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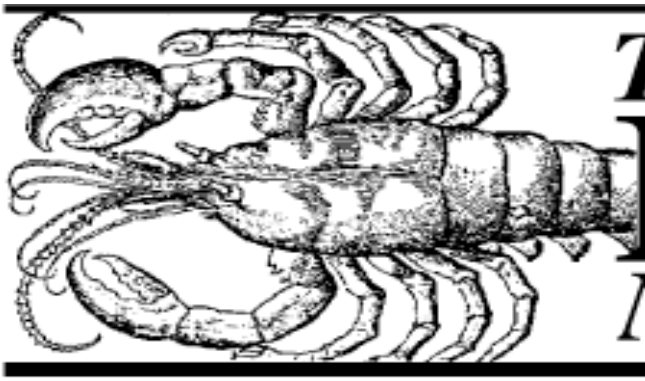

The Lobster NEWSLETTER

ANNOUNCEMENTS

Conference

10th International Conference and Workshop on Lobster Biology and Management

Lobsters in a Changing Climate

10th ICWL
Cancún, México
May 18-23, 2014

May 18–23, 2014
Cancún, México
Iberostar Cancun Hotel

Celebrate the 10th edition of the largest international event on lobster research and management! Participants from all disciplines of lobster research and management from all over the world are welcome.

Contributions in English on any topic pertaining to all kinds of lobsters (shallow- or deep-water; scampi, clawed, spiny, or slipper lobsters) that are of scientific or management interest will be considered.

Convener:
Instituto de Ciencias del Mar y Limnología, UNAM
Coordinators:
Patricia Briones-Fourzán and Enrique Lozano-Álvarez

http://www.dmc-cancun.com/icwl2014
(*web page will become operational in early May 2013)

If you are not yet in the mail list, send us a message to: icwl2014@gmail.com

For more information on registration, please contact
Patricia Briones-Fourzán/Enrique Lozano-Álvarez, Conveners, 10th ICWL.
E-mail: icwl2014@gmail.com

New Book Release

Call for Information

Lobsters in Antiquity: Their history, utilization, and research by early civilizations and people

INFORMATION NEEDED regarding the history and utilization of lobsters by humans including the early research history of lobsters. We kindly request information, publications, reports (preferably in English) and contacts with research scholars of other disciplines (archaeologists, pre-historians, historians, anthropologists, etc.). We are looking for evidence of how early humans utilized lobsters of any species from ancient times up to the first half of the 20th century. We will accept and appreciate any and all materials including articles, citations, pictures and drawings as well as email addresses of those who may be able to help.

Please email all materials to Ehud Spanier: spanier@research.haifa.ac.il, Kari Lavalli: klavalli@yahoo.com, or Jason Goldstein: jsh5@wildcats.unh.edu.

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Obituary: Dr. Jiro Kittaka

Dr. Jiro Kittaka when researching actively and serving as a dean of Kitasato University in Sanriku from 1988-1992.

Dr. Jiro Kittaka, the world authority on aquaculture of crustacean larva, especially the phyllosoma of spiny lobsters, passed away from a ruptured aortic aneurysm in Chiba Japan, on March 24, 2013 at the age of 84.

Dr. Kittaka was born on December 21, 1928. After graduation from the University of Tokyo in 1951, he served in Kyoto Prefectural Fisheries Experimental Station and Kobe University, being involved in the study of fish production in brackish waters. This work later brought him his Ph. D. from the University of Tokyo. In 1960, he joined a company for Kuruma prawn (*Marsupenaeus*) farming in Kagawa, newly founded by Dr. Motosaku Hudinaga, a famous pioneer in prawn culture. After research for years at prawn farms in Yamaguchi, Kagoshima in Japan and Panama City, FL in USA, he became a Professor of Kitasato University in Sanriku, Iwate in 1974, later a dean (1988-1992) and then an Emeritus Professor of Kitasato University. He transferred to the Research Institute for Marine Biological Science of Tokyo University of Science and Nemuro City Fisheries Research Institute in 1994. After retirement, because of an accidental injury in a fall at work in 2005, he served as an advisor to Nemuro City.

Dr. Kittaka's hard work under Dr. Hudinaga led to a great success in mass production of Kuruma prawn, setting the scene for worldwide prawn culture. In Sanriku, he successfully bred *Homarus* lobsters, and organized the overseas scientific surveys that finally led to phyllosomas of *Jasus* spiny lobsters being cultured to the puerulus stage. This world first gave him an international reputation. He cultured several spiny lobsters from egg to puerulus, *J. lalandii* 1988, *Palinurus elephas* 1988, *Panulirus japonicus* 1989, *Sagmariasus verreauxi* 1997, and *J. edwardsii* 2005. In recognition of his achievements, he was honored with the drawing of the final stage of *Jasus* phyllosoma at the 2004 Hobart conference dinner (7th ICWL). He had most recently been working towards mass production of *Paralithodes* crabs in Nemuro, and, with other researchers, had shown that the glaucothoe was a non-feeding stage like the puerulus, of extreme importance to aquaculture.

Dr. Kittaka convened the 4th International Conference and Workshop on Lobster in Sanriku in 1993 (4th ICWL) and the Nemuro Workshop in 1995. He was an author as well as a co-editor of world-class books on lobsters. He also contributed to the Japanese Society of Fisheries Science (JSFS) as a convener for the autumn meeting in Sanriku and a Member of the Board of Directors. He received JSFS Award of Merit 1998, and had been an Honorary Member of JSFS since 2000.

Taking over an orthodox aquaculture from Dr. Hudinaga, Dr. Kittaka's life had been dedicated to aquaculture. By all means I would like to express my sincere condolence and introduce words from Dr. John Booth of New Zealand, a world authority on spiny lobsters. *"As a pioneer in the world of spiny lobster aquaculture no name stands above that of Jiro Kittaka. Working at Sanriku in Iwate Prefecture towards the north of the main island Honshu, and later Nemuro in the north of Hokkaido, he was the first to grow any spiny lobster through its full larval development, to settlement. In the end he accomplished this for five species. The progress towards spiny lobster aquaculture worldwide owes him a great debt."*

May he rest in peace.

Yasuhiro Hayakawa
Former Professor, National Fisheries University, Japan

SYMPOSIUM REVIEW

For the American lobster fishery, 2012 may have gone down as the year that drove climate change home. The ocean heat wave that covered much of the North Atlantic and broke all the records triggered conflict between the US and Canadian sides of the fishery. The early molt brought on by warmer waters put a glut of US lobsters on the market well before the Canadian fishery closed for the season, and in turn, caused a price crash that even caught the attention of the Wall Street Journal: *"Lobster glut slams prices"* (WSJ online, 16 July, 2012). At the time, planning for this symposium was already well underway.

The story of the American lobster over the last two decades is one of striking contrasts. Just as lobster abundance in Maine, and parts of Maritime Canada, has climbed to historic highs in the wake of groundfish depletion, the fishery in southern New England has collapsed, plagued by disease and heat-induced mass mortality. Now Maine lobstermen are perilously dependent on this single fishery just as harvesters in Rhode Island have for the first time in history had to consider the prospect of a fishing moratorium.

The two-and-a-half-day symposium divided into four themes:

- Anthropogenic and Environmental Stressors,
- Foodweb Dynamics,
- Population Connectivity and Metapopulation Dynamics, and
- Coupled Human-Natural Systems and Ecosystem-based Management.

Some 150 academic and government scientists, students, resource managers and industry members attended the symposium. Theme sessions were introduced with plenary talks by leaders in the field, followed by 48 oral and 25 poster presentations. Guided discussion followed each session. For the full program and media highlights see: seagrant.umaine.edu/lobster-symposium. In the next four pages discussion moderators summarize their sessions.

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Session Summaries from the Symposium

Session 1: Anthropogenic & Environmental Stressors

Environmental stress is manifested in lobster by diseases and various pathologies. Crustacean pathologist, Jeffrey Shields (Virginia Institute of Marine Science) opened the session with the message that to understand the conditions promoting disease one must study the interactions between the environment, host, pathogen, and human activities (Fig. 1). Some 18 oral and 8 poster presentations elaborated on the topic.

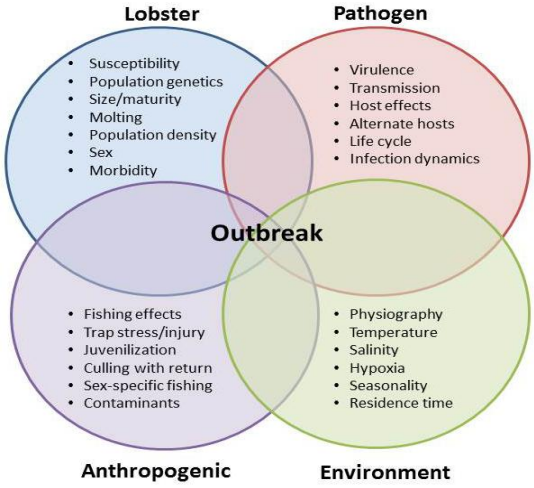

Figure 1. Interacting factors influencing the outbreak of marine diseases.

Much attention focused on how climate change affects lobster health. Warmer than average summers have caused mass mortalities and disease at the southern edge of the American lobster's range, just as lobster numbers have expanded in historically cooler regions in the north. Highly publicized and contrasting cases in point are the shell disease epizootic in southern New England, USA, and lobster "glut" in the eastern Gulf of Maine. Discussion also turned to the degradation of lobster habitat through water pollution, the accumulation of human debris, including ghost traps, and direct disturbance by fishing activity such as dredging and trawling.

Burning questions emerged:

- Are some lobsters more resistant to disease than others?
- How does fishing pressure affect the resilience of lobster populations to environmental change?
- How can fishermen observations be turned into a real-time data stream?
- Can lobster populations recover from mass mortality? At low numbers, is population reproductive performance compromised by sperm limitation?

Recommendations:

Presenters highlighted the need for more longitudinal studies of environmental change. Retrospective and prospective studies on climate change influences on lobster will allow us to define if anthropogenic or environmental changes make lobster stocks more vulnerable. A general epidemiological model for lobster diseases is needed to generate testable hypotheses and identify information gaps. This requires large scale ecological and laboratory based approaches that permit integration of information over the entire species' range. It also requires better integration with fishery managers to mitigate disease effects. Correlative data on other marine species in these areas may further improve understanding of ecosystem health. This means coordinating centers of scientific expertise between the US and Canada. Discussion defined the type of studies needed to predict, prevent or manage disease outbreaks.

- Standardized monitoring programs for all life stages including health and disease indicators, and a method to rapidly incorporate fishermen's observations and local knowledge.
- Rapid dissemination of survey data on trends/patterns of lobster abundance and disease prevalence .
- A better understanding of lobster immunity and the development of disease resistance.

- A lobster tissue bank to archive samples from different regions for retrospective studies.
- Physiological and functional genomics studies to evaluate host response to pathogens, contaminants and environmental conditions

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Session 2: Food web dynamics

Four themes emerged from the plenary talk by Bob Steneck, *Lobster dynamics in a brave new ocean*, and the six talks, three posters, and discussion that followed. These presentations drew a time line of human depletion of the top predators in the lobster ecosystem, the decimation of the groundfish assemblage in our lifetime perhaps being only the most recent. Many attribute the dramatic expansion of the lobster population in the Gulf of Maine and Atlantic Canada to the relaxation of predation pressure. Here, the four themes are captured from the discussion.

Theme 1: Can cod and lobster co-exist, or do we have to choose? Foodweb research has perhaps focused too much on Atlantic cod alone as a key-stone predator. Evidence is contradictory regarding the importance of cod dynamics as a top-down driver of the lobster surge. Future studies need to consider: (1) How body size changes in cod influence interactions with lobsters; (2) When and where lobster and cod overlap in habitat; and (3) Whether other species in the groundfish assemblage are more important lobster predators than cod, and (4) Whether climate change will alter predator species ranges, and in turn, their interaction with lobsters?

Theme 2: Lobsters and food web diversity. Low diversity ecosystems like the coastal Northwest Atlantic may be more vulnerable to boom and bust dynamics because losses of a single consumer species can have greater proportional impacts on their prey. Comparative trans-Atlantic studies of top-down mechanisms may help us understand the consequences of foodweb diversity for the population dynamics of the ecologically similar *Homarus* sibling species on opposite coasts, and could yield important insights needed to manage these food webs.

Theme 3: Density dependence and lobster population dynamics. With lobster populations so high in parts of their range, do crowding effects and density dependent feedbacks now occur? New evidence presented at the symposium suggests that surging lobster populations in the Gulf of Maine may result in lobsters consuming themselves. Stable isotope analysis is a promising technique that, along with more conventional methods such as stomach content analysis and *in situ* predation experiments, may help discern the relative contribution of different sources of food.

Theme 4: What do we need to be monitoring? It's important to assess the predator-prey interaction correctly. Just as we consider top-down drivers, we equally need to assess bottom-up processes and the degree to which resources limit lobster numbers. In particular, bottom up resources such as natural prey availability may be particularly important. These factors deserve further attention, especially in the context of climate change.

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Session 3: Lobster meta-population dynamics and connectivity

The "meta-population" is defined as a group of local sub-populations connected by dispersal. Connectivity is the exchange of individuals among sub-populations. Tagging studies, biophysical dispersal modeling, and population genetics are the tools to understand connectivity. The plenary talk by Lew Incze (UMaine) and contributed presentations set the stage for discussion over seven questions:

Question 1: Is knowledge of population genetic structure important to lobster management? Participants said yes, but there should be parallel ecological and genetic studies to cross-validate interpretations of connectivity. Recent advances in genomics now permit processing of thousands of genetic markers that could substantially improve resolution of population genetic structure. A mismatch between the spatial scale of genetic structure and management is likely, but the population response to fishing pressure may be more relevant to management.

Question 2: How is the concept of meta-population dynamics applied in management? Literature suggests stock resilience to fishing pressure may be enhanced by an external subsidy of recruits from other areas. However, fishermen may not support particular conservation measures if the benefit goes to neighboring areas more than their own. Redefining management boundaries might be prudent in such cases.

Question 3: What types of data are most important? Genetics, dispersal modeling, tracking movements are all important, but hard to prioritize. Pelagic larval transport has largely been understood through modeling, but adult movements have been studied by tagging. It's more important now to integrate approaches among areas of expertise.

Question 4: What spatial and temporal scales are most relevant? A hierarchy of integrated spatial scales is called for, but the smallest scales may not be relevant to fishery management. Growing evidence suggests lobsters may "self-recruit" at scales smaller than expected. That requires a better understanding of near-shore processes, cross-shore currents and larval vertical migration, and in turn the relevance to stock definition.

Question 5: Where are the knowledge gaps? Quantitative estimates of connectivity over the species range are still lacking. Incorporating postlarval behavior in dispersal models could improve connectivity estimates. These need to be validated against field data. A new class of genetic markers, Single Nucleotide Polymorphisms, could provide greater resolution to predict the location or persistence of population barriers. Finally, policy development could better align biological population boundaries with management boundaries, even at an international scale.

Question 6: Is it important to know what environmental factors shape population structure? Some sub-populations may be locally adapted to disease, heat, and pollutants. Population and functional genomics studies that evaluate gene expression in response to changes in the environment could be enlightening.

Question 7: Does fishing pressure affect our ability to apply these concepts to manage the fishery? Yes. Size- and sex-specific harvesting can be important selective forces shaping the genetic structure of lobster populations and need to be better understood.

Conclusions: The meta-population concept is relevant to American lobster conservation. New population genomics methods coupled with larger scale pelagic and benthic dispersal modeling, all verified by field and lab studies, will be important to a refined view of lobster population structure and local adaptation in a fast-changing environment.

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Session 4: Human-Natural Systems & Ecosystem-Based Management

Mike Fogarty's (National Marine Fisheries Service) plenary talk underscored the need for ecosystem-based management: "*management frameworks that ignore biological interactions, environmental/climate change, and the social and economic context cannot fully capture the relevant dimensions necessary for effective lobster management.*" Twelve contributed talks and five posters added fuel for discussion. Northern and southern segments of the lobster fishery may be walking diverging paths. But both face new economic challenges, the former because of a glut in supply, the latter because of recruitment failure. Uncertainties over the future of the fishery stem in part from uncertainties over climate change impacts, the internal dynamics of the population (disease, etc.) and in part from the volatility of a global economy.

In the Gulf of Maine's new "lobster-dominated ecosystem," the old rules no longer seem to apply. The restraints that worked so well in a world of scarcity are not so clearly beneficial in a world of super-abundant lobsters. Fishermen now question long-standing measures to protect egg-bearing females simply because there are 'too many;' territoriality over ideal lobster habitat has softened because lobsters have moved out to previously unsuitable expanses of shelterless mud habitat because predatory groundfish are now so depleted.

Different regional responses of lobsters to a warming climate and new studies showing self-recruitment at a finer scale than previously assumed, both point to the possible need for management responses at less than a state-wide scale, e.g., what might be appropriate in eastern Maine may not be appropriate in western Maine.

One big question is how fishermen and managers might prepare for the surprise that everyone expects but can't predict. The unexpected price collapses in 2008 and 2012 were caused by very different conditions: one rooted in global economics, the other a market surplus rooted in biology and ecology. In both cases though fishermen had only two choices: either stop fishing or fish harder. It comes down to supply and demand: When the price is low, putting more lobster into the supply chain only makes sense if the cost of its production is very low. Consequently, in places where lobsters were abundant fishermen fished harder; where they were not, there was little choice but to stop fishing and switch to something more profitable. It is possible that a uniform coastwise coordinated response may have helped the economics of the fishery, but in both 2008 and 2012 the uncoordinated response produced a result that was tailored to the circumstances of each area and fisherman with no obvious conservation consequences.

While there was strong support for long-standing conservation measures, the need was also expressed to think outside the box. Ecosystem-based management may offer a flexible and adaptive strategy to manage the lobster fisheries' response to shifts in the distribution and abundance of lobsters and the vagaries of the economy. It's clear that fishing smarter under EBM requires tracking the key ecological and economic drivers of the fishery. It is also clear that EBM is a daunting information-intensive undertaking. How to implement it remains one of the central challenges of the decade.

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RESEARCH NEWS

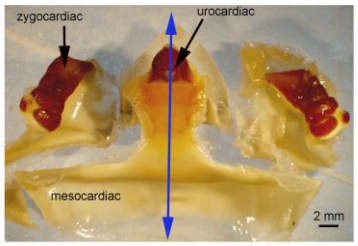
Direct method to determine the age in crustaceans

From: Raouf Kilada

The detection and measurement of annual growth bands preserved in calcified structures underlies the assessment and management of exploited fish populations around the world. However, the estimation of growth, mortality, and other age-structured processes in crustaceans has been severely limited by the apparent absence of permanent growth structures. In 2012, a Canadian team started looking into the cuticle of the eyestalk and gastric mill of four decapod species. The team worked on investigating the potential of the detection of growth bands in calcified regions of the eyestalk or gastric mill in shrimps, crabs, and lobsters. Finally, the work was concluded and published (Kilada et al. 2012).

Throughout the course of the project that lasted for almost four years, the team compared growth band (Fig. 1) counts with reliable, independent estimates of age. The results strongly suggest that the bands form annually, thus providing a direct and accurate method of age determination in all of the species examined. The team also used chemical tags in the lobster cuticle and found that the chemical marks were retained through one or two molts that occurred over the duration of an experiment, as apparently was the mesocardiac ossicle containing the growth bands in the gastric mill. Sex-specific growth curves were readily developed from growth band examination in multiple species, suggesting that routine measurement of growth and mortality in decapod crustaceans may now be possible.

The technique has proven to be applicable on crustaceans from Chile and west Australia. This may hopefully lead to a joint collaboration with different scientists from various places.



Whole gastric mill ossicles blue arrow indicating the cutting axis

Longitudinal Section (120 µm) in the mesocardiac ossicle showing the growth bands (red dots)

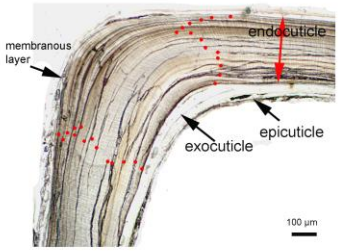


Figure 1. The gastric mill ossicles (whole and thin section) in the American lobster (*Homarus americanus*)

Literature cited:

Raouf Kilada, Bernard Sainte-Marie, Rémy Rochette, Neill Davis, Caroline Vanier, And Steven Campana (2012). Direct determination of age in shrimps, crabs, and lobsters. Can. J. Fish. Aquat. Sci. 69: 1728–1733

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European lobster thrive in Norwegian MPAs: new study demonstrate benefits of small scale protection

From: Even Moland

In 2006, MPAs (0.5 – 1 km²) were implemented along the Norwegian Skagerrak coast offering complete protection to shellfish and partial protection to fish through a ban on all types of standing gear (nets, traps, pots) including long line (Fig. 1). The MPAs were established, based on consultations with local commercial fishers, to generate knowledge on the development of lobster populations in areas unaffected by extractive fishing. This experimental management action was motivated by the perception of the Norwegian lobster stock as greatly reduced since the late 1950s, with little signs of recovery in the past 30 years. This situation, as reflected in catch-per-unit-effort (CPUE) statistics from the last nine decades (Fig. 2), led to the inclusion of

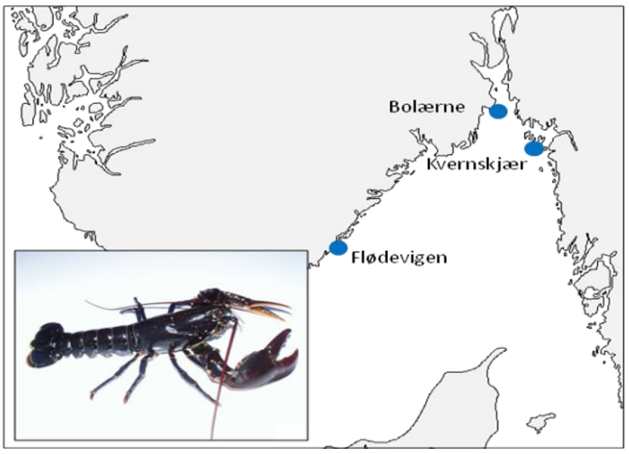

Figure 1. Location of three MPAs/ lobster reserves (blue dots) established in 2006 on the Norwegian Skagerrak coast. Development of lobster populations inside and outside of the three areas is monitored by the Norwegian Institute of Marine Research (IMR).

European lobster in the Norwegian red list for species, with status as near threatened (NT), according to the International Union for Conservation of Nature (IUCN) criteria in 2006, and again in 2010. Landings data show a similar pattern but their usefulness is debated due to the complexity of a fishery dominated by recreational participants (≈ 65 % of total effort) with no obligation to report landings.

Although there might be ample reason for concern, the resilient species is far from extinction and most areas sustain seemingly viable populations of lobster. A recent study (Kleiven et al. 2012, see *Related reading*, below) suggested that only a quarter (24 %) of lobster

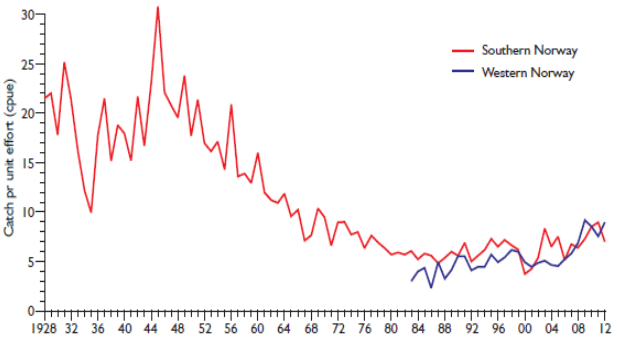

Figure 2. Catch-per-unit-effort (lobsters per 100 traps day^{-1}) of European lobster as reported by selected fishers to the Norwegian Institute of Marine Research during the period from 1928 – 2012.

landed commercially are sold through the legal market and thus documented. The same study estimated that total landings (commercial and recreational) may be 14 times higher than reported officially. A number of new management measures were recently introduced in an effort to turn the trend. As of 2008, lobsters are legally caught during a two month season (1 October – 30 November), when greater than or equal to 25 cm total length (minimum legal size, ≈ 90 mm carapace length) in traps fitted with two circular escape vents measuring 60 mm in diameter. A trade and landings ban on egg-bearing females was also introduced in 2008 and effort was limited to 10 and 100 traps for recreational and commercial participants, respectively.

An annual standardized research trapping survey, including capture–mark–recapture, was conducted by the Norwegian Institute of Marine Research (IMR) inside three proposed MPAs during three consecutive years prior to protection (2004–2006). In 2006, in the last sampling season prior to implementation of the MPAs, adjacent control areas were designated and included in the survey. Thus, as of 2006, the assessment programme was designed as a before–after control-impact paired series approach. The results from the long term BACI monitoring study were recently published in Proceedings of the Royal Society B (doi:10.1098/rspb.2012.2679, open access). The study represents one of the northernmost documentations of MPA effects to date.

By 2010, European lobster CPUE had increased by 245 % (≈ 3.5 times) in MPAs, whereas CPUE in control areas had increased by 87 % (Fig. 3). Mean size of lobster increased by 13 % in MPAs whereas changes in control areas were negligible. The mean increase in body size in MPAs is indicative of an ongoing recovery of the age and size structure. This, in turn, is likely to benefit the reproductive potential within the MPAs as fecundity increases, and egg size variability decreases with female body size (larger females = larger and more evenly sized eggs, see Moland et al. 2010, *Related reading* below). Our study, in combination with results from the Lundy Island no-take zone in southern UK (Hoskin et al. 2011, see *Related reading* below), demonstrate that MPAs can be useful management tools in rebuilding and conserving portions of depleted European lobster populations throughout the species range.

Establishment of the MPAs, in which lobster was the primary target species for protection and research, spurred renewed research efforts and saw the creation of an active lobster research team at the IMR Flødevigen Marine Research station. In light of the MPA-monitoring it was timely to address research questions pertaining to home range and site requirements. Telemetry and data storage tag studies in two of the MPAs indicated that though small in size the MPAs might offer

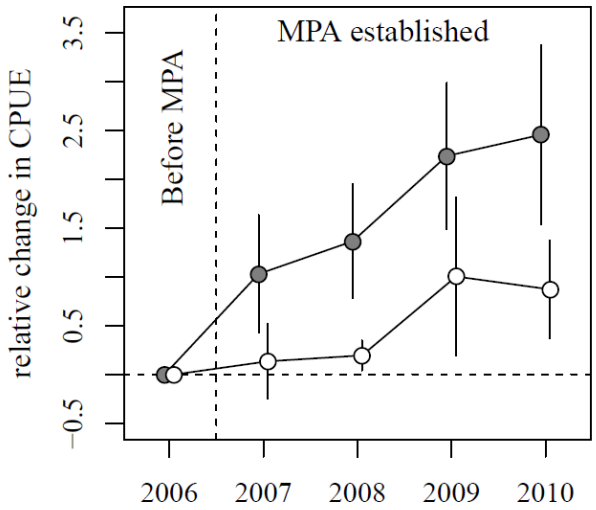

Figure 3. Mean relative change in lobsters per trap (catch-per-unit-effort, CPUE) in MPAs (grey) and control areas (white) after MPA designation. Error bars are ± standard error. For more information, see Moland et al. 2013 (in *Related reading*, below).

sufficient space, but also suggested that movement across boundaries will occur when these intersect patches of habitat preferred by the species, and, that deeper habitat should be included to ensure long term protection.

Next steps in direct relation to the MPAs and lobster are a recently funded project in which we will quantify spill-over into adjacent fished areas. This work will base itself on tag recoveries and reports from fishers (all lobsters caught in the ongoing long term monitoring are individually marked with T-bar tags), and on our own experimental trapping work. Egg samples have been collected from ovigerous females in MPAs and control areas since 2007, and ongoing work includes a study to compare to what degree maternal effects on offspring size is realized in protected versus harvested states. As the frosting on the cake, an exciting PhD project looking at multiple paternity and sexual dynamics of protected versus harvested lobster populations is well under way.

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RELATED READING

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Effect of effort reductions on the economic performance of the western rock lobster fishery of Western Australia

From Nick Caputi, Simon de Lestang, Chris Reid, Alex Hesp, Jason How and Peter Stephenson

The western rock lobster fishery was one of the first to be made limited entry with the number licences limited since 1963. Historically the main focus of the assessment and management of the fishery has been on the status of the breeding stock to ensure biological sustainability. However the commercial fishery has been facing significant economic pressure from increasing costs and lower prices for lobsters as well as reduced catches as a result of low recruitment.

A preliminary assessment of the maximum economic yield (MEY) was undertaken to assess management options to optimize profits. The objective of the analysis was to estimate the level of effort in each Zone of the fishery that would maximise the net present value (NPV) of profits over the period 2008/09 to 2013/14. This was done by estimating the difference between the predicted NPV of profits under a range of effort levels and the predicted NPV of profits under 2007/08 effort levels over the specified period using a discount rate of 10% per annum. A conservative assumption was made that prices would be maintained at $27/kg and perfectly inelastic, i.e. that changes in catch levels would not cause changes to the price received. Predicted vessel numbers were assumed proportional to effort but that the number of vessels would take three years to be reduced by a level commensurate with the effort reduction. Stock assessment modelling

undertaken in October 2008 estimated future catches using a level of recruitment that was based on puerulus settlement and under effort levels between 10–100% of that observed for the 2007/08 season. It takes about 3-4 years for the puerulus to recruit to the fishery.

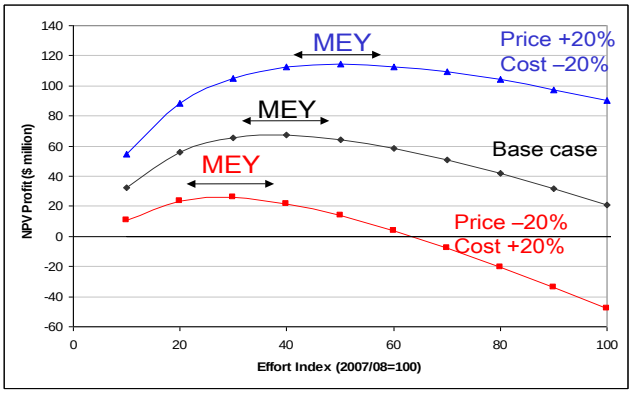

Figure 1: A sensitivity analysis NPV of profit for the MEY assessment showing the combined effect of a 20% increase in costs and 20% decrease in prices and the effect of a cost decrease by 20% and prices increased by 20% of 2007/08 levels.

The MEY assessment showed that that the level of effort (pot lifts) associated with MEY was in the order of 30 to 50% of 2007/08 effort levels. A sensitivity analysis assessing the effect of 20% increases in costs and 20% decreases in prices showed that optimum effort reduces to 20-40% of 2007/08 levels. However if costs decreased by 20% and prices increased by 20% then optimum effort increases to 40-60% of 2007/08 levels (Fig. 1). This indicates that effort decreases at about 40% of 2007/08 effort levels are reasonably robust as an optimum level of fishing under reasonable variations in costs and prices.

As a result of persistent low puerulus settlements, including the lowest settlement in 40 years, substantial changes were made to the management of the fishery for the 2008/09 and 2009/10 seasons in order to reduce catch levels in the fishery and maintain breeding stock at sustainable levels. This has resulted in a significant carryover of legal lobsters into future years when lower recruitments to the fishery are expected. The management measures introduced led to a 44 and 73% reduction in nominal fishing effort in the 2008/09 and 2009/10 seasons, respectively, compared with the 2007/08 season. The reductions were at a level consistent with the maximum economic yield. This also provided a unique opportunity to assess the effect of a fishery moving to an MEY level of management within two years. In 2010/11 the fishery introduced individual catch limits on the fishery with an overall catch quota of 5,500 t and this resulted in 71% effort reduction relative to 2007/08.

The catch rate increased from 1.1 kg/potlift in 2007/08 to 1.7 and 2.7 kg/potlift in 2008/09 and 2009/10, respectively (Fig. 2). These increases were much higher than the levels expected (1.2 and 1.1 kg/potlift, respectively) if the 2007/08 effort had been maintained for the two years. The catch rate under catch quota in

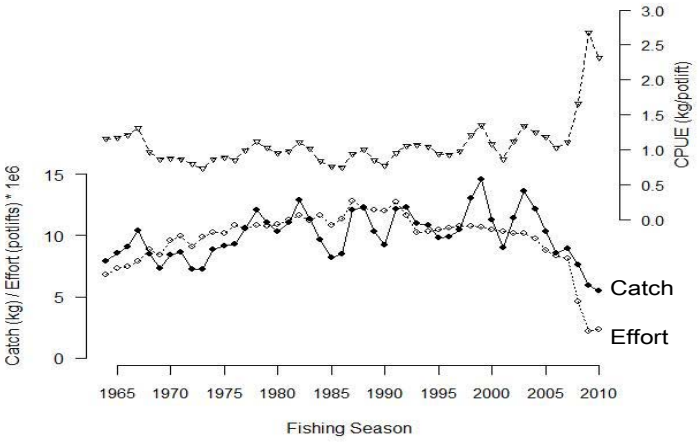

Figure 2: Catch, effort and CPUE showing the effect of the effort reductions in the last three years (2008/09 to 2010/11) on the CPUE.

For the whole fishery the actual reductions in fishery revenue ($30-40 million) were much less than expected ($67-85 million), mainly due to the higher prices than those that would have been received at catch levels associated with a maintenance of 2007/08 effort levels (Table 1). These price changes were not taken into consideration in predicting fishery revenues in the MEY assessment. The reduction in revenue in 2010/11 is expected to be less than $30 million as higher prices were also achieved as a

result of moving to quota as fishers were able to high grade and target their fishing during periods of higher prices.

The vessel numbers declined by 14% (395 vessels) and 36% (294 vessels) in 2008/09 and 2009/10, respectively, compared to 460 vessels in 2007/08. A significant reduction in fishery costs of $44 and $91 million was achieved over the first two years (Table 1). The cost decline of greater than $90 million is expected for 2010/11 season as the effort was similar to 2009/10 but there was a further reduction in vessel numbers (279) and bait usage was also reduced.

Table 1: Difference in fishery revenue, costs and profits ($ millions) and predicted revenue, costs and profits compared to that under maintaining 2007/08 effort.

Year	Revenue decline ($m)	Cost decline ($m)	Change 'Profit' ($m)
2008/09	31	44	+13
2009/10	42	91	+49
2010/11 (ITQ)	<30	>90	>60

The fishery profit is estimated to have increased by $13 and $49 million for 2008/09 and 2009/10, respectively, compared to that under 2007/08 effort levels and is greater than predicted profits (Table 1). This contrasts with the prediction that profits would be lower in 2008/09 ($12 million) than predicted profits under 2007/08 effort levels. The driver of the greater than predicted increase in profitability was a less than predicted catch decline and higher prices associated with reduced catch levels. A profit increase of greater than $60 million is expected for the 2010/11 season compared to that expected under continued 2007/08 effort level.

An assessment of the relationship between lobster prices and catch resulted in a significant negative relationship. If this relationship is taken into account in the MEY assessment then the MEY level of effort would be about 20-40% of 2007/08 effort compared to 30-50% estimated using constant prices (Fig. 3).

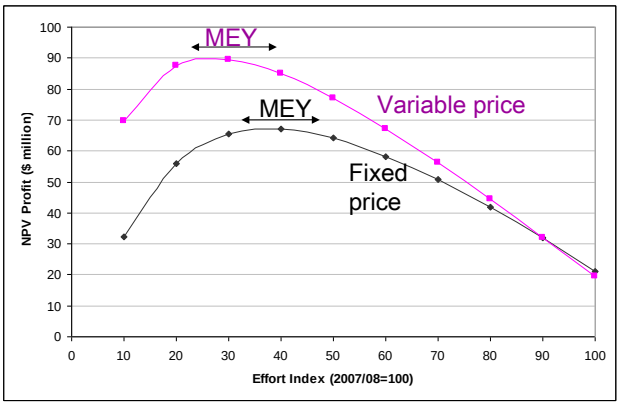

Figure 3: The comparison between the MEY assessment assuming a fixed lobster price with that for a variable price based on the price-catch relationship.

This assessment has demonstrated the benefits of reducing fishing effort to a level close to MEY under an input and output control management regime. The decision rule framework for the management of the fishery is currently based on having the egg production above a threshold level that enables the fishery to be managed sustainably. However the MEY assessment has been undertaken to help develop a target reference point that takes into account the economic returns. Industry consultations have been occurring about the development of a target reference point that has been informed by the MEY assessment.

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Case report of a cuticular neoplasm on the abdomen of *Homarus americanus*

From Jeffrey D. Shields & Hamish J. Small

In September, 2012, we were notified by Kathleen Reardon, Maine Dept. Natural Resources, that a commercial fisher from Stonington, ME, had landed a lobster with an unusual tumor on the abdomen. The lobster was shipped to VIMS by overnight express and arrived in good condition. The lobster was a mature, nonovigerous female, 83.1 mm CL. A large, rugose, bright blue "tumor" projected laterally from the first abdominal somite (Fig. 1AB). The tumor was 25.2 mm in breadth, 16.3 mm high, and appeared to have a basal attachment area of approximately 6.0 mm. The tumor arose directly from the abdomen, with a slight deformation of the left, posterior cephalothorax adjacent to the affected somite. There was no apparent disruption to the cuticle around the abdomen other than the area affected. The tumor was hard to the touch, not flexible, and had a cauliflower-like appearance (Fig. 1CD). Three small bivalve larvae (spat) were located within the folds of the tumor.

The lobster was assigned identification number ME040 as part of a larger series of animals from Maine. After examining a hemolymph smear, and saving hemolymph in various buffers, the animal was killed by injection of ice-cold saturated KCl, then dissected, with various tissues fixed in Z-Fix fixative for 48 hrs. Tissues were processed through routine histological procedures, cut at 5-6 um, and stained with Mayer's H&E. Hard structures were decalcified in an EDTA-citric acid solution prior to processing.

Gross examination of cross sections of the tumor (Fig. 1E) indicated that it was comprised internally of fibrous connective tissues. While sinuous, the cuticle appears relatively normal with the exception that certain regions have little epicuticle present (not shown). Histologically, the underlying epidermis is primarily comprised of secretory columnar epithelial cells overlying a stroma of fibrous connective tissue with scattered muscle fibers and no tegmental glands (Fig. 1F-H).

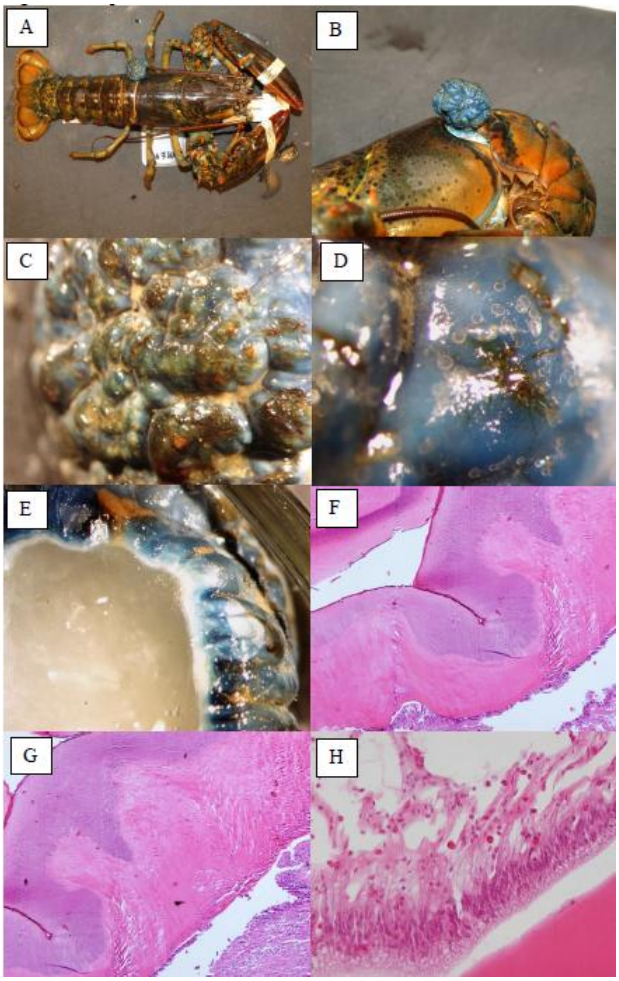

Figure 1. Neoplasm on the abdomen of an adult female lobster.

We tentatively identify the tumor as a benign, papilliform neoplasm, in the inclusive sense, as an abnormal mass of tissue arising from an abnormal proliferation of cells. The extensive rescaffolding of fibrous connective tissue and the occurrence of secretory epithelia indicate that the neoplasia was likely induced by injury. We speculate that the tumor arose as the response to bleeding or a wound to the

abdominal somite, possibly occurring near ecdysis. If the lesion arose peri-ecdysis, then the rugose, cauliflower-like nature of the tumor may be due to unfolding of new cuticle and epidermis as it projected outward from the wound. The animal would have survived molting, because the lesion was adjacent to the softer arthrodial membrane separating the abdomen from the cephalothorax.

Three cases of neoplasms have been reported from crustaceans, and all three have been described from shrimp (see Brock & Lightner 1990, for review). The lobster case is similar to one reported from *Penaeus aztecus* by Sparks and Lightner (1973) in which a cauliflower-like lesion was observed on the 6th abdominal somite. The histology of the neoplasm in shrimp is strikingly similar to that observed here.

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FURTHER READING

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Maine Lobster Fishery Awarded Prestigious International Certification

From Maine Department of Marine Resources, USA

Governor Paul R. LePage announced Sunday [10 March 2013] that the iconic Maine lobster fishery has received the prestigious international Marine Stewardship Council's Sustainable Seafood Certification.

MSC certification recognizes ecologically sound practices, from the harvest through delivery to consumer. Certification provides a competitive advantage in marketing to the growing number of retailers and consumers around the world who place a premium on seafood harvested in an environmentally responsible, sustainable manner.

The Governor made the announcement at the Shucks Maine Lobster booth at the International Boston Seafood Show. "The Marine Stewardship Council's certification will provide the Maine lobster industry with a globally-recognized seal of approval," said the Governor. "This certification recognizes our longstanding practices of good stewardship and ensures that every lobster caught in Maine waters can be marketed not only as delicious, healthy food, but also as a resource that meets the most stringent international environmental standard for seafood sustainability."

Efforts to support marketing for the Maine lobster have received widespread support in the wake of last season when supply exceeded demand, resulting in the lowest per pound prices in over twenty years. "This places greater emphasis on the need for effective marketing and highlights the unique marketing advantage MSC certification provides," said Governor LePage.

The Marine Stewardship Council is the premier international certification program for wild-capture fisheries. MSC certification is the only seafood certification program that meets all the major international standards on sustainable fishing, ecosystem protection, and eco-labeling. Currently, more than 100 fisheries worldwide are MSC certified.

To achieve MSC certification, fisheries are assessed based on a rigorous set of standards that include the health of the fish stock, marine ecosystem protection, and the effectiveness of fishery management. Within these core areas are 31 performance indicators used by accredited independent, third-party certification bodies to evaluate a fishery applying for certification.

The MSC certification program includes a process for tracing each certified lobster to its location of origin, Maine waters, which is key to protecting the Maine brand. "This global certification program will open new markets worldwide and just as important it will provide the means to trace our certified lobsters, no matter where in the world they end up, back to waters of Maine," said The Governor.

For more information on MSC certification for the Maine lobster fishery, contact John Hathaway, President of Shucks Maine Lobster, by phone at 207-329-1791 or by email at johnny@shucksmaine.com.

The Lobster NEWSLETTER

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