Today’s date: 6/10/09

Project number: R/CFR-11

Project title: Does sperm limitation take place in certain areas of the American lobster fishery and, if so, why?

Project initiation date: 2/1/2008

Principal investigator: Win Watson

Affiliation: Department of Biological Sciences

Associate investigator(s) and affiliation(s):

Technicians, industry partners, collaborators, etc. (specify which) and affiliations:
Kari Lavalli, Lecturer, Boston Univ.
Michael Clancy, Lecturer, BU

Brief project overview/Abstract:
Despite being one of the most productive and lucrative fisheries in the North Atlantic, there is continued concern that North American lobster stocks are overfished and that models used to predict fishery trends need to be recalibrated. Many of these models are based on a certain proportion of the sexually mature female lobsters contributing a large number of new recruits to the fishery each year. However, it is possible that the full reproductive potential of a portion of the sexually mature females is not being met, possibly due to skewed sex ratios and a paucity of large males. The overarching theme of this project is to determine if sperm limitation is becoming a factor in specific regions of the American lobster fishery and if so, what are some of the implications for lobster populations and the fishery that relies upon them. If sperm limitation is a factor, then we will determine if it is correlated with certain characteristics of the local populations, such as sex ratio and size differences between males and females. A final goal of this project will be to investigate one possible mechanism that might give rise to sperm limitation: the inability of small males to mate with significantly larger females.

Objectives:

1. Quantify the sex ratios and size differences between sexually mature male and female lobsters from at least 4 regions of the fishery.
2. Measure the percent of non-berried and berried females in each size class that are carrying sperm in the spring and fall of each year.
3. Determine the percentage of berried females in each region carrying fertilized eggs, as well as determining the percentage of eggs within a clutch that are fertilized.
4. Determine if small males are capable of: 1) mating with larger females and; 2) providing sufficient sperm to fertilize and entire brood
5. In the laboratory, determine if eggs that are not fertilized are carried for a shorter period of time than fertilized eggs.

Research findings/accomplishments/progress to date:

Although we have only worked on this project for one field season, we have made substantial progress towards meeting the objectives stated above. We were able to collect data from hundreds of lobsters in study sites ranging from offshore canyons to Rhode Island coastal waters. In each location we extracted the contents of the seminal receptacles to determine if females were carrying sperm and, in cases when eggs were not obviously fertilized, we removed some eggs to bring to the lab to determine if they had been fertilized. In order to obtain data from offshore populations, we conducted port sampling at a local offshore company and we obtained a permit so offshore lobstermen could bring us eggs samples.

One of our biggest concerns was making sure that our sperm sampling protocol was accurate. Because this technique is rarely used in the field, no precise method has ever been published and few control studies have been carried out to validate it. On three different occasions we sampled sperm from females, we examined the samples under a microscope to determine if the samples contained sperm, and then, if we no sperm were present, we dissected that female to confirm this assessment. This approach proved to be very useful and we are now quite confident in our sperm sampling protocol. We are now preparing a publication that describes the method in detail and provides some of our preliminary findings from both the field and the laboratory.

While we consistently found, as expected, that a portion of the females sampled in the field were not carrying spermatophores, we were somewhat surprised by three findings. First, a large number of small, potentially immature females were positive for spermatophores. Second, many of the largest females from the Georges Bank area contained spermatophores, even though the sex ratio there is very skewed toward females. Finally, a large proportion of berried females contained spermatophores, suggesting that female lobsters do not use all the sperm they carry to fertilize a clutch of eggs and therefore they could fertilized two clutches of eggs following one mating event. All of these data indicate that it would be very useful to reevaluate our view of the “normal” reproductive cycle of female lobsters.

In the laboratory we were able to continuously videotape male:female pairs from June-August in 2008. While this effort was successful, the number of successful matings was low, because we were having difficulty obtaining sufficient females that were ready to molt. We have plans to alleviate that problem in 2009. In total, we observed 13 mating events and all of these took place between lobsters that were of comparable sizes. On two occasions we also observed females lobsters mating while in the intermolt condition.

We also made progress developing a method for staining eggs to determine if they have been fertilized. This technique takes advantages of the properties of Hoechst stains, which interact with nucleic acids and thus stains nuclei. Eggs that have been fertilized and are developing have many nuclei that fluoresce bright blue, while unfertilized eggs have a single nucleus. This method should make it possible to process more samples obtained in the field both by our workers and commercial lobstermen.

The preliminary results we obtained during the first year of this project also made it possible to obtain a modest grant from SNECRI (Southern New England Collaborative Research Initiative). This proposal extends the work initiated as part of this Sea Grant
Proposal, to southern NE waters. The data obtained should very nicely complement our work in NH.

**Impacts to date** (Impacts are higher order, usually long-term results of a program’s activities that have significant scientific, economic or social benefits. Impacts may involve behavioral, policy or economic changes. Seminal contributions to science are considered impacts, especially if the research findings lead to major progress in a particular field, implementation of new technologies or have a substantive bearing on an economic or societal issue. While breakthroughs do occur, it is important to realize that impacts are developed over the long term—both in the scientific arena and through sustained, integrated efforts by Sea Grant programs themselves.):

This project has provided support and educational experiences to three graduate students and two undergraduates. One graduate student is basing her PhD thesis on this project. We have presented some of our preliminary data at regional stock assessment meetings and our data appear to have some impact on those decisions. However, it is early in the project and thus we are not fully prepared to present firm recommendations. The preliminary data we collected helped us to obtain additional funding from the Southern New England Collaborative Research Initiative. That project is titled: “The Buzzard’s Bay lobster resource: Are changes in reproduction having a negative impact on the fishery?” I am particularly proud of this grant, even though the amount awarded is relatively small, because proposals are reviewed by members of the industry. Thus, they consider our work to be of potential benefit to the lobster fishery as a whole.

**Patents:**

**Technology transfer** (Has a private company utilized this research successfully?):

**Related grants and contracts** (other grants and contracts that funded this research or that were obtained as a result of this research):

**Problems encountered:**

We have encountered three problems, both of which have been solved. First, we discovered that our original sperm sampling method may have given us false negatives in some instances. We spent the winter revising and testing our methods and now we are very confident in our results. We have also been working hard to develop a good staining method to detect eggs that are fertilized. This took most of the winter, but we are now confident in this method as well. Finally, the recent renovations of both JEL and CML have been very difficult to work around and this is delaying our progress this summer (2009).

**Publications to date** (please attach PDF if applicable): None.
Presentations to date, with published abstract citation if applicable:
This work is potentially quite controversial and, because one of our collaborators is associated directly with management, we are being very cautious with our public comments. We want to make sure our results are valid before presenting them. That said, we have a short paper in preparation and we are also going to present our preliminary data at a lobster meeting in September.

Students associated with project (for graduate students, please provide full name, thesis/dissertation title if the thesis/dissertation research was supported by N.H. Sea Grant, and degree being pursued; for undergraduates, please provide full name and major):

Jason Goldstein. PhD candidate. He will probably graduate in 2010. He has been involved in the project from the start, but it is not the focus of his thesis, which does not have a title yet.

Tracy Pugh, PhD candidate. Tracy just started and this will be the focus of her thesis. She does not have a thesis title yet.

Tom Langley, MA candidate. This is not the focus of his thesis, but he has been involved with the project and supported by the project.

Kirby Johnson. Undergraduate. Kirby is helping us develop the staining method.

Casey Tobin. Undergraduate. Casey is helping with lab work and data analysis this summer.

Haley White. Undergraduate. Haley is helping with the field work this summer.