A Preliminary Report on a Larval Study Relative to the Feasibility of Introducing Deep-water Homarus americanus into Oregon Waters.

J. J. Gonor and S. L. Gonor
Department of Oceanography
and
Marine Science Center
Oregon State University

A cooperative study between the University of Rhode Island, Oregon State University, and the Oregon Fish Commission on the feasibility of introducing American lobsters into Oregon waters was initiated in December, 1969, with the successful shipment of both male and berried female lobsters to the Marine Science Center. Published information on the biology of the deep-water stock being considered for introduction is very scanty. The available literature does not permit an evaluation of the possibility that a planted stock would successfully reproduce under Oregon off-shore oceanographic conditions. We have agreed to assist in the evaluation by conducting laboratory experiments designed so that the results will enable us to predict to what degree larval survival would be affected by the oceanic regime existing in offshore Oregon waters during the larval release season. These experiments will determine the effect of temperature and salinity on larval survival and rate of development in laboratory culture.

Since the larval development of this species is rather lengthy, these experiments will take a long time to complete. Some preliminary experiments, largely concerned with determining the best method for holding larvae under experimental conditions have been completed. The completed experiments are not adequate to fully answer the questions being asked, but some of the results bear on them. Because the final experiments will not be completed for some months, this informal report is provided to those interested as an indication of the progress made to date.

1. Source of larvae for preliminary experiments.

All of the larvae in the experiments reported here originated from swarms hatched in a tank in the public aquarium at the Marine Science Center, following a period when the water warmed to about 17°C for several successive days. The larvae used were taken from four batches released between January 28 and February 4 from a single female. All larvae were used the day they hatched.

2. Purpose of the experiments.

These experiments were planned to test methods of rearing larvae under the conditions required for the definitive experiments. They were designed to test:

a. The effect of crowding on survival in multi-larval cultures held at 30 o/oo and several temperatures.

b. The effect of volume of water used in rearing on the survival of isolated larvae.

c. The effect of temperature on the rate of development and survival of larvae reared in isolation.

3. Methods.

Culture vessels placed on a water table with running sea water were maintained at ambient winter sea temperature, ranging from 9 to 13°C. Constant temperatures of 10, 15 and 20°C were obtained by placing culture vessels in water baths regulated to within $\pm$ 0.5°C of these temperatures. All glassware used in the experiments was washed in hot tap water and autoclaved before each use. The sea water used was filtered through a 40 micron pore size filter after collection and stored in pyrex jugs before use. Only water with a salinity ranging between 29 o/oo and 32 o/oo was used. Early larvae were fed live Artemia nauplii, later stages older Artemia of various sizes. At the fourth stage and beyond, boiled fish muscle was also used for food. Each culture vessel was inspected daily and food added when needed. The culture water and vessels were changed at four-day intervals for the 15 and 20° cultures and at

six-day intervals for the 10°C and ambient cultures. Daily records were kept of survival and molting. After cannibalism had reduced the number of larvae in some crowding experiments, the remaining larvae were isolated and treated individually.

4. Crowding experiments.

Groups of larvae were placed in 1000 ml beakers and gallon and quart jars as listed in the following table, and kept at ambient sea temperatures on a water table. Air bubblers were placed in the gallon jars for aeration and circulation.

No. of Containers	Type	Total Vol. of water	No. of larvae per container	Total no. of larvae	Ratio of larvae to water volume in mls.
11	1000 ml	650	9 or 10	108	1/65
1	quart A	825	13		1/66
1	" B	825	25		1/33
1	" C	825	37		1/22
1	" D	825	50		1/16.5
1	gallon E	3300	50		1/66
1	" F	3300	100		1/33
1	" G	3300	150		1/22
2	" H	3300	200	400	1/16.5

Mortality in multi-larval cultures kept at different temperatures was examined by keeping groups of larvae in 500 ml flasks with 300 ml of sea water as summarized in the following table.

No. of flasks	No. of larvae per flask	Ratio	Total no. of larvae	Temperature
10	5	1/66	50	10°C
11	6 or 7	1/66	70	15°C
17	3 or 2	1/132	50	20°C

The following tables summarize the results on percent survival of larvae in multi-larval cultures maintained under the different conditions mentioned above.

MULTI-LARVAL CULTURES AT AMBIENT SEA TEMPERATURE

Day	5	10	15	20	25	30
Container						
1000 ml beaker	95%	90	51	42	26	*
Quart A	100%	85	69	23	*	
" B	88	72	56	4	*	
" C	89	62	46	5	*	
" D	86	48	22	2	*	
Gallon E	70%	52	28	0		
" F	71	50	28	0		
" G	55	28	3	0		
" H	67	35	16	2	*	

*Experiment stopped at this point.

SURVIVAL IN MULTI-LARVAL CULTURES AT CONTROLLED TEMPERATURES

Day	5	10	15	20	25	30	35	40	45	50
Temp. 10°C	96	90	74	70	68	52	28	10	6	*
15°C	81	46	40	29	17	13	11	7	7	6
20°C	76	46	36	36	34	28	26	14	13	*

Larvae kept under the most crowded conditions showed high early mortality as well as cannibalism. Under less crowded conditions, mortality due to crowding alone appeared to be slight, but cannibalism was very evident and mortality due to this cause remained high. Food density (nauplii) appeared to have little effect on cannibalism. Even at the low density of 5 larvae per flask, mortality due to cannibalism was apparent, especially at molting. This can be seen by comparing survival in low density cultures with that of larvae reared in isolation at the same temperature. In these tests, cannibalism was so high under conditions otherwise suitable for experiments, that mass cultures of any density will not be suitable for temperature and salinity experiments. To eliminate cannibalism as a mortality factor, larvae will have to be reared in isolation so that the temperature and salinity effects can be clearly identified. While development of

mass culture methods is important for hatchery and aquaculture techniques, it does not appear to be a feasible method to study the effects of physical factors and we plan no further crowding experiments.

5. Water volume experiments.

Individual larvae showed good survival when reared in 250 ml flasks with 125 ml of water. A brief set of experiments was conducted using smaller containers of several shapes in order to determine the effect of small water volumes on survival of isolated larvae through the first molt. All containers were kept at 16°C.

Beakers

number	Type	Water volume used
25	25 ml	20 ml
25	50 ml	40 ml
20	100 ml	25 ml

Culture tubes

number	Dimensions	Water volume used
16	105 x 28 mm	25 ml
5	95 x 17 mm	12 ml
10	75 x 10 mm	5 ml

Survival of isolated larvae in these containers is given in the following table.

Beakers	Day 5	8	10
25 ml.	100%	*	
50 ml	100%	84%	80%
100 ml	90%	85%	85%

* Discontinued.

Molt occurred on Day 7.

Tubes	Day 3	5	
small	60%	60%	*
medium	60%	60%	*
large	100%	100%	*

*Discontinued before first molt.

Survival through the first molt in beakers with 25 ml or more of water was similar to the survival obtained with 250 ml flasks, indicating that containers as small as 25 ml. beakers would be adequate for experimental use. A covered polypropylene container 65 mm wide and 65 mm high of 100 ml capacity has been tested for toxicity and selected for use in the definitive experiments. This container provides sufficient volume to minimize mortality due to culture conditions and is also small enough to permit large numbers of them to be placed at once in the water baths.

6. Survival of isolated larvae at different temperatures.

Larvae were reared in isolation from hatching in 250 ml flasks with 125 ml of sea water. These served as controls for the larvae reared in multi-larval cultures, and gave some results on the effect of temperature on development rate and survival. All isolated larvae were derived from the egg mass of the same female, but hatched on different days. Isolated larvae were maintained at 10, 15 and 20°C. Larvae kept at 10 and 15°C hatched the same day. Larvae hatched on a different day were used in the 20°C experiment. Groups of twenty-five isolated larvae were reared at 15° and 20° and twenty larvae reared at 10°C. In addition data on surviving individuals from multi-larval flasks was combined with the information on these larvae.

In the following table, survival of larvae reared in isolation from the day of hatching at controlled temperatures is given as percentages of the initial numbers of larvae.

Day	5	10	15	20	25	30	35	40	45	50	55
10°C n = 20	100%	85%	80%	70%	70%	60%	35%	5%	0%		
15°C n = 25	100%	88%	84%	80%	68%	20%	12%	12%	4%	4%	4% *
20°C n = 25	88%	88%	88%	84%	68%	60%	48%	32%	20%	*	*

*Experiment still in progress, some individuals surviving into the post-larval period.

In the following table, all available survival data on individual larvae kept at controlled temperatures have been pooled with the data above to increase the sample size.

Day	5	10	15	20	25	30	35	40	45	50	55
10°C n = 29	100%	90%	86%	79%	79%	72%	55%	21%	10%		
15°C n = 36	100%	92%	89%	86%	78%	39%	28%	22%	17%	14%	
20°C n = 37	92%	92%	92%	89%	78%	68%	57%	41%	32%		

In the following table, the effect of temperature on molting success in larvae isolated from hatching is given. The number of larvae surviving each molt by one day is given as the percentage of the initial number of larvae present at the start of the experiment. These figures differ from survival figures alone because some larvae survive for long periods of time to die eventually without molting.

Temp. °C.	% molt to Z II	% molt to Z III	% molt to Megalopa
10°	75%	15%	0%
15°	88%	76%	20%
20°	88%	88%	72%

In the following table, the effect of temperature on the rate of development as indicated by timing of molting is given for larvae reared in isolation from hatching. The period, in days from hatching, over which each molt occurred, the range of this period in days, and the mean number of days taken for each molt is given. The effect of temperature on the number of days required for the group of larvae to start and finish each molt, and on the synchrony of molting, is indicated by these figures.

	Temp. °C	Period of molting	Range in days	Mean day of molting
MOLT TO ZOEA II	10°	Day 12 to 15	4	Day 13.6
	15°	Day 6 to 11	6	Day 7.3
	20°	Day 5	1	Day 5.0
MOLT TO ZOEA III	10°	Day 29 to 30	2	Day 29.7
	15°	Day 13 to 15	3	Day 13.6
	20°	Day 8 to 12	5	Day 10.0
MOLT TO MEGALOPA	10°	No third molt at 10°C		
	15°	Day 22 to 32	10	Day 26.6
	20°	Day 14 to 21	8	Day 17.4

The following table summarizes the mean stage duration in days, of the isolated larvae kept at controlled temperatures, and shows the accelerating effect of temperature on development.

T°C	STAGE Zoea I	Zoea II	Zoea III
10°	13.6	16.1	All died before molt.
15°	7.3	6.3	13.0
20°C	5.0	5.0	7.4

Megalopae (fourth stage larvae) kept at 15° and 20°C have not all molted at this time.

LOBSTER STUDY

Oceanographic Description of Station NH-25

Station NH-25 is the first regular station proceeding west on the Newport hydrographic line where the depth of water reaches 100 fathoms. Station NH-25 is located 25 nautical miles due west of Newport at 44° 37'N, 124° 38'W (Loran readings: 2H4-2315, 2H5-3370) in 212 meters (116 fathoms) of water.

From the historical records of the OSU Department of Oceanography, 68 temperature-salinity hydrographic casts of NH-25 from the surface to 200 meters were obtained. These data were then ordered into oceanographic season: Winter (December, January, February, March), Spring Transition (April, May), Summer (June, July, August, September), and Fall Transition (October, November).

For each season a temperature and salinity profile from the surface to 200 meters was plotted, showing minimum, mean, and maximum reading at each depth. The four resultant graphs are attached as an appendix to this report.

The temperature results at 200 meters are as follows:

	Temperature (°C)			Temperature (°F)		
Season	Min.	Mean	Max.	Min.	Mean	Max.
Winter	6.95	7.59	8.26	44.5	45.7	46.9
Spring Trans.	6.32	6.97	7.39	43.3	44.6	45.3
Summer	6.16	6.91	7.64	43.1	44.4	45.7
Fall Trans.	7.11	7.76	8.42	44.8	46.0	47.2

Of the 68 hydrographic casts, the coldest 200-meter temperature was 6.16C (43.1F) taken during the Spring Transitional season and the warmest temperature was 8.42C (47.2F) taken during the Fall Transitional season. Mean 200-meter temperatures on a seasonal basis ranged from a low of 6.91C (44.4F) during Summer to a high of 7.76C (46.0F) during Fall Transitional. The overall mean 200-meter temperature of the 68 casts was 7.28C (45.1F).

The salinity results at 200 meters are as follows:

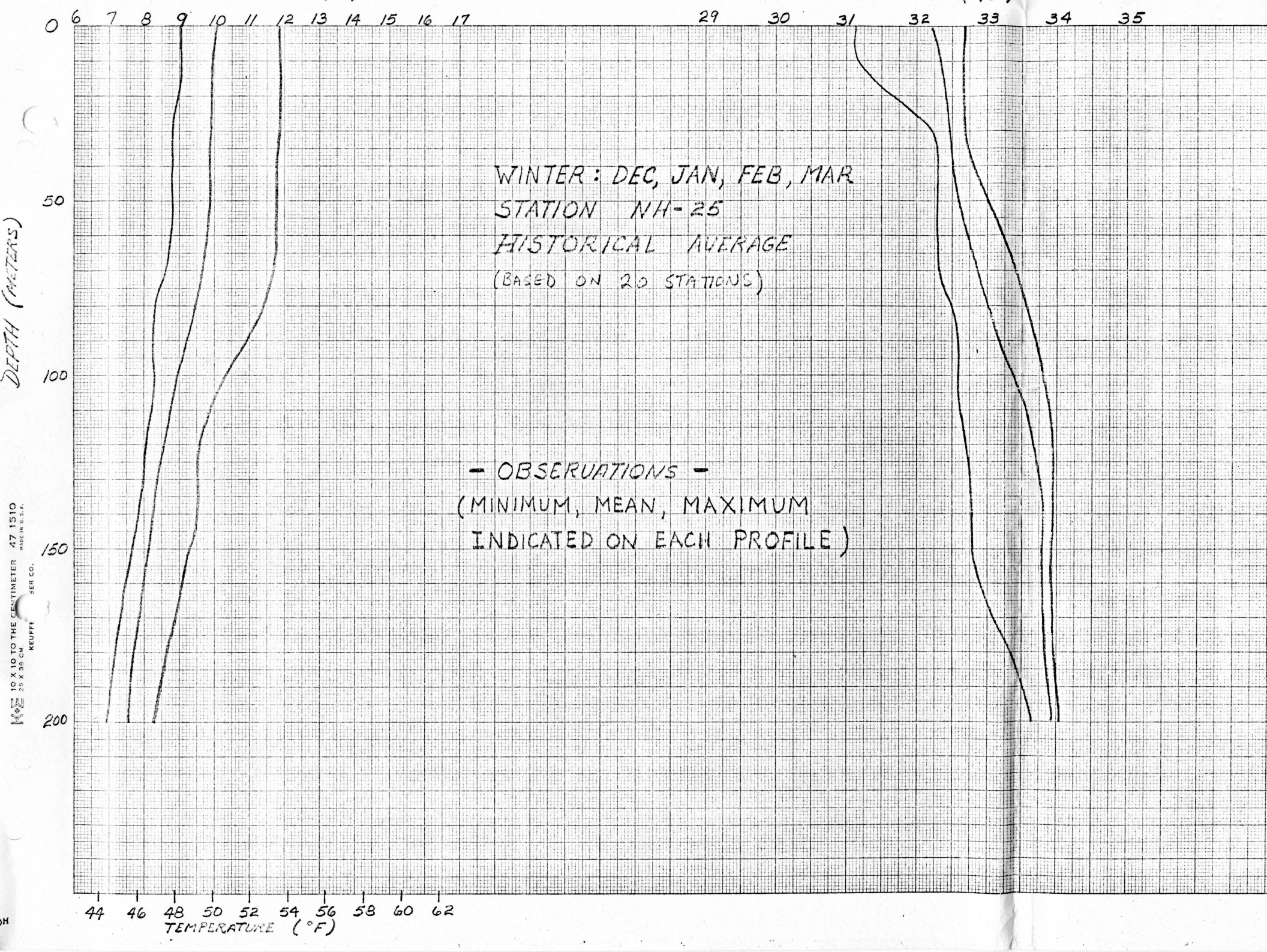
Salinity (°/₀₀)

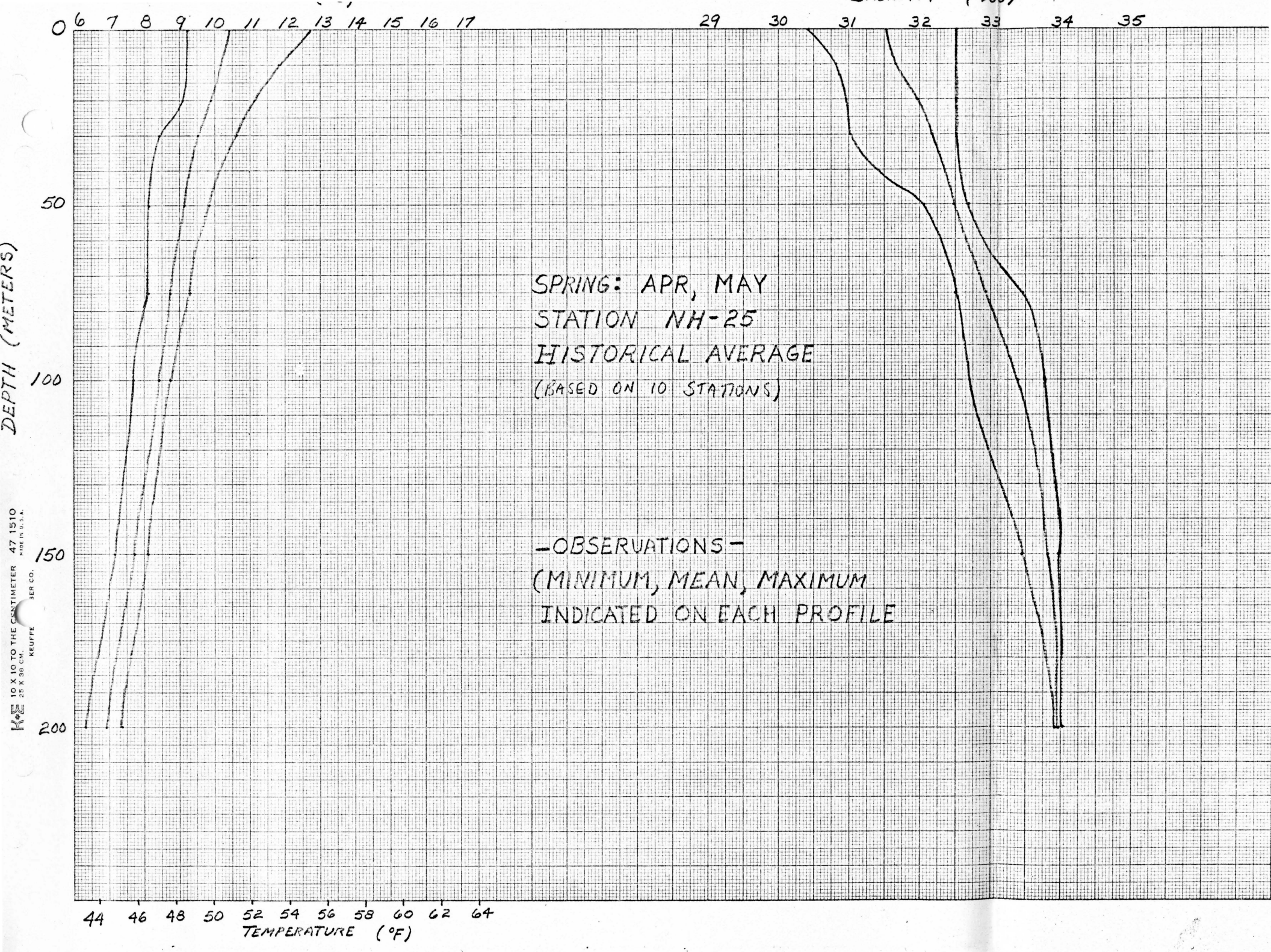
Season	Min.	Mean	Max.
Winter	33.63	33.90	34.00
Spring Trans.	33.94	33.98	34.03
Summer	33.90	33.98	34.04
Fall Trans.	33.60	33.89	33.96

Of the 68 hydrographic casts, the lowest 200-meter salinity was 33.60°/₀₀ taken during the Fall Transitional season and the highest salinity was 34.04°/₀₀ taken during the Summer season. Mean 200-meter salinities on a seasonal basis ranged from a low of 33.89°/₀₀ during Fall Transitional to a high of 33.98 during both Spring Transitional and Summer. The overall mean 200-meter salinity of the 68 casts was 33.94°/₀₀.

Little information on light is available. In clearest coastal water, probably not achieved off either coast of the United States, light intensity is reduced from 0 to 200 meters by a factor of 10^{13} (that is, by 13 orders of magnitude), which results in an insignificant amount reaching 200 meters. There seem to be no striking differences between the Atlantic and Pacific coasts of North America. Probably less light reaches 200 meters along the Pacific coast, especially during upwelling season when high productivity would retard light transmission. In any event, the lower limit of light intensity necessary to attract crustaceans never reaches deeper than 150 meters, even in clearest coastal water. So light is probably not a factor with lobsters at 100 fathoms off either the Atlantic or Pacific coasts of North America.

Prepared by: Daniel A. Panshin
Extension Specialist, Oceanography
Sea Grant
8 September 1970

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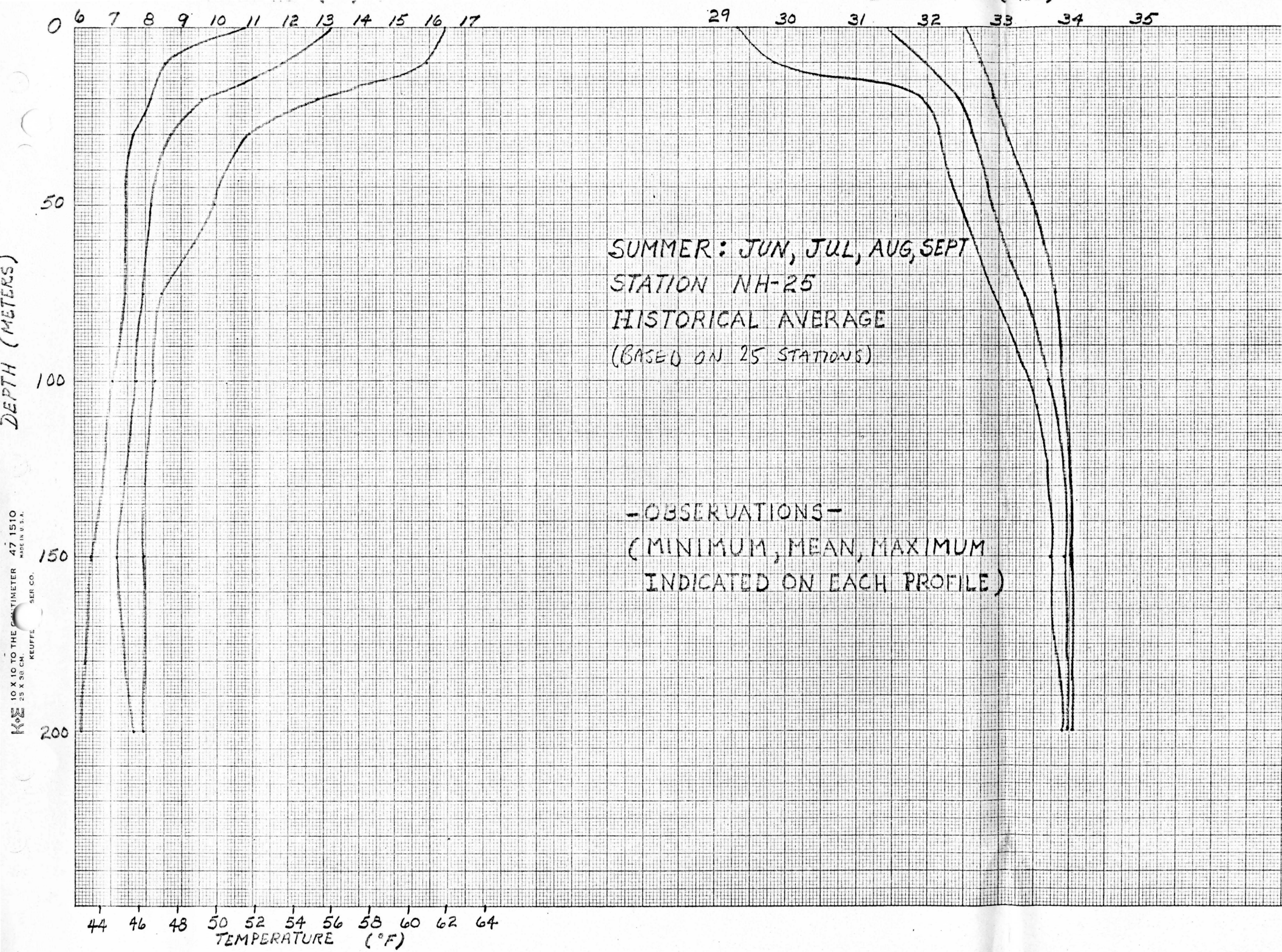
TEMPERATURE (°F)
SPRING: APR, MAY
STATION NH-25
HISTORICAL AVERAGE
(BASED ON 10 STATIONS)
-OBSERVATIONS-
(MINIMUM, MEAN, MAXIMUM
INDICATED ON EACH PROFILE
K&E 10 X 10 TO THE CENTIMETER 47 1510
25 X 38 CM. MADE IN U.S.A.
KEUFFEL & ESSER CO.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TEMPERATURE (°F)
SUMMER: JUN, JUL, AUG, SEPT
STATION NH-25
HISTORICAL AVERAGE
(BASED ON 25 STATIONS)
-OBSERVATIONS-
(MINIMUM, MEAN, MAXIMUM
INDICATED ON EACH PROFILE)
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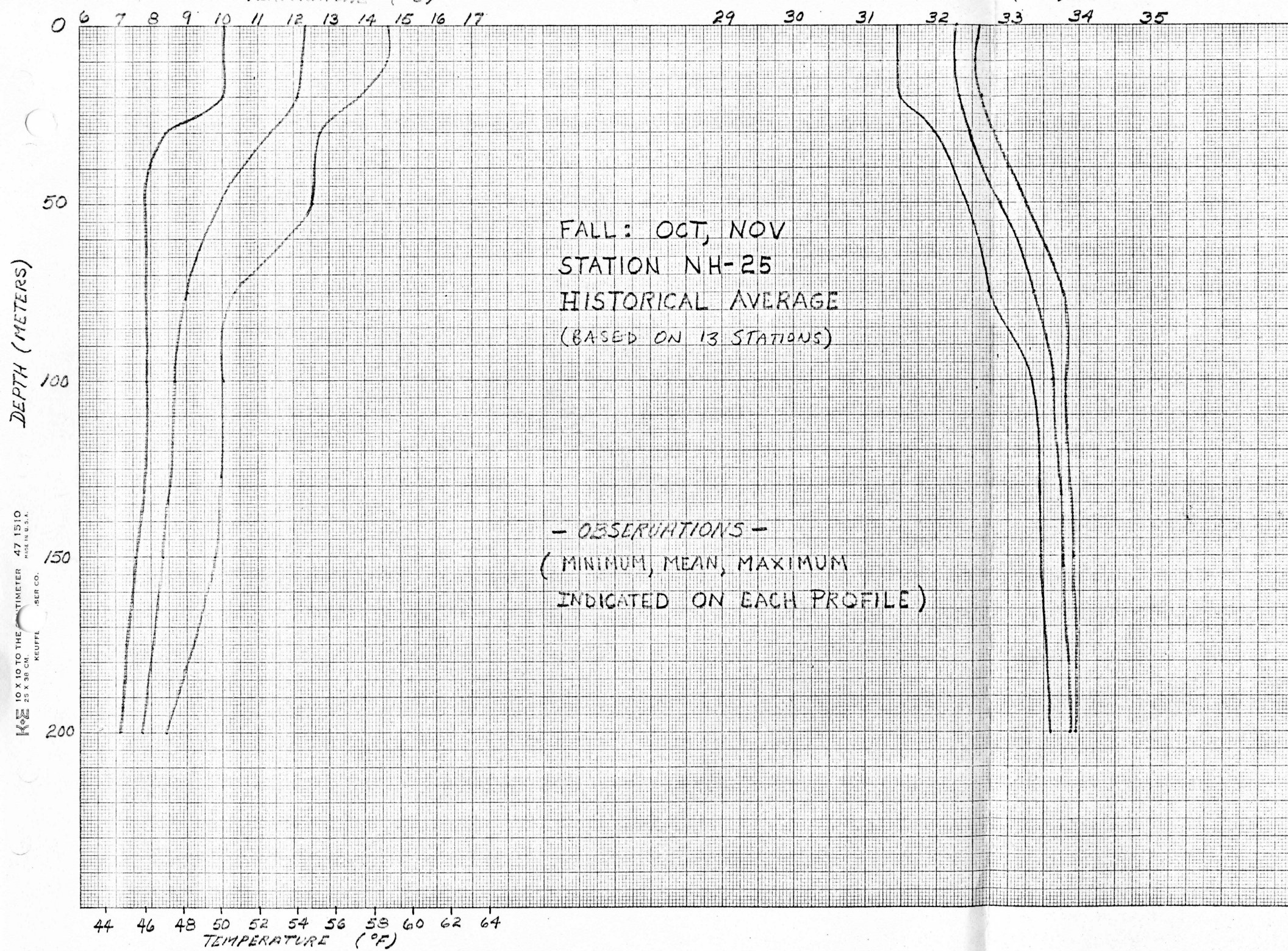
KEUFFEL & ESSER CO.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KEUFFEL & ESSER CO.

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COOPERATIVE EXTENSION SERVICE

OREGON STATE UNIVERSITY
MARINE SCIENCE CENTER
Marine Science Drive
NEWPORT, OREGON 97365

Phone 867-3011

November 6, 1970

AIR MAIL

James A. McCauley
Assistant Professor
Department of Fisheries and Marine Technology
Woodward Hall
University of Rhode Island
Kingston, Rhode Island 02881

Dear Jim:

Jeff has answered a number of the questions which you raised. There may be some merit in considering further the idea of commercial sales on the West Coast and holding lobsters in pounds. The animals which you brought out last year are certainly the most hardy animals that any of us have seen.

Basil Edmunds of Garibaldi, Oregon will be at the Naval Officers' Training Center in Newport, Rhode Island for the next three weeks. Basil owns and operates Edmunds Seafoods, a combination crabbing and processing establishment. Basil has one large crab boat and processes crabs for several others. He is a very good personal friend and would probably like to talk to you about crabbing on the West Coast compared to the East Coast. Additionally, you might sound him out on the lobster program. Basil has been interested in shipment of live crabs and might offer some advice. I don't know how much time he will have while in school there, but I'm sure he will welcome the chance to talk to a fellow fisherman and might be interested in taking a look at Rhode Island operations.

Thanks again for your continuing interest. Our program here is going in fits and starts but, hopefully, some progress is being made.

Best wishes to Walter and John.

Very truly yours,

William Q. Wick, Head
Marine Advisory Program, Sea Grant
(Professor)

WQW:pc

Wick

OSU

NEWPORT, OREGON 97365

OREGON STATE UNIVERSITY

MARINE SCIENCE CENTER
Marine Science Drive

November 4, 1970

Dr. James A. McCauley
Assistant Professor
University of Rhode Island
Dept. of Fisheries & Marine Technology
Woodward Hall
Kingston, R. I. 02881

Dear Jim:

Bill Wick passed your letter on to me, thinking that I could answer some of your questions. We were not able to do any more experimental work with larvae last winter beyond that described in our mimeographed report. The conclusions from that limited amount of work are necessarily limited too, but it seems that the hydrographic conditions that prevail from surface to bottom at the 100 fathom line are unfavorable for larval survival. Despite their deep, cold water parentage, these larvae had the survival characteristics of Atlantic coast surface layer plankton, that is they showed very poor laboratory survival below 15°C. The surface waters here over the 100 fm depth seldom reach temperatures above 15, even in summer. Spring and summer averages run between 10°C and 13°C; not very favorable temperatures as judged from our experimental results. Larvae do survive at these temperatures, but their development is very slow and I would think that this would expose the survivors to mid-water predators for so long a time as to virtually wipe them out. My general opinion from all this is that while adults would survive well at the 6 to 8°C bottom temperature at our 100 fm line, and possibly produce eggs and larvae, the latter would not survive in numbers sufficient for good recruitment to the adult stock because of our cold surface waters.

While I think that this makes natural reproduction unlikely, I do not think that it necessarily rules out the feasibility of a type of introduction involving a hatchery program to rear larvae to the benthic stage. These larvae are very hardy at the proper temperature and eat almost anything, unfortunately especially each other in mass culture. A west coast hatchery would be technically feasible if a technique to minimize larval loss through cannibalism were developed. This might be no more complicated than using large vats and very large numbers of larvae so as to yield the desired numbers of survivors. We kept our survivors through several post-larval molts, but had to discard them because of other things. Several individuals were kept in the Fisheries wing as pets and are now about three inches long.

There has been no 'final disposal' of the remaining adult lobsters. I have been hanging on to them like grim death. They survived well through our last winter period of lowered salinity, hatched all eggs, and despite neglect, starvation, and unfavorable conditions, many survived to early fall molting time. Of course they had a fine time eating each other during the molting period, but some survived this and some of the females mated and are now carrying a new batch of obviously fertile eggs. There are about 30-40 survivors and possibly 6 berried females so far. Of course animals kept on display in the aquarium and fed well have survived much better. The temperature regime of our sea water supply drawn from Yaquina Bay is adequate for adult survival, and you are certainly correct in thinking that no summer refrigeration would be needed for holding pounds located anywhere in the Pacific Northwest, or Northern California.

I am sorry that I cannot comment on your question about further interest in developing a lobster transplant here in Oregon. That's outside my province.

Sincerely yours,

Jeff Gonor

JJG:gb

Jefferson J. Gonor
Assistant Professor

UNIVERSITY OF RHODE ISLAND • KINGSTON, RHODE ISLAND 02881

Department of Fisheries and Marine Technology *Woodward Hall*

March 16, 1970

Labsters

Mr. William Q. Wick
Sea Grant Marine Advisory Program
Marine Science Center
Marine Science Drive
Newport, Oregon 97365

Dear Bill:

Sorry I was unable to attend the Sea Grant Conference, I am afraid there were too many ahead of me either by date or by weight. I had intended to wait until I could meet with you in person to discuss the developments to date on the lobster proposal.

I was not surprised at the position of the Fish Commission with regard to the proposal at this time. I would hope that Dr. Goner has been able to establish whether or not the larvae has a reasonable chance of survival in the offshore area. If the outcome of his studies are favorable I would feel that the project has merit at some future date.

There is little doubt that the incidence of disease should be carefully checked. It would not be surprising, however, if some of the lobsters did develop Gaffkya if they were impounded in the holding facilities used by the Canadians at Nanaimo, since there has already been several occurrences of the disease in lobsters from the East Coast Provinces. Other than that possibility I would not expect future developments in the area of disease.

I assume some thought has been given to a regional approach to the introduction of lobsters to the West Coast. The effects of the introduction would be beneficial or detrimental to all the states in the area. Financing of the project should therefore be of a regional nature or Federal or a combination of both. I would not expect any individual state to assume the entire project. Joint efforts of this nature are common in the New England area and I am sure this approach is used on the West Coast regardless of the origin of the project. The information gathered by the Center should be made available in the event there appears to be merit in the project even though the state of Oregon cannot finance the project because of prior commitments.

I could not help referring to the grand total of 88-309 money which is granted California, Oregon, Washington and Alaska. I am sure everyone in the marine community has an eye on it but an evaluation of some past projects may make the lobster proposal quite realistic.

The State of Rhode Island has allocated $10,000 through the General Assembly to purchase egg bearing lobsters at $1 each for transplant from offshore to inshore areas effective March 15. This is a continuation of

last year's efforts although the biological data through the tagging program was not complete in that there is no sure way of determining the effectiveness of last year's efforts. Politically speaking, however, efforts of this kind are always excellent. The general public may have a very limited knowledge of many projects being carried out in the marine area but the work with lobsters seems to gain a great deal of attention especially in this area.

I would be interested to hear of the results of the lobster studies as they take place. If there is any further developments on a future transplant either in Oregon or the neighboring states or interest on a Federal level, I would appreciate hearing about it. I am sure the effort to date has been worthwhile and the information obtained quite valuable for future developments of this kind.

Sincerely yours,

Jim

James A. McCauley
Assistant Professor

JAMcC:gc

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

DEPARTMENT OF NATURAL RESOURCES

VETERANS' MEMORIAL BUILDING, PROVIDENCE, R. I. 02903

JOHN L. REGO
DIRECTOR

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DIVISION OF
CONSERVATION

February 11, 1970

Mr. William Wick
Marine Advisory Program Leader
Marine Science Center
Newport, Oregon 97365

Dear Mr. Wick:

Jim Mc Cauley has asked me to drop you a line concerning the hatching of your berried female lobsters and some of the problems you'll encounter. One of the most serious is nematodes of various species. All eggs which come free from the females should be removed from the holding tanks. Nemotod outbreaks apparently start in dead, free eggs but will quickly spread to living attached eggs if not checked.

After hatching, the young possess very strong cannibalistic tendencies. This tendency toward cannibalysm is particularly strong during the first four stages. Much of this cannibalisym can be prevented by keeping the water in constant motion by bubbling air through it. Over feeding will also prevent cannibalisym.

After stage four, the animals are out of the water column and actively crawling. At this stage, they tend to be secretive. Beyond this stage, lobsters are very difficult to raise. Mortality now is due to aggressive behaviour and and territorial and not cannibalisym, although cannibalisym continues to occur. It is at this stage I would recommend you liberate the animals.

If we can be of any assistance in the future, please let me know.

Sincerely yours,

George W. Gray, Jr.
Senior Marine Biologist

FISH COMMISSION

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State Fisheries Director

February 3, 1970

Professor William Q. Wick
Head, Marine Advisory Program
Oregon State University
Marine Science Center
Newport, Oregon 97365

Dear Bill:

The questions of (1) do we want to accept Jim McCauley's offer of aid in obtaining deep water lobsters for release here and (2) what do we want to do with the lobsters on hand have been considered and the following conclusions reached.

We believe that a transplant should not be attempted this spring and probably not for some time to come. Several arguments apply. First, we tend to go along with the Canadian position that a few thousand pounds of adult animals is not a sufficient number to release directly and expect quick, if any, establishment. If, as suggested, the adult lobsters were berried females, the process could be speeded up by rearing the young in hatcheries but cost goes up too. Second, while the estimated cost of $2,600 may be a bargain price for lobsters, it is not an item that we budgeted for in this biennium so it would mean giving up other previously justified activities to make the purchase. Further, I am sure that expenses beyond the $2,600 would be involved, particularly if we established a lobster hatchery. Third, and most important, is the question of disease. While there is some evidence that Gaffkya is possibly not carried by the deep water lobsters, we think that further appraisal of incidence is needed before they can be given a clean bill of health. Pounding in inshore areas has been suggested as a means of sorting out infected animals but at this point I would worry about it being a place for infecting animals. In addition to examination of the lobsters we need further study of

the susceptability of our crabs, particularly the Dungeness, to Gaffkya before we would want to chance introducing lobsters. And last, there are questions yet unanswered on the suitability of our offshore areas for lobsters. Are temperatures, salinity, predator levels, etc. favorable to the survival of them as a species on the west coast?

Since we too are attracted by the possibility of enriching our offshore resources, by establishing a valuable creature like the lobster, we are not ready to forget about them. We would like to see studies done on the relation of environmental factors to the lobster including the larval stages. We understand that Dr. Gonor will do studies of this type at Newport and we hope that Tom Gaumer of our staff can work closely with him on an informal basis. We plan to explore means of getting further studies done on Gaffkya and the threat it poses to crabs. One step we will take is to contact BCF at Boothbay, Maine, and see if we can arrange a study of the vulnerability of wounded and intact Dungeness crabs to Gaffkya. We would rather ship the crabs to them than to bring the disease out here. We will also check further with west coast Canadians to see how they stand on the threat of Gaffkya or of other diseases for that matter.

The lobsters on hand pose two problems. The first one is what do we do with the larvae as they hatch. Our preference is to collect them, use what we want and destroy the rest. If this is not practical in the big tank then "scrubbing" the females would take care of the problem. We will have to hope that larvae that already escaped us pose no threat. The other question is what to do with the adult lobsters and we think that the approaches suggested when we last talked, viz., retain what are needed at the Marine Science Center and distribute the rest to Dr. Joyner at the University of Washington, the Canadians at Nanaimo and to public aquaria in that order, would be desirable. A step that should be taken before distribution to other areas is to check blood smear from each lobster for Gaffkya. This would give us a measure of the incidence, if any in this shipment and would help assure us that we are not spreading it to areas that have not already been exposed.

We are considering requesting funds in the next biennial budget to examine the lobster import problems. Accordingly, we will not be budgeting for or encouraging others to introduce lobsters for awhile.

Sincerely,

RL

Robert E. Loeffel
Marine Research Supervisor

cc: Kruse
Snow
Gaumer

Memorandum 20 January 1970

To: W. Q. Wick
From: J. J. Gonor
Re: Lobster project

I have had time to read a few of the older papers on lobster reproduction and know a bit more now. It appears that mortality was not recorded in the one study I have been able to find on t/s effects on lobster larvae. Only the time of development of survivors was recorded. We therefore could not even predict from this whether or not inshore lobster larvae would survive Oregon coastal conditions in May and June. If we can get our females past this difficult period of low salinity in the lab, we have a chance to make a contribution here.

We need a seasonal temperature and salinity description of the 100 fm area off Newport. I think that Station NH 25 or NH 35, regular stations on the Newport line are the first ones at that depth. We need to have the data files and reports searched and a seasonal surface to bottom description compiled. Dan Panshin could be of great help here in supervising data retrieval by Bill Gilbert. If a computer search is needed, there is ample unused Sea Grant computer time dating back to 1968 available. Its use could be fully justified on the basis that I need this information for my Sea Grant larval work.

Jim McCauley's memo talks about a 10-12°C preferendum. Because of upwelling and other differences in the hydrographic regime, this temperature is not reached on bottom at all at 100 fms, so far as I know. I think that the annual range at NH 35 is about 7 to 8.5°C. The 10-12 range is found immediately inshore. Also, if light is a factor in keeping the lobsters deep, we should know what is available about this also. Because of turbulence and runoff, light penetration inshore here is probably less than along the East coast, This would mean that the light as well as the temperature conditions found at 100 fms on the east coast exist closer inshore here. Panshin could discuss this matter with George Beardsley or Bob Smith, and put some of that basic physical oceanographic information to work.

For the moment I have decided against trying to accelerate egg development of any of the females with elevated temperatures in the 15°C range. We really need to know how larvae which have developed in the egg at local winter temps respond to various temperature and salinity combinations. Too little is known about crustacean reproductive ecology to know what to anticipate. The lobsters in nature here would never experience 15°C., and we want a relevant experiment.

I have kept the carbon copies of Jim McCauley's memoranda and return the originals to you.

FISH COMMISSION
INTRA-DEPARTMENT

MEMORANDUM

DATE: January 19, 1970

TO: Bob Loeffel

FROM: Dale Snow

SUBJECT: Lobster Import

I have reviewed the information supplied by Bill Wick, McCauley and other agencies. For the sake of brevity I will attempt to put key items in capsule form for evaluation.

The Bureau of Commercial Fisheries has been subjected to considerable political pressure to introduce lobsters on the west coast; however, they prefer to cooperate with the Fisheries Research Board of Canada in their program rather than to duplicate it.

In personal communication with Dr. Ray Ghelardi and Gordon Bell, I have obtained the following information. The Canadians first put lobsters in the Pacific ocean in 1898, with periodic introductions to date. The largest of these introductions was in 1966 when 3,650 animals were brought to the west coast. Dr. Ghelardi feels that any introduction of less than 1/2 million pounds is wasted effort. The Canadians have been quite concerned over the possibility of introducing disease that could prove to be epizootic in the Dungeness crab populations. The disease of primary concern is Gaffkya homari (red-tail disease) also referred to as Gaffkemia or Gaffkyaremia. Gaffkemia is a bacterial blood disease (gram positive micrococcus) that destroys the blood cells. Consequently, the Canadians attempted to find Gaffkya in the Dungeness crab or in mud from areas inhabited by C. magister with negative results. They were unable to transmit the disease by either feeding infected lobsters to crabs or contact. However, they were able to transmit the disease by intramuscular injection to both Dungeness crab and spot shrimp. Not all of the crab died but became carriers of the disease for an indefinite period, while some of the crab died within 8-12 hours of the disease. The bacteria survives well in crab hemo lymph. They feel preshipment quarantine is essential and that Gaffkemia could be a major problem to crab. They have yet to try infection by lesion. On the other hand they also feel that a protozoan found on crab could be a problem to lobsters.

McCauley contends that deep-water lobster are a separate race from the inshore populations. This is somewhat substantiated by morphometric measurements and a tagging study by Saila and Flowers. They tagged 1,258 berried females from deep water and released them inshore. They recovered 474 of the tagged animals. Statistical analysis of the data indicated a directional movement toward the capture site after the eggs had hatched and three were recovered very near the original capture area. McCauley also mentions that summer surface waters may reach 80° (layer where larvae develop?). He also states that there are no fish

FISH COMMISSION
INTRA-DEPARTMENT

MEMORANDUM

DATE: January 19, 1970

TO: Bob Loeffel

FROM: Dale Snow

SUBJECT: Lobster Imports

large enough on the east coast to be predators on the deep-water lobster (I wonder about our wolf eel?). He also says there is no information on Gaffkemia in deep-water lobsters; however, all information available to me indicates such limited sampling that no definite conclusion can be drawn. He also says shipment should take place before April.

Other workers (Goggins, Getchell and Taylor) in other studies have found Gaffkya outside the lobster in mud or slime and miles at sea. The disease in lobsters is transmitted by feeding on infected animals, association with infected lobsters or through the water. Another disease that causes considerable mortality to lobsters on occasion is shell disease. It is caused by a bacteria that destroys chitin, however, it can usually be detected macroscopically.

The fact that the deep-water lobster appears to be a separate race from the inshore lobster warrants our investigating the possibility of introduction. However, there are enough gray areas regarding disease, water temperatures at which the larvae rear for 21-28 days and (to the best of my knowledge) unexplored shell disease as related to crab, I feel we should proceed with caution. In view of how little I know about all of these areas, I would recommend: (1) no further importation this year and no future imports without preshipment quarantine; (2) rear the resultant larvae from lobsters on hand and subject them to temperatures and salinities that we know occur along our coast at the free swimming period for these animals; (3) encourage the Canadians (or anyone capable) to attempt transmission of Gaffkemia to Dungeness crabs through lesions; and (4) re-evaluate our position on import of deep-water lobster after rearing experiments have been completed ~~and~~ and more information is obtained on Gaffkemia.

cc: Snow
Files

SNOW:lk

UNIVERSITY OF RHODE ISLAND • KINGSTON, RHODE ISLAND 02881

Department of Fisheries and Marine Technology *Woodward Hall*

January 13, 1970 Lobsters

Prof. William Q. Wick
Marine Advisory Program Leader
Oregon State University
Marine Science Center
Newport, Oregon 97365

Dear Bill:

Enclosed are some of the answers to the questions offered by Dr. Gonor. I was quite surprised that more information of a biological nature was not available. I am not fully convinced that there has not been additional studies made and I will continue trying to develop additional information along these lines.

I hope that the lack of sufficient data on the offshore population does not endanger the proposal to the degree that it may not be considered feasible. The lack of information leaves room for considerable study of this lobster population. Possibly a joint study might be worthwhile among various interested parties including Dr. Joiner, whom you mentioned in your last correspondence.

Work of this nature on the offshore population has offered some difficulties to scientists in the past because of the distance to the grounds and the lack of adequate vessels. This situation has been altered of late with my addition to the faculty as well as the leasing of a 54 ft. vessel by the Graduate School of Oceanography.

Once we determine the probability of success from Dr. Gonor's initial experiments, a course of action by way of further studies could probably be implemented. I appreciate your letter keeping me up to date on the proposal. Possibly there are other people that could be brought in to assist in the venture , since everyone here as well as at the Center seems to have much more than they can handle as it is.

I suggested your name and the topic for the Fishermen's Forum; I hope you can make it. We usually have good attendance and the audience will be mostly fishermen so you should feel right at home.

Our midwater trawl project is progressing quite well. I think we have a good chance of coming up with a winner although the early stages were trying as usual. So far we have had 50,000 in three short tows totaling about two and a half hours towing time.

Sincerely yours,

James A. McCauley
Assistant Professor

JAMcM:gc

Review of Lobster Proposal

J. A. McCauley

Supply

The stock for transplanting would be caught from the same area to insure that we would have all the lobsters from the same shoal. This procedure would carry out the basic assumption that the lobsters have a decided tendency to stay together in shoals even under adverse conditions, such as experienced during mass trawling operations. Pot lobster fishermen try to move their pots to follow similar shoals in inshore waters.

Holding

The lobsters will be held in tanks for a relatively short period of time (one month) during the collecting phase. The tanks and water supply would be isolated from other lobster tanks during this period to combat the possibility of disease.

Shipping

The period of time for any shipment would be between the middle of November to the middle of April. This choice would eliminate the possibility of shedders among the males as well as allowing the females to become acclimated to their new environment prior to hatching their eggs. The average hatching period would be expected in May or June.

In addition, our experience in shipping lobsters during warm weather has not been good even when using the styrofoam containers.

Packing

Packing would be carried out in the same manner as the early shipment, which I considered to be satisfactory for our purposes.

Transportation

The preferable way to ship the lobsters would be in two shipments of approximately 2500 pounds each. I would prefer shipment by commercial airlines in that there would be far less variables as compared to using National Guard aircraft, i.e., considerable advanced notice, one shipment, delayed flight, possibly two days one way.

By using two shipments, we would not be required to hold the lobsters quite so long also the handling, packing, etc., of 5,000 at one time presents quite a problem at both ends.

Holding prior to planting

The excellent holding tank at the center, now being used for the early shipment, would be adequate for 2,500 pounds. The lobsters should be held at least 24 to 48 hours to determine their condition.

Area for transplant

The best place to transplant the lobsters in the Oregon area has already been discussed. Again, I would prefer 80 to 100 fms. in order to stay within the depth range from which the lobsters have come. Bottom temperature in that area should be within the 10° to 12°C range. Soft bottom such as previously described would be the best choice.

There has been a great deal of concern over the possibility of competition with the Dungeness Crab and other species. I think it would be important to consider the extent of the crab fishery and how much of the population has been caught and the sustained level that is anticipated. Obviously, as the number of crabs diminishes in the area due to fishing effort, more food will be available for the remaining population as well as any new species, such as the lobster. I would not think that the lobster would populate any area very quickly and as soon as fishing for lobster becomes feasible, the level of the population will be controlled through the fishing effort. At the current price structure, overpopulation would be unlikely.

Purpose of the Initial Transplant

The purpose of the transplant of large females and males would be primarily to establish an offshore area which the lobsters would find suitable for sustaining a population. Lobsters are not required to feed regularly since they are often held for at least a month without feeding. This combination plus their mobility should allow ample time for resettlement on their own if our choice of location is inadequate. There may or may not be any results from the first hatch, however by supplying a percentage of males, a continuous mating process should become established. This is assuming that Dr. Gonor's work in the area of temperature and salinity allows for the survival of the larvae. I believe the concept of providing lobsters from the same shoal will have a decided effect on the success of this phase.

Since it is evident that 5,000 pounds of lobsters, approximately 1,000 animals, does not represent a population, a hatchery program would probably be necessary to add to the initial planting. The final choice of location by the first group of lobsters would then offer the best known place to introduce the young lobsters.

I believe this concept is the most important part of the proposal. Hopefully, there will be some natural reproduction from the egg bearers introduced; however, in order to build a sizeable population in a relatively short time, a hatchery program seems inevitable.

Monitoring the lobsters after planting

In discussions with members of the Fish Commission and fishermen in the Newport area, it would appear feasible to keep a reasonable check on the movement of a body of lobsters of this size through incidental catches of lobsters by trawlers and/or pot fishermen. Again, a great deal depends on the tendency of the lobsters introduced to remain as a body rather than arbitrarily dispersing.

Hatchery program

There is ample information available on raising lobsters in hatcheries. There would be no problem in duplicating and probably improving upon existing installations, such as the Massachusetts State Hatchery on Marthas Vineyard. The information obtained through the experiments being undertaken by Dr. Gonor should substantiate the success of a hatchery under the existing conditions of the Oregon coast.

Conclusions

Although lobster transplants have been tried in the past without success, there is no cause to doubt that it can be done. The initial tests conducted at the Marine Science Center should be able to answer some of the unknowns as far as reproduction. I do not believe we can progress too much farther until this work has been evaluated.

The big question of whether the lobsters will remain in the depths they are taken from remains unanswered. I appreciate the concern about the possibility of the lobster taking over the crab ground, however, as I have pointed out, these grounds have obviously been supporting a much larger crab population prior to the fishing activity that now exists. Should the crab population continue to diminish, there will be room for other species to be sustained in the same area. I would think that rather than having some other species fill this gap it would be worth considering an attempt to fill the gap with a valuable species of our own choosing.

In the New England area we have seen a reversal of this situation in that there appears to be an increasing abundance of Cancer borealis offshore and an increase of Cancer irroratus on the inshore fishing grounds. Plans are being made to harvest both groups under a joint study by the Department of Natural Resources of the State of Rhode Island. At the present time both these crabs represent a nuisanceto pot and trawler fishermen alike. Hopefully, the population can be controlled through fishing effort as well as providing an additional fishery. Whether the reduction of the population will affect the lobster population by relieving the pressure on the available food supply remains to be seen.

Comments on Questions Relating to Lobsters in Memorandum

from J. J. Gonor to W. Q. Wick

by J. A. McCauley

Accurate data of a biological nature on the offshore lobster population appears to be noticeably incomplete. The partial answers by Dr. Saila to the questions presented by Dr. Gonor indicate to some degree the extent of the studies to date on the offshore lobster population.

Looking at catch records as indicated in Inclosure I, a picture of the fishing industry economy in the State of Rhode Island, it is interesting to note that the offshore lobster population has rapidly replaced the inshore population as the main source of supply in Rhode Island. A similar comparison could be made in Massachusetts and New Jersey. It appears that the offshore population of lobsters, excluding the Gulf of Maine, is much larger than the inshore population. I believe this is due in part to better overall conditions for survival of the young as well as availability of the food supply. There are few large fish or other possible predators in the offshore area. The type of bottom in the area where the offshore lobster population is found apparently offers a greater food supply. (Silty sand, silt, clayey silt. Bottom samplings by B.C.F. Ref. Serial Atlas of the Marine Environment, American Geographical Society 1965.)

The offshore population has experienced a great deal of fishing pressure over the years, however the size of the catches has not diminished to any degree in the last five years, although the average size of the individual lobsters being caught is smaller.

Comments on Questions Relating to Lobsters:

2. The reference referred to by Dr. Saila is one which, I believe, was provided to W. Q. Wick in the initial proposal.

3. I will attempt to get further information from Mr. John Hughes of the Massachusetts State Hatchery at Marthas Vineyard, Mass. Dr. Saila has suggested that any attempt at raising lobsters in quantity would probably require a visit to the Marthas Vineyard hatchery by the participating individuals.

6. Recent offshore surveys carried out by the Dept. of Natural Resources and the Dept. of Fisheries under the direction of Dr. Thomas Meade indicate that the red crab, Geryon quinquedens, does not coexist with either Cancer or Homarus.

6. (continued)

Previous studies carried out on chartered vessels had led project leaders of the red crab study to believe that the red crab and the lobster occupied the same grounds. Through personal experience and knowledge of the tows made at that time, there is little doubt that the trawler captain was actually trawling for lobsters in 200 fms., then swinging into deep water, 250 fms. or more, prior to hauling in order to fulfill the catch requirement of red crab. Therefore, I would disagree about the incidental catch suggested on page 15 of the report, "Commercial Potential of the Deep Sea Red Crab," by Dr. Andreas Holmsen, Occasional Paper 68-138, which I have enclosed.

Since this report was completed, my own vessel, F/V "Jerry and Jimmy" with myself as captain, has been chartered for the red crab study under the supervision of Dr. Meade. We have proven that the two species are not coexisting on the same ground.

7. According to Dr. Meade's studies, the Geryon quinquedens is found in colder water, 7° to 8°C, compared to the offshore lobster population which is found in 10° to 12°C.

Reference: Bottom temperature studies by B.C.F. Serial Atlas of the Marine Environment, American Geographical Society 1965.

Surface temperatures range from 5°C in winter to 16-17°C in May and June, reaching a maximum temperature of 25°C in late August.

I am attempting to locate substantial information on the light present in the 100 fm. region. There is no difference in the catch rate during daylight and darkness, which is normally an indication of light influence with other species.

9. Most of my comments concerning the report by Dr. Gallardy on the Canadian Fatty Inlet experiment have been expressed in conversation with Dr. Gonor. I would say that the success of the initial shipment now being held at the Marine Science Center is proof of the healthy condition of the offshore lobster, especially those in that particular size range. The condition of these lobsters is in sharp contrast to those described in the report on the Fatty Inlet project.

Partial Answers to Questions Relating to Lobsters,

Numbered in the Sequence Given in Memo to W. Q. Wick of 12/10/69

By:

S. B. Saila and J. A. McCauley

1. The most recent contribution is a paper by Saila and Flowers (1969) in the last issue of Systematic Zoology. It indicates separate breeding populations. I suggest they are partially adapted genetically. However, the paper did not contribute to this problem. There is no justification for assuming the two adult populations are derived from the same larval swarm due to the nature of early life history stages and physical oceanography of the Atlantic region in which they are found.

2. They don't migrate back directly. If they are berried, they remain in shallow water until they have shed eggs and/or molted. I'm of the opinion light acclimatization is to some extent involved in the homing movements. See: Saila and Flowers: 1968. J. Conseil. 31: 342-351.

3. The young and larvae of the deep forms behave identically with the shallow forms from all outward appearances. The lobster hatchery at Martha's Vineyard has hatched both inshore and offshore eggs. I don't know (nor does anyone know) if the early life history stages differ very much under initial analyses. We don't know for sure whether the young of the deep form seek adult habitat, if the parents have been displaced. I'm reasonably certain that the depth/temperature/light regime is at least partially determined genetically. However, no critical studies are available.

4. I don't know the answer to this. It appears, from all available evidence, that the larvae of lobsters will not naturally move great distances from the area in which they settle assumming the area settled in is conducive to survival.

5. I'm sure lobsters can capture decapod crustacea in nature. Their diet in nature seems to be mainly fish, but includes crustacea (chiefly isopods), mollusks, echinoderms and hydroids.

6. I have no answer to this. However, Homarus Cancer and Gerion are

taken from the same grounds - clearly suggesting that they are not occupying the identical niche.

7. I don't know specific details. However, I suggest the Northwest Atlantic and Northeast Pacific are reasonably similar at 100 fathoms.

8. The deep water adults show more migrating tendency than the shallow water adults. They do undergo cyclic reproductive activities similar to shallow water.

9. I don't know. It is my understanding that this source is entirely from shallow water.

27 January 1970

AIR MAIL

James McCauley
Assistant Professor of Fisheries
Department of Fisheries & Marine Technology
University of Rhode Island
Kingston, Rhode Island 02881

Dear Jim:

We have been checking the lobsters on a regular basis and find that to this date the animals are vigorous, the eggs are coming along rapidly, and things seem to be going well. This is especially remarkable considering the fact that we've had about 15 inches of rain in January and our salinity has dropped as low as 2.6 ppt. We have monitored the large holding tank closely and kept the salinity above 25 ppt as often as we could. To study the stress of fresh water Tom Gaumer placed some animals in the regular flow of water as it came into the Center. As I mentioned, this dropped as low as 2.6 ppt and the animals did not seem to endure any stress, although, of course, we do not know whether egg fertility was affected. In another instance, we found that by keeping lobsters in a tank without adding aeration, in water of sufficient salinity, the lobsters spread themselves widely, apparently attempting to soak up more oxygen from the water. Upon adding additional aeration these lobsters came back to the normal position.

Dr. Gonor and Tom Gaumer of the Oregon Fish Commission are continuing to work on reproductive studies. We are still awaiting word from the Fish Commission of Oregon concerning permission for the large-scale transplant. This project has been a very exciting program and I believe we are even starting to convert some of the no-go's.

Dan Panshin, our Oceanographer, is studying current patterns and flows

off Oregon's ocean, along with physical data on two areas so that Jeff Gonor can coordinate physical conditions with conditions in the laboratory.

I understand that Fred Smith is going to attend your Fishermen's Forum this year and I hope that you enjoy his work as much as we do. I think Fred is one of the top-notch people in the country in his field and does an excellent job with presentation.

I'll keep you informed of how things go here and I hope that we can get some action.

Sincerely,

William Q. Wick, Head
Sea Grant Marine Advisory Program
(Professor)

WQW:pc

Lobsters.

24 December 1969

Dr. Thomas G. Scott
Head, Department of Fisheries & Wildlife
315 Extension Hall
Oregon State University
Corvallis, Oregon 97331

Dear Tom:

This relates to your letter concerning deep water lobsters. You may be interested to know that I, too, have played the Devil's Advocate role in this project. I will try to comment on each question.

1. Advisory program activities vary in different locations. For instance, the Texas A & M Marine Advisory Program is involved in culturing of shrimp which may be termed applied research rather than extension. As indicated in my letter and the letter from McCauley, the initial small shipment was a test primarily of shipping conditions and acclimation to enclosed waters here at the Marine Science Center. There were to be no releases and there will not be. Dr. Jefferson Gonor volunteered to make some reproductive studies on several of the animals to determine whether eggs will hatch in our waters.

2. The Oregon Fish Commission was advised of this experiment approximately one month before the lobsters were shipped. Further, a Commission biologist inspected the lobsters at the airport and provided transportation for them back to the Center. On December 10th, McCauley and I

met with Bob Loeffel, Marine Superintendant of the Oregon Fish Commission, and Jack Neilsen, Aquatic Biologist, to discuss the entire matter. The complete information that I have has been sent to the Bureau of Commercial Fisheries Regional Office in Seattle for comment.

3. Results and methods of previous introductions of American lobsters to our Coast have been examined. In all cases the lobsters planted were of the inshore variety where environmental conditions are much different than our off-shore or Atlantic off-shore conditions where the temperature at 100 fathoms averages 45 to 50 degrees Fehrenheit.

4. The Fisheries Research Board of Canada at Nanaimo has been involved in lobster work for a number of years. It is my understanding that many of the lobsters which have been used there have already escaped and, therefore, introducing lobsters to off-shore waters in the Pacific has already been done. I have contacted the Maine Department of Sea and Shore Fisheries and the Bureau of Commercial Fisheries at Boothbay Harbor, Maine, for information relating to any possible diseases. Reports from these and many other sources on the East Coast indicates that disease potentials are minimal at best.

5. Our Extension Oceanographer has been studying water data relating to off-shore Oregon waters in relation to the marine environment from which these animals came and finds that, in most cases, the environment appears to be similar.

6. Although there are, as you indicated, about twelve commercially important spiny lobsters distributed throughout the world, these are tropical and/or sub-tropical in nature. The North American varieties are found in the area south of Santa Barbara, California, and south of Cape Canaveral on the Atlantic Coast.

As I've indicated in letters to the Oregon Fish Commission, the Bureau of Commercial Fisheries, and others, I did not propose this experiment and at this stage am neither for nor against it. The offer, however, was made in good faith by a professional staff member of the University of Rhode Island, a sister Sea Grant Institution, as a partial exchange for the Coho Salmon eggs which were shipped by the Department of Fisheries and Wildlife to URI a short time ago.

Any decision regarding the importation and release of deep-water lobsters will have to be made by the Fish Commission of Oregon after a complete study of the available facts. As biologists, both of us realize that an overwhelming majority of introductions world-wide have been either a failure or have created problems. On the other hand, there are a few notable examples of success. It appears at this stage that we do have an off-shore niche which is relatively uninhabited at the 100 to 250 fathom level and if there is a chance to establish a dollar-a-pound ex vessel animal to the fishery it would suggest serious study. -If you have further questions or comments please let me know.

Sincerely,

William Q. Wick
Head, Marine Advisory Program

WQW:pc
cc: Joe Cox
Herb Frolander
Bob Leoffel

OSU

OREGON STATE UNIVERSITY
DEPARTMENT OF FISHERIES AND WILDLIFE

CORVALLIS, OREGON 97331

December 17, 1969

Mr. William Q. Wick
Marine Advisory Program Leader
Marine Science Center
Newport, Oregon 97365

Dear Bill:

Of the copies of letters which you passed on to me at the last Sea Grant meeting which I attended, I have just now discussed with members of the staff the one from Professor James A. McCauley, University of Rhode Island, of November 19, 1969, to you concerning the "experiment" with transplanting offshore lobsters.

I do not know how far you are with this undertaking, but I suggest that you hold it up until some fairly difficult questions have been answered. I do not enjoy playing the role of the Devil's Advocate, but I must pass on to you some of our questions and comments concerning this experiment.

1. It hardly seems to be the type of activity in which one would expect a Marine Advisory Program to become engaged, at least not until that Program is in a position to provide reliable answers to the difficult questions raised by such an undertaking.

2. Has the Fish Commission of Oregon been advised of this experiment and does the experiment have the Commission's approval?

3. Has anyone examined the results of previous introductions of American lobsters to our coast and attempted to hypothesize on why they have been unsuccessful?

4. Has the staff of the Fisheries Research Board of Canada at Nanaimo been contacted concerning this experiment? Canadian researchers have introduced American lobsters to the western shore of Vancouver Island and are concerned about the possibility of introducing diseased lobsters to Pacific waters. They also have some knowledge of the problems involved in transplanting lobsters.

OREGON STATE UNIVERSITY 1868 1968 CENTENNIAL

5. Has anyone examined the available data on the waters off the coast of Oregon to determine whether we have a marine environment which will match those of the lobsters to be transplanted? Also, are these data adequate for such an evaluation.

6. There are about 12 commercially important spiny lobsters distributed throughout the world. Have the ecological requirements of these lobsters been studied to determine whether any of them might be more suitable to our waters than the American lobster?

U of Santa Barbara + commercial in Atlantic coast

Sincerely yours,

Thomas G. Scott

Thomas G. Scott, Head
Department of Fisheries and Wildlife

TGS/ar
cc: H. F. Frolander w/encls.

24 December 1969

Dr. Thomas G. Scott
Head, Department of Fisheries & Wildlife
315 Extension Hall
Oregon State University
Corvallis, Oregon 97331

Dear Tom:

This relates to your letter concerning deep water lobsters. You may be interested to know that I, too, have played the Devil's Advocate role in this project. I will try to comment on each question.

1. Advisory program activities vary in different locations. For instance, the Texas A & M Marine Advisory Program is involved in culturing of shrimp which may be termed applied research rather than extension. As indicated in my letter and the letter from McCauley, the initial small shipment was a test primarily of shipping conditions and acclimation to enclosed waters here at the Marine Science Center. There were to be no releases and there will not be. Dr. Jefferson Gonor volunteered to make some reproductive studies on several of the animals to determine whether eggs will hatch in our waters.

2. The Oregon Fish Commission was advised of this experiment approximately one month before the lobsters were shipped. Further, a Commission biologist inspected the lobsters at the airport and provided transportation for them back to the Center. On December 10th, McCauley and I

Wick on the phone - no news release by mutual agreement
- Dr Tanner ecf, to get lobsters.
- will hatch out eggs

12-30-69

met with Bob Loeffel, Marine Superintendant of the Oregon Fish Commission, and Jack Neilsen, Aquatic Biologist, to discuss the entire matter. The complete information that I have has been sent to the Bureau of Commercial Fisheries Regional Office in Seattle for comment.

3. Results and methods of previous introductions of American lobsters to our Coast have been examined. In all cases the lobsters planted were of the inshore variety where environmental conditions are much different than our off-shore or Atlantic off-shore conditions where the temperature at 100 fathoms averages 45 to 50 degrees Fehrenheit.

4. The Fisheries Research Board of Canada at Nanaimo has been involved in lobster work for a number of years. It is my understanding that many of the lobsters which have been used there have already escaped and, therefore, introducing lobsters to off-shore waters in the Pacific has already been done. I have contacted the Maine Department of Sea and Shore Fisheries and the Bureau of Commercial Fisheries at Boothbay Harbor, Maine, for information relating to any possible diseases. Reports from these and many other sources on the East Coast indicates that disease potentials are minimal at best.

5. Our Extension Oceanographer has been studying water data relating to off-shore Oregon waters in relation to the marine environment from which these animals came and finds that, in most cases, the environment appears to be similar.

6. Although there are, as you indicated, about twelve commercially important spiny lobsters distributed throughout the world, these are tropical and/or sub-tropical in nature. The North American varieties are found in the area south of Santa Barbara, California, and south of Cape Canaveral on the Atlantic Coast.

As I've indicated in letters to the Oregon Fish Commission, the Bureau of Commercial Fisheries, and others, I did not propose this experiment and at this stage am neither for nor against it. The offer, however, was made in good faith by a professional staff member of the University of Rhode Island, a sister Sea Grant Institution, as a partial exchange for the Coho Salmon eggs which were shipped by the Department of Fisheries and Wildlife to URI a short time ago.

Any decision regarding the importation and release of deep-water lobsters will have to be made by the Fish Commission of Oregon after a complete study of the available facts. As biologists, both of us realize that an overwhelming majority of introductions world-wide have been either a failure or have created problems. On the other hand, there are a few notable examples of success. It appears at this stage that we do have an off-shore niche which is relatively uninhabited at the 100 to 250 fathom level and if there is a chance to establish a dollar-a-pound ex vessel animal to the fishery it would suggest serious study. If you have further questions or comments please let me know.

Sincerely,

William Q. Wick
Head, Marine Advisory Program

WQW:pc
cc: Joe Cox
Herb Frolander
Bob Loeffel

what is a pound

Lobster discussion McCauley, Nielsen, Wick
Corvallis Dec 10, 69

1. timely now to ship from east coast - politically
2. desease has not been demonstrated to be present in deep water animals - limited sample
3. discovered 12 years ago - are off shore from the ground fishes ; little over lap
4. moult in spring - summer.
5. Jeff Gonor is able to test salinity - temperature reactions
6. Catch on smooth muddy bottom
7. Can be caught readily with pots as well as with trawl
8. grow faster than inshore lobsters
9. spawn every other year and carry eggs for 10 months
10. Select about 3 lbs go for $1.00/lb.
11. total catch might be 1000,000 lbs now and
12. rear well in a hatchery and this could be used to establish populations and use large lobster introduced to determine where to they prefere to be
13. thinks shipment should be made before April
14.

To implement my recommendations on lobster studies, I would suggest the following:

1. The lobsters on hand should be examined for Gaffkya homari by examination of blood. I would suggest either John Fryer or Dr. Gonor as the people most capable of doing this. Slides could be sent to either Gordon Bell or G. E. Hoskins, F.R.B.C. Nanaimo, B.C. for confirmation readings.

Method of Hoskins & Hurst / Bell / Gorgin / Redfield

2. Transmissions through lesions (testing) could be accomplished by breaking off crab legs (or other mutilation) and exposing the animals to infected lobsters. I would suggest as a possibility for conducting these experiments: (1) Bell and Hoskins if they can work it into their programs or the people at the B.C.F. Laboratory at Boothbay, Maine. There are undoubtedly several other laboratories that would do the work if we air ship them live Dungeness crab. (It can be done as we have air shipped crab to Maryland).

Lobster Discussion

1. (…) now to ship from east coast politically
2. Disease has not been demonstrated to be present in deep water animals
3. Discovered 12 years ago- are offshore from the ground fishes – little overlap
4. Moult in spring-summer
5. Jeff Goner is able to test salinity-temperature reactions
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Fle Lobster Study

MEMORANDUM

December 10, 1969

TO: W. Q. Wick

FROM: J. J. Gonor

SUBJ: A larval study relative to the feasibility of introducing deep-water Homarus americanus into Oregon waters.

Successful introduction of this species will ultimately depend upon successful reproduction of the planted stock. Hatchery methods for rearing the shallow water 'race' of this lobster have been well developed for some time, and there is some information on the effect of salinity and temperature on survival of its larvae in culture. However, it is not known whether the temperature requirements, phototactic behavior and other aspects of larval biology are the same for the deep-water and shallow-water populations. Since the two types differ in adult behavior, larval differences may reasonably be expected to occur. It cannot therefore be predicted from available information whether or not the larvae of the deep water variety would be able to survive under the oceanographic regime existing in offshore Oregon waters during the larval release season. If larval survival is very low under these conditions, it might be considered that introduction would have little chance of success and therefore not be practical. On the other hand, if the larval survival is high, physical environmental conditions would probably not limit successful introduction and consideration of the feasibility of introduction could be restricted to other factors.

We propose to cooperate in the evaluation by using our present Sea Grant supported capabilities to conduct laboratory experiments on the effect of temperature and salinity on larval survival of the deep water lobster. Using the results, we will attempt to predict to what extent these two physical variables would affect larval survival in the sea should an attempt to introduce the species be made. The experiments will be planned in such a way that viability of larvae from different females will be compared, in order to eliminate the bias that the use of a single female would introduce. We would like to ask that four females of the present stock be provided now so that we may attempt to keep them under controlled conditions before hatching. It is unlikely that we would require more than one set of experiments to produce usable results since the survival of these larvae at optimum conditions appears to be rather high, but we would like to ask that four additional females be reserved for this work if needed.

In addition to the immediate question of feasibility of introduction and suitability of Oregon environmental conditions, the information gained by such a study would aid any future Oregon lobster hatchery or aquaculture investigation and also help in understanding the biological differences between the two East coast populations.

Questions related to the feasibility of introducing deep-water Homarus americanus in Oregon waters.

1. Are the populations of lobster on the East Coast really different breeding populations? Are they genetically adapted as populations to the two habitats? Perhaps they are populations of individually acclimatized adults derived from the same larval swarm.

2. When deep water individuals are transplanted to shallow areas, why do they migrate directly back to deep water? Is this an individual temperature or light response because of previous acclimatization? Is it a true homing response of a territorial animal, using temperature or other clues to re-find the home range? Would deep animals held inshore for weeks or months lose this ability because it is based on individual acclimatization?

3. How do larvae and young of the deep forms behave compared to the shallow? Do young of the deep form seek the adult habitat? Is the depth/temperature/light regime preference genetically determined?

4. If deep water adults were successfully transplanted and successfully bred, would their young spread by currents return to deep water or settle and occupy shallower areas as well?

5. Can and do lobsters in nature capture and feed upon crabs and shrimp? How much?

6. To what extent is there an overlap in diet between Homarus, Cancer, Gerion and other large benthic decapods on the East coast? How do they avoid complete overlap of food preferences and requirements in areas where they coexist?

7. What is the light and temperature regime of the deep East Coast habitat? How does this compare with Pacific conditions at 100 fms?

8. Do deep adults on the east coast show seasonal migrations into areas of different conditions? Do they undergo cyclic reproductive activities under deep water conditions? What temperature and etc. cycles do adults require to successfully complete reproductive activities?

9. To what extent is the success or failure of the Canadian Fatty Inlet hatchery and transplant experiment due to the deep or shallow source of the transplant and hatchery stock being used?

WILLIAM Q. WICK

Bill Wick

RONALD W. GREEN, COMMISSIONER

STATE OF MAINE
DEPARTMENT OF SEA AND SHORE FISHERIES
STATE HOUSE
AUGUSTA, MAINE 04330

December 2, 1969

Mr. William Q. Wick, Leader
Oregon State University
Marine Advisory Program
Marine Science Center
Newport, Oregon 97365

Dear Bill:

Following our conversation I talked with Bernie Skud, Director of the Bureau of Commercial Fisheries' lab at Boothbay Harbor.

Bernie said that they have identified several parasites or symbiotes on the lobsters from offshore, but that their pathogenicity was uncertain. They have found no evidence of Gaffkya in offshore specimens, but have expended no effort looking for it. We can say that in the absence of concerted effort Gaffkya will not be found in fresh caught stocks, but have real doubts that it does occur naturally on the shelf.

The place where you should fear Gaffkya is in holding pounds where lobsters are kept for a number of months under extremely crowded conditions. I do not believe that you have any such facilities in Oregon.

In any event, Ray Ghelardi of the Fisheries Research Board of Canada has been importing and rearing lobsters from the Bay of Fundy, inshore New England, and offshore New England waters. If there are any crustacean pathogens to be imported from this side of the Atlantic you may get them from British Columbia. For a write-up of Ray's program refer to Fisheries of Canada, Vol. 20, No. 9, March 1968, a magazine published by the Department of Fisheries of Canada at Ottawa. The article in question is called, "Will Atlantic Lobsters Breed in B. C. Waters?"

Bernie indicated that he had heard some rumors of your project. I think he would appreciate receiving a copy of the project plan, and

know that he would be willing to help with technical advice.

Enclosed are a sheaf of our papers on lobster diseases and disabilities. Don't let them scare you unduly. I believe the risks to be minimal.

Sincerely yours,

DONALD M. HARRIMAN
Director of Marine
Fisheries Extension

DMH/abr
ENC.

UNIVERSITY OF RHODE ISLAND • KINGSTON, RHODE ISLAND 02881

Department of Fisheries and Marine Technology *Woodward Hall*

November 24, 1969

Mr. William Wick
Marine Advisory Program Leader
Marine Science Center
Newport, Oregon

Dear Mr. Wick:

I neglected to enclose the lobster tank specifications that are used for commercial holding tanks. Enclosed is a brochure on the fiberglass tanks used locally.

The holding tanks can be made of marine plywood and then fiberglassed or they may be left untreated. The latter, of course, is adequate for short periods of time (up to three weeks) at which time they should be drained, cleaned and allowed to dry. We have never used any paint whatever on the inside of the tanks. A heavy coat of fiberglass resin over plywood is quite effective and easy to fabricate.

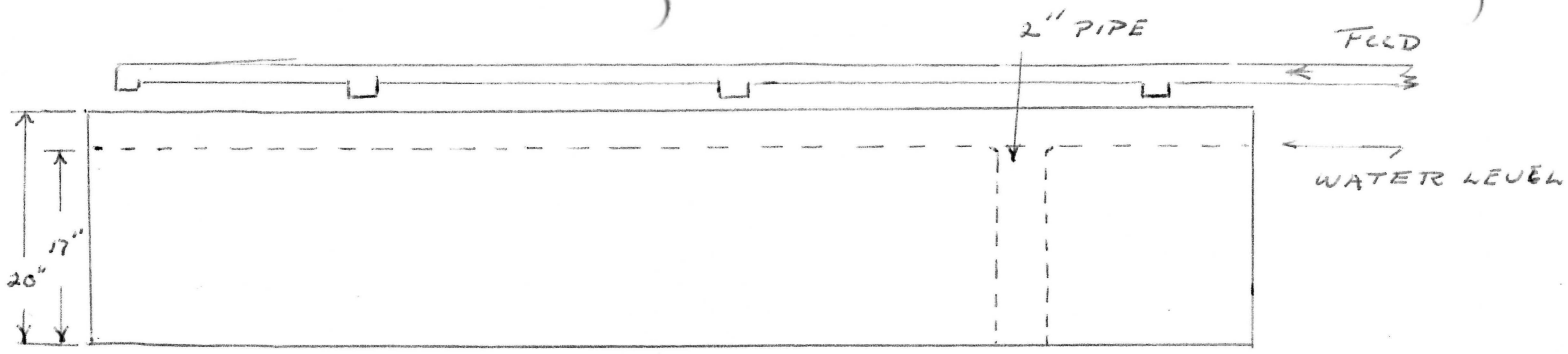
The commercial shore holding tanks average 10' x 6' x 20", a depth of 17" of water is usually maintained. (See sketch) A quantity of no more than 600 lbs. can be held for up to several months. If you intend to hold them for longer periods, such as the trial shipment, I would suggest 300 lb. Since this is about 635 gallons, a circulating system supplying 20 - 30 gallons per minute would be adequate for this tank design.

On board vessels, we use a plywood wash tank, for example, 8' long x 3 ft. wide x $3\frac{1}{2}$ ft. high, which will hold about 1,000 lbs. Tanks such as these require between 30 - 40 gallons per minute of water supplied under pressure through perforated plastic pipe located at the bottom of the tank. Overflow porting is located near the top. This method floats out sediment and waste materials. The bottom of the tank should have a rack of lathes about three inches off the bottom. This area will allow heavier sediment to settle out.

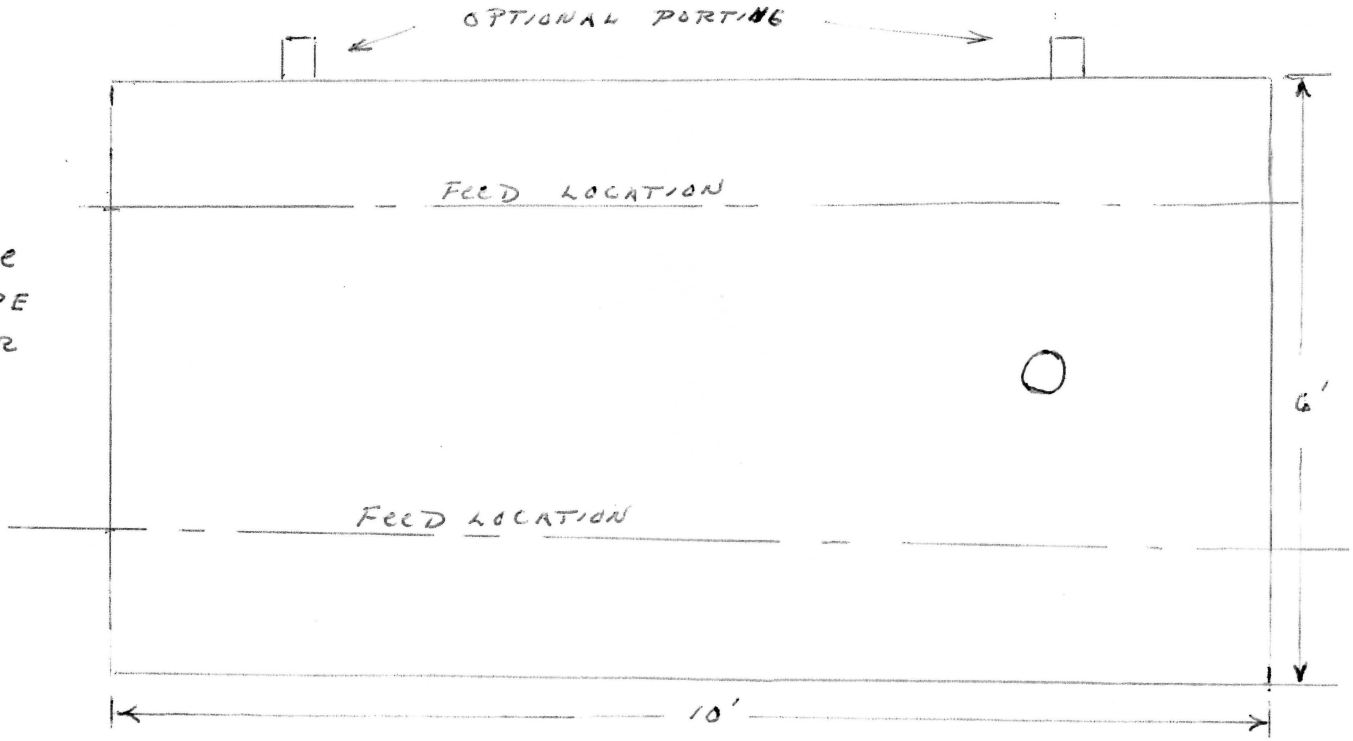
Sincerely yours,

James A. McCauley

James A. McCauley
Assistant Professor

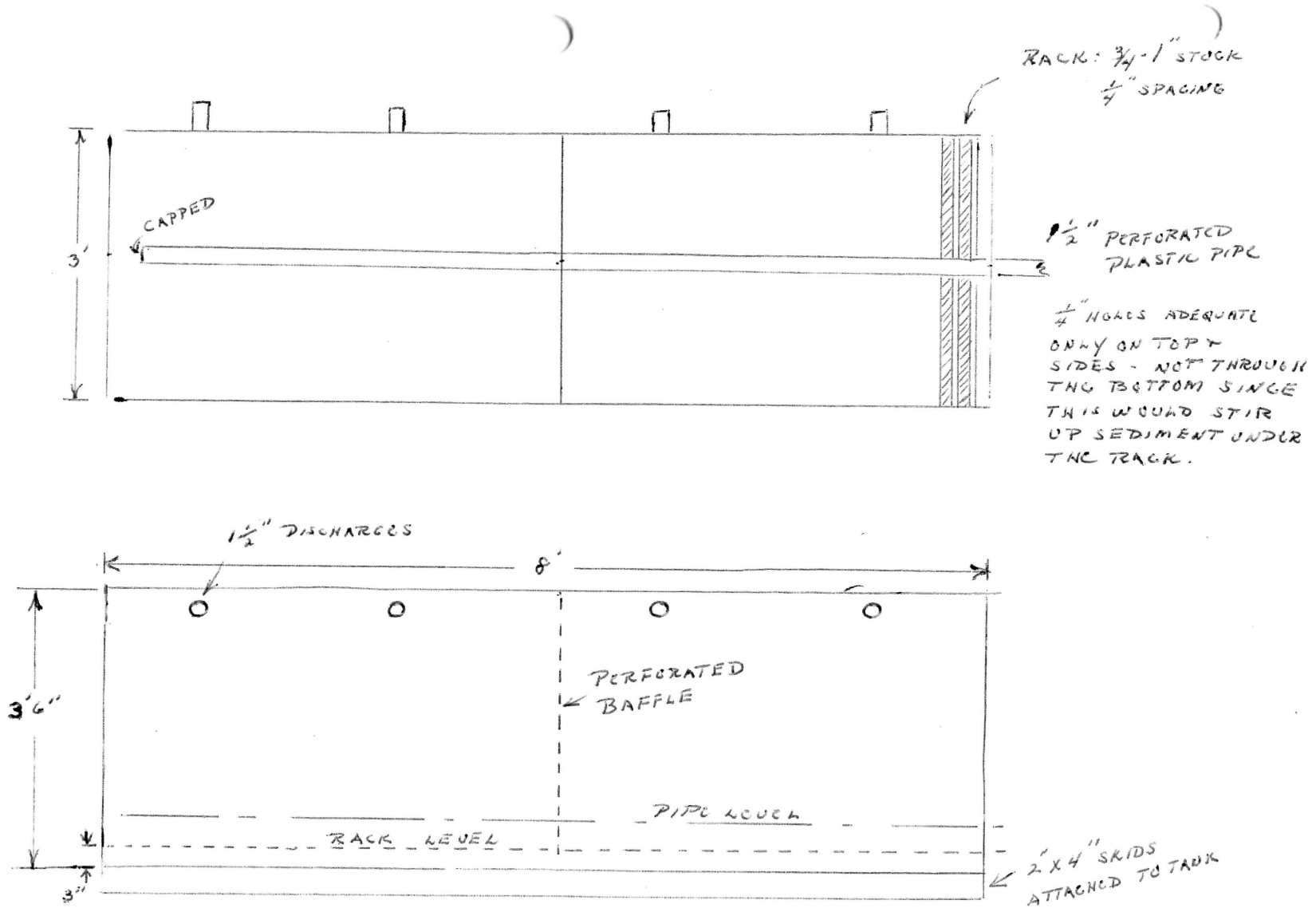


PIPE NEED ONLY BE INSTANNED THIS WAY IF STACKING OF TANKS IS PLANNED.



FEED MAY BE THROUGH ONE PIPE IN THE MIDDLE OR 2 AS SHOWN

SHORE HOLDING TANKS



VESSEL WASH TANK

UNIVERSITY OF RHODE ISLAND • KINGSTON, RHODE ISLAND 02881

Department of Fisheries and Marine Technology *Woodward Hall*

November 19, 1969

Lobsters

Mr. William Wick
Marine Advisory Program Leader
Marine Science Center
Newport, Oregon 97365

Dear Bill:

I am enclosing some basic information that is necessary to further the transplant proposal. Some of the suggestions and comments under my name represent an accumulation of discussions that I have had within the University.

Dean Knauss, Provost for Marine Affairs and Dean of the Graduate School of Oceanography, was very enthusiastic about the possibilities of this proposal, but again the feeling of initiating on your end seemed most feasible. If a letter of support from him would be of help, I am sure it can be accomplished.

By way of explanation, I have proposed the transplant of the offshore lobsters as an interesting and worthwhile experiment.

I am not interested in any personal monetary gain, which is evident from the modest costs of this proposal. If the supply of lobsters necessary for a worthwhile experiment had to be purchased at the market price, we would probably not consider the project. (Price this date is $1.25 for select 3 lb. and 85 cents for large and culls per lb.) The State of Rhode Island has purchased egg-bearing lobsters at $1 apiece, regardless of size. Even at that price, the project is prohibitive where air freight is involved.

My vessel is catching these lobsters every fishing day and throwing them back. The vessel has more than ample carrying capacity to handle the additional egg bearing lobsters. I have discussed the project with my crew members, who are highly competent and well paid, and the amount of additional work was agreed to be insignificant.

The State of Rhode Island is willing to support the proposal by giving my vessel permission to land the egg bearers for this purpose. Written support for the project could be obtained from Mr. John Rego, Director of Natural Resources for the State of Rhode Island, if necessary.

Shore holding tanks are available at the Point Judith Fishermen's Co-op. lobster facilities at no cost, since I am a member and also one of the largest lobster suppliers. Additional holding facilities have been made available by the Experiment Station of the U.R.I. Graduate School of Oceanography.

I have the additional help and cooperation of the students of the U.R.I. Fisheries School for shipment handling, etc.

I feel that since I am in this position, I should make this offer. Again, I am interested only from the point of view that this is a worthwhile proposal and the means to carry it out are readily available to me at a minimum of cost.

If I can get away from my duties, I will come out to Oregon on my own to discuss the whole project more completely prior to the Christmas Holidays.

Sincerely,

James A. McCauley

James A. McCauley
Assistant Professor

JAMcM:gc

Comments on Gaffkemia - a bacterial disease of the Lobster, Homarus americanus

Saul B. Saila
Graduate School of Oceanography
University of Rhode Island
Kingston, R.I. 02881

The following comments are a summary of the available information I have on the subject.

(1) In a telephone conversation with Dr. Sun Feng (11-13-69) of the University of Connecticut Marine Laboratory, he indicated he has found no evidence of Gaffkya in the examination of approximately 60 lobsters taken from the Connecticut area. However, he did indicate that he has tentatively identified one lobster infected with this disease in 1966.

(2) The personnel of the Graduate School of Oceanography, University of Rhode Island and of the Rhode Island Department of Natural Resources have not found or reported an incidence of Gaffkya in Rhode Island to date. However, it should be pointed out that only a limited number of animals have been examined.

(3) It is my understanding that an intact integument is an effective barrier against the disease. Obviously, it would be important to consider transplanting only healthy animals with intact integuments.

(4) It is my opinion that Dr. J. E. Stewart of the Fisheries Research Board of Canada, Halifax Laboratory, Halifax, Nova Scotia could provide the best and most recent information on the incidence of Gaffkemia along the Northwest Atlantic Coast of the United States and Canada.

(5) I believe that there is virtually no information available on this disease in offshore stocks of the lobster.

GENERAL COMMENTS ON TRANSPLANT PROPOSAL

James A. McCauley
Assistant Professor
Fisheries Department

Based on the study, "Movement and Behavior of Berried Female Lobsters Displaced from Offshore Areas to Narragansett Bay, Rhode Island," by S. B. Saila and J. M. Flowers, I would strongly suggest a tagging arrangement as part of the lobster transplant proposal. The costs involved would not be too high for the tagging, etc. The cost of rewards for returning the lobsters would be variable, depending on the cooperation of the fishermen in the area.

Once transplanting takes place, continued monitoring of the area with fine mesh pots could be carried out to give information on the new lobsters.

As previously mentioned in telephone discussions, an area where tide is not too strong would be ideal for the berried females. There is a period of 21 to 28 days when the eggs are carried by the tides prior to returning to the bottom. Your knowledge of the area with regard to this matter should make this requirement possible to achieve.

Holding facilities will require about 100 gallons per minute of circulating water for 3,000 lbs. of lobsters; any combination of this requirement would suffice. As long as water is not recirculated, there should be no need for aeration.

Enclosed sketches of commercial holding tanks used in this area are included.

Commenting on the incidents of Gaffkemia, I would feel that the close proximity of the lobster in the offshore area with our Jonah Crab or Rock Crab (Cancer borealis or occasional Cancer irroratus) would tend to make the lobster compatible with the Dungeness Crab (Cancer magister) on the West Coast. My understanding of the disease is that it is found more commonly in lobster pounds, such as those located in Maine and the Canadian Provinces. The lobsters we will be handling will not be held for more than two weeks and will not be kept with other lobsters or in water which has been circulated through other lobsters of either the inshore or offshore variety.

If possible, I will ship some samples of the Jonah Crab for study. I do not know how successful we will be with regard to survival during shipment.

Tags may be purchased from: Floyd Tag and Manufacturing Co.
2909 North East Blakely Street
Seattle, Washington 98105

FD 67 Gun @ $25.
FD 67 Tag or FD 68 @ 80 - 107 per thousand

CATCHING AND HOLDING INFORMATION ON OFFSHORE LOBSTERS

James A. McCauley
Assistant Professor
Fisheries Department

The offshore lobster population is located from Virginia to the eastern part of George's Banks.

I have personally caught commercial quantities of lobsters in most of the area ranging in depth from 50 fathoms to the extreme of 325 fathoms. The normal winter fishery is in the 80-240 fathom range, whereas the summer fishery is in the 50-100 fathom range. I refer to these ranges with reference to commercial quantities of lobsters which would be a bushel an hour or more in trawling time.

The bottom temperature, where these lobsters are caught, is between 38°-48°F. We have held lobsters for one week periods aboard the vessel in water temperatures up to 65°F with moderate losses of about 10 percent. Small quantities have been held in 71°F and 72°F water with a large volume of aerated water being continuously circulated, however this method has not proven commercially feasible.

The past summer has been significant in that six vessels operating in these waters have successfully used refrigerated sea water systems. The temperature maintained in the system is between 45°-50°F. The water is recirculated and sprayed back into the holding tanks for aerating purposes. I have gained some valuable experience in this method of holding lobsters, since I was captain of my own vessel during this past summer when the system was installed.

There are several significant examples which indicate the ability of the offshore lobsters to withstand both pressure and temperature changes without loss or injury.

Many of the trips of lobsters caught to date have been made in depths in excess of two hundred fathoms. These lobsters have been held in holding tanks three or four feet deep aboard the vessels and finally in tanks less than two feet in depth at shore holding facilities--the latter for several months. It is safe to conclude that the lobsters are virtually unaffected by pressure changes, at least within this depth range.

The recuperative ability of the offshore lobster can be demonstrated by the following normal situation which so often occurs with the trawling method of catching.

During the summer period, the surface temperature of the water can reach 80°F and the lobster must pass through this range during trawling operation. In fact, the cod-end remains near the surface for approximately five to ten minutes while the trawl is being taken aboard. The lobsters are hoisted on deck in a standard cod-end of $3\frac{1}{2}$" mesh where they are sorted. The air temperature on deck during the daylight hours may be in the 90°F range. The lobster, at this time, usually gives the impression that it has no chance of survival. When picked up, banded, and washed, the lobster is limp with little visible life remaining. One-half hour after being placed in refrigerated sea water, however, the lobster is restored to full activity.

Our losses in seven-day trips average about 5 percent during the summer months using refrigerated sea water. Most of these losses are shedders or soft lobsters that were injured in the trawl. The lobsters are in a soft condition on the offshore grounds only during the summer months--May through September.

This would be my main objection to any thoughts of attempting a transplant during this period, in addition to questionable survival during shipment in hot weather even with insulated containers.

The opposite situation to the previous example occurs during the winter months. There are times when temperatures are well below freezing during catching and unloading operations, when the lobsters are limp from the cold. Care must be taken that the lobsters are not handled by the claws since they will readily drop a claw under these conditions. Losses during cold weather are in the 1-2 percent range for a one week trip. If the temperature of the air is between 35°-40°F the lobsters can be held for up to forty-eight hours just by covering them with wet burlap. In fact, this was one of the holding methods used during the early years of trawling offshore lobsters.

The ideal time for the holding and shipment of these lobsters would be between November 15 and April 15. I would be certain that the survival would be extremely good and would allow for delays during shipment.

In addition to the previously mentioned conditions which the offshore lobsters are normally subjected to, is the trawling technique itself. Because of the makeup of the bottom in some areas, there are often times when the cod-end is full of mud and starfish. The lobsters in these catches again appear to be beyond saving. However, they are thoroughly washed and then held in a "wash tank" for a period of not less than twenty-four hours. This is a standard procedure for all trawl lobsters. After this period of time the lobster will have had the opportunity to clear the gill area of mud and the operator can determine the fitness of the lobster. Entire trips are often caught under these conditions. At the end of a one week trip there is no trace of mud in the gill area unless it is caused by a poor circulation system within the vessel. Again, I point out these catching and holding methods to stress the ability of the offshore lobsters to adapt to extreme conditions. The survival factor with regard to a transplanting operation should be of primary importance.

I suggest that the lobsters used should be in the $2\frac{1}{2}$ to 7 pound range. I believe the possibility of survival would be better for this size based on my own observations with regard to losses occurring under trip conditions. I would also believe that lobsters of this size would not be in danger from predators which might be present in the waters used for the transplant. There are no large fish which could be considered predators in the area where the offshore lobsters are now found.

An important consideration with regard to the offshore population of lobsters is the unlikely prospect of contamination from pollution, etc., due to the distance to the grounds.

I am including a chart (C & GD #1108) showing the location of the grounds where these lobsters will be taken. I would expect that the vessel will be work-

ing the area around Veatch Canyon during the winter months. This area is especially suitable in that there is a strong, continuous, southwesterly tide which tends to supply the area with water from the George's Bank region rather than the flow from the Hudson River.

In the event that the proposed transplant takes place, I would use my own vessel during the catching phase, which has a superior circulation system compared to other vessels operating in the area. The vessel is fitted with a built-in, fiberglass, partitioned well which has a holding capacity for 15,000 pounds of lobsters. The system is especially suitable in that the sea water is allowed to come into the tanks by free flow through a 10" diameter hull fitting and distributed to the various compartments. The water is continuously pumped from the bottom of the well by a 4" centrifugal pump removing all traces of mud or other contamination from the holding tanks as it settles to the bottom.

There have been many trials made on methods of holding large quantities of lobster, but to my knowledge this system is the most satisfactory and also the cleanest from the point of view of delivering a healthy, marketable lobster to the dock.

ESTIMATED COSTS (revised)

Container Costs (styrofoam lined, 45 lb. capacity) 100 @ $3	$300.00
Purchase of 1,000 lbs. of male lobsters @ .75	750.00
Shipping Costs $25.25 per hundred for shipments of 2,000 lbs. and over	
Propose 2 shipments of 2,500 lbs. each	1,262.50
Trucking to Boston (2 trips)	25.00
Personal expenses involving trip to Oregon would be approximately $400, however, there is a possibility that this cost could be taken care of through Sea Grant funding at U.R.I. if there is objection to this expense within this proposal	400.00