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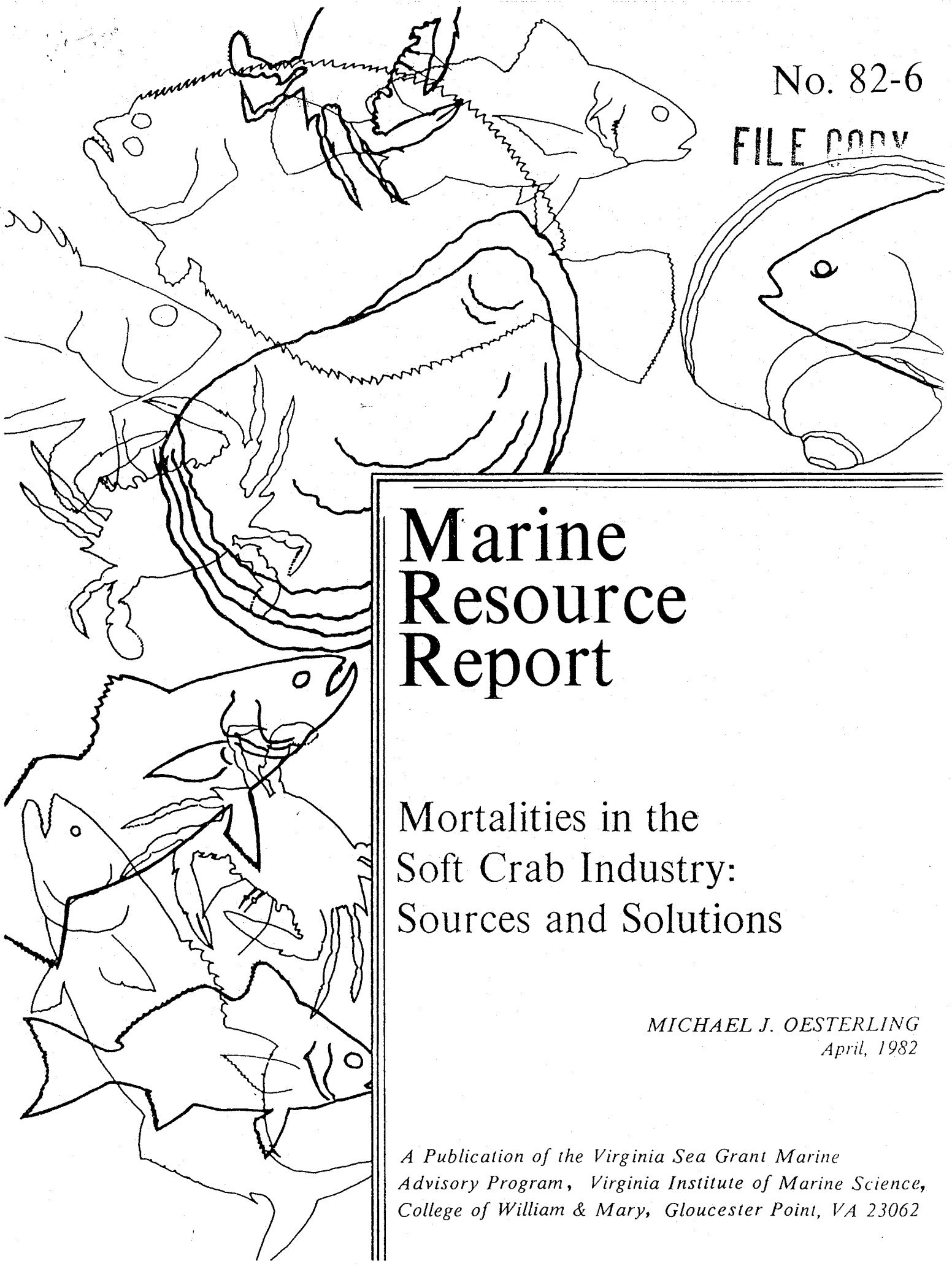

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MORTALITIES IN THE SOFT CRAB INDUSTRY:

SOURCES AND SOLUTIONS

By

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PRE-HARVEST (STILL IN THE WATER)

1. Disease - Parasites. There's really nothing you could do to remedy the causes of this situation. If you suspect that the crabs in your harvest area are infected with any diseases or parasites, you may wish to reduce your harvesting or relocate to another area.

2. Predators. Peelers are favorite foods for fish, turtles, birds, and other crabs to name a few. Your control over these is extremely limited, except in your harvesting which will be addressed later.

3. Low Food Supply. Reduced food supply will increase the competition and possibly result in cannibalism among crabs. Besides direct causes of mortality this could lead to other problems to be discussed in following sections.

4. Silt Load of River. Although not a direct cause of mortality, a heavy silt load in the water can cause problems for shedding houses. Most obvious is the interference with respiration (breathing). This could put the crab into a weakened state prior to harvesting.

   Secondly, a heavy silt load can contribute to reduced oxygen problems later in the year. Associated with the silt will be organic matter. When this settles to the bottom oxidative break-down will begin. Oxygen will be consumed in this process, thus lowering the oxygen available to other bottom organisms.

   Your only options in the case of heavy silt loading are to reduce your harvesting or move to another area.

5. High (or Low) Water Temperature. Water in lower depths is generally cooler and, conversely, upper level or shallow water is warmer. Changing your fishing strategy may help alleviate temperature problems; for example, set your pots and/or pounds shallower in spring and fall, deeper in summer.

6. Low Dissolved Oxygen. On hot days with little or no wind blowing, the surface and bottom waters do not get mixed. If this condition lasts for many days, the dissolved oxygen at the bottom of rivers is depleted. When this happens, crabs held in pots and in pounds can be killed. This situation usually does not last long. Similarly, "red water" conditions can cause crab deaths,

since red water is associated with low oxygen levels. Likewise, red water conditions usually do not last for extended periods. Heavy organic matter concentrations on the bottom will add to these problems. In either case, moving of crab pots to areas of water mixing, near creek mouths or strong tidal flow, or away from red water will help reduce the possibilities for crab deaths.

HARVEST AND TRANSPORTATION TO SHEDDING HOUSE

1. Harvest Method. Your selection of peeler harvesting gear may determine the quality of crab you catch. In the following, gears are listed in order, beginning with the least damaging and progressing to the most damaging: dip nets; doublers on trotlines; scrapes; jimmie baited peeler pots; hard crab pots; fish baited peeler pots; peeler pound; fish pound; haul seine.

2. Original Condition of Peeler. If the peeler is weak for any of the reasons listed above in "Pre-harvest," there is little that can be done other than cutting back on fishing. Good handling methods can help reduce some loss (see 3 and 4, this section). Also, reducing the length of time that the peeler is in the trap, pot, etc. can be beneficial. This may mean changing the frequency with which you check your pots/traps during certain times of the year.

3. Culling and Handling. Handle peelers as gently as possible. When emptying pots or traps, try not to shake too much or dump peelers on top of each other in order to minimize puncture wounds, cutting, bleeding, and the loss of claws and legs. Care at this point may make a big difference in shedding success.

4. Packing or Boxing for Transportation. When packing or boxing avoid crushing effects by limiting the number of peelers packed. Shallow containers will help prevent over-packing. Also, keep peelers right side up. Alternate layering of moist sea grass or pine needles will help reduce the possibilities for injury.

5. Sun (High Temperature). Keep boxed peelers out of direct sunlight. Put them in a shaded area of your boat. Also, keep them covered with moist burlap (croaker sacks) or other materials (grass or pine needles).

6. Oil and/or Gas. Keep your bilge as clean and free of oil and/or gas as possible. Don't carry your peelers where they could come in contact with oil/gas leaks or fumes.

7. Time Out of Water. Reduce the amount of time peelers are exposed to air by speeding up transporting them from traps/pots to the shedding house. Soft crabs may be transported in salt water wells, but peelers should not be transported in water. Also follow the suggestions presented in paragraphs 3, 4, and 5 of this section.

SHEDDING HOUSE

1. Original Condition, Sex and Sign of Peeler. Any crabs with physical injuries (for example, puncture wounds) may not complete a shed. For this reason, try to use only undamaged peelers (see preceding section).

Male peeler doublers (white sign) may delay their shedding when in the presence of rank females. It would be best to separate male peelers from females. This may also reduce injuries from males fighting for females.

The sign of the peeler has a lot to do with success in shedding. The following table illustrates the results of a study conducted in Crisfield, Maryland, on shedding success of different sign peelers held in floats:

Sign	% Shedding	Time to Shed
Red	91.2	1-3 days
Pink	83.5	2-5 days
White	59.2	3-10 days
Green	47.5	5-25 days

Therefore, red or pink line crabs would be the best peelers to hold.

Do not hold any "mossy" back crabs, regardless of size. This condition indicates that the crab has not shed for a long time and there may be something wrong with their hormone system.

2. Culling/Grading or Fishing Your Floats. Be gentle with your peelers! Don't throw or dump peelers into your floats (tanks), but release them slowly. Try to spread

them out, not in a large pile. When fishing your floats avoid unnecessary agitation.

If you do hold white line crabs, the following fishing schedule may be advisable: after 3 days check for pink or red lines, remove these to appropriate floats; after 3 more days repeat, removing pink or red lines; at this point either sell the remaining white lines for peeler bait or discard. It becomes uneconomical to hold white lines beyond this point.

3. Nicking. In one word, don't nick! Improper nicking can cause bleeding, swelling and blood clot formation in the joint which may lead to infection and death. Also, swelling may prevent successful claw extraction causing the crab to "hang-up" and die. Proper separation of different signs and good handling practices, along with a properly functioning float/tank, should be sufficient to keep fighting and cannibalism to a minimum.

4. Crowding. During the main part of the shedding season, maintain only from 200 to 300 peelers per 4' x 8' tank with 4" of water. For the "first run", however, more crabs can generally be held without increased mortalities because water temperatures are lower. Besides physical injuries, oxygen problems can develop from over-crowded conditions.

5. Handling. Keep your handling of peelers to a minimum when you are fishing your floats/tanks or grading by signs. Increased handling can increase mortalities.

6. Water Flow/Circulation. If you are using floats, locate them where there is adequate water flow, either from tidal action or currents. Natural ebb and flood of water or currents are required to promote movement of water through the floats. This will help remove any waste products as well as providing fresh, oxygenated water. Water depth should be sufficient to keep floats from resting on the bottom at ebb tide. A breakwater may be required to keep high waves from rocking the floats and tearing them loose from pilings. Floats must be periodically removed from the water, to be scrubbed and dried to destroy rot and wood-borers, as well as to remove fouling plants and animals.

For open-flow or closed-flow tank systems, design good circulation in your tanks. One method to insure good circulation is to have water injection at opposite ends of the tank with a central drain (see Figure 1). It is necessary to have only enough water to cover the

backs of crabs, about 4", within each tank. Proper drain pipe construction will accomplish this (see Figure 2). In a 4' x 8' tank with 4" of water, or about 80 gallons, it is recommended to turn-over the water at least three times per hour. This would translate to a flow rate of about 5 gallons per minute per tank.

7. Salinity. The salinity of water in your floats/tanks should be at approximately the same level as the area that your peelers came from; at least no more than 5 parts per thousand higher or lower than the salinity in the area of peeler harvest. If at all possible, protect your facility from experiencing wide fluctuations in salinity.

8. High Temperature. Water temperatures near 70°F are required for active shedding, although crabs will shed at lower temperatures. When water temperatures approach 80-85°F, respiration problems can occur. To reduce temperature, keep your shedding tanks shaded. Besides helping to keep temperatures down, it will reduce the growth of algae in your tanks. If you are shore-based, using a flow-through system, draw your intake water from as deep as possible. You may wish to consider adding a cooling tower to your system; it will lower temperatures 4-5°F or more. Or, you might consider drilling a "saltwater well" to provide a more constant temperature water. In extreme cases, consider the use of supplemental cooling such as refrigeration coils (non-toxic materials only). Also, re-circulating, closed-flow systems, with a water cooling tower or other means of temperature regulation, tend to offer better control over temperature.

   High temperature effects are linked to oxygen problems (see 9 below).

9. Oxygen. Oxygen levels should be maintained as high as possible. As water temperature and salinity increase, the amount of oxygen that can be carried by the water decreases (Table 1). Therefore, lower water temperature will help maintain adequate oxygen.

   On hotter days, the number of crabs held per float/tank should be reduced. For open-flow or closed-flow systems, the method used for water inflow to your tanks can help increase oxygen levels. The use of aspirators or venturi-apparatus is recommended. Supplemental aeration by using compressed air is not recommended.

Additionally, maintenance of good water circulation will contribute to adequate oxygen levels (see 6 this section). A small amount of air (oxygen) is absorbed by water at the water's surface. Mixing of air into the water column depends on the turbulence of the flow of water. Also, the amount of air in a cubic inch of water depends on the depth of water; more air per cubic inch is absorbed in 4 inches of water than in 12 inches. Therefore, keep the level of water in the tanks at about 4 inches.

10. Debris, etc. Maintain your shedding system as clean as possible. Try to clean floats/tanks at least once a day to remove mud, excreta, lost appendages and dead crabs. Permitting these to build-up can contribute to oxygen problems and open the way for bacteria or disease infestations. Consider installing self-cleaning drains in open-flow and closed-flow systems (see Figure 2).

11. Filtration. This applies to closed-flow systems only. Monitor the nitrogen level in your waters, primarily ammonia-nitrogen. An increase in ammonia signals a break-down in your filtration capacities. Remember, ammonia-nitrogen is toxic and will cause the death of crabs.

12. Float/Tank Construction. Floats should be constructed to permit adequate water exchange (circulation), as well as prevent pests (eels, turtles, bull minnows, etc.) from attacking peelers. This means some combination of slats or wire. If you paint your floats, use a non-toxic paint; avoid paints containing copper which is toxic to crustaceans.

For tank systems (open or closed), no toxic paints or metals should be used, either in the tank or plumbing and pumps (see Figure 1). Tanks can safely be constructed of wood, wood coated with a sealer/water proofer such as Gluvit or fiberglass, all fiberglass, or concrete. Each has its own advantages and disadvantages, length of service and cost. If you choose to paint your tanks, avoid light colors like white. A more "natural" brown (sand-colored) is recommended.

Always install an emergency drain, so that all but about one-inch of water will drain from your tanks should water stop from electrical failure, pump breakage, etc. (see Figure 2). Overhead lighting should be kept to a minimum and only used when necessary to harvest soft crabs or cleaning, otherwise keep it dark.

13. Diseases. Vibrio or Paramoeba could cause crab deaths in your shedding system. Other than trying to keep from holding diseased crabs, there is little you can do. Try to recognize any telltale signs of these diseases.

14. Insecticides, Pesticides or Herbicides. Do not use poisons of any type around your shedding house. Good management and maintenance of the grounds surrounding your shedding house will help keep down nuisance pests. Also, do not handle your peelers while wearing insect repellant. It can be washed off into your floats/tanks or adhere to crabs, causing deaths.

15. Predators. Be concerned about all types of predators, swimmers (fish, turtles, etc.), 4-legged (raccoons, etc.), and 2-legged (birds and man). Screening or having your tanks in a building will reduce losses.

TABLE 1. Amount of oxygen which can be dissolved into seawater at different temperature and salinity combinations. Temperature is in degrees Fahrenheit (°F), salinity in parts per thousand (ppt), and oxygen in milliliters per liter (ml/l).

°F \ ppt	3.6	7.3	10.9	14.5	18.1	21.7	25.3	28.9	32.5	36.1
60.8	6.74	6.59	6.45	6.30	6.17	6.03	5.91	5.78	5.66	5.54
62.6	6.60	6.46	6.32	6.18	6.04	5.91	5.79	5.66	5.54	5.43
64.4	6.47	6.33	6.19	6.05	5.92	5.80	5.68	5.56	5.44	5.53
66.2	6.34	6.20	6.06	5.93	5.80	5.69	5.57	5.45	5.34	5.23
68.0	6.21	6.07	5.94	5.81	5.69	5.58	5.47	5.35	5.24	5.14
69.8	6.09	5.96	5.83	5.70	5.58	5.47	5.37	5.25	5.15	5.05
71.6	5.97	5.85	5.72	5.60	5.48	5.37	5.26	5.16	5.06	4.96
73.4	5.86	5.74	5.61	5.49	5.38	5.27	5.17	5.07	4.97	4.88
75.2	5.76	5.63	5.51	5.39	5.28	5.18	5.08	4.98	4.88	4.79
77.0	5.65	5.53	5.41	5.29	5.19	5.09	4.99	4.89	4.80	4.71
78.8	5.54	5.43	5.32	5.20	5.10	5.00	4.91	4.81	4.72	4.63
80.6	5.44	5.33	5.23	5.11	5.01	4.91	4.82	4.73	4.64	4.55
82.4	5.34	5.24	5.14	5.02	4.93	4.83	4.74	4.65	4.56	4.47
84.2	5.25	5.15	5.05	4.94	4.85	4.76	4.66	4.57	4.48	4.39
86.0	5.16	5.06	4.97	4.86	4.77	4.68	4.59	4.50	4.41	4.32

A = Water pump; 2 Hp recommended for 10-15 tables.

B = Main water delivery line; 2-inch PVC.

C = Valve with reduction coupling (2-inch to 1-inch); either brass or PVC recommended.

D = Table water delivery lines; 1-inch PVC recommended.

E = Table drain (2-inch PVC); see Figure 2 for additional drain system alternatives.

F = Main drain line; 2-inch to 6-inch PVC.

Arrows indicate the direction of water flow.

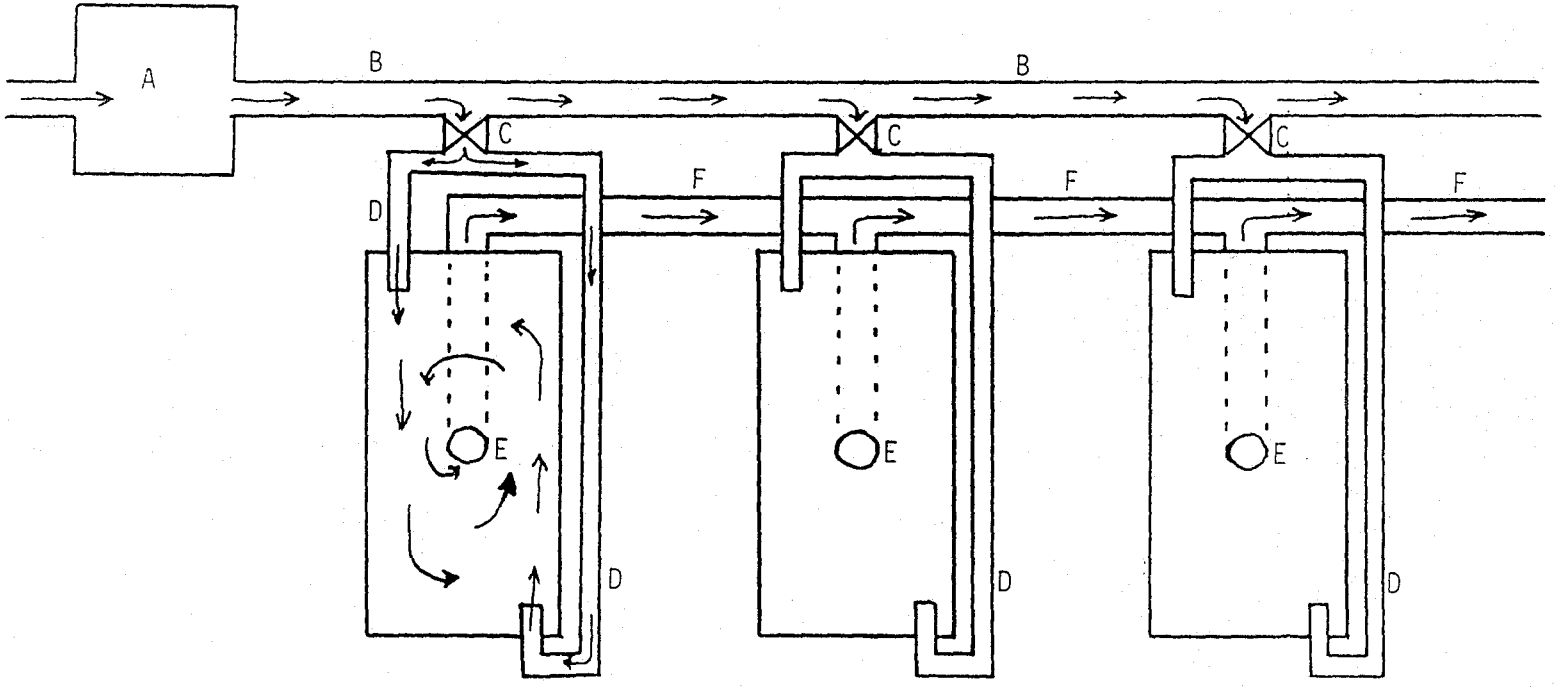
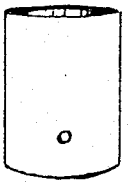


FIGURE 1. Typical lay-out for a flow-through shedding system. This particular system employs dual water injection and center drain for optimum water circulation. Other types of water delivery/drain systems are also common.

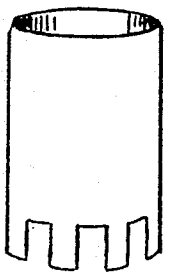
FIGURE 2. Center drain construction options.

A. Simple piece of PVC pipe cut to the desired water depth (about 4"), draws water over the top for drainage. It should be removable to facilitate total draining or for tank cleaning purposes.



small hole, 1-inch from bottom for emergency drainage

B. Pipe-within-pipe design. A 2-pipe system where the water depth is controlled by the inner pipe. Outer pipe insures that water is drawn from the bottom, thus helping to remove mud, excreta and other debris. Both pipes should be easily removable for total drainage and tank cleaning.

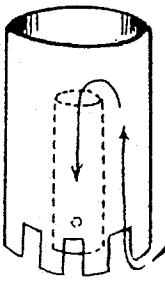


serrations all around base

outside pipe

small hole, 1-inch from bottom for emergency drainage

inside pipe



direction of water flow

total system

DETERMINING AMOUNT OF WATER IN A SHEDDING SYSTEM

1. Amount in gallons

   a) First determine the water volume in one tank

      For example purposes, use a 4' x 8' tanks with 4" of water.

      Multiply 4' x 8' x 1/3' = 10.56 cubic feet

      Therefore in one tank 4' x 8' with 4" of water there will be 10.56 cubic feet of water.

   b) To convert this to gallons, multiply the number of cubic feet of water by 7.5 gallons per cubic foot of water.

      10.56 cubic feet of water x 7.5 gallons/cubic foot = 79.2 gallons

      Therefore, there will be almost 80 gallons of water per 4' wide, 8' long tank filled with 4" of water.

2. Amount in pounds of water

   a) Using the above information determine the number of gallons of water per tank.

   b) To convert this to pounds, multiply the number of gallons of water by 8.3 pounds per gallon of water.

      79.2 gallons x 8.3 pounds/gallon = 657.4 pounds

      Therefore, in a 4' wide, 8' long tank filled with 4" of water, the weight of the water alone will be about 657 pounds.

To determine the volume in gallons of water in your entire shedding system, simply multiply the number of gallons in one tank by the total number of tanks.

10 tanks (4' x 8' with 4" water)

79.2 gallons/tank

10 x 79.2 - 792 gallons of water in all tanks

If you have additional tanks or reservoirs within your system, simply calculate the volume of water held in each and follow the above examples to determine number of gallons of water.