HOLDING TANK LOBSTER SYSTEMS MANUAL

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PRODUCED BY
THE LOBSTER INSTITUTE
AND THE SEA GRANT
MARINE ADVISORY PROGRAM
AT THE UNIVERSITY OF MAINE

Edited by Susan K. White
Designed by MaJo Keleshian

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Table of Contents

Acknowledgments

Thanks to Bruce Estrella, Senior Lobster Biologist, Massachusetts Division of Fisheries; Jim Ward, President, James J. Ward Company; and Herb Hodgkins, President, Maine Lobster Pound Association, for reviewing this manual.

1 Introduction

Building and maintaining lobster holding systems is a vital part of the lobster industry. Lobsters from Maine are shipped around the globe, often to places far from the sea, and they need to be stored in tanks. The guidelines set out in this manual will answer most of the commonly asked questions about how to set up a lobster holding system and maintain live and healthy lobsters.

Source and Appearance of Lobsters

Lobsters should be banded, not plugged. Plugged lobsters are more susceptible to gaffkemia or red tail, a fatal bacterial infection that enters a lobster through a wound or break in the shell. Therefore, the shell and membrane should be free of any perforations and the antennae should be long with no evidence that they have been chewed. Chewed antenna are a sign that lobsters have been previously stored, since lobsters chew on each other when held in crowded conditions such as pounds or cars.

New Shell Lobsters

A new shell lobster, sometimes called a "shedder" or soft shell, is one that has recently molted. This process allows the lobster to grow. New shell lobsters have less meat per unit total weight and have a softer shell. Since their shells are more vulnerable to puncture, new shell lobsters should be handled carefully. There is also more cannabalism among new shells.

Handling

1. Examine every lobster. Remove and market or process lobsters that are weak and those with cracked shells or claws first.
2. Always set crates down gently. Never drop them, even a few inches. The sharp shell projections will pierce the shells and membranes of the lobsters that are inside the crate.
3. Band lobsters that have no bands.

Ratio of Lobsters to Water

Tanks are usually loaded at 1 pound of lobster to 2 gallons of saltwater. Reservoir storage is included in this calculation. You can calculate tanks and reservoir size as 462 cubic inches (or .267 cubic feet) per pound of lobster.

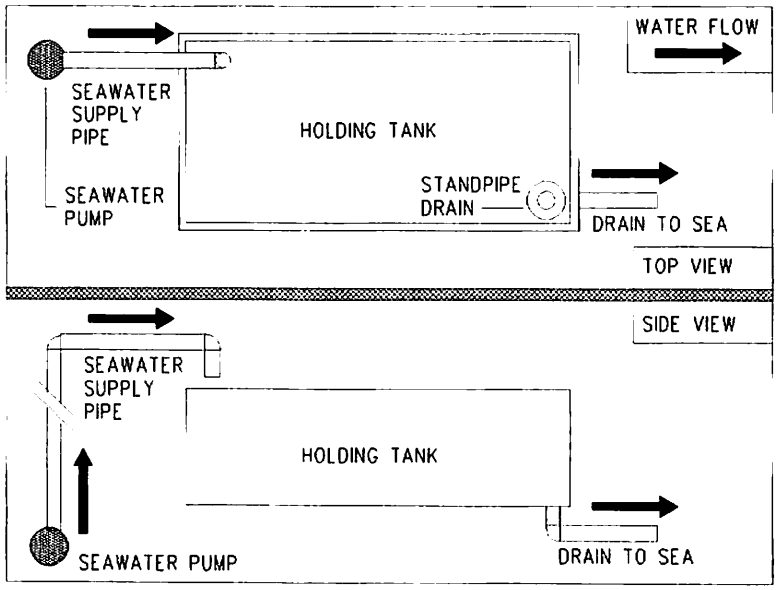
Here are some standard conversions which may be handy when calculating loading and filter size.

1 gallon = .134 cubic feet	1 liter = .0353 cubic feet
1 gallon = 3.78 liters	1 liter = .2645 gallons
1 gallon = 231 cubic inches	1 liter = 61.06 cubic inches
1 cubic foot = 7.5 gallons	
1 cubic foot = 28.3 liters	
1 cubic foot = 1728 cubic inches	

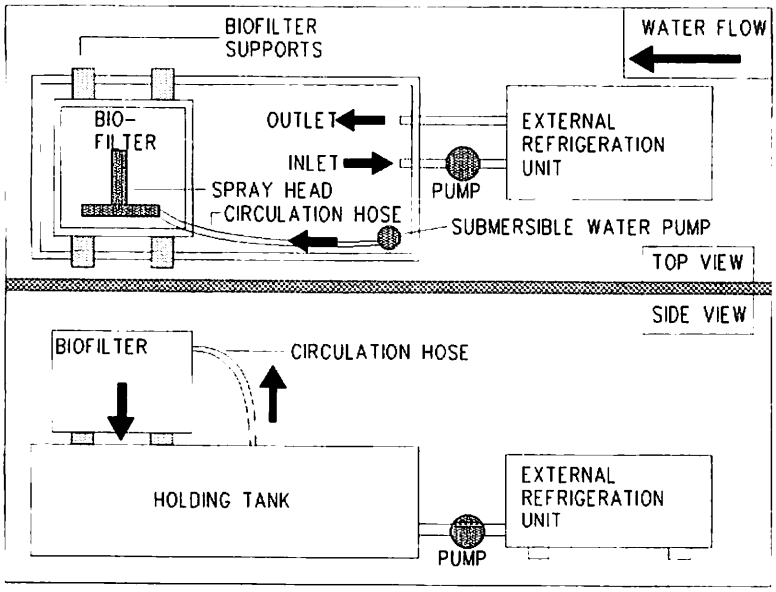
2 Types of Holding Tank Systems

The simplest type of lobster holding tank system is an open or flow-through system. In an open system, water is pumped directly from the ocean into the tanks and then drains back into the ocean. This design consists of two basic elements: tanks for storing lobsters and pumps to circulate water. Aeration may also be used to ensure adequate water oxygenation. The open system is most appropriate in coastal locations with good water quality.

Lobsters may also be held in a closed or recirculating system. Recirculating systems differ from open ones in that water in the system is continually recycled. Since water is reused, the design must include not only holding tanks and circulator pumps, but also aeration, filtration, and refrigeration to maintain proper water conditions. Recirculating systems are best for inland locations or at sites with poor water quality.



Flow-through system



Recirculating system

3 Tank Construction

There are many types of tanks that can be used for lobster storage. They may be designed to hold lobsters loose or in crates. A plywood box lined with mat or woven fiberglass and coated with resin is commonly used.

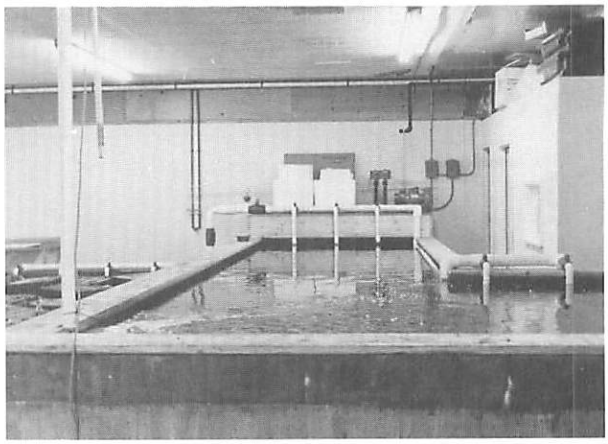
Crates in a tank

Either polyester or epoxy resin may be used. *However, caution is needed with polyester resin.* New polyester resin will leach styrene into the holding system. If it is a recirculating system, the styrene can accumulate to toxic levels. Epoxy resin leaches fewer chemicals, but is four times more expensive than polyester. An economical compromise is to fiberglass the tank with polyester resin and, after the polyester cures, coat it with one or two coats of epoxy resin.

In either case, the tank system should be thoroughly flushed to ensure removal of all toxic leachates from the resin. To flush a tank, fill it with water and allow it to soak for 24 hours before draining it. This process should be repeated on a daily basis for a period of two weeks. The water should not have any resin taste or smell after flushing.

Stainless steel and plastics like PVC are also used in lobster tanks. Used bulk milk tanks from dairy farms, which are equipped with refrigeration, are excellent for holding lobsters. There are also many manufacturers of glass display tanks.

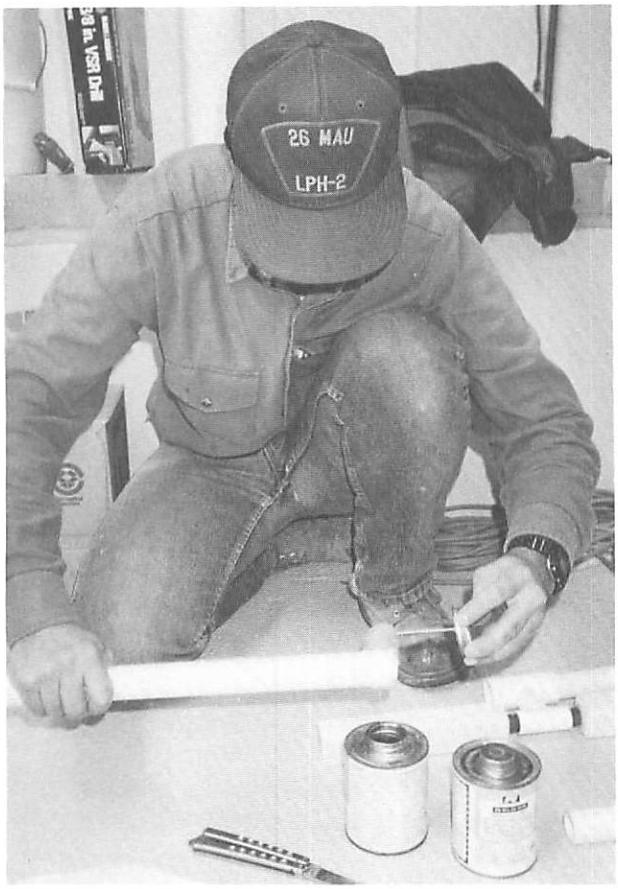
Concrete is often used in open systems, but it should be lined for closed recirculating systems due to potential leaching of aluminum and other metals that may be in the sand used to make the cement.



Concrete tank in an open system

To reduce the cost of refrigeration, it is advisable to have 2 inches of styrofoam insulation around the outside of the tank. An insulated tank cover is also worthwhile.

Plumbing should be constructed of stainless steel, food-grade vinyl tubing, or PVC pipe. PVC pipes should be glued so that a minimum amount of glue collects inside the pipe. Glue *must* be allowed to dry thoroughly (1-2 days) before putting lobsters in the tank. Plumbing should be flushed with fresh water to remove leachates. For PVC pipe, one day of flushing is usually sufficient.



Applying glue to outside of PVC pipe

Copper pipe should *not* be used, as copper is toxic to lobsters. Dissolved copper from the pipes will accumulate in the water and reach lethal levels within several days. Copper alloys (brass and bronze), lead, and zinc should also *not* be used anywhere in the system.

4 Refrigeration

The tank should be kept as cold as possible, as long as it's above freezing. At low temperatures, water holds more oxygen and lobsters are less active and require less oxygen. Cannabalism and the threat of disease are also reduced. About 5% of all lobsters will have gaffkemia, a disease that is fatal to lobsters but harmless to people. The colder the water, the longer the infected lobsters will survive. A reasonable temperature to aim for is 40-45° F.

The refrigeration unit (or chiller) consists of a compressor and cooling coils, also referred to as a heat exchanger. In most systems, the cooling coils and compressor are one unit. One system has a submersible chiller that is immersed in the tank to cool the water. Other systems have a chiller separate from the tank and water is pumped from the tank, through the chiller unit, and back to the tank system. The preferred system uses a titanium external chiller. When selecting a compressor, you should get advice from someone knowledgeable about refrigeration who can help determine the correct capacity of the compressor and appropriate refrigeration coils.

No copper or copper alloy should be used in any part of the system at any time. A titanium cooling surface is best. This surface allows for high efficency and offers excellent resistance to corrosion and galvanic action.

Cooling coils should be covered with a wooden-slatted or plastic floor to prevent lobsters from coming in direct contact with the coils. A good water flow across the coils is also necessary to prevent ice formation on the coils.

Estimates of Compressor Requirements and Tank Loading

Horsepower*	Gallons of Water*	Lobster Poundage	Cubic Feet of Biofilter (foam)	(balls)
1/3	75-125	37-63	3-6	6-12
3/4	200-250	100-125	10-12	20-24
1	275-400	138-200	14-20	28-40
1 1/2	425-700	212-350	21-35	42-70
2	800-1100	400-550	40-55	80-110
3	1200-1500	600-750	60-75	120-150

*(Estrella 1993)

Heat Exchanger Materials

- Titanium is the best because it is an efficient heat exchanger and is corrosion resistant. However, it is expensive.
- PVC is inexpensive and easy to work with. Glue must be thoroughly dried and the glued coils must be soaked before using. However, PVC is not a very good heat exchanger.
- Black iron should not be used because it corrodes very quickly.
- Galvanized iron should not be used. Zinc, the metal used to galvanize iron and steel, is toxic to lobsters and dissolves very quickly in salt water.
- Bronze and brass should not be used because they contain copper which is toxic to lobsters.

5 Pumps

A pump should provide at least two turnovers of water per hour and be self-priming if possible.

Submersible pumps are quick and easy to install since they do not require cutting holes through tank sides and bulkhead fittings. One disadvantage of submersible pumps is that they generate some heat in the water.

The most common cause of failure of submersible pumps is water leaking into the motor along the shaft seal. Magnetic-drive pumps avoid shaft seal problems and do not burn out when claw parts or seaweed pieces jam the impeller blade, as can happen with conventional drive pumps. However, magnetic-drive pumps cost more than conventional shaft-driven pumps.

Note: Pumps and impeller blades should *not* be made of bronze, brass, zinc, or other materials toxic to lobsters.

Gas Disease

Gas disease in lobsters results when water in the tank becomes supersaturated with air. It occurs when there is an air leak in the water pump intake. High pressure head contributes to the problem. Mortality occurs in hours or days depending on the severity. A percolation filter can help de-gas. (See "Types of Filters" on this page.)

6 Filtration

Filtration is an essential component of any holding system. Filtration removes insoluble, particulate matter from the system, as well as some dissolved compounds such as ammonia and nitrite. Particulates are removed primarily by mechanical means such as filter mats and settling tanks which allow water to pass through but trap insoluble material. Dissolved compounds are removed by what is known as a biological filter which utilizes living bacteria to remove ammonia and nitrite from the system.

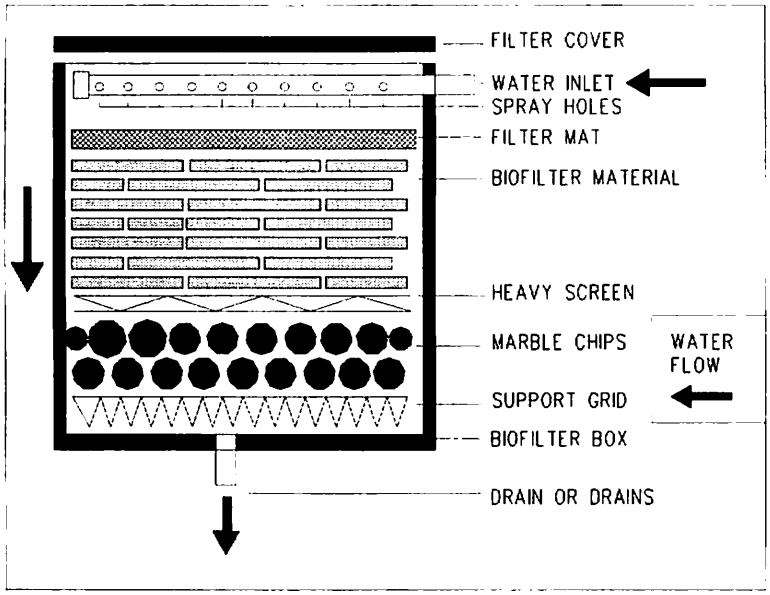
Mechanical filtration alone is usually sufficient for a successful flow-through lobster holding system. A closed system, however, must use both mechanical and biological filtration. Biological filtration is required in a closed system because lobsters produce ammonia as a waste product. Ammonia is highly toxic to lobsters, and a recirculating system without a "biofilter" could experience severe losses in a relatively short period of time.

In the biofilter, bacteria grow on the surface of the foam, plastic, oyster shells, or marble chips. Some of these bacteria, called *Nitrosomonas*, "eat" the ammonia and excrete nitrites. Nitrites are also very toxic but another type of bacteria, *Nitrobacter*, grow with the *Nitrosomonas*. *Nitrobacter* ingest the nitrite and excrete nitrate. Nitrate is much less toxic to lobsters than ammonia or nitrite.

Types of Filters

Pressure drum or cartridge type filters are expensive, require frequent replacements, and are prone to getting plugged with particulate materials.

Gravity percolation filters are the simplest type of filter. They offer the advantage of de-gassing and oxygenating the water and will support a biological filter. It is advisable to use a pre-filter of non-woven fiber or unfaced fiberglass insulation with biological percolation filters. The pre-filter can be washed or discarded as waste material accumulates.



Gravity percolation filter

Biofilters

Oyster shell is a common type of biological filter. Activated carbon is another type that is sometimes used to remove dissolved organic material from the water. An alternative to oyster shells is to use marble chips. The latter are available at most hardware and lawn and garden centers, are inexpensive, and provide excellent buffering. A buffer is a substance that stabilizes the pH of the water, preventing it from becoming too acidic or alkaline. Marble chips or oyster shells should be thoroughly washed with fresh water before they are incorporated into a biofilter.

Plastic biofilter media are also available and include foams, balls, and rings. Some of these are carbon impregnated. Supplementary marble chips or oyster shells should be used in conjunction with plastics for the buffering capacity of calcium carbonate ($CaC0_3$) found in the chips and shells.

To estimate the size of your biofilter, assume you need 1 cubic foot of filter foam or 2 cubic feet of plastic balls or rings for each 10 pounds of lobster in your holding system. If you use only oyster shells or marble chips for your filter, you should use about 1.5 cubic feet for each 10 pounds of lobster. The reason for the difference in volumes of materiels used is that materials differ in the amount of surface area they have for bacteria to grow on.

The start-up time for a biofilter may take from five days to three weeks, depending on the water temperature. The filter bed must first be innoculated with bacteria. You can purchase commercial starter cultures or innoculate from an existing filter by squeezing some water or removing some material from the old filter and placing it directly in the new system.

It is common for a new system to show elevated ammonia levels for one or two days. If this occurs, some of the lobsters should be removed until the filter bacteria multiply and the ammonia levels decrease.

In time, a biofilter may become fouled with organic matter and need to be cleaned. To do this, remove half the material, wash it, and return it to the system. Wash the other half a few weeks later.

Care and Feeding

Lobsters are not usually fed in recirculatory systems. Uneaten feed and feces will plug the filters. If they are kept cold, lobsters can survive without feed for months.

Settling tanks may be needed if feed is used. In this system, unused feed and feces accumulate on the bottom and are removed.

Check the tank regularly for dead lobsters and remove them promptly. Dead lobsters consume oxygen in the water when they decompose.

7 Water Quality

Water Composition

Optimal salt concentration ranges from 30-35 parts per thousand (ppt) or 2.0-3.5 % salt by weight. This translates into 30-35 grams of salt per liter of water, or 113.6-132.5 grams per gallon of water, or .25-.29 pounds of salt per gallon of water.

There are many sources of salt. All commercial salt mixes should adequately support marine life. Synthesized seawater is cleaner than natural sea water. In mixing seawater using municipal water, be sure there is no residue chlorine. Chlorine can be removed with activated carbon or by circulating the water overnight.

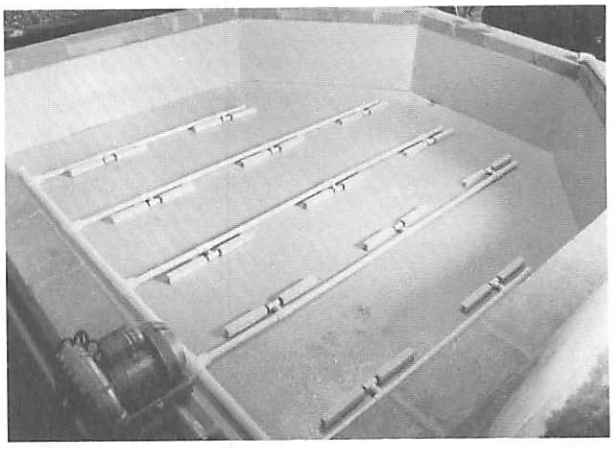
Commonly used salt mixes include *Forty Fathoms* and *Instant Ocean* which can be obtained from suppliers listed in the appendix. Other mixes may be purchased from local aquarium dealers or chemical supply houses.

Natural seawater is the best and cheapest way to operate if you are near the shore and can pipe your water or easily transport it by truck. Know the source of your water and what the truck has been previously used for to make sure the water is free of pollutants. Seawater may contain barnacle or mussel larvae which can clog pipes so periodic cleaning may be required.

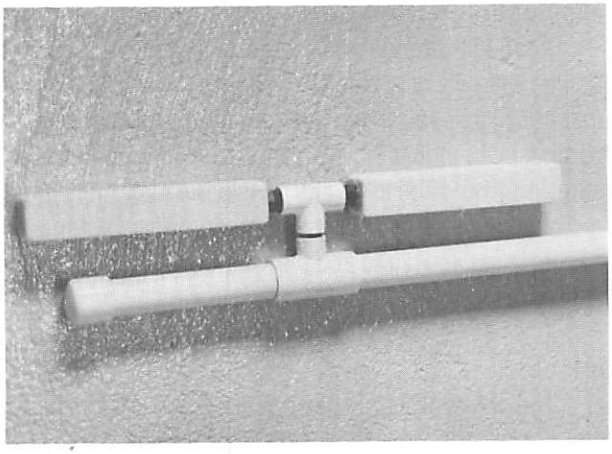
Pre-filter water through a washable plastic filtration mat to remove feces and other solids. The mat should be removed and cleaned daily.

Aeration & Oxygen Measurement Techniques

Aeration is important to maintain a proper concentration of oxygen in the holding tank system, which is critical to keeping lobsters healthy. The size of pump required depends on the volume of the holding tank. A tank with up to 1000 gallons of water can be run on a 1/2 horsepower diaphragm pump. This assumes that water in your system is at the optimal temperature (40-45°F) for holding oxygen. A manifold system consisting of 1-1/2 inch PVC pipe with airstones can be used to increase the efficiency of your air distribution system.



Manifold with airstones attached



Airstones

The oxygen level in the tank should be monitored regularly. The best instrument for measuring oxygen is an oxygen meter which can be purchased from several suppliers, some of which are listed in the appendix. Other test kits for oxygen are available that are less expensive and depend on a chemical reaction that causes a color change.

Measuring dissolved oxygen level in water with hand-held oxygen meter

Ammonia Nitrate and Nitrite Measurement and Control

Although ammonia is a normal metabolite excreted though the gills of a lobster, it can become toxic when it reaches high levels in the tank. Ammonia test kits may be purchased to monitor the level and then appropriate measures may be taken to control it. As previously mentioned, a biological filter may be used to detoxify ammonia by turning it first into nitrite and then nitrate which is less toxic to lobsters.

pH

The pH level should be kept at 6.5-8.5. Maintaining a proper pH level should not be a problem with an adequate buffer in the filter. (See "Types of Filters" on page 9.)

Pesticides

Never store or use pesticides in the same room where lobsters are held. Lobsters are very sensitive to insecticides. Signs of insecticide poisoning in lobsters are hyperactivity followed by tetany, a condition characterized by muscle spasms. Carbaryl (commercially available as *Sevin*) is instantly lethal at only 40 parts per billion (ppb) which is equal to 1 teaspoon in 264,550 gallons of water.

Some Water Quality Parameters

Component	Recommended Limits	Lethal Limits
Ammonia	9.4 ppm max	98 ppm
Dissolved O_2	6.0 ppm min	3 ppm
Salinity	28-35 ppt min-max	45 ppt
Nitrite	10 ppm max	100 ppm
Nitrate	50 ppm ma	500 ppm
Chlorine	.69 ppm	
Metals (note: parts per billion)		
Copper	6 ppb	60 ppb
Lead	100 ppb	1000 ppb
Mercury	3.3 ppb	33 ppb
Zinc	170 ppb	1700 ppb

*Taken from *Biology and Managment of Lobsters* (Stanley Cobb and Bruce Phillips, Academic Press, New York, 1980) and *Crustacean and Mollusk Aquaculture in the United States* (Jay V. Huner and E. Evan Brown, Van Nostrand Reinhold, New York, 1985).

8 Troubleshooting

In order to hold lobsters successfully, it is important to be able to identify problems when they occur and know what to do to remedy the situation as soon as possible.

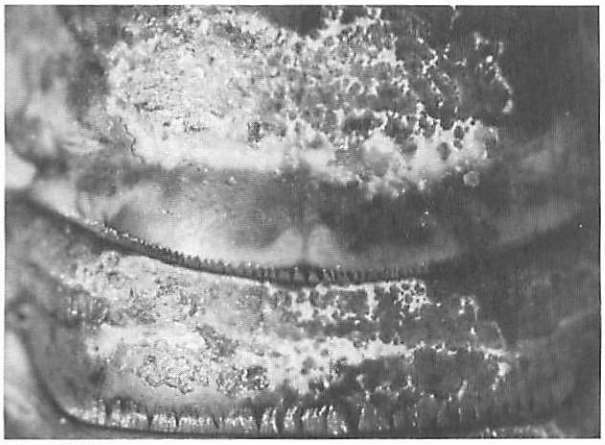
TROUBLESHOOTING CHART

Problems, Likely Causes, and Suggested Treatments in Recirculating Holding Systems

Problem	***Likely cause***	***Treatment***
Foam on water	Too much protein in water possibly from bleeding lobsters, feces, or bacterial growth	Change water; put in drop or two of vegetable oil; check lobsters for gaffkemia
High ammonia in water	Biological filter not functioning properly	Reduce lobster density; innoculate filter with commercially available bacteria; change some water
Hyperactive lobsters	Insecticide poisoning	Change water; dispose of lobsters
	High salinity	Add enough fresh water to attain recommended salinity
Dead or lethargic lobsters	Disease (see below)	Check blood for gaffkemia and ciliated protozoans (see procedure in *Lobster Health Manual*, Sea Grant publication #MSG-E-93-13)
	Copper poisoning	Remove any copper plumbing; change water
	Low or high salinity	Add salt or water
	High ammonia	Change water

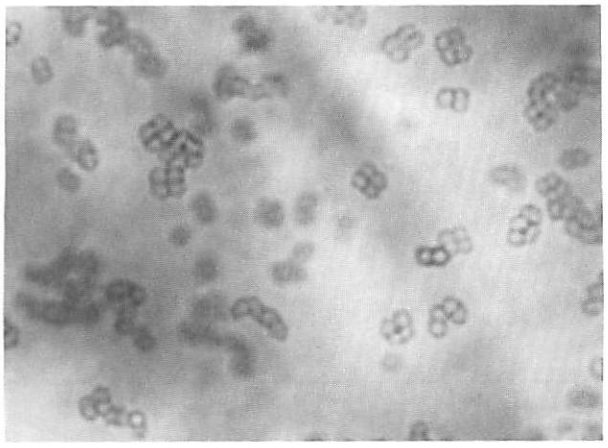
9 Diseases

Lobsters held in tanks often contract a disease. Following are some of the most common ones with recommendations on what should be done.



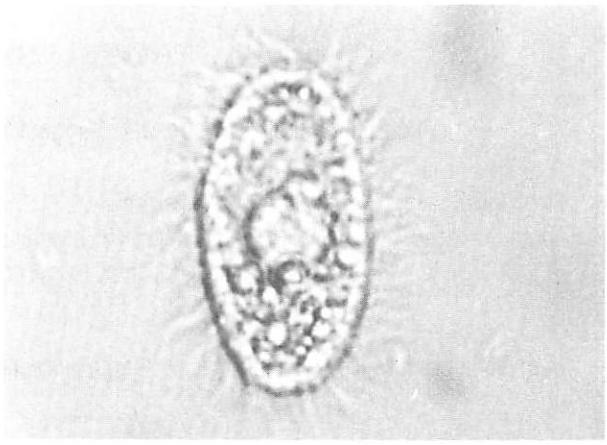
Shell Disease

Lesions of the shell are easily observed. Do not hold lobsters with shell disease. Market them or use for meat. This disease does not affect humans.



Gaffkemia

A very infectious disease in lobster that can be easily seen in a microscopic smear. (See *Lobster Health Manual*, Sea Grant publication # MSG-E-93-13 for the procedure for making a blood smear.) If a large number of lobsters have this disease, market your stock and get rid of the water. This disease does not affect humans.



Ciliated Protozoan

Protozoans can be seen in a drop of fresh blood with a microscope at 100 magnifications. They are egg-shaped and highly motile. If a large number of lobsters have the disease, market your stock and get rid of the water. Then wash your system with fresh (not salt) water. This disease does not affect humans.

Gas Disease

Gas disease in lobsters results when water in the tank becomes supersaturated with air. It occurs when there is an air leak in the water pump intake. High pressure head contributes to the problem. Mortality occurs in hours or days depending on the severity. A percolation filter can help de-gas.

To remedy the situation, fix the intake line on the pump. Dispose of dead lobsters and market live ones or use for meat. This disease does not affect humans.

Alarms

An auto dialer should be connected to your system so that if aeration and/or water flow stops or temperature rises, appropriate personnel are notified immediately.

10 Appendix

Equipment Suppliers

Aquanetics Inc.
5252 Lovelock St.
SanDiego CA 92110
(619) 291-8444 (FAX 619-291-8335) — 7

Aquarium Systems
8141 Tyler Blvd.
Mentor OH 44060
(216) 255-1997 (FAX 216-255-8994) — 4

Aquatic Ecosystems Inc.
2056 Apopka Blvd.
Apopka FL 32703
(407) 886-3939 (FAX 407-886-6787) — 1—8 (except 2)

Fritz Pet Products
P.O. Drawer 17040
Dallas TX 75217
(800) 955-1323 (FAX 214-270-0179) — 6

J.L. Gallagan Engineering Co.
P.O. Box 424
Greenland, NH 03840
(800) 424-3005 (FAX: same) — 7

Granger
425 Warren Ave.
Portland ME 04103
(207) 797-7693 (FAX 207-797-8434) — 1

Hach Co.
P.O.Box 389
Loveland, CO 80539
(800) 227-4224 (FAX 303-669-2932) — 5

Hamilton Marine
P.O.Box 227
Searsport ME 04974
(207) 548-6302 (FAX 207-548-6352) — 2

Le Gay Fiberglass Ltd.
P.O. Box 117
933 Cobequid Rd.
Waverly, Nova Scotia BON 2SO
(902) 860-0822 (FAX 902-860-0819) — 8

Marine Biotech, Inc.
54 West Dane St.
Beverly, MA 01915
(508) 927-8720 (FAX 508-921-0231) — 1—9

Marine Enterprises International, Inc.
8800A Kelso Dr.
Baltimore MD 21221-3125
(410) 682-5303 (FAX 410-687-2562) — 4, 5

Stoney Creek Trout Farms
11073 Peach Ave.
Grant MI 49327
(616) 834-7720 (FAX 616-834-5537) — 1, 3, 6

Wolf Marine Systems Division
709 Hart St.
Brooklyn, NY 11221
(718) 443-1567 (FAX 718-443-1250) — 1—9

Equipment/Supply Code
1 Water and air pumps
2 Fiberglass and resins
3 Plumbing supplies
4 Sea salt
5 Water quality testing supplies
6 Filtration materials
7 Refrigeration
8 Tanks
9 Complete systems

To order the Lobster Health Manual (Sea Grant publication #MSG-E-93-13), contact the Lobster Institute at (207) 581-1448.

To receive a free copy of *Techniques for Live Storage & Shipping of American Lobster*, contact Bruce Estrella, Massachusetts Division of Marine Fisheries, at (508) 888-1155.

SEA GRANT

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This publication is made possible by grant NA36RG0110-01 from the National Oceanic and Atmospheric Administration to the Maine/New Hampshire Sea Grant College Program. The views expressed herein do not necessarily reflect the views of NOAA or any of its sub-agencies.

MSG-E-94-2 #4 1M