

UNITED STATES
DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
State, Federal & Constituent Programs Division



FINAL REPORT

Grantee: **COASTAL PLANTATIONS INTERNATIONAL, INC.**

Project No: **94-FIG-068**

Grant No: **NA56FK0097**

Project Title: **DEVELOPMENT OF PORPHYRA (NORI) POLE CULTURE AND
THE ESTABLISHMENT OF THE AMERICAN SEAWEED FARMER**

Period Covered: _____

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Approved by: _____

Date: **DECEMBER 17, 1996**

Statutory Funding Authority: ☐ Anadromous Fish Conservation Act
(P.L. 89-304)
☐ Chesapeake Bay Studies
☐ Endangered Species Act
☐ Interjurisdictional Fisheries
Act (Title III of P.L. 99-659)
☐ Magnuson Act
☐ Oyster Disease Research
☐ Saltonstall-Kennedy
☒ Unallied Industry Projects
☐ Unallied Science Projects
☐ ACFCMA

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One Blackburn Drive
Gloucester, MA 01930

FISHING INDUSTRY GRANT (FIG)
NOAA Award Number NA56FK0097
**Development of *Porphyra* (NORI) Pole Culture and the Establishment of the
American Seaweed Farmer
Final Report**

Submitted By:
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December 17, 1996

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I. Executive Summary

CPI has endeavored to establish a *Porphyra* (Nori) cultivation and processing industry in the Gulf of Maine and Maine's coastal waters. The company's efforts have resulted in the expansion into the Maritime Provinces of Canada and a planned expansion into the other coastal New England States. Restrictions on the size of aquaculture concerns in Maine (150 acres of lease sites per company) has resulted in CPI developing the concept of the family nori farmer and the nori farming cooperative to provide additional nori crop landings to meet market demands. The additional cultivation capacity is essential in realizing economies of scale in the processing, marketing and distribution of nori.

The Fishing Industry Grant (FIG) award through the offices of the United States Department of Commerce (USDC), National Oceanic and Atmospheric Administration (NOAA), and the National Marine Fisheries Service (NMFS) Award # NA56FK0097 was critical to our efforts to recruit, train and develop independent nori farmers. The 18 month award enabled CPI to: 1. Create a pilot nori pole farm; 2. Recruit potential nori farmers; 3. Develop a nori farming manual, training course; 4. Identification of the economic opportunities related to nori pole farming; and 5. Exam critical biological issues involved in the farming process.

The program, now complete, offered an eight month training course, including both in class and on site experiences. Lessons ranged from industry history, cultivation biology and techniques to economic opportunities. Subsequently, a nori manual incorporating the lessons of the course has been authored by CPI.

Results can both be immediately assessed and determined in the years to come. Presently, one individual fisherman and one growing cooperative started by a fisherman are well through their initial stages. Future participation will be a function of the initial successes by the "pioneers" and the State's resolve to support additional aquaculture lease in the coastal waters.

The development of a marine agronomic industry in New England has been difficult, but the initial period is now complete. The first five years of development have resulted in an emerging industry. The potential is great for this environmentally beneficial aquaculture opportunity in the coastal waters of the United States.

II. Introduction

"Vilor Algae" (translated as more vile or worthless than algae), wrote Virgil, the Latin poet. However, the importance and value of algae had been realized long before the poems of Virgil were composed. The use of algae dates back to

the time of Shen Nung, the father of husbandry and medicine, approximately 3000 BC (Wood, 1974; Dias-Pifferer, 1979; Doty, 1979). Seaweeds have been, and are, used as a source of; food, chemicals, pharmaceuticals, animal fodder, and fertilizer. The consumption of nori, long prized by the Japanese and macrobiotic diets, is a source of taurine (Noda et al., 1975) which controls blood cholesterol levels (Tsuji et al., 1983). Additionally, Noda (1993) concluded *Porphyra* is a valuable health food source as it contains high levels of protein (25-50%), vitamins (greater percentage of Vitamin C than in oranges), trace minerals, and dietary fiber.

Red seaweed and seaweed products represent more than a billion dollar per year industry (Edwards et al., 1982; Mumford and Miura, 1988). Humans have largely depended on the harvest of wild stocks for its supply of algae, but an increasing demand for certain species has created a need for reliable sources of raw materials. Seaweed cultivation has increased tremendously in the last decades, making seaweed the sixth largest dollar earner of all mariculture products (Pillay, 1976) and the largest dollar earner among fishery products in Japan (Anonymous, 1982).

The cultivation of *Porphyra* is 1000 and 1500 years old in Japan (Korringa, 1976; Chen et al., 1990) and China (Tseng, 1981), respectively. Historical culture techniques included habitat manipulation and selection as a function of natural *Porphyra* reproduction cycles. The identification of the alternate form of *Porphyra* (Drew, 1949) resulted in the development of the modern nori cultivation system.

The red alga *Porphyra* (Rhodophyta: Bangiales) has been utilized by humans as a food source throughout the world. In 1992, approximately 15 billion sheets of *Porphyra* (nori) were produced (N. Takaoka, pers. comm.). The consumption of nori in the United States is dependent upon importation from Japan, Korea and China. *Porphyra* is a preferred source of R-Phycoerythrin utilized in fluorescent immunoassay and microscopy.

The nori market is global, with North America comprising a small percentage of the total. Markets experiencing the greatest rates of growth include the USA, United Kingdom, Germany, and Taiwan (Japan Ministry of Finance, 1976-1991). Presently, the largest markets are located in China and Japan.

The development of a competitively produced American nori would establish an alternative business and/or employment opportunity to U.S. commercial fishermen who have been affected by the recent changes in their industry. Domestically produced nori would provide the consumer with a fresher and healthier source of this delicacy, establishing a local source of R-Phycoerythrin and promote an alternative utilization of aquaculture lease sites.

III. Purpose

The successful development of an efficient nori production and processing program in Maine would stimulate similar aquaculture systems in United States coastal waters from Maine to North Carolina and from Washington State south to California.

The development of a fixed pole culture nori system can utilize both the subtidal and the lower intertidal zones throughout the Northeast and are especially suited to Cobscook Bay and its eight meter tidal regimes. The mud flats can be leased through the State's individual Municipal Clam Committees. Eastport's Committee has previously voted to allow such development, which provides an opportunity to individual nori farmers such as displaced commercial fishermen. Presently, there are conflicts to intertidal aquaculture. These activities have recently been challenged by riparian land owners and supported by the courts, resulting in the restriction of intertidal nori culture.

The critical phases in the development of a nori pole culture industry is the successful transfer and modification of nori cultivation technology from Japan to the Maine coastal environment.

The area of investigation is Cobscook Bay, Northeastern Maine. The geographical isolation of this region has historically limited the economic diversification. The population is an under utilized, marine experienced labor resource. The development of the labor intensive algal mariculture industry would significantly reduce the unemployment rate, offer new opportunities to coastal fisherman, and reduce the reliance on the single dominant (salmon farms) source of employment.

The Northeastern fishing fleet has been significantly affected by the fish population decline and the subsequent regulations and restrictions. Government support is essential for mariculture expansion which would significantly increase the nori farming access to individuals and cooperative efforts. It is beyond the means of Coastal Plantations International, Inc. to invest in the essential research and development necessary to establish the economic and technical viability of nori pole culture and the establishment of the independent American Seaweed Farmer.

Project Goals

1. **Establishment of a family seaweed farmer.** Recruitment and training of displaced fishermen will be a resource pool of future nori farmers. The transformation of fisherman to fisherman/nori farmer has been successfully undertaken in Southeast Asia and the concepts developed from that model will be utilized in this project.

2. **Creation of nori farming manual and training course.** Coastal Plantations International, Inc. has previous history in sponsoring fellowships, nori seminars, and on-site training for potential nori farmers. This experience will be expanded into a standardized format to be offered by the individual State Cooperative or Aquaculture Extension Services Departments.

3. **Establishment of a pilot nori pole farm.** CPI will transfer the floating cultivation system technologies to the fixed pole format.

4. **Evaluate the nori farming business and/or employment opportunities for displaced fishermen.** A proforma will be developed from pilot farm financials including economies of scale and CPI marketing research.

IV. Approach

A. The work performed was segregated by objective.

1. Establishment of family seaweed farmer

Building upon CPI's October 12, 1994 nori farming workshop (Figures 1&2) notices were placed in the March 24, 1995 (page 13) of The Quoddy Tides, City of Eastport and Washington County newspaper (Figure 3) and the April 1995 Commercial Fisheries News (page 24A) (Figure 4). The public notices, word of mouth and contacting previously interested individuals resulted in a list of potential nori farmers (Table 1).

2. Nori manual and Training Course

The course was offered from May 1995 - December 1995 (Appendix I). The classroom activities were held at the Washington County Technical College, Eastport, Maine. All practical or hands on training was accomplished at the CPI lab and factory, 11 Madison Street, Eastport, ME 04631 or on-site at the pilot pole farm, Cobscook Bay, Maine.

The training manual was developed by CPI personnel throughout the training program and completed some months thereafter.

3. Establishment of pilot nori pole culture farm

Application for and receipt of Maine Department of Marine Resources (MDMR), Army Corps of Engineers (ACE) and United States Coast Guard (USCG) permits and licenses were received April 4, 1995, April 4 and May 1 1995 and March 28, 1995 respectively (Appendix II).

The farm was assembled by CPI personnel prior to the training course. Original concept and design specifications were ascertained from Japanese farming sources and modified to Cobscook Bay environmental parameters.

4. Nori farm economic potential

Economic opportunities were developed from estimates and observations made by field personnel and reviewed by in-house accountants and the CPI management team. The economic potential of the pole farm was developed for three size farms, 100, 200 and 500 saku (net space) farms. The typical single family farm in Japan is 200 Saku. The differences between a typical Japanese model and this analysis is no labor nor insurance costs are encumbered. Additionally, primary processing is usually performed by the family farmer's local cooperative.

The analysis is based on economic assumptions thought to be accurate as of August 1996. CPI shall not be held responsible for the cost assumptions and estimated throughout this analysis. The potential changes and variability of estimated values are a function of the fluctuations in Local, State, and Country political policies, elapsed time, inflation rates, and exchange rates, which are beyond the control of CPI for this exercise (Appendix VI).

5. Experimentation

Determination of tested environmental parameters was a function of cultivation uncertainties. The experiments were conducted under field conditions and not in laboratory bench facilities. External environmental parameters were controlled as closely as possible considering the basic premise of the study; the identification and delineation of specific data whose results would assist the farming program. All experimental design, experiments data collection and analysis were performed by CPI personnel at the Eastport facility, aquaculture lease site, or the corporate lab (1219 Maine Street, Poland, Maine 04274). Experiments initially were designed to optimize growth, flavors and pigment content as a function of temperature, nutrient level, water motion, salinity, light quality, quantity and photoperiod.

B. All work, except that done by the consultants, was performed by CPI. Classroom space was leased from Washington County Technical College, Eastport, Maine.

Project Management:

Principle Investigator - Ira A Levine, Ph.D., President of CPI

Nori Manual Author and training Manager - Steve Crawford, CPI

Cultivation Field Supervisor. Steve Theriault, CPI
Maraculturists - CPI field staff employees:
Consultants - Cultivation Science, disease control, Japanese technology
transfer assistance;
Dr. Donald Cheney - Northeastern University
Dr. John Merrill, Applied Algal Research

Additionally the Maine Aquaculture Association, Maine Aquaculture Innovation Center, and Maine Sea Grant College Extension officer, Chris Bartlett, assisted in information and farmer recruitment.

V. Findings

A. Actual Accomplishments and Findings

See Appendix III - copies of CPI quarterly progress reports for a time series of progress.

1) **Establishment of seaweed farms** was initiated through the training program recruitment process which yielded a list of 79 potential nori farmers. (See Table 1) The program was open ended with registrations recorded from March 1st through December 31, 1995.

2) **Nori Farm Manual** is presented as Appendix IV. The training course (See Appendix I) was initiated March 1995 and completed December 1995. Topics included; nori introduction and biology, FIG program, economic potential, permitting, and farming techniques (farm materials and equipment, seeding, nursery techniques, site selection, farm assembly, harvesting and primary processing). Training course attendance ranged from 22 to 47 nori farming training participants.

3) **Pilot Farm** permitting was completed May 1, 1995 (see Appendix II). Farm Assembly was complete July 1995 (See Appendix V). The pole farm consisted of 15 nets (five rows of three nets each). Seeded nets were deployed in July 1995 with the final harvests completed by November 1995. Disassembly was completed by Jan 1, 1996. Harvest yielded approximately 300 pounds of market grade nori.

4) **Economic opportunity** - The potential gross and net profits were estimated for a 100, 200 and 500 saku (net frame space) farms at \$ 34,000/4,866; 68,000/24,052 and 170,000/58,074, respectively. These figures are based upon equipment amortized over five years (refer to Appendix VI for details). Net profits for a 100, 200 and 500 saku farm increase to \$ 9,350,

31,077 and 72,645, respectively when capital equipment is amortized over ten years.

5) **Experimental design** concentrated on conchocelis growth, conchospore release and attachment, monospore production, indoor blade cultivation and the establishment of the optimal net position in the pole array. Results can be found in Appendix VII. Optimal environmental parameters are: 1. Conchocelis cultivation - 22°C, long day (16:8), exposed to full spectrum fluorescence; 2. Conchospore release - light intensity 200 - 1000 $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$, sunlight, mercury or sodium halide light, and 18-20°C; 3. Conchospore attachment - light intensity 400-800 $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$, mercury or sodium halide light, and new nets; 4. Monospore production and attachment - day neutral (12:12) and light intensity 200 $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; 5. Indoor blade cultivation - temperature 12°C; and 6. Net position of 1.3 to 1.6 meters above mean low water.

B. Significant problems encountered

Difficulties encountered included; permitting difficulties, effects of commercial dragging, equipment acquisition, the fishing - farming transition and experimental design.

Permitting

CPI experienced a drop in attendance midway through the training course. Apart from normal course attrition we were made aware of a prevalent attitude of the Maine Department of Marine Resources concerning future permitting of nori farms outside the waters of Eastport, Maine. The following was related to Mr. Harold Mears of NMFS in my letter dated April 3, 1996.

Mr. Foster, a Scientist IV of the Maine Department of Marine Resources (MDMR) took it upon himself, with no authorization, to interpret our existing permits. Mr. Foster, without notifying CPI or his MDMR superiors, determined that our ability to grow nori was restricted to the waters of Cobscook Bay. Our permits clearly stated that nori cultivation is intended for the Coastal Waters of Maine and/or the Gulf of Maine. We became aware of this situation when several potential nori farmers started to complain about their ability to secure nori growing lease sites in Maine waters. After hearing this we traced the source of these concerns back to Mr. Foster. I immediately notified the MDMR's commissioner and inquired as to the status of our program. Penn Esterbrook the assistant commissioner was unaware of any difficulty nor directive in this area. Continued investigation brought Mr. Foster's action to everyone's attention. Mike Hastings, Executive Director of the Maine Aquaculture Innovation Center, arranged a conference call between himself, Esterbrook, Foster and myself with the stated goal to ascertain the root cause of Mr. Foster's actions. The result of the call was Mr. Foster admitting to his unauthorized and personal interpretation of the permits. We consulted Dr. Jim Carlton of International Council of the Exploration of the

Seas and the University of Connecticut at Mystic who was instrumental in our getting permit approval. Dr. Carlton refuted Mr. Foster's interpretation. As a result Mr. Esterbrook and Mr. Hastings assured me that Mr. Foster would be silenced, and that the MDMR did not share his opinion concerning our permits. Mr. Foster was recently demoted to a scientist II position. He has not been heard from since!

Commercial Dragging

Affects of urchin and scallop dragging have been noted over the years. The increase in turbidity from secchi disc readings of + 4.0 meters to <0.5 meters upon the initiation of seasonal dragging has resulted in growth rate fluctuations and dislocation and/or complete collapse of our floating cultivation systems due to illegal dragging inside the aquaculture equipment exclusion zone.

Equipment Acquisition

Pole acquisition continues to be a major challenge in Eastport and all waters located at the mouth of Bay of Fundy. The extreme tidal amplitudes realized prevent standard nori poles (Japan) from being utilized. Additional materials were investigated and rejected. Wood (diameter too large and uneven) was found too difficult to install and assemble appropriate hardware to, domestic fiberglass was found to be too expensive at \$7/ft.

Surplus metal poles were acquired for this project. Standard nori poles can be imported or molded domestically for areas experiencing tidal amplitudes of less than five meters. Continued efforts are needed to identify a cost effective material for appropriate nori pole farm sites with tidal amplitudes greater than five meters.

Fishing - Farming Transition

Nori farming represents a disciplined marine agronomic commitment requiring daily maintenance and attention to detail. This concept was continuously discussed throughout the program. Comparisons to dairy farmers and their work schedules were made. These concepts of attention to detail and the daily if not hourly scheduling of work efforts were not received enthusiastically by the commercial fisherman who were involved with the program.

Experimental Design

Field based experimentation and the control of dependent and independent variables proved to be a challenge. The results of several experimental designs were rendered useless due to uncontrolled fluctuations in both variables. Nutrient and field production experimentation were critically hampered and thus discontinued.

VI. Evaluation

a. Description of the original project goals and objectives, and the context in which the project was to benefit the fishing industry.

a-1) Original Project Goals and Objectives

Establishment of a family seaweed farmer

The development of viable family seaweed farmers and nori farming cooperatives could offer displaced commercial fisherman an opportunity to maintain an independent open water working lifestyle.

Creation of a nori farming manual and training course

The nori farming manual and training course offered in 1995 were intended as the first two practical steps in training the next generation of nori farmers for this region.

Establishment of a pilot pole farm

The assembly of the region's first pole farm would provide the training course participants with an actual cultivation system by which to observe and experience nori farming. Secondly, the pole farm represents an attempt to exploit new habitats, closer to shore, resulting in a system more appropriate for the contract farmer.

Evaluation of Economic Potential

Nori farming will only be embraced if and when an attractive rate of return is both projected and realized by the pioneer participants.

Experimental Program to reduce cultivation uncertainties

The Experimental program was designed to reduce a number of cultivation inconsistencies experienced over the course of developmental cultivation phases.

a-2) Are goals measurable or quantifiable?

Family Farmer results are quantifiable by delineating the number of recruits, nori training course participants, and the number of new nori farmers.

Farming Manual/Training Course completion is measurable by receipt of CPI farming manual.

Pole Farm value is both measurable and nori-measurable. The farm was assembled and a measured crop delivered. Parameters of pole farming was ascertained and quantified resulting in an increase in cultivation efficiencies.

Economic opportunities have been quantified via development of proforma.

Experimental Design resulted in data which increased cultivation efficiencies.

a-3) The single modification to project goals entailed the training course. The course was offered and delivered on-site at the CPI facilities. No external packaged course has been developed for off-site, extension program officer delivered training program.

a-4) CPI believes goals 1-4 plus the experimental program were achieved to variable degrees of success. We await additional nori farmer commitments in the near future (two additional efforts from New Brunswick are presently in the permitting and funding acquisition stage) after the documented success by the initial pioneer participants is achieved and publicized.

b. Specific Project Accomplishments in Relationship to Project Goals and Objectives

b-1) List the specific information, products or services produced: 1. Recruitment list; 2. Completed training course; 3. Farming Manual; 4. Pilot Farm; 5. Economic opportunity of Nori Pole Farming; and 6. Cultivation Data.

b-2,3) This project's goals and objectives had one unifying vision; to recruit, train and develop an independent nori farmer primarily from the population of displaced commercial fishermen. The processes of recruitment, training, development of supplemental materials and the identification of the economic potential are all pieces of a complex social-biological-economic transition for many people. The information produced by this project can assist the presently involved aquaculturist as well as individuals and groups of individuals starting from square one. The final products of this program will assist the initial participants but also offer valuable reference materials to those who may become involved in the future.

b-4) Increases in economic, social and biological value are difficult to quantify. Presently, interested future nori farmers can request the farming manual and proforma. CPI is available to assist in equipment specifications, site selection, permitting and as a source of seeded frozen nets. How does one value the information necessary to assist new farming projects. Quantification shall be left to a review of the industry status some point in the future and lies outside the capacity of this project.

Two ex-fishermen are presently risking their sweat equity and personal wealth on this concept. The commitment to a new untried industry is difficult for most individuals. One must possess the "frontier spirit" to jump in where no one

has before. The success of these initial efforts will fuel the recruitment of future nori farmers.

The ability to efficiently produce seeded nets and effectively farm nori on fixed pole configurations represents a unique facet to open water agriculture and a new industry to the United States.

c. Benefits to the Fishing Industry

Presently, it is unclear how the fishing industry will benefit from this program. Information is now available and the chance for success high but is highly dependent on the functional discipline of the individuals involved.

c-1) Product Access

CPI's FIG award was well publicized. CPI built on the initial publicity award generated with notices in the local newspaper as well as a traditional commercial fishing publication. The MAA, MAIC, News Articles, Radio and TV programs which covered our programs all mentioned the availability of the nori training course. We received inquiries from literally across the street to around the world. Training course participants traveled from Boston to Eastport to attend. The geographical and temporal responses we have and continue to generate indicate a near universal awareness to the opportunity.

c-2) Project Product Utilization

The extent to which this project's products have been utilized have been well documented. Two fisherman have embraced the concept through the permitting and financing stages. Dennis Moran (ex-commercial Fisherman formed the Blue Hill nori farming cooperative (see Appendix 8) in Eggemoggin Reach, Maine and Glen Foster (lobsterman) of Grand Manan, New Brunswick, Canada have received the permits and financing for a nori farm scheduled for initial deployment in spring of 1997. This represents the blueprint for the future. One individual farmer and one nori growing cooperative. The final part to the nori farming troika is the development of nori:salmon polyculture which is presently being developed.

c-3) Future Industry Utilization

The future utilization of the farming manual and economic analyses can not be determined at this time. Anecdotally, the New England States and the Maritime Province have expressed interest in the concept as well as the relationship between CPI and the independent nori farmers.

There now exists an ability to access information and tap into CPI's experience to support an expanded, independent nori farming industry in the Gulf of Maine.

c-4) Additional Support to Fishing Industry

As nori cooperatives evolve along with nori-finish polyculture, the need for skilled, water experienced labor will increase employment opportunities. Presently, there are no estimates as to the magnitude of this opportunity.

Domestic sources of nori poles, nets and boats must be developed. CPI has struggled with importation of equipment and supplies. CPI has developed several domestic suppliers of nori capital goods, often providing technical diagrams or molds to assist the local manufacturers. Increased capital equipment and supply acquisition from domestic sources will support local economies which increase the economic well being of coastal communities resulting in increased abilities to support local fisheries.

D. Specific Economic Benefits to the Fishing Industry

The economic benefits realized as a result of this program are difficult to demonstrate at this time. The recruitment and training course introduced the concept to a skeptical and uninformed public. As in any new concept, there will be pioneers and followers. We have closely assisted the first individuals and growing cooperative. They have received direct benefits including; an award of \$ 74,000 NMFS Demonstration Farm Grant to determine the economic benefits of independent nori farming, private and public funding of the New Brunswick nori farming initiative. Determination of the final results of these projects are years away. The Blue Hill Nori Farming Cooperative has been granted their ten year, 8 acres nori lease site on December 6, 1996. The Grand Manan project is scheduled to put their first nets into the water in the late spring of 1997.

The completion of the farming manual and the successful conclusion to the pioneering efforts will result in the next wave of nori farmers.

This programs actual nori yield is negligible as compared to future potential landings. The question of demonstrable effects should be revisited in five to ten years.

E. Federal Assistance

The need for federal assistance to develop nori cultivation as a mature industry are as follows:

1. The second question asked after "What the heck is nori and you actually eat this stuff" is "How much does it cost to start a nori farm". As in any business venture, start up capital may be the greatest barrier to entry;
2. The need to develop appropriate, commercially viable strains for geographical diverse culture sites;
3. Site selection and permitting assistance providing potential nori farmers with an extension officer schooled in site selection preferences and the perils and pratfalls of aquaculture lease site permitting;
4. Support for an aquaculture extension office providing nori training seminars adapted to individual States' environmental challenges. Additionally, the public/private participation in Florida's gulf coast shellfish aquaculture industry provides a model for establishing a new maraculture potential to a depressed area. Assistance with site selection, capital acquisition, permits, seed stock, and training has resulted in a growing shell fish aquacultural industry in Florida. Similar models can be adapted by either State or Federal programming mandates.

VII. Conclusions

1. There is a strong desire by the public for new, ocean going aquaculture opportunities.
2. Pole farming offers a stable platform to cultivate nori.
3. Fisherman can make good nori farmers if they possess the organizational discipline of a dairy farmer.
4. Demonstrable success will inspire additional nori farming recruits.

Will nori farming provide a viable alternative to displaced commercial fisherman? Yes, but it is premature to claim fisherman will embrace nori farming regardless of the potential opportunity. Secondly, coastal States must adapt a pro-aquaculture lease policy and aggressively pursue and protect lease site infrastructure. Future work includes: continued basic research on nori ecology and production, strain selection as a function of developing new cultivation grounds, refinement and standardization of training program; training program for extension agents, development of domestic equipment and supply vendors, and the continued development of economic opportunities for nori farmers.

Marine Agronomy represents an environmentally beneficial industry which has the opportunity to provide economic and social benefits to a wide variety of coastal communities. The future of this industry is dependent upon the individual states aggressively supporting aquaculture site permitting and the recruitment of

individuals with a "Frontier Spirit" to embrace a demanding yet very exciting way of life.

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Table 1. CPI
NORI SEMINAR MAILING LIST

First Name	Last Name	Company	Address	City	State	Postal Code	Phone	Work
		C-Tek	113 Palm Street	Bangor	ME	04401		
George	Albani		P.O. Box 1561	Manomet	MA	02345	508-224-2874	
Victoria	Babb		5922 Kingman Ave #D	Bueno Park	CA	90621	714-739-8378	
Art	Barbour		RR 1, Box 36	Trevett	ME	04571		
Dr. Bob	Bayer	UMO	Hitchner Hall	Orono	ME	04469		207-581-2785
Debra	Bishop		General Delivery	Sargentville	ME	04673		
William	Blaiklock		Route 127, Hc33	Bath	ME	04530	207-443-9725	207-442-2978
Jim	Bonnes		RR1, Box 1305	Blue Hill	ME	04614	207-374-5483	
Michael	Browne		47 Hunts Point Rd.	Cape Elizabeth	ME	04104	207-767-6578	
Bob	Bruce		58 Kenwood St	Portland	ME	4102	207-874-6487	
Darrell	Buck		6590 E. Price Rd.	St. Johns	MI	48879		
Cecil	Cates		138 Water Street	Eastport	ME	04631	207-853-4423	
Robert	Chaffey		2 Custom Street	Eastport	ME	04631	207-853-4660	
Charlie	Chandler	Chandler Fisheries		Gloucester	MA	07930	508-468-6271	
David	Chapman		381 County Rd.	Scarborough	ME	04074	207-839-6987	
Joe	Cilliers	Rand African Univ.	P.O. Box 1157	Auckland Park, S.Africa		2006	fax 27 11 837 2	
Craig	Cirone		P.O. Box 274	Adison	ME	04606	207-483-2232	
Ernest	Cirone		P.O. Box 274	Adison	ME	04606	207-483-2232	
Lori	Collier		P.O. Box 424	Bucksport	ME	04416	207-464-3201	
Sarah	Conner		P.O. Box 365	W. Southport	ME	04576		
John	Cook		P.O. Box 256	Raymond	ME	04071	207-655-4436	207-627-4599
Steven	Coombs		P.O. Box 191	Bath	NH	03740	603-747-3425	603-747-3572
Matthew	Davis		Rfd 1, Box 580	Surry	ME	04684		
Ralph	DeWitt		High Street	Eastport	ME	04631	207-853-0662	
Job	Eagleson	320 Liliuokalani Ave	Apt 1603	Honolulu	HI	96815	808-922-3854	
Gene	Fletcher		P.O. Box 194	Harrington	ME	04613	207-483-4044	
Rob	Gray		10 Gibbs Ave	Warham	MA	02571	508-295-3540	
John	Gulline		P.O. Box 449	Blue Hill	ME	04614	207-374-5371	
Steph	Hart		P.O. Box 315	North Haven	ME	04853	207-867-2040	
Anne	Hawkins		9 Franklin	Eastport	ME	04631	207-853-6248	
Barry	Hill		St. George	New Brunswick EOG	2YO	Canada	506-953-4000	
Mark	Hoster		P.O. Box 518	Warren	ME	04864	207-367-5886	207-273-3795
Reg	Hoyt	C-Tek	113 Palmer Street	Bangor	ME	4401	207-941-8554	
Paul	Hughes		1 Atattac Street	Marramack	MA	01860	508-346-8384	
Ellen	Irving		240 Madison, Ste. 12-D	New York	NY	10002		
Ron	Jackson	N. Atlantic Produce	P.O. Box 146	Rockland	ME	04841	207-546-0331	
Jerry	Jackson	N. Atlantic Produce	P.O. Box 146	Rockland	ME	04841	207-546-0331	
Stafford	Jones		P.O. 245	Eastport	ME	04631	207-853-2649	
Bob	Lally		RR1, Box 188A	Pembroke	ME	04666	207-726-4694	

Table 1. CPI
NORI SEMINAR MAILING LIST

Tom	Lane		RR1, Box 250	Pembroke	ME	04666	207-726-4694		
Jerry	Levy	Kew Garden Rd	107-81 Ave.	Kew Garden	NY	11415-1107			
Bill	Look			Beale Island	ME		207-497-2834		
Kevin	Lynch		HCR31 Box 485	Ellsworth	ME	04605			
Stanley	MacNichol		Gin Cove Road	Perry	ME	04667			
Hugh	Madill		P.O. Box 129	St. George	NB	EOG-2YO	Canada		506-755-4000
Jim	Malloy		P.O. Box 94	Birch Harbor	ME	04613	207-963-7230		207-546-2331
Patrick	Mehr		RR1, Box 40025	Charlotte	ME	04666	207-454-7441		
Phillip	Minor		P.O. Box 73	East Bluehill	ME	04929			
Dennis	Moran		P.O. Box 251	Deer Island	NB	EOG-2JO	Canada		
Mike	Moody		RR1, Box 240	Pembroke	ME	04666	207-276-3943		
Eric	Morrison		RR1, Box 269	Harrington	ME	04643	207-483-2425		
Jeff	Moser		RR1, Box 630A	Boothbay	ME	04537	207-633-7006		
Ed	Nato		41 Eastman Rd.	Nashua	NH	03060	603-888-0125		
Jim	Nunes		RFD Box 34 B	Cherryfield	ME	04622	207-546-2150		
David	Paiva		703 Main Street	Malden	MA	02418	617-397-2874		
Wesley	Patterson		Back Bay	Canada	NB	EOG-1BO	206-755-3077		
Bryan	Pearce	UMO	Aubert hall	Orono	ME	04469			207-581-1216
Tom	Pereira		Box 519	Woods Hole	MA	2543	508 457 1019		
Tom	Pottle			Perry	ME	04667			
Paul	Raspante		P.O. Box 34	Surry	ME	04684	207-667-7206		
R.	Raymond		4 Hawkes Ave	Eastport	ME	04631	207-853-0631		
Lee	Richardson		RR1, Box 393	Machias	ME	04654	207-255-3863		
Bruce	Riley		21 Mist Hill Drive	Brookfield	CT	06804-1611	207-775-5811		
Gary	Robedee		RR5, Box 258	West Gorham	ME	04038	207-727-5811		
Connie&Angela	Rogerson		Leonardsville	Canada	NB	EOG-2GO	506-747-2007		
Robert	Roxby		86 North 4th Street	Old Town	ME	04468	207-581-2816		
Dave & Ellen	Simmons		P.O. Box E	Sargentville	ME	04673	207-359-2314		
Emily	Sinagra		28 Rare Eastern PT. Rd	Gloucester	MA	07930	508-281-5915		
Peter	Steenstra		5 Dillingham Rd	Camden	ME	04543			
Eric	Streiff		109 Whipple Rd	Kittery	ME	03904	207-439-0370	fax	207-439-2789
Carrie	Sucher		HCR 31, Box 314	Phippsburg	ME	04562	207-389-2622		
Nancy	Taylor		49 Pleasant Valley Dr.	Worcester	MA	06105	207-853-6843		
Steven	Therault		51 Shackford Street	Eastport	ME	04631	207-853-2134		
Paul	Thompson		P.O. Box 375	Cutler	ME	04626	207-255-2134		207-255-3931
James	Tucker		RR1, Box 4547	Camden	ME	04843	207-236-4160		
Peter	Wan		RR4, St. George	Canada	NB	EOG-2YO	506-755-2664		
Pat	Wankrea		P.O. Box 300	Bowdoin	ME	04008	207-737-2022		
Thomas	Wentworth		P.O. Box 75	Pembroke	ME	04666	207-726-4751		
Greg	Wilcox		P.O. Box 40	Canada	NB	EOG-2HO	506-659-3096		
Debra	Wilson		P.O. Box 476	Boothbay Harbor	ME	04538	207-633-2013		

THE QUODDY TIDES

Most Easterly Newspaper Published in the United States

Vol. 26, No. 21 Published the 2nd & 4th Fridays of each month Friday, September 23, 1994 Second class postage paid at Eastport, Maine, & St. Stephen, N.B. 75 cents a copy

Workshop on nori farming to be held

Last year, Coastal Plantations International Inc. (CPI) in Eastport produced thousands of sheets of nori seaweed wrappers for sushi, a Japanese delicacy made of raw fish and rice. On October 12, CPI will host a one-day nori farming workshop at Washington County Technical College (WCTC) in Eastport to share their expertise with potential nori farmers.

The workshop, co-sponsored by the University of Maine Sea Grant Marine Advisory Program, will cover the history of nori farming, the status of the industry in the U.S. and the Far East, nori biology, farming techniques, economic potential, and the nori fisherman development program. Morning seminars will be held at WCTC and site visits to CPI's nori farm

in Cobscook Bay and their processing facility in Eastport are scheduled for the afternoon.

CPI has the only nori processor in the western hemisphere.

Last year, nori represented a \$2 billion industry in Japan. Although the U.S. market for nori is about \$30 million a year and expanding 10 to 15 percent a year, all of the product is imported. According to CPI General Manager Steve Crawford, nori is an ideal candidate species for aquaculture since it grows like a weed, brings over \$25 a pound wholesale, requires very little capital investment for the grower, and is much less of a risk than growing fish.

CPI is still experimenting with growing, harvesting and processing nori and has not grown any other product on a commercial scale. Their long-range goal is to sell seeded nets to those interested in growing nori, and then CPI would harvest, process and market it. Crawford sees seaweed farming as a complementary adjunct to finfish aquaculture since the seeded nets can be installed at existing fish cage sites.

The nori farming workshop will be offered free of charge. For more information, contact Chris Bartlett or Joanne O'Grady at 207-853-2518.

Seafare

A publication of the University of Maine/University of New Hampshire Sea Grant College Program • Fall 1994

(Photo by Bob Bayer)

In the past decade, Eastport, Maine, has become the salmon farming capital of the U.S. Now this small town is the site for the newest aquaculture industry—seaweed farming—and home of Coastal Plantations International, Inc. (CPI), the only seaweed farming company in North America.

Last year, CPI produced over one million sheets of nori wrappers for sushi, Japanese delicacies made of raw fish and rice that are rapidly gaining popularity in this country.

On October 12, CPI hosted a one-day workshop at Washington County Technical College (WCTC) in Eastport to share its expertise with potential nori farmers. The workshop, cosponsored by the Maine/New Hampshire Sea Grant Marine Advisory Program, drew more than 50 participants from as far away as Massachusetts and Nova Scotia. Ike Levine, president of CPI, led the morning session at WCTC, which included seminars on the history of nori farming, the status of the industry in the U.S. and the Far East, nori biology, farming techniques, economic potential, and the nori fisherman development program.

In the afternoon, participants visited CPI's 120-acre nursery and grow-out site in Cobscook Bay and its processing facility in Eastport. Nori is a red-brown, translucent seaweed that is usually dried, ground into a pulp, and

However, it is also eaten in its natural form in many parts of the world. In Asia, where it has been grown for over a thousand years, it is an everyday food. For centuries, nori has been recognized for its medicinal qualities. It is now known to lower cholesterol and is being studied as a cure for stomach cancer and ulcers.

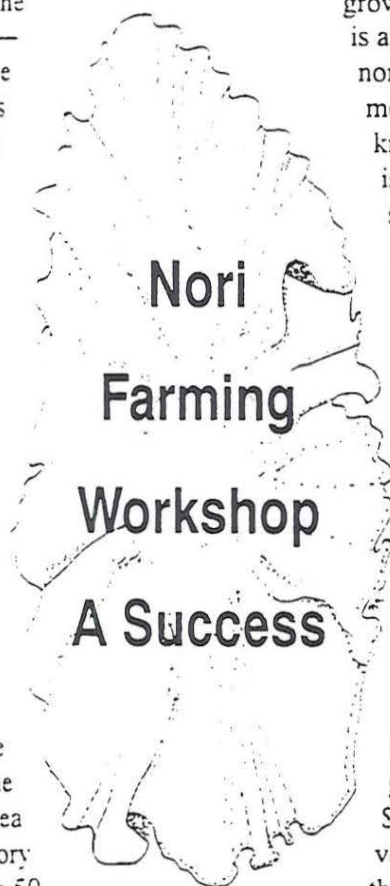
Nutritionally, nori is very high in vitamins A and C, calcium, and protein.

Last year, nori represented a \$2 billion industry in Japan. Although the U.S. market for nori is about \$30 to \$50 million a year, and expanding 10 to 15 percent a year, nearly all of the product is imported.

According to Steve Crawford, general manager of CPI, nori is an ideal candidate species for aquaculture since it grows like a weed, brings about \$50 a pound wholesale, requires very little capital investment for the grower, and is much less of a risk than growing fish. Nori farming can also be lucrative.

Levine estimates that a person with a five-acre lot site could net about \$30,000 to \$50,000 per year.

Crawford sees seaweed farming as a complementary adjunct to finfish aquaculture since the seeded nets can be installed at existing fish cage sites. Levine further explains that nori thrives on the nutrients from salmon waste, and that by placing nori plantations around salmon pens, salmon farmers would help cleanse the water of fish waste while nourishing the nori.



THE QUODDY TIDES

Coastal Plantations International, Inc.

ANNOUNCES

Nori (Seaweed) Farming Training Program

Where: Eastport, Maine (Washington County Technical College)
Cobscook Bay (CPI Experimental Aquaculture Culture Site)

When: April through December, 1995 (1-2 days per month)

The no cost training program will include a "classroom" component in addition to "on the job" training with a goal of preparing up to 100 nori farmers for this developing industry. Biology, farming techniques, economics, and permitting will be covered in this program. Partial funding for this program provided by the National Marine Fisheries Services' Fishing Industry Grant.

Please call or write (ASAP): Ike Levine, P.O. Box 209, Poland, Maine 04273, 207-998-4909. We need your name, telephone no., address, any fishing or Aquaculture experience, and why you want to be in this program.

Cobscook Bay is ideal for growing nori

by Gail Menzel

Cobscook Bay and the other areas of the Quoddy region may possess the world's ideal growing conditions for the Japanese seaweed nori, says Steve Crawford, manager of Coastal Plantations International in Eastport, who spoke March 21 at a meeting of the Schoodic Chapter of the Maine Audubon Society.

A former commercial fisherman and environmental activist, Crawford discovered the potential of aquaculture in 1970, and after a stint in the Peace Corps in India and the Phillipines, experimented with catfish farming in Oklahoma. By 1988, the cost of production and depressed market prices made catfish less economically feasible. Crawford and his wife made a stab "at the globe and the pencil ended in Maine."

After settling in Eastport, Crawford noted that nori naturally occurs in local waters, although the native variety is not desirable as an edible product. He consulted with Japanese, American and Canadian experts, who advised him that the Japanese variety of the seaweed should flourish in the tidal conditions of the Fundy region. Following approval from U.S. and Canadian authorities, and government assistance in funding his operation, Crawford now leases 140 acres at three sites for nori farming. He has established a processing plant in Eastport

with half a million dollars worth of machinery to wash, press, dry and roast the seaweed into sheets for marketing, mostly in Japan where nori sells for \$150 per pound.

Since no individual company can lease more than 150 acres for aquaculture in Maine, Crawford hopes to expand his business by becoming the processor for other nori farmers who could lease as little as 10 acres, he says, and have an economically viable business. He estimates that with an investment of \$10,000 in a 10-acre farm, one and a half people could net \$40,000 to \$50,000 for their labor during the six-month nori growing season.

However, Crawford cautions potential nori entrepreneurs not to invest their "last cent" in start up costs, since government funding is still available for aquaculture ventures, particularly to commercial fishermen who are seeking retraining.

Although Crawford has experienced some resistance from commercial fishermen, such as scallop-draggers who view his operation as limiting their catch area, he believes the two industries should be compatible because of their growing seasons — nori is grown from May 1 to December 1, and scallops are harvested from November to April. Crawford thinks nori production would be an ideal off-season activity for the scallop dragger, providing year-round income.

At present the global market for nori is two billion dollars annually, mostly in Japan where the product is used as sushi wrappers, in medicinal teas and in preparing many traditional foods. The North American market is small but growing, largely in the health food industry.

Coastal Plantations International, Inc.

ANNOUNCES

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Coastal Plantations International, Inc.

ANNOUNCES

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Appendix I



April 27, 1995

Dear Nori Farming Training Program Participant:

Thank you for your interest in Coastal Plantations International's upcoming Nori Farming Training program. The program is partially funded by a National Marine Fisheries Service (NMFS), Fishing Industry Grant (FIG). The goal of this program is to offer training in a potential new industry using the coastal waters of New England.

There will be a series of educational forums offered. The programs will be held in the evenings and/or during the weekends to better facilitate participation by the men and women who have expressed their interest. It is recommended that all classes be attended as we will be covering valuable information during each meetings agenda. All seminars will be held at the Washington County Technical College in Eastport, Maine, and at CPI's Nori pilot farm in Cobscook Bay, Eastport, Maine.

The first forum will be on Wednesday, May 10, 1995, at 6:30 p.m.. The main topics being discussed on that evening will be an Introduction and General Information to Nori Farming. We will also be discussing the general biology and techniques for Nori farming and also the economic feasibility of the product and process. Future topics will include equipment, construction, farming techniques, and harvesting.

Additional preliminary dates for the Nori Farming Training programs are as follows:

Wednesday, May 31 at 6:30 p.m.

Saturday, June 24 at 9:00 a.m.

Saturday, July 22 at 9:00 a.m.

Saturday, August 19 at 9:00 a.m.

Saturday, September 23 at 9:00 a.m.

(The dates and times are subject to change with advance notice.)

We look forward to seeing you on May 10th. Please bring pencil and paper and come ready to explore the possibilities of joining CPI in a new future for you and New England's Aquaculture industry.

Yours truly;

Ike Levine
President

IALill

22
COASTAL PLANTATIONS INTERNATIONAL, INC.

FACILITY: 11 MADISON STREET ■ EASTPORT, MAINE 04631 ■ 207-853-6238
OFFICE: P O BOX 209 ■ ROUTE 26, POLAND MUNICIPAL CENTER ■ POLAND, MAINE 04273 ■ 207-998-4909

CPI's Nori Farming Training Program

May 10, 1995

6:30 PM to 8:30 PM

Washington County Technical College. Eastport, Maine

Meeting called by:

Coastal Plantations
International and
NMFS

Type of meeting:

First in a series of in class and field seminars to
recruit and train Nori Fisherman for the coastal
waters of Maine and New England

Agenda

1. INTRODUCTION	Ike Levine	6:30-6:45 PM
2. NMFS GRANT PROGRAM		6:45-6:55 PM
3. NORI FARMING TRAINING		6:55-7:00 PM
4. INDUSTRY HISTORY		7:00-7:10 PM
5. NORI BIOLOGY		7:10-7:20 PM
6. FARMING TECHNIQUES		7:20-7:30 PM
7. ECONOMIC POTENTIAL		7:30-7:40 PM
8. TRAINING SCHEDULE		7:40-7:50 PM
9. QUESTIONS		7:50-8:30 PM

Additional Information

Please contact Ike Levine at (207) 998-4909 for additional information or mail any questions to P.O. Box 209, Poland, Maine 04273. Please leave your name, address and phone number on signup sheet, especially if you are not on CPI's mailing list.

COASTAL PLANTATIONS INTERNATIONAL, INC.

PO BOX 209

EASTPORT, MAINE 04273

(207) 998-4909

Dear Nori Farming Training Program Participant:

Thank you for your interest in our Nori Seaweed Training Program, our first meeting held at the Washington County Technical College in Eastport, Maine was well attended and the interest was very high. Our next session is now rescheduled for Thursday Evening at the Washington County Technical College at 6:30 PM.

This will be our second in a series of meetings and our last one in the classroom. The topics to be discussed are: materials and equipment, startup cost, startup experiences, economics, permitting, site selection, and more discussions on nori farming in general. Of course we will take the time to answer any questions that you might have left over from our first session.

Dates for our next session will be determined in class and notices will be sent.

We look forward to the returning participants and welcome all those who missed the first session but would like to be involved. We will take some time and review the content of our first session.

Yours very truly,

Ike Levine

COASTAL PLANTATIONS INTERNATIONAL, INC.

PO BOX 209

EASTPORT, MAINE 04273

(207) 998-4909

June 16, 1995

Dear Nori Farming Training Program Participant:

Thank you for your interest in our Nori Seaweed Training Program. We have now completed our two classroom experiences and it is time to head out to the field. Our next meeting is now scheduled for Wednesday, July 12, 1995 at 6:30 P.M. at our wet laboratory and processing facility at 11 Madison Street, Eastport Maine 04631. We are located one block north of the main pier and warehouse.

This will be our third in a series of meetings. The topics to be covered include: seed production, net seeding and storage, nursery techniques, equipment function and assembly, and land support activities and processing.

Dates for our next session will be determined at the factory and notices will be sent.

We look forward to the returning participants and welcome all those who missed the first two sessions but would like to be involved. We will take some time and review the content of our previous sessions.

Yours very truly,

Ike Levine

COASTAL PLANTATIONS INTERNATIONAL, INC.
PO BOX 209
EASTPORT, MAINE 04273
(207) 998-4909

July 27, 1995

Dear Nori Farming Training Program Participant:

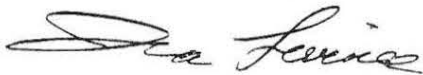
Thank you for your interest in our Nori Seaweed Training Program. We have now completed our two classroom experiences and one seminar at the processing facility, therefore it is finally time to get our feet wet. Our next meeting is now scheduled for Saturday, August 19, 1995 at 9:00 A.M. at our wet laboratory and processing facility at 11 Madison Street, Eastport, ME 04631. We are located one block north of the main pier and warehouse. Please be punctual, as we will be leaving the processing facility as a group, shortly after 9:00 A.M. to go to the boat moorings. If you need further directions to our facility, please call us at the phone number listed above.

This will be our forth in a series of meetings. During this session, we will be ferrying out to the farm, assembling systems and putting up nets. This will be a hands-on experience, so please bring appropriate outdoor gear with you.

Dates for our next session will be determined at the factory and notices will be sent.

As always, we look forward to the returning participants and welcome all those who missed the first three sessions but would like to be involved. We will take some time and review the content of our previous sessions.

Yours very truly,



Ike Levine

COASTAL PLANTATIONS INTERNATIONAL, INC.
P.O. BOX 209
POLAND, ME 04273
(207) 998-4909

October 2, 1995

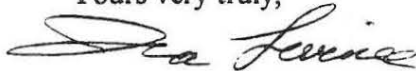
Dear Nori Farming Training Program Participant:

Thank you for your continued interest in our Nori Seaweed Training Program. As you know, we have now completed two classroom seminars, and one seminar at the processing facility. In addition, during our last meeting, we learned how to assemble systems and put up nets. Our next step will be learning the proper harvesting techniques. We hope you will join us on Saturday, October 21, 1995 at 9:00 A.M. at our wet laboratory and processing facility, 11 Madison Street, Eastport, ME 04631. We are located one block north of the main pier and warehouse. If you need further directions to our facility, please call us at the phone number listed above. **Again, we ask that you be punctual, as we will leaving the processing facility as a group, shortly after 9:00 A.M. to go to the boat moorings.**

During this session, we will be ferrying out to the farm and harvesting the nori. As with the system assembly and net installation, this will be a hands-on experience, so please bring appropriate outdoor gear with you.

As usual, the dates for our next session will be determined at the factory and notices will be sent. We look forward to the returning participants and welcome all those who missed the first few sessions but would like to be involved. We will take some time to review the content of our previous sessions if necessary.

Yours very truly,



Ike Levine

Appendix II



Angus S. King, Jr.
Governor

Robin Alden
Commissioner

DEPARTMENT OF MARINE RESOURCES

Telephone (207) 624-6550
FAX (207) 624-6024

April 4, 1995

SPECIAL LICENSE NUMBER ME 95-28

Acting under the authority vested in the Commissioner of Marine Resources under 12 M.R.S.A. §6074, I hereby issue a Special License to IRA LEVINE AND STEVEN CRAWFORD doing business as Coastal Plantations, Inc. This Special License allows the above individuals and person in their employ and under their direction to place various equipment in coastal waters at Carrying Place Cove in Cobscook Bay for the purpose of furthering research and development regarding the culture of Nori.

This Special License is issued subject to the following conditions:

1. Coastal Plantations shall requisite approvals from the Army Corps of Engineers in accordance with 33 CFR 325.5.
2. Access to the site for other uses shall be allowed to the degree that they do not interfere with the purposes of the project and the equipment associated with it.
3. Any infraction of these conditions or any violation of Marine Resource laws or regulations may be grounds for the immediate revocation of this Special License.

This Special License expires December 31, 1994.

ROBIN ALDEN
Commissioner

RA/CAT



REPLY TO
ATTENTION OF

Regulatory Division
CENED-OD-R-51

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

April 4, 1995

Permit Application of: Coastal Plantations International, Inc.
Application Number: 1995-00676

Gentlemen:

In accordance with 33 CFR 325.5, the Corps of Engineers intends to issue a Letter of Permission for the minor work shown on the attached plans, which includes the installation and maintenance of 5, 210'x 11' rows of fiberglass or timber pile supported net systems within a 240'x 120' area in Carrying Place Cove at Eastport, Maine. The nets will be used to raise Porphyra spp. (Nori) as an experiment to test this system's productivity and durability. The nets will be free floating as they are secured to the 3" diameter piles and will be suspended above the bottom at mean low water. The structures will be in place for only the 1995 season and will be removed in their entirety by January 31, 1996. The findings of this experiment will be used to determine the viability of this form of Nori farming on a similar or larger scale.

If you have any objections to the work, please notify Jay Clement in writing at our Manchester, Maine Project Office within 15 days of the date of this letter. If we do not hear from you, we will assume you have no objections.

The address of our Maine Project Office is US Army Corps of Engineers, RR 2, Box 1855, Manchester, Maine 04351. The telephone number is 207-623-8367/8124; FAX is 207-623-8206.

Sincerely,

Jay L. Clement
ref David H. Killoy, P.E., C.P.G.
Chief, Permits Branch
Regulatory Division

Enclosure



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254-9149

REPLY TO
ATTENTION OF

MAY 01 1995

Regulatory Division
CENED-OD-R-51
PERMIT NUMBER 1995-00676

Ira A. Levine, President
Coastal Plantations International, Inc.
P.O. Box 209
Poland, Maine 04273

Dear Mr. Levine:

This refers to your request dated February 10, 1995. We have completed our evaluation and wish to inform you that, under the provisions of Section 10 of the Rivers and Harbors Act of March 3, 1899, you are hereby authorized to install and maintain 5, 210'x 11' rows of fiberglass or timber pile supported net systems within a 240'x 120' area in Carryingplace Cove at Eastport, Maine. The nets will be used to raise Porphyra spp. (Nori) as an experiment to test this system's productivity and durability. The nets will be free floating as they are secured to the 3" diameter piles and will be suspended above the bottom at mean low water.

This Letter of Permission (LOP) is subject to all conditions in Attachment No. 1 and is made in accordance with the plans attached hereto entitled: "PROPOSED SEAWEED CULTIVATION, COASTAL PLANTATIONS INTERNATIONAL, INC., COBSCOOK BAY, EASTPORT, MAINE" in four (4) sheets undated.

In addition to the attached conditions, the following Special Conditions are applied to this Letter of Permission:

1.) The permittee is required to mark the structures in accordance with appropriate Coast Guard Regulations and to contact First Coast Guard District, Aids to Navigation Office at 617-223-8338.

2.) Except in the surface areas physically occupied by the net structures, the permittee shall permit normal fishing and/or recreational and commercial boating activity to occur in the area.

3.) This operation represents a temporary test of the site's potential. Consequently, this is a limited authorization which expires January 31, 1996. All structures shall be removed in their entirety from the site by that date and stored upland.

Permanent occupation of this site or others in the area will require separate individual permits from the Corps, the Maine Dept. of Marine Resources and the municipality.

This authorization contains a stated set of conditions which must be complied with. If a contractor performs the work for you, both you and the contractor are responsible for assuring the work is done in conformance with the conditions and limitations of this authorization. Please be sure the person who will do the work has read and understands these conditions.

Performing any work not specifically authorized by this LOP, or failing to comply with its conditions, may subject you to the enforcement provisions of our regulations. If any change in the plans or construction methods is found necessary, please contact us immediately to discuss modification of your authorization. Any change must be approved before it is undertaken.

Condition (m) of this LOP requires that you notify us before the work is begun so that we may make timely inspections to insure compliance. To assist you in meeting this condition we have attached a notification form for you to fill out and return to us as soon as you are aware of when you intend to begin work.

It is understood that this authorization does not give any property rights either in real estate or material, or any exclusive privileges; and it does not authorize any injury to private property or invasion of private rights, or any infringement of Federal, State or local laws or regulations, nor does it obviate the necessity of obtaining any state or local assent that may be required.

BY AUTHORITY OF THE SECRETARY OF THE ARMY:


For James C. Wong
Acting District Engineer

Enclosure



16518
28 MAR 95

Mr. Ira A. Levine
Coastal Plantations Int'l, Inc.
P. O. Box 209
Poland, Me. 04273

Dear Mr. Levine:

Regarding your letter of 21 February 1994:

Because your project is located in a shallow cove surrounded by mudflats it would seem to have little or no impact on the mariner. Private aids to navigation, therefore, will not be required. If, for your own purposes, you still wish to deploy such aids, you are welcome to apply for Coast Guard authorization.

No further Coast Guard action is required at this time. If, in future, we become aware of information indicating your proposed structures are more hazardous than we had first supposed, we may impose additional requirements but, until then, good luck with your project.

Sincerely,

A handwritten signature in dark ink, appearing to read "C. E. Negretti", written over a horizontal line.

C. E. NEGRETTI
Chief, Signal Management Section:
Aids to Navigation Branch;
By Direction of the Commander.

Appendix III



April 20, 1995

Mr. Robert M. Klaucke
U.S. Department of Commerce, NOAA
National Marine Fisheries Service
One Blackburn Drive
Gloucester, MA 01930

RE: Quarterly Report
NA56FK0097

The Development of a *Porphyra* (Nori) Pole Culture and the Establishment
the American Seaweed Farmer.

March 1-31, 1995.

Zero Federal Dollars were utilized during this initial period. FAD identification number was secured March 7, 1995. Appropriate financial forms were sent to Grants Management Division, Maryland.

Please refer to Milestone Chart (Appendix A) included in this report. All activities are frame shifted three months to accommodate the initial date change from January 1, 1995 to March 1, 1995.

1. Pole Culture permitting. Permit applications were submitted to: Maine Department of Marine Resources; Army Corps of Engineers; and United States Coast Guard. Please refer to Appendix B.
2. Pilot Farm Installation. Initial discussions underway with pole suppliers. Materials considered for pilot farm include: PVC, PVC coated with fiberglass, Wood, Metal Pipe, and fiberglass. Standard fiberglass nori poles from Japan unworkable due to available lengths, shipping time, and yen:dollar relationship.
3. Nori Cultivation. Scheduled to be initiated in July, 1995
4. Development of Training Manual. Initial outline being developed.

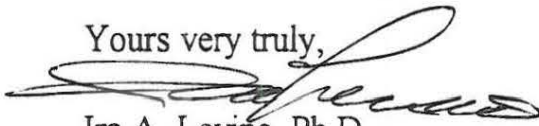
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5. Nori Farming Training Course. Advertisement copy developed, see Appendix C. Initial response to course offering tremendous.

6. Evaluation and Final Report Development scheduled for 1996.

As this is our initial quarterly report, please do not hesitate to comment on substance and style of presentation. If necessary, we will resubmit this report in a standard format if one is available. Please contact me after you have had the opportunity to review this report.

Yours very truly,

A handwritten signature in dark ink, appearing to read 'Ira A. Levine', written over the typed name.

Ira A. Levine, Ph.D.
President



July 25, 1995

Mr. Robert M. Klaucke
U.S. Department of Commerce, NOAA
National Marine Fisheries Service
One Blackburn Drive
Gloucester, MA 01930

RE: Quarterly Report
NA56FK0097

The Development of a *Porphyra* (Nori) Pole Culture and the Establishment
the American Seaweed Farmer.

April 1 - June 30, 1995.

\$ 20,254.58 Federal Dollars were utilized during this initial period. Appropriate financial forms were sent to Grants Management Division, Maryland and copies are included with this report (Appendix A-1).

Please refer to Milestone Chart (Appendix A-2) included in this report. All activities are frame shifted three months to accommodate the initial date change from January 1, 1995 to March 1, 1995.

1. Pole Culture permitting. Permit applications were submitted to: Maine Department of Marine Resources; Army Corps of Engineers; and United States Coast Guard. All necessary permits have been secured for this pilot nori farm project. Please refer to Appendix B.

2. Pilot Farm Installation. Discussions underway with pole suppliers. Materials considered for pilot farm include: PVC, PVC coated with fiberglass, Wood, Metal Pipe, and fiberglass. Standard fiberglass nori poles from Japan unworkable due to available lengths, shipping time, and yen:dollar relationship. Initial installation experiences have resulted in the rejection of wood poles (diameter too large and uneven, weight of pole and logistical difficulties), domestic fiberglass poles (cost - quoted at \$ 7.00/foot). Presently, we are installing metal poles with pipe anchors to secure test systems.

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3. Nori Cultivation. Scheduled to be initiated in July, 1995 but with equipment delays, August, 1995 more realistic time frame for farm net installation.

4. Development of Training Manual. We have reviewed the information prepared for the first three nori training sessions including our training manual handouts and have concluded the development and completion of the nori training manual would be rescheduled for the first quarter of 1996. The delay would enable us to incorporate the nori farmer trainees input concerning content, style, and depth of information presented. The result will be a more "user friendly" training manual.

5. Nori Farming Training Course. Response to our advertisements have resulted in the included mailing list (Appendix C). Attendance has ranged from 22 to 47 nori farming training participants.

6. Evaluation and Final Report Development scheduled for 1996.

We have completed four of 18 months of this research and training project. Two challenges have arisen that need to be overcome. First, the cost of the poles. Presently the cost to utilization ratio draws CPI away from fiberglass and in the absence of bamboo we need to develop an alternative material or make some arrangements with either an American or foreign fiberglass pole manufacturer. We have identified a scrap source of 275 metal poles from a salvage yard which will be utilized in this project, but will do little to establish a standard material for this form of nori farming. Secondly, we have encountered a drop of attendance in our training seminars due in part to rumors that abound that permitting outside of Cobscook Bay would be difficult to obtain for nori (*Porphyra yezoensis*) farming. We have finally identified the source of this misinformation and are taking steps to overcome this perception.

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As this is our second quarterly report, please do not hesitate to comment on substance and style of presentation. If necessary, we will resubmit this report in a standard format if one is available. Please contact me after you have had the opportunity to review this report.

Yours very truly,

A handwritten signature in dark ink, appearing to read "Ira Levine", with a long horizontal flourish extending to the right.

Ira A. Levine, Ph.D.
President



October 31, 1995

Mr. Robert M. Klaucke
U.S. Department of Commerce, NOAA
National Marine Fisheries Service
One Blackburn Drive
Gloucester, MA 01930

RE: Quarterly Report-Amended
NA56FK0097

The Development of a *Porphyra* (Nori) Pole Culture and the Establishment
the American Seaweed Farmer.

July 1 - September 30, 1995.

\$ 36,226.00 Federal Dollars were utilized during this initial period. Appropriate financial forms were sent to Grants Management Division, Maryland.

1. Pole Culture permitting. Permit applications were submitted to: Maine Department of Marine Resources; Army Corps of Engineers; and United States Coast Guard. All necessary permits have been secured for this pilot nori farm project.

2. Pilot Farm Installation. Discussions underway with pole suppliers. Materials considered for pilot farm include: PVC, PVC coated with fiberglass, Wood, Metal Pipe, and fiberglass. Standard fiberglass nori poles from Japan unworkable due to available lengths, shipping time, and yen:dollar relationship. Initial installation experiences have resulted in the rejection of wood poles (diameter too large and uneven, weight of pole and logistical difficulties), and domestic fiberglass poles (cost - quoted at \$ 7.00/foot). The full pole farm has been assembled and adjusted utilizing metal poles. The system is fully functional and has withstood 30 knot winds, rain, and 9 meter tides.

3. Nori Cultivation. Pole farm was assembled in July, 1995 and seeded nets were installed. The nori growth rates of less than 1% per day in the pole farm for August and September coincided with an unusually low nitrogen

40
COASTAL PLANTATIONS INTERNATIONAL, INC.

FACILITY: 11 MADISON STREET ■ EASTPORT, MAINE 04631 ■ 207-853-6238
OFFICE: P O BOX 209 ■ ROUTE 26, POLAND MUNICIPAL CENTER ■ POLAND, MAINE 04273 ■ 207-998-4909

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concentration from July through September. However, due to the first rainfall in 60 days, and the commencement of dredging operations in the bay, growth rates increased to previously experienced levels of 6%-9% per day.

4. Development of Training Manual. We have reviewed the information prepared for the first six nori training sessions including our training manual handouts and have concluded the development and completion of the nori training manual would be rescheduled for the first quarter of 1996. The delay would enable us to incorporate the nori farmer trainees input concerning content, style, and depth of information presented. The result will be a more "user friendly" training manual.

5. Nori Farming Training Course. Response to our advertisements have resulted in the included mailing list. Attendance has ranged from 12 to 47 nori farming training participants. We continue to receive inquiries regarding participation, and requests for information about the next training program.

6. Evaluation and Final Report Development scheduled for 1996. We have completed seven of 18 months of this research and training project. Two challenges have arisen that need to be overcome. First, the cost of the poles. Presently the cost to utilization ratio draws CPI away from fiberglass and in the absence of bamboo we need to develop an alternative material or make some arrangements with either an American or foreign fiberglass pole manufacturer. We have identified a scrap source of 275 metal poles from a salvage yard which will be utilized in this project, but will do little to establish a standard material for this form of nori farming. No further work has been accomplished identifying a future source of "nori poles". The salvage metal poles have been secured and assembled at the test site. Secondly, we have encountered a drop of attendance in our training seminars due in part to rumors that abound that permitting outside of Cobscook Bay would be difficult to obtain for nori (*Porphyra yezoensis*) farming. We have finally identified the source of this misinformation and are taking steps to overcome this perception.

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Appropriate state officials have been notified, and individuals confronted. I have been given verbal confirmation that this problem will not persist.

We have had one site inspection during this period, results of which have been discussed between you and myself.

Yours very truly,

Ira A. Levine, Ph.D.
President



January 17, 1996

Mr. Robert M. Klaucke
U.S. Department of Commerce, NOAA
National Marine Fisheries Service
One Blackburn Drive
Gloucester, MA 01930

RE: Quarterly Report
NA56FK0097

The Development of a *Porphyra* (Nori) Pole Culture and the Establishment
the American Seaweed Farmer.

October 1 - December 31, 1995.

\$ 20,074.00 Federal Dollars were utilized during this quarter for a total of
76,554.58 allocated during the first four quarters of this grant. Appropriate
financial forms were sent to Grants Management Division, Maryland.

1. Pole Culture permitting. All necessary permits have been secured for this pilot
nori farm project.
2. Pilot Farm Installation. Pole farm installation was completed utilizing metal
poles. The system was fully functional and has withstood 70 mph winds
(November 12, 1995), rain, and 10 meter tides.
3. Nori Cultivation. Pole farm was assembled in July, 1995 and seeded nets
were installed. The low summer growth rates realized in 1995, were replaced by
elevated growth rates of 6-9% per day upon resumption of normal rain patterns,
initiation of urchin dragging season (October 1, 1995) and seasonal nutrient
cycling.

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4. Development of Training Manual. This task is reserved for the first two quarters of 1996.

5. Nori Farming Training Course. The initial training course is now complete. We continue to receive inquiries regarding participation, and requests for information about the next training program. Inquiries are ranging from New York to New Brunswick.

6. Evaluation and Final Report Development scheduled for 1996. We have completed ten of 18 months of this research and training project. Two challenges have arisen that need to be overcome. First, the cost of the poles. No additional work has been accomplished identifying a future source of "nori poles". This matter will be investigated in early 1996. Secondly, concerns attributed to permitting difficulties have been identified and assurances from State Officials have alleviated this situation.

We have had one additional site inspection during this period, results of which have been discussed between you and myself.

Yours very truly,

Ira A. Levine, Ph.D.
President



April 18, 1996

Mr. Robert M. Klaucke
U.S. Department of Commerce, NOAA
National Marine Fisheries Service
One Blackburn Drive
Gloucester, MA 01930

RE: Quarterly Report
NA56FK0097

The Development of a *Porphyra* (Nori) Pole Culture and the Establishment
the American Seaweed Farmer.

January 1 - March 31, 1996.

\$ 4,595.00 Federal Dollars were utilized during this quarter for a total of
81,149.58 allocated during the first five quarters of this grant. Appropriate
financial forms were sent to Grants Management Division, Maryland.

1. Pole Culture permitting. Complete.
2. Pilot Farm Installation. Complete.
3. Nori Cultivation. Complete. The following list includes the range of
experiments conducted during the previous 13 months. Data has been
accumulated. Statistical analysis and reduction will be concluded in the next
quarter.

Conchocelis Culture

Culture Conditions: light intensity versus photoperiod (500-2000 lux,
8:16, 12:12, 16:8); LD 100 as function of 6% sodium hypochlorite, salinities;
conchosporangia induction as a function of light intensity, photoperiod, water
temperature (maximum and minimums); conchospore release as a function of
light intensity, light quality (mercury halide, sodium halide, metal halide,
fluorescent), water temperature; conchospore attachment a function of light
intensity, substrate quality; conchocelis growth as a function substrate and
species and cultivar.

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Blade Culture

Monospore Production as a function of light quality, quantity, and photoperiod. Thallus growth as a function of light quality, quantity, and photoperiod; fertilizer affect as a function of concentration (36,6,6, Ammonia nitrate, Guillard's F/2) application methodology (spraying, soaking, diffusion) and frequency of application.

Pole Culture

Growth as a function of net depth

Indoor Culture

Growth as a function of light quantity, quality, and photoperiod

4. Development of Training Manual. The first draft has been completed. Review and editing of manuscript by internal CPI personnel and independent sources will be initiated next quarter.
5. Nori Farming Training Course. The initial training course is now complete. We continue to receive inquiries regarding participation, and requests for information about the next training program. Inquiries are ranging from New York to New Brunswick. Two Maine and one New Brunswick concerns are in various stages of permitting and financing to establish nori farming efforts in 1996.
6. Evaluation and Final Report Development scheduled for 1996. We have completed 13 of 18 months of this research and training project. The remaining period of the grant will be dedicated to data analysis and the completion of the training manual. I assume my April 3rd memo to Harold Mears was sufficient to answer his March 28th request for information.

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Please contact me if there are any questions concerning this or other grant matters.

Yours very truly,

Ira A. Levine, Ph.D.
President

IAL:kab



July 8, 1996

Mr. Robert M. Klaucke
U.S. Department of Commerce, NOAA
National Marine Fisheries Service
One Blackburn Drive
Gloucester, MA 01930

RE: Quarterly Report
NA56FK0097

The Development of a *Porphyra* (Nori) Pole Culture and the Establishment
the American Seaweed Farmer.

April 1 - June 30, 1996.

\$ 8575.42 Federal Dollars were utilized during this quarter for a total of
89725.00 allocated during the first six quarters of this grant. Appropriate
financial forms were sent to Grants Management Division, Maryland.

1. Pole Culture permitting. Complete.
2. Pilot Farm Installation. Complete.
3. Nori Cultivation. Complete. Data has been accumulated, statistical analysis
and reduction is 85% completed.
4. Development of Training Manual. The second draft has been completed.
Review and editing of manuscript by internal CPI personnel and independent
sources will be completed within 30-60 days.
5. Nori Farming Training Course. Complete.

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6. Evaluation and Final Report Development scheduled for 1996. We have completed 16 of 18 months of this research and training project. The remaining period of the grant will be dedicated to data analysis, the final report, and the completion of the training manual.

I received a letter dated June 17, 1996 from Theresa Westwater of USDA, NOAA, Office of Administration, stating the expiration date is July 31, 1996. I will base all completion deadlines (90 days) on that date.

Please contact me if there are any questions concerning this or other grant matters.

Yours very truly,

Ira A. Levine, Ph.D.
President

IAL:kab

Appendix IV

NORI FARMING HANDBOOK

I. INTRODUCTION

Seaweed and seaweed products represent a three billion dollar per year industry. Humans have largely depended on the harvest of wild stocks for its supply of algae, but an increasing demand for certain species has created a need for reliable sources of raw materials. As a result, seaweed cultivation has increased tremendously in the last several decades.

The red alga *Porphyra* (nori) is utilized by humans as a food source throughout the world. There are 60 - 70 species of nori worldwide, but only a few are suitable for making sheets of "hoshi" nori used to wrap sushi, one of its most common uses. The commercially viable species have been cultivated in Japan, China, and Korea for several hundred years. Modern techniques were developed in Asia throughout this century resulting in; highly controlled methods of seeding nets, open water cultivation systems, and the science of freezing nursery nets to prolong the growing season.

In 1995, approximately 12 billion sheets (approximately 36,000 dry metric tons) of *Porphyra* were produced. Nori, long prized by the Japanese and in macrobiotic diets, is a valuable health food source as it contains high levels of protein (41%), vitamins (greater percentage of Vitamin C than in oranges), trace minerals, and dietary fiber and is a source of taurine, which controls blood cholesterol levels. The consumption of nori in the United States was wholly dependent upon importation from Japan, Korea and China prior to Coastal Plantations International (CPI) entering the market.

Coastal Plantations International, Inc. (CPI) was founded in 1991 by Dr. Ira Levine a seaweed scientist, and Steve Crawford, an aquaculturist. CPI represents a marine agronomic and biotechnology effort which has over the past six years endeavored to create a viable

algal cultivation and processing industry in the coastal waters of New England and the Maritime Provinces of Canada. In this short period of time we have accomplished the following:

- Convened an International Seminar "Potential *Porphyra* (Nori) Cultivation and Processing Industry in Maine" held at the Washington County Technical College
- Purchase and assembly of nori processing plant and cultivation equipment
- Establishment of culture laboratory
- Successful seeding and cultivation of *Porphyra yezoensis* (Japanese cultivar)
- Production of market quality nori sheets
- CPI has been awarded permits, licenses and approvals from; local (City of Eastport), state (Department of Environmental Protection and Dept. of Marine Resources), federal (Army Corps of Engineers, United States Coast Guard, and Environmental Protection Agency), Canadian (National Department of Fisheries and Oceans, New Brunswick Provincial Departments of Fisheries and Aquaculture and the Environment) and global (United Nations' International Conference for Exploration of the Sea (ICES) agencies, organizations and governments.
- Assembled genetic improvement research team
- Established Japanese nori farmer exchange program
- Sponsor Marine Agronomy Fellowship Program
- Bulk nori sales to biomedical industry
- Expansion into Canadian waters
- Awarded organic certification from the Organic Crop Improvement Association International, Inc.
- CPI awarded National Coastal Research Institute Grant, Northeast Regional Aquaculture Center (USDA) Grant, National Marine Fishery Service Grant, Receipt of two Maine Aquaculture Innovation Center Research Grants and Sea Grant College of Maine/New Hampshire nori research grant
- Developed Maine Nori Company, packaging and product identity

- Domesticated local wild nori
- Genetically improved several strains of nori
- Successfully established direct marketing program

The following manual represents CPI's follow-up effort to its 1995 Nori Farming Training Course supported by the Company's 1995-1996 FIG-NMFS NOAA Grant Award NA56FK0097. The intent of this manual is to offer a primer to any individual or cooperative that wishes to become nori farmers. This manual is not intended to be a text book on *Porphyra* biology but a reference tool for nori cultivation from the production system stage through harvesting and primary processing for transport to the CPI processing facility. The nori training course, as offered by CPI, is one step in the support system the company offers to recruit, train, and assist the formation of individual and cooperative nori growing concerns.

Nori has two major forms in its life history (Figure 1). Nori's leafy thallus (gametophyte) stage is utilized as a food source and inhabits the intertidal and subtidal waters. The commercial Asian forms are evident from November through March. The alternative morph is produced by carpospores which settle on sea shells. This stage, called "conchocelis", enzymatically burrows into the shells and grows for several months. At the end of summer the conchocelis produces conchospores which are planktonic and eventually settle, attach and germinate on rocks, pilings, or other seaweeds and grows into the leafy thallus. Maine's local species of *Porphyra* can be found throughout the year but these species do not produce a commercially viable sheet. Recently, CPI and its supporting University laboratories have domesticated the local species which will be farmed in 1997 for alternative markets.

In cultivation systems, conchospore release is carefully controlled and the spores are used to seed the nets. The nets are placed in nursery systems which are designed to raise the nets out of water for

daily drying, simulating intertidal variations. After the 20 to 30 day nursery phase is completed, the nets are then transferred into the production systems. The nets are ready for harvest in 15 - 20 days and can be trimmed weekly or so for two months. Nets scheduled to be deployed later in the cultivation season are placed in freezers, and are deployed after the first set of production nets have yielded their complete crop or have experienced disease or structural failure.

II. ECONOMICS

Presently, Maine nori cultivation is conducted from May through December, when the water temperature is above 6° C (40° F). This cultivation model does not provide year round employment for the producer but this situation is scheduled to change in 1997 with the cultivation of local species year round.

The nori requires constant tending and cultivation success is dependent on both the discipline and nature of the farmer along with the vagaries of the weather as with most forms of agriculture. Nori cultivation has certain advantages over other forms of mariculture. It does not require large amounts of capital investment, and unlike any other aquaculture crop it reaches a harvestable stage in several weeks as compared to years to harvest experienced by the fin and shellfish industries.

The following represents CPI's best estimates related to the economics of three nori farms. The typical Japanese family farm size is 200 saku. This exercise is intended to illustrate the potential economic opportunities nori farming can provide and are not intended or offered as business plan's economic analysis or proforma. The following economic models are for a 100, 200, and 500 "saku" farm, where a saku is the area taken by one net. The term saku is used because during the course of the season as many as 3 nets may be deployed in the same place. The following assumptions were utilized in the analyses.

- All seeded nets are provided by CPI at \$130/net, the current price for a minimum of 100 nets.
- The growing season is from May 1st to December 15th.
- Two set of nets will be used during the season.
- The average total harvest from each net is 3,530 sheets (5 weekly harvests of 706 sheets each, or about 70 LB wet weight/harvest and 350 LB total/net). CPI's harvests have yielded zero to as much as 7,000 sheets per net.
- The price paid to the farmer is estimated at \$ 0.085/sheet. Nori pricing is dependent upon quality and is assessed at time of delivery. One could use tobacco auctions as a pricing model which illustrates the difficulty in assessing prices per sheet in advance.
- The equipment needed is based on 1995 prices (see list of suppliers).
- Capital purchases are amortized over 5 years and 10 years.
- The nori farmer has his own 16 - 20' boat and outboard.
- No expenses have been included for the lease site permitting process.
- The lease site is a minimum of 2.5 acres for each 100 saku unit, with an average current of 100 cm/sec (approximately 1 knot). The water depth is less than 20 feet at HMW with a sand or mud bottom.
- Maine aquaculture leases cost = \$50/acre/year.

III. CULTIVATION TECHNIQUES

CPI has adopted and modified the most modern Chinese, Japanese, and Korean farming techniques. The Asian countries have developed the science and art of nori farming and are very attentive to detail while increasing efficiencies and decreasing uncertainties to a minimum. CPI has adopted this philosophy to nori pole culture and this approach is described in the following sections.

There are two types of nori cultivation: open-water or "furyu" culture and pole or "shichu shichi" culture. Open water culture is done only in subtidal areas and all moorings consist of anchors. Pole culture is shallow water or intertidal culture where the nets are tied to fixed poles and is the subject of this farming manual.

Advantages to open water culture are:

- The lease site is not limited to shallow (< 20') water depth
- Increased net accessibility for harvest, treatment, or cleaning
- Reduced capital expenditure

Advantages of pole culture include:

- Decreased exposure to storms and strong tides and system integrity is easier to maintain.
- Decreased fouling from floating debris, usually resulting in decreased labor costs.
- The nori is usually higher quality due to closer correlation to natural growing conditions realized in intertidal zone.

A. Ropes and Knots.

There are two important considerations concerning ropes used in nori farming; nori ropes should float and they should be able to hold a knot. While loose floating ropes in the culture area may foul outboard motor propellers, the ability to find dropped ropes or the item attached to them quickly outweighs this disadvantage. Wall brand "steel rope",

a blend of several fibers, is ideal, being inexpensive, easy to tie, floats, and resists chafing. Lines for tying nets to poles can be 5/16" or 3/8".

The only knot utilized to tie the nets to the poles is a sheet bend with a loop (Figure 2). The location requires frequent adjusting and untying, and this knot allows efficient untying by simply pulling the loop through . When tying a net to the pole, always begin the knot by running the end from the top of the net down (Figure 3), never from the bottom up. When the knot is completed, the loop will be on top of the net. The advantage of this becomes obvious when harvesting the net, as the loop stays clear of the harvest blade.

B. System Deployment

The individual site's specific environmental parameters will determine the most efficient system design. There are virtually an infinite number of designs to deploy (Figures 4,5,6,7). Current, water depth, rockweed abundance, wind exposure, lease site dimensions and orientation, distance from land, other leases, moorings, docks, piers, and channels are just a few of the factors that determine the system configuration. Trial and error is the only way to learn the best design for your lease site.

Orient the system so that the nets lie in the same direction as the predominant direction of the current. This can be surprisingly difficult to determine in a very high energy bay such as Cobscook Bay.

C. Pole Culture System Installation

The technique of installing poles for a pole system is quite simple, consisting of merely pushing or driving the poles sufficiently far into the sand or mud bottom to keep the poles from pulling out. The challenge is the logistical problem of installing 2,200 poles for each 100 saku. Guide lines are moored to keep the boat secured for proper placement of the poles. The large tides and currents experienced in the Gulf of Maine require eleven pairs of poles to support each net. Be sure to drill a hole at the base of each pole just above the substrate to facilitate

water drain from the pole with each changing tide. This reduces the weight the pole must support at low tide. CPI used 2" diameter steel boiler tubes 20' long and drove the poles into a clay substrate with a homemade pole driver (Figure 8). If the poles are in a strong current, they will vibrate and may loosen and fall over. A three to five foot 1" fiberglass "wand" can be attached to the top of the pole and will act as a vibration damper, greatly reducing the magnitude of the movement of the pole.

There are two methods of net deployment in a pole farm. The first is to establish slip rings around the poles which results in the nets floating on the surface with the changing tides. CPI initially experimented with this system and found it inferior to a fixed height system. The determination of the optimal position to fix the net to the pole is critical. The determination of the optimal net height is accomplished by attaching one end of the net to the pole at the surface during mean low water (mlw) and the other to the pole at the surface during mean high water (mhw). The resultant slope of the net will provide a continuous depth gradient by which to monitor growth. Monitor the growth for approximately one month, or until it becomes obvious at which height results in the optimum growth rate and thallus color. During this test, the remaining nets should be tied to the poles where they will experience two hours of emersion per day. The distance above mlw which will result in this emersion pattern will vary for every cove in every bay and must be empirically determined. Upon completion of the optimal pole position study, readjust the remaining nests to the appropriate height.

D. Nori Production Nets

Nori production nets are provided frozen by CPI, covered with 2-3 cm (1") long nori ready to be put into production systems. The nori nets all come from Asia, and are the result of considerable technology and experience. CPI nets are about 1.8 m (5') wide and 18 m (60') long. The mesh is 18 cm (6.5") bar size, or 30 - 35 cm (13") stretch mesh size. The twine consists of three circular shaped rather than sharp-angled or square-shaped fibers; nylon for strength, polypropylene

and/or polyethylene for softness, and a third fiber which enhances the sticking of the spores. The nets have the capacity to absorb water, swell rapidly and dry very quickly. These characteristics are essential during the nursery cultivation phase which provides the nori seedlings with a daily drying period, which kills diatoms and microbes. As the nets are raised out of the water to dry and then dropped back into the water, the net fibers shrink and swell rapidly, causing the dead diatoms and microbes to be displaced from the net. The net's fibers are tuned to the local environments as a function of predominant weather patterns experienced, i.e. how many foggy and rainy days there are during the cultivation season.

E. Handling and Installation Freezer Nets

CPI cultivates nori nets in nursery systems until the thalli are approximately 2-3 cm (about 1") long. The nets are then removed from the nursery system, returned to the company's factory and carefully frozen in bundles of five at 0° F (-18° C) in airtight 6 mil plastic bags in special cardboard boxes. These nets can be stored for several months with over 70% survival of the nori on each net. The nets are shipped frozen to the farmer for deployment.

It is extremely important that the nets stay frozen to within two hours of being deployed. If the nets' temperature rises above 20° F or the nets are thawed and the nets are refrozen, serious or complete failure will result. It is remarkable how fast a nori net can thaw, due to the lack of free water in the nets, which is the key to successful freezing.

Thawing Do not open the bag of nets until on-site just prior to deployment. Place the bag of nets into the water, unopened, allowing the nets to warm up to the ambient water temperature. Five minutes is generally sufficient time. This tempering is necessary to prevent potential damage to the young fronds. Should the storage bag be opened prior to the nets reaching ambient temperature, atmospheric fresh water will condense on the nori thalli resulting in plant stress or mortality.

When the bag is first opened, a pleasant odor will be emitted. If it is necessary to take a deep breath over the bag to detect this odor, this indicates good survival rate of the nori. A strong odor indicates high mortality. Slowly add sea water to the bag to re-hydrate the nori plants.

This procedure should not take more than five minutes. Observe the color of nori at this time, it should resemble eggplant purple. A portion of the nori will exhibit a red rust color indicating dead nori. If the red-rust color is very obvious or predominant, the nets are of poor quality.

Deployment Place the bag of five nets into the bow of the boat and maneuver the boat between the two rows of poles. All five net end lines are tied together and a bundle of net end lines will be on top of the bag. The lines will have a red color. Pull the bundle of net end lines out and examine the corner of the nets these lines are attached to.

All nori nets have a "2-corner end" and a "3-corner end" (Figure 9). If the corner is a three corner end, tie the bundle of 5 end lines to the right side line of poles. If the bundle is a "2-corner end", tie to the left.

This distinction is important. When the nets are seeded, the plants on top of the nets grow much faster and denser than on the bottom. It is critical to place the nets into the system with the top up. CPI always puts the 3-corner ends on the right side. Only one end of the nets is colored, and this end is always tied in first to prevent the nets from being tied in up-side-down. Tie the other bundle of net end lines to the opposite pole. This results in one bundle of five nets being attached to the first net pole support. Move the boat backward toward the opposite end of the row of poles, unraveling the nets out of the bag as the boat is moved. Grab the nori net ends as they appear out of the bag. Pull one bundle of net end lines very tight to determine if the nets have rolled or twisted, and tie the bundle of end lines to the proper end support pole. Tie the other end lines to the remaining corner pole.

At this point, one bundle of five nets will be tied into one row of poles and now it is necessary to separate them. Untie one bundle of net end lines and separate the top net, and then do the same on the opposite pole. Pull the net up over the bow of the boat letting the boat slide over the remaining four nets. The top net should be laid into a

basket as the boat is pulled along. When the final support pole is reached, untie the bundle of net end lines and separate the top net. There should be 2 red end lines on top of the net in the basket. Move the boat back to the original pole position and remove the next net in the same manner, to prevent the possibility of placing a net in up-side-down. Repeat this procedure until one net remains. There will be four nets in the boat. These are deployed one net to each row of support poles (Figures 4,5,6).

Upon completion of securing the four ends of each of the first five nets, it is time to tie in the sides of the nets. The net ties are at each pole. Use a sheet bend with a loop, and be sure to start the knot from the top of the net to the bottom so that the loop is on top of the net. The nets must be tied in tightly and symmetrically.

Examine the nets for color and coverage. Some spots of rust red will be seen; up to 20% is not unusual. The nets should have 100% coverage. It is worthwhile to have a net numbering system and to record the net number, approximate amount of rust color observed as a percentage, and any bare spots, both size and location. The next day there will be an increase of bare spots, especially if the site has a strong current. Up to 30% of good nets may be denuded within the first week. These areas will fill in by two methods. If a strand with no visible nori is examined under a microscope at 100x, small plants of 2 to 8 cells long (less than 0.2 mm) will be seen. There should be from 10 to 100 per mm of net strand. Nori at this size freezes extremely well, and if these are not on the strand the net has been thawed for too long before placing in the ocean or re-frozen. The second method results from the fact that freezing stimulates the production of spores in the nori plant. These spores are released from the margins of the plants and settle on the net strands, in effect re-seeding the nets. The spores can only settle on the net strands that have no nori on them, and after a period of two weeks the bare spots should be covered with plants up to 1 cm long.

F. Daily Maintenance.

Daily monitoring is required to achieve success. It is helpful to keep daily notes on the length and appearance of the nori. A careful examination will show daily changes in the nori's shape, length, and color. Under ideal conditions the nori will grow in spurts of approximately 1 cm/day. Usually a phytoplankton bloom occurs during these ideal conditions and the nori growth will slow as competition for nutrients increases. It should take approximately three weeks to grow from 2 to 15 cm, when it is ready for the first harvest. This growth rate has occurred in sea water temps from 7° C to 14° C.

When the nori reaches 4 - 6 cm long, it is necessary to use 5' PVC spreader bars. At least six 1.905 cm (0.75") PVC bars are needed per net. These bars permit uniform fast growth all over the net. If not used, the nori on the edges of the nets where they are tied into the production lines will grow much faster. Nori that exceeds 20 - 25 cm before harvest becomes tough, and because of its length shades smaller nori and out competes it, and also tends to harbor more diseases. If the nori on the edges is 25 cm long while the nori in the middle is only 10 cm, a poor harvest will result and the net never will produce a proper quantity of nori.

All floating debris must be removed from the nori nets on a daily basis. This is extremely important on the day of the harvest. Extraneous materials harvested with the nori will decrease the quality even to the point of destroying the harvest. Rockweed (predominantly *Ascophyllum nodosum*) is the largest concern in Cobscook Bay, especially during the early season and spring tides. As it sweeps into the nets, it causes several problems. If the current drives the weed under the nets, the nets are raised above the water surface, desiccating the nori. The rockweed also rubs the nori off the nets during this action. If it floats over the top of the nets, it shades the nori reducing its growth. Massive mats of rockweed can become entangled in the system, decomposing and fouling the water, and inhibiting the nori's growth. Lowering the nori one foot under the water surface allows the rockweed to float over the top and off the system, and six foot spaces between the net rows allows channels for the rockweed to flow through. A variety of booms and diversionary devices have been tried

to prevent rockweed from entering the nori system, but none have been very effective. The largest challenge is created because the current flow in Cobscook Bay is rarely laminar, and comes from several directions during a tidal cycle. The rockweed goes around the diversion device into the nori system. The most effective technique is to lay an extra row of nori nets on the sides of the nori system and to use them to collect debris. It usually takes 2 - 4 hours per day to clean a 100 saku system. If a day is missed, it may take two to three days to get the system clean again.

The nori nets must remain tight in the system. Loose nets cause distortion of the net resulting in unequal growing conditions. If the nets become very loose they may even fold over, shading sections of the net and reducing growth.

The nori thalli change color as a function of changing environmental regimes, i.e. light and nutrient conditions. The best nori for making sheets has an eggplant color and the darker the color the better the quality. It is helpful to obtain a Pantone Color Guide to be able to objectively monitor the plant's color.

G. Harvesting

The nori harvester (Figure 10) can be purchased from CPI. The three blades are 158 cm (70") long, or a little wider than the net, and they are rotated by a 5 HP Honda gas engine. The harvester is placed in a barge or boat, the net, still tied to the pole support system, is dragged over the top of the harvester. The blades rotate in the direction that the boat or barge is pulled under the nets, slapping the nori off rather than cutting them as in a reel-type grass mower. The amount of blade exposure to the net is controlled by a moveable panel on the top of the harvester. There are four positions with the greatest exposure of the blade to the net resulting in the closest cut. In pole culture it is possible to harvest the nets without removing them from the poles at approximately one hour before mlw. An alternative technique requires the removal of the nets into baskets in an adjacent boat or barge, pull the nets over the top of the harvester, and then retie

the nets into the poles. With practice 2 laborers can untie, harvest, and retie 40 nets in the two hours around mlw. Even if a problem occurs and the nets must be tied onto the poles at suboptimal, the nets can be adjusted to the correct position the during the next tide or following day. The latter method reduces anxiety of working within a very short tidal cycle window but does increase labor effort.

It takes two workers to harvest a net, one on each side of the net to keep the net stretched tight across the top of the harvester. If the net becomes slack, it may wrap around the blades, sometimes cutting the net. One worker must be next to the engine to be able to stop the engine in a moment's notice when a problem occurs.

The first harvest should occur when approximately 50% of the spaces between the net meshes are filled with nori. The mesh size is approximately 15 cm (6") bar; that is, there is approximately 15 cm (6") between the net twine knots. This distance has been carefully determined to provide proper density and growing conditions for the nori. When the nori plants exceed 15 cm (6"), they tend to become tougher, and experience has shown that total production of the net is reduced. As the nori exceeds 15 cm (6"), the nori ends cover the next mesh, causing competition between the nori plants, and growth is affected. Some nori plants grow much faster than others and these are the plants first harvested. If the first harvest is delayed, serious damage to the remaining crop can result. The longest nori out competes the shorter by causing shade, and if allowed to grow over 25 cm (12"), it becomes tough and is also more likely to harbor disease. The nori should be cut back to about 7 - 8 cm (3"). It is much better management to cut frequently than to allow the nori to become too long. The first harvest should result in about 10 kg (22 lb) wet weight per net. The product is very soft and it can be difficult to make good sushi sheets from this harvest. Some Japanese farmers first-cut 20 -30 nets and throw the harvest away. The next week they harvest the same nets again, getting a slightly tougher product, and first-cut an additional 20 - 30 nets and mix the harvests together, which can result in a very high quality product.

Under good growing conditions there should be 7 - 10 days between harvests. The nori will become tougher between each harvest, until by the fifth or six harvest it will not yield good product for sushi sheets. The harvester blades are then set to maximum exposure to the nets and the nori is cut as close as possible. The nets are then removed from the system and returned to CPI, and new seeded nets are put in place if there is sufficient growing time left in the season.

H. Post Harvest Events

The harvested nori is brought in as soon as possible and must be processed within 2 hours after harvest or quality decreases. If it is not possible to process within this time frame, the nori can be stored in a storage tank with continuous sea water flow until processing time. If the farmer is more than two hours away from CPI, then the harvest is frozen and shipped to CPI in a frozen state. While the nori is left in baskets it begins to decompose immediately, and the nori on the bottom of the baskets becomes noticeably warmer, with quality decreasing rapidly. It should never be left out in the sun, especially during the summer. It is best to place the harvest in an insulated container, or at least place an insulated cover over the top of the nori. Frozen gel packs have been used in Japan effectively by placing 2 to 3 packs in the center of the basket to cool the nori.

The nori must be cleaned and de-watered before it can be frozen. All foreign material must be removed from the nori, and free water must be removed or the freezing process will damage the harvest. Ten kilograms (22 lb) of nori, wet weight, is placed in a nori liner. Two nori-filled liners are put in the de-waterer (centrifuge) and spun until no water drips out of the drain. This will take 10 - 20 min., depending on how quickly from time of harvest this process is conducted. Each liner will then hold about one kilogram of de-watered nori. Since a good net will produce approximately 32 kg (70 lbs) of product, if 20 or 30 nets are harvested, considerable time must be devoted to this de-watering process. Proper care must be given to the baskets of nori that have not been dried to prevent that nori from decomposing. Ideally the baskets should be placed in a walk-in cooler to prevent deterioration. CPI has a

4' x 8' x 8' fiberglass tank with continuous flow through sea water at 20 gpm to store product waiting to be processed. An agitator in the middle of the tank turns at 15 rpm to prevent the nori from floating on the water surface and decomposing there. After dewatering, the nori is placed in 6 mil plastic bags and tightly sealed, with each bag holding not more than 2 kg (5 lb), so that rapid freezing can occur. The bags are placed in a freezer at -18° C (0° F). The bags must have spaces maintained between them, easily done with small pieces of lath, to allow freezing. The bags must be turned over after 24 hours to ensure complete freezing. The nori can be safely stored in this manner for several months.

I. Factors affecting Nori Quality.

The production of high quality nori sheets is more of an art than a science. CPI uses only four grades to distinguish quality, A is the best, B is good, C is fair, and D is poor or unusable for sheets. Quality is a function of but not limited to culture density, temperature, wind and rain, freezer net quality, pollution, plankton populations, disease, growth rates, storage conditions, and harvester blade sharpness. Additional factors affecting quality are the variety of nori grown, time of day of harvest (photosynthesis during the day changes the chemical components of the cell, so that the quantity of sugars and amino acids at the end of the day are quite different than at dawn), amount of sunlight, contamination of the harvest by other algae, small animals such as amphipods, shrimp, and other types of debris (pine needles pose a special problem in Cobscook Bay). Exposure of the harvested product to gasoline or oil from the gas engine on the harvester or the outboard motor will ruin the entire harvest.

The production and harvest of high quality nori thus results from a very personal involvement of day to day nurturing and management techniques that can only be learned by experience. One of the world's largest nori growers told us that "It takes passion to produce good nori". Experience has found him to be right, and that there is a real danger to get caught up in strictly technological advances that make

daily chores easier but distract the nori farmer from the daily nurturing required in the production of high-quality nori.

J. Organic Certification Requirements.

CPI's organic certification requires strict record keeping. Each harvest has a lot number which describes the date and location of the harvest and is processed separately so that the processed sheets have a track record. This may result in a higher price for the sheets. If a nori farmer wishes to have his product OCIA - certified, the farmer must follow certain guidelines in the nurturing of the crop, the harvest, and the care of the harvest. These are listed below.

- No chemicals can be used on the nori nets during grow-out.
- A designated barge must be used to harvest the nori to avoid contamination from outboard motor fuel or other sources of contamination.
- Fuel and lubricating oils must be kept away from the harvest. Remove the harvester engine from the barge before adding fuel to avoid spillage from contaminating the deck.
- A designated trailer or truck liner to haul the harvest from the barge to the storage/freezing area must be used.

IV. SPECIAL CONCERNS

The successful nori farmer must carefully observe the growing nori on a daily basis. The crop will give indications of growing conditions by changing in size, shape, color, toughness, and texture. Prompt identification of signs of poor growing conditions as shown by the plants will aid the farmer in attempting to ameliorate the situation. Generally, the sooner a problem is identified, the easier it is to correct. The following section describes nori characterizations one might experience.

Pale color.

Healthy, high quality nori has an eggplant purple color. It is helpful to have a Pantone Color Guide and daily monitor the color of the fronds. The color should be observed at the base of the nori strand where numerous nori fronds overlap. One excellent technique is to cut a typical nori net strand and lay it on heavy matted drawing paper while emersed in water, carefully remove from water and lay the sheet on some newspapers, cover it with waxed paper, more newspaper, and a book to press the specimen flat. The sample will dry out overnight and will be preserved. It will maintain its color as long as it is kept in low humidity and away from light. Daily samples will give a permanent record of color, growth, morphology of the nori. Good color nori is 497-C in the Pantone Color Guide.

Nori can turn pale due to many causes, it can indicate lack of nutrients, specifically nitrogen. This element is a key component of photosynthetic pigments such as phycoerythrin which gives nori its purple color. In low energy areas 100 $\mu\text{g/l}$. (100 ppb) of nitrogen is required for proper nori growth. Cobscook Bay frequently has less than 8 $\mu\text{g/l}$ (ppb) but with rapid water currents sufficient nitrogen flows past the nori to provide adequate growth. Frequent rainfall and subsequent runoff from terrestrial agriculture is required to maintain this level of nitrogen in the Bay. In low energy areas additional space between nets will provide better water circulation.

If lack of nitrogen is suspected, Ammonium nitrate can be safely added to the crop. Nori less than 7 cm long will respond overnight to this treatment. If the crop is organically certified, this treatment cannot be made. Successful applications have been made in several ways. For practical purposes it is not possible to over-fertilize and damage the nori. Laboratory experiments using 100,000 times more ammonium nitrate (1,000 ppm) indicated better growth than untreated nori. The primary factor is economical. Ammonium nitrate sells for about \$10/50lb in Maine. By placing 500 grams (about 1 lb) or \$.20 worth

of chemical into 200 l (50 gal) sea water in the bottom of a 5' x 10' x 1' barge, and laying the nets in this solution for 5 to 10 min., 20 - 30 nets can be treated depending on how long the nori is and how dirty the nets are. Chemical costs per net are minimal and the only real expense is labor.

This fertilizer can be applied on top of the nets if the nets are on the surface of the water. A hand sprayer of 10 liter capacity is used, placing 200 grams (0.5 lb) of ammonium nitrate in the sprayer and filling with sea water (it dissolves much faster if warm sea water is used), and the solution is sprayed from a boat moving up and down the rows of nets. Some success has resulted by treating 4 nets with each 10 liter solution. The nori has the ability to soak up the nutrients very quickly and store them for later use.

A third technique is to place ten kilograms of ammonium nitrate in a 6 mil plastic bag 50 cm long and 30 cm wide. Four slits, ten centimeters long, are cut in the sides of the bag to allow sea water to enter. The bag is hung off a production line next to the nori net in a position so that the prevailing current sweeps the dissolved fertilizer into the net. Four nets can be fertilized in this manner. The fertilizer dissolves in several days and then is replaced.

Pale nori also occurs when there is too much sunlight, which is common during June through August. The Japanese nori cultured is normally a winter crop, thriving during the season of 10 hr days and 14 hour nights. Summer days in Maine are 15 hours long. Just as with any plant cultured in flower pots or gardens, there are ideal amounts of sunlight or shade and temperature. Some success in darkening the nori can be had by lowering the nets below the surface of the water. At Carringplace Cove, Cobscook Bay, the nori exhibiting the finest color grew one meter (3 ft) above mean low water. At high tide the nets were approximately six meters (20 feet) below the surface.

Daily color changes will be noticed after a prolonged cloudy or foggy period. The best growing conditions for nori in Maine during the

summer are several weeks of foggy weather, which frequently occurs in July. 30 year weather records for Cobscook Bay during June through September show that 28% of the time is foggy or overcast. Islands off the coast of Maine will have more foggy days. After September 15th, the day length and solar intensity become satisfactory for nori and then a prolonged period of cloudiness results in pale color. After one day of sunny weather the nori will darken considerably.

Green algae infestation

Green algae, most commonly *Enteromorpha*, grows under similar conditions as nori. It will be found on bare net strands after 2 - 3 weeks deployment at any time during the growing season. If harvested with the nori it severely reduces the value of the nori. The best defense against green algae is to have 100% covered nori nets, which prevent it from attaching to the nets. When a few strands are found they can be pulled off by hand. If patches of green algae begin to grow on the nets, the nets can be pulled from the system and given a long drying in the shade on a breezy afternoon. When salt crystals appear on the nori but the nori is still rubbery, replace the nets back into the system. If this does not kill the green algae, the nets can be frozen. They are dried in the shade, and then placed in airtight bags and frozen at -18° C (0° F) for 8 - 10 days. This will kill the green algae, but almost two weeks of production is lost. Nori nets with green algae can be treated with 0.2 - 0.5% citric acid solution. 1.5 kg (approx. 3 lb.) of citric acid is dissolved in 200 gal. of sea water. The nets are placed in this solution for up to 10 minutes. Thirty nets can be treated with this same solution if they are not too dirty. Do not dry the nets before placing them in the solution. Always mix up the solution the day before use and place a few nori laden strands of net in the solution, give the strands different time treatments of 5 minutes, 10 minutes, and 15 minutes, then place each strand in a different jar of sea water and place in your refrigerator. Examine the nori the next day for rust red color, which indicates dead nori. This trial will help determine the length of time it is safe to soak the nori. An accurate pH meter is required. No acid treatment can be used if the nori is OCIA certified.

Frayed edges.

Careful observation of the nori frond side edges shows rips or raggedness. Healthy nori edges are smooth with no serrations. The top of the nori frond will likely be ragged after the first harvest because the nori harvester slaps the top of the plant off rather than cuts it.

Abrasion from floating objects or seaweed (rockweed) is the most common cause. If floating eel grass (*Zostera marina*) is in the area it can damage nori because its edges are serrated and it wraps around the nori strand. As the current moves the eel grass blade along the strand, the nori is cut off or damaged. Daily cleaning of all floating objects from the system will limit this damage.

A heavy sea state caused by strong winds can do extensive damage to nori fronds. Placing the nori site in protected waters is the only practical remedy.

Photooxidation, which can occur when periods of intense solar radiation occur when there are low nutrients and/or low water temperatures, will cause ragged edges. Some cells on the margin of the nori are killed, and as the adjacent cells continue to divide and grow, the area where the dead cells are cause a wrinkle to occur. If these environmental conditions are expected to continue, such as a drought period during the summer, then the best remedy is to lower the nets 10 - 15 ft below the surface. This is labor intensive and rather drastic, but these environmental conditions can cause complete failure of the nets for the season.

CPI has not observed any evidence of herbivory by animals such as periwinkles (*Littoria littorina*), amphipods, limpets, or fish.

Crepeness

The edges of the nori fronds are wavy and curly, just as crepe paper appears. This condition indicates some physiological problem.

The growth of the fronds will noticeably decrease, and the nori tends to be tougher.

A possible cause is photo-oxidation. This condition is most commonly found during the summer months, and did not occur in nets fixed at 3 ft above mlw, or 20 ft below mhw.

Frond Perforations

Perforations that are visible to the naked eye probably are caused by abrasion. If numerous holes exist, examination at 100x with a microscope should be conducted. Holes of only 2 -3 cells wide can indicate disease problems. A sample of nori net twine with fronds attached should be dried in paper towels or cheese cloth to remove most of the free water, placed in a zip-lock plastic bag and then shipped overnight to CPI. Be sure to remove all free water before shipping. The nori will survive for a surprisingly long time in a sealed zip-lock bag as long as it is kept dark and cool. If the cells surrounding the holes have a pale color or are totally clear, this may indicate disease. Holes lined with greenish color cells indicate a fungal disease (Chytrid). Prompt harvest must occur, and removal of infected nets from the system must be conducted. Holes lined with a red ring, visible to the naked eye, may indicate red spot disease. Careful monitoring should be conducted. Several sightings of red spot in a whole system should not cause much alarm. If numerous sightings on one net are seen, immediately remove the net. This disease has been seen in Cobscook Bay but has not been an economical problem at this time.

If the holes are larger than several cells wide, and the cells on the margins of the holes have good brown-purple color, it is possible that sand can produce the holes. If the nori site is at the mouth of a large river and there have been heavy rains, this "shot-hole" condition can occur. The only remedy is to move the nets to a different site, or possibly freezing the nets until the environmental situation changes. Both remedies are rather extreme.

Additional Frond Color Changes

- i. Pale edges near the top of the fronds. .

Male sex cells (antheridia) appear as pale areas on the edges. These cells are produced during late fall.

- ii. Dark red spots in streaks in the fronds.

Female sex cells (cystocarps) are produced after the male sex cells. These sexual cells do not affect quality or production of the nori.

- iii. White edges of the fronds.

This condition is usually caused by diatom infestation. If it is very wide spread, the nori blades themselves will appear without any luster.

Healthy nori "shines". Special attention must be given to pole culture nets for diatom infestation when the low or neap tides occur around dawn and sunset. Pole culture nets are set low in the water so that they get about 4 hours of drying per 24 hour period. When the exposure times are at dawn and dusk, the low sun intensity does not dry the nets and kill the diatoms. This period lasts 5- 6 days before the nets get a good drying. Diatoms may be washed off with a 2" water pump and hose. The nets can be brought in to shore and hung in a shady area for 2-3 hours, or until salt crystals form on the nori. The nori should remain rubbery or leathery. If it becomes so dry that it is hard or brittle, the nori will die. Heavy diatom infestation will reduce the quality of the nori sheet. Such nori is called "hata-fun" nori, or pigeon excrement nori, which is self-descriptive.

Low Growth Rates

Healthy nori in good growing conditions will show a daily increase in growth to the naked eye. Occasionally several days may go by without any noticeable change and then growth is obvious. A plankton bloom in the area may be the cause as the plankton uses up the available nutrients. If observable growth stops for 5 or more days, then this becomes economically detrimental. Carefully observe the nori

fronds for signs of disease or excess plankton growth. Growth stoppage during the summer can be due to lack of nutrients, but the nori will almost always turn pale before it stops growing. Dark-colored nori that stops growing may be inhibited by too much sun. Prolonged sunny conditions will inhibit and even kill nori.

LIST OF EQUIPMENT SUPPLIERS

Rope: Wall brand "steel" rope

Wall Industries
P.O. Box 907
East Greenwich, RI 02818
(401) 885-1444

Fluke Anchors
Harvester
Centrifuges

CPI
1219 Maine Street
P.O. Box 209
Poland, ME 04274
(207) 998-4909

Floats: Lobster pot buoys,
torpedo shaped gill net buoys
50 LB sphere shaped

Carlson Product Co.
1 New Haven Ave.
Derby, CT 06418
1-800-243-6682

Mussel buoys

Duro Plast LTD
P.O. Box 2087
St. John, N.B. E2L 3T5
1-800-567-3966

Basket Liners

CMI
205 Bluewater Rd.
Bedford, NS B4B 1H1

Citric Acid, Monohydrate

GFS Chemicals Inc.
P.O. Box 245
Powell, OH. 43065
1-800-858-9682

Pantone Color Guide

Pantone, Inc.
590 Commerce Boulevard
Carlstadt, N.J. 07072
(201) 935-5500

Figure 1. Life History of the commercial species *Porphyra yezoensis* (Mumford & Miura, 1988).

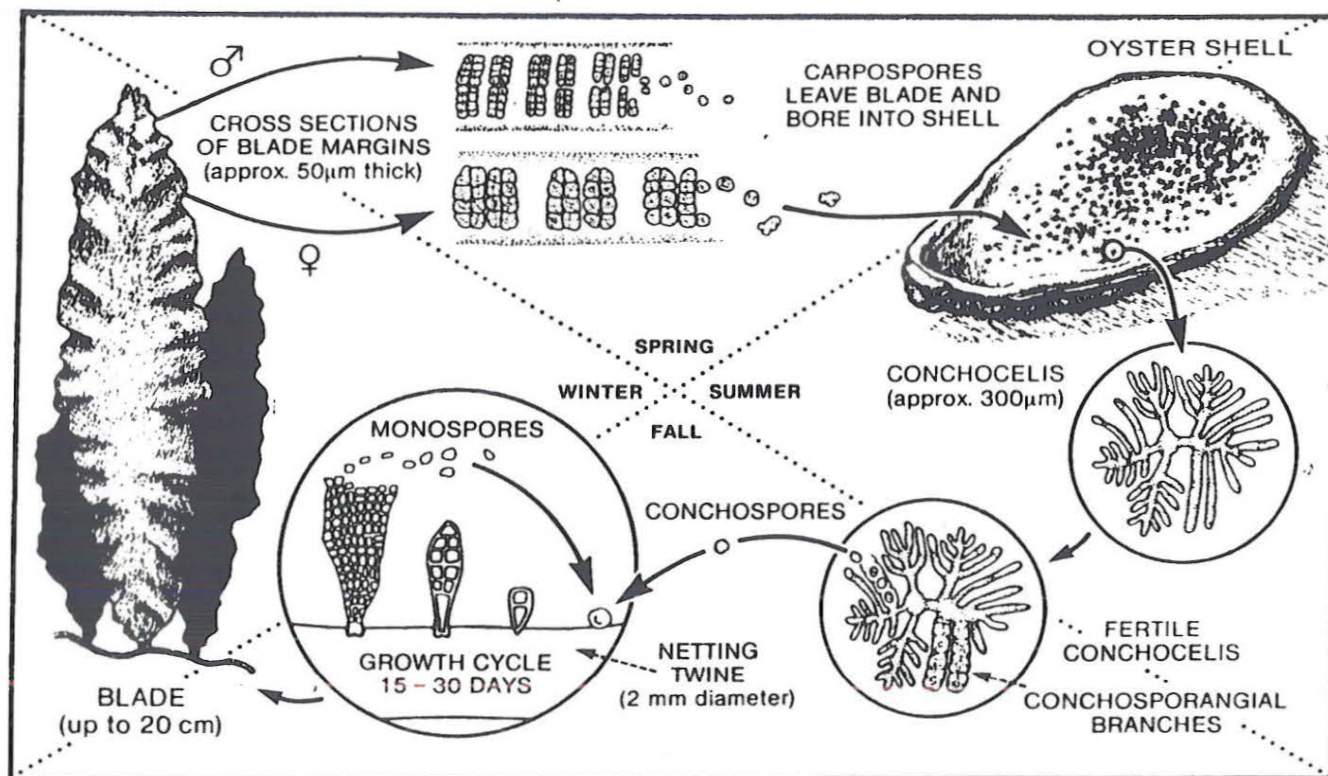


Figure 2. Sheet bend with a loop.

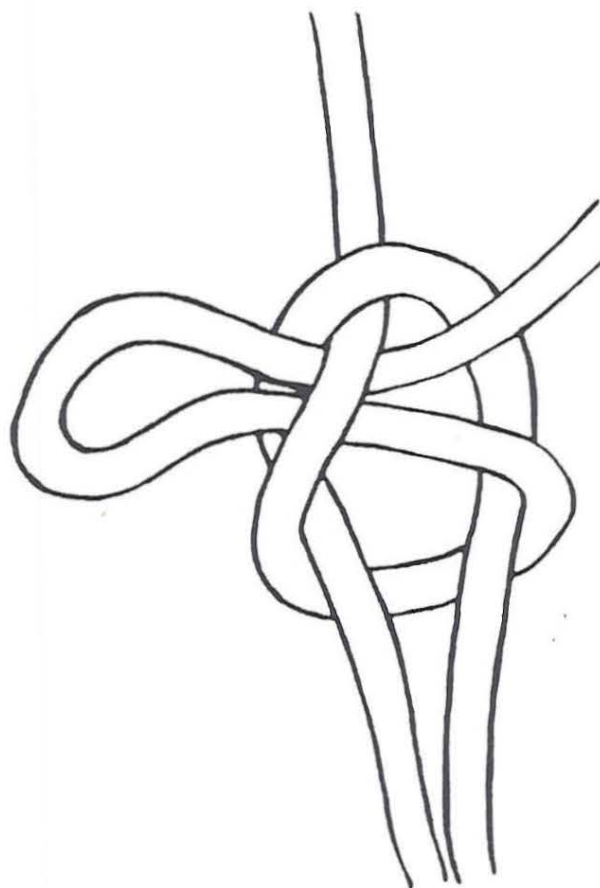


Figure 3 Tying a net into the system. Always begin the knot by running the end of the line from the top of the net down, to keep the loop on top of the net.

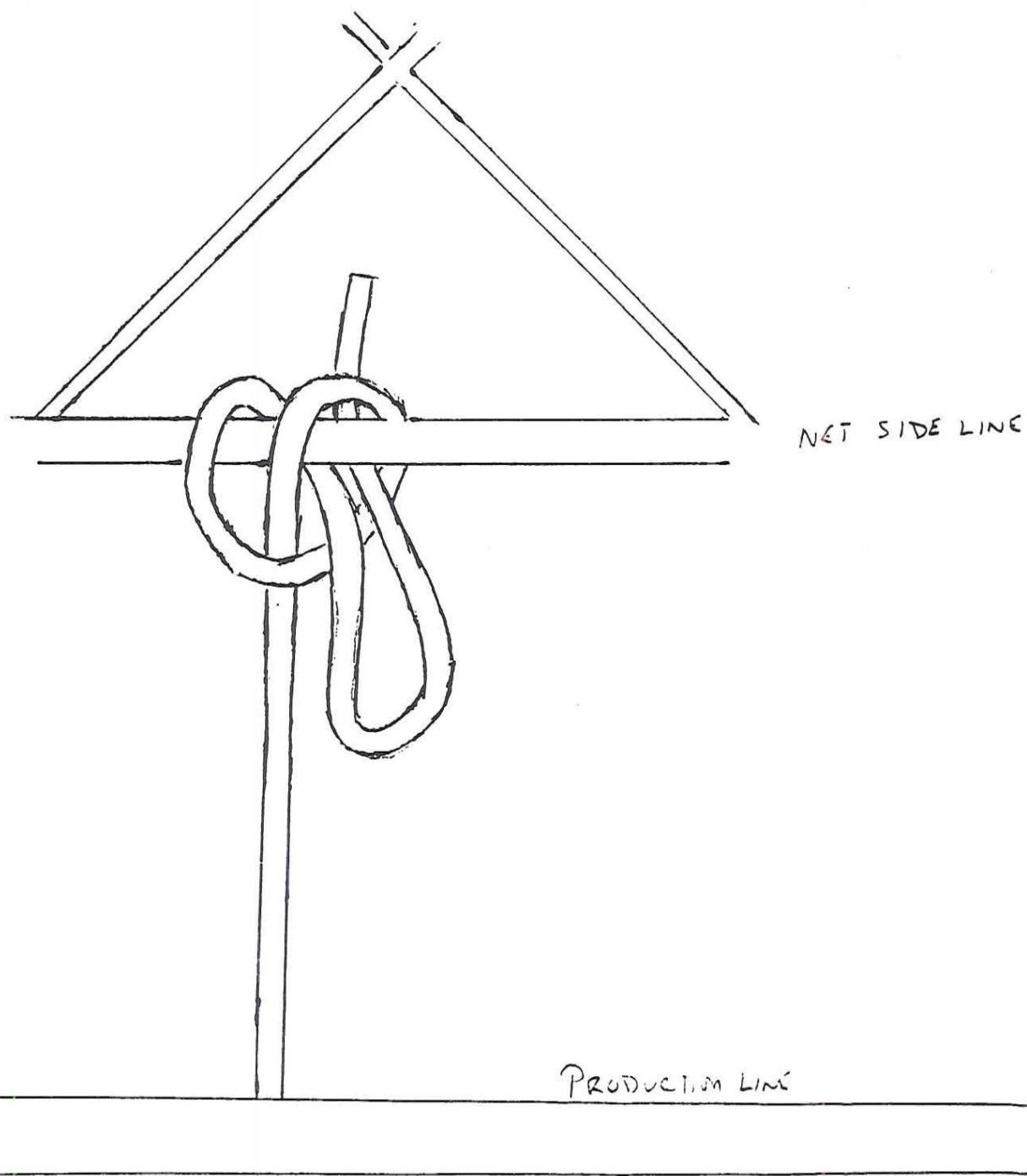
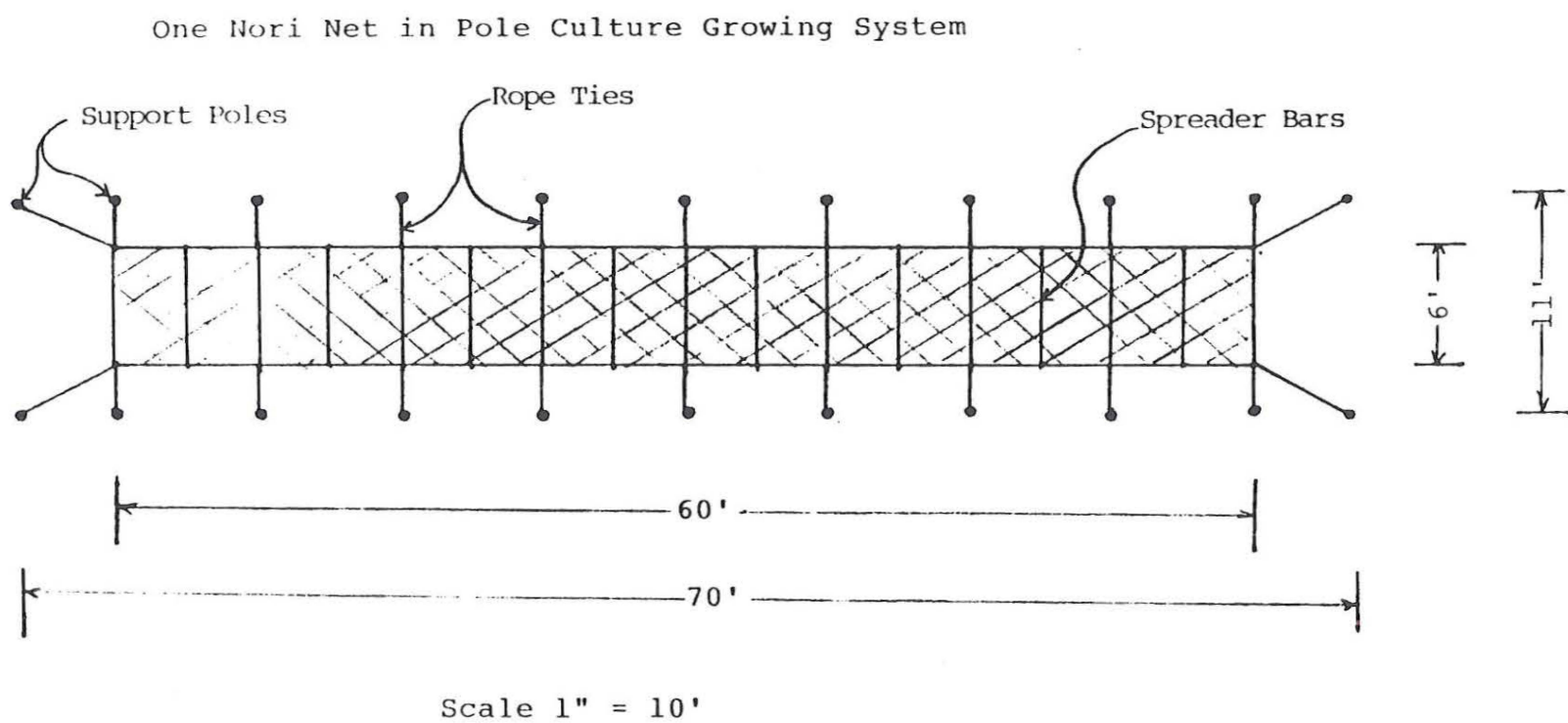


Figure 4



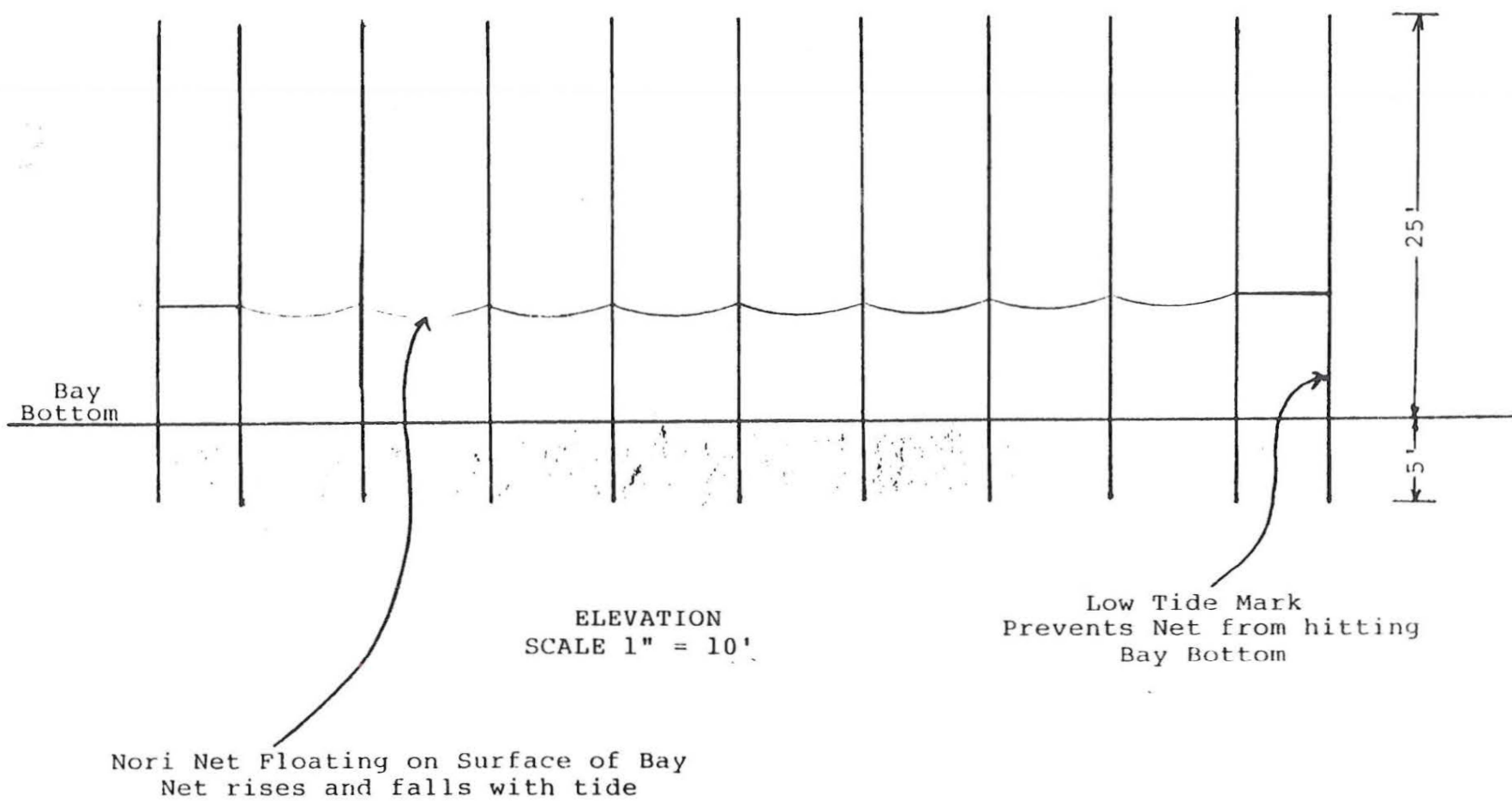
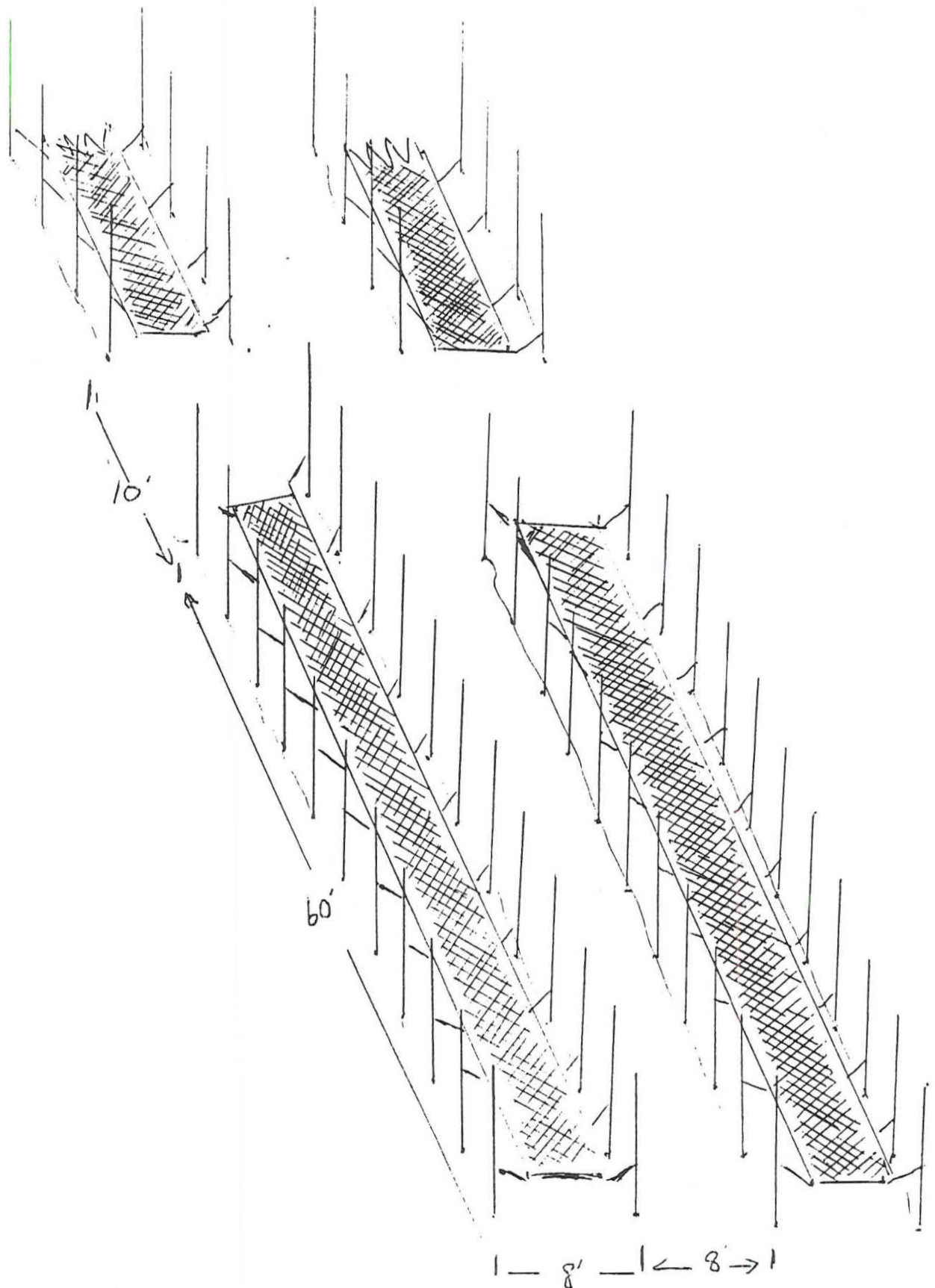
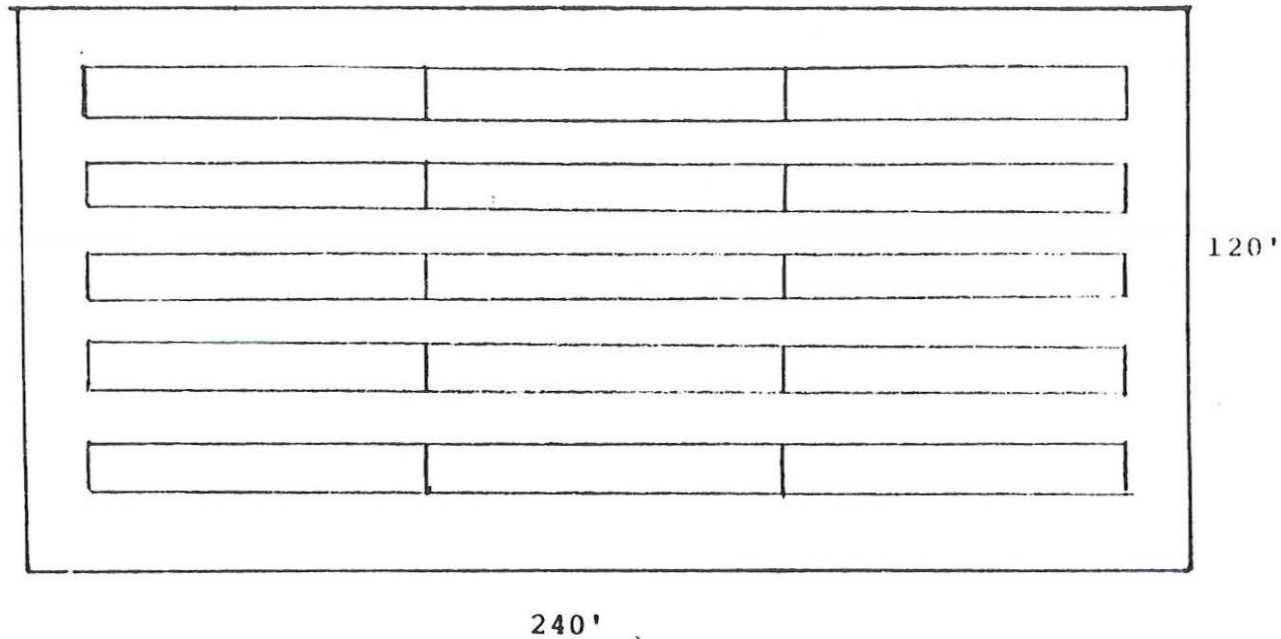


Figure 5

Figure 6. Pole Farm Net Array



Site Plan - CPI's Experimental Nori Pole System



Configuration to be used in Pole Farm Production Site
Scale: 1" = 40'

Each of the five rows as indicated represent three nori nets including the support poles (70' x 11'). Each row measures 210 feet long by 11 feet wide. Ten feet separate each row. A buffer of 15 feet surrounds the outer rows of this system to the edge of proposed experimental lease site.

Figure 7.

Figure 8. CPI Nori Pole Driver

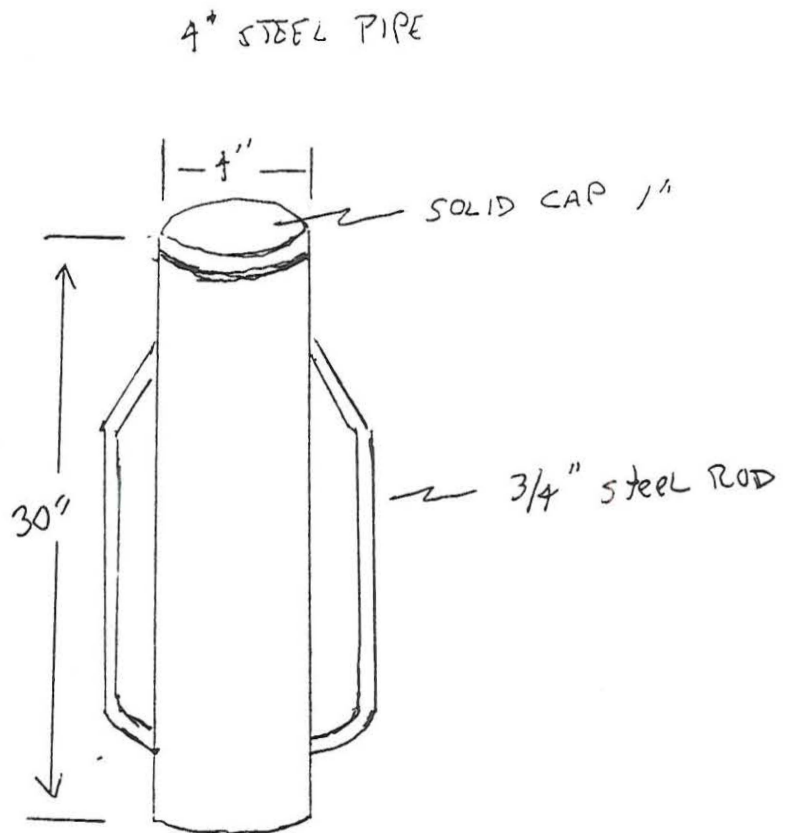


Figure 9. Nori net. Note the two-corner side and the three corner side, used to help determine the top and bottom of the net. (Byce et al., 1984)

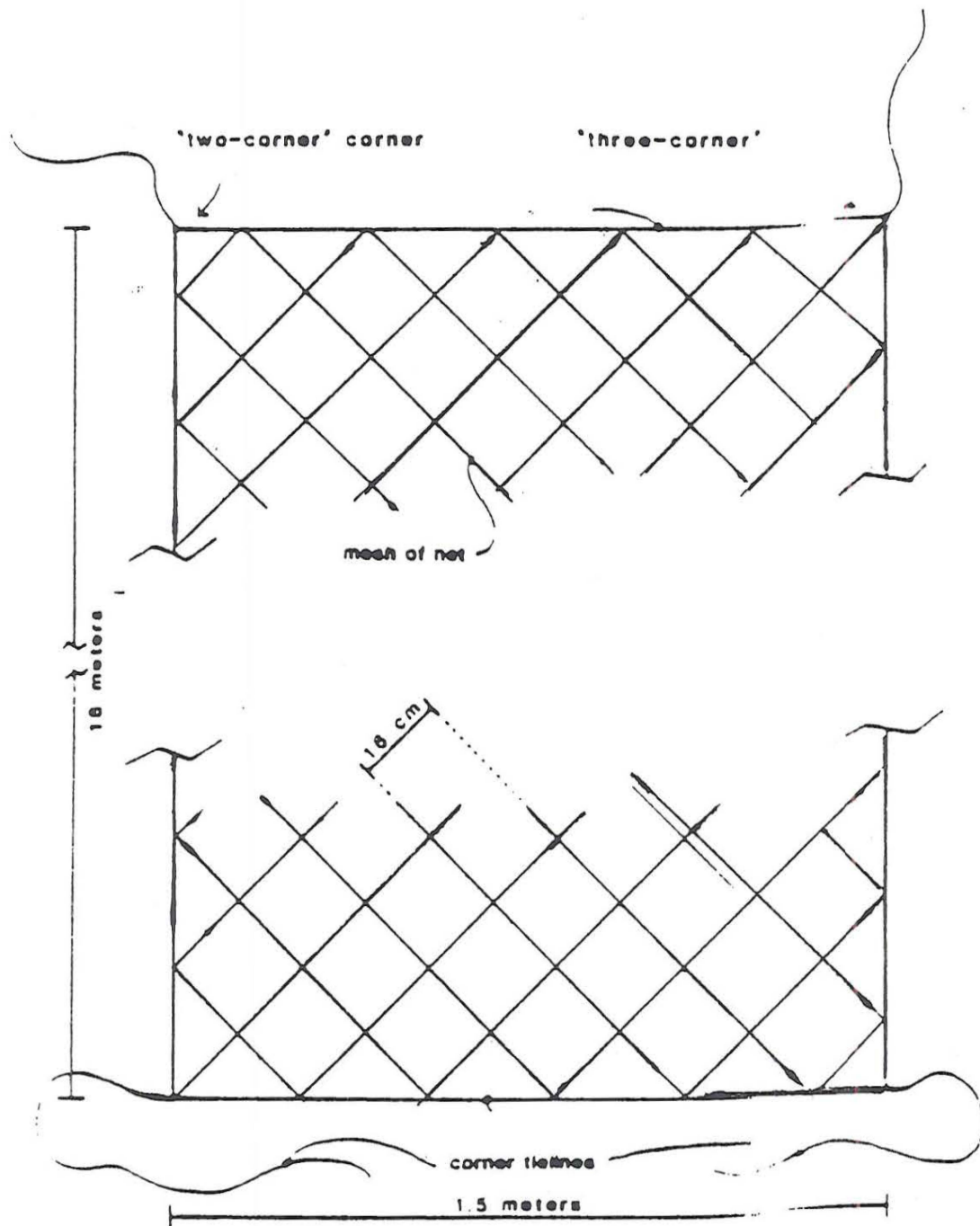
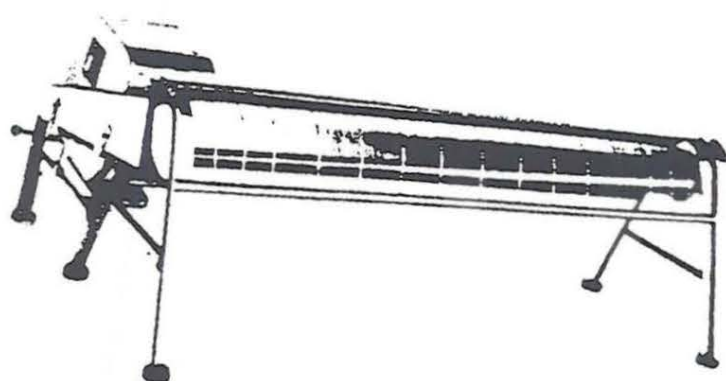
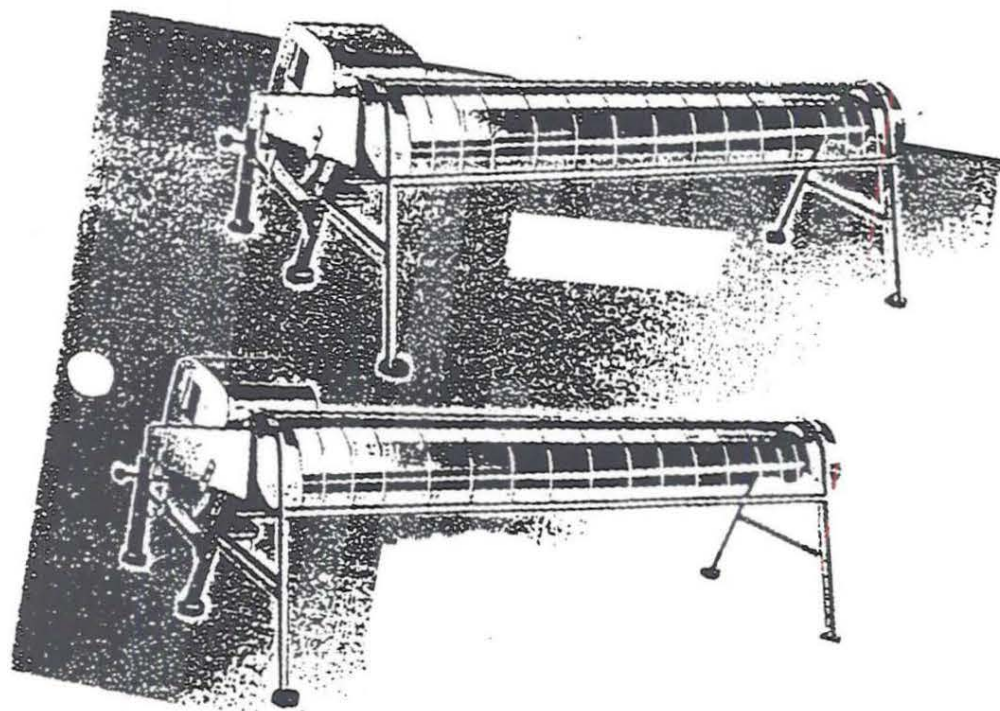


Figure 10. Nori Net Harvesters



Appendix V

EASTPORT QUADRANGLE

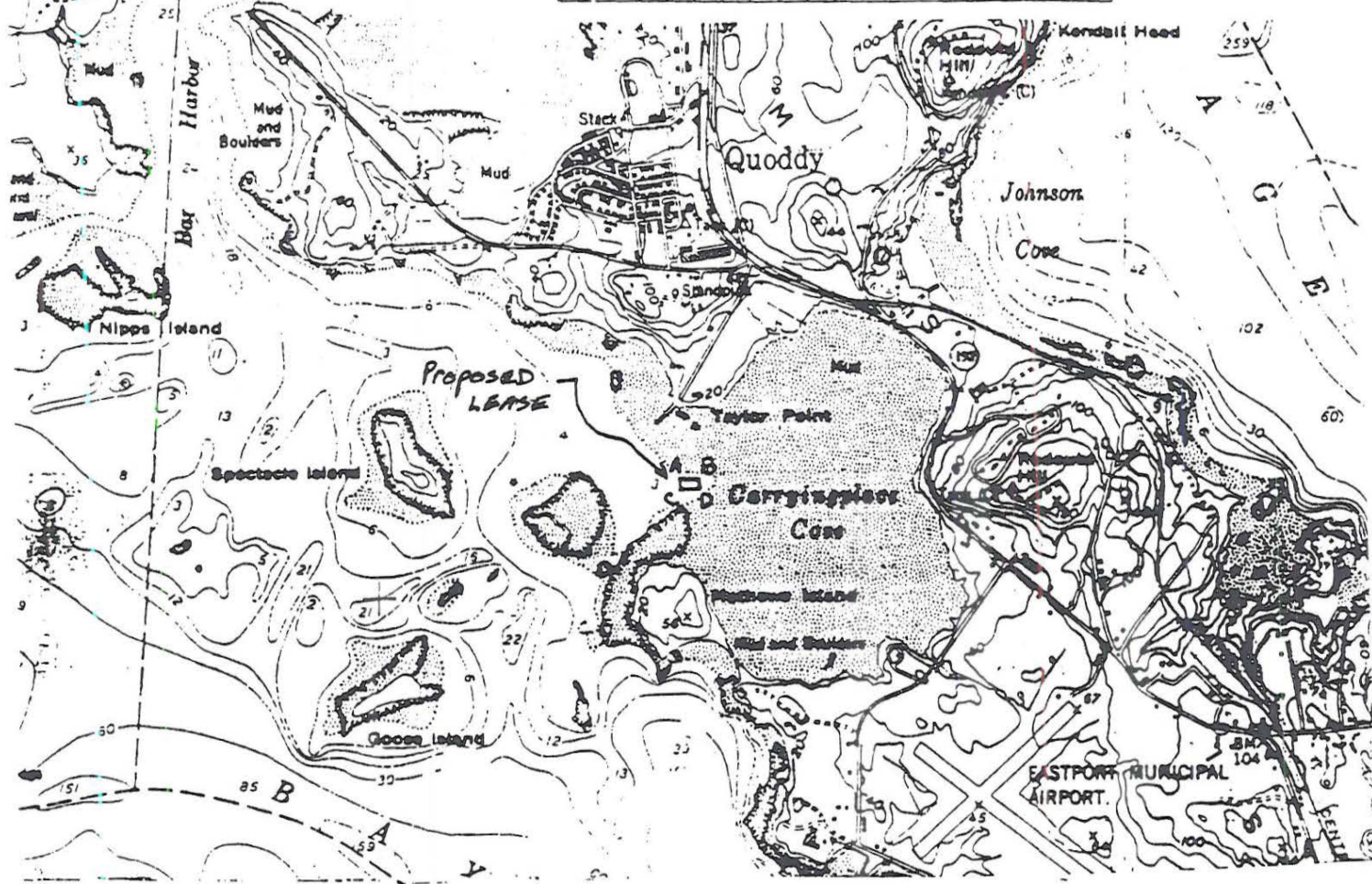
MAINE-WASHINGTON CO.

7.5 MINUTE SERIES (TOPOGRAPHIC)

SCALE 1:24,000

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER



1983

Page 1

STATE PLANE COORDINATES,

ZONE: ME F

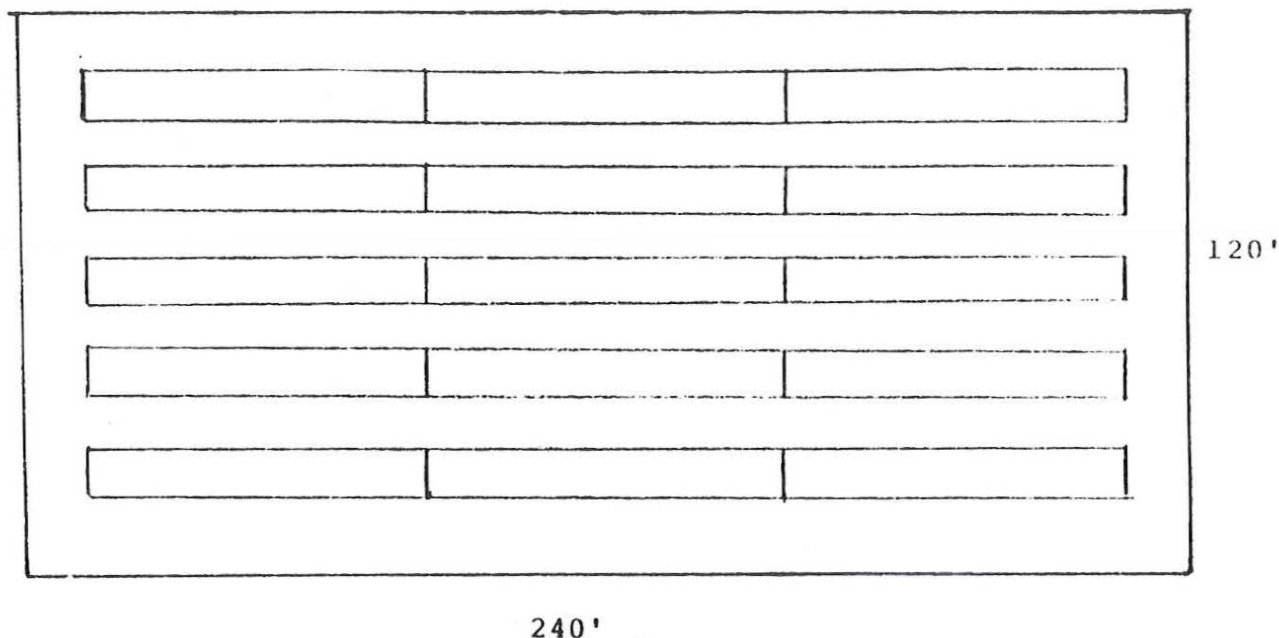
Linear Units: US Foot

Point	Northing	Easting	Latitude	Longitude	Convergence	Scale F.
D	460415.959	1365230.693	44 55 12.924	67 1 44.845	+1 2 19.4	1.00006576
C	460415.959	1364990.693	44 55 12.967	67 1 48.180	+1 2 17.1	1.00006555
A	460535.959	1364990.693	44 55 14.152	67 1 48.149	+1 2 17.1	1.00006555
B	460535.959	1365230.693	44 55 14.109	67 1 44.815	+1 2 19.5	1.00006576

PROPOSED SEAWEED CULTIVATION
COASTAL PLANTATIONS INTERNATIONAL,
COBSCOOK BAY
EASTPORT, MAINE
INC.

SHEET 1 OF 4

Site Plan - CPI's Experimental Nori Pole System

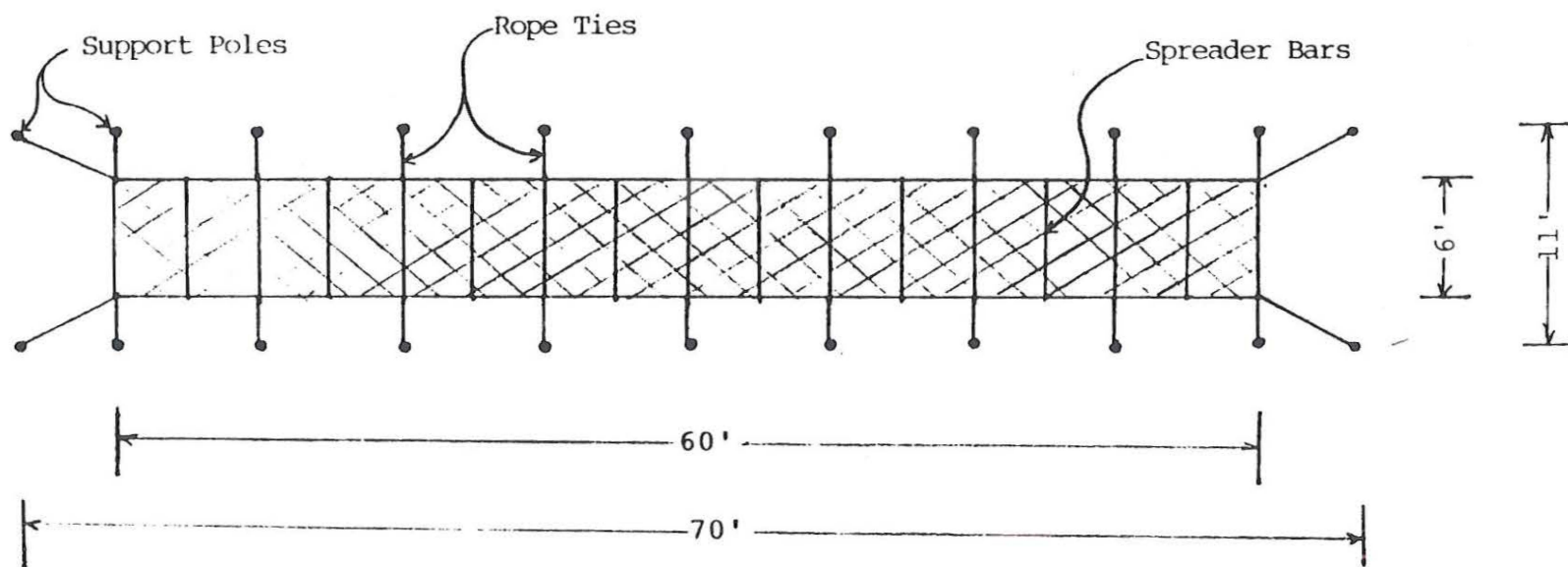


Configuration to be used in Pole Farm Production Site
Scale: 1" = 40'

Each of the five rows as indicated represent three nori nets including the support poles (70' x 11'). Each row measures 210 feet long by 11 feet wide. Ten feet separate each row. A buffer of 15 feet surrounds the outer rows of this system to the edge of proposed experimental lease site.

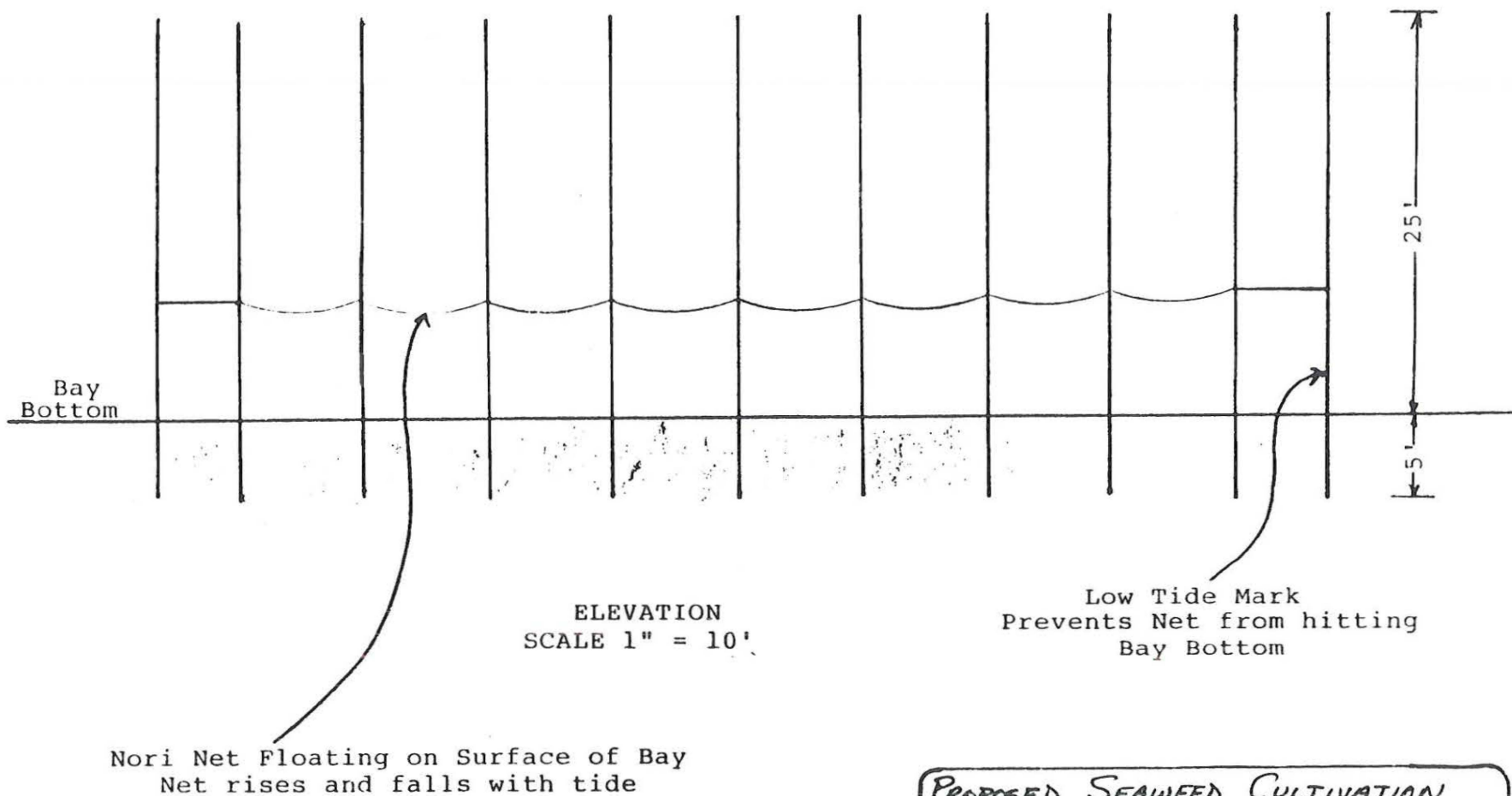
PROPOSED SEAWEED CULTIVATION
COASTAL PLANTATIONS INTERNATIONAL, INC.
COBSCOOK BAY
EASTPORT, MAINE SHEET 2 OF 4

One Nori Net in Pole Culture Growing System



Scale 1" = 10'

PROPOSED SEAWEED CULTIVATION
COASTAL PLANTATIONS INTERNATIONAL,
COBSCOOK BAY INC
EASTPORT, MAINE SHEET 3 OF 4



PROPOSED SEAWEED CULTIVATION
COASTAL PLANTATIONS INTERNATIONAL INC.
COBSCOOK BAY
EASTPORT, MAINE SHEET 4 of 4

Appendix VI

100 Saku Farm
Pole Culture

Equipment Needed: (Refer to figure 2-1B)

	Quantity	Price	Extension
Poles:			
2" x 20'	2200	\$ 11.00	\$24,200.00
Ropes:			
5/16" "steel line"	16,160	\$ 0.03	\$ 484.80
Sub Total			<u>\$24,684.80</u>
Other Equipment			
1 Harvester		\$ 3,200.00	\$ 3,200.00
20 Baskets		\$ 15.00	\$ 300.00
20 Basket Liners		\$ 3.00	\$ 60.00
1 Centrifuge		\$16,000.00	\$16,000.00
1 Freezer		\$ 600.00	\$ 600.00
Sub Total			<u>\$20,160.00</u>
Total Capitalized Equipment			<u><u>\$44,844.80</u></u>

Gross Receipts:	200	Nets	\$ 300.00	\$ 60,000.00
Less Merchandise Costs	200	Nets	\$ 130.00	<u>\$ 26,000.00</u>
Gross Profit				<u>\$ 34,000.00</u>
Expenses:				
Fixed:				
			Equipment (amortized over 5 years)	\$ 8,968.96
			Insurance	\$ 1,000.00
			Lease Cost (2.5 Acres @ \$50/acre)	\$ 125.00
				<u>\$ 10,093.96</u>
Variable:				
	Labor	1.5 Laborers @ \$9/Hr, 40 hrs/week, 26 week		\$ 14,040.00
	Fuel			\$ 1,000.00
	Repairs			\$ 2,000.00
	Electricity			\$ 1,000.00
	Miscellaneous			\$ 1,000.00
				<u>\$ 19,040.00</u>
Total Fixed and Variable				\$ 29,133.96
Net Profit				<u><u>\$ 4,866.04</u></u>

200 Saku Farm
Pole Culture

Equipment Needed: (Refer to figure 2-1B)

	Quantity	Price	Extension
Poles:			
2" x 20'	4400	\$ 11.00	\$48,400.00
Ropes:			
5/16" "steel line"	32,320	\$ 0.03	\$ 969.60
Sub Total			<u>\$49,369.60</u>
Other Equipment			
1 Harvester		\$ 3,200.00	\$ 3,200.00
40 Baskets		\$ 15.00	\$ 600.00
40 Basket Liners		\$ 3.00	\$ 120.00
1 Centrifuge		\$16,000.00	\$16,000.00
1 Freezer		\$ 600.00	\$ 600.00
Sub Total			<u>\$20,520.00</u>
Total Capitalized Equipment			<u><u>\$69,889.60</u></u>

Gross Receipts:	400	Nets	\$ 300.00	\$120,000.00
Less Merchandise Costs	400	Nets	\$ 130.00	<u>\$ 52,000.00</u>
Gross Profit				<u>\$ 68,000.00</u>
Expenses:				
Fixed:				
Equipment (amortized over 5 years)				\$ 13,977.92
Insurance				\$ 2,000.00
Lease Cost (5 Acres @ \$50/acre)				<u>\$ 250.00</u>
				\$ 16,227.92
Variable:				
Labor 2Laborers @ \$9/Hr, 40 hrs/week, 26 weeks				\$ 18,720.00
Fuel				\$ 2,000.00
Repairs				\$ 4,000.00
Electricity				\$ 1,000.00
Miscellaneous				<u>\$ 2,000.00</u>
				\$ 27,720.00
Total Fixed and Variable				<u>\$ 43,947.92</u>
Net Profit				<u><u>\$ 24,052.08</u></u>

500 Saku Farm
Pole Culture

Equipment Needed: (Refer to figure 2-1B)

	Quantity	Price	Extension
Poles:			
2" x 20'	11,000	\$ 11.00	\$121,000.00
Ropes:			
5/16" "steel line"	80,800	\$ 0.03	\$ 2,424.00
Sub Total			<u>\$123,424.00</u>
Other Equipment			
1	Harvester	\$ 3,200.00	\$ 3,200.00
60	Baskets	\$ 15.00	\$ 900.00
60	Basket Liners	\$ 3.00	\$ 180.00
1	Centrifuge	\$16,000.00	\$ 16,000.00
2	5' x10'x1' Plywood Barge	\$ 400.00	\$ 800.00
2	Freezer	\$ 600.00	\$ 1,200.00
			<u>\$ 22,280.00</u>
Total Capitalized Equipment			<u><u>\$145,704.00</u></u>

Note: Two 16'-20' skiffs are needed for this size system

Gross Receipts:	1,000	Nets	\$ 300.00	\$300,000.00
Less Merchandise Costs	1,000	Nets	\$ 130.00	<u>\$130,000.00</u>
Gross Profit				<u>\$170,000.00</u>
Expenses:				
Fixed:				
				Equipment (amortized over 5 years)
				\$ 29,140.80
				Insurance
				\$ 4,000.00
				Lease Cost (12.5 Acres @ \$50/acre)
				\$ 625.00
				<u>\$ 33,765.80</u>
Variable:				
	Labor	6Laborers @ \$9/Hr, 40 hrs/week, 26 weeks		\$ 56,160.00
	Fuel			\$ 5,000.00
	Repairs			\$ 10,000.00
	Electricity			\$ 2,000.00
	Miscellaneous			\$ 5,000.00
				<u>\$ 78,160.00</u>
Total Fixed and Variable				<u>\$111,925.80</u>
Net Profit				<u><u>\$ 58,074.20</u></u>

Pole Farms
Amortized Over
10 Years

Profit in Pole Culture if amortized over 10 years

100 Saku Farm

Gross Receipts:				
	200	Nets	\$ 300.00	\$ 60,000.00
Less Merchandise Costs				
	200	Nets	\$ 130.00	\$ 26,000.00
Gross Profit				\$ 34,000.00

Expenses:

Fixed:

Equipment (amortized over 10 years)	\$ 4,484.48
Insurance	\$ 1,000.00
Lease Cost (2.5 Acres @ \$50/acre)	\$ 125.00
	<u>\$ 5,609.48</u>

Variable:

Labor 1.5 Laborers @ \$9/Hr, 40 hrs/week, 26 weeks	\$ 14,040.00
Fuel	\$ 1,000.00
Repairs	\$ 2,000.00
Electricity	\$ 1,000.00
Miscellaneous	\$ 1,000.00
	<u>\$ 19,040.00</u>

Total Fixed and Variable **\$ 24,649.48**

Net Profit **\$ 9,350.52**

500 Saku Farm

Gross Receipts:				
	1,000	Nets	\$ 300.00	\$ 300,000.00
Less Merchandise Costs				
	1,000	Nets	\$ 130.00	\$ 130,000.00
Gross Profit				\$ 170,000.00

Expenses:

Fixed:

Equipment (amortized over 10 years)	\$ 14,570.40
Insurance	\$ 4,000.00
Lease Cost (12.5 Acres @ \$50/acre)	\$ 625.00
	<u>\$ 19,195.40</u>

Variable:

Labor 6 Laborers @ \$9/Hr, 40 hrs/week, 26 Weeks	\$ 56,160.00
Fuel	\$ 5,000.00
Repairs	\$ 10,000.00
Electricity	\$ 2,000.00
Miscellaneous	\$ 5,000.00
	<u>\$ 78,160.00</u>

Total Fixed and Variable **\$ 97,355.40**

Net Profit **\$ 72,644.60**

200 Saku Farm

Gross Receipts:				
	400	Nets	\$ 300.00	\$ 120,000.00
Less Merchandise Costs				
	400	Nets	\$ 130.00	\$ 52,000.00
Gross Profit				\$ 68,000.00

Expenses:

Fixed:

Equipment (amortized over 10 years)	\$ 6,952.96
Insurance	\$ 2,000.00
Lease Cost (5 Acres @ \$50/acre)	\$ 250.00
	<u>\$ 9,202.96</u>

Variable:

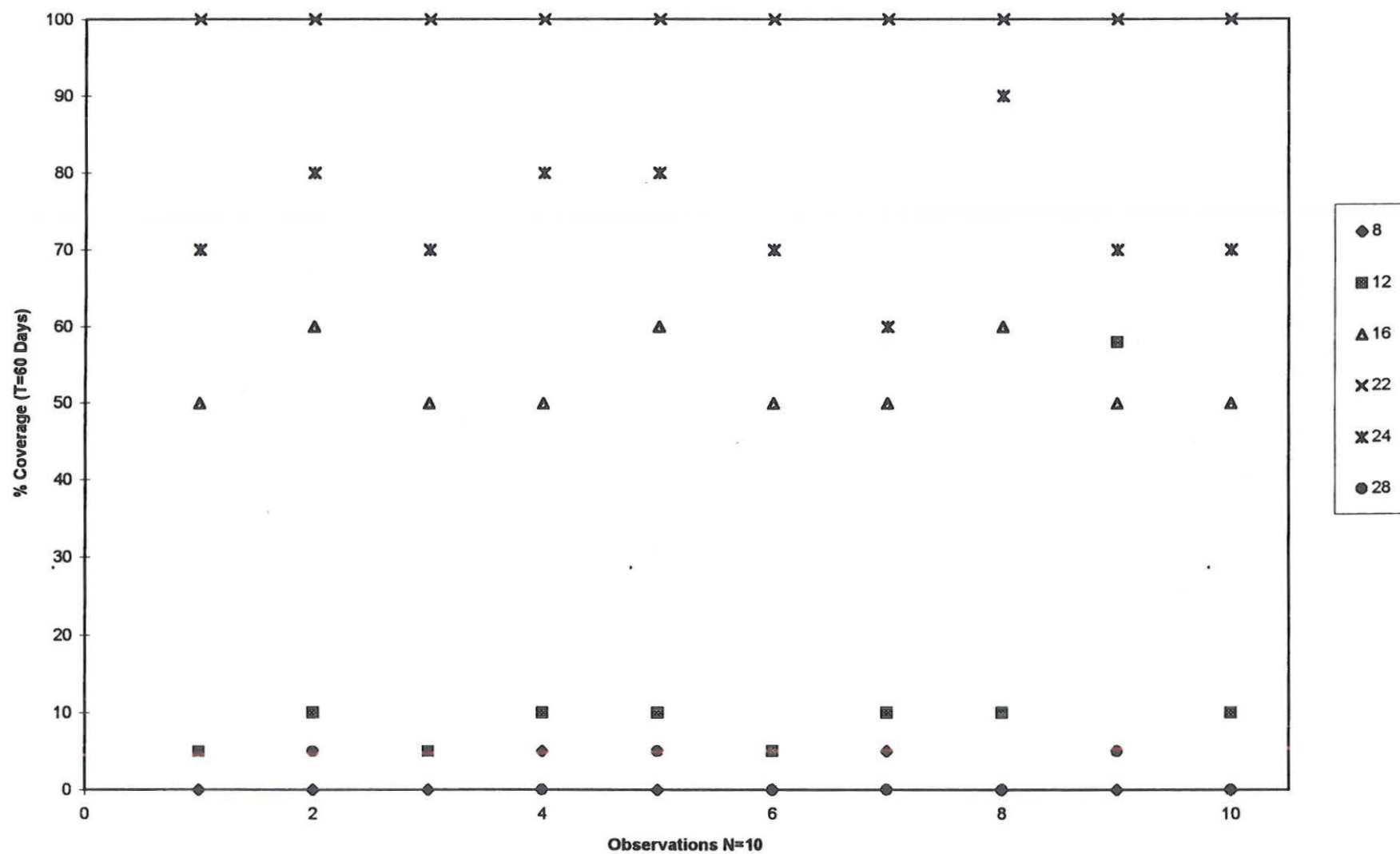
Labor 2 Laborers @ \$9/Hr, 40 hrs/week, 26 Weeks	\$ 18,720.00
Fuel	\$ 2,000.00
Repairs	\$ 4,000.00
Electricity	\$ 1,000.00
Miscellaneous	\$ 2,000.00
	<u>\$ 27,720.00</u>

Total Fixed and Variable **\$ 36,922.96**

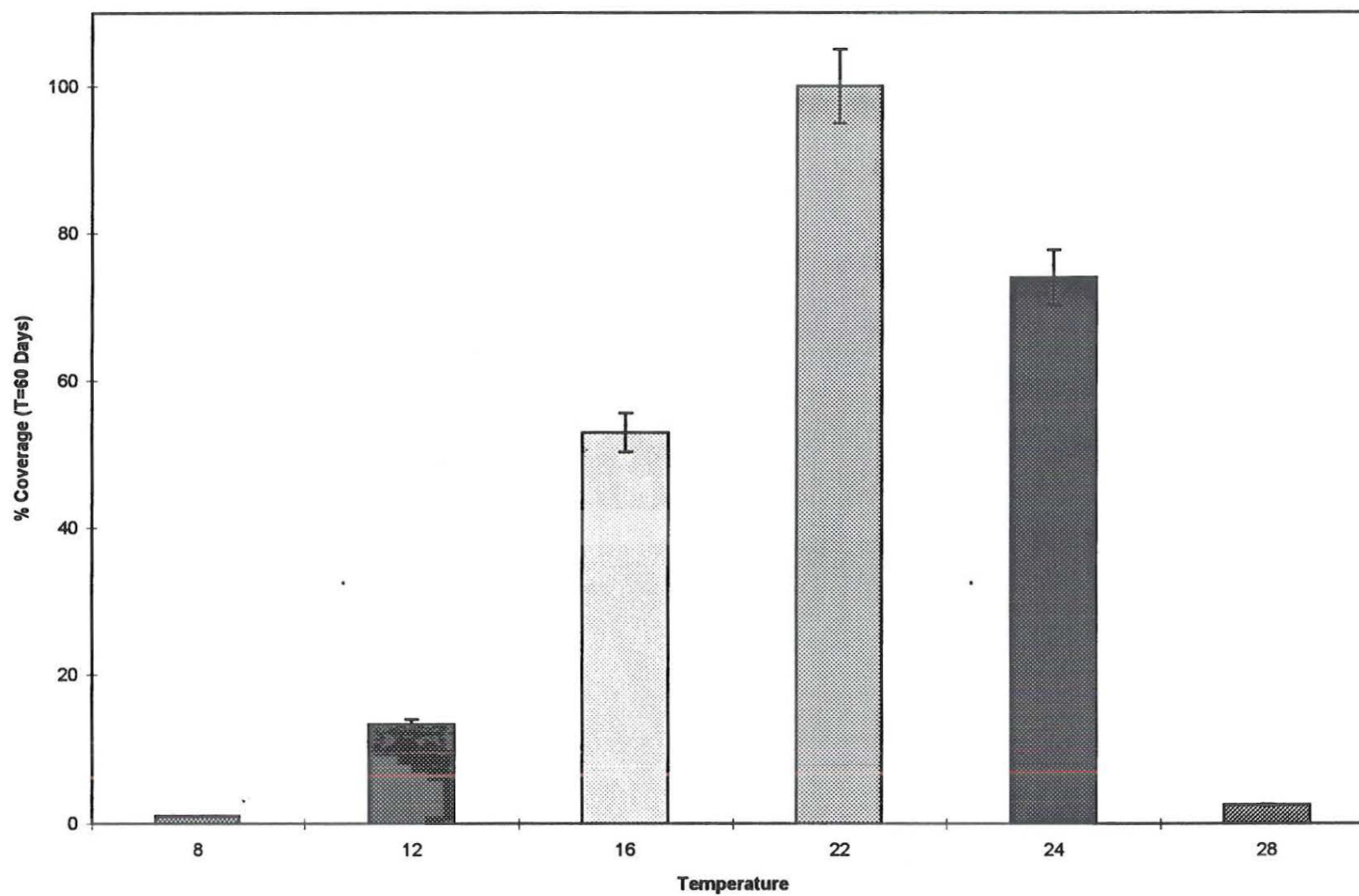
Net Profit **\$ 31,077.04**

Appendix VII

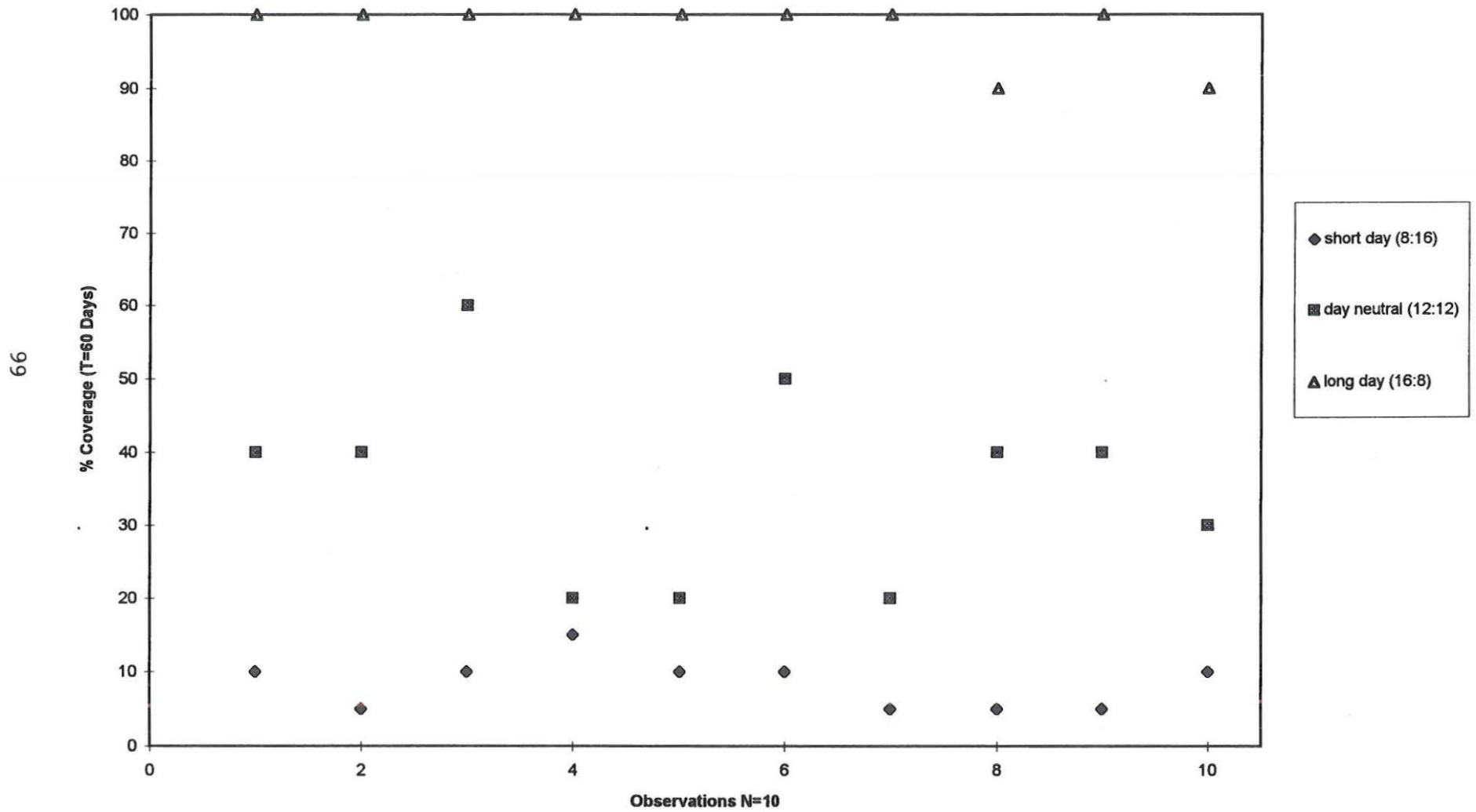
Conchocelis Culture Within Calcium Carbonate Substrate - As a Function of Temperature - Raw Data



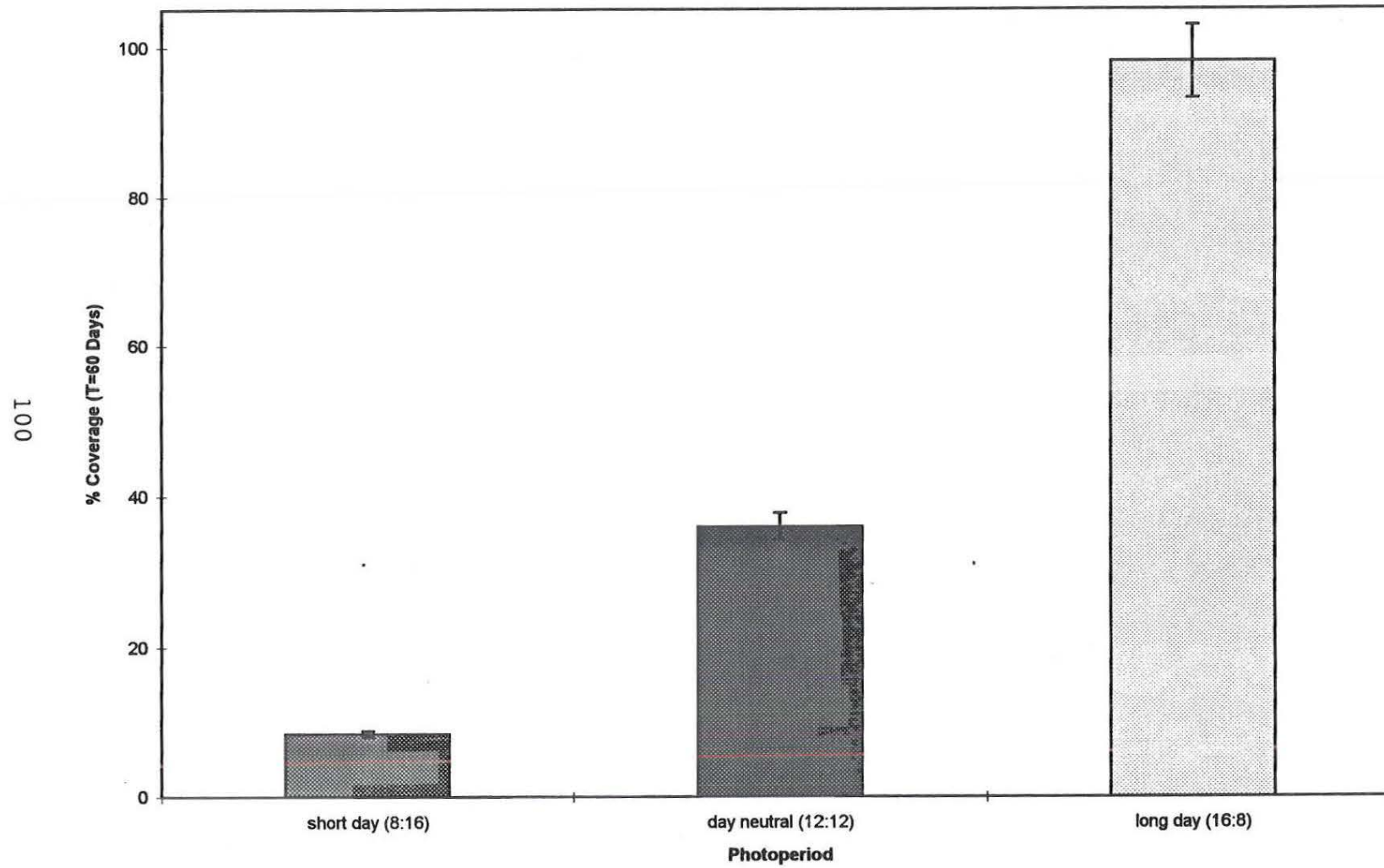
Conchocelis Culture Within Calcium Carbonate Substrate As a Function of Temperature



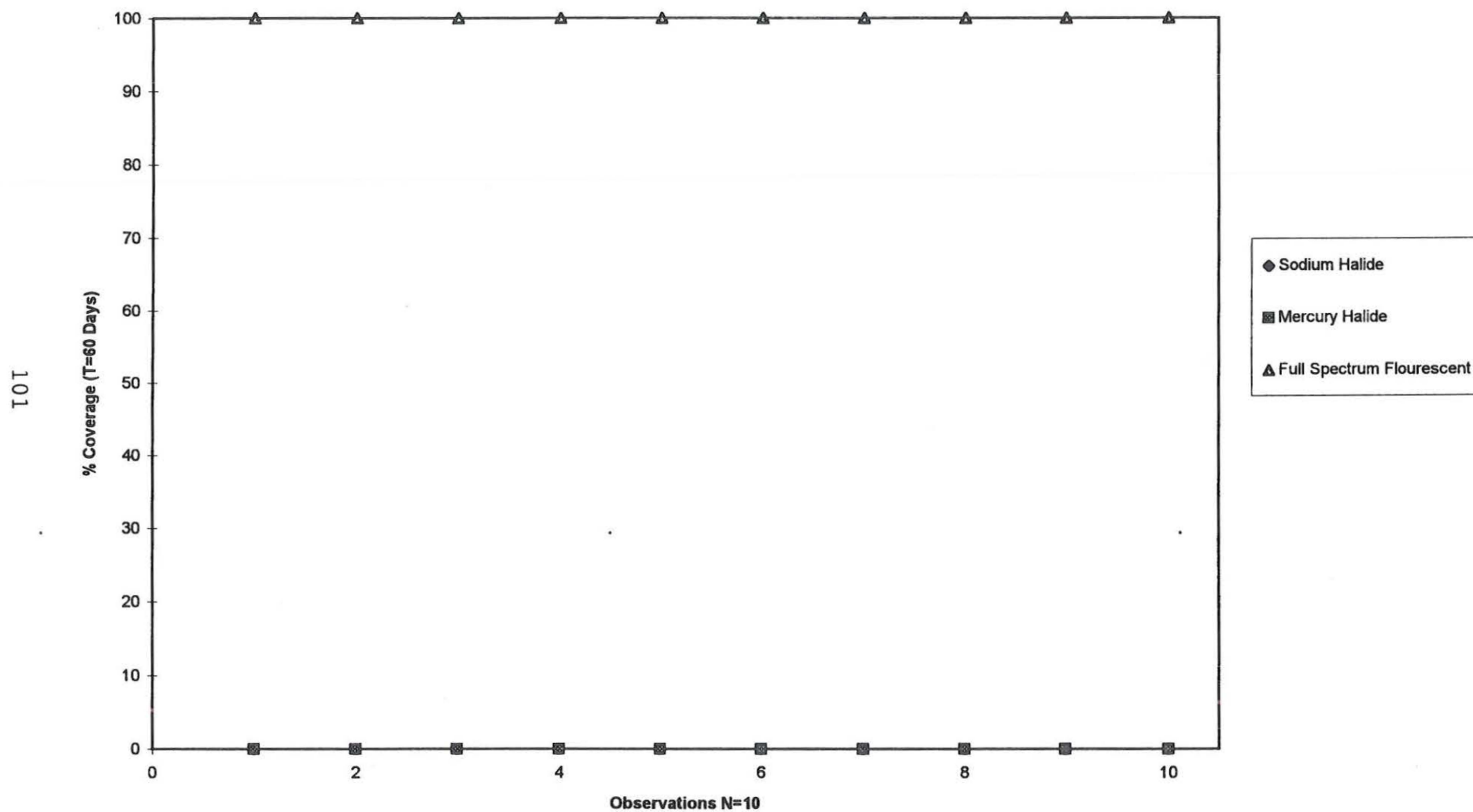
Conchocelis Culture Within Calcium Carbonate Substrate As a Function of Photoperiod - Raw Data



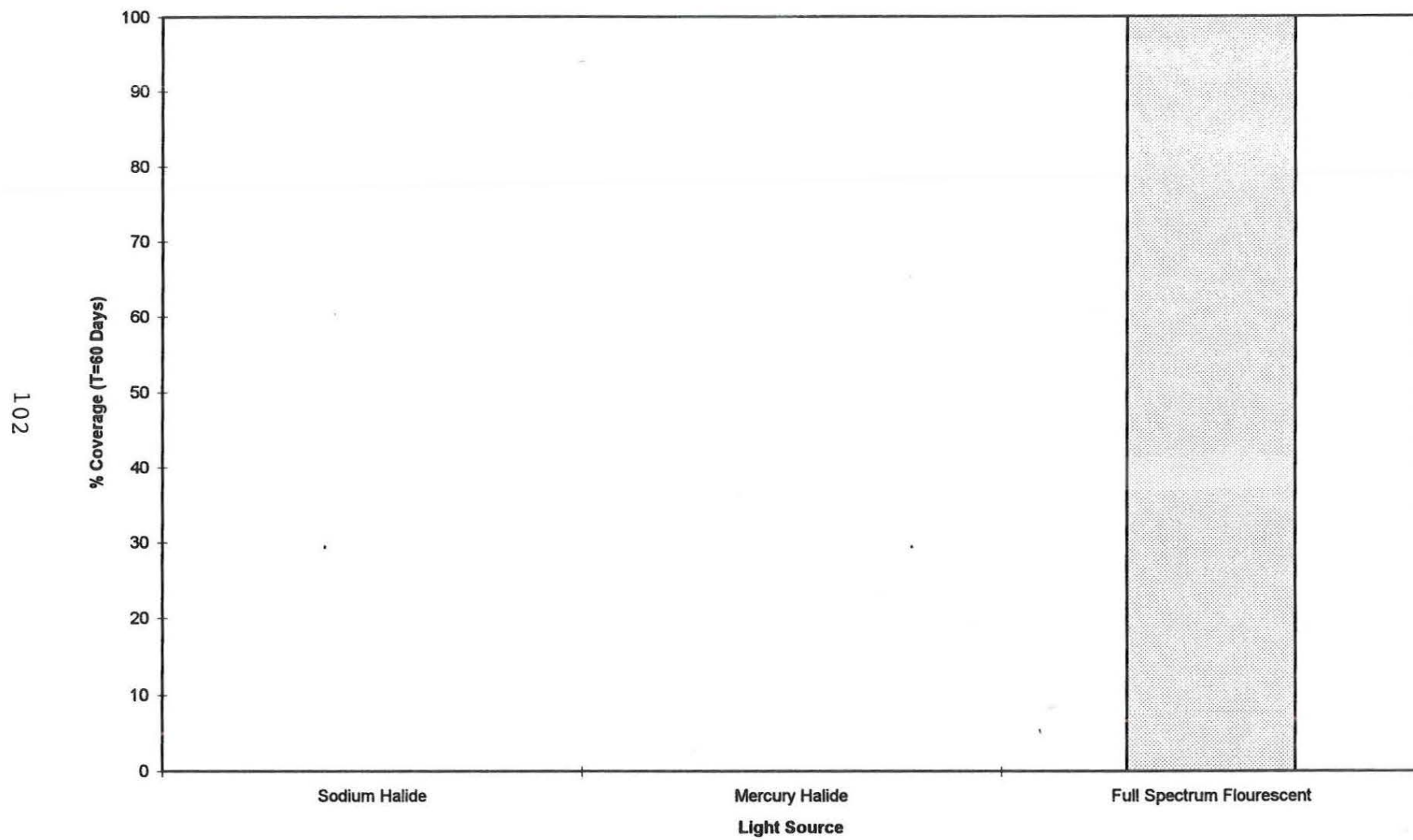
Conchocelis Culture Within Calcium Carbonate Substrate As A Function of Photoperiod



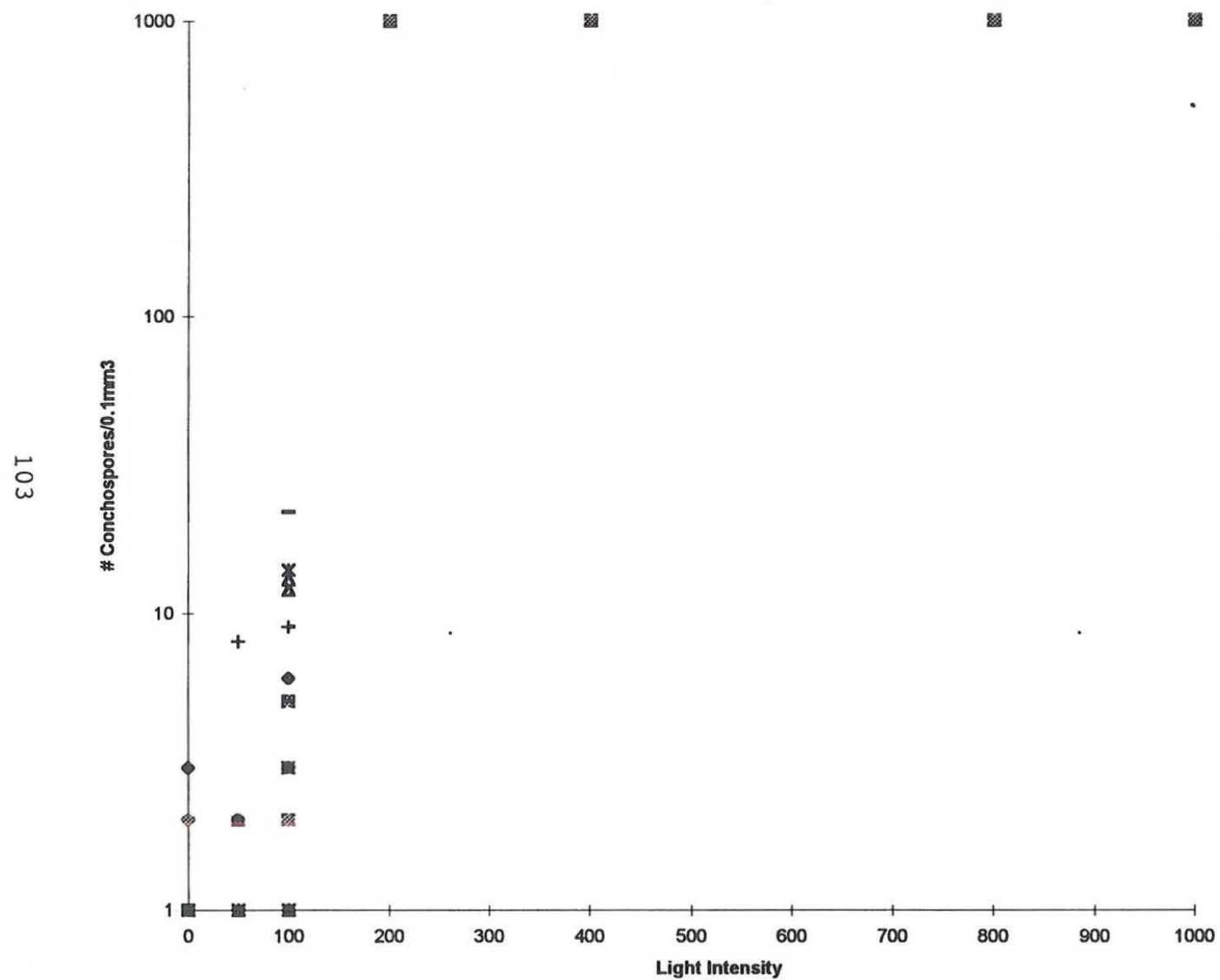
Conchocelis Culture Within Calcium Carbonate Substrate As A Function of Light Source - Raw Data



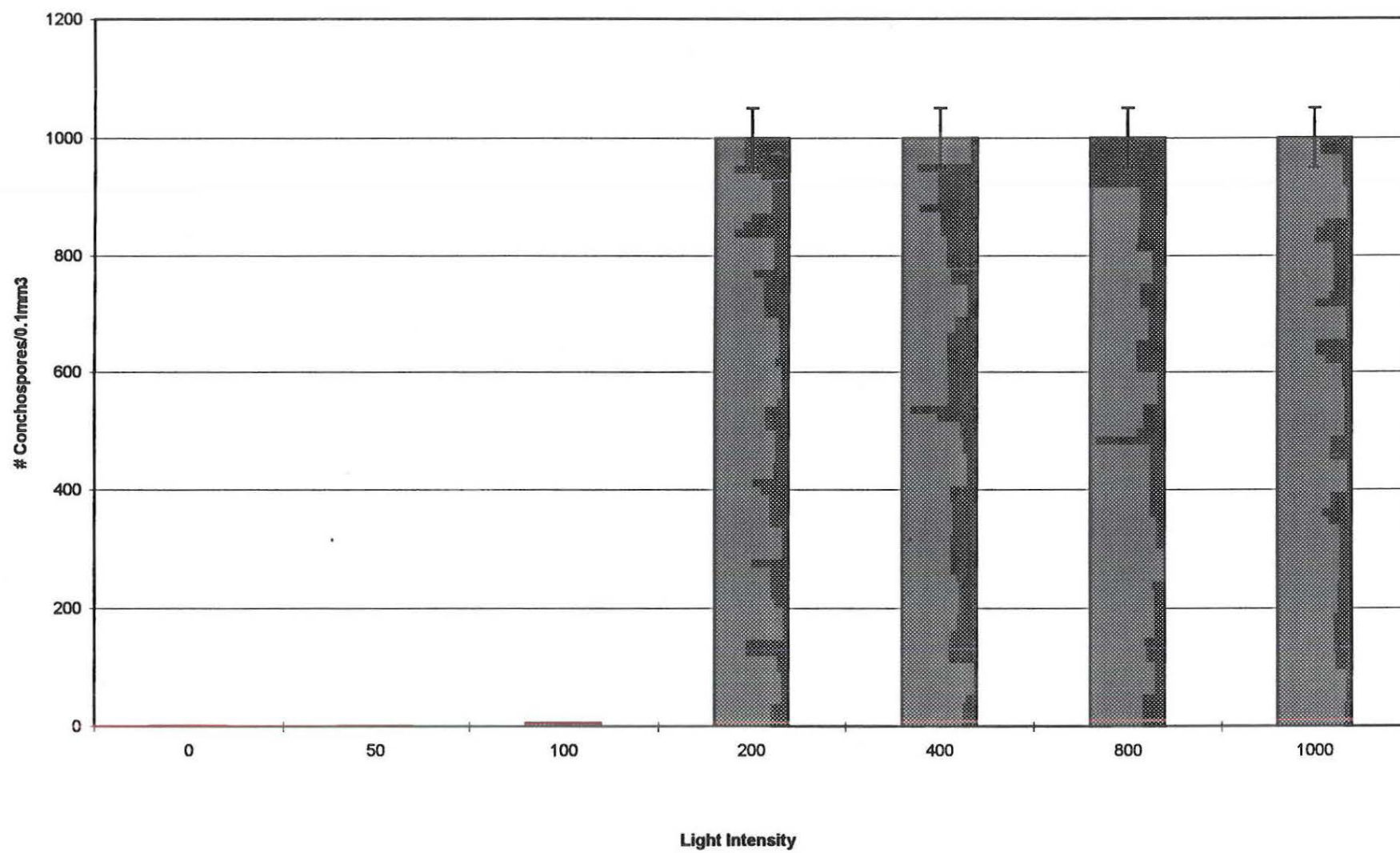
Conchocelis Culture Within Calcium Carbonate Substrate As A Function Of Light Source



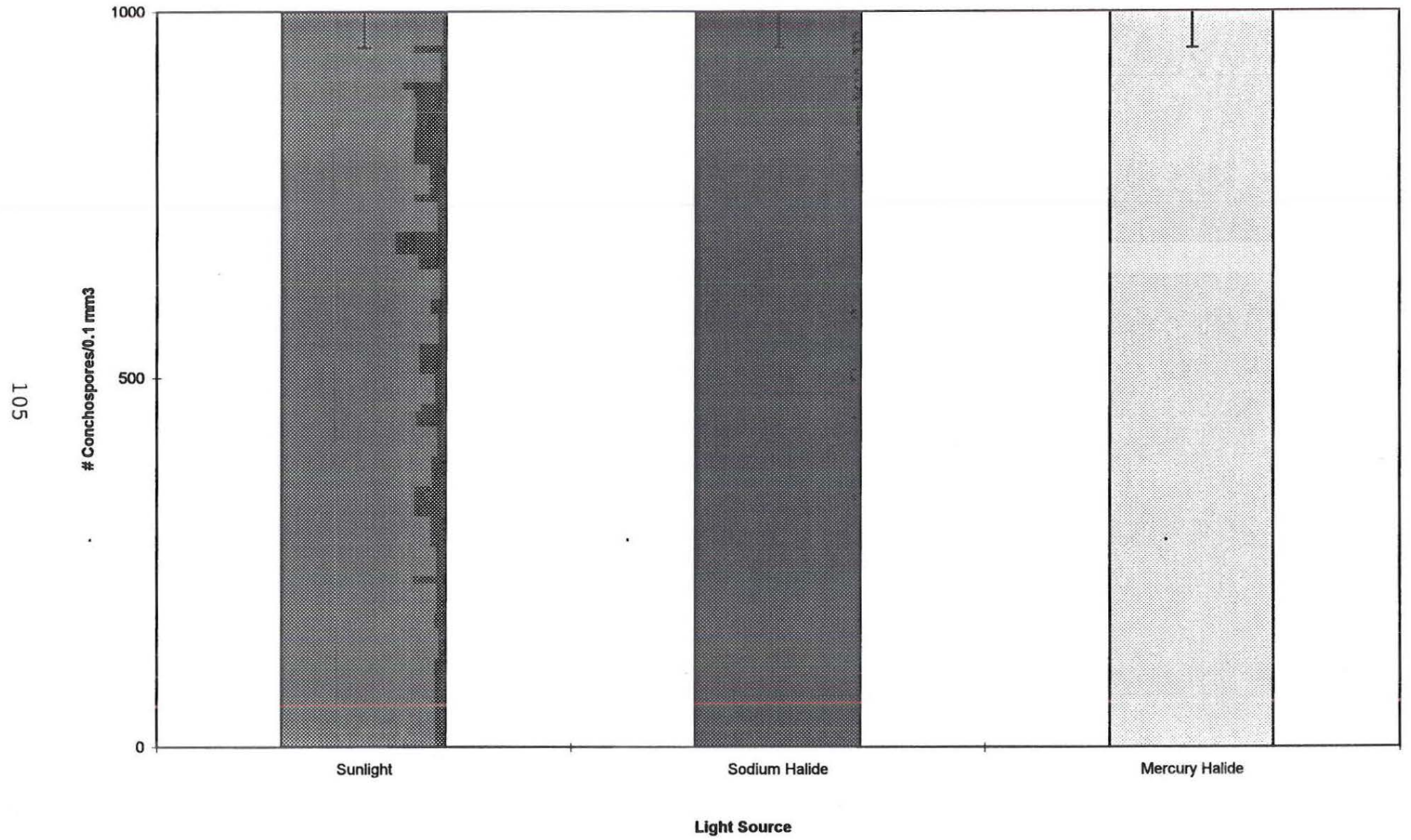
Conchospore Release - Raw Data



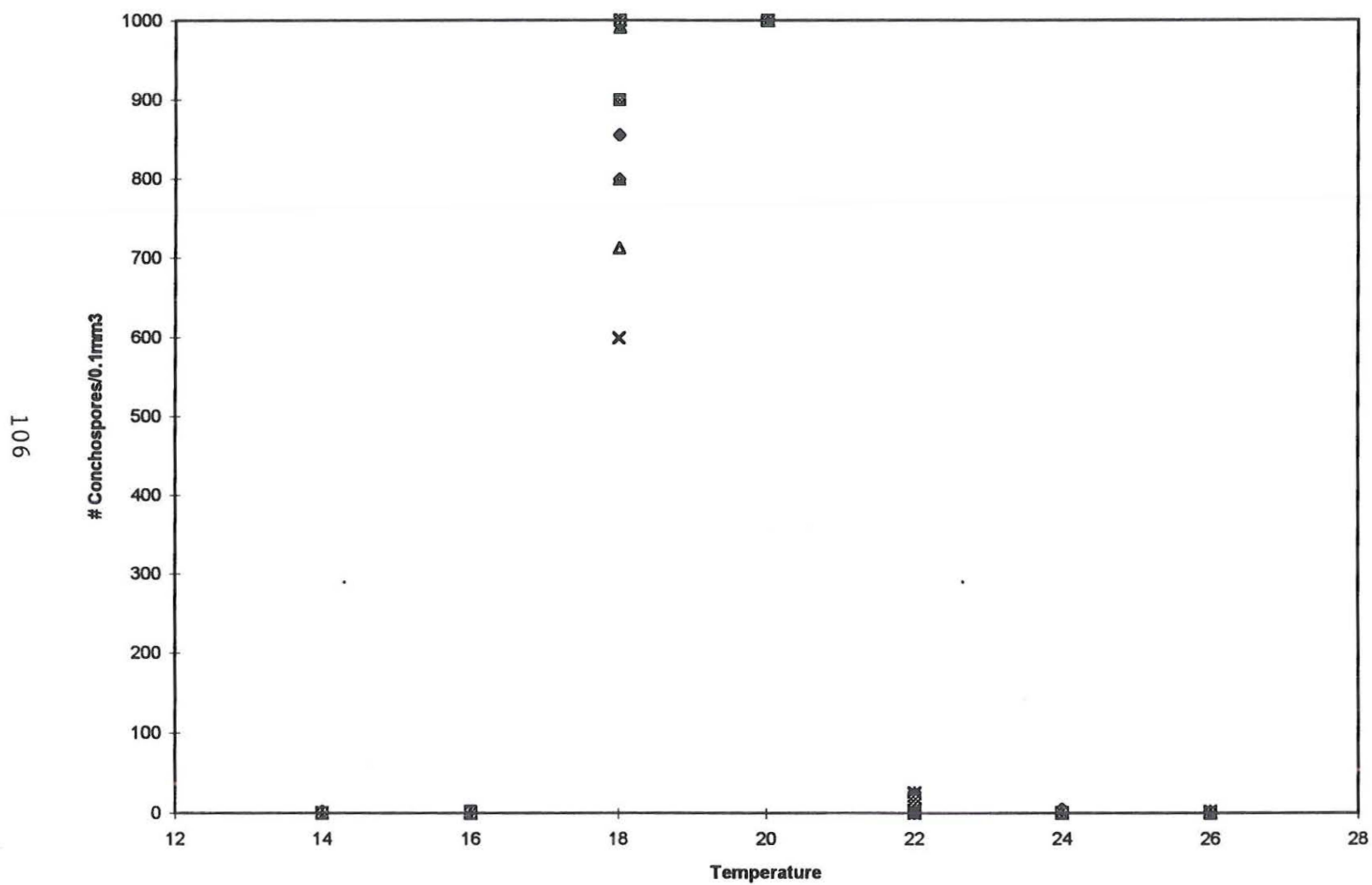
Conchospore Release



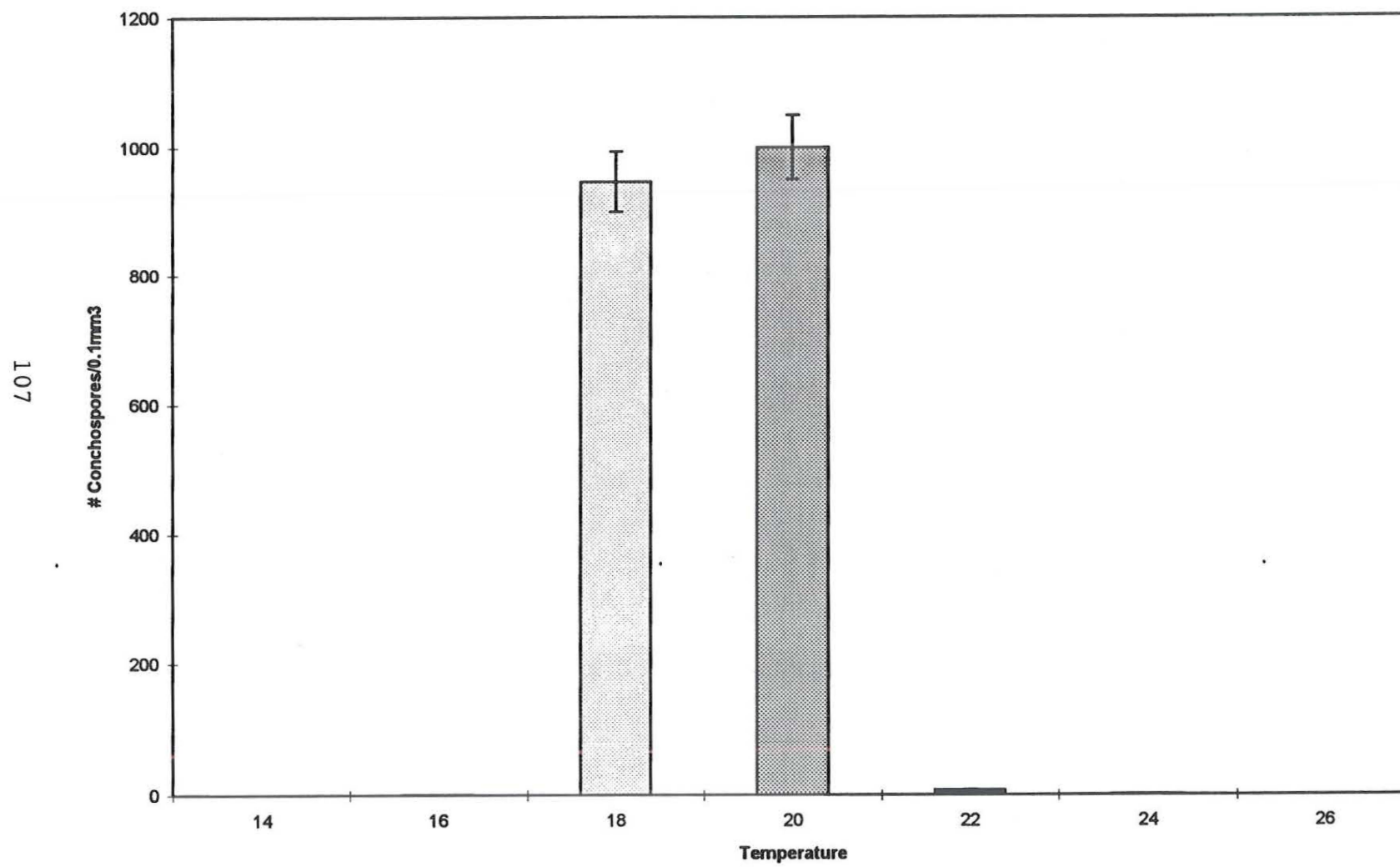
Conchospore Release - Light Quality



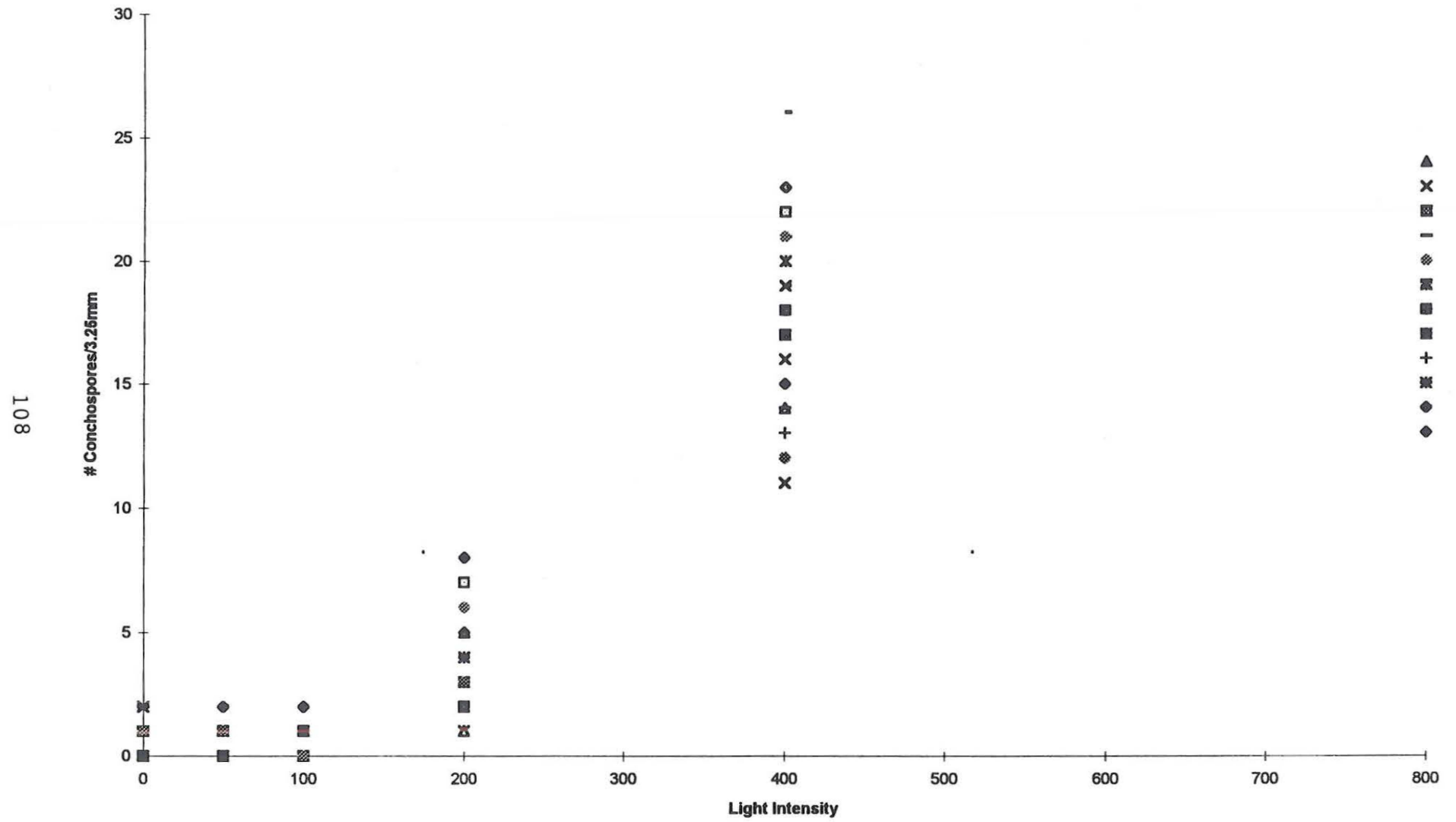
Conchospore Release - Temperature - Raw Data



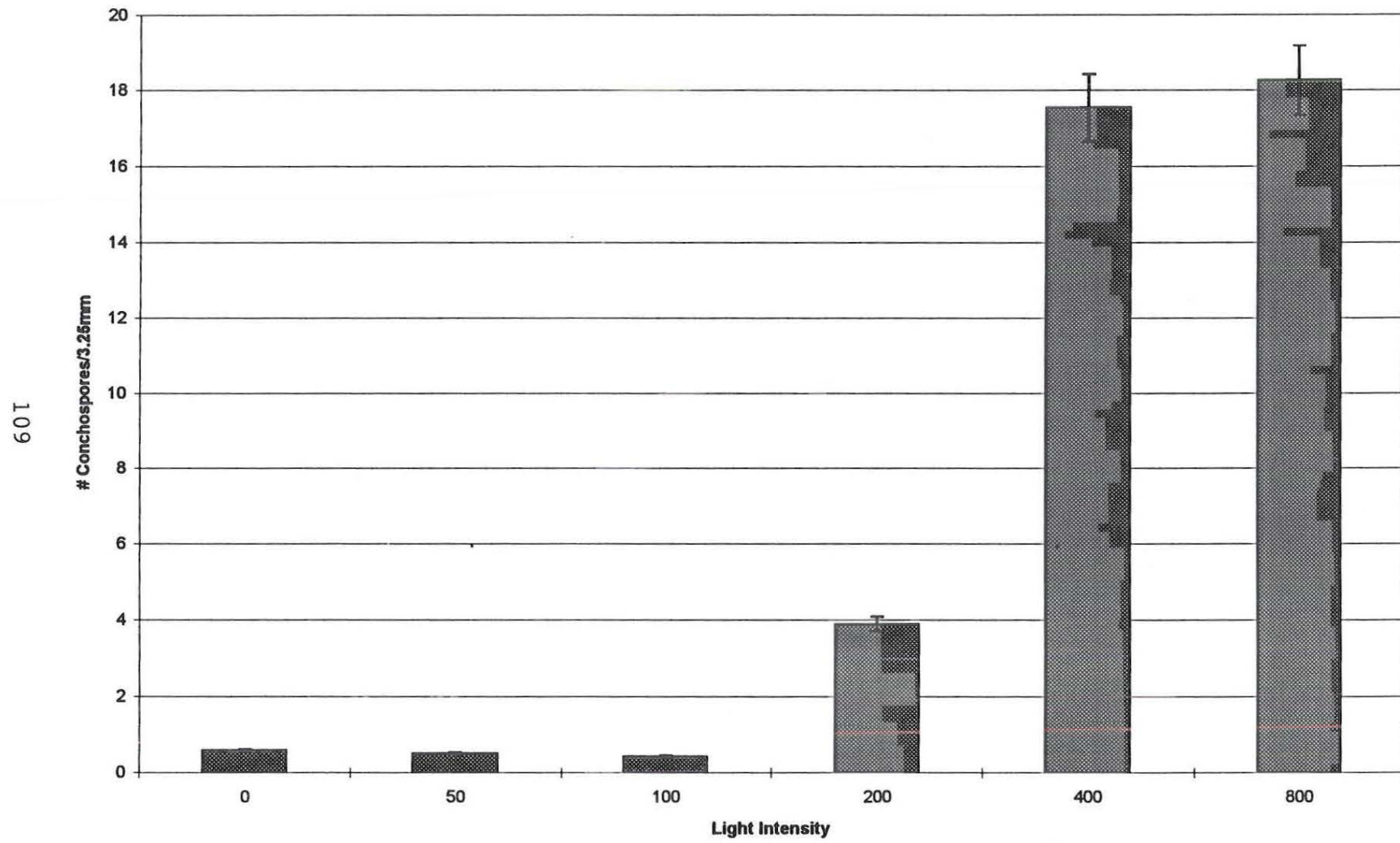
CONCHOSPORE RELEASE - TEMPERATURE



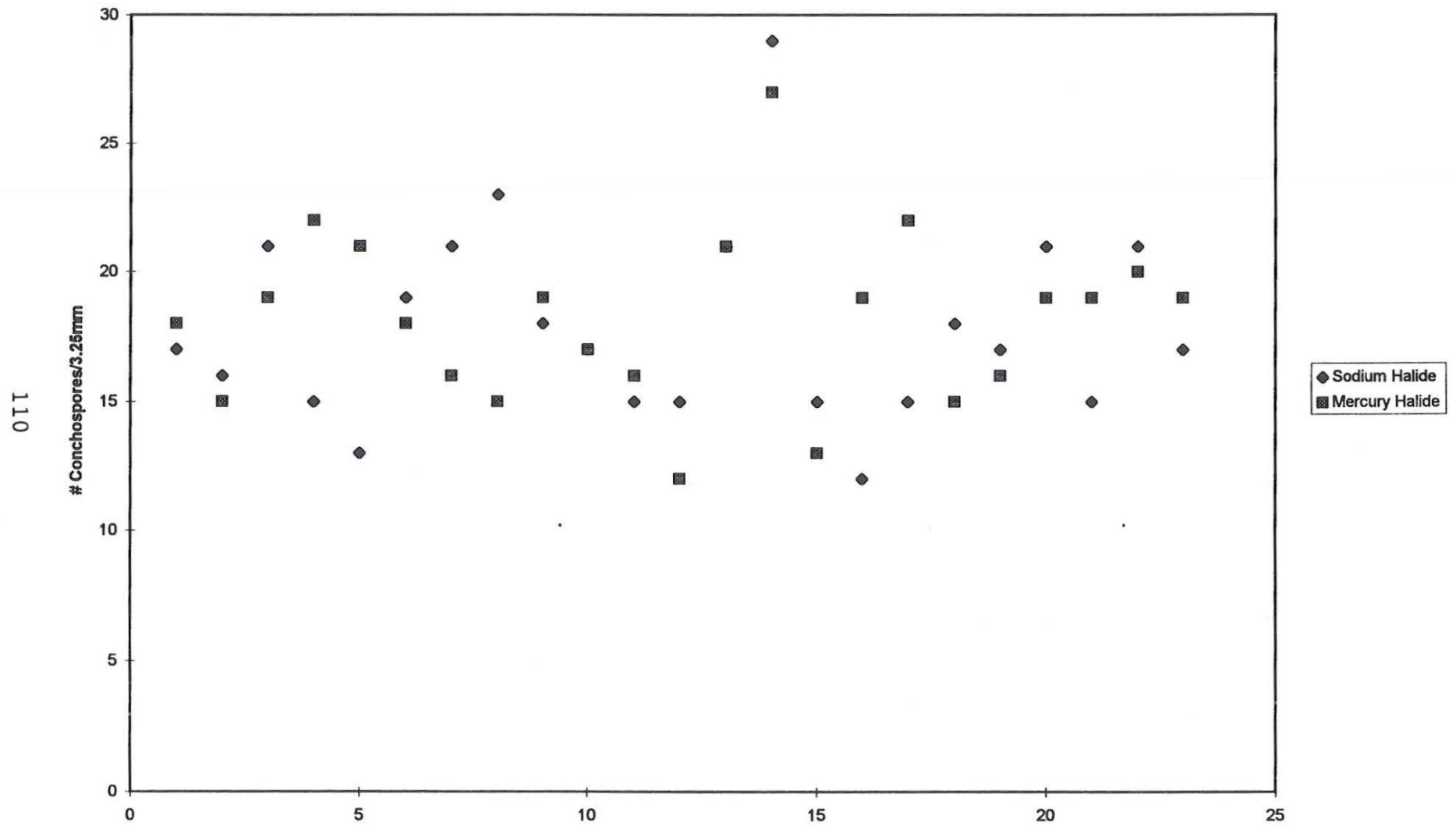
Conchsopore Attachment - Raw Data



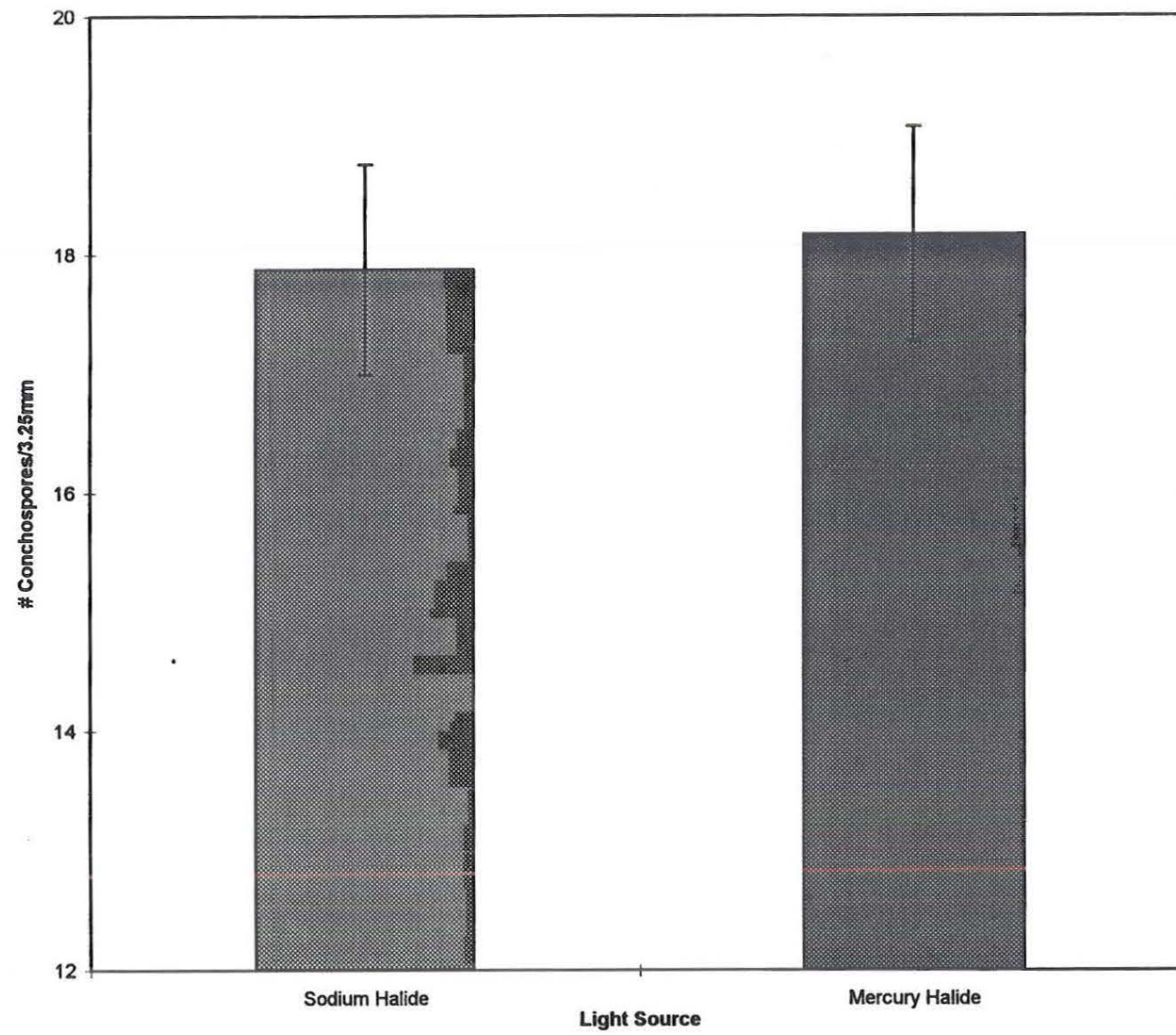
Conchospore Attachment



Conchospore Attachment - Light Source Raw Data

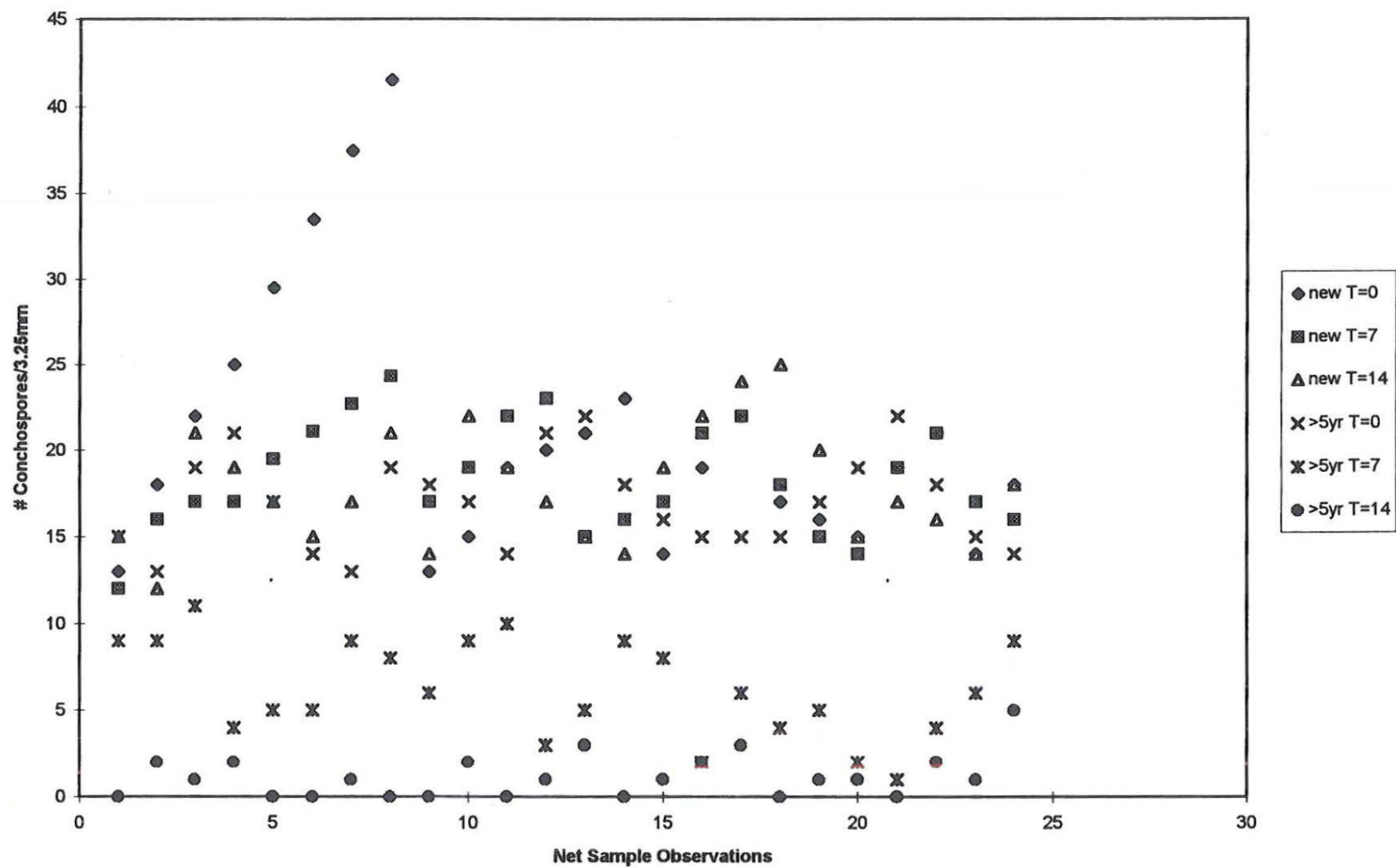


Conchospore Attachment - Light Source

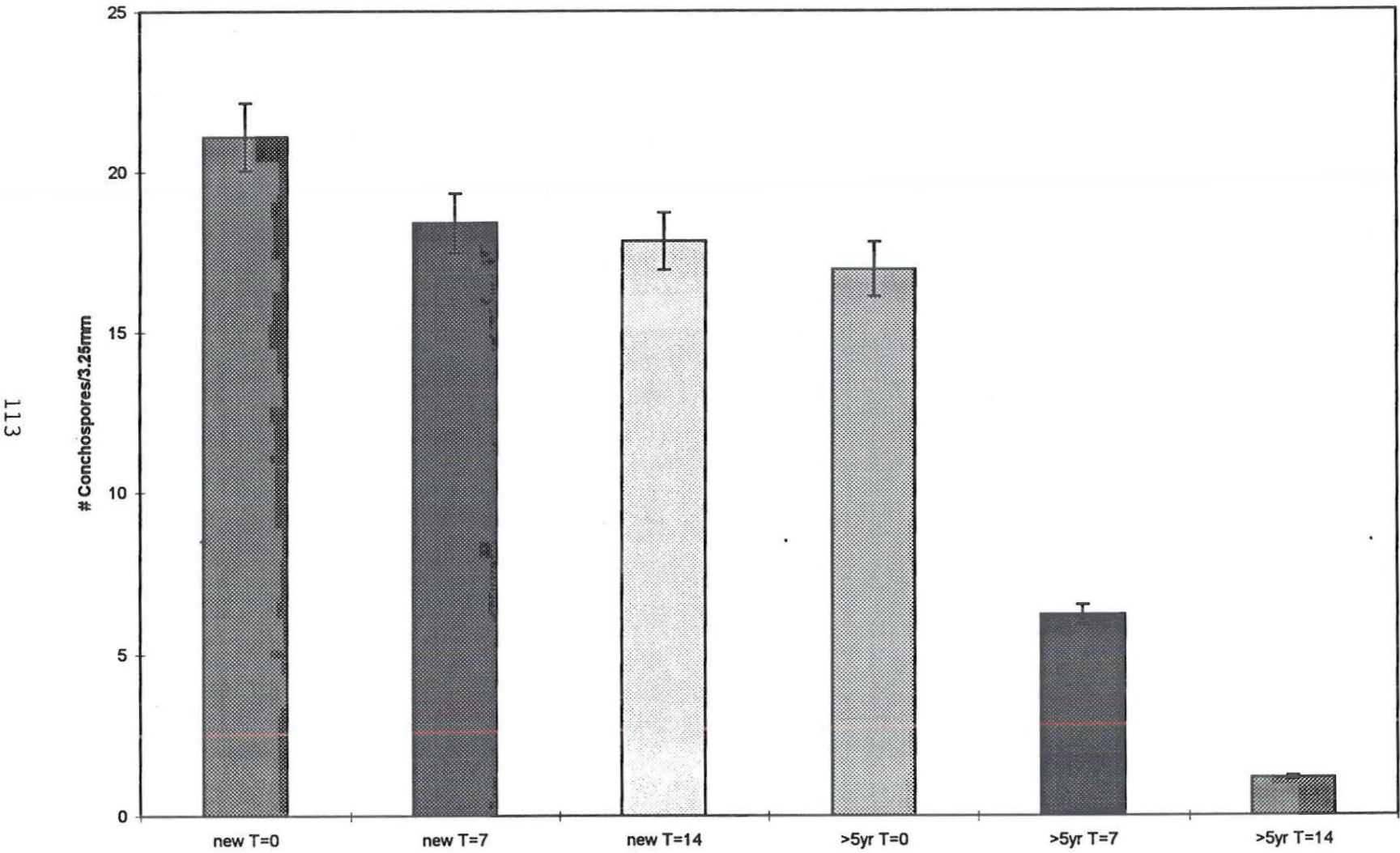


111

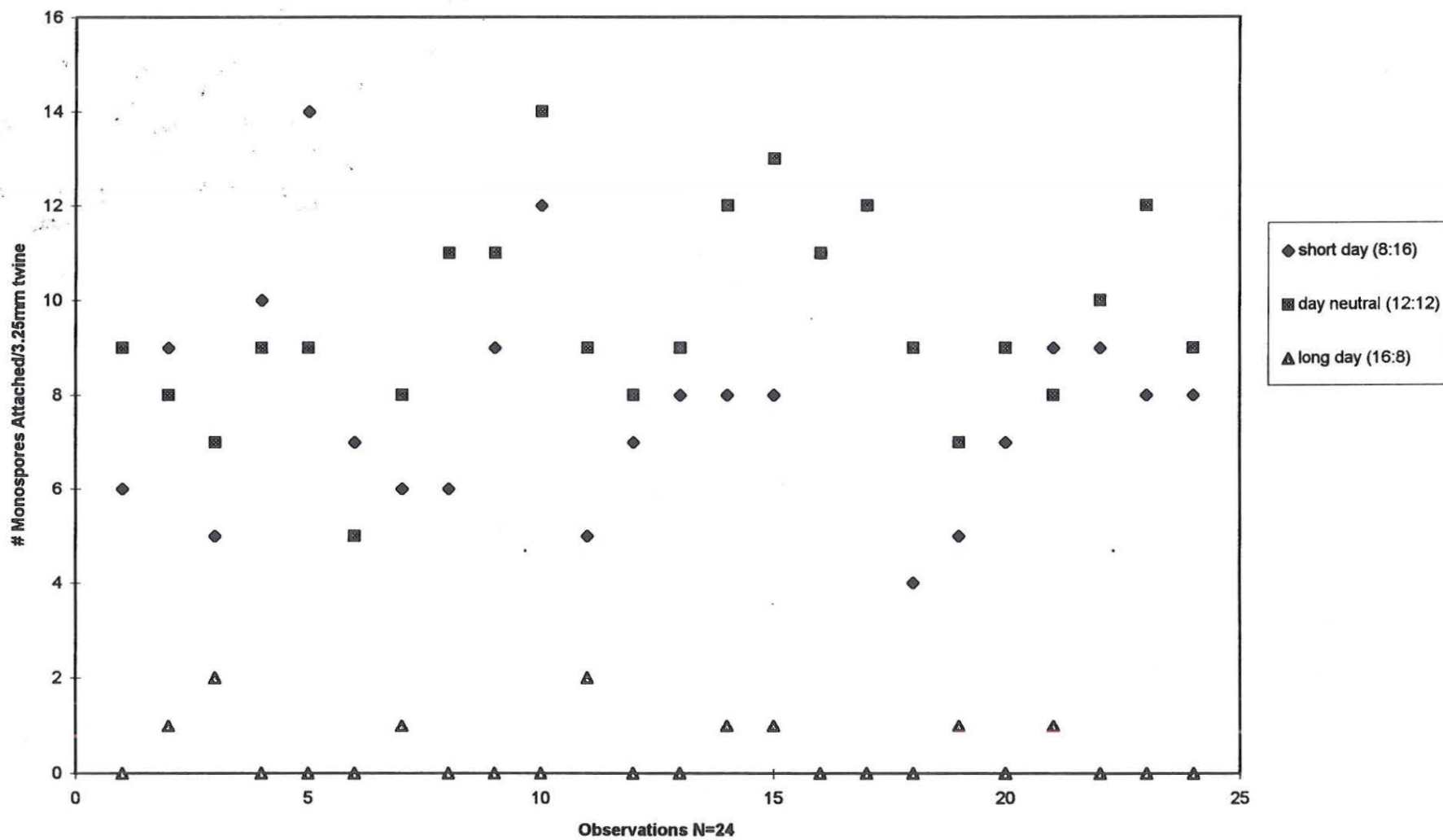
Conchospore Attachment - Net Age as a Function of Time - Raw Data



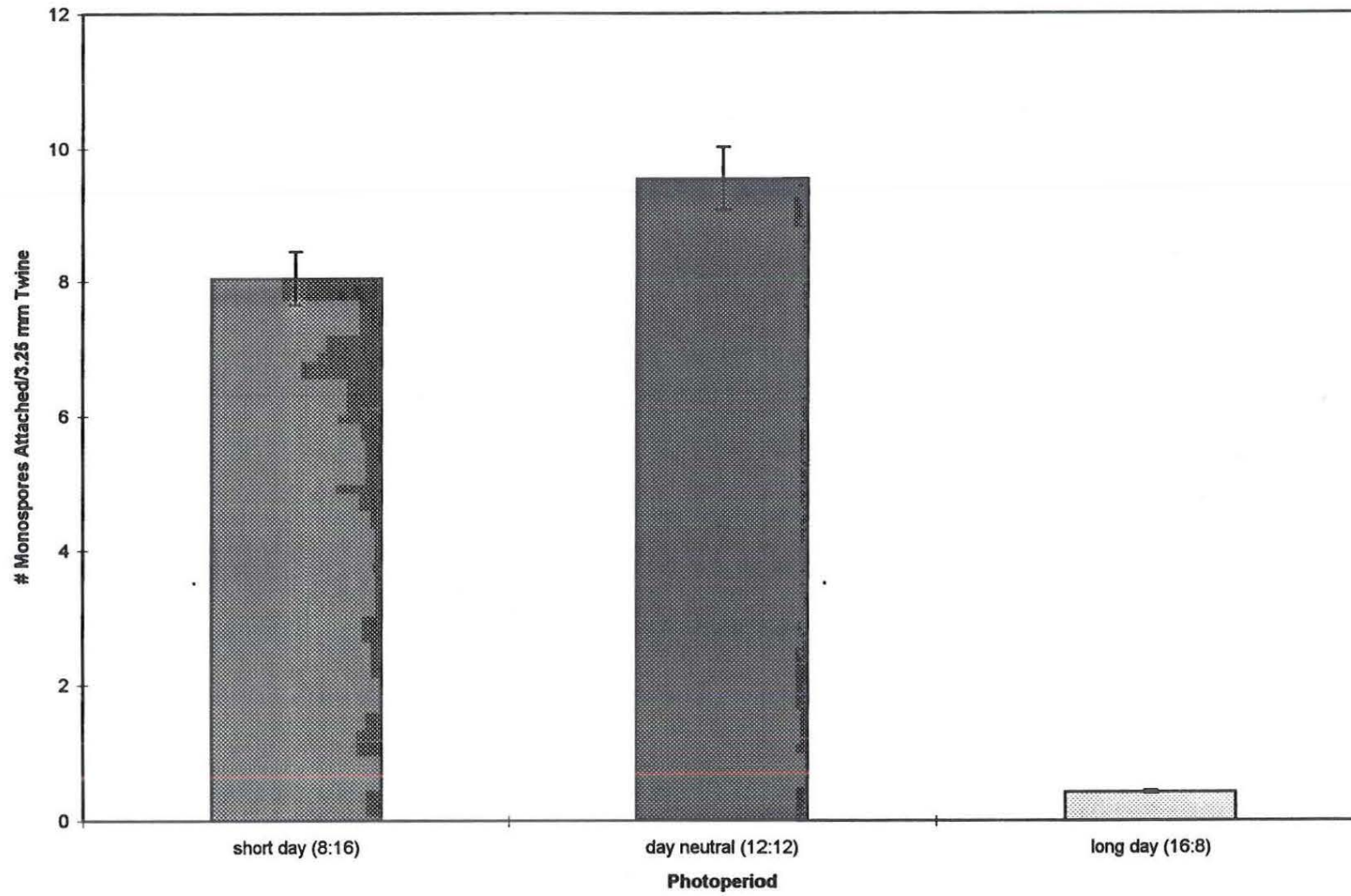
Conchospore Attachment - Net Age as a Function of Time



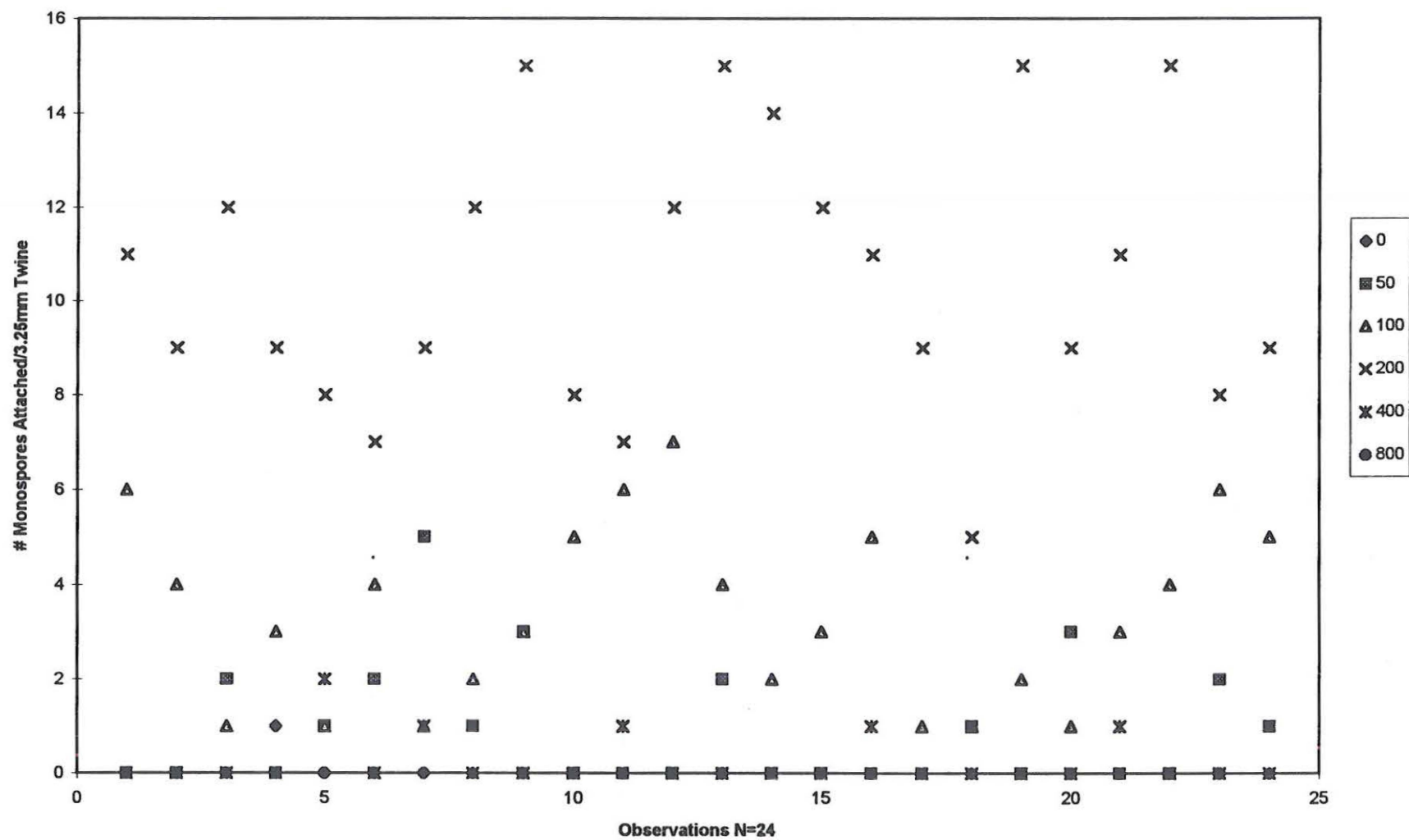
Monospore Production - Photoperiod - Raw Data



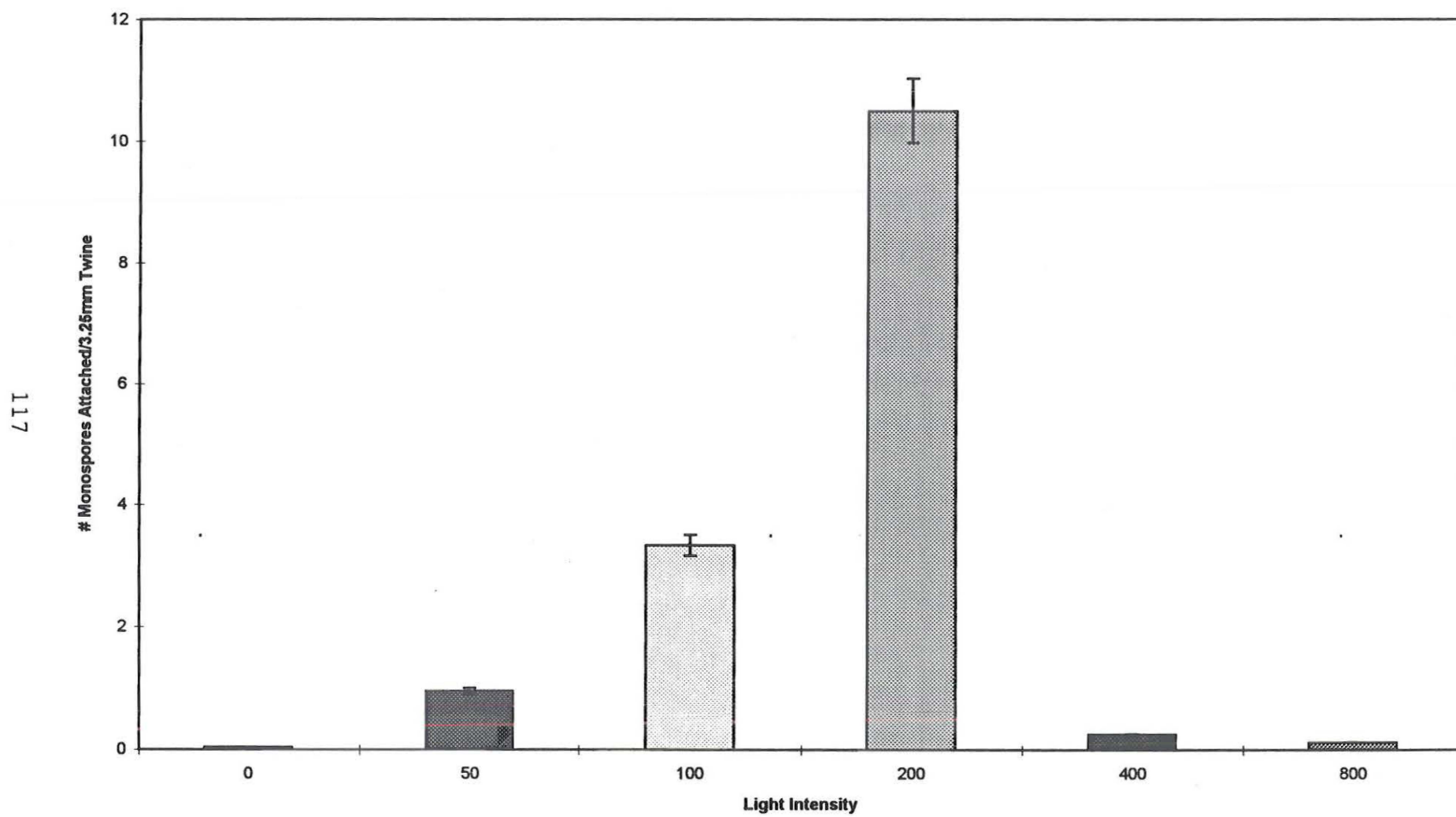
Monospore Production - Photoperiod



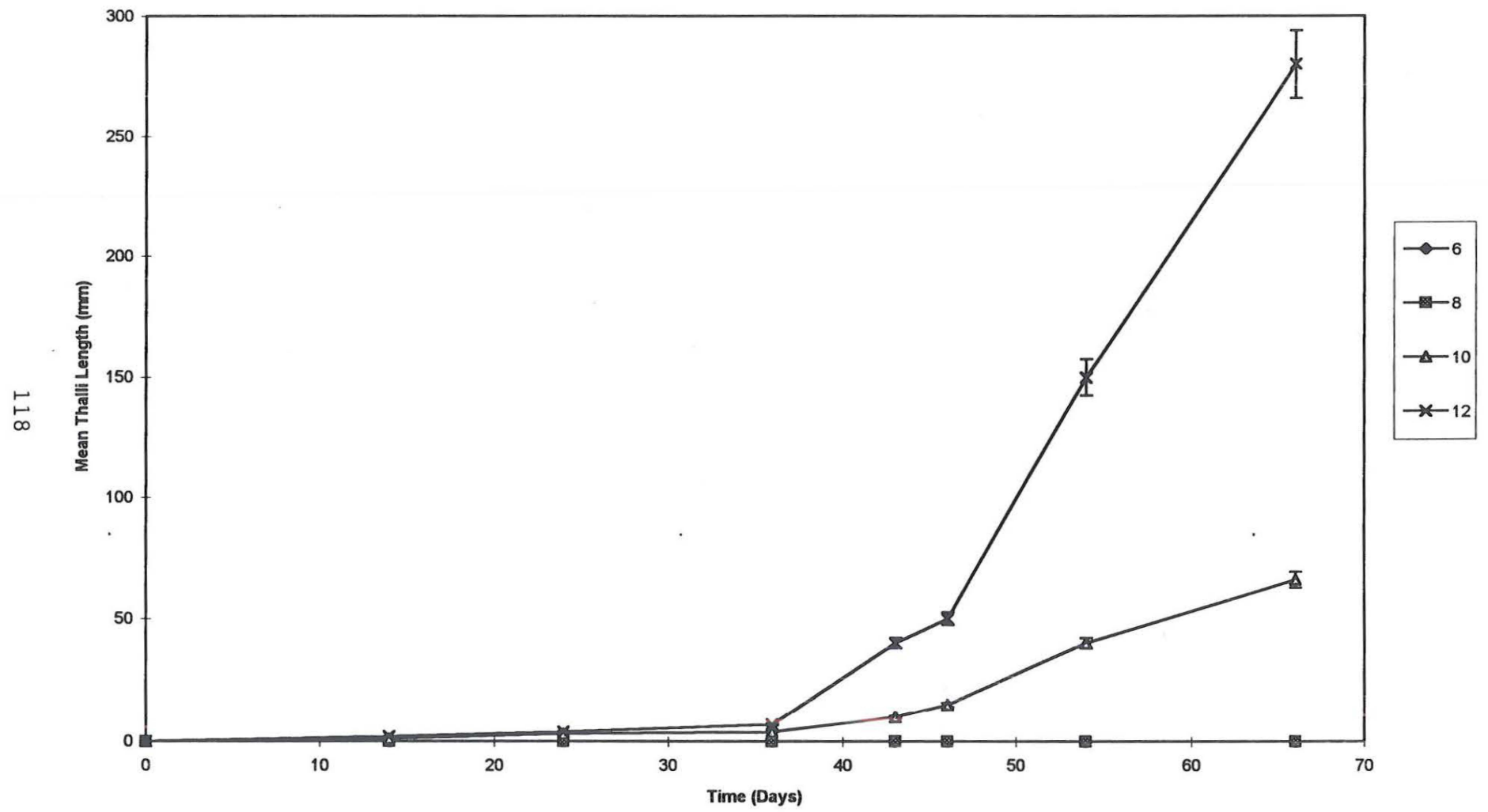
Monospore Production - Light Intensity - Raw Data



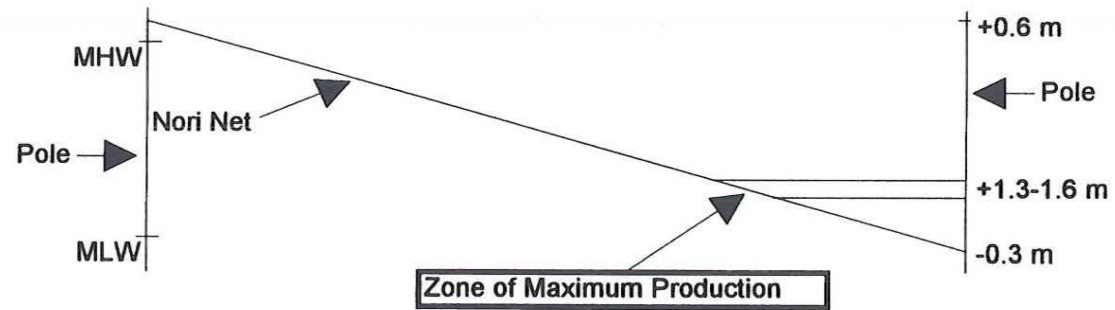
Monospore Production - Light Intensity



Indoor Blade Cultivation



Nori Pole Farm Net Position



Appendix VIII



NORI DEMONSTRATION PROJECT BEGUN IN EGGEMOGGIN REACH

National Fish and Wildlife Foundation awards grant

Maine's newest aquaculture industry, seaweed farming, is beginning to capture the interest of communities along the Gulf of Maine. After several years of pioneer work carried out by Coastal Plantations International, Inc. (CPI) in the Bay of Fundy, nori cultivation is spreading westward to Blue Hill Bay, where it is being tested this fall in the Eggemoggin Reach.

The Principal Investigator of this project is Dennis Moran, a marine biologist who together with MAIC's Mike Hastings obtained a \$74,000 grant from the National Fish and Wildlife Foundation to set up a demonstration farm in the Reach. The project will not only test the commercial potential of the area for nori cultivation, but will also promote this activity within the local fishing community, hard hit by dwindling fish stocks and tougher regulations. There are already nine community members actively participating in the project on a voluntary basis.

The Blue Hill group will purchase eight nets seeded with *Porphyra yezoensis* from CPI and place them at two sites in the Reach: off Bridges Point and near Wells Cove. If growth is good this fall, Mr. Moran will apply for a small lease (less than 20 acres) and test the productivity of the area approaching commercial conditions with thirty nets. These nets will be harvested and the raw nori transported to Eastport for processing.

The end result of the study will be a business plan for a nori growers cooperative that would be used to obtain the financing to develop the first commercial farms in the Blue Hill Bay area. The cooperative would buy seeded nets from CPI and sell the raw nori back to CPI's processing plant.

Appendix IX

RECIPIENT: Coastal PlantationsInternational, Inc.

PROPERTY/INVENTIONS/PATENTS/ROYALTIES

xxx

Government property is not involved.

Government property is involved and
required listing of unit cost,
description and disposition is attached.xxx

_____Inventions/Patents/Royalties are not
involved.Inventions/Patents/Royalties are
involved and descriptions attached. - -Signed: Date: 12/16/96Title: President & PI

Program Officer's Certification Concur Does not concur with the above information.

Remarks:

 All program objectives have been satisfactorily
completed including required deliverables.

Signed: _____

Program Officer

Date: _____

Appendix X

FORM CD-281 LF
(10-72)
DAO 208-0

U.S. DEPARTMENT OF COMMERCE

DATE OF REPORT

12/16/96

CONTRACT NUMBER

NA56FK0097

REPORT OF GOVERNMENT PROPERTY IN POSSESSION OF CONTRACTOR

(See DOC Manual for Control of Government Property by Contractors)

This report covers: ☒ expendable ☒ non-expendable property

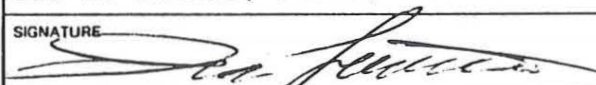
NAME AND ADDRESS OF CONTRACTOR (Type or print)

Coastal Plantations International,
P.O. Box 209
1219 Maine Street
Poland, Maine 04274

NAME AND TITLE OF AUTHORIZED REPRESENTATIVE

Ira A. Levine, Ph.D., President

SIGNATURE



GOVERNMENT ID NO. AND FSN	DESCRIPTION OF ITEM	MFR.	MFR. SERIAL NUMBERS	QUANTITY	CONDITION	LOCATION	COST	DATE RECEIVED
	No Government Property is in Possession of Contractor							