ronquillo (NSAC), J. Spinney (Orion Seafood International), M. Theriault (Université Sainte-Anne), and C. Vogel (Orion Seafood International).

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Gulf of Maine Lobster Fishery Rethinks Its Future

From: Pat White & Erin Peletier

In the Gulf of Maine the American lobster (*Homarus americanus*) fishery has long been the economic engine for coastal communities. But in the past few years the industry has been plagued by soaring costs of fuel and bait, as well as the added burden of Federal regulations to protect whales against entanglement in fixed gear. Then in late 2008 lobster prices plummeted from the drop in demand brought on by the world financial crisis. Even the most experienced fishermen now find it challenging to make their business profitable. New ideas and approaches are needed to ensure the long-term sustainability of the lobster resource and its workforce.

From November 2008 to May 2009, the Gulf of Maine Lobster Foundation (GOMLF), in partnership with the Nicholas Institute for Environmental Policy at Duke University, is convening a dialogue on the future of the region's lobster industry. Through a series of workshops involving fishery managers, scientists, fishermen and other stakeholders, the team hopes first to develop a broader understanding of the challenges facing the industry, and from that a consensus on the next steps in lobster management.

In the workshops conducted to date, the most common concerns expressed were related to fishing effort, the economic crisis, the need for better data and whale regulations. Because business as usual is no longer profitable, there is widespread support to reduce fishing effort, to rethink the efficiencies within the industry, and how to maximize the profitability of each trap. There is also concern that the data available to inform and manage the fishery is inadequate, and that current monitoring programs will be cut as agency revenues shrink.

The GOMLF is preparing reports from each workshop that will be presented to the individual state marine resource agencies, as well as to the Atlantic States Marine Fisheries Commission, the consortium of state agencies that with the National Marine Fisheries Service is charged with managing the US east coast's lobster fishery. The reports will highlight and evaluate the strengths and weaknesses of the options available. Expectations are that this compilation will be a critical tool for industry, managers and scientists as they develop a strategy for the next decade.

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