Aquaculture/Marine Fisheries Process Wastewater

Project Completion Report

Bill Branch

Louisiana Cooperative Extension Service

LSU Agricultural Center

September 15, 1990

Acknowledgement:

The activities on which this report is based were financed in part by the Department of Interior, U. S. Geological Survey, through the Louisiana Water Resources Research Institute.

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Abstract:

Wastewater samples from alligator production/processing facilities, and from crawfish, catfish and crab processing plants were collected and analyzed to determine quality and quantity characteristics which would help producers/processors prepare permit applications and/or reduce costs of managing wastewater and help the Louisiana Department of Environmental Quality establish wastewater discharge permits, consultants design treatment systems. Little data was previously available to characterize alligator or crawfish wastewater and for small plants processing other species.

Results from alligator wastewater analysis indicated considerable variation between facilities and within facilities depending on time of sample collection. Crawfish processing wastewater varies with the process being sampled and time of day of sampling. Boiling process generates strongest effluent. Catfish and crab samples varied somewhat from published data. Technology transfer programs with Fisheries Agents, regulatory agency staff and producers/processors have been instrumental in increasing understanding of problems and probable solutions.

Purpose and Research Objectives:

Consumption of seafood and aquacultural products is increasing as a result of raised levels of health consciousness among Americans. Louisiana's fisheries produce more tonnage than any other state. Marine fisheries and aquacultural production rank second only to forestry in terms of cash receipts to producers of food and fiber in Louisiana. Value added in forestry, however, is several times as great as receipts by producers, whereas value added in aquaculture/marine fisheries is approximately equal to receipts by producers. Much of Louisiana's aquacultural/marine fisheries harvest is shipped out of state after little or no processing. Economic development goals include increasing processing which will lead to more value added to product and more income in the state.

Current processing is dispersed among more than 600 plants. The Louisiana Department of Environmental Quality (DEQ) is developing point source discharge permits for all aquacultural/marine fisheries processors. There is little data available to characterize the quality and quantity of wastewater produced by small processors of any aquacultural/seafood commodity. Species unique to Louisiana, such as alligator and crawfish, have received little attention. Without adequate data, DEQ will have to estimate parameters and levels to be regulated, consultants will have to estimate characteristics for design purposes and, all producers/processors will face higher costs of attaining required treatment levels. The smaller producers/processors will bear a disproportionally high cost of achieving discharge standards.

This project was intended to develop data useful to the industry in their efforts to meet water quality goals and to consultants and DEQ. Effort was to be focused on those species for which the least data existed, alligators and crawfish. Evaluation of existing treatment systems was considered desirable. After data was collected, agency field staff were to be informed of data and assisted in transferring information to the producers/processors and consultants.

Related Research:

Malone and Zachritz (1) completed a study for DEQ in 1988 which examined seafood processing in Louisiana in light of pending point source permitting actions by DEQ. They described the processing of shrimp, oysters, blue crab, crawfish, and edible and inedible finfish. They provided data characterizing quality and quantity of wastewater generated and suggested treatment alternatives which would allow attainment of various discharge permit standards.

Joanen collected and Kuss analyzed (2) wastewater samples from alligator research facilities in 1978. The data was used to design at least one alligator wastewater lagoon system.

Bankston, et al, (3) collected wastewater samples from two crawfish processing plants in 1983, 1985, and 1986. The data was analyzed and has been used for design purposes.

Payne (4) obtained data from a small catfish processor and developed anaerobic and aerobic lagoon and septic tank-field line recommendations for wastewater treatment.

Seafood processing wastewater and treatment has been described in several documents, including EPA (5), (6), (7), Wheaton (8), Pohland (9), Carawan (10), Lomax (11), and Wheaton (12).

An economic analysis by EPA (13) indicated that closures due to costs of implementing wastewater treatment technologies would occur most frequently in smaller plants.

Fuller (14) reported that larger plants could more readily afford capital intensive byproduct recovery systems which help defray the costs of wastewater treatment systems.

Methods and Procedures:

Louisiana Cooperative Extension Service (LCES) Fisheries Agents and County Agents located in appropriate parishes were contacted and asked to make arrangements with local producers/processors of alligators and crawfish to collect grab samples of wastewater for analyses. Samples were collected in containers with appropriate preservatives which were provided by commercial wastewater analysis labs in the area. Samples were maintained on ice until delivery to lab within specified time limits as determined by parameters selected for analysis. Agents were asked to determine characteristics pertinent to each source that might help explain variation in data. In some cases additional data such as from water meters was collected. A small number of samples were taken from crab and catfish sources for comparison with data available from the literature. Based on results of preliminary data analysis and discussions with knowledgeable professionals, parameter selection was occasionally modified to reduce analytical cost.

Training sessions were held with Fisheries Agents who then arranged for producer/processor meetings in which status of regulations, probable treatment efficacies, data and treatment costs were discussed. Agent training was conducted by Gary Aydell and Jim Delahoussaye, DEQ, Office of Water Resources, Permits Section, and Dr. Ron Malone, Professor, Sanitary Engineering, and Dr. Marty Tittlebaum, Associate Director, Institute of Recyclable Materials, LSU Department of Civil Engineering. Meetings with producers/processors were conducted by Fisheries Agents and included Dr. Malone; Gary Aydell, Jim Delahoussaye, and other DEQ staff; Harry Hawthorne, Chief Engineer, USDA SCS, and SCS Area

Engineers; Charles Conrad and other representatives of the Department of Health and Hospitals; and Larry de la Bretonne, Jim Avery and Dr. David Bankston, Aquacultural and Marine Fisheries Specialists with LCES.

Principal Findings and Significance:

Alligators:

Alligator producer/processors grow animals in pens which contain shallow water and some area above water. The hatchlings grow from a few inches in length in September to three feet or longer within 12 - 18 months, at which time they are harvested for hides and meat. Feed is provided 3-7 times per week. Pens are drained and filled with clean water 3-7 times per week. Feed is pelletized from commercial sources or may be ground fish or nutria. Rations are carefully formulated to maximize growth. Barns and water are kept close to 95°F. Water flow appears to average about 2 gallons per animal per day, but varies from 1.5 to 3.3. Lagoons were the most frequent treatment system. They were generally shallow with two or three ponds in series. The only previous data found was the 1977 Rockefeller Wildlife Refuge research (2). The means of barn effluent and lagoon sample data collected in this study are comparable to the 1977 data. See Table 1.

Table 1

Alligator Wastewater Data
(mg/1)

Parameter	Barn Effluent	Lagoon Effluent	Previous Data
BOD_5	432	233	324
COD	798	686	
TS	900	5415	
TSS	498	235	
VS	446	860	
TKN	95	96	
NH_3	66	62	135
O&G	97	97	

Nitrate-nitrite was determined for several samples. One sample was reported as 0.3 mg/1, and the rest as <0.05 mg/1. No further testing for nitrate-nitrite was done.

Several samples were tested for fecal coliform. All results were "too numerous to count". No further testing for fecal coliform was done. Alligators are cold-blooded animals and initial assumptions were that fecal coliform testing was not required. The fecal coliform may come from the alligators or from their feed.

Feeding and flushing variations contributed to much of the variation in data. Several different types of feed are used. Some growers feed and flush daily and some feed and flush three times each week. Time of day and day of week of sampling will have a significant effect on results. Flushing occurs in less than two hours. One sample taken at the end of a flush had much higher values than other samples taken before or during flushing on the same farm. Strength of waste increases with age and weight of animal but many growers have several sizes in various pens in the barn at the same time, so that total barn effluent strength does not necessarily increase with time during the growing season. Samples taken from nursery or baby pens had lower strength values and were not included in Table 1.

Some farms had consistently stronger effluent than others with no, as yet, verifiable explanation. Excess or wasted feed could be expected to contribute significantly to effluent quality. Some producers do not dress out their own animals so that processing wastes are not necessarily present in their wastewaters. No effort was made to separate these possible contributing factors.

The last pond frequently had algal growth. These samples were much darker in color than the barn effluent or alligator pen samples. This contributed significantly to the lagoon values shown in Table 1. Treatment was occurring, but discharge standards could not be met without some kind of polishing technique.

Crawfish:

Crawfish processors generally wash, boil, peel and pack. Some plants include more steps and some less. Previous work (3) indicates water flow of about 400 gallons per 1000 pounds live weight processed per day and increasing strength with decreasing production. Sanitary wastes may or may not be included in the treatment loads. In most plants, flows from washing, boiling, packing and wash down are not separated. Septic tanks and lagoons are the most frequently used treatments. Means of data for plant effluent and treatment lagoons are shown along with data from Bankston in Table 2.

Table 2

Crawfish Processor Wastewater Data
(mg/1)

Parameter	Plant Effluent	Lagoon Effluent	Previous Data
BOD_5	718	97	1014
COD	1536	205	
TS	2027	1179	
TSS	593	207	467
VS	1071	789	
TKN	99	57	
NO_3	2		
NH_3	43	37	
O&G	181		

Nitrate-Nitrite was measured in several samples and found to average 2 mg/1. It was eliminated as a parameter for the rest of the testing.

Fecal coliform was determined to be "too numerous to count" in several samples and was eliminated from further testing.

Considerable variation in parameter values occurs depending on where the sample is collected. Highest values were found in boiling water discharge.

Water flow rates and pounds live weight processed on days of sampling were not determined. Variations in processing steps between processors were not determined.

Lagoon effluent indicates some treatment has occurred but not enough to meet discharge standards. Sumps, grease traps and septic tanks were sampled where found but no large treatment effects were observed and results were not included in Table 2.

No attempt was made to determine design parameters such as hydraulic detention time or operating parameters such as level of maintenance of sumps, grease traps, septic tanks or lagoons.

<u>Catfish:</u>

Catfish processing samples were taken from two plants and hauling tank water samples were taken at one plant. Data were considerably higher than found in the literature in most cases. See Table 3.

Table 3

Catfish Processing Plant Data
(mg/l)

Parameter	Value	Previous Data
BOD_5	908	340
COD	2521	
DS	1215	
SS	3959	
VSS	350	
TKN	167	
NH_3	12.7	
NO_2	0.04	

Crab:

Crab processing samples were taken from two plants. Values were lower than found in the literature except for suspended solids which were much higher from one plant. Considerable variation can be found depending on time of day that sample is taken. Crab processing is very similar to crawfish processing and may be done in the same plant. Refrigeration capacity for quick cooling of boiled crabs is generally lacking so that picking may occur very late at night. Wash down water should be very strong at this time but samples taken of effluent being discharge early in the morning may show very light loadings. See Table 4.

Table 4

Crab Processing Plant Wastewater Data
(mg/l)

Parameter	Value	Previous Data
BOD_5	1204	4400
COD	20178	
DS	9674	
VS	4223	
TSS	30025	620
VSS	2726	
TKN	315	
NH_3	17	50
NO_2	0.23	
O&G		220

Conclusions:

Data indicates considerable variation in quality of wastewater between facilities and within facilities depending on time of day of sampling and process being sampled. DEQ, consultants and producers/processors must be cautious in sampling if representative values are to be obtained. Sampling over a daily processing/feeding-flushing cycle would be preferred to obtain a composite sample. Sampling each facility rather than relying on industry averages would be preferred.
Data was collected which will be of value to DEQ in establishing standards, to consultants in designing treatment systems, and to producers/processors in applying for permits. Results of the project include better informed Fisheries Agents with information which has been included in training of producers/processors to reduce their wastewater management costs and improve the quality of discharges.

Publications and Professional Presentations: Project Completion Report available from Louisiana Water Resources Research Institute or from the Louisiana Cooperative Extension Service.

M.S. Theses/Ph.D. Dissertations: None

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Appendices:

APPENDIX 1
ALLIGATOR WASTEWATER DATA

Farm	Sample	BOD5	COD	TS	TSS	VS	TKN	NH3	NO3 NO2	O&G	FC
1	1/90 GOM	160	320	690	212	242	145	80	<0.05	-	-
1	1/90 NURM	110	170	365	74	142	28	21	<0.05	-	-
1	1/90 GOT	1200	2720	2110	1800	988	190	106	<0.05	150	-
1	7/90 GOF	30	32	343	53	206	58	34			
1	9/89	1372			1700						
1	Lagoon2	120	185	862	202	693	130	102			
2	1/90 GOM	24	62	541	75	196	28	23	0.3		
2	1/90 GOT	260	715	903	394	474	66	26	<0.05	10	
2	7/90 GOF	50	51	466	110	274	62	39			
2	9/89 BSCR	258			360						
2	9/89 AFLTR	467			340						
3	7/90 1 YRM	12	204	732	103	432	71	70		<2	TNTC

Alligator Wastewater Data

Farm	Sample	BOD5	COD	TS	TSS	VS	TKN	NH3	NO3	NO2	O&G	FC
3	7/90 2 YRM	14	183	398	25	298	54	50			<2	TNTC
3	7/90 DRAINTH	540	4270	3040	1280	1490	212	161				
3	Lagoon	45	153	596	83	414	36	30				
4	5/90 PKG	1300	3710	3750		2660						
4	5/90 Lagoon	260	879	22,600		1860						
4	7/90 PKG	3350	4250	6071	3820	3820	268	160				
4	7/90 Lagoon	200	362	1486	287	1063	157	105				
5	7/90 GO	1300	2800	1660	652	496	194	118			158	TNTC
5	7/90 Lagoon (IN)	540	1850	1530	369	268	61	12			97	TNTC
6	7/90 SUMP	468	890	1160	650	850	79	14			68	TNTC
7	9/89 NUR	62			65							
	8/16		1600				189					TNTC

APPENDIX 2
CRAWFISH PROCESSING PLANT WASTEWATER DATA

Plant	Sample	BOD_5	COD	TS	TSS	VS	TKN	NH_3	NO_3-NO_2	O&G	FC
1	XBoiler San?	2500	4270	5140	654	2940	361	63	<0.05	119	TNTC
2	Wash Down	365	453	1350	304	990	62	25	2.8	780	170,000
2	Same	75	402	888	87	284	11	2	0.6	20	TNTC
2	Wash Down & San	180	342	1770	1340	602	22	15	0.2	5	TNTC
2	Conveyor/ Auger	1300	811	2840	418	1800	110	66	6.2	1850	700,000
2	Same	480	370	1880	50	1140	26	6	0.2	3	TNTC
3	Plant San	78	162	456	39	114	7	2	0.8	4	
4	Plant San	160	583	3460	2930	1390	25	2	<0.05	62	TNTC
5	Septic Tank	1050	992	2560	810	1840	210	138	9.4	135	900,000

CRAWFISH PROCESSING PLANT WASTEWATER DATA

Plant	Sample	BOD_5	COD	TS	TSS	VS	TKN	NH^3	NO^3-NO^2	O&G	FC
6	Sump	320	595	1350	92	276	27	14	<0.05	4	TNTC
7	Boiler	3800	12200	2630	1440	1810	330	240	16	132	$20X10^6$
7	Septic Tank X Boiler	640	899	2750	562	1710	160	94	2	294	500,000
7	2 Lagoons	210	203	1130	76	610	140	91	4	11	300,000
8		750	1790	2430	376	1230	137	31	0.2	89	
9		44	338	934	37	358	4	<1	0.2	33	TNTC
10		370	2730	1070	439	230	176	30	0.3	103	
11		1500	2890	2150	379	824	161	13	0.3	38	
12		360	514	2310	1520	1510	95	58	1.7	157	$2.2 X 10^6$
13		300	436	1790	212	940	52	30	1.2	12	$3.5 X 10^6$
13		270	341	1560	247	870	132	80	1.0	42	800,000
14		390	695	1950	117	1310	35	27	<0.05	47	
14	1Lagoon		42	67	925	64	563	18	10		
14	2Lagoon		40	346	1481	480	1193	14	9		

CRAWFISH PROCESSING PLANT WASTEWATER DATA

Plant	Sample	BOD_5	COD	TS	TSS	VS	TKN	NH^3	NO^3-NO^2	O&G	FC
15	Floor Drain	300	1130	1720	564	724	36	7	<0.05	12	TNTC
16	Floor Drain	570	841	1610	436	678	6	<1	<0.05	33	TNTC

Appendix 3
CATFISH PLANT WASTEWATER DATA

	Effluent		Septic Tank & Grease Tray		Truck		Skinner	
	A_1	A_2	B_1	B_2	T_1	T_2	E_1	E_2
BOD	852	517	731	813	741	803	1441	1369
COD	>2800	2600	>2800	>2800	1920	1890	2680	2680
DS	1427	1379	1015	1051	796	793	1569	1695
SS	4744	4669	4553	4883	1137	1144	5260	5284
VSS	524	450	322	291	68	69	515	558
TKN	101	101	179	137	67	127	304	320
NH_3	10.9	9.7	13.8	16.2	15	14	11.28	10.94
NO_2	.04	.03	.05	.03	.05	.03	.03	.04

APPENDIX 4
CRAB PROCESSING PLANT WASTEWATER DATA

CRAB	JZ	C_1	C_2	D_1	D_2
BOD	16	1288	1461	1568	1686
COD	52	2600	22,800	2640	72,800
TS	2910				
VS	445	8000			
VSS			7637	191	351
TSS	35	70,000	70,000	4943	5149
DS		18,000	16,000	2316	2379
TKN	9	357		441	452
NH_3	8.5		25.		
NO_3	<0.1	0.3	.3	0.4	.03
O&G	4				