STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

PUBLIC WORKS AND FLOOD CONTROL DIRECTORATE

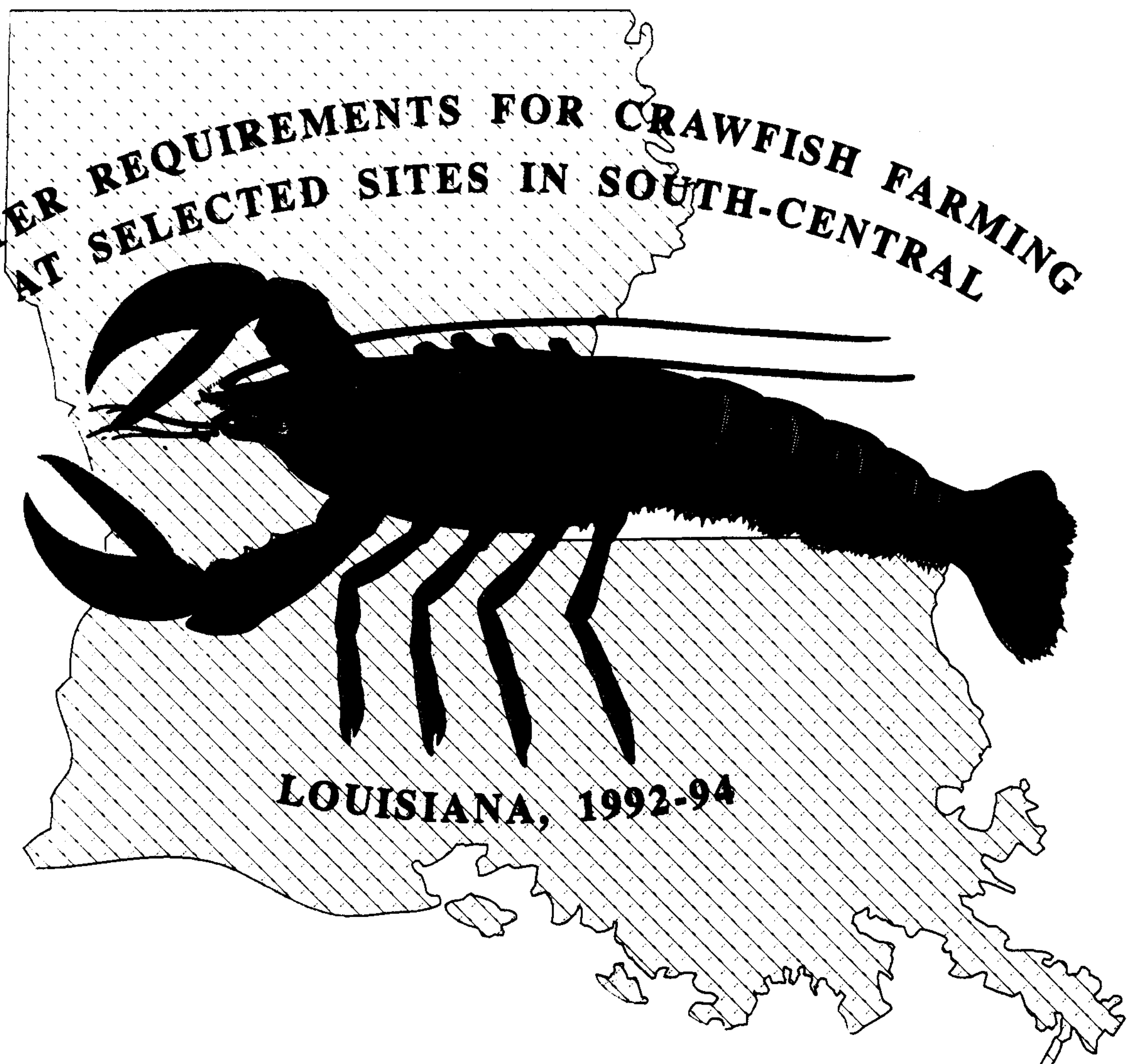
WATER RESOURCES SECTION

WATER RESOURCES

SPECIAL REPORT

NO. 8

WATER REQUIREMENTS FOR CRAWFISH FARMING AT SELECTED SITES IN SOUTH-CENTRAL LOUISIANA, 1992-94



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Multiply	By	To obtain
inch	25.4	millimeter
	0.0254	meter
foot	0.3048	meter
foot per second	0.3048	meter per second
mile	1.609	kilometer
acre-foot per acre	1,233	cubic meter per meter
	0.001233	cubic hectometer per hectometer
cubic foot per second	0.02832	cubic meter per second
cubic foot per hour	28.32	liter per hour
million gallons per day (Mgal/d)	3,785	cubic meters per day

acre	43,560	square foot
cubic foot per second	7.4805	gallon per second
cubic foot per hour	7.4805	gallon per hour
	0.01247	gallon per minute
million gallons per day (Mgal/d)	3.069	acre-feet per day
	1,120	acre-feet per year
	1.547	cubic feet per second
	694.4	gallons per minute
	48.7934	million cubic feet per year

Abbreviated water-quality unit used in this report:

milligrams per liter (mg/L)

WATER REQUIREMENTS FOR CRAWFISH FARMING AT SELECTED SITES IN SOUTH-CENTRAL LOUISIANA, 1992-94

By John K. Lovelace

Abstract

More than 100,000 acres of land are used for crawfish farming in Louisiana. Crawfish ponds are flooded with water from ground and surface sources to a depth between 18 and 24 inches each year. Water levels and water quality in the ponds usually are maintained by pumping additional water into the ponds during the crawfish growing season, September through May. The amount of water applied to ponds during the season may vary greatly from farm to farm, depending on the cost of pumping water and individual farming practices.

To estimate the amount of water farmers apply to crawfish ponds during a growing season, the U.S. Geological Survey monitored water withdrawals at 16 sites on 10 crawfish farms in south-central Louisiana during the 1992-93 and 1993-94 growing seasons. Total pumping time and pump discharge data were collected at 19 pumps on the farms. Farmers using only ground water applied from 0.57 to 1.17 acre-feet per acre of water to crawfish ponds during each season. The amounts of water applied to ponds by farmers pumping from surface sources were highly variable and ranged from 3.07 to 26.03 acre-feet per acre. Ponds supplied by a combination of ground and surface water received from 1.27 to 2.58 acre-feet per acre during each season. However, the acreage of the monitored ponds represents only approximately 2 percent of the total acreage of crawfish ponds in Louisiana.

INTRODUCTION

More than 100,000 acres of land are used for crawfish farming in Louisiana (fig. 1) (Louisiana Cooperative Extension Service, 1994). Aquaculture specialists report that ponds used for crawfish farming are filled with water to a depth between 18 and 24 inches each year (Larry de la Brettone, Louisiana Cooperative Extension Service, oral commun., 1990). Water levels in the ponds are maintained at this depth throughout the growing season, which lasts from September to May of the following year. To fill ponds and maintain water levels, water is pumped from ground and surface sources. In 1990, an estimated 500 Mgal/d was withdrawn from ground- and surface-water sources for the crawfish farming (Lovelace, 1991).

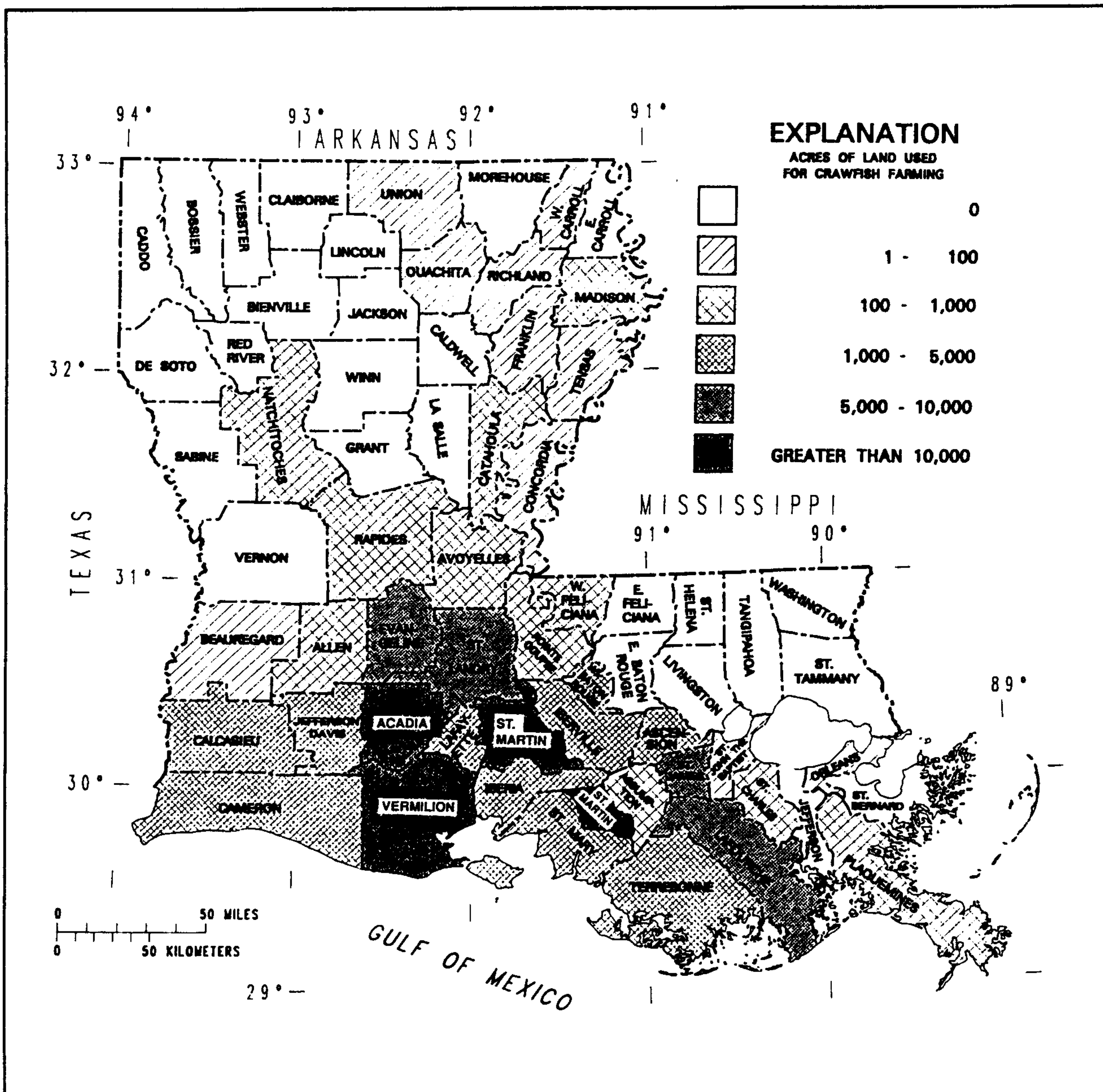

Figure 1. Land used for crawfish farming in Louisiana by parish, 1993. (Source: acreage from Louisiana Cooperative Extension Service, 1994)

Water-use data have been collected and reported on a 5-year basis by the U.S. Geological Survey since 1960. Since 1980, aquaculture has been recognized as an independent water-use category in Louisiana along with public supply, industry, power generation, rural domestic, livestock, and irrigation (Walter, 1982). Aquaculture withdrawal is defined as the withdrawal of water from natural sources for fish, crawfish, and alligator farming. Since 1980, reported water withdrawals for aquaculture have increased 260 percent. However, most of this increase was attributed to the methods used to estimate the amount of water withdrawn rather than actual changes in farming practices or a dramatic increase in pond acreage (Lovelace, 1991).

Estimates of pond acreage and per-acre application rates for crawfish farming have been obtained from county agents in each parish for the 5-year water-use reports. It was assumed that crawfish farmers, like the many rice farmers in the area, probably use similar application rates, which are primarily dependent on local precipitation. During the 1990 water-use data collection effort, a wide variation in application rates reported by the county agents was noticed. Subsequently, several crawfish specialists, county agents, and crawfish farmers were contacted by the author in an effort to verify the application rates and assure a uniformity in the withdrawal estimates. These conversations produced a similar wide range of application rates. To improve understanding about the role of water in crawfish farming and, thereby, improve the quality of the estimates of water withdrawals for crawfish farming in the 5-year water-use reports, 10 crawfish farms in south-central Louisiana were monitored during two growing seasons, in cooperation with the Louisiana Department of Transportation and Development. These data can be used by water managers and planners to appraise the effects of current and future uses of Louisiana's abundant water resources.

Purpose and Scope

This report presents water-withdrawal data collected at 16 sites on 10 crawfish farms located in south-central Louisiana during the 1992-93 and the 1993-94 seasons of crawfish production. The data include cumulative pumping time and pump discharge measurements made at 19 pumps, 7 pumping from ground-water wells and 12 from surface-water sources. The acreage of monitored ponds represents approximately 2 percent of the total acreage of crawfish ponds in Louisiana, and the number of farms monitored represents less than 1 percent of the total number of crawfish farms in Louisiana.

Acknowledgments

This report was made possible through the assistance and cooperation of the following crawfish farmers and land owners on whose farms the study was conducted:

Lee Allee	David Degeyter	Albert "Rusty" Gaude
Emile Barras	Louis Drouant	Russell Huval
Louis Cramer	Glen Dugas	Richard LaHaye
Jeffrey Crochett	Warren Fontenot	Adam Reed.

The author wishes to express appreciation to Dwight Landreneau, Thomas Hymel, and James Garrett of the Louisiana Cooperative Extension Service for assisting in site selection and to Zahir "Bo" Bolourchi, Chief, Water Resources Section, Louisiana Department of Transportation and Development, for assistance provided during this study.

STUDY APPROACH

Ten crawfish farms were instrumented so that the amounts of water applied to the ponds by the farmers could be calculated. Site selection, the types of instruments used, and data collection procedures are described in this section.

Site Selection

Site selection was made on the basis of farmer cooperation. Area aquaculture specialists with the Louisiana Cooperative Extension Service provided names of farmers located in south-central Louisiana who were willing to participate in the study. In general, the farmers who volunteered are interested in improving their production and are considered to have well-managed ponds. This may have biased the study somewhat because a substantial number of crawfish farmers are not considered to have well-managed ponds (R.P. Romaire, Louisiana State University, oral commun., 1991).

Sixteen sites on 10 farms were selected that represented a variety of sizes and pumping situations. Farm locations are shown in figure 2. A total of 19 pumps on the farms were monitored. The number of sites chosen was limited due to equipment and time constraints.

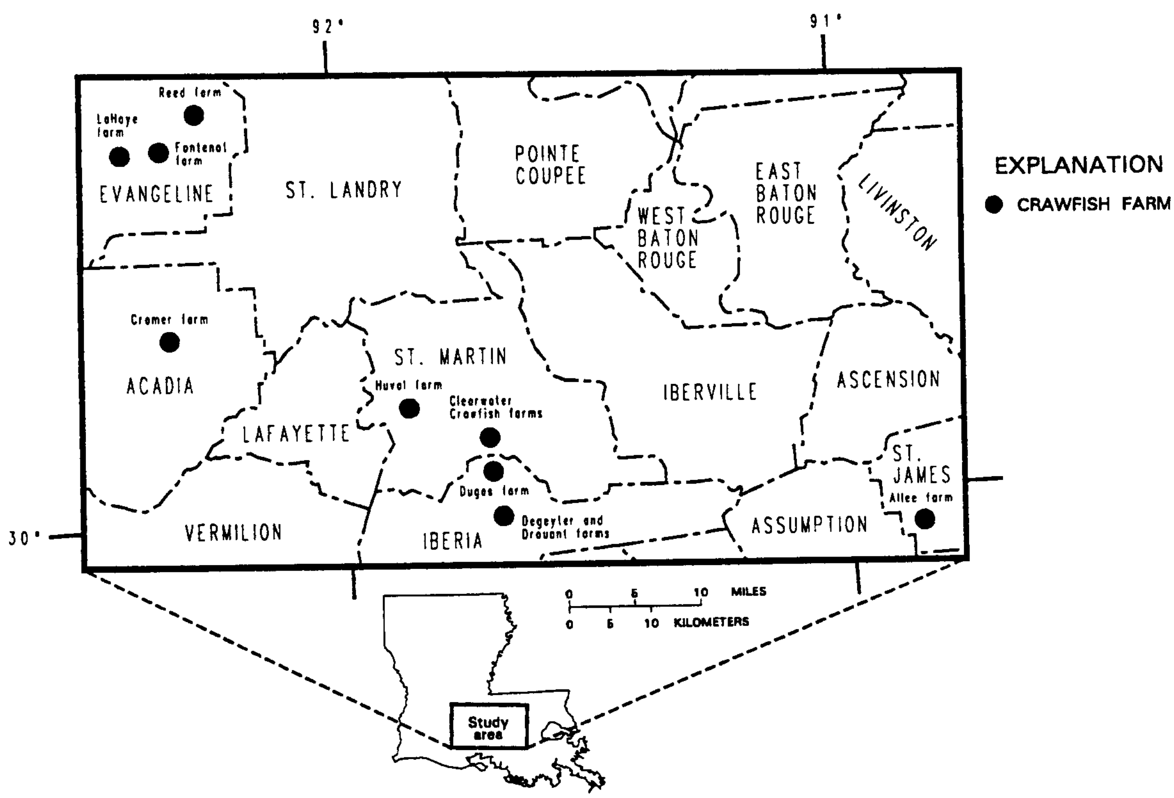

Figure 2. Locations of crawfish farms used in study, south-central Louisiana.

Instrumentation

A vibrational time totalizer (VTT) was used to record the cumulative time that each pump operated. The VTT accumulates running time only when it senses the steady vibration produced by the pump's motor. The VTT was attached to some part of the pump, motor, or mounting structure that would vibrate while the pump was running. As a precaution, the electric or natural gas meter (if available) was read at each site so that pumping times could be estimated if a VTT failed.

A Polysonics Hydra portable flowmeter was used to make instantaneous measurements of the rate of flow from the pumps. This is a non-invasive, reflective-doppler type flowmeter that measures the velocity (v), in feet per second, of water flowing through a pipe. The interior pipe radius (r), in feet, was determined by measuring the outer circumference of the pipe (OC), in feet, with a tape measure and measuring the thickness of the pipe (d), in feet, with an electronic thickness gage and using the formula:

$$r = [OC / (2 * \pi)] - d, \qquad (1)$$

where π is 3.1416.
The interior pipe radius, in feet, was then converted to a cross-sectional area and multiplied by the velocity, in feet per second, to determine a volumetric flow rate (q), in cubic feet per second. The formula used is given below:

$$q = v * \pi * r^2. \qquad (2)$$

Arvin (1992) compared a number of non-invasive, portable flowmeters during a study on the feasibility of using flowmeters and time totalizers for determining water use.

Data Collection

The VTT's were installed at each site in late September 1992. A few of the farmers had already started pumping water into the ponds prior to installation of the VTT's and hours of pumping were estimated by the farmer or from utility records. The VTT's remained on the pumps until May 1994, near the end of the 1993-94 crawfish growing season. Visits to the sites were made every few weeks during the first 3 months of each season and then once every 2 to 3 months as the season progressed and pumping slowed. In a few instances where VTT's failed, hours of pumping were calculated from electric or natural gas meter readings or estimated by the farmer. Equation 3 was used to estimate hours of pumping from utility meter readings.

$$T = [M_n * (VTT_{n-1} - VTT_0) / (M_{n-1} - M_0)] - VTT_{n-1}, \qquad (3)$$

where

- T is the hours of pumping between the time the VTT was found to be inoperable and last VTT reading;
- M_n is the utility meter reading, dimensionless, at the time the VTT was found to be inoperable;
- VTT_{n-1} is the last VTT reading, in hours;
- VTT_0 is the VTT reading, in hours, at start of season (prior to initial pumping);
- M_{n-1} is the last utility meter reading, dimensionless; and
- M_0 is the utility meter reading, dimensionless, at start of season (prior to initial pumping);

Instantaneous flow measurements were made whenever pumps were running during the visits. Between one and six flow measurements were made at each site. Because measured flow rates at each pump varied from one visit to the next, flow measurements made during each season were averaged over the entire season.

Variations in discharge measurements made at each pump could be attributed to a number of factors. The motors driving the pumps, especially those running on diesel or natural gas, can usually be run at variable speeds, which produces a variable pumping rate. This is an especially important factor when more than one person is managing a pump. The replacement or repair of a pump or motor at a site can also affect the discharge rate.

Variations in surface-water stage or ground-water level also affect pumping rates. The shorter the vertical distance over which the pump must lift the water, the greater the volume of water that will be pumped. Also, many of the farms in this study use a network of underground pipes to deliver water to various areas of the farm. These pipes usually terminate with valves that can be opened or closed by the farmer. Backpressure in the system is created by closed valves. The flow velocity at the pump is dependent on the number of valves that are open or closed in this type of system.

CRAWFISH FARMING IN LOUISIANA

In 1993, Louisiana farmers used 114,928 acres for crawfish production (Louisiana Cooperative Extension Service, 1994). This acreage is in the form of shallow ponds ringed by low levees. Water is pumped into the ponds in late September or early October when daytime temperatures start to decline. The ponds usually are filled to a depth between 18 and 24 inches. The crawfish, which have burrowed into the ground during the summer to escape the summer heat, find water, and reproduce, emerge from their burrows with their young, thus producing the new crop of crawfish. At this point, farmers are concerned with maintaining both forage materials and dissolved oxygen in the ponds. Forage material generally consists of rice stubble and other volunteer or cultivated vegetation that has grown in the pond during the summer. (Crawfish feed primarily on decaying vegetation and on micro-organisms and invertebrates associated with decomposition. If food is not readily available, the new crop of crawfish will remain small in size and number.) As the plants decay, dissolved oxygen in the water is depleted. A low dissolved-oxygen concentration (less than 3 mg/L) also may stunt the growth of the crop (Thomas Lawson, Louisiana State University, oral commun., 1991). Cooler weather generally slows the decaying process and loss of water to evaporation, thereby helping to maintain dissolved-oxygen concentrations.

A common technique used by farmers to manage their ponds is a partial exchange of water, called a turnover. Water is pumped into the pond at one point and allowed to discharge at another. This causes circulation and flushing to occur, while maintaining a constant level in the pond. As the water is pumped into the pond, it is thrown into the air over one or more wire screens that break up the stream and increase aeration. This action increases the dissolved-oxygen concentration in the water. Aquaculture specialists with the Louisiana Cooperative Extension Service currently recommend 9 to 12 turnovers during the season, but admit that most farmers probably make three or fewer turnovers (Larry de la Brettone, Louisiana Cooperative Extension Service, oral commun., 1990).

The cost of pumping is a major factor in the number of turnovers a farmer will make. Pumps used for crawfish ponds are powered by motors running on electricity, diesel fuel, or natural gas. Pumping from a surface source generally requires lifting the water 5 to 15 feet from the water level of the source to the discharge into the pond. This requires relatively little fuel compared to pumping well water, which may have to be lifted many tens of feet in this area of Louisiana. In areas where the cost of pumping is expensive, a minimum withdrawal will occur and many farmers add water only to replenish water lost through soil infiltration or evapotranspiration.

Additional pumping, precipitation, and wind increase the dissolved-oxygen concentration in the ponds. However, a few farmers are now using special equipment (similar to a paddle wheel) to churn and aerate the water in their ponds. The use of this type of device is less expensive than pumping water and may reduce the amount of pumping necessary to maintain desired concentrations of dissolved oxygen in the ponds.

WATER REQUIREMENTS FOR CRAWFISH FARMING AT SELECTED SITES

Water requirements for crawfish farming were monitored at 10 farms in south-central Louisiana during the 1992-93 and 1993-94 crawfish growing seasons. Data collected at these 10 farms include total hours of pumping and pump discharge for 19 pumps at 16 sites. The amount of water applied at each site was calculated using equation 4.

$$V = t_T * Q * C / A, \qquad (4)$$

where

- V is the volume of water applied, in acre-feet per acre;
- t_T is the total pumping time, in hours;
- Q is the pump discharge or average pump discharge, in cubic feet per hour;
- C is $2.296 * 10^{-5}$ acre per square foot; and
- A is the pond area, in acres.

In three instances, two pumps were used to fill the same pond acreage, and the total water from the two pumps was combined before dividing by the pond acreage. The data for the 10 farms inventoried are listed in table 1.

The amounts of water applied to the ponds at the selected farms during the two seasons ranged from less than 1 to more than 26 acre-feet per acre (table 1). Farmers pumping exclusively from wells applied from 0.57 to 1.17 acre-feet per acre of water to their ponds during each season. The amounts of water applied by farmers pumping from surface sources were highly variable and ranged from 3.07 to 26.03 acre-feet per acre. Ponds supplied by a combination of ground and surface water received from 1.27 to 2.58 acre-feet per acre during the two seasons.

The farm that applied the least amount of water during both seasons, the Reed farm, used ground water and applied it only during the first 2 months of the season. A paddle wheel was used to mechanically aerate the water, and precipitation generally made up for losses due to evapotranspiration and soil infiltration at the Reed farm during the remainder of the season. Farms that applied large amounts of water, such as the Dugas and Drouant farms, used surface water from canals. Water in their ponds was aerated by numerous, almost constant, turnovers throughout the season. The variability in pumping schedules is illustrated in figure 3.

The amounts of water applied to ponds decreased by an average of 22 percent at 11 of the 16 sites from the 1992-93 growing season to the 1993-94 growing season (table 1). However, at the other five sites, the amounts of water applied increased by an average of 30 percent from the 1992-93 growing season to the 1993-94 growing season. The changes in the amounts applied could be due to variations in climatic conditions (rainfall or temperature) or changes in management practices.

Additional water withdrawals for crawfish may have occurred at some sites after the end of the monitored periods listed in table 1. However, water withdrawals for rice usually begin at or after this time, and it was not possible to separate withdrawals for rice from withdrawals for crawfish. Therefore, it was assumed that any additional withdrawals for crawfish that may have occurred at some sites were negligible and would have little influence on the overall results.

Table 1. Summary of water requirements for crawfish farming at selected sites in south-central Louisiana during the 1992-93 and 1993-94 growing seasons

[GW, ground water; SW, surface water; N/A, not applicable]

Site no.	Pump	Water source	Fuel	Monitored period 1992-93 season	Monitored period 1993-94 season	Total pumping time (hours) 1992-93 season	Total pumping time (hours) 1993-94 season	Discharge or average discharge (cubic feet per hour) 1992-93 season	Discharge or average discharge (cubic feet per hour) 1993-94 season	Number of discharge measurements 1992-93 season	Number of discharge measurements 1993-94 season	Pond acreage	Water applied (acre-feet per acre) 1992-93 season	Water applied (acre-feet per acre) 1993-94 season	Percent increase or decrease in the amount of water applied from the 1992-93 season to the 1993-94 season
1	Fontenot pump 1	GW	electric	9-25-92 - 3-26-93	9-16-93 - 2-18-94	565.84[a]	285.68	7,443	11,277	2	2	175 (58)[b]	1.27	1.52	+25
	Fontenot pump 2	SW	electric	9-25-92 - 2- 9-93	9-16-93 - 2-18-94	372.99	26.68	14,638	23,204	1	1				
2	Fontenot pump 3	GW	electric	9-25-92 - 2- 9-93	9-16-93 - 2-18-94	240.55	50.79	19,579	([c])	2	0	110 (30)[b]	0.98	0.76	-22
3	Reed pump 1	GW	natural gas	9-25-92 - 2- 9-93	9-16-93 - 2-18-94	116.34	91.25	6,697	7,668	1	1	28	0.64	0.57	-11
4	LaHaye pump 1	GW	natural gas	9-25-92 - 3-26-93	9-16-93 - 2-18-94	518.05	166.53	5,502	21,135	2	1	300	0.98	0.75	-23
	LaHaye pump 2	GW	electric	9-25-92 - 2- 9-93	9-16-93 - 2-18-94	695.23	532.86	14,293	11,783	2	1				
5	Cramer pump 1	GW	natural gas	9-25-92 - 2- 9-93	9-16-93 - 2-18-94	173.73[d]	241.98[e]	7,564	8,414	1	1	40	0.75	1.17	+56
6	Clearwater pump 1	SW	diesel	9-31-92 - 3-26-93	9-19-93 - 4-18-93	581.35[f]	563.02	34,666	([c])	2	0	123	3.76	3.64	-3
7	Clearwater pump 2	SW	diesel	9-31-92 - 3-29-93	9-19-93 - 4-18-94	1,188.29	1,167.32	94,100	67,584	2	2	589	4.36	3.07	-30
8	Clearwater pump 3	SW	diesel	9-31-92 - 3-29-93	9-19-93 - 4-18-94	404.46	487.23	70,471	43,248	2	2	142	4.61	3.41	-26

Table 1. Summary of water requirements for crawfish farming at selected sites in south-central Louisiana during the 1992-93 and 1993-94 growing seasons — Continued

Site no.	Pump	Water source	Fuel	Monitored period 1992-93 season	Monitored period 1993-94 season	Total pumping time (hours) 1992-93 season	Total pumping time (hours) 1993-94 season	Discharge or average discharge (cubic feet per hour) 1992-93 season	Discharge or average discharge (cubic feet per hour) 1993-94 season	Number of discharge measurements 1992-93 season	Number of discharge measurements 1993-94 season	Pond acreage	Water applied (acre-feet per acre) 1992-93 season	Water applied (acre-feet per acre) 1993-94 season	Percent increase or decrease in the amount of water applied from the 1992-93 season to the 1993-94 season
9	Clearwater pump 4	SW	diesel	9-31-92 - 3-29-93	9-19-93 - 4-18-94	1,091.67	1,220.15	26,870	23,685	2	3	172	3.91	3.85	-2
10	Dugas pump 1	SW	electric	9-28-92 - 3-29-93	9-15-93 - 4-18-94	2,293.93[g]	2,060.74	30,640	22,426	2	2	62	26.03	17.11	-34
11	Degeyter pump 1	SW	electric	9-16-92 - 3-29-93	9-19-93 - 4-18-94	2,525.88[h,i]	2,302.15	30,608	28,145	4	2	150	12.30	9.92	-19
12	Drouant pump 1	SW	electric	9-16-92 - 3-19-93	9-19-93 - 4-18-94	2,962.46[j]	1,364.14	36,334	39,872	4	1	57	([k])	21.90	N/A
13	Huval pump 1	SW	electric	9-28-92 - 3-29-93	9-19-93 - 4-18-94	903.24	986.47	7,524	9,176	2	2	100 (pumps 1 and 2)	1.89	2.58	+36
	Huval pump 2	GW	electric	9-28-92 - 3-29-93	9-19-93 - 4-18-94	554.58	863.28	2,591	2,510	2	1				
14	Allee pump 1	SW	diesel	9-30-92 - 3-26-93	9-15-93 - 4-25-94	530.48	533.85	15,232	([c])	1	0	18	10.60	10.67	+1
15	Allee pump 2	SW	diesel	9-30-92 - 3-26-93	9-15-93 - 4-25-94	669.35	922.10[l]	13,708	([c])	2	0	18	12.04	16.58	+38
16	Allee pump 3	SW	diesel	9- 1-92 - 3-26-93	9-15-93 - 4-25-94	636.55[m]	382.45[n]	14,470	18,223	3	2	29	7.29	5.52	-24

[a]Hours of pumping during the period 9-1-92 and 9-25-92 were calculated from electrical meter readings.
[b]Pond acreage during the 1993-94 season.
[c]No discharge measurements were made during the 1993-94 season. The average discharge for the 1992-93 season was used to calculate the amount of water applied during the 1993-94 season.

[d]Hours of pumping during the period 9-20-92 to 9-25-92 were estimated by the farmer.

[e]Hours of pumping during the period 9-16-93 to 10-8-93 were calculated from natural gas meter readings.

[f]Incomplete record due to an inoperable VTT (vibrational time totalizer) during the period 11-25-92 to 2-9-93.

[g]Hours of pumping during the period 9-1-92 to 9-28-92 and the period 11-25-92 to 2-9-93 were calculated from electric meter readings.

[h]Degeyter pump 1 was inoperable for a period during the early part of the 1992-93 season. During this time, water from Drouant pump 1 was applied to the Degeyter pond.

[i]Hours of pumping during the period 9-16-92 to 9-28-92 were calculated from electrical meter readings.

[j]Hours of pumping during the period 9-16-92 to 10-19-92 were calculated from electrical meter readings.

[k]Water applied at this site was 43.35 acre-feet per acre. However, this number maybe somewhat misleading, because water from the Drouant pond was allowed to flow into the larger, adjacent Degeyter pond during a period in the 1992-93 season in which Degeyter pump 1 was inoperable. Therefore, water from Drouant pump 1 was actually being applied to 207 acres for part of the season. However, there was no way to estimate how much water flowed into the Degeyter pond. If all water applied to the two sites during the 1992-93 season is combined and divided by the total pond acreage of the two sites, the volume of water applied is 20.51 acre-feet per acre.

[l]Hours of pumping during the period 10-7-93 to 10-28-93 were estimated by the farmer.

[m]Incomplete record due to an inoperable VTT during the period 11-24-92 to 2-12-93.

[n]Incomplete record due to an inoperable VTT during the period 9-16-93 to 10-7-93.

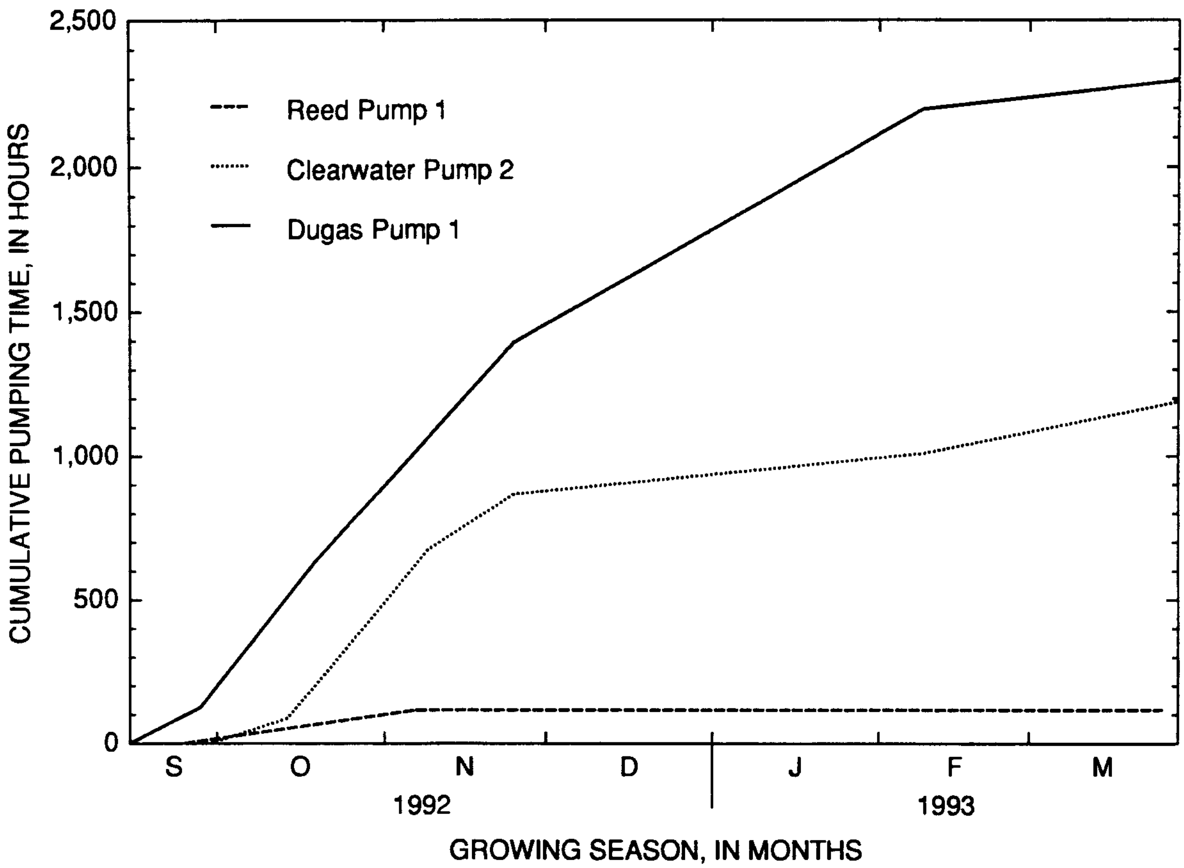

Figure 3. Cumulative pumping time at selected crawfish farms in south-central Louisiana during the 1992-93 growing season.

SUMMARY

More than 100,000 acres of land are used for crawfish farming in Louisiana. Aquaculture specialists report that crawfish ponds are flooded with water from ground and surface sources to a depth between 18 and 24 inches each year. Water levels and water quality in the ponds usually are maintained by pumping additional water into the ponds during the crawfish growing season, September through May. The amounts of water applied to ponds during the season may vary greatly from farm to farm, depending on the cost of pumping water and individual farming practices.

To estimate the total amount of water farmers apply to crawfish ponds during a season, water withdrawals at 16 sites on 10 crawfish farms in south-central Louisiana were monitored during the 1992-93 and 1993-94 crawfish growing seasons. Vibrational time totalizers were used to record pumping time, and a portable flowmeter was used to make instantaneous flow measurements at 19 pumps on the farms. The amount of water applied at each site was calculated by multiplying the total pumping time by the average discharge rate.

Farmers using only ground water applied from 0.57 to 1.17 acre-feet per acre of water to crawfish ponds during each season. The amounts of water applied to ponds by farmers pumping from surface sources were highly variable and ranged from 3.07 to 26.03 acre-feet per acre. Ponds supplied by a combination of ground and surface water received from 1.27 to 2.58 acre-feet per acre during each season. From the 1992-93 growing season to the 1993-94 growing season, the amounts of water applied to ponds decreased at 11 sites by an average of 22 percent, but increased at the other 5 sites by an average of 30 percent. However, the acreage of the monitored ponds represents only approximately 2 percent of the total acreage of crawfish ponds in Louisiana.

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