Water Quality in Soft Crab Shedding

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INTRODUCTION

The words "good water quality" have different meanings to different people. To a public health official, for example, good water quality means water that is safe for human use, while to a chemist good water quality may mean water that is ultra-pure, free of any chemicals. Good water quality to a crab shedder means water capable of holding crabs through a molt with minimal stress.

Maintaining good water quality in a crab shedding system is essential to keeping peelers healthy—a prerequisite for healthy soft crabs and high profits. In this issue, I discuss water quality in general terms and then address specific characteristics of water quality and methods for measuring them.

THE PROPERTIES OF WATER

The three properties of water that a crab shedder needs to consider are physical, chemical and biological. Although these properties are interrelated, for clarity I will discuss them separately.

Physical Properties

Physical properties are those dealing with matter and energy. The physical properties of importance to crab shedders are water temperature and suspended particles.

A crab is a coldblooded animal—it maintains its body temperature close to the temperature of its surroundings. Since the crab's metabolism is directly related to its body temperature, the crab in cold water is sluggish and in warm water tends to be very active. A crab in warm water also tends to shed faster than one in cold water, although water that is too hot often leads to crab mortalities.

Suspended particulate matter is another physical property crab shedders need to keep in mind. Any substance not dissolved in the water is particulate matter. Silt, algae, or crab body parts are examples. Excessive particulate matter in a crab shedding system could be just unsightly, or it can lead to severe problems. An abundance of crab body parts floating around the shedding system is not only an eyesore, but may clog pipes and drains. Some flowthrough systems have severe problems with sand or silt pumped into the system from muddy source waters. Too much silt and sand cause sediment buildup in shedding tanks and may even lead to crab mortalities, the result of silt clogging up the crabs' gills.

Chemical Properties

Chemical properties of crab shedding water are defined by substances dissolved in the water. The salt water environment is abundant with dissolved chemicals—many are naturally present and beneficial, others are pollutants that could be harmful. A few chemicals are critical to either success or failure in crab shedding. For ease of explanation they can be categorized as either essential nutrients or toxic chemicals.

Dissolved oxygen and salts are the essential nutrients of main interest to crab shedders. Crabs need dissolved oxygen in the water to breathe. The term "salts" refers to a host of compounds present in the water, of which sodium chloride (table salt) is the most abundant and essential for shedding crabs. Other salts include calcium, magnesium and potassium salts, which are not only essential nutrients, but also help to buffer the water. Buffering helps maintain a pH in the water close to neutral (7.0). Crabs prefer a pH in the range of 6.5 to 8.5; waters that are too acidic (low pH) or too basic (high pH) are stressful and may be lethal.

Many chemicals can be toxic to crabs; some, like ammonia and nitrite, are associated with waste products from the crabs themselves. Both ammonia and nitrite are toxic and can cause high crab mortalities, especially in closed system crab shedding. Other chemicals may be present in the water as a result of some kind of pollution. Potentially harmful pollutants include pesticides, petroleum products, metals, hydrogen sulfide gas, antifouling paints and hardeners for plastics and fiberglass resins. These chemicals should be avoided to minimize mortalities.

Biological Properties

Biological properties of crab shedding water are defined by living organisms in the water. Bacteria and algae are the two predominant organisms associated with crab shedding waters. Most bacteria in a crab shedding system are harmless; many are beneficial. Nitrifying bacteria, for example, convert toxic ammonia and nitrite into nontoxic nitrate. (In a closed shedding system nitrifying bacteria are cultured in the biological filter.)

Nevertheless, harmful bacteria can occur in crab shedding waters and should be avoided. Pathogenic or harmful bacteria could cause problems for either the crabs or humans. Water from restricted or polluted sources often contains high numbers of pathogenic bacteria. Crab shedders should be careful not to use water from restricted shellfishing areas in either closed or flowthrough shedding systems.

Algae, like bacteria, can be either beneficial or harmful. In specially designed algal filters, algae are important for removing excess nitrates from closed shedding systems. However, some species of algae can be indirectly harmfull or problematic. Massive algal blooms, especially of dinoflagellates, or red tide algae, can cause dissolved oxygen problems in a flowthrough shedding system. Other algal blooms foul water lines and tanks.

While it's neither practical nor necessary for the crab shedder to measure all the characteristics that make up the physical, chemical and biological properties of water, there are several that must be carefully monitored to ensure good water quality. These are the characteristics, or parameters, that define water quality in terms the shedder can easily measure.

PARAMETERS THAT DEFINE GOOD WATER QUALITY

Six parameters of shedding water are important and require constant attention for successful shedding; they are: dissolved oxygen, temperature, pH, ammonia, nitrite and salinity.

Although there are many other water quality parameters that could be important to the success of a shedding system, they are either difficult to measure or do not affect every system. Some of these parameters include toxic chemicals such as petroleum products, pesticides, plasticizers and dissolved metals; bacterial populations such as pathogenic bacteria; suspended sediment; and possibly some dissolved gases such as hydrogen sulfide or nitrogen.

The best way to avoid the problems caused by these noxious contaminants is to avoid the contaminants themselves by constructing your system of the correct, properly cured materials, and by using water that is free from contamination.

Here I'll discuss the parameters most crab shedders need to monitor.

Dissolved Oxygen

Oxygen is one of the most important parameters of the water in a crab shedding system: molting crabs need to breathe oxygen in order to live. During the shedding process, the amount of oxygen in the system can be critical to shedding success. The biological filter in a closed system also needs oxygen in order to function properly.

The concentration of oxygen in water will depend on water temperature and salinity. One hundred percent saturation exists at normal atmospheric pressures when oxygen in the water is at equilibrium with oxygen of the surrounding air, and nothing in the water is either consuming or giving off oxygen.

Dissolved oxygen varies inversely with temperature and salinity. This means the amount of oxygen in the water increases with decreasing temperature and/or salinity, and decreases with increasing temperature and/or salinity. Dissolved oxygen is also consumed by aquatic organisms such as crabs and bacteria.

For optimal shedding success, maintain dissolved oxygen levels in the system as close to saturation as possible. At normal shedding salinities and temperatures, try to maintain oxygen levels above 7.0 parts per million (ppm). Low levels of dissolved oxygen may become problematic when they fall below 2.0 ppm for more than an hour.

Temperature

Water temperature is a measure of the amount of heat in the shedding system water. Several important factors are influenced directly by water temperature. As the water temperature increases, crabs will tend to shed faster, will produce more waste products (ammonia), and will increase their respiratory rate. At the same time, nitrifying bacteria in the biological filter will grow and reproduce faster, and remove ammonia and nitrite faster.

The water temperature in a crab shedding system is influenced by the surrounding air temperature. In general, water temperatures should be in the range of 70 to 80 degrees Fahrenheit (°F). Water temperatures falling below 70° F will slow down the shedding process, while temperatures above 80° F will stress the shedding crabs.

Another consideration when facing higher water temperatures is the amount of dissolved oxygen that the water is able to carry. Keep in mind the relationship between temperature and dissolved oxygen: as water temperature increases, the dissolved oxygen concentration decreases.

Salinity

Salinity is the amount of inorganic and organic material dissolved in water. Crabs do not adjust well to rapid changes in salinity. Therefore, it is important to maintain the shedding system salinity close to that of the waters from which the crabs were taken. A good rule of thumb is to maintain the salinity of the closed system within 5 parts per thousand of the waters from which the crabs came. As water evaporates from the shedding system, the salinity will gradually increase, so add fresh water to the system periodically. Again, remember that salinity affects dissolved oxygen the same way temperature does: the higher the salinity, the lower the amount of oxygen the water can hold.

pH

The acidity (or basicity) of water is measured in units of pH. A pH of 7.0 is neutral; pH values above 7.0 are basic, while pH values below 7.0 are acidic. In general, try to maintain a shedding system pH in the range of 6.5 to 8.5.

In a crab shedding system, increased crab wastes and the resulting conversion of ammonia to nitrate tends to decrease the pH (water becomes more acid). As the water becomes more acidic, the biological filter becomes less efficient, and the crabs are increasingly stressed. By selecting the proper filter media, changes in system pH can be buffered or minimized. Usually, filter media such as oyster shell or dolemitic limestone provide adequate buffer capacity for the system, thus reducing wide pH fluctuations.

Ammonia

One of the major waste products of crabs is ammonia. In its unionized form, NH_3, ammonia is very toxic to crabs, while in its ionized form, NH_4^+, it is relatively nontoxic. The form of ammonia, ionized or unionized, is a function of the pH of the water. As the pH increases, the ammonia in the water takes the unionized form. For pH values less than 8.0, the ammonia is predominantly ionized. Thus, for all but very high concentrations of ammonia, the toxicity of ammonia should be minimal, as long as the system pH is below 8.0.

Because of the pH dependence, it is difficult to recommend an absolutely safe level of ammonia. As a general rule of thumb, systems with total ammonia concentrations below 1.0 ppm (or mg/L) should be safe for crabs. Remember, this is only a general recommendation; some systems could exhibit problems with ammonia levels of 1.0 ppm. Most biological filters, when properly functioning, will have daily ammonia readings well below this 1.0ppm limit.

Nitrite

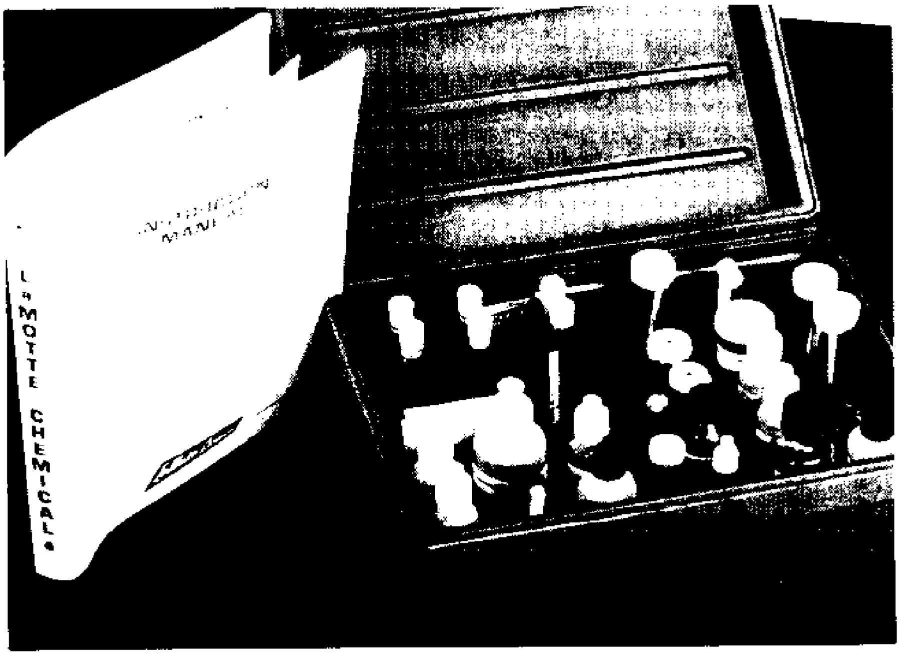
Probably the most toxic chemical encountered in most crab shedding systems is nitrite. In the conversion of ammonia into nitrate there is an intermediate step where ammonia is first converted to nitrite by one species of bacteria, *Nitrosomonas*, and then from nitrite to nitrate by another, *Nitrobacter*. Nitrite is highly toxic to crabs and often causes high mortalities in closed shedding systems. Ammonia is also toxic to crabs, whereas, nitrate is usually considered nontoxic.

There are many possible reasons for high levels of nitrites in a shedding system. For example, the biological filter may not meet the demands placed upon it, or the bacteria responsible for the conversion of nitrite to nitrate do not perform their job. Some reasons for poor performance in the biological filter include insufficient startup time, lack of oxygen in the filter, too much nitrite in the system causing toxicity to the nitrifying bacteria, or overload of the system.

Ideally, levels of nitrite should not exceed 0.5 ppm for extended periods of time. Nitrite levels in the range of 1.0 to 2.0 ppm usually are not immediately toxic to shedding crabs, but prolonged exposures (more than 1 day) can lead to high mortalities. Levels of nitrites above 5.0 ppm are usually toxic to shedding crabs after only a short exposure.

WHY MEASURE WATER QUALITY?

For a crab shedding system to operate properly, water in the shedding tanks must be of sufficient quality to support the number of crabs being held. Flow through systems do not lend themselves to altering the incoming water to any appreciable degree, mainly because of the economics involved. Closed systems, however, allow a shedder to control the water quality in the shedding system.



Monitoring water quality in a closed soft crabbing system is easy and inexpensive using test kits like this one. See Table 1 for a list of test kit suppliers.

A successful closed crab shedding system depends on the proper function of the system components. System failures are almost always related to the failure of one of the system filters. The most important filter in the system, the biological filter, or biofilter, is an unruly beast that can be hard to manage under the best of conditions. Biofilters are used in the closed system to remove ammonia from the water. Remember, ammonia is a waste product from crabs and at high levels can be toxic to them.

The biological filter removes ammonia from the system water by using nitrifying bacteria to convert ammonia to a more desirable nitrate. An intermediate step in the bacterial decomposition of ammonia is the production of nitrite, which is also toxic to crabs.

One signal that the biofilter is not working is to count the number of dead crabs. This can be, of course, a very expensive water quality monitoring scheme. A more economical approach to monitoring a closed system is to make use of test kits. Their cost in time and money will be more than repaid in profits from live crabs.

WHAT TO MONITOR

Water quality parameters that should be monitored are dissolved oxygen, temperature, pH, salinity, ammonia and nitrite. Some crab shedding systems may require monitoring of more exotic parameters, but determining whether this is necessary will require an evaluation of the specific system in question.

HOW TO MONITOR

Several companies produce test kits that allow even the most inexperienced user to measure water quality with ease (see Table 1). Using the test kits involves taking a small sample of the water to be tested, diluting it if necessary, adding chemicals in the form of powders and/or liquids, and then comparing colors with predetermined standards.

Dissolved Oxygen

Dissolved oxygen can be measured with either test kits or by portable meters. Of the test kits available, the ones for dissolved oxygen are the most difficult to use, though they are still relatively simple. When testing for dissolved oxygen, meters are much simpler to use; however, in this case, simplicity costs more money. Dissolved oxygen is not usually a problem in a closed system, as long as there is adequate aeration and circulation of the water. For this reason, dissolved oxygen can usually be measured two to three times per week and a test kit will be adequate for the job.

Temperature

Water temperature can be easily measured with a thermometer. A good shielded thermometer with a degrees Celsius scale will allow for daily measurements of water temperature.

Salinity

Salinity can be measured in several ways, and the easier and more accu-

A Note about Diluting

Occasionally the parameter you're measuring does not fall within the range of values the test kit can detect. This is usually because the water from your system has too much of whatever it is you're trying to measure. In such cases you must dilute your sample and then remeasure with the test kit, multiplying your result by the appropriate factor. Instructions for diluting samples are available in "Diluting Water Quality Samples for Soft Crab Shedding" (UM-SG-MAP-88-02), available from Maryland Sea Grant or your local Extension office.

TABLE 1. Companies producing test kits suitable for soft crab shedding.

LaMotte Chemical Products Co.
P.O. Box 329
Chestertown, MD 21620
(301) 778-3100

Hach Company
P.O. Box 389
Loveland, CO 80539
1-800-227-4224

(The mention of these companies does not constitute an endorsement of their products. Other equally suitable test kits may be available from other suppliers.)

rate the method, the more it is likely to cost. A refractometer is the most costly, and most accurate, method. Refractometers can be found that are temperature compensating and direct reading. For a crab shedder who must often make salt water, and who is constantly adjusting the salinity of the system, a refractometer may be a worthwhile investment. A less costly approach is to use a hydrometer. Similar to, but not the same as those used to measure the specific gravity of antifreeze solutions or battery acid in an automobile, hydrometers suitable for use in soft crabbing can be found in pet stores that specialize in salt water aquariums. Conversion tables for hydrometers, and instructions for their use, are available in two Maryland Sea Grant Extension publications, both called "Water Quality Conversion Tables for Soft Crab Shedding" (UM-SG-MAP-85-01 and UM-SG-MAP-85-03).

There are also test kits for the measurement of salinity. These kits are fairly simple and provide sufficiently accurate results. Salinity should be measured two to three times a week and before adding new make up water. The salinity of make up water and the salinity of the water from which the crabs are caught should also be monitored regularly.

pH

The measure of the acidity of water is most often reported as the pH of the water and, like dissolved oxygen, pH can be measured with either test kits or meters. Of the test kits available, those for monitoring pH are the simplest to use. While meters are more accurate, they are more expensive. pH needs to be measured two to three times a week and can be adequately done with test kits.

Ammonia

Ammonia and nitrite are both easily and economically measured with test kits. Both should be measured daily when the shedding system is started in the spring. When the closed system stabilizes, usually after a month of operation, ammonia and nitrite can be measured three times a week or whenever there is a large change in the number of crabs in the system.

SUMMARY

The definition of good water quality for crab shedding has three components. Physically, good water is clear and warm enough to promote optimal shedding activity. Chemically, good water has all of the desired essential elements, is adequately buffered to ensure proper pH, and does not contain any toxic chemicals. Biologically, good water is free from pathogenic bacteria and unwanted algae and contains nitrifying bacteria and algae necessary to remove nitrogenous wastes.

Proper water quality is critcal to the success of the shedding operation. Water quality, as measured by temperature, salinity, pH, dissolved oxygen, ammonia and nitrite, must be monitored regularly to determine the well being of the shedding system.

Proper record keeping of the measured water quality parameters, as well as the number of crabs into and out of the system, is also necessary to document the health of the system. Good records allow for the shedder to determine the break-in characteristics of the biofilter, and to predict system problems before the water quality becomes deadly.

REFERENCE

Information in this "Crab Shedders Workbook" has been adapted from: Perry, H. and R. Wallace. 1985. Water Quality Concerns. Gulf Coast Research Laboratory. Publication number MASGP-85-001.

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