THE SAN DIEGO SEA URCHIN PROJECT

The San Diego Watermen's Association

November 2008

The San Diego Sea Urchin Fishery as a model for the expansion of the role of Fishermen/Managers in science-based management and value-added marketing.

Work performed under State Coastal Conservancy Contract number 06-112

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Cover page from top left, clockwise

- Ricci del Mare appetizer, photo by Jim kinkade
- Dr. Shroeter explaining the layout of transects to Mitch Horbon, photo by Peter Halmay
- Ricci del Mare bisque, photo by Marcie Rothman
- Red Sea Urchin at 159 meter depth, photo by John Butler

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California's inshore fisheries, including the sea urchin fishery, are generally managed under data-poor or data-moderate conditions. Because of the sea urchin resource's spatial structure and the state's chronic budget problems, it is unlikely the status will change to data-rich anytime soon under the existing management system. This is especially true for the red sea urchin which has many sub-populations. These sub-populations have very different characteristics and may or may not be connected through larval interchange.

In this report, we present a scientifically sound model for community-based management of the sea urchin fishery. We, the San Diego Watermen's Association, believe that community-based management is the approach most likely to lead to the long-term sustainability and profitability of the fishery.

The sea urchin fishery is particularly suited to community-based, cooperative management, since the species is basically sedentary, spatially explicit and the fishery is small-scale. Ideally, the scale of management areas should be at the sub-population level centered around the ports.

For several years, divers in San Diego have been collecting data on sea urchins and sharing this data with scientists. This data provided the basis for a local stock assessment and has led us to conclude that stock assessments and management can and should be conducted at the sub-population scale. Our local data collection program, in fact, has been so successful we believe that it should be expanded to include more information from outside fishing grounds and other environmental conditions. Scientists have told us that an expanded data collection program would also make it possible to manage the fishery directly with real observational data used to monitor trends, as opposed to using a quantitative stock assessment model.

We recognize that community-based management requires social capital (an internal level of cooperation, goodwill and good-faith among its members) to work properly. We undertook to build such as part of this project. This is an ongoing task continuing beyond the project's timeline. At the rate of progress observed in the last year, however, we anticipate that the San Diego sea urchin diver community will be ready to take on some management duties by 2010.

We believe that funding for these activities, at least in part, should come from the fishery itself.

As part of this project, we also explored ways to change the fishery to achieve sustained profitability and self-funding for management. This work is preliminary and exploratory.

At this time, we have a strategy but not a detailed business plan. Our strategy is to figure out how to direct market live urchins to new markets, such as Mediterranean and seafood restaurants, through the development of cooperative harvesting, delivery, and management.

ACKNOWLEDGEMENTS

In spite of our stubborn nature, we received a great deal of support from a large number of people. This support was at times technical in nature and very often was just to validate our goals and encouragement to continue on our path to Community Based Management.

We would like to thank all of our friends at the Ocean Protection Council, and the Coastal Conservancy for awarding us the grant that allowed us to do this work.

Here is a list of the people who helped, if your name was omitted it was our error:

Ray Hilborn, Nicolas Gutierrez, Steve Schroeter, Ana Parma, Loo Botsford, Jeremy Prince, Pete Kalvass, Kristine Barsky, Kathryn Johnson, John Duffy, Michael Robinson, John Butler, Deanna Pinkard, Ken Franke, Kevin McAleese, Brent Haglund, Barrett Walker, Don Leal, Alex Echols, Tony D'Amato, Antonio Mure, Kazumi Yokoyama, Jason Ha, Marcie Rothman, Gerry Furth-Sides, Tara O'Leary, Susan Schlosser, Pamela Tom, Yoshi Mochizuki, Mike Dickerson, Christina Johnson, Greg Wells, Ben Gilbert, Michael DeAlessi, Kathryn Viatella, Celeste Benham, Chris Miller, Michael Weber, Al Ducheny, Jonathan Hardy, Henry Pontarelli.

Above all we would like to thank Mr. Naoyuki Tao who through his life work with the Japanese co-operative movement provided us with the inspiration.

Chapter A Stock Assessment and Review

Introduction

The goal of this project was to collect the data and determine the appropriateness of various statistical models in stock assessment. The purpose of the assessment was to determine the status of the Point Loma red sea urchin stock and the sustainability of the present harvest rates.

Additionally we attempted to determine if the metapopulation concept was useful in providing scientific guidance for management in a defined geographical area.

Summary

We found that it was not only feasible but desirable to adopt the metapopulation concept and to continue expanding local data collection protocols. Another important finding: Using sea urchin divers to help collect and manage the data is very cost and time effective. We believe that engaging sea urchin divers in data collection and management would make the management program affordable and sustainable for many years to come.

The assessment, which showed a stable CPUE in recent years, suggests that the fishery is sustainable and that continued monitoring of trends in species abundance and length frequency could be used as a basis for ongoing management.

The assessment also indicates that the existing data program should be expanded to include more information from outside fishing grounds, as well as more information on environmental parameters. In the future, when Pt. Loma-specific growth data and estimates of abundance outside fished areas become available, a statistical size-transition model may be applied to help manage the fishery.

The expansion of the data collection program also would make it possible to monitor trends in abundance without having to resort to a formal assessment model. If closed areas are established within what are now normally fished grounds, then the abundance and size distribution in the closed areas would need to be monitored as well. A management strategy and fishery tactics could be developed based on the monitoring of trends in abundance and size frequency rather than from statistical models.

Workshops

In preparation for the Stock Assessment, two workshops were held on July 14, 2006 and March 19, 2007. The purpose of these workshops was to collect all the pertinent data that would be used in the Stock Assessment. A total of 27 presenters, and guests, and 17 sea urchin divers attended the workshops. The data collected included fishery dependent data, and fishery independent data.

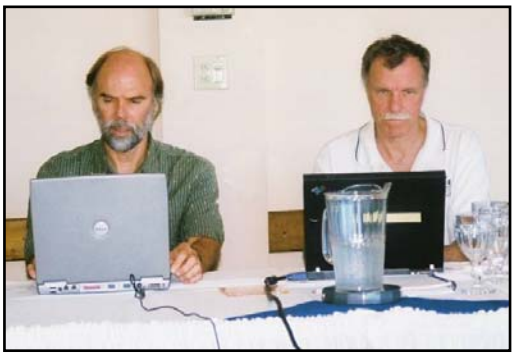


Figure I-A-1 From left: Steve Schroeter and Ray Hilborn at the Workshop

Figure I-A-2 From left: Chris Miller, Steve Schroeter, Nicolas Gutierrez, Ray Hilborn

We were very fortunate that in attendance at the workshops were several participants of the fishery and the Department of Fish and Game who were the pioneers in the San Diego Red Sea Urchin Fishery.

These participants were able to provide their experiential knowledge and to ground truth some of the historical data. The reports of these Workshops are presented in Appendix I-A-1 *"REPORT ON SEA URCHIN STOCK ASSESSMENT WORKSHOP July 14-16, 2006"* and Appendix I-A-2 *"REPORT ON SEA URCHIN STOCK ASSESSMENT WORKSHOP, March 19-20, 2007"*.

Stock Assessment

The goal was to conduct the first assessment for red sea urchins in this area, and one of the first assessments for sea urchins in California, by exploring a range of assessment tools, rather than selecting an individual assessment model.

Professor Hilborn explored alternative approaches to assessing the history of stock, surplus production, current stock size and exploitation rate in the Point Loma sea urchin fishery: All of the assessment approaches support the hypothesis that there are no major sustainability concerns for this stock at its current level of exploitation and productivity. The trend in CPUE suggests stable populations in recent years, and the length frequency data are mostly consistent with reasonably low fishing pressure.

This assessment suggests that the current status of this fishery is sustainable and that continued monitoring of trends in abundance and length frequency could be used as the basis for an ongoing management program. Thus the primary need at present is to obtain abundance samples from outside the fishing grounds, and to identify if there are large populations of cryptic individuals within the fishing grounds. Another high priority would be Point Loma specific studies of red sea urchin growth. We need to determine if growth increment data that are available are representative. Other data that need to be collected on an ongoing basis are length frequency of the catch, and kelp abundance.

The report also explored whether it would be feasible to create a spatially structured model that would be used in management. The report is presented in Appendix I-A-3 *"ASSESSMENT OF RED SEA URCHIN IN THE PT. LOMA KELP BEDS".*

Science Review

The San Diego Watermen's Association hosted a science review of the San Diego Red sea urchin stock assessment. There were two goals for this review: peer review the scientific basis for the stock assessment and to use an open review process as an education tool for researchers, Department of Fish and Game (CDFG) biologists, and members of the sea urchin industry.

Figure I-A-3 Science review panel from left at review table: Ray Hilborn, Nicolas Gutierrez, Steve Schroeter, Pete Kalvass, Jeremy Prince, Ana Parma, Loo Botsford, and Dave Datz

Agenda For June 14, 2007 Science Review

9 AM -10:15 AM San Diego red sea urchin stock assessment

- Overview of assessment
- Review of data
- Assessment approaches used

10:15 AM -10:30 AM Coffee break

10:30 AM-NOON

- What do we now know?
- Assessments in the future and data needs.

NOON-1:30 PM Sushi lunch at Driscoll's Wharf

1:30 PM-4:30 PM the human element

- Governance system (social capital, co-management)
- Field studies to test hypotheses (MPAs, rotating closures, max size, and quality improvements)
- How will science be used to inform management?
- Implications for Fishery management at the appropriate scale.
- The processor/diver dilemma (division of labor or co-management?)

4:30 PM-5PM Next steps

Science Review, *continued*

Professor Hilborn, Dr. Schroeter, and Nicolas Gutierrez presented the first Stock Assessment of the Red Sea Urchin Stocks in San Diego to a scientific review panel consisting of a world class panel of experts in the field of population dynamics; Dr. Jeremy Prince (committee chairman), Dr. Louis Botsford, and Dr. Ana Parma.

Nicolas Gutierrez presented an analysis of the barefoot ecologist data collected during the last three years. The usefulness of this data albeit with shortcomings in the area of sea urchin population density was clearly demonstrated.

The reviewers presented two separate reports. These reports were intended to be considered by the stock assessment panel and also to serve as guidance for future work by the San Diego Watermen's Association.

Figure I-A-4 Sushi on the Docks hosted by SDWA

These are presented in Appendix I-A-4 "*REVIEW OF THE ASSESSMENT OF RED SEA URCHIN IN THE PT. LOMA KELP BED-RECOMMENDATION FOR FUTURE ACTION FOR THE SAN DIEGO WATERMEN'S ASSOCIATION*" by Jeremy Prince, Louis Botsford; and Ana Parma and Appendix I-A-5 "*COMMENTS ON THE STOCK ASSESSMENT OF RED SEA URCHINS IN THE PT. LOMA KELP BEDS*" by Louis Botsford.

The goal of using the science review as an outreach and education tool proved a success when 37 guests from the CDFG, environmental organizations, academia (from Scripps and UCSB) as well as fishermen and their representatives attended the meeting. Many of those attending the meeting were there to learn whether this pilot project could be applied to other areas or other fisheries.

Chapter B Sea Urchin Density Calibration

Introduction

An important component of any Stock Assessment is an estimate of the population size. Red sea urchins have an extremely patchy distribution and to confound matters the sea urchins move. Density determinations have been estimated using various protocols for random transects. In this project we evaluate the various protocols by comparing the results to the actual density in areas that are large enough to represent the patchy nature of sea urchin populations. This important step is normally not performed for two reasons: It is very labor intensive and it has to be performed in a wide variety of habitats and densities.

Summary

We conducted seven calibration experiments under the direction of Dr. Steve Schroeter. We estimated not only precision but also accuracy. Whereas precision is normally assessed using repeated sample points, estimates of accuracy are not done because it requires sampling in locations where abundance is known without error. To determine this, an exhaustive counting of all sea urchins within an area must be done. In this work, this exhaustive counting was performed under various sea urchin concentration levels.

We compared three different sampling procedures; CDFG, SDWA-1, SDWA-2, and SDWA-3. The results of the calibration experiments indicate that SDWA-1 is roughly the equivalent of the method presently used by CDFG. The two other methods; SDWA-2 and SDWA-3 have been developed by an SDWA member (Dave Datz) and may prove to be far superior in precision and accuracy that the other methods.

SDWA-3 was developed some 10 years ago and used to develop harvest strategy by determining the rate of replenishment of areas subject to harvest. It utilizes a search pattern developed through experiential knowledge of harvesting. We recommend that further calibration of these two methods be performed to establish their accuracy and precision.

One of the key findings of this project is that commercial sea urchin divers are trained observers and should be an essential component of the data collection program. The number of surveys needed to determine the density with accuracy and precision are beyond the capability of Government agencies. The costs would be prohibitive given the small-scale nature of the fishery and the number of sea urchin sub-populations that exhibit largely differing characteristics.

We plan to work with the Department of Fish and Game to prepare a Memorandum of Understanding so that we may begin to more formally apply these protocols to monitor the status of the stocks.

Density Calibration

California Department of Fish and Game senior biologists, Pete Kalvass sent us a schematic showing where the transect should be placed according to CDFG protocols.

Members of SDWA performed the transects at all the sites under the direction of Dr. Schroeter. They also devised a method for outlining an area on the bottom so that the outline of the site would be accurate, and every red sea urchin inside the boundary would be counted. It was necessary to be very accurate to ensure that the red sea urchins counted actually were inside the area surveyed.

The results of the density calibration are presented in Appendix I-B-1 *"CALIBRATION OF SAMPLING PROTOCOLS USED TO ESTIMATE THE ABUNDANCE OF RED SEA URCHINS (STRONGYLOCENTROTUS FRANCISCANUS) IN THE POINT LOMA KELP BED"*.

Figure I-B-1 Dr. Schroeter explaining the layout of transects to Mitch Horbon.

Figure I-B-2 Shows the patchy distribution at site High D.

An Alternative Paradigm

In the collection of data, the accuracy, precision and cost should be considered. This can be represented by DPUE (Data Per Unit Effort). SDWA member Dave Datz has developed a survey methodology over the past 12 years using a search pattern developed through the experience gained in harvesting red sea urchins. These protocols are based on the idea that a sea urchin diver with 20 or more years of experience and over 10,000 dives is constantly making density assessments during each and every dive he makes. He evaluates the red sea urchin patch distribution and the number of sea urchins within a patch. Adapting these protocols and translating them into quantitative density determinations would lead to a very high DPUE.

The calibration surveys we have conducted, albeit preliminary in nature, seems to indicate that the protocol SDWA-3 appears to be more accurate, and precise than any random transect, at a far lower cost. The design of the software program to record this data shall be presented in a s supplementary report. We recommend that further calibration of SDWA-3 protocols be conducted in the future.

Chapter C Deep Water Surveys ROV

Introduction

As part of our data collection protocols, we measured the size of harvested red sea urchins in the fishing grounds. These measurements revealed that a large percentage of the catch in certain areas consisted of red sea urchins greater than 95mm. These areas are shown in Figure I-C-1 2005 Pt. Loma Urchin Average Proportion Large (top right).

The minimum size of the harvests is 83mm and the estimated maximum growth rate from studies conducted by Ebert, Schroeter and Dixon in the California Bight is 3mm/annum. At this rate, red sea urchins would avoid harvest for approximately four years past the minimum size when they became vulnerable to harvest. The summary of all the growth experiments is shown in Figure I-C-2 Red Sea Urchin Growth Experiments (bottom right).

There are four possible explanations for the occurrence of very large red sea urchins in the fishing grounds:

- Only a small proportion of the population is harvested each year
- Localized areas of extremely fast growth rates (>10mm/annum)
- Emergence from cryptic habitat
- Migration from outside the fishing grounds

In the peer review of the stock assessment, Dr. Botsford states "A second slightly different response that I have regards the apparent influx of large individuals into the population. That was regarded by Hilborn, et al as a good thing, as it was keeping the population at high levels. However, I would wonder

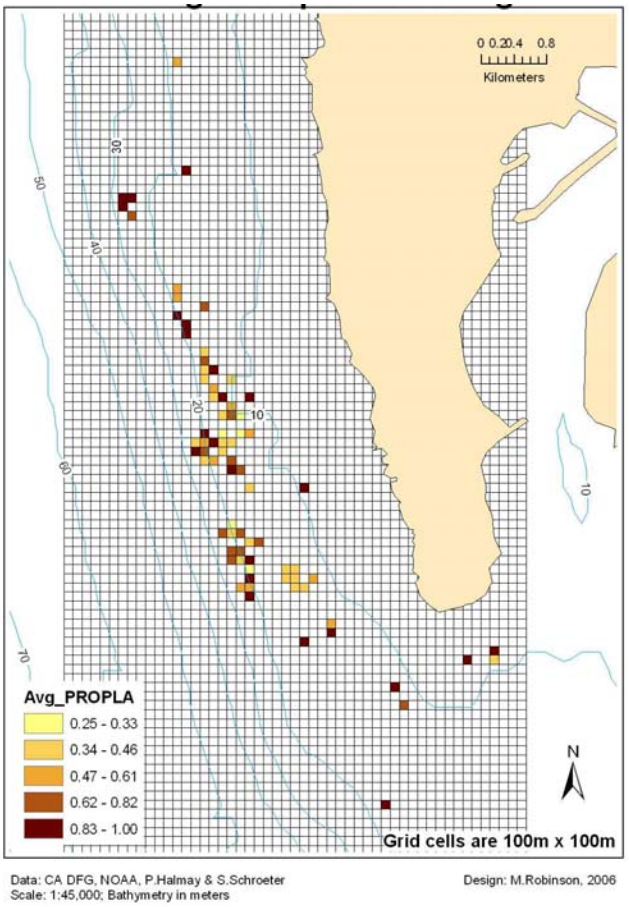


Figure I-C-1 (top) and **Figure I-C-2** (bottom)

where the large urchins are coming from, and what their dynamics are. I like the idea of more research on the source of those individuals and their dynamics. Ultimately the dynamics of that pool of unfishable, legal individuals needs to be included in the model. You need to estimate the abundance of the individuals too deep to be fished soon."

We decided to test the hypothesis that there were large sea urchins at depths greater than 90 feet that migrated into shallower water and then became vulnerable to harvests.

Summary

We trialed many different approaches to monitoring the abundance of red sea urchins in areas that are too deep to be fished. Initial surveys were done using the highly sophisticated (and expensive) ROV survey team of NOAA. This survey showed us the capability of this methodology and allowed us to get an idea of the extent of the hard bottom in deep water. There is a very large expanse of deep water hard substrate, and this equipment is prohibitively expensive for the small scale nature of the sea urchin fishery.

We encountered many difficulties with the side scan sonar surveys and surveys with a small ROV. Encounters with boat traffic and entanglement with lobster gear forced us to abandon the side scan surveys. The small Video-Ray ROV proved to be very difficult to maneuver in the ocean environment.

The drop camera seemed to hold the most promise. It could be handled without the use of mechanical equipment and up to 100 drops can be made during one day. The addition of laser beams to outline the area surveyed would enable us to obtain accurate density measurements over a very large area at a minimal cost.

NOAA ROV Survey

The NOAA ROV survey team was conducting surveys off San Diego looking for populations of white abalone (Butler et al 2006). Since the present habitat of the remnant population of white abalone is in depths greater than 90 feet, this overlapped with our search for red sea urchins at similar depths.

We persuaded the NOAA ROV team to search for red sea urchins during a one day cruise. Although this would in no way establish the size of the population in depths greater than 90 feet, it would provide us with insight as to the equipment needed and issues involving searching at these depths. The results of the NOAA survey are presented in Appendix I-C-1 "*OPTICAL SURVEYS USING A REMOTE OPERATED VEHICLE (ROV)*".

Exploratory Side Scan Sonar surveys

We contracted with Mr. Paul Brown to conduct side scan surveys in the area of the Ancient Sea Cliffs where the habitat was suitable for red sea urchins, and also to look for suitable habitat south of the San Diego shipping channel. Deployment of side scan sonar "fish" is shown in Figure I-C-3.

The surveys indicated a promise for this type of surveys prior to ROV surveys to locate suitable substrate. The "fish had to be towed at a distance of some 300 feet behind the boat, which caused interaction with the heavy boat traffic near the mouth of San Diego Bay. The surveys were abandoned since the "fish" also caused entanglement with lobster gear. This type of survey can only be performed during the closed season for fishing lobsters and away from where heavy boat traffic occurs.

Figure I-C-3 Deployment of the "Fish"

Drop Camera Surveys

SDWA developed a simple inexpensive method of obtaining a rough estimate of the sea urchin population in deep water. An underwater camera with a monitor was used. The camera was lowered to approximately 10 feet off the bottom and the number of red sea urchins in the field of view was counted. The results of these surveys shall be presented in a supplemental report.

Chapter D Software Development for Barefoot Ecologist Toolbox

The results of the Software Development shall be presented in a supplemental report.

Chapter A Governance Reform

Summary

During the past year, San Diego divers' mindset has changed from looking at a bleak future to one in which they are asking: "If I were in charge how would I do it?" In regularly scheduled meetings, they have begun to build social capital and to work together toward a common goal of creating a profitable, sustainable, locally managed fishery. This cannot be viewed as a completed task but as steps down a long road. We have taken steps to collect fisheries relevant data and ito begin cooperative ventures. We celebrate this progress. We have demonstrated that the long-held, old-school belief that organization requires central direction and coercion by external authorities is false. It is imperative that our efforts this year are sustained and championed by decision makers. Within two years, the building of our social capital likely will ripen and reach a plateau. Before or by 2010, a local governance system based on port cooperatives should be considered. This would allow divers to realize gains from their improved understanding of sea urchins, coordinated harvests and marketing.

Current Governance

The sea urchin fishery occurs entirely within California state waters and is managed under the authority of the California Fish and Game Commission (CFGC). Regulations and fishery management plans are developed by the California Department of Fish and Game (CDFG) with participation by stakeholders. These regulations and plans are presented to the CFGC in a series of open hearings for approval and adoption.

The approach for managing the fishery is top-down (Leal et al. 2008). The state sets the rules, including a minimum-size limit and annual fishing seasons. There is a statewide restricted-access plan with a capacity goal of 300 permits, but no limitation on the areas in which harvesting may occur. Because of the state's chronic budget problems, the state relies primarily on fishery-dependant data to manage the fishery.

Proposed Governance

The stock assessment that this group led shows that sea urchin fishermen are fishing in a sustainable manner, but we need to increase and expand monitoring to improve our understanding of stock dynamics and environmental factors affecting growth rates and particularly the transition from un-harvestable to harvestable sea urchins. The transition is governed by many factors including growth, movement, and food supply. The development and sharing of the local knowledge from such local monitoring could guide decisions regarding harvesting strategy.

In order to implement this guidance, we are proposing the establishment of some form of community-based management, in which fishery participants would bear some responsibility for data collection and management. Community-based management

requires local infrastructure development. The primary building block would be a port-based fishing association. This may take the form of a single fishing cooperative or a complex, interrelated group of associations, united under the umbrella of a Port Federation of Fishing Associations (this is discussed in the chapter on Preparation of a Business Plan). In order to achieve real benefits, sea urchin divers would have to act not only as individuals but also as a part of the community. The collective action strategy also helps with benefits and reduces other costs.

There has been a lot of talk by various outside entities about area-based management, catch shares and ITQs for the San Diego sea urchin fishery. We recommend that those discussions be halted until social capital in the San Diego sea urchin fishery is adequately developed. Success in the development of any form of area-based management depends on the majority of fishery participants taking ownership of the process. In order for this to happen, they must be imbued with the cooperative ethic (Cancino et al, 2007). Once this is well underway, this model should be scaled up to adjacent communities before discussions of area-based management can take place. A premature discussion would unnecessarily alienate members of the fishery outside the area without any substantial benefits to local fishermen.

Additionally, CFGC and CDFG presently have the sole authority to manage fisheries. We will have to demonstrate to them that we can be trusted, and are capable of handling the duties needed to manage the resource and to arrange for community-based co-management. This includes the development of a financially sustainable system.

We began to approach co-management ideas through collaborative research with CDFG on red sea urchin density calibration and translocation experiments, discussed in the sections Density Calibration and Translocation in this report.

We took steps toward these goals by starting to develop internal monitoring and management systems. The idea was to develop methods to make and enforce decisions governing the coordination and success of the fishery.

In order to develop Social Capital we undertook five tasks:

1. Education and communication
2. Data collection and management
3. Collaborative research
4. Trialing of cooperative arrangements
5. Establishing a commitment to a working fishing port

These tasks are all interrelated and their goal is to have divers thinking about the welfare of all the members of the community.

The present system of governance has worked to stifle cooperation and to encourage competition among the fishery participants. The idea has been to get to the resource ahead of the other divers and harvest before they do, regardless of the quality “If I don’t

get it he will". Competition among divers also exists in the selling of the product as divers compete to get a higher price for sea urchins, often at the expense of other divers.

Education and Communication

Driver's Meetings

The goal of holding regular meetings was to develop the sense of community needed for cooperative action. Over the past year we have had a total of 13 meetings with attendance averaging about 10 divers out of a total of 21 divers (15 are active divers). Divers seemed better able to assess situations and make better decisions when they communicated face to face.

An effort was made to involve all the San Diego sea urchin divers at these meetings. The building of trust, expectations, and delegation of responsibilities was built at these meetings. It is the building of social capital at these meetings that led to the changes in data collection, and cooperative arrangements.

The experiential knowledge of the divers is an important component of social capital and is illustrated in Figure II-A-1 Experiential Knowledge.

Figure II-A-1 Sea urchin divers John Ritenour (78 years old), Peter Halmay(67 years old)

Workshops and Presentations

SDWA members attended a large number of meetings and made presentations at these meetings. The goal was to explain to a wide variety of people what we were doing and why. We also received many helpful suggestions and encouragement from these sources. These provided the impetus to continue with what seemed at times like a dauntless task.

- At the invitation of Pacific Urchin Harvesters Association, Peter Halmay attended the Urchin Summit 2007 in Vancouver Canada on March 6, 2007.
- At the invitation of PERC, Peter Halmay was a speaker at a Congressional briefing" Beyond IFQs in Marine Fisheries" in Washington D.C. April12, 2007 (Ref 1).
- Attended five meetings of the Commercial Fisheries Core Committee for the Commercial Fisheries Revitalization Plan during September2007- October 2008.
- Hosted the Philanthropy Roundtable at a Conservation field trip and banquet on November 7, 2007.
- Made a presentation at a Sand County Foundation workshop on Improving Fisheries management on November 13-15, 2007 at Mystic, CT (Ref 2).
- Provided testimony to the California Fish and Game Commission at hearings on February 7, 2008 and August 7, 2008.

- Attended a meeting of the Southern California Joint Cable Fisheries Liaison Committee as one of the Directors in San Pedro, CA on February 9, 2008.
- Made a presentation to Slow Food Orange County on February 20, 2008.
- Attended a retreat with Shorebank Enterprises Cascadia on March 10-11, 2008.
- Attended a Workshop on Ensuring Sustainability and Profitability by OSU on March 28, 2008.
- Attended a workshop on Collaborative Fisheries research by SCC on April 29-30, 2008

The challenge is to work with a large constituency without altering our goals in order to conform to others' views and timetables. We will continue attending as many meetings, workshops and Conferences as our limited budget allows, since success in the political arena will ultimately come from building a large and varied constituency.

Figure II-A-2 Philanthropy Roundtable members and SDWA Directors on the docks

Data Collection and Management

Data Collection

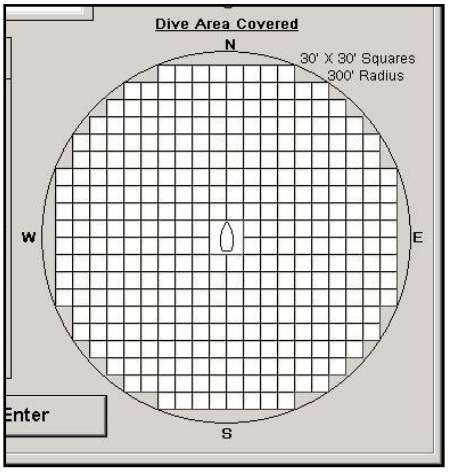
We considered data collection a very important feature of community based management. In order to establish some form of co-management, the first step is to provide a linkage between effective fishery monitoring programs, sustainable resource management, and public acceptability of data collected by fishermen. The science review noted that the system of data collection recommended by Dr. Prince (Prince, Hilborn 2003) was not being implemented by very many divers. Our goal was to have every active San Diego sea urchin diver collecting and sharing the data.

A new three-tier system was developed that allowed divers to begin collecting data at a level they selected and then move up to the next tier when they were ready. The Tier 1 and Tier II data sheets are shown in Figure II-A-3 (page 23) and Figure II-A-4 (page 24). Tier III shall be presented in a supplemental report.

Figure II-A-3 San Diego RSU Data Collection Tier I

Boat name_____
Diver name(s)_____
Date_____
Dive number_____
Dive location N_____ W_____
Depth (ft.) _____
Bottom Description A B C D E
Kelp Type A B C D E F
Harvest (lbs.) _____
Yield_____% QR (1-10)_____
Time of Dive (mins.)_____
Urchins Left Behind (lbs.)_____
Small urchins (>1 1/2in.): LOW___MED____ HIGH_____
Overgrazing Potential LOW___ MED___ HIGH___

Bottom Description	Kelp Type
A Boulders	A giant kelp
B ledges	B palm kelp
C high reefs	C elk horn kelp
D rock pile	D laminaria
E pavement	E giant kelp edge
	F palm kelp edge



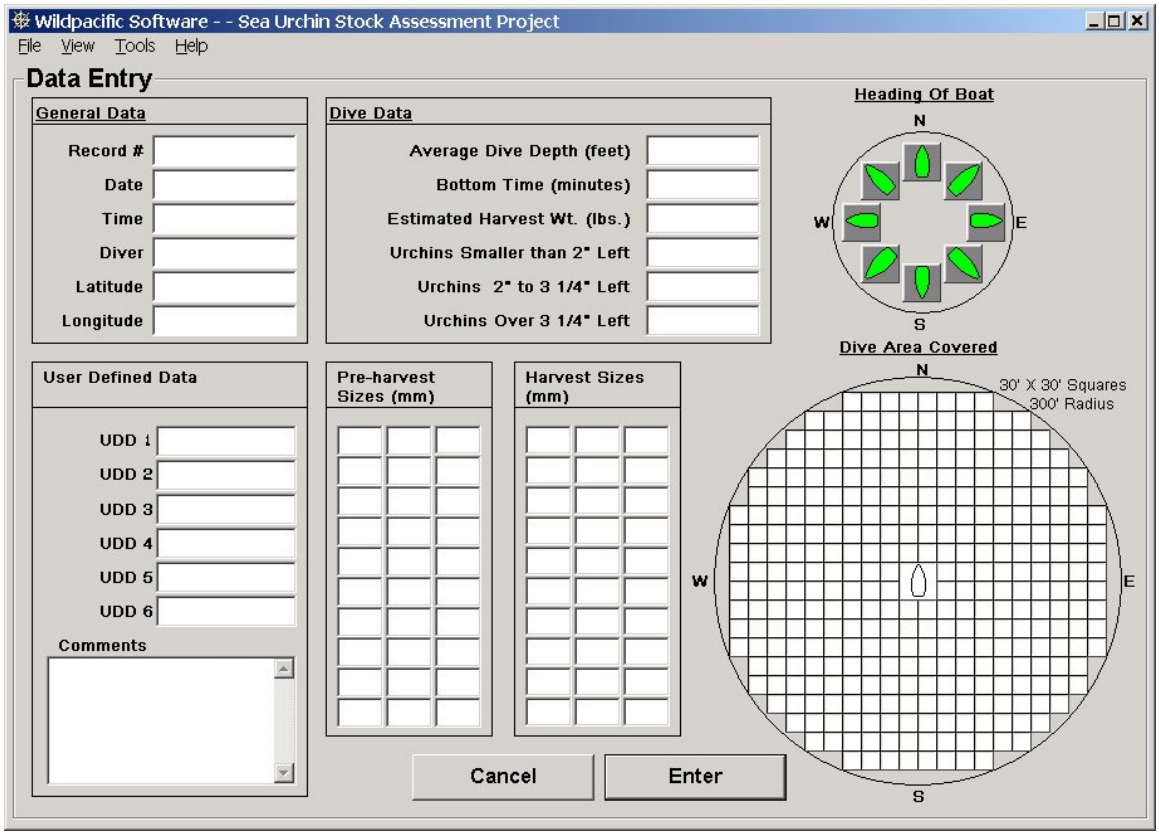
Mark Area searched_____Sq. meters

(To calculate area searched every 30ft.by 30 foot square is 100sq. meters)

Or mark area on circle <------

Revised 07/2008

Figure II-A-4 Data Collection Tier II



Utilizing the tiered approach, we achieved participation in the first three months by 9 divers out of 15 divers who are presently active in the sea urchin fishery.

We also provided rewards for participation; at the completion of 50 days of data collection an award was presented with a $100 reward. The first recipient of the award was Henry Davis who was also awarded a hand held GPS to allow him to accurately mark the location of his harvest.

The challenge is to make sure that the data collected is accurate. The other challenge is to reassure the divers submitting the data that others will not use it to their advantage at the expense of the data collector.

The goal in the next year is to have every active San Diego sea urchin diver collecting data. The data collected will be expanded to include the data suggested by the scientists in Chapter A: Stock Assessment and Review.

Data Management

The goal was to have the capacity to manage the data being collected in a system that was error free and easily accessible. SDWA contracted with the Office of Sponsored Programs at the University of Washington to perform the following work:

- Provide staff for managing data; error checking, transferring the files, putting them into a data base. This data shall be transmitted by mailing hard copies or transmitted electronically on a monthly basis.
- Enter other sources of data into the data base as directed by SDWA.
- Prepare reports and manuscripts under the guidelines indicated below.
- In the contract with UW, SDWA stipulated some Guidelines for Data Use:
    - UW agrees to use reasonable care to avoid the unauthorized disclosure of information which one or both parties consider to be confidential.
    - This confidential information includes the data from individual divers, including the location of catch effort and value. This information may not be shown on a map nor transmitted to a third party without express permission of SDWA.
    - Individual vessel data shall not be published.
    - A person assigned by SDWA shall review all proposed publications to prevent any inadvertent disclosure of the data collected by SDWA.
- In publications where SDWA's intellectual property (data collected under the guidance of SDWA) is utilized, UW agrees to demonstrate this fact through co-authorship of the publication by a person assigned by SDWA.

  On a quarterly basis the participating divers are provided two reports. One report consisted of only their data whereas the second report included all the data that had been submitted by all participating divers.

These reports are useful for the divers' personal business model and will also aid in the development of cooperative fishery tactics and the placement of MPAs. In the collective reports, no maps are shown and the area harvested is only identified as an area of 1 minute latitude. The exact location of the area is known only to the Data Coordinator.

A sample of these reports is presented below as Figure II-A-5 and Figure-A-6 sample individual reports and sample collective reports, respectively on page 26.

Figure II-A-5 Sample Individual Reports

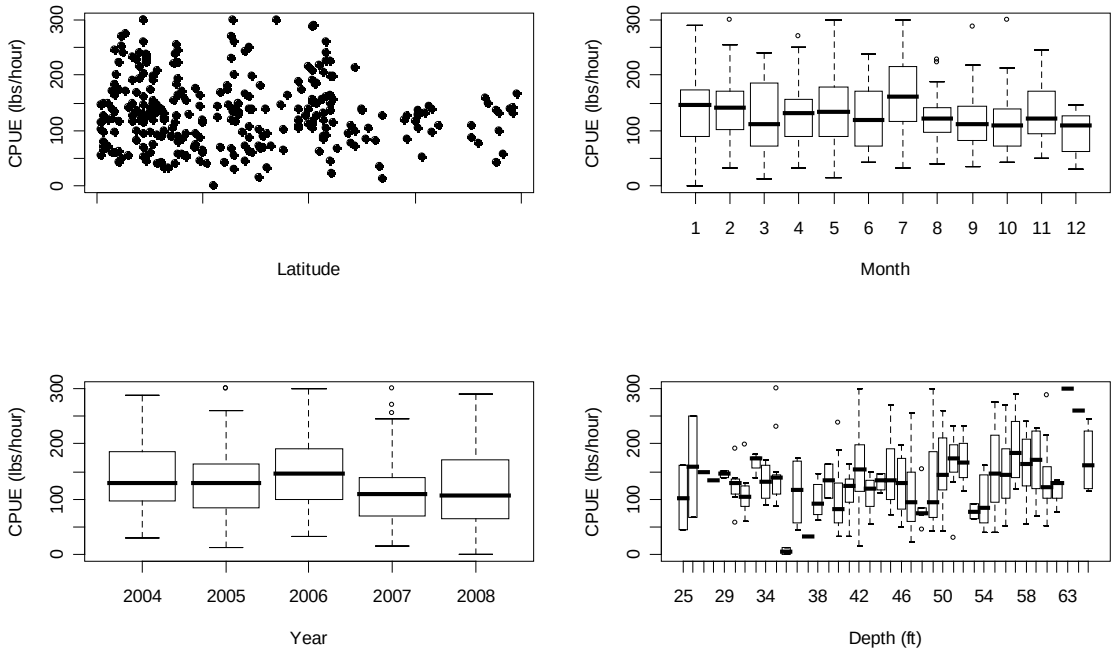
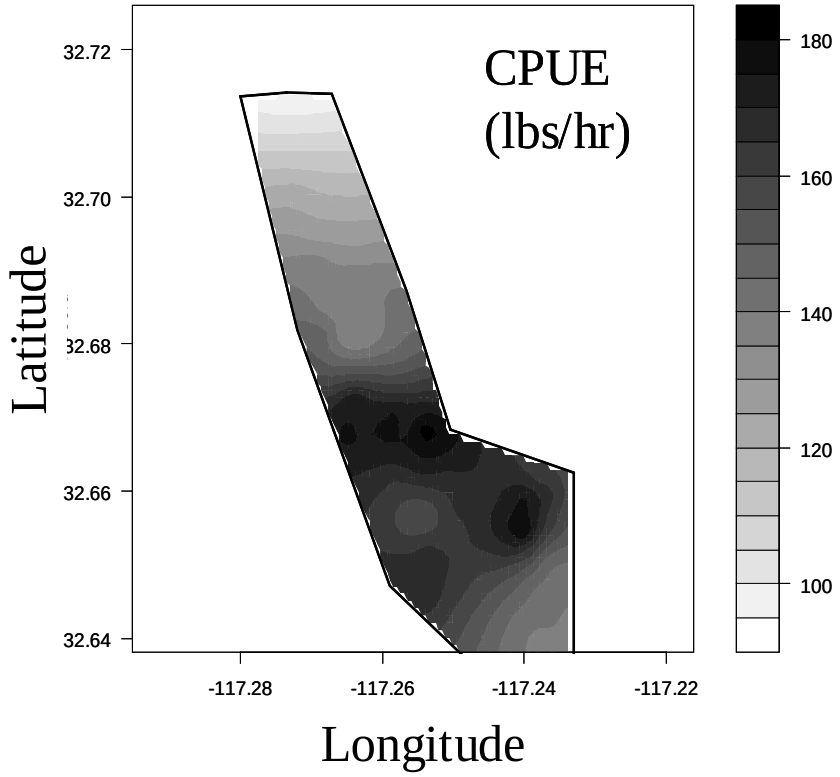


Figure II-A-6 Sample Collective Report



The idea of contracting with honest brokers; Professor Ray Hilborn and Nicolas Gutierrez of the University of Washington seemed to overcome the stumbling block of divers sharing their proprietary information.

In July 2008, approximately six months after the start of the tiered approach, we held a Data Collection Workshop. The purpose was to review what had been done, standardize the collection and encourage divers to increase their data collection. The results of this workshop are presented in Appendix II-A-1 *"DATA COLLECTION WORKSHOP JULY 12, 2008"*.

The next step will be to demonstrate the usefulness of the data collection by utilizing this data in simulation models.

In the future, this data shall be placed on a platform where it may be accessed by researchers, thereby providing an ecosystem service to the community.

Collaborative Research

The goal of collaborative research is to demonstrate to the Department of Fish and Game, the Fish and Game Commission, and other interested parties that divers are capable of collecting a large amount of accurate data. Given the proper incentives they can be trusted to collect, and share this data so it may be used for management purposes. This partnership in data collection may be seen as a step toward Community Based Management.

Department staff joined us in the field on two occasions to perform red sea urchin density calibrations. After these two initial occasions, Department staff was satisfied to send our consultant a diagram of where they wanted their transects placed, and SDWA staff conducted the surveys according to CDFG specifications. This is discussed in detail in the Section on Density Calibrations. The Calibration Crew is shown in Figure II-A-7.

Figure II-A-7 The calibration crew consisting of consultants, CDFG biologists and a sea urchin diver.

Department staff attended many of our workshops and provided guidance at various stages. Senior Biologists Pete Kalvass, Kristine Barsky, and Debbie Aseltine-Neilson were especially helpful. In addition to the collaboration, they reviewed and approved our applications for the many experiments that were a part of this project.

Our collaborations also extended to working with graduate students from Scripps Institute of Oceanography.

A team of students developed a proposal to study "San Diego Sea Urchin Fishery: A Biological and Economic Inquiry into Sea Urchin Quality."

They set out with the following goals:

- Investigate the effect of sea urchin diet on uni quality using lab-based experiments.
- Investigate the potential for determining uni quality prior to harvest, possibly resulting in a decrease of cost per unit effort for all parties involved.
- Investigate the economic implications of regulated uni quality, such as how quality is determined for marketing purposes and the impact of quality on price.

Together with Dave Rudie of Catalina Offshore Products, we provided data on historic sea urchin prices. We also harvested some 300 red sea urchins of poor quality for use in their diet experiments.

Another group of students under the direction of Dr. Burton are conducting a high resolution genetic study designed to determine the scales and patterns of larval connectivity among populations of red urchins in California using AFLP and Microsatellite markers. This research may provide valuable insight that may be used in resource management. We assisted these students by providing live sea urchins in three size categories (<30mm, 30mm-50mm,>50mm).

A letter from Celeste Benham, a graduate student from Dr. Burton's lab is attached as Appendix II-A-2 "*LETTER FROM CELESTE BENHAM, SCRIPPS INSTITUTE OF OCEANOGRAPHY*".

Our goal is develop these arrangements into a more collaborative rather than a cooperative approach. We have supported many of the grant proposals by University researchers and will continue to do so in the future. We are planning on opening discussions with Department senior staff to determine what type of agreement can be reached for Essential Fishery Information to be routinely collected by SDWA members under the direction of a Consultant. Additionally we shall work with the Ocean Protection Council to develop Collaborative Research arrangements that provide a franchise type role for fishing cooperatives that have shown to adhere to established standards.

We are presently preparing a proposal in consultation with the representatives of other San Diego based fisheries and researchers from Scripps Institute of Oceanography and University Of California Santa Barbara to perform collaborative fishery research.

Trialing of Cooperative Arrangements

Present Arrangement

The goal of developing cooperative arrangements is to implement an approach to maximizing the value of the San Diego resource rather than merely increasing the individual's slice of the pie.

The primary system of selling red sea urchins in San Diego is for divers to deliver sea urchins to one of two unloading facilities; Point Loma or Mission Bay. The only sea urchin processor in San Diego, Catalina Offshore Products (COP), unloads the boats, and delivers the sea urchins by truck to the COP plant for processing. Two days after the sea urchins are

offloaded; the diver is notified about the quality of the processed product and is assigned a price based on a formula developed by the processor.

Deliveries

In order start working cooperatively, divers at one of the meetings suggested that we make some effort to pool a portion of our day's catch and develop collective deliveries. It was decided that each diver would contribute a small portion of his load and the aggregate of all the loads would be sold as a unit at a single price. The proceeds of these sales would be held in escrow for use by the group in a manner that would be decided later.

Two collective deliveries were made with 10 divers participating. Information about the delivery and sale was shared with all the participating divers. The divers were able to compare their individual price (the price paid by the processor for the portion of the catch sold individually) to the aggregated price to compare the relationship of their individual price to the average price for that day.

Marketing

The existing market path was seen as overly restrictive and the divers sought to develop alternative market paths. The initial attempt was to facilitate direct marketing by divers. A partnership was formalized of 10 San Diego based divers that enabled all to market directly to restaurants, wholesalers, and individuals. The partnership provided the mechanism to obtain all the required licenses and permits. However the issue of shared liability arose almost immediately and this caused justifiable concerns. It is our intent to modify the corporate structure from a Partnership to a Limited Liability Company in the near future.

The group is in the process of developing formal arrangements for reporting, sharing information, and sharing overhead costs.

In the future we will expand the direct marketing to other products that may be harvested in San Diego waters, and work to consolidate deliveries. We understand that this effort may be met with resistance from those who now are the major players in the distribution channel. However we believe that this may be accommodated because of the relative scales of the enterprises.

The development of the harvest for some of the underutilized species will be guided by data obtained locally and by the development of harvest practices that lead to sustainable use. This would be based on the Sentinel Fishing Program developed in Eastern Canada.

Establishing a Commitment to a Working Fishing Port

Revitalization Project

In order for sea urchin divers, or any small-scale fisherman, to have a viable future in San Diego, a commitment to their future by the San Diego community at large is needed.

We received substantial support toward this goal when the Port of San Diego received a grant from the State Coastal Conservancy to Preserve and Encourage Commercial Fisheries in San Diego Bay.

This opportunity to improve the business of fishing in San Diego by developing a world class Working Fishing Port at the site of the present Driscoll's Wharf would change the present business model.

The Working Fishing Port would be developed in such a way that it would serve as a hub for San Diego Commercial fishing enterprises.

An offloading dock with the infrastructure to offload a wide variety of species would complement fish storage and processing facilities as well as a fish market and restaurant.

San Diego residents and tourists would be able to watch the fish being offloaded from the boats and then purchase them live, or fresh in the fish market, at weekly dockside markets or prepared in the restaurant at the site.

A report and business plan shall be prepared by Lisa Wise Consulting as part of this project. We shall utilize this report to prepare our business plan.

Reducing the Carbon Footprint

As we write this report, the price of diesel fuel has risen to almost $5 per gallon. Consumers are becoming more aware of the connection between global warming and the use of fossil fuels. Those enterprises that are making efforts to reduce their carbon footprint shall be rewarded by consumers. By altering our fishing and marketing practices we intend to develop protocols that will reduce the carbon footprint in the San Diego Sea Urchin Fishery:

- Small boats harvesting primarily within 15 miles of the Port
- Establish cooperative harvesting tactics to maximize the harvest of the edible portion of the sea urchin
- Match harvest to markets thereby reducing waste.
- Concentrate on local markets within a short distance from the Port
  Develop methods to provide a steady supply of small quantities of live product directly to individual markets
- Diversify by harvesting underutilized species in a Sentinel Fishery program

Chapter A Quality Standards

Introduction

What part of the sea urchin do we eat?

The market for edible sea urchin products is based solely on the animal's gonads. Only three types of cells occur in the sea urchin gonads: nutritive phagocytes which store nutrients in the sea urchin and are the actual focus of the gonad as a human food product, gametogenic cells from which gametes are formed, and gametes (Explorations Unlimited Inc.2006, Olivarez 2004)

The abundance of nutritive phagocytes in sea urchins is generally explained by patterns of food availability, and the gametogenic cells are a function of the somatic cycle.

The value of the gonad as an economic product is directly proportional to the abundance of the nutritive phagocytes. Although the gametes are biologically the ultimate product of the organ their increasing presence during the somatic cycle actually diminishes the economic value of the gonad as they suck nutrients out of the nutritive phagocytes to produce gametes.

What is quality?

Quality is determined by the size, color, shape, texture and taste of the gonad. The size or gonad index, color and taste depend on the availability and type of food, the shape depends on the age and growth pattern, and the texture depends on both the food supply and the somatic cycle.

Color and flavor seem to be linked and dependant on the type of food digested by the sea urchin; an aesthetically pleasing color seems to coincide with a delicate taste, wherein the smell of the sea is mixed with the characteristic sweetness of the sea urchin.

Unfortunately one cannot determine the quality of a sea urchin until it is cracked open. The natural quality is different from the processed quality since the finished product is an artifact of the processing cycle.

Why is quality important?

Quality is important for four basic reasons:

1. Quality determines whether a sea urchin should be harvested or not.
2. Quality is used to determine the ex-vessel price of the sea urchin.
3. Quality is divided into three grades and sold by the processor at determined prices for each grade.
4. When sold at auction, the quality will determine the price paid to the processor for the shipment.

Summary

Although quality is considered to be very important in the supply of fresh seafood, in the case of sea urchins it is not well defined. This hampers actions to improve quality since no standards have been set.

We determined that it is important that quality assessments be made by someone other than the processors. It is also important that a quality determination be made of the natural quality in addition to the quality rating of the finished (processed) product.

With the assistance of the Food and Science lab at UC Davis we performed experiments on determining color and texture in a quantitative manner. In the future we will continue our association with the UC Davis Food and Science lab to develop the quality baseline. Several experiments are needed to standardize the grades using the Hunter Lab Scan. Once this is standardized we will begin to trial a portable color meter at the dock as part of our data collection program. When these calibration experiments are completed we will be able to assign grades based on a single number obtained from the Hunter Lab Scan. This will permit SDWA to develop a dockside testing program at the time of unloading the sea urchins. The testing program would include recovery (yield), color, and texture. These site specific quantitative determinations may be used in price negotiations with the processors as well as in the development of cooperative fishing tactics to yield optimum quality harvests.

Natural Quality

The natural quality of the red sea urchin is estimated by the diver during harvest. This is done by "reading the bottom" which is based on the experience of the diver in finding good quality under certain conditions during certain times of the year. The diver cracks open sea urchins at intervals during the harvest to validate his experiential knowledge. He observes visually whether the "roe" meets certain minimum standards. When the sea urchins are hauled aboard the dive vessel, the diver does a second random check of quality. The natural quality is not used in determining the value of the catch but only as a guide for harvesting, and to validate the processor's quality determination. However in the future, once we have calibrated the standardized color determination, and performed simple dockside tests on determining the recovery (amount of roe in the sea urchin) we would have a quantifiable and verifiable method of determining natural quality without waiting for the results of the processing. The unbiased determination of quality may be used in establishing fishing tactics that yield optimum quality harvests.

It is highly unusual for the buyer to be the sole arbiter of quality, since this type of analysis is routinely done for other commodities by an independent third party so that the quality is not determined by the buyer or the seller. An example is the method used by USDA to provide grading services that grade beef according to quality and/or yield. Both types of grading are optional and cost the producer (rancher) some money to pay for the USDA grader to provide a grade.

Quality variation

Experiment 1

We harvested along a red sea urchin feed line, where the quality is relatively uniform and sent in samples for processing. Although there was no apparent change in the natural quality, we observed variations in processed quality. This is shown in the Table III-A-1 Processed Yield and Quality Variation for a Constant Natural Quality.

Table III-A-1 Processed Yield and Quality Variation for a Constant Natural Quality

DATE	AREA	YIELD	QR	PRICE	TOTAL YIELD
3/16/2007	feed line	3.7	2.9	0.46	5.4
3/17/2007	feed line	6.9	3.4	0.88	7.8
3/21/2007	feed line	5.5	3.7	0.74	6
3/26/2007	feed line	5.3	3.8	0.79	6.5
3/29/2007	feed line	4.1	3.8	0.54	3.9
3/30/2007	feed line	3.7	4.3	0.54	4.3

QR* is the amount of A grade on a scale of 1 to 10 with 10 as 100%

It may be seen that although the natural yield and color stayed constant, the processed yield varied between 3.7 and 6.9% and the Quality rating varied between 2.9 and 4.3 indicating a large variation in the color and /or texture of the processed sea urchin roe.

Experiment 2

We performed an experiment by obtaining the natural yield prior to processing and comparing this to the processed yield. The results are shown in Table III-A-2 Comparison of Natural Quality and Processed Quality.

Table III-A-2: Comparison of Natural Quality and Processed Quality

Date	SDWA Avg. Size (mm)	SDWA Weight	COP weight	SDWA Count	COP Count	SDWA Yield	COP Yield	SDWA Edible (lbs.)	COP Edible (lbs.)
10/15/2007	96.80	50	51	50	50	5.88%	2.37%	2.94	1.21
11/14/2007	97.28	50	52	50	50	6.50%	2.75%	3.25	1.43
12/19/2007	96.90	51	51	50	50	6.75%	2.75%	3.44	1.40

The natural quality is shown as SDWA yield in the Table and was arrived at by scooping out the gonad and weighing it in the field. The COP yield or processed quality was determined by separating the loads from these areas prior to processing so that a site specific value would be obtained.. It can be seen that the processed quality is roughly half the natural quality. This difference is caused by waste during processing, low grade uni and the use of an astringent (potassium alum) to firm up the final product.

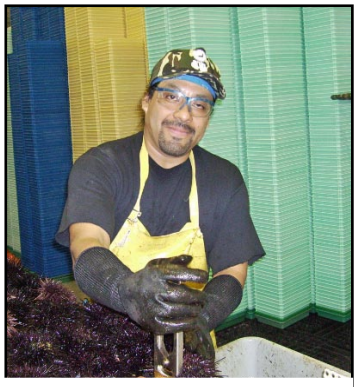
Processed Quality

History of Quality Determinations

The processed quality is different from the natural quality since the finished product is an artifact of processing. The various steps in processing are shown in Figure II-A-1 Processing Steps.

Figure III-A-1 Processing Steps

Step 1: Moving from the cooler to the cracking table. If care is not taken during moving operation, sea urchins are dropped with reduced consistency (melting) as a result.



Step 2: Cracking open the sea urchin. The cracking tool must be placed between skeins of "roe" otherwise a part of the "roe" is sliced off.

Step 3: Removing the "roe" from the shell. Part of the "roe" remains attached to the shell if care is not taken to insert the spoon at the interface between the "roe" and the shell, or if the sea urchin is dried out.

Step 4: Separating the stomach. A labor intensive task where care must be taken to not waste product yet clean it completely.

Step 5: Soaking the "roe" in alum, an astringent to expel gametes and water. Leaving the roe in too little or too long affects the consistency and the (processed) yield.

Step 6: Packing "roe" in tray. The packer uses experience to pack the different grades in separate trays.

The Japanese market demands a very dry product that can be easily handled. This requires soaking the product in an alum bath to reduce the moisture and expel the gametes if they are present. This changes the amount of gonad and perhaps alters the color, and flavor. The astringent, Potassium Alum, will allow for extending the shelf life of processed sea urchins for 5 or more days however the inherent flavor and sweetness of the sea urchin are lowered with the use of the astringent.

Who determines processed sea urchin quality?

During the early years of the fishery (1970-1993) most of the California sea urchin products were exported to Japan and sold at auction at the Tokyo central market (Tsukiji) or one of the seven regional markets (Bestor T.C. 2004)

When the market received the product, trained market staff made the gross quality determination separating the shipment into one of two grades. However the auction process was actually a social process capable of defining and resolving questions of value and price (C.W. Smith 1990) On any given day, depending on quality, and demand, the price would vary between 1500 and 8000 yen per 300gm. tray.

During the early years, California owned the world wide winter market (October-January) and the price increase during these months was dramatic. However in the mid 1990's the market for California sea urchins shifted to a domestic market and in this market the product was separated into three categories by individual processors:

- **"California Gold"** - bright gold, yellow or orange color; firm buttery texture; fresh salty ocean scent; and with a sweet buttery taste. Uni sections are large and complete intact pieces. This is exceptionally high-grade uni for use in top quality sushi. (formerly grade A)
- **"Premium California"** - gold, yellow or orange color but less brilliant than California Gold; firm buttery texture; salty ocean scent; with a crisp and nutty taste. Uni sections are smaller but still primarily intact pieces. Premium uni is used for sushi, soups, salads, or combination dishes where uni is the featured item. (formerly grade B)
- **"Select California"** - medium hues of yellow and orange or even tending to brown in color; salty ocean scent; softer creamy texture; with a more neutral nutty taste. Uni may be intact sections but can consist of broken pieces of the other grades. Frequently Select is packaged and shipped frozen. Uses include soups, sauces and dishes where the uni is mixed with other ingredients, including other seafood. (formerly grade C)

When the market path changed from export to Japan to domestic sales each processor established their own grading system and this grading was affected by market demand. Wholesalers and retailers paid for the product depending on the category assigned by the processor.

Quantitative Standard Experiments

We formed a partnership with the UC Davis Food Science & Technology Dept and California Sea Grant to develop quantifiable and repeatable analysis of quality. The results of this study are presented in Appendix III-A-1 *"RED SEA URCHIN GONAD COLOR REPORT DECEMBER 2007 AND MARCH2008 DATED 23 JUNE, 2008"*.

The results of these analyses indicate that the color component of quality can be determined in a scientific and replicable manner. Approximately three additional tests are needed before the color determination is calibrated so that it may be used. Once the calibration is complete, we envision using a field version of the Hunter color analyzer to

classify a sample of the harvest into the corresponding grade. Additionally, a gonad index may be obtained dockside to determine the amount of "roe". If this were done at the time of offloading the red sea urchins from the boat, the diver would have a clear scientific evaluation of the natural quality. These natural quality determinations may then be used in price negotiations with the buyers. In addition this unbiased assessment of color combined with a dockside check on recovery would enable us to develop cooperative fishery tactics in real time.

Quality Judging Experiment

An experiment was designed to test the objectivity of the present grading system. In order to test the objectivity of the grading system, we randomly selected 15 pieces of sea urchin "roe" from the refrigerated storage area in the processing plant prior to packing. In this selection process we made sure that all three grades were represented in the sample. We placed the 15 pieces in a bulk tray.

We selected 17 judges, who were classified in four categories; processors, divers, sushi chef, and consumers. They were each tasked with assigning a grade of A, B, or C to each piece of "roe". The results of the judging are shown below in Table III-A-3 Results from the Quality Judging Experiment.

Table III-A-3 Results from the Quality Judging Experiment

JUDGES	Participants	% A grade	% B grade	% C grade
		Avg. & Range	Avg. & Range	Avg. & Range
Processors	5	19 (7-33)	53 (47-67)	28 (13-47)
Divers	6	27 (20-33)	44 (33-53)	29 (20-40)
Sushi Chef	1	40	27	33
Consumers	5	28 (7-47)	33 (27-40)	39 (27-53)
AVERAGE		30	39	31
RANGE		(7-47)	(27-67)	(13-53)

It can be seen that there is a large range and overlap in the grades assigned by the various players in the experiment. The lowest classification of A grade was assigned by processors, which is probably merely caused by competitive bias. Another noteworthy part of this experiment is that consumers assigned the highest percentage of C, or poor quality. This tells us that consumers are becoming sophisticated and they recognize poor quality.

Chapter B Translocation Experiments

Introduction

The primary objective is to determine whether it is logistically and economically feasible to use transplanting red sea urchins as a management tool. We approached this by designing experiments to test three basic means of developing a management tool:

- Improve sea urchin quality
- Re-establishing sub-populations
- Determining growth, mortality, and movement of sub-populations

We designed experiments to determine if the gonad index, the amount of edible product (uni), and the sea urchin quality can be increased by moving adult red sea urchins from an area with high red sea urchin densities, and little benthic algae to an area with few red sea urchins and abundant benthic algae.

We designed a second set of experiments to determine if a local populations of red sea urchins be reestablished in areas where there were historical harvests but harvests no longer occur because of a past pollution episode or other environmental factors. In designing some of the experiments we selected a wide range of sizes, from juveniles to large adults to reestablish the areas so that they will not all be harvested within a short period.

Summary

We performed several experiments to determine if sea urchin yield and quality can be improved by translocating red sea urchin from an area of sparse algae to an area where algae were plentiful. These experiments lasted approximately six months and the results are not clear. The change in yield and quality were measured as natural yield and also processed yield. The variation in results from these two measurements confounded the findings. However our impression is that the extra labor to harvest the sea urchins twice would not be economically advantageous.

We also performed experiments to determine if red sea urchin sub-populations that have not recovered after harvest could be re-established by translocating red sea urchins with a wide range of sizes (50mm-100mm). Since these experiments are of a duration that is beyond the time frame of this project we have only preliminary information. We have observed that the mortality rates observed during the translocation of the red sea urchins is minimal, and after a few months they are thriving in the new environment.

Density measurements taken before the experiment, and after two years, may reveal that this technique should be used in the management of the red sea urchin.

We also performed one experiment with 999 tagged sea urchins. We measured and tagged these individuals prior to moving them to a receiver site where an area 50 meters by 50 meters had been cleared of all red sea urchins. A small sample taken at mid point in the

one year experiment shows remarkable growth rates far in excess of the average rates that had been used in the past. We plan to collect the sea urchins in December 2008 in such a fashion that we will obtain growth, mortality rates and also a pattern of movement during the year.

CDFG Authorization

SDWA requested and was granted the authority to conduct a large array of experiments pursuant to Section 120.7(a) (2), Title 14, CCR. For the translocation experiments we received authorization to do the following:

- Up to 5,000 pounds of red sea urchins may be harvested from areas of poor quality (roe recovery equal to or less than four percent by weight) and may be transplanted to an area of good habitat, as determined by SDWA, within the Point Loma study area;
- Up to 250 pounds of such transplanted red sea urchins may be harvested once a week for the purpose of determining roe quality;

The authorization letter is presented as Appendix III-B-1 *"CDFG AUTHORIZATION"*.

Increasing Sea Urchin Quality

We performed experiments where red sea urchins of known poor quality (source) were translocated to areas where the existing population was of good quality (receivers). Figure III B-1 shows the diver descending with a lift bag to pick up sea urchins.

Figure III-B-1 diver descending with a lift bag to pick up sea urchins

Experiment 1

On October 10,2007,diver Mitch Hobron harvested 454 red sea urchins (approximately 370 pounds) with a minimum size of 3 ¼ inches. The depth of the source site is 35 feet, and the depth of the receiver site is 45 feet. The red sea urchins were moved from an area with little algae to an area where macrocystis was abundant. We sent a sample to the processing plant (COP) on October 10, 2007 to determine the processed yield of the red sea urchins at the source site. The results of this experiment are shown in Table III-B-1 Experiment 1 Results.

Table III-B-1 Experiment 1 Results

Number of days	Processed Weight (pounds)	Yield (%)	QR	Price $USD
0(start)	116	5.6	1.7	0.57
34	50	8	4.1	1.12
54	38	6.3	0	0.38
124	55	6.9	3.8	0.91
182	159	8.5	3.6	1.09

Experiments to Re-establish Sub-populations

The results of these experiments shall be presented in a supplemental report.

Determining growth, mortality, and movement

We performed an experiment to determine Growth, Mortality, and Movement of Subpopulations in the Point Loma Kelp Forest. This experiment was performed collaboratively by members of SDWA and Dr. Steve Schroeter.

The results are presented in Appendix III-B-2 "*TRANSPLANT EXPERIMENTS TO DETERMINE GROWTH, MORTALITY, AND MOVEMENT OF SUBPOPULATIONS IN THE POINT LOMA KELP FOREST".* This experiment was added during the performance of the project when we realized that information regarding growth, mortality and movement could be started without incurring extra expenses. However the experiment was not completed during this phase since we lacked the time and funding to survey, collect, and examine the animals at the end of one year. The locations of the source and receiver sites are shown in Figure III-B-2 Location of Source and Receiver Sites.

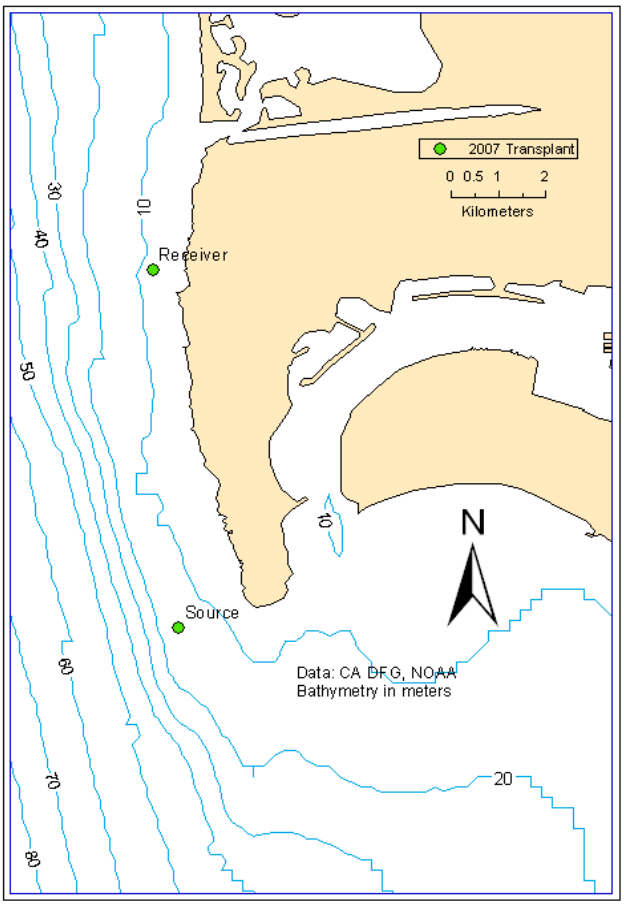


Figure III-B-2: location of the source and receiver sites.

Chapter C Direct Marketing

Introduction

The purpose of this project was to determine the feasibility of direct marketing value-added product to restaurants and markets, as opposed to selling red sea urchins to processors as a commodity. We selected live red sea urchin as the most appropriate product for direct marketing since it requires no processing and presently is underutilized by all restaurants except sushi bars, where urchin roe is sold as uni sushi. We developed menu items utilizing live sea urchin and looked at the potential to expand our marketing base to non-Japanese restaurants.

Summary

While American and Korean chefs showed interest in adding urchin to their repertoire, Mediterranean chefs were especially enthusiastic about live red urchin. Urchin is not just "uni" anymore, it is also "ricci del mar", "ricci linguini", and "crème d'oursine". Because Mediterranean restaurants prefer unprocessed sea urchin, we see them as being a potentially exciting new direct marketing opportunity.

We believe we could sell live red urchins to restaurants and markets for about three times the price currently paid by processors. We would like to transition to this niche market, as it would allow us to increase revenues on lower harvests, burn less fuel, etc. The main obstacles are quality assurance and delivery costs, as well as maintaining a steady supply of product.

Our next step is to develop a quality assurance program so that every live sea urchin delivered will be of good quality. This may require developing a cooperative harvesting strategy and special handling of "ripe" sea urchins. In order to achieve economies of scale and to compete in the marketplace, we shall consider joining forces with fishermen in other San Diego fisheries.

The direct sale of live sea urchins to restaurants and markets is the most promising avenue for increasing revenues for an organized group of sea urchin divers. The direct sale of unprocessed local sea urchins to local outlets also provides an ecosystem service by reducing the carbon footprint of the fishery.

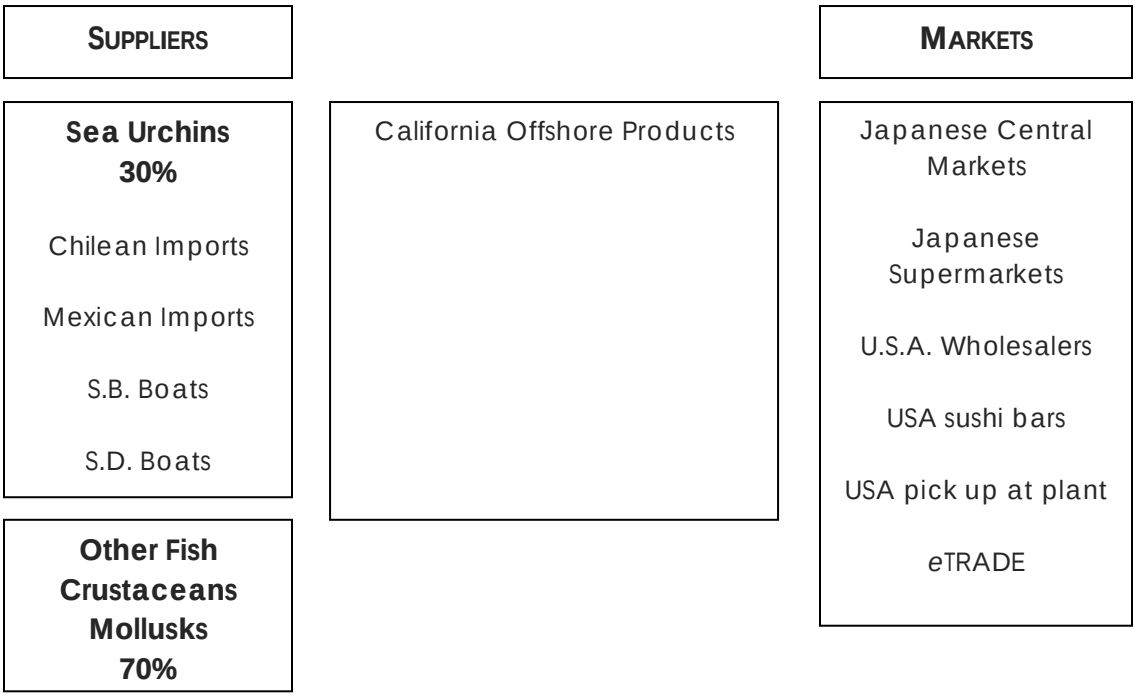
Direct Marketing

Direct marketing was considered in order to respond to four basic requirements for a successful fishery:

- Resource sustainability
- Profitable fishery
- Steady supply of product to the markets
- Quality assurance
- Traceability of the product through the market chain
- Reducing the Carbon Footprint

Presently almost all the red sea urchins harvested by San Diego divers are sold to Catalina Offshore Products. The present distribution network is shown in Figure III-C-1 Distribution Network.

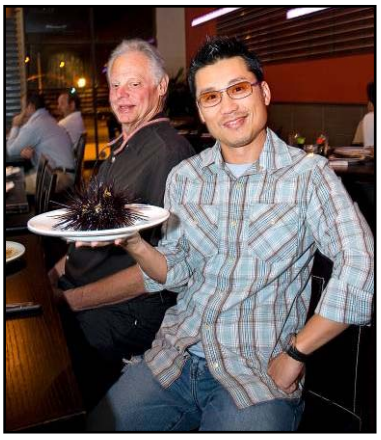
Figure III-C-1 Distribution Network



We decided to explore the various facets of direct marketing by selecting four restaurants and began weekly, or bi-weekly, deliveries. We made agreements with the chefs and owners that in return for the product they would give us feedback regarding their assessment of the quality of the sea urchins, how they were utilizing the product, and customers satisfaction with the dishes that were prepared. During this project we made over 200 deliveries to the restaurants. The deliveries were made on a weekly or b-weekly basis, and the number of sea urchins per delivery ranged from 8 to 90 red sea urchins.

Figure III-C-2 Consulting Chefs

Chef Kazumi



Owner/Chef Jason

Chef Memmo

Based on these deliveries, we developed information on the following subjects:

- Product development
- Delivery and Shelf life
- Infrastructure needs
- Public acceptance and Public relations
- Market issues

Product Development

In order to market live sea urchins directly to restaurants and markets, we learned that further development was needed at all the stages of the supply chain; harvesting, transport, and the preparation in the kitchen.

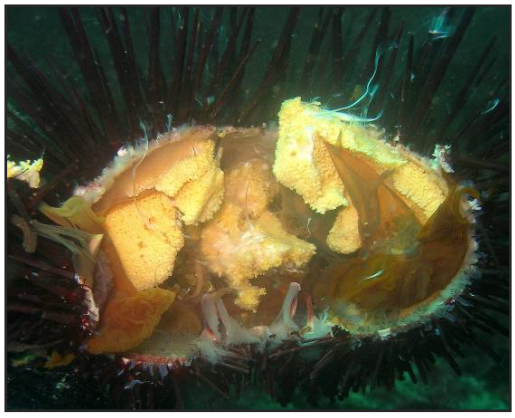
Harvesting

In order to market live sea urchins we had to determine that the product met certain quality standards prior to delivery. When sold to a processor as a commodity, there could be a wide range of quality and the processor would separate them and market accordingly. However when the product is sold "live" we had to know the quality without cracking the sea urchin.

There is a great deal of spatial and temporal variation in quality, so divers use their experiential knowledge to harvest in areas where the quality meets the standard for live sea urchins. The sushi bars prize firmness of the "roe" very highly. This requires extra care to harvest animals that are not at a stage of the somatic cycle where they are excreting gametes. This is shown in Figure III-C-3 Red Sea Urchins at Different Stages of the Somatic Cycle.

Figure III-C-3 Red Sea Urchins at Different Stages of the Somatic Cycle

Sea urchin at the start of the somatic cycle with no gametes



Sea urchin at the peak of the somatic cycle oozing gametes

The areas that produce the quality required by the "live sea urchin" market comprise only a small portion of the fishing grounds. In addition these areas change temporally, and spatially. The data on these areas is presently being collected so cooperative harvest strategies may be applied in the future.

In the Kitchen

Most sushi chefs are accustomed to using processed sea urchins packaged in trays. When the chef receives live sea urchins, some additional expertise and time is needed to prepare the sea urchin for presentation on the menu. We recognized that the restaurant or sushi bar would have to have someone in their employ with the skill sets, willingness, and time to prepare, or process the sea urchins. By providing samples on a weekly basis, the chefs had the opportunity to experiment with various presentations that took advantage of the freshness and the added customer experience of eating uni or ricci directly from the sea urchin shell. Given this opportunity the chefs' imagination and cultural background took over and instead of just uni sushi we saw a large number of menu items: uni soup, uni and oyster, uni shooters, live uni in the shell, ricci del mare e Prosecco, ricci del mare bisque, ricci del mar linguini, ricci del mare Risotto, and crème d'oursine. Some of these presentations are shown in Figure III-C-4 Sea Urchin Presentations.

Figure III-C-4 Sea Urchin Presentations

Carpaccio de Ricci

Ricci del mare pata in the shell

Ricci del mare linguini

Sea Urchin Bisque in the Shell

Ricci con Prosecco in the shell

Traditional uni sushi

Uni shooter

Issues

During our deliveries we discussed with the chefs the problems they encountered in presenting live sea urchins. The major complaint was softness, especially when the gonad was excreting gametes. This issue was more important to the sushi chefs since the sushi market has become accustomed to the standard "dry" uni.

The solution is to carefully select the harvest site to avoid these sea urchins or to develop special handling procedures. We plan to conduct trials that vary the temperature at various stages of the delivery to keep the sea urchins alive, or methods of artificially excreting the gametes without chemicals.

A great deal of time was spent establishing personal relationships with the four chefs at the pilot restaurants. This is a necessary facet of marketing. At this stage and we foresee having to use this personal approach by divers in the development of the market. This will be very time consuming since a relationship based on trust has to be established between the supplier (diver) and each individual market. Chefs at the sushi bars and restaurants are presently mostly buying processed product and not serving the live product. In the development of the market for live sea urchins or processing the sea urchins at the restaurant level, we must exhibit patience and provide assistance to the chefs in building this expertise.

Delivery and Shelf Life

Making over 200 deliveries in a period of one year allowed us to begin to standardize the packing of live sea urchins to maximize the product quality. In order to achieve these results we put the sea urchins in a cooler, chilled with blue ice, and covered the sea urchins with kelp. The ice maintained the temperature of the sea urchins below 55 F and the kelp kept the surface moist. This is shown in Figure III-C-5 Packing Live Sea Urchins.

The sea urchins were delivered the same day and the chefs determined that the maximum shelf life of live sea urchins was 2 days. After this period the sea urchins die and the gonads become targets for the sea urchins' digestive enzymes. This causes some changes in the taste and increases the runniness of the product (Explorations Unlimited, 2006).

Figure III-C-5 Packing Live Sea Urchins

Live red sea urchins in a Styrofoam box covered with kelp

After two days the chefs removed the gonads from the shell and placed them in the refrigerator to extend the shelf life. Based on a full year of supplying this test market we estimate that each restaurant may use approximately 20-40 sea urchins per week. In order to concentrate deliveries we may work with individual restaurants

to feature sea urchin (Uni, Oursine, or Ricci del Mare) on a specific day when customers know that live sea urchins will be available. These sea urchin specials or Banquets, paired with wines may allow the restaurant to purchase up to 80 sea urchins for each event.

Infrastructure Needs

The small size of each individual delivery will necessitate some storage of live sea urchins at or near the docks. This would allow for a steady supply of live sea urchins in small quantities without the diver having to harvest them at the fishing grounds.

The open season for sea urchins is only four days a week in the summer months, with Friday, Saturday, and Sunday closed to harvest. Demand appears to be greatest during these times and live red sea urchins will have to be available on these three days

We have begun experimenting with cages and shore side circulating chilled sea water tanks to hold live sea urchins for several days. (See Chapter on Receivering).

Presently coolers are used and returned with each subsequent delivery. However packaging will have to be designed so that it will be functional in keeping the red sea urchins alive and with a pleasant appearance. A small refrigerated truck will be needed to make the deliveries. This would allow multiple deliveries on the same day. Marketing will also require the establishment and maintenance of a web site.

Public Acceptance and Public Relations

Banquets

Once the chefs completed their in-house trials, we tested public acceptance through a series of Banquets that featured sea urchins. A total of four banquets were held to introduce sea urchins to people who had never eaten them or had not tried the new menu items that were recently developed SDWA held two banquets; one for the visiting Scientists who attended the Science Review and another for members of the Philanthropy Roundtable who participated in the Conservation Field trip during their Annual meeting. These banquets featured sea urchin presentations that were developed by the chef, and they proved to be an enormous success. Based on these successes, SDWA promoted two dinners featuring live sea urchins at Italian restaurants where guests paid $70-$85 for a five course dinner featuring sea urchins, with each course paired with an Italian wine. We determined that the public did not judge these prices to be excessive which allowed the restaurant to afford the live sea urchins and still make their profit.

Public Relations and Media

We were very fortunate to receive advice, support and an introduction to media contacts from three public relations experts; Marcie Rothman, Gerry Furth-Sides, and Tara O'Leary. With their guidance we were introduced to the media so that our events were widely covered. This not only helped to increase the participation in the planned events but also to raise interest in the idea of the "from the boat to the throat" program.

A write-up of the San Diego banquet appeared in the San Diego Reader and seven members of the media attended the banquet in Pacific Palisades:

1. GAYOT PUBLICATIONS
2. VENICE MAGAZINE
3. LOS ANGELES MAGAZINE, LOS ANGELES TIMES
4. LOS ANGLELES TIMES (internet)
5. ANGELENO MAGAZINE,
6. AMERICAN RADIO NETWORK
7. VIDEOGRAPHER for footage requested by Food TV Network, Travel Channel and KNBC

This led to a radio interview by Evan Kleiman host of Good Food on KCRW radio which aired on Saturday, May 17, and an interview by Alain Gayot and an article in the Food paper The Articles are presented in Appendix III-C-1 *"MEDIA EXPOSURE"*.

Market Issues

Licenses and Permits

In order for fishermen to sell directly to the final consumer, he may obtain a Fisherman's Retail License from the California Department of Fish and Game (CDFG) for a fee of $78.25. However if the fisherman wishes to sell to restaurants, and markets, he must obtain a Fish Receiver's License from CDFG for a fee of $624. We developed a cooperative mechanism for dealing with this license that is described in Chapter II: Governance Reform. Additionally a Business License from the City of San Diego is needed.

We have decided that the sea urchins have to be stored dockside for quality assurance and steady supply purposes, so a list of health service requirements has to be met:

- A permit should be obtained from the San Diego County Department of Environmental Health
- A certified HACCP plan is needed
- The dockside facility should be registered as Food facility by USFDA

Marketing Plan

It is beyond the scope of this project to develop a Marketing Plan however we realize that there is a large urban community of some 3 million people within 50 miles of the docks. However because of the economic power of the processors and indirectly the wholesalers it will be necessary to develop niche markets where head to head competition is avoided. Alternately we may seek to develop agreements to share markets with one or more processors. In the development of the niche market, the product line shall be expanded by working with other fishermen to include some of the more than 60 species of fish presently landed in San Diego. The list of fish landed in San Diego is presented in Appendix III-C-2 *"CDFG TABLE 21 SD PUB POUNDAGE AND VALUE OF LANDINGS BY PORT, SAN DIEGO AREA DURING 2006."*

Chapter D Receivering Live Sea Urchins to Develop Steady State Supplies

Purpose

As divers explore direct marketing of live sea urchins it is necessary to consider in more detail the issue of reliable quality and steady supply to the markets. We proposed to build and test various types of enclosures (receivers), cages and tanks, to determine if it was feasible to hold harvested red sea urchins in an enclosed area in order to develop a steady supply of red sea urchins during closed seasons and periods of inclement weather. Additionally we would test whether the red sea urchin quality could be maintained or improved during the holding period by feeding or regulating temperature (in the tanks, not the Ocean).

Several experiments were performed:

- Build and test several types of receivers to determine if they would stand up to inclement weather in the open ocean.
- Build and test receivers in the bay to determine if the water quality and temperature is suitable for holding the red sea urchins
- Build circulating sea water tanks dockside to hold red sea urchins for short periods.

Summary

We found that the structural design of the cages was of utmost importance. In order to withstand the harsh ocean environment we had to construct cages of modest size made of materials that had been tested in trap fisheries, an deployed in a fashion that they would not be disturbed. The cages placed in the harbor were dependant on the water quality in the bay. We could not determine the causal factors for the unacceptable mortality rate for the red sea urchins kept in the bay during this study but we suspect that poor water quality played a role. In future the fishermen should work cooperatively with the Port of San Diego Water Board and the Bay Clean Up Program to assess the water quality in San Diego Bay, and more specifically in the areas adjacent to Driscoll's Wharf.

The circulating seawater tank at the docks showed the most promise. Controlled experiments should be conducted in the future to test methods to improve the quality while the sea urchins are in the tanks. During this exploratory period, we have determined that the red sea urchins may be kept in the tanks for several days to ensure steady supply to direct markets during periods of inclement weather, or fishery closures.

Authority to Conduct Experiments

In a letter dated July 23, 2007 we received authority from the Department of fish and Game to test several models of sea urchin enclosures to augment quality and minimize mortality for the period August 1, 2007 through July 31, 2008, pursuant to Section 120.7(a)(2), Title 14, CCR This letter is presented in Appendix III-B-1 *"AUTHORIZATION LETTER"*.

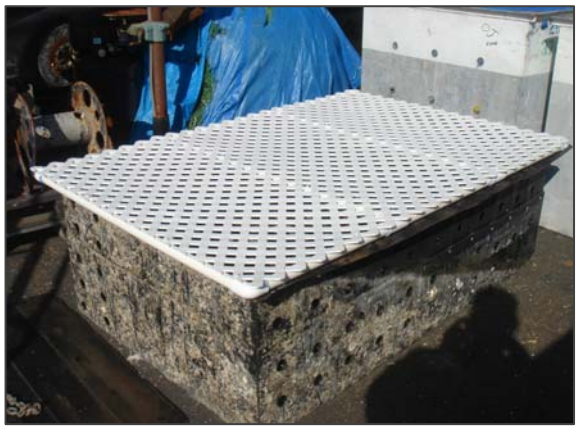
Certain rules regarding the size of the enclosures were made a part of the agreement;" The largest temporary sea urchin enclosure will measure 4' X 6' X 2'. The enclosures will be marked with a tag "SDWA research call (619) 697-2912". Some of the enclosures will be made of wood and plastic, whereas others will be made of welded wire. All temporary sea urchin enclosures used in this study shall be removed from the water not later than 15 days after this authorization expires.

Open Ocean Enclosures

Initial Experiments

We conducted tests on a series of large enclosures. These enclosures are shown in Figure III-D-1First Generation Enclosures.

Figure III-D-1 First Generation Enclosures



These enclosures were deployed during a period of large swells in approximately 50 feet of water. All the cages suffered structural damage and had to be scrapped. The large enclosures holding approximately 350 red sea urchins proved unwieldy to manage and were removed from the ocean. The lessons learned from this part of the experiment were applied in the second stage.

Second Stage Experiments

Based on the results of the initial experiments we designed enclosures of a more modest design. We utilized a basic wire mesh lobster trap which was modified to hold approximately 30 red sea urchins. The red sea urchins were placed in these enclosures and deployed in depths of 100 feet or more.

The design of these enclosures permitted the use of a lobster trap puller mounted on one of our vessels. The enclosures were deployed in deep water where mechanical pullers were required to reduce poaching. The results of these experiments indicated that red sea urchins could be kept in wire cage enclosures for several days with negligible mortality. No poaching occurred during the period of these experiments.

The major issue with holding red sea urchins in these enclosures is related to cost. Harvesting, placing the sea urchins in the enclosures, deploying the enclosures, and then collecting them, proved to be very labor intensive. When the cost of the constructing and maintaining the enclosures were added, the costs of this method proved to be prohibitive.

Dockside Enclosures

In this pilot project we attempted to hold red sea urchins in cages at the docks for five days without supplying any feed. The purpose was to determine if we could establish a steady supply of live sea urchins during periods of inclement weather or during the three days that the fishery is closed during the months of April through October. (The fishery regulations were modified in July, 2008 so that presently the fishery closures in April through October are three days a week).

We built several cages that held approximately 80 sea urchins each and deployed them in the slips at Driscoll's Wharf marina in San Diego Bay. This cage is shown in Figure III-D-2 Dockside enclosure being filled with red sea urchins.

Figure III-D-2 Dockside enclosure being filled with red sea urchins.

We loosely placed 40 red sea urchins in the cage on December 14, 2007. Five days later the sea urchins had developed lesions and the mortality rate was 40%. This experiment was repeated several times with mortality rates of 25%-100% after five days. Since these experiments were done in the winter when the water temperature in the bay is around 61 degrees (F), this should not have been a factor. We believe that degraded sea water quality was the cause of the mortalities. We plan to work with the Port of San Diego Water Board that regulates many projects within the port: the Bay Clean-Up Program, Clean Up and Abatement Orders, Report of Waste Discharge, NDPES permits. This work shall be done as part of the project funded by grant by the Coastal Conservancy to the Port of San Diego titled " Preserve and Encourage Commercial Fisheries in San Diego Bay".

Circulating Sea Water Tanks

The goal of this experiment was to determine if red sea urchins could be kept in a closed system sea water tank for three to seven days. This would enable us to provide live red sea urchins during periods of inclement weather and on Fridays, Saturdays, and Sundays when fishing is not allowed by law.

We determined during the dockside enclosure experiments that the sea water in the bay was of poor quality. Therefore we constructed a circulating sea water tank and used filtered water obtained from Scripps Institute of Oceanography. This system is shown in Figure III-D-3 Circulating Sea Water Tank.

Figure III-D-3 Circulating Sea Water Tank

The system is housed at Driscoll's Wharf Marina at the foot of the offloading pier. The tank and chiller are outside a locked shed whereas the equipment; sump, fluidized bed filter, protein skimmer, and pumps, are located inside the shed. We used an insulated fish tote as the holding tank with a capacity of approximately 170 gallons. We are experimenting with the optimum concentration of red sea urchins that may be kept in the tank. Preliminary tests show that 50 red sea urchins may be the optimum concentration.

During certain periods of the year the harvested red sea urchins spawn during transportation to the dock. We are monitoring the conditions that preclude spawning in the tank and whether the sea urchin quality was degraded or improved after they spawned.

We also compared the quality of the sea urchins kept in the seawater tanks for five days with the quality of red sea urchins harvested from the same area but delivered to the restaurant the day of the harvest. This would determine what length of time the red sea urchins could be kept, whether feeding, or alteration of the temperature was needed to maintain or improve the quality. The preliminary tests show that the chefs observed no difference in the quality of sea urchins harvested the same day and the sea urchins kept in the tank for five days.

Visual inspection of red sea urchins kept in the sea water tank for five days is shown in Figure III-D-4 Cracked red sea urchins after five days in the seawater tank.

We propose to conduct experiments to determine how the firmness and color may be improved through feeding or temperature modification.

The development of this system was exploratory in nature and is intended to serve as a pilot program in preparation for the infrastructure improvements to be developed as part of the Port of San Diego Commercial Fisheries Revitalization and Coastal Public access study funded through a grant by the Ocean Protection Council. Should circulating sea water tanks prove to be useful in storing red sea urchins for several days, we envision ramping up this program to hold several hundred sea urchins and possibly other species.

Figure III-D-4 Cracked red sea urchins after five days in the seawater tank

These tanks may prove to be a necessary part of our ability to provide a steady supply of high quality sea urchins to the markets. Additionally they may prove to be an attraction to the general public visiting the Working Fishing Harbor.

Chapter E Preparation of a Business Plan Framework

Introduction

Although our initial goal was to develop a business plan, for cooperative harvests an value-added product development, distribution, and marketing for the San Diego region of the fishery, we recognized early on that our fledgling Association was not prepared to commit to a business plan without obtaining more background information. Instead we initiated a process of creating a strategic framework that will be used to guide the organization's growth and development over the next three years.

It is the intent of the SDWA to utilize this strategic framework as a foundation for the development of a replicable model for the management of the sea urchin fishery based on science, community-based governance, and value-added markets.

Summary

The Strategic Framework allows SDWA to concentrate on the promising avenues in the near future. Since the incorporation of our Association, SDWA has organized under three primary program areas: Collaborative Research; Market and Business Development; and Local Area Management. We have concluded that SDWA's current primary program areas, objectives and activities are still accurate. Additionally, we have concluded that the broader operating environment will impact our efforts at multiple levels. To address this we shall explore the concept of a broader San Diego fisheries organizing effort.

Consideration for the development of an organizational structure and a business plan at the San Diego Port level is presently being considered in a separate project, under a grant by the Coastal Conservancy to the port of San Diego titled "Preserve and Encourage Commercial Fisheries in San Diego Bay". The work plan for this project includes preparing fisheries business models for San Diego based fisheries.

After assessing the implications of the studies SDWA conducted as part of this project, and reviewing the work by Lisa Wise Consulting we shall initially craft a timeline or critical path of activities, process and decisions. This would be a working document and continually revised as we move forward and learn more.

Strategic Framework

We obtained the services of Mr. Mike Dickerson of Shorebank Enterprises to facilitate workshops and retreats that enabled SDWA directors to develop the framework. The framework was developed in two stages. In the first stage a strategic framework outline was prepared by the SDWA directors at a two day workshop held in September 2007. The second stage consisted of a two day retreat on March 10 and 11, 2008 to develop the Strategic Framework that would guide our actions. This framework is presented in Appendix III-E-1 *"SAN DIEGO WATERMEN'S ASSOCIATION STRATEGIC FRAMEWORK, JULY 2008"*.

Commercial Fisheries Revitalization Plan

The Port of San Diego received a grant from the California Coastal Conservancy to conduct a study called "Commercial Fisheries Revitalization and Coastal Public Access Plan Services". The Port hired Lisa Wise Consulting to work with the fishing industry to increase efficiency by supporting public infrastructure improvements, developing improved market paths, and markets for value added products

It is planned to redesign the working harbor as a center of fishing activity and commerce. The study will consider how the infrastructure and facilities shall be modernized and upgraded for the supply, offloading, transporting and marketing of fish. The study shall make recommendations as to how marketing may be expanded to include direct sales to processors, wholesalers, retailers and the public in both live and fresh states. Task 7 in the proposed work plan of the Revitalization Project is to develop Fisheries Business Models for the fishermen in the Port of San Diego.

The business plan for the San Diego sea urchin industry should nest within the overall San Diego fisheries business models. Once the fisheries business model for the fishermen of San Diego has been completed we shall craft a timeline or critical path of activities, process, and decisions for the sea urchin fishery part.

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APPENDICES