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National Animal Health Monitoring System

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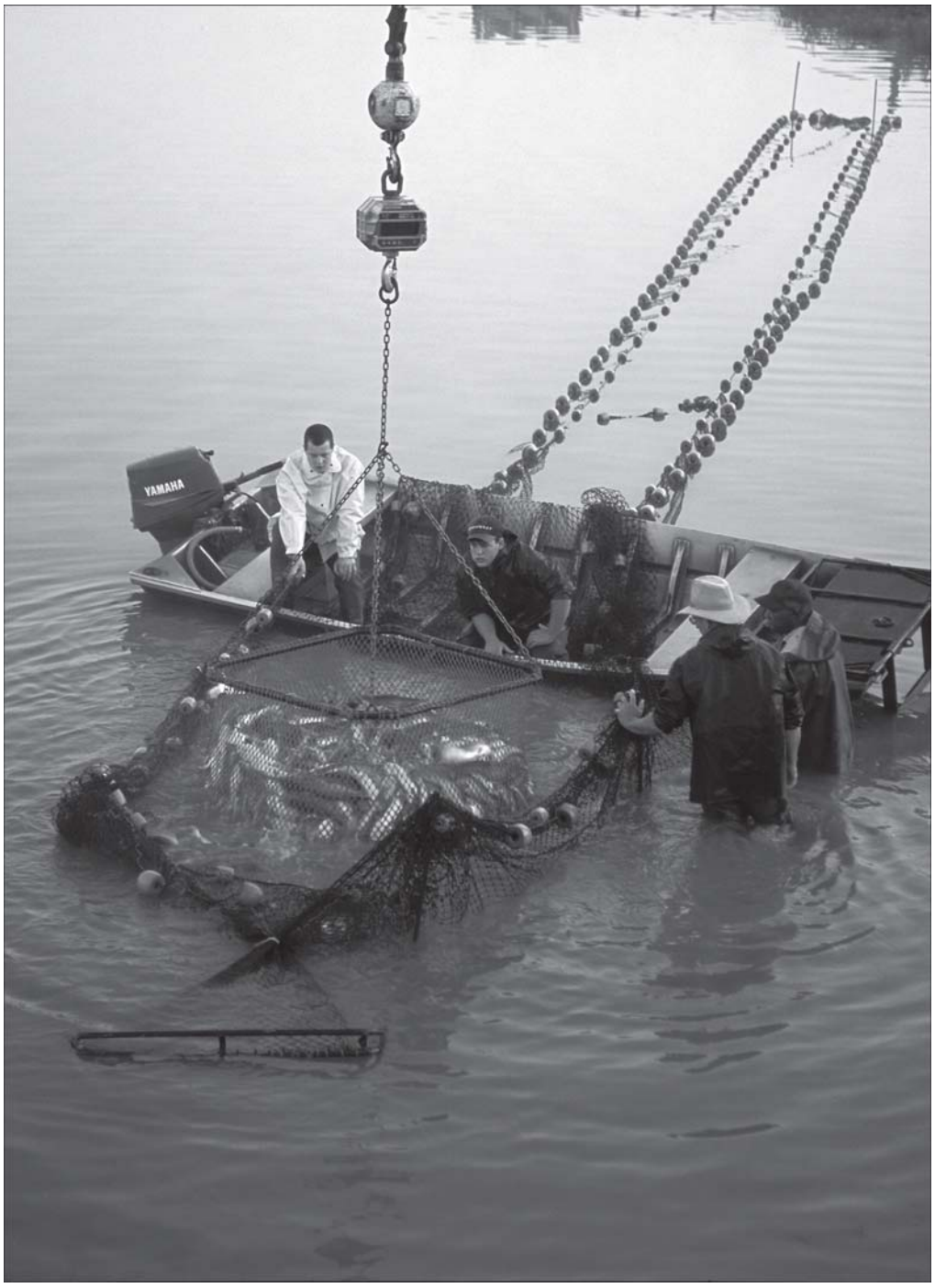
Catfish 2010

Part II: Health and Production Practices for Foodsize Catfish in the United States, 2009



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Items of Note

The Catfish 2010 study represents the third study of the catfish industry conducted by the National Animal Health Monitoring System. Catfish 2010 takes a broad look at management, production, and health practices across the various facets of the catfish industry, including breeding, hatching, and foodsize-fish growout. The study builds upon knowledge obtained from previous studies and examines new topics important to the industry. This report focuses on the foodsize-fish production segment of the catfish industry.

Channel x blue hybrid catfish

Recent improvements in the ability to produce eggs and fry from the cross breeding of female channel catfish with male blue catfish have increased the availability of the hybrid for use in foodsize-fish production. The hybrid was raised on approximately one of five foodsize-fish operations, with 21.2 percent of operations having hybrid fish present on January 1, 2010; however, the hybrid accounted for only 5.9 percent of that day's inventory. Hybrid catfish were harvested from 12.7 percent of operations during 2009. The difference in the percentage of operations that raised the hybrid compared with the percentage that harvested the hybrid in 2009 may reflect new addition of the hybrid to many operations. Producers who raised both channel catfish and the channel x blue hybrid catfish were asked about their perception of the two catfish types' resistance to certain diseases. Most producers (85.5 percent or higher) did not know if one type was more resistant to disease than the other. For those producers who saw a difference, however, the hybrid was perceived to be more resistant to disease.

Causes of loss of foodsize fish

Causes of foodsize-fish loss include predation, low dissolved oxygen, and infectious diseases. Although producers are often able to identify the predominant causes of loss affecting their growout ponds, it is difficult for them to quantify the losses. Losses due to predation occurred on 53.9 percent of operations during 2009, while two bacterial diseases—enteric septicemia of catfish and columnaris—caused losses on 36.6 and 39.0 percent of operations, respectively. Higher percentages of operations in the East region than in the West region lost fish to these two bacterial diseases. Low dissolved oxygen caused fish loss on 28.1 percent of operations. The magnitude of fish losses can vary considerably by cause and by loss event. More than half of producers (53.2 percent) who lost any foodsize fish to "other" causes of loss reported the severity of those losses as severe (losses greater than 2,000 pounds of fish per mortality event). More than two-thirds of these "other" losses were attributed to *Aeromonas*. About one-fourth of operations categorized average losses due to anemia and trematodes as severe.

Off-flavor issues

Off-flavor in catfish is typically caused by metabolites produced by algae. Although the off-flavor condition is transient, processers reject fish that are off-flavor. Delays in harvest caused by off-flavor episodes have economic consequences for producers and processors. Off-flavor problems delayed the harvest of some fish on 80.7 percent of operations in 2009. The average delay in harvest was 15 to 60 days for 69.7 percent of foodsize-fish operations that had harvest delays in 2009.

Flesh discoloration at processing time

Recently, anecdotal reports have noted problems with discolored flesh (red flesh and yellow flesh) in fish being processed. Some people have suggested that red flesh is a harvest problem and that yellow flesh is associated with feed, but the causes of the discolorations are not known. Producers can receive lower payments, or dockage, at processing time when these conditions are present. Overall, 13.3 percent of operations had dockage at processing during 2009 because of red flesh in fish. Only 3.2 percent of operations had dockage during 2009 because of yellow flesh in fish. A higher percentage of operations in the largest size category (150 or more surface acres for foodsize fish) than operations in the smaller categories had dockage due to yellow flesh.

Laboratory diagnosis of *Aeromonas*

Almost 10 percent of operations (9.9 percent) had fish mortalities primarily due to *Aeromonas* that were diagnosed by a diagnostic laboratory; the vast majority of the losses occurred in the East region compared with the West region (15.8 and 0.6 percent, respectively).

Acknowledgments

This report was a cooperative effort between two U.S. Department of Agriculture (USDA) agencies: the National Agricultural Statistics Services (NASS) and the Animal and Plant Health Inspection Service (APHIS).

We thank the NASS enumerators who contacted catfish producers and collected the data. Their hard work and dedication were invaluable. We also appreciate the efforts of many individuals from universities, State and Federal agency employees, and producers who helped develop the study objectives and create the survey instrument. We also thank the personnel at the USDA–APHIS–Veterinary Services' Centers for Epidemiology and Animal Health for their efforts in generating and distributing this report.

All participants are to be commended, particularly the producers whose voluntary efforts made the Catfish 2010 study possible.

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Introduction

Catfish 2010 is the third study of health and production management practices on U.S. catfish operations by the National Animal Health Monitoring System (NAHMS). NAHMS, a nonregulatory program of the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS), is designed to help meet the Nation's animal-health information needs.

NAHMS' first study of the catfish industry, Catfish '97, was the first national examination of production and health management practices for the industry. The second national study, Catfish 2003, also examined production and health management practices, but in more detail than the initial study. Catfish 2003 also focused on breeding and fingerling management, prevalence of disease problems, and the issue of off-flavor in foodsize-fish production systems.

Catfish 2010 was also designed to provide participants and the industry with valuable information about production and health management practices used on U.S. catfish operations. The third study, which focused primarily on practices used during 2009, also examined vaccination practices and the use of hybrids of channel and blue catfish, and it evaluated in more depth the trends in practices over time.

This report is the second in a series of reports documenting Catfish 2010 results. Specific objectives of Catfish 2010 are described in Section II (Methodology).

The USDA's National Agricultural Statistics Service (NASS) collaborated with APHIS Veterinary Services to query catfish producers in four participating States: Alabama, Arkansas, Louisiana, and Mississippi. These four States represented the Nation's major catfish-producing States, accounting for the following aspects of catfish production:

- 53.5 percent of all U.S. catfish operations for January 2008;
- 91.5 percent of the total national catfish sales in 2009; and
- 91.3 percent of the water surface acres to be used for catfish production from January 1 through June 30, 2010.

In January 2010, NASS enumerators administered a questionnaire—either by phone or through a personal visit—to all known catfish producers in the four participating States. The overall usable response rate was 83.9 percent, with 424 respondents to the questionnaire (Alabama had 127 respondents, Arkansas had 77, Louisiana had 13, and Mississippi had 207).

All NAHMS Catfish 2010 publications are based on data collected from these producers during this one collection period. The major publications are described below:

- Part I: Reference of Catfish Health and Production Practices in the United States, 2009—focuses on aspects of disease and production of catfish fingerlings;
- Part II: Health and Production Practices for Foodsize Catfish in the United States, 2009—focuses on aspects of disease and production of foodsize fish;
- Part III: Reference of Catfish Health and Production Practices in the United States, 2009—trends.

The methodology used in Catfish 2010 is documented in the last section of each report.

Further information on NAHMS studies and copies of reports are available at http://www.aphis.usda.gov/nahms

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Study Objectives and Related Outputs

1. Investigate foodsize-fish production practices
    - Part II: Health and Production Practices for Foodsize Catfish in the United States, 2009, July 2011

2. Describe fingerling production practices
    - Part I: Reference of Catfish Health and Production Practices in the United States, 2009, December 2010
    - Part III: Changes in the U.S. Catfish Industry, 1997–2009, expected June 2011

3. Address a broad range of fish health issues
    - Part I: Reference of Catfish Health and Production Practices in the United States, 2009, December 2010

4. Quantify the magnitude of the problem of off-flavor
    - Info sheets, expected summer 2011

Terms Used in This Report

Algal toxins: Algae-produced chemicals that can kill fish.

Alkalinity: The quality in water that neutralizes acids, especially calcium sulfate or bicarbonate, measured in mg/L $CaCO_3$, and usually expressed as ppm.

Breeding operation: For this study, a breeding operation is defined as one that breeds catfish for egg collection.

Broodfish: Adult catfish (male and female) intended for use in spawning.

Channel x blue hybrid catfish: First-generation offspring from an artificial mating of a female channel catfish and a male blue catfish.

ESC: Enteric septicemia of catfish, an economically important bacterial disease of catfish; also known as hole-in-head disease.

Fingerling: This study defined fingerling fish according to the National Agricultural Statistics Service's weight-based size category of 2 to 60 pounds per 1,000 fish. Typically, fish considered to be fingerlings and falling into this weight-based category would be about 1 to 8 inches long.

Foodsize fish: Fish of marketable size, generally more than 10 inches long and up to 3 pounds in weight.

Fry: Newly hatched fish less than 1 inch long.

Growout: The process of raising fingerlings to harvest size (generally 1.3 to 3.0 pounds).

Growout pond: Typically, pond in which fingerlings are stocked and allowed to grow until they attain harvest size.

Hardness: The quality in water that is imparted by the presence of dissolved chemical compounds, especially of calcium or magnesium, often expressed as ppm.

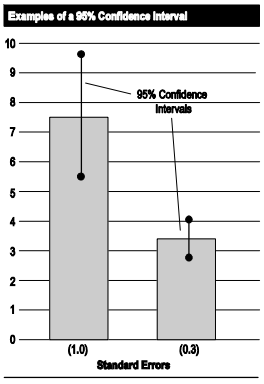
Hatchery: Portion of operation devoted to hatching of eggs and the initial rearing of fry.

Ich (pronounced "ick"): Also known as white spot disease, ich is caused by a protozoan parasite, *Ichthyophthirius multifiliis*. Ich typically occurs in freshwater fish and is characterized by white nodules on the skin that can rupture, releasing thousands of new infective parasitic forms. Many affected fish die. Ich can also infest the gills.

Multibatch (or multiple batch) production: A production method In which ponds are incompletely harvested and then restocked with fingerlings. This method is considered to be continuous production (compare with single-batch production).

Operation average: The average value for all operations. The value reported for each operation is summed for all operations reporting; the sum is then divided by the number of operations reporting. For example, operation average number of fish stocked per acre (shown on p 17) is calculated by summing the reported average number of fry hatched over all operations divided by the number of operations.

Pond-run channel catfish: Fish originating from foodsize-fish production ponds that lack the documented history of genetic improvement that is usually associated with identifiable broodfish lines. (Some hatcheries might perform some type of mass selection, such as retaining the largest fingerlings, or fingerlings from the earliest spawn, to use as broodfish. Such fish might be called “unselected commercial lines.”)



Population estimates: Estimates in this report are provided with a measure of precision called the **standard error** (abbreviated within as Std. Error). A 95-percent confidence interval can be created with bounds equal to the estimate plus or minus two standard errors. If the only error is sampling error, the confidence intervals created in this manner will contain the true population mean 95 out of 100 times. In the example to the left, an estimate of 7.5 with a standard error of 1.0 results in limits of 5.5 to 9.5 (two times the standard error above and below the estimate). The second estimate of 3.4 shows a standard error of 0.3 and results in limits of 2.8 and 4.0. Alternatively, the 90-percent confidence interval would be created by multiplying the standard error by 1.65 instead of 2. Most estimates in this report are rounded to the nearest tenth. If an estimate was rounded to 0, the standard error was reported (0.0). If there were no reports of the event, no standard error was reported (—).

Raceway: A fish culture unit with a continuous flow of water.

Regions:

- **East:** Alabama and eastern Mississippi.
- **West:** Arkansas, Louisiana, and the delta of Mississippi.

Renovation: The draining and drying of ponds, followed by collection and use of accumulated sediments from the pond bottom for rebuilding of levees.

Sac fry: Newly hatched fry that still have an external yolk sac evident.

Sample profile: Information that describes characteristics of the sites from which Catfish 2010 data were collected.

Single-batch production: A production method in which all fish are stocked in a pond at a single time and the pond is not restocked until all fish have been harvested (compare with multibatch production).

Size of operation: Operation size is based on January 1, 2010, inventory.

Production Phase	Small	Large
Breeding operations	2,000 or fewer broodfish	More than 2,000 broodfish
Hatchery operations	1,000 or fewer egg masses	More than 1,000 egg masses
Fingerling operations	1 million or fewer fry stocked	More than 1 million fry stocked
Acres for foodsize fish	Defined in tables.	

Stocker: A small to medium-sized fish. One thousand stockers typically weigh 61 to 750 pounds. This definition follows weight-based size categories the National Agricultural Statistics Service uses in its inventory surveys.

Understock: The practice of stocking smaller fish (fingerlings or stockers) in ponds that have existing inventories of foodsize fish from previous stockings (carryover).

Vaccination: Two vaccines are in use in the catfish industry: one for ESC and one for columnaris. Fry are vaccinated by being immersed in a bath containing the vaccine.

Selected Highlights of Catfish 2010 Part II

- The majority of foodsize-fish operations (81.9 percent) raised unspecified lines of channel catfish. More than one-fifth of operations (21.2 percent) raised channel x blue hybrid catfish. A lower percentage of operations with 1 to 19 surface acres raised channel x blue hybrids (11.9 percent) compared with larger operations; at least 20.0 percent of operations in the three larger size categories raised channel x blue hybrids.
- Operations in the West region* were larger in terms of both average number of growout ponds (27.9) and average total surface acres (314.9 acres) than operations in the East region, which averaged 9.6 ponds and 95.1 total surface acres. Average pond size was 10.8 surface acres.
- Well water was used for 99.8 percent of all growout ponds in the West region, while the majority of ponds (66.7 percent) in the East region were filled using surface water.
- In both regions, the majority of ponds averaged 4 to 5 feet in depth. A higher percentage of operations in the East region than in the West region had ponds with average water depths greater than 5 feet (28.3 and 13.2 percent of operations, respectively).
- Dissolved oxygen levels were hand monitored on about one-half of operations (48.9 percent). Automated sensors were used by 40.9 percent of operations. Almost one-half of operations with 1 to 19 surface acres did not regularly monitor dissolved oxygen (46.7 percent).
- For all operations, slightly more than one-third (35.2 percent) tested water quality at least once a month. A lower percentage of operations with 1 to 19 surface acres (12.5 percent) tested water quality at least once a month than did operations with 20 or more acres. More than one-half of operations with 1 to 19 surface acres (50.7 percent) did not test water quality in 2009.
- The most important criterion for selecting fingerlings or stockers for stocking was price (33.9 percent of operations), followed by producer's reputation (28.8 percent of operations), and growth characteristics (15.0 percent of operations). Distance from supplier was rarely the most important criterion (1.5 percent of operations).
- The operation average stocking rate was 5,553 fingerlings per acre. The operation average stocking rates ranged from 4,224 fingerlings per acre on operations with 1 to 19 surface acres to 5,921 fingerlings per acre on operations with 50 to 149 surface acres.
- Almost one-half of foodsize-fish operations (46.4 percent) stocked at least one fish species in addition to the primary fish (catfish). The highest percentages of operations stocked threadfin shad (29.6 percent of operations), a natural food item and phytoplankton grazer, and grass carp (25.4 percent), an herbivore used primarily to control aquatic weeds.

***Regions:**

East: Alabama, Eastern Mississippi.

West: Arkansas, Louisiana, and the delta of Mississippi.

- Multibatch-harvested fish represented the highest percentage of channel and channel x blue hybrid catfish harvested (82.4 percent). Single-batch harvested fish represented a much smaller percentage (13.8 percent) of the harvest, although 41.2 percent of channel x blue hybrid catfish were harvested by single-batch practices.
- More than one-half of operations (53.9 percent) lost foodsize fish to predation, while 28.1 percent of operations lost fish to low dissolved oxygen. The three diseases causing fish loss on the highest percentages of operations were columnaris (39.0 percent of operations), enteric septicemia of catfish (36.6 percent), and winter kill (20.6 percent). Severe losses (average loss per event of more than 2,000 pounds) were caused by predation and columnaris, respectively, in 5.2 and 3.5 percent of growout ponds.
- Only 6.2 percent of foodsize-fish operations stocked any fish that had been vaccinated for ESC. Of fish stocked into growout ponds in 2009 on all foodsize-fish operations, an operation average of 4.9 percent were vaccinated against ESC.
- The columnaris vaccine became available to the catfish industry in March 2005. In 2009, 3.9 percent of operations stocked any fish that had been vaccinated against columnaris disease into growout ponds. An operation average of 2.7 percent of fish stocked into growout ponds in 2009 were vaccinated against columnaris.
- During 2009, off-flavor problems delayed harvest on 80.7 percent of all operations and 48.1 percent of all ponds on operations from which foodsize fish were harvested. The percentage of operations with delays due to off-flavor increased as operation size increased.

Section I: Population Estimates

A. Distribution of Catfish Production Phases

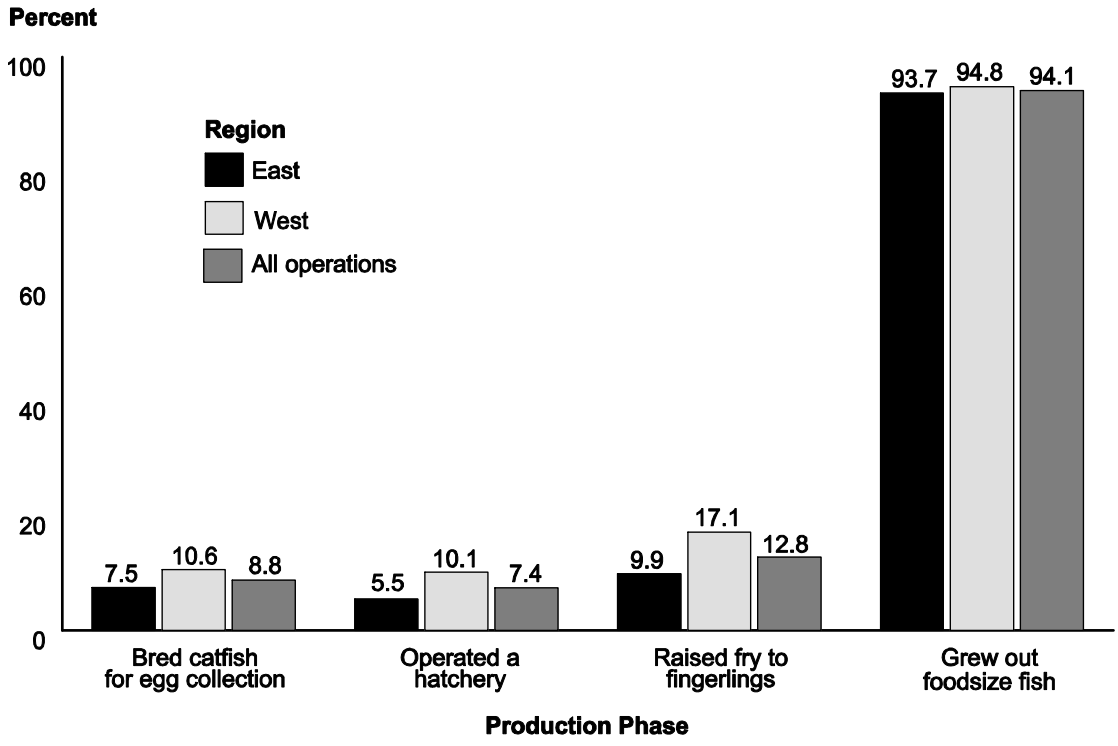
During 2009, most catfish operations (94.1 percent) raised foodsize fish. Although the percentage of operations growing out foodsize fish did not differ by region, percentages for other production phases did differ by region. A higher percentage of operations bred catfish for egg collection, operated a hatchery, or raised fry to fingerlings in the West region than in the East region.

Regardless of region, a higher percentage of operations raised fry to fingerlings than either bred catfish for egg collection or operated a hatchery. Some breeding operations did not operate a hatchery; these operations might have allowed eggs to hatch in breeding ponds.

Percentage of all catfish operations by production phase in 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Production Phase	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Bred catfish for egg collection	7.5	(0.5)	10.6	(0.7)	8.8	(0.4)
Operated a hatchery	5.5	(0.5)	10.1	(0.7)	7.4	(0.4)
Raised fry to fingerlings	9.9	(0.6)	17.1	(0.8)	12.8	(0.5)
Grew out foodsize fish	93.7	(0.5)	94.8	(0.4)	94.1	(0.3)

Percentage of All Catfish Operations by Production Phase in 2009, and by Region



B. Inventory Characteristics

1. Size distribution

Most catfish operations depend on harvest of foodsize fish to meet cash-flow needs. This continual need for foodsize fish necessitates having some smaller fish (fingerlings and stockers) in the production system.

Operations that grew any foodsize fish for harvest in 2009 were asked about their inventory. Of these operations, 3.1 percent did not have any catfish inventory on January 1, 2010. The percentage of foodsize-fish operations with fish was higher in the East region than in the West region. A higher percentage of foodsize-fish operations in the West region had fingerlings and stockers (26.8 and 53.2 percent, respectively) compared with operations in the East region (11.1 and 44.6 percent, respectively).

Percentage of foodsize-fish operations by size of fish present on January 1, 2010, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Size	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Fingerlings	11.1	(0.5)	26.8	(0.7)	17.2	(0.4)
Stockers	44.6	(0.8)	53.2	(0.8)	47.9	(0.6)
Foodsize fish	96.2	(0.3)	90.3	(0.4)	93.9	(0.3)
Any fish	99.6	(0.1)	92.7	(0.4)	96.9	(0.2)

2. Genetic lines

The majority of foodsize-fish operations (81.9 percent) raised unspecified lines of channel catfish. More than one-fifth of foodsize-fish operations (21.2 percent) raised channel x blue hybrid catfish. A lower percentage of operations with 19 surface acres or less raised channel x blue hybrids (11.9 percent) compared with larger operations; at least 20.0 percent of operations in the three larger size categories raised channel x blue hybrids. Goldkist/Harvest Select fish were raised on 7.0 percent of all operations. The Auburn line was raised on 6.0 percent of operations with 19 surface acres or less.

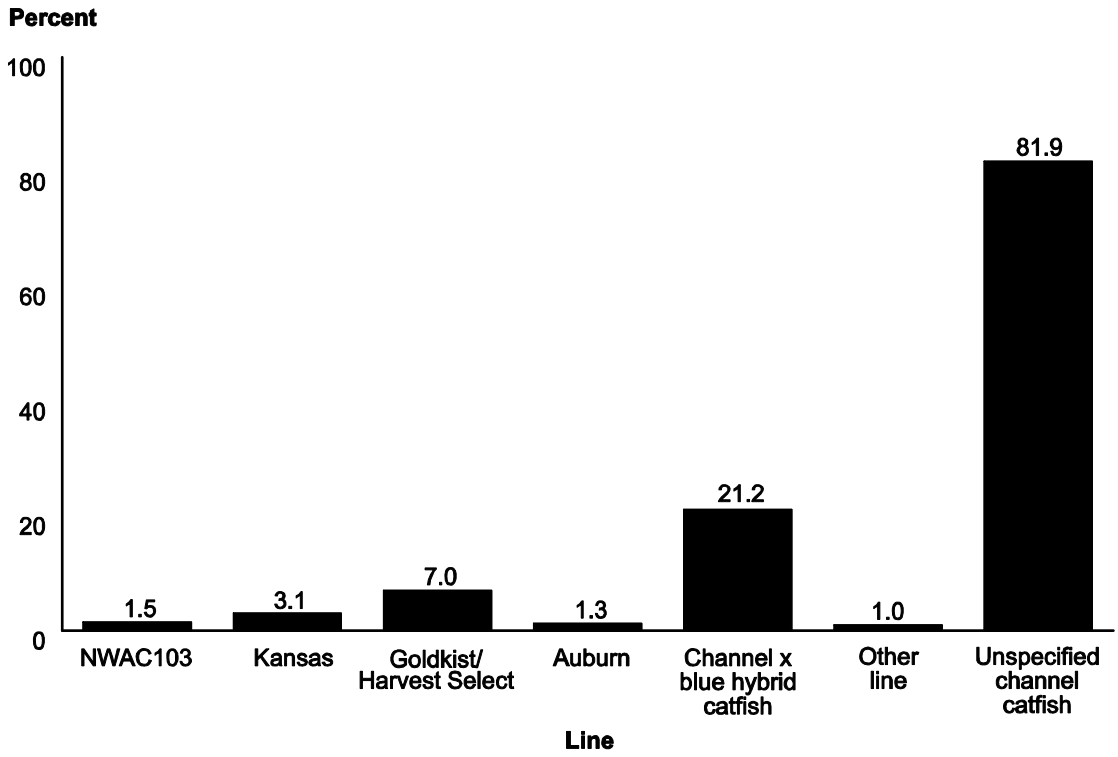
a. Percentage of foodsize-fish operations that had any of the following lines of fish present on January 1, 2010, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Line	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
NWAC103	0.0	(—)	2.3	(0.1)	0.8	(0.0)	2.5	(0.2)	1.5	(0.1)
Kansas	3.0	(0.4)	1.3	(0.4)	3.3	(0.4)	4.2	(0.4)	3.1	(0.2)
Goldkist/ Harvest Select	0.0	(—)	7.5	(0.8)	9.2	(0.6)	8.5	(0.5)	7.0	(0.3)
Auburn	6.0	(0.6)	0.0	(—)	0.0	(—)	0.8	(0.2)	1.3	(0.1)
Channel x blue hybrid catfish	11.9	(0.9)	20.0	(1.2)	27.9	(1.0)	20.7	(0.8)	21.2	(0.5)
Other line	1.5	(0.3)	2.5	(0.4)	0.0	(—)	0.8	(0.2)	1.0	(0.1)
Unspecified channel catfish	82.1	(1.1)	83.9	(1.0)	79.2	(0.9)	83.1	(0.6)	81.9	(0.4)

Percentage of Foodsize-fish Operations that had any of the Following Lines of Fish Present on January 1, 2010



Regionally, a higher percentage of foodsize-fish operations in the East region than in the West region raised channel x blue hybrid catfish (24.3 and 16.0 percent, respectively). The NWAC103 line, which originated in the West region, was raised by 3.3 percent of operations in the West region and 0.4 percent of operations in the East region.

b. Percentage of foodsize-fish operations that had any of the following lines of fish present on January 1, 2010, by region:

	Percent Operations			
	Region			
	East		West	
Line	Percent	Std. Error	Percent	Std. Error
NWAC103	0.4	(0.1)	3.3	(0.0)
Kansas	3.0	(0.3)	3.3	(0.3)
Goldkist/Harvest Select	6.8	(0.4)	7.2	(0.4)
Auburn	1.7	(0.2)	0.7	(0.2)
Channel x blue hybrid catfish	24.3	(0.7)	16.0	(0.5)
Other channel catfish line	1.3	(0.2)	0.7	(0.2)
Unspecified channel catfish	80.8	(0.6)	83.7	(0.5)

Photograph courtesy of Stephen Ausmus, Agriculture Research Service

The vast majority of catfish present on January 1, 2010, were unspecified channel catfish. Although the channel x blue hybrid was present on one-fifth of operations (see table B.2.a), the line represented only 5.9 percent of inventory. The percentages of inventory by line did not differ substantially across regions.

c. Average percentage of foodsize fish by line of fish present on January 1, 2010, and by region:

	Average Percent Foodsize Fish					
	Region					
	East		West		All Operations	
Line	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
NWAC103	0.3	(0.2)	0.6	(0.3)	0.5	(0.2)
Kansas	3.8	(2.2)	1.5	(0.7)	2.2	(0.8)
Goldkist/ Harvest Select	8.4	(3.3)	2.2	(0.7)	4.2	(1.2)
Auburn	0.2	(0.1)	0.1	(0.0)	0.1	(0.0)
Channel x blue hybrid catfish	9.7	(1.8)	4.1	(1.0)	5.9	(1.0)
Other channel catfish line	0.2	(0.1)	1.8	(1.2)	1.3	(0.8)
Unspecified channel catfish	77.4	(4.5)	89.7	(2.5)	85.8	(2.4)
Total	100.0		100.0		100.0	

3. Selection criteria

Overall, one-third of operations (33.9 percent) indicated price as the most important reason for selecting fingerlings or stockers for purchase, while 28.8 percent of operations selected producer's reputation as the most important reason. About one of seven operations (15.0 percent) chose growth characteristics as the most important reason. Notably, a lower percentage of operations with 1 to 19 surface acres (19.9 percent) listed producer's reputation as the most important reason for selecting fingerlings or stockers compared with the other operation-size groups.

Percentage of operations by **most important reason** for selecting fingerlings or stockers, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Reason	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Price	35.4	(1.3)	28.7	(1.3)	34.4	(1.0)	36.1	(0.9)	33.9	(0.6)
Growth characteristics	18.5	(1.1)	14.6	(1.0)	17.2	(0.8)	11.0	(0.6)	15.0	(0.4)
Disease resistance	2.9	(0.4)	1.1	(0.0)	5.9	(0.6)	4.4	(0.4)	3.9	(0.2)
Fish size	13.6	(0.9)	15.7	(1.1)	7.4	(0.6)	9.9	(0.6)	11.1	(0.4)
Distance from source (supplier)	2.8	(0.4)	1.2	(0.3)	0.9	(0.2)	1.6	(0.2)	1.5	(0.1)
Producer's reputation	19.9	(1.2)	31.7	(1.3)	29.6	(1.1)	31.4	(1.0)	28.8	(0.6)
Other	6.9	(0.6)	7.0	(0.6)	4.6	(0.4)	5.6	(0.5)	5.8	(0.3)
Total	100.0		100.0		100.0		100.0		100.0	

C. Stocking Practices

1. Stocking density

The stocking density of fingerlings in catfish production ponds is a key production variable and can have far-reaching production implications. Variability in stocking rate among operations has been attributed to differences in production goals, facilities, and other resources that vary from farm to farm.

For the number of fish stocked per acre on foodsize-fish operations, both the overall operation average and the weighted average (weighted by number of fish stocked) were similar (5,553 and 5,836). Operations with 1 to 19 surface acres for foodsize fish had lower stocking rates than operations in the larger size categories.

a. Average number of fish stocked per acre, and by size of operation:

Average Number Stocked per Acre

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Stocking Rate	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Operation average	4,224	(79)	5,741	(52)	5,921	(30)	5,816	(38)	5,553	(24)
Weighted average	4,485	(196)	5,704	(143)	5,903	(86)	5,842	(216)	5,836	(176)

Overall, most foodsize-fish operations usually stocked between 4,000 and 8,000 fish per acre. A relatively low percentage of operations stocked fewer than 2,001 fish per acre or more than 8,000 fish per acre (6.4 and 6.3 percent, respectively). Slightly more than one-half of foodsize-fish operations with 1 to 19 surface acres stocked 4,000 fish or fewer per acre (50.4 percent). In comparison, more than two-thirds of operations with 20 or more acres stocked between 4,000 and 8,000 fish per acre.

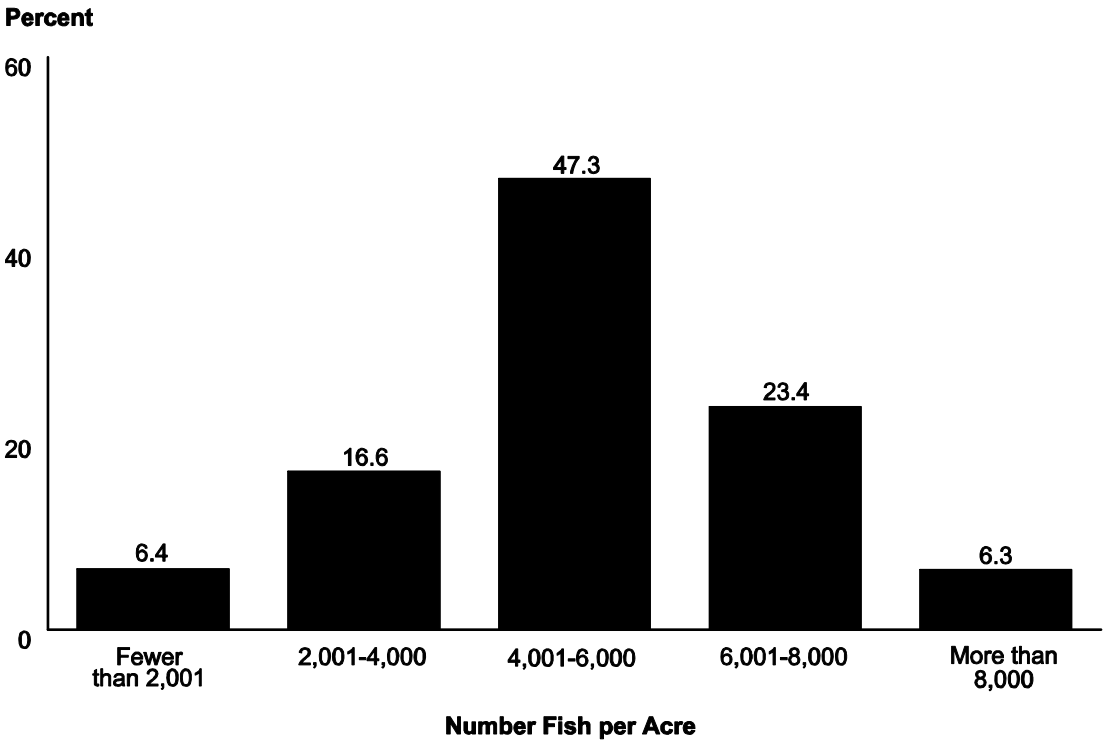
b. Percentage of operations by number of fish per acre usually stocked in growout ponds, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Number Fish per Acre	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Fewer than 2,001	28.1	(1.3)	4.8	(0.4)	0.8	(0.2)	0.8	(0.0)	6.4	(0.3)
2,001 to 4,000	22.3	(1.2)	16.6	(0.9)	8.9	(0.6)	21.4	(0.8)	16.6	(0.4)
4,001 to 6,000	33.2	(1.4)	46.6	(1.4)	56.4	(1.1)	46.4	(1.0)	47.3	(0.6)
6,001 to 8,000	11.9	(1.0)	24.6	(1.3)	29.8	(1.0)	22.4	(0.8)	23.4	(0.5)
More than 8,000	4.5	(0.5)	7.4	(0.7)	4.1	(0.4)	9.0	(0.7)	6.3	(0.3)
Total	100.0		100.0		100.0		100.0		100.0	

Percentage of Operations by Number of Fish per Acre Usually Stocked in Growout Ponds



2. Additional species stocked

In a practice called polyculture, other fish species in addition to catfish are stocked into production ponds. Producers practice polyculture for a variety of reasons, including taking advantage of unused resources (e.g., phytoplankton, zooplankton, aquatic plants) to help maximize pond production. Although some of the noncatfish species can be harvested and sold, most of the species being stocked are intended to serve as an additional food source for the catfish.

Almost one-half of all foodsize-fish operations (46.4 percent) stocked at least one fish species in addition to the primary fish (catfish). More than one-half of foodsize-fish operations with 50 to 149 surface acres (57.6 percent) stocked at least one additional species, compared with less than one-third of operations with 1 to 19 acres (31.2 percent). The species stocked by the highest percentages of operations were threadfin shad (29.6 percent of operations), a potential prey item, and grass carp (25.4 percent), an herbivore used primarily to control aquatic weeds.

Percentage of operations by additional fish species stocked into ponds used for foodsize catfish, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Species	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Threadfin shad	9.8	(0.7)	23.2	(1.3)	47.9	(1.1)	26.9	(0.9)	29.6	(0.6)
Gizzard shad	1.4	(0.3)	9.8	(0.9)	15.0	(0.8)	7.1	(0.5)	9.1	(0.4)
Redear sunfish (shellcrackers)	0.0	(—)	1.2	(0.4)	1.6	(0.2)	0.8	(0.0)	1.0	(0.1)
Fathead minnows	4.3	(0.7)	8.3	(0.7)	9.0	(0.6)	8.2	(0.3)	7.8	(0.3)
Grass carp	18.5	(1.0)	28.9	(1.3)	22.0	(0.9)	30.5	(0.8)	25.4	(0.5)
Other	4.3	(0.5)	1.1	(0.0)	1.6	(0.2)	2.4	(0.0)	2.2	(0.1)
Any	31.2	(1.3)	44.5	(1.4)	57.6	(1.1)	45.3	(1.0)	46.4	(0.6)

3. Percentage of inventory stocked

The percentage of inventory on January 1, 2010, that was stocked in 2009 can be interpreted in many ways. One way is to assume that the target fish weight is 1.5 pounds, which fish can reach after 1 year in a pond. Given this assumption, one-half of the fish would be replaced annually. If fish are not growing that fast or sales are slow, then the operation might have stocked a lower percentage of inventory in 2009. Also, some operations are fee-fishing operations, and they might have stocked a lower percentage of inventory in 2009 so that fish remain in the pond longer and get much larger.

Based on the weighted average inventory, 48.3 percent of the total January 1, 2010, inventory was stocked in 2009. Only 27.5 percent of the weighted inventory on foodsize-fish operations with 1 to 19 acres was stocked in 2009, compared with 50.8 percent of operations with 150 or more surface acres.

a. Average percentage of January 1, 2010, inventory stocked in 2009:

Average Percent Stocked

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Stocking Rate	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Operation average	26.2	(1.1)	40.9	(1.1)	39.1	(0.9)	42.0	(0.8)	38.0	(0.5)
Weighted average	27.5	(3.4)	40.8	(2.8)	37.2	(2.4)	50.8	(3.9)	48.3	(3.3)

The relatively low percentage of inventory stocked in 2009 by operations with 1 to 19 acres for foodsize fish appears to be related to the relatively high percentage of these operations (64.9 percent) that did not stock any fish in 2009. Overall, 45.4 percent of foodsize-fish operations did not have any January 1, 2010, inventory that was stocked in 2009. The largest operations (those with 150 or more surface acres for foodsize fish) had the lowest percentage of operations (35.8 percent) that did not have any January 1, 2010, inventory that was stocked in 2009. Notably, almost one-fifth of all operations (18.9 percent) had 100 percent or more of their January 1, 2010, inventory stocked during 2009.

b. Percentage of operations by percentage of January 1, 2010, inventory stocked in 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Percent Inventory	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
0	64.9	(1.4)	43.5	(1.4)	44.7	(1.1)	35.8	(0.9)	45.4	(0.6)
1 to 49	4.2	(0.4)	7.3	(0.8)	12.8	(0.7)	17.1	(0.8)	11.4	(0.4)
50 to 99	15.6	(1.1)	32.8	(1.4)	22.9	(1.0)	25.1	(0.9)	24.3	(0.5)
100 or more	15.3	(1.0)	16.4	(0.9)	19.6	(0.9)	22.0	(0.8)	18.9	(0.5)
Total	100.0		100.0		100.0		100.0		100.0	

A slightly higher percentage of operations in the West region than in the East region had 1 to 49 percent of their January 1, 2010, inventory stocked in 2009 (17.3 and 7.6 percent, respectively). In contrast, a higher percentage of operations in the East region (27.9 percent) had 50 to 99 percent of their inventory stocked in 2009 compared with operations in the West region (18.6 percent). The percentages of operations that had either none or 100 percent or more of their January 1 inventory stocked in 2009 did not differ by region.

c. Percentage of operations by percentage of January 1, 2010, inventory stocked in 2009, by region:

	Percent Operations			
	Region			
	East		West	
Percent Inventory	Percent	Std. Error	Percent	Std. Error
0	44.9	(0.8)	46.3	(0.8)
1 to 49	7.6	(0.5)	17.3	(0.6)
50 to 99	27.9	(0.8)	18.6	(0.7)
100 or more	19.6	(0.7)	17.8	(0.5)
Total	100.0		100.0	

4. Sources of fish

Overall, more than three-fourths of foodsize-fish operations (78.3 percent) purchased fingerlings from another operation to stock into ponds in 2009, but the sources of fish differed by operation size. A lower percentage of the smallest operations (1 to 19 surface acres for foodsize fish) and of the largest operations (150 acres or more) purchased fingerlings from another operation (64.4 and 60.1 percent, respectively), while a higher percentage of these operations produced their own fish for stocking in 2009 (35.6 and 32.1 percent, respectively). Some smaller operations operated hatcheries and produced fry, but others likely allowed breeding in ponds and did not need to purchase fingerlings. Some larger operations operated hatcheries and produced their own fry.

a. Percentage of operations by source of fish stocked into growout ponds in 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Source	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Purchased as fry from another operation	4.2	(1.2)	6.3	(0.8)	4.4	(0.7)	18.1	(1.0)	9.6	(0.5)
Purchased as fingerlings from another operation	66.9	(2.4)	91.9	(0.8)	94.1	(0.8)	60.1	(1.3)	78.6	(0.7)
Produced by this operation	36.9	(2.4)	5.9	(0.6)	2.9	(0.3)	32.1	(1.3)	17.6	(0.6)

The pattern of percentage of fish obtained from different sources was similar to the pattern observed for percentage of operations obtaining fish from those sources (see previous table).

b. Operation average percentage of fish stocked in 2009 by source of fish, and by size of operation:

Operation Average Percent Fish Stocked

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Source	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Purchased as fry from another operation	2.1	(0.6)	3.4	(0.6)	4.4	(0.7)	14.3	(0.9)	7.4	(0.4)
Purchased as fingerlings from another operation	61.7	(2.3)	90.7	(0.9)	93.0	(0.8)	56.4	(1.3)	76.1	(0.7)
Produced by this operation	36.2	(2.4)	5.9	(0.6)	2.6	(0.3)	29.4	(1.2)	16.5	(0.6)
Total	100.0		100.0		100.0		100.0		100.0	

5. Sizes of fish stocked

Initial stocking size is related to stocking density and intended growout period. Larger fingerlings cost more but will reach marketable size in less time. Fingerlings 5 inches or more in length typically grow to an average weight of 1.25 pounds in a single 200-day growing season.

Three-fourths of all operations (74.4 percent) stocked at least some fingerlings that were between 6 and 8 inches long. A higher percentage of operations with 150 or more acres for foodsize fish stocked fingerlings more than 8 inches long than did operations in the three smaller size categories. More than one-fourth of small operations (29.3 percent) stocked some fish that were 5 inches or less in length.

a. Percentage of operations that stocked fish in the following size groups during 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Size Group	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
5 in. or less (less than 40 lb/ 1,000 fish)	29.3	(2.1)	16.3	(1.1)	11.7	(0.9)	20.8	(1.1)	17.9	(0.6)
6 to 8 in. (40 to 70 lb/1,000 fish)	71.0	(2.0)	83.5	(1.3)	77.6	(1.2)	66.4	(1.3)	74.4	(0.7)
More than 8 in. (more than 70 lb/ 1,000 fish)	16.2	(1.7)	12.6	(1.1)	20.9	(1.3)	44.7	(1.3)	26.6	(0.7)

The percentage of fish stocked by size group differed substantially from the percentage of operations that stocked any fish of a specific size. More than one-half of fingerlings stocked in 2009 (56.6 percent) were more than 8 inches long, while only one-third (33.2 percent) were 6 to 8 inches long. This finding probably results from the influence of larger operations, which tended to stock larger fingerlings. Only 0.8 and 3.6 percent of the fingerlings stocked by operations with 1 to 19 or 20 to 49 surface acres for foodsize fish, respectively, were more than 8 inches long.

b. Percentage of fish stocked in growout ponds in 2009 by size group, and by size of operation:

Percent Fish Stocked

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Size Group	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
5 in. or less (less than 40 lb/ 1,000 fish)	14.7	(8.8)	23.3	(11.8)	18.5	(7.1)	9.4	(3.9)	10.2	(3.7)
6 to 8 in. (40 to 70 lb/1,000 fish)	84.5	(8.9)	73.1	(11.4)	58.8	(8.3)	30.4	(8.9)	33.2	(8.3)
More than 8 in. (more than 70 lb/ 1,000 fish)	0.8	(0.5)	3.6	(1.6)	22.7	(8.0)	60.2	(9.8)	56.6	(9.3)
Total	100.0		100.0		100.0		100.0		100.0	

6. Types of ponds stocked

The industry has widely practiced understocking (placement of fingerlings into ponds with existing catfish inventory), most likely to allow for more continual harvesting of fish (and resulting increased cash flow) or to more fully use pond resources. Three-fourths of operations (76.0 percent) stocked fingerlings during 2009 into ponds that already contained fish. Channel x blue hybrid catfish tended to be stocked in empty ponds in a single-batch mode because of harvesting issues (see table J.2.g). Almost one-third of operations (31.1 percent) stocked at least some fingerlings into ponds empty of fish; some of these operations might have been raising the channel x blue hybrid or they might have been raising single-batch channel catfish. The percentage of operations that stocked fingerlings into stocker ponds increased with increasing operation size; this trend may be due to greater flexibility of larger operations with more ponds.

a. Percentage of operations that stocked any fingerlings directly into the following types of pond during 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Pond Type	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Growout ponds that already contain fish (understocking)	65.5	(2.6)	87.4	(1.2)	74.8	(1.2)	73.0	(1.0)	76.0	(0.7)
Growout ponds empty of fish	47.4	(2.6)	24.9	(1.5)	36.5	(1.5)	25.0	(1.2)	31.1	(0.8)
Stocker ponds	0.0	(—)	2.0	(0.1)	8.6	(0.5)	14.9	(0.6)	8.3	(0.3)

Most fingerlings stocked in 2009 were stocked directly into growout ponds already containing other fish or into growout ponds empty of fish, although the standard error values indicate high variability in these data. Only 5.3 percent of fingerlings were stocked into stocker, or nursery, ponds.

b. Operation average percentage of fingerlings stocked directly into the following types of pond during 2009:

	Operation Average Percent	
Pond Type	**Pct.**	**Std. Error**
Growout ponds that already contain fish (understocking)	54.9	(12.1)
Growout ponds empty of fish	39.8	(12.8)
Stocker ponds	5.3	(2.0)
Total	100.0	

Compared with stocking rates for all ponds (see table C.5.a), ponds that were understocked typically had more fish per acre than other production ponds. With the exception of small foodsize-fish operations (1 to 19 surface acres), the average number of fish in production ponds, including carryover from the previous year and newly stocked fish, was close to 7,000 fish per acre.

c. Average number of fish per acre, including newly stocked fish and carryover fish in ponds that were understocked, and by size of operation:

Average Number of Fish per Acre									
Size of Operation (Surface Acres for Foodsize Fish)									
1–19		**20–49**		**50–149**		**150 or More**		**All Operations**	
Avg.	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
6,182	(207)	6,718	(132)	7,798	(101)	7,164	(89)	7,152	(60)

Average inventory of stocked fingerlings and carryover fish was higher in the East region than in the West region.

d. Average number of fish per acre, including newly stocked fish and carryover fish in ponds that were understocked, by region:

Average Number of Fish per Acre			
Region			
East		West	
Average	Std. Error	Average	Std. Error
7,509	(81)	6,354	(64)

D. Pond Characteristics

1. Pond size

Overall, foodsize-fish operations used an average of 16.7 ponds and 180.4 total water surface acres for production during 2009. Foodsize-fish operations were about three times larger in the West region than in the East region in terms of number of ponds and total surface acres. The foodsize-fish operations in the West region lie in the broad, flat Mississippi River delta, while operations in the East region tend to be in rolling hills in eastern Mississippi and western Alabama.

a. Average number of ponds and total surface acres used by foodsize-fish operations during 2009, and by region:

	Average Region					
	East		West		All Operations	
Ponds/Acres	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Number of ponds	9.6	(0.2)	27.9	(1.4)	16.7	(0.6)
Total surface acres	95.1	(2.7)	314.9	(15.6)	180.4	(6.5)

The size of the average growout pond increased as operation size increased.

b. Average size in surface acres of growout ponds* used during 2009, and by size of operation:

Average Pond Size (Acres)									
Size of Operation (Surface Acres for Foodsize Fish)									
1–19		**20–49**		**50–149**		**150 or More**		**All Operations**	
Avg.	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
2.5	(0.1)	6.8	(0.1)	10.1	(0.0)	11.6	(0.1)	10.8	(0.1)

*Calculated based on those producers reporting both the number of ponds and total surface acres.

Despite differences in geography and operation size, the average growout pond size was only slightly larger in the West region than in the East region (11.3 and 9.9 surface acres, respectively).

c. Average size in surface acres of growout ponds* used during 2009, by region:

Average Pond Size (Acres)			
Region			
East		West	
Average	Std. Error	Average	Std. Error
9.9	(0.1)	11.3	(0.1)

*Calculated based on those producers reporting both the number of ponds and total surface acres.

With improvements in production practices for channel x blue hybrid catfish, hybrid fingerlings are available for stocking on foodsize-fish operations. Commonly, these hybrids are grown in separate ponds from channel catfish, at least in part due to differences in harvesting practices.

Channel x blue hybrid catfish production accounted for 7.3 percent of total water surface acreage in 2009. The largest operations (150 or more acres) used a lower percentage of total water surface area for hybrid production than did other operations. Operations with 50 to 149 surface acres for foodsize fish had the highest percentage of surface acres in hybrid production. These findings might indicate that producers in some size categories were experimenting with the hybrid in part of their operations, because one 10-acre pond would represent 50 percent of total acreage for an operation with 20 surface acres but only 6.7 percent of an operation with 150 acres.

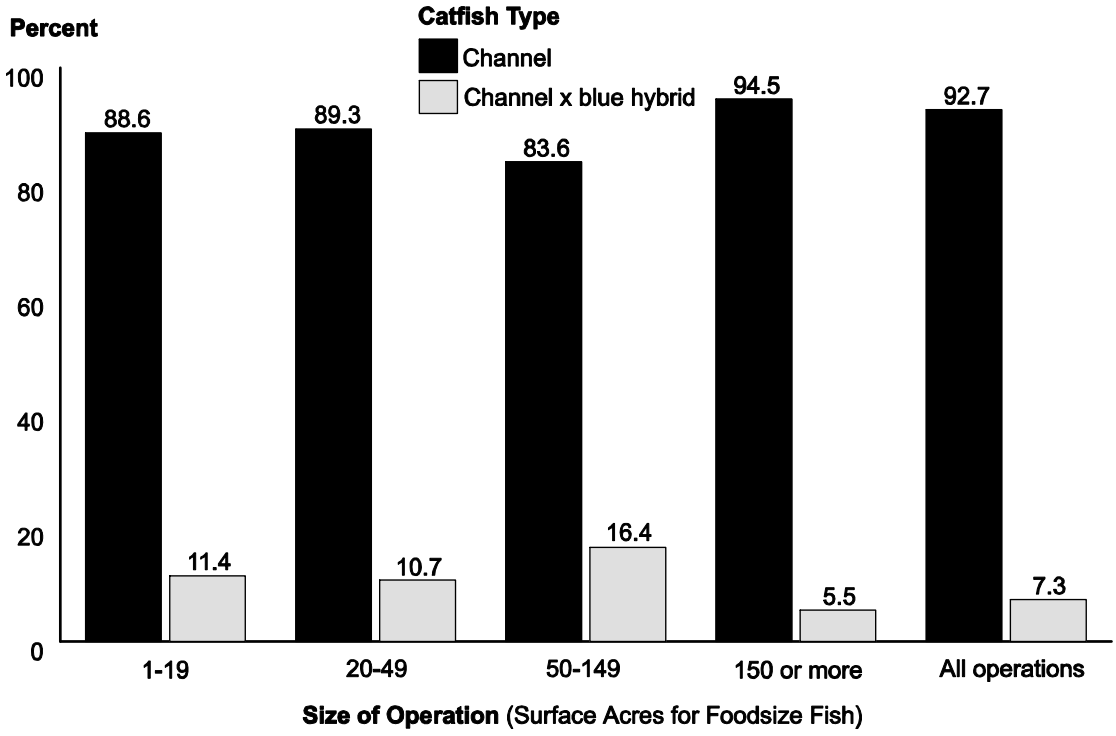
d. Percentage of total surface water acres used during 2009 by catfish type, and by size of operation:

Percent

Size of Operation (Surface Acres for Foodsize Fish)

Catfish Type	1–19 Pct.	1–19 Std. Error	20–49 Pct.	20–49 Std. Error	50–149 Pct.	50–149 Std. Error	150 or More Pct.	150 or More Std. Error	All Operations Pct.	All Operations Std. Error
Channel	88.6	(1.2)	89.3	(0.6)	83.6	(0.8)	94.5	(0.3)	92.7	(0.3)
Channel x blue hybrid	11.4	(1.2)	10.7	(0.6)	16.4	(0.8)	5.5	(0.3)	7.3	(0.3)
Total	100.0		100.0		100.0		100.0		100.0	

Percentage of Total Surface Water Acres Used During 2009 by Catfish Type, and by Size of Operation



A higher percentage of total surface water acres in the East region (10.3 percent) was used for growing channel x blue hybrid catfish compared with the West region (5.9 percent).

e. Percentage of total surface water acres used during 2009 by catfish type and by region:

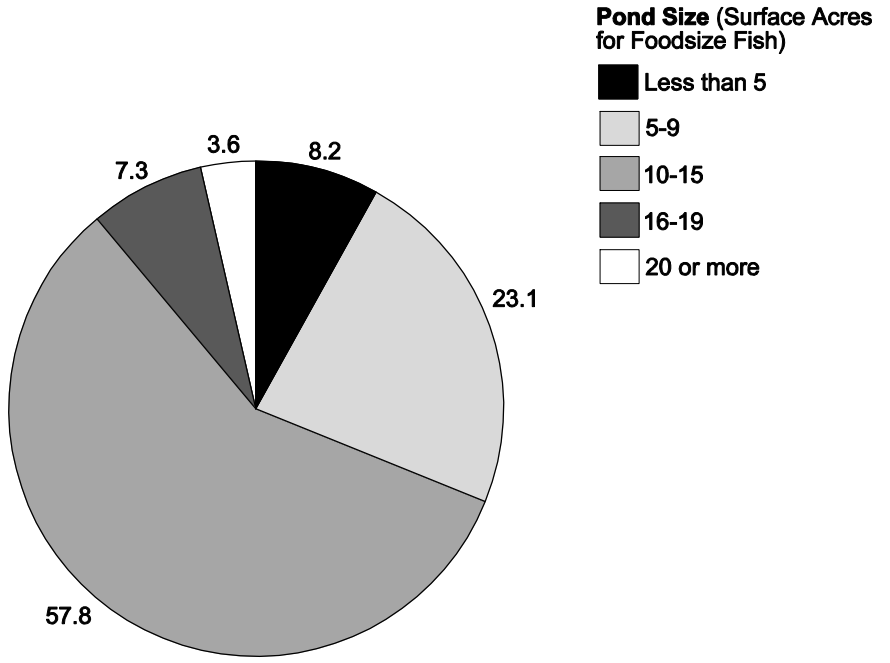
	Percent			
	Region			
	East		West	
Catfish Type	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Channel	89.7	(0.4)	94.1	(0.4)
Channel x blue hybrid	10.3	(0.4)	5.9	(0.4)
Total	100.0		100.0	

More than one-half of all growout ponds (57.8 percent) were 10 to 15 surface acres. The East region had a higher percentage of smaller ponds (less than 5 and 5 to 9 surface acres) than the West region, which had a higher percentage of ponds that were 10 to 15 and 16 to 19 surface acres. Pond-size differences between regions likely reflect differences in the geographical features between the areas.

f. Percentage of all growout ponds used for production during 2009 by size of pond (surface acres) and by region:

	Percent Ponds					
	Region					
	East		West		All Operations	
Pond Size (Surface Acres for Foodsize Fish)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Less than 5	13.2	(0.4)	5.4	(0.3)	8.2	(0.3)
5 to 9	30.5	(0.7)	19.1	(1.3)	23.1	(0.9)
10 to 15	46.1	(1.0)	64.1	(1.4)	57.8	(1.1)
16 to 19	5.9	(0.4)	8.2	(0.3)	7.3	(0.2)
20 or more	4.3	(0.3)	3.2	(0.3)	3.6	(0.2)
Total	100.0		100.0		100.0	

Percentage of All Growout Ponds Used for Production During 2009 by Size of Pond (Surface Acres)



Overall, more than one-half of all foodsize-fish operations had some ponds that were 5 to 9 or 10 to 15 surface acres. This generally applied across both regions, except that only 45.5 percent of operations in the West region had ponds with 5 to 9 surface acres. A higher percentage of operations in the West region than in the East region had ponds that were 16 to 19 acres (20.8 and 10.8 percent, respectively).

g. Percentage of operations with growout ponds of particular size during 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Pond Size (Surface Acres for Foodsize Fish)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Less than 5	36.9	(0.8)	19.7	(0.7)	30.2	(0.5)
5 to 9	59.0	(0.8)	45.5	(0.8)	53.8	(0.6)
10 to 15	65.0	(0.8)	74.5	(0.7)	68.7	(0.5)
16 to 19	10.8	(0.4)	20.8	(0.7)	14.6	(0.4)
20 or more	8.6	(0.4)	11.4	(0.6)	9.7	(0.3)

2. Water source

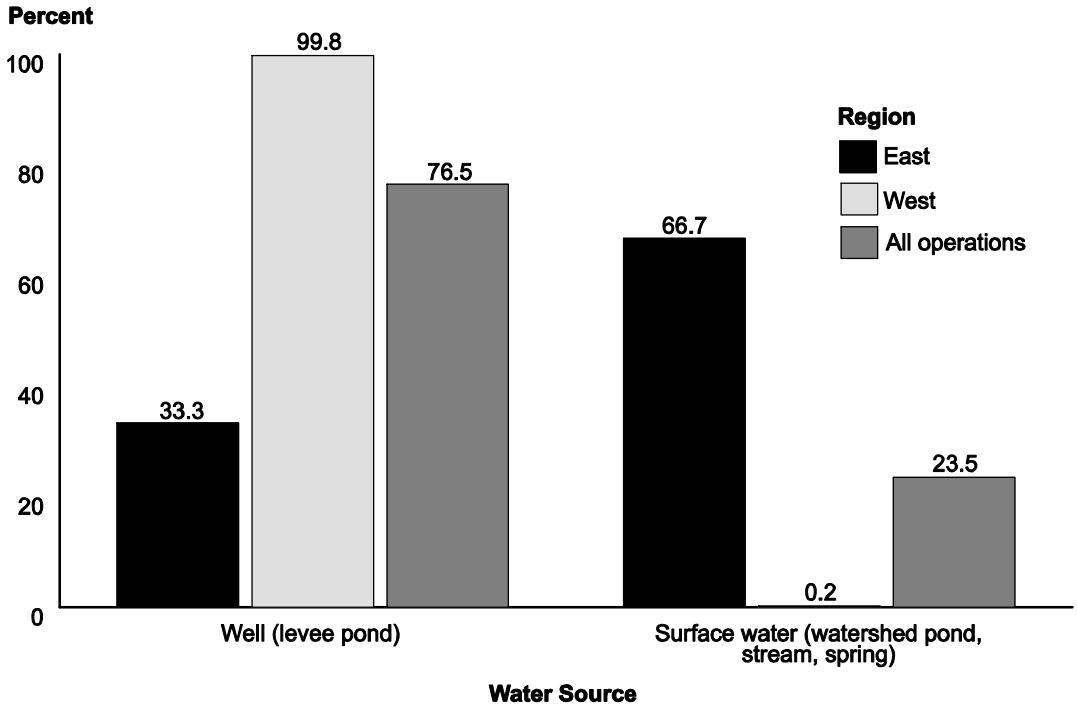
Well water is a dependable source of water and is free of wild fish and potential fish pathogens, and it might also be less likely to contain undesirable materials. There are costs associated with wells, however, such as pumping. Surface water—including watershed ponds, streams, and springs—may contain fish and fish pathogens, as well as undesirable materials. Also, surface water might not be as dependable a source of water as wells.

The water source for almost all of the ponds in the West region (99.8 percent) was well water, while the source for two-thirds of ponds in the East region (66.7 percent) was surface water.

Percentage of growout ponds used during 2009 by water source and by region:

	Percent Ponds					
	Region					
	East		West		All Operations	
Water Source	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Well (levee pond)	33.3	(1.1)	99.8	(0.0)	76.5	(1.0)
Surface water (watershed pond, stream, spring)	66.7	(1.1)	0.2	(0.0)	23.5	(1.0)
Other	0.0	(—)	0.0	(—)	0.0	(—)
Total	100.0		100.0		100.0	

Percentage of Growout Ponds Used During 2009 by Water Source and by Region



3. Pond water depth

Recommended pond depths are a minimum of 3 feet and a maximum of 5 feet, but these requirements are often associated with levee ponds rather than watershed ponds, which may be constructed in hilly terrain.

Three-fourths of all operations had an average pond depth of 4.0 to 5.0 feet. Ponds in the East region are more likely to be watershed ponds, and a higher percentage of operations in the East region than in the West region had average pond depths of 5.1 feet or more (28.3 and 13.2 percent, respectively).

a. Percentage of foodsize-fish operations by **average** pond water depth in 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Average Pond Water Depth (Feet)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Less than 4.0	1.3	(0.2)	5.0	(0.4)	2.7	(0.2)
4.0 to 5.0	70.4	(0.7)	81.8	(0.7)	74.8	(0.5)
Greater than 5.0 to 6.0	16.5	(0.6)	10.8	(0.6)	14.3	(0.4)
Greater than 6.0	11.8	(0.5)	2.4	(0.2)	8.2	(0.3)
Total	100.0		100.0		100.0	

In keeping with the greater average pond water depth on operations in the East region, most operations in the East region (91.6 percent) had maximum depths greater than 6.0 feet, compared with only about 4 of 10 in the West region (39.9 percent).

b. Percentage of foodsize-fish operations by **maximum** pond water depth in 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Maximum Pond Water Depth (Feet)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Less than 4.0	0.0	(—)	1.2	(0.3)	0.5	(0.1)
4.0 to 5.0	2.1	(0.2)	23.6	(0.7)	10.3	(0.3)
Greater than 5.0 to 6.0	6.3	(0.4)	35.3	(0.8)	17.5	(0.4)
Greater than 6.0	91.6	(0.5)	39.9	(0.8)	71.7	(0.5)
Total	100.0		100.0		100.0	

E. Management of Production Ponds

1. Levee management

Almost all operations (95.7 percent) use gravel or vegetation (or both) to control levee erosion. A higher percentage of foodsize-fish operations in the East region use vegetation than operations in the West region (94.9 and 84.8 percent, respectively).

Percentage of foodsize-fish operations that use the following measures to control erosion or to improve vehicle access on levees, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Levee Management Measure	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Vegetation on levee sides	94.9	(0.4)	84.8	(0.6)	91.0	(0.3)
Gravel on levee tops and/or sides	81.0	(0.6)	81.8	(0.6)	81.3	(0.4)
Either measure	98.3	(0.2)	91.5	(0.5)	95.7	(0.2)

2. Draining and renovation

The highest percentage of foodsize-fish operations (41.9 percent) typically drains ponds every 6 to 10 years. As operation size increases, the number of years between draining of ponds increases. For example, almost one-half (48.2 percent) of operations with 1 to 19 surface acres drain ponds every 5 years or less. In comparison, only 7.8 and 10.3 percent of operations with 50 to 149 and 150 or more surface acres, respectively, drain their ponds at least every 5 years. More than 20 percent of operations with 20 or more surface acres typically wait 16 years or more between draining, compared with only 10.3 percent of operations with 1 to 19 acres.

As with draining of ponds, about two-fifths of operations (38.9 percent) wait 6 to 10 years between complete renovations of ponds. A higher percentage of operations wait 11 or more years between complete renovations of ponds (55.3 percent) compared with draining of ponds (39.4 percent).

a. Percentage of foodsize-fish operations by usual number of years between draining or complete renovations of growout ponds, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

Years Between…	1–19 Pct.	1–19 Std. Error	20–49 Pct.	20–49 Std. Error	50–149 Pct.	50–149 Std. Error	150 or More Pct.	150 or More Std. Error	All Operations Pct.	All Operations Std. Error
Draining										
1	13.3	(1.1)	0.0	(—)	0.0	(—)	0.0	(—)	2.2	(0.2)
2 to 5	34.9	(1.7)	27.6	(1.5)	7.8	(0.5)	10.3	(0.5)	16.5	(0.5)
6 to 10	36.6	(1.7)	32.9	(1.6)	46.5	(1.4)	44.5	(1.1)	41.9	(0.7)
11 to 15	4.9	(0.7)	16.7	(1.6)	21.2	(1.3)	19.8	(1.0)	17.2	(0.6)
16 or more	10.3	(1.0)	22.8	(1.7)	24.5	(1.2)	25.4	(1.1)	22.2	(0.6)
Total	100.0		100.0		100.0		100.0		100.0	
Complete renovations										
1	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)	0.0	(—)
2 to 5	14.9	(1.3)	0.0	(—)	5.1	(0.5)	5.5	(0.4)	5.8	(0.3)
6 to 10	48.4	(2.2)	54.5	(1.9)	33.3	(1.4)	34.5	(1.1)	38.9	(0.7)
11 to 15	11.1	(1.3)	13.8	(1.6)	33.5	(1.4)	25.9	(1.0)	24.3	(0.7)
16 or more	25.6	(1.9)	31.7	(1.9)	28.1	(1.3)	34.1	(1.1)	31.0	(0.7)
Total	100.0		100.0		100.0		100.0		100.0	

On average, foodsize-fish operations wait 11.7 years between pond drainings, and operations with 50 or more surface acres wait longer than smaller operations do. This pattern by size of operation also applies to the number of years between complete renovations, although the overall difference in years between complete renovations is not as large as for draining of ponds.

A comparison of draining and renovation times by operation size shows that the time difference between these two activities decreases with increasing operation size. For example, the smallest operations drain ponds every 7.6 years and renovate every 12.3 years, while the largest operations drain every 13.0 years and renovate every 14.6 years. It is likely that a high percentage of large operations drain ponds completely only when they are renovating the pond.

b. Operation average number of years between draining or complete renovations of ponds, and by size of operation:

Operation Average Number Years

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Pond Management	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Draining	7.6	(0.2)	10.6	(0.2)	12.8	(0.2)	13.0	(0.1)	11.7	(0.1)
Complete renovations	12.3	(0.2)	13.0	(0.2)	14.2	(0.2)	14.6	(0.1)	14.0	(0.1)

3. Water-level management

Lowering water level in ponds has been recommended to prevent levee erosion. Almost 6 of 10 operations (58.5 percent) either actively lower water levels or allow them to drop without intervention.

Percentage of foodsize-fish operations by water-level management practice used in the fall, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Water-level Management Practice	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Release water to lower level	7.6	(0.5)	25.2	(0.8)	14.5	(0.4)
Allow level to drop without intervention	55.6	(0.8)	25.7	(0.6)	44.0	(0.6)
Maintain water level (do not let water level drop)	36.8	(0.8)	49.1	(0.8)	41.5	(0.6)
Total	100.0		100.0		100.0	

4. Monitoring of dissolved oxygen

High feeding rates and densely stocked ponds increase the chances of problems with low dissolved oxygen in foodsize-fish production ponds. Monitoring oxygen levels allows operations to intervene in a timely fashion to prevent mortality events.

All operations with 50 surface acres or more monitored dissolved oxygen on a regular basis during 2009. Only 4.8 percent of operations with 20 to 49 acres did not regularly monitor oxygen, while almost half (46.7 percent) of the smallest operations (1 to 19 acres) did not regularly monitor oxygen levels. Less-intensive culture practices, such as lower stocking rates (see table C.1.a), might not lead to conditions that promote dissolved oxygen problems and thus not necessitate monitoring of pond oxygen levels.

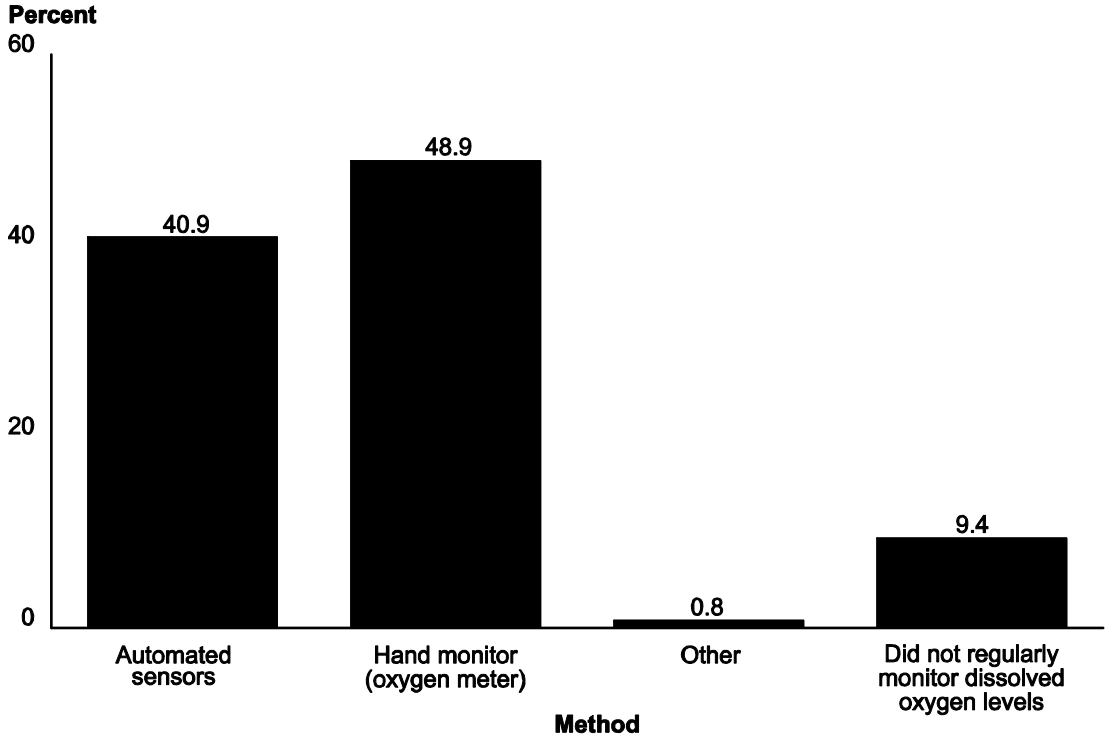
Percentage of foodsize-fish operations by primary method used to regularly monitor dissolved oxygen in growout ponds during 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Method	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Automated sensors	13.9	(1.1)	53.9	(1.4)	58.9	(1.1)	29.3	(0.9)	40.9	(0.6)
Hand monitor (oxygen meter)	35.1	(1.3)	41.3	(1.3)	41.1	(1.1)	70.7	(0.9)	48.9	(0.6)
Other	4.3	(0.6)	0.0	(—)	0.0	(—)	0.0	(—)	0.8	(0.1)
Did not regularly monitor dissolved oxygen levels	46.7	(1.4)	4.8	(0.5)	0.0	(—)	0.0	(—)	9.4	(0.3)
Total	100.0		100.0		100.0		100.0		100.0	

Percentage of Foodsize-fish Operations by Primary Method Used to Regularly Monitor Dissolved Oxygen in Growout Ponds During 2009



5. Horsepower of fixed aeration

The average horsepower of fixed aeration per surface acre was 2.5. Only the smallest operations (1 to 19 acres) had an average less than 2.5 hp/acre (2.0 hp/acre).

a. Operation average horsepower of fixed aeration per surface acre of growout ponds, and by size of operation:

Operation Average Horsepower

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
2.0	(0.0)	2.6	(0.0)	2.8	(0.0)	2.5	(0.0)	2.5	(0.0)

The average horsepower of fixed aeration was higher in the East region than in the West region.

b. Operation average horsepower of fixed aeration per surface acre of growout ponds, by region:

Operation Average Horsepower			
Region			
East		West	
Average	Std. Error	Average	Std. Error
2.6	(0.0)	2.3	(0.0)

The lower average of horsepower of aeration used by operations with 1 to 19 surface acres (see table E.5.a) was influenced by a relatively high percentage of operations in this size category that did not have any fixed aeration (17.0 percent). Ponds that are not aerated do not need regular oxygen monitoring, so it would be expected that farms that did not monitor oxygen did not aerate ponds. Close to one-half of small operations (46.7 percent—Table E.4.a) did not monitor dissolved oxygen.

Overall, the highest percentage of operations had fixed aeration of 3.0 to 3.9 horsepower per surface acre. The highest percentage of operations with 1 to 19 surface acres for foodsize fish had 0.1 to 1.9 average horsepower of fixed aeration per acre. The highest percentages of operations with 20 to 49 or 50 to 149 surface acres had 3.0 to 3.9 average horsepower of fixed aeration. The highest percentage of operations with 150 surface acres or more either had between 2.0 and 3.9 average horsepower of fixed aeration.

c. Percentage of operations by average horsepower of fixed aeration per surface acre of growout ponds, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Horsepower per acre	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
0.0	17.0	(1.0)	6.1	(0.6)	0.8	(0.2)	0.9	(0.2)	4.7	(0.2)
0.1 to 1.9	29.1	(1.3)	10.4	(0.7)	15.7	(0.7)	24.7	(0.8)	19.6	(0.4)
2.0 to 2.9	19.7	(1.2)	22.7	(1.1)	21.7	(0.9)	30.5	(1.0)	24.2	(0.5)
3.0 to 3.9	18.6	(1.3)	46.3	(1.4)	41.5	(1.1)	27.4	(0.9)	34.4	(0.6)
4.0 or higher	15.6	(1.1)	14.5	(1.0)	20.3	(0.9)	16.5	(0.6)	17.1	(0.4)
	100.0		100.0		100.0		100.0		100.0	

Almost half of operations in the East region (48.8 percent) had average horsepower of fixed aeration of 3.0 to 3.9. In the West region, 67.6 percent of operations had average horsepower of fixed aeration of 0.1 to 1.9 or 2.0 to 2.9.

d. Percent of operations by average horsepower of fixed aeration per surface acre of growout ponds, and by region:

	Percent Operations			
	Region			
	East		West	
Horsepower per acre	Percent	Std. Error	Percent	Std. Error
0.0	6.5	(0.4)	1.9	(0.2)
0.1 to 1.9	11.3	(0.5)	32.6	(0.7)
2.0 to 2.9	17.4	(0.7)	34.9	(0.8)
3.0 to 3.9	48.8	(0.8)	11.8	(0.6)
4.0 or higher	16.0	(0.6)	18.8	(0.5)
Total	100.0		100.0	

Emergency aerators are mobile units used to supplement fixed aeration; they are usually run by tractors using power take-offs. The number of emergency aerators available for use increased with operation size. The need for more units would be expected to increase with the number of ponds, and larger operations also would be more likely to have more tractors available to run the aerators.

e. Average number of emergency aerators (power take-offs or PTOs) on foodsize-fish operations, and by size of operation:

Average Number of Aerators									
Size of Operation (Surface Acres for Foodsize Fish)									
1–19		20–49		50–149		150 or More		All Operations	
Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
1.5	(0.0)	2.6	(0.0)	6.0	(0.1)	25.1	(0.9)	10.1	(0.3)

F. Water Quality and Treatments

1. Chloride level

High chloride levels in ponds help protect against nitrite exposure, which can lead to brown blood disease—the impairment of oxygen transportation in the blood. Chloride levels in excess of 100 ppm are considered adequate to preclude the need to regularly monitor nitrite levels (see table F.4.b. for frequency of nitrite testing). Average chloride levels during summer months exceeded 100 ppm in both the East and West regions.

Operation average chloride level (parts per million) in growout ponds during summer, and by region:

Operation Average Chloride Level (ppm)

Region					
East		**West**		**All Operations**	
Average	**Std. Error**	**Average**	**Std. Error**	**Average**	**Std. Error**
116.9	(1.2)	119.8	(0.9)	117.9	(0.8)

2. Salt use

If chloride levels in ponds are not sufficiently high, foodsize-fish producers can add salt. About one-half of all foodsize-fish operations (50.1 percent) routinely added salt to ponds during 2009 to maintain a desired chloride level. A higher percentage of operations in the East region than in the West region routinely added salt (58.4 percent and 37.0 percent, respectively). This might be because the East region had a much higher percentage of watershed ponds (see table D.2), which are naturally flushed and require more salt.

Almost one-third of all operations (31.3 percent) did not add salt during 2009. The percentage of operations that did not add salt was higher in the West region than in the East region (43.9 and 23.3 percent, respectively).

Percentage of foodsize-fish operations by use of salt in growout ponds during 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Salt Use	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Routinely added salt to maintain a desired chloride level	58.4	(0.8)	37.0	(0.8)	50.1	(0.6)
Added salt only in response to health problems	18.3	(0.6)	19.1	(0.7)	18.6	(0.5)
Did not add salt	23.3	(0.7)	43.9	(0.7)	31.3	(0.5)
Total	100.0		100.0		100.0	

3. Alkalinity

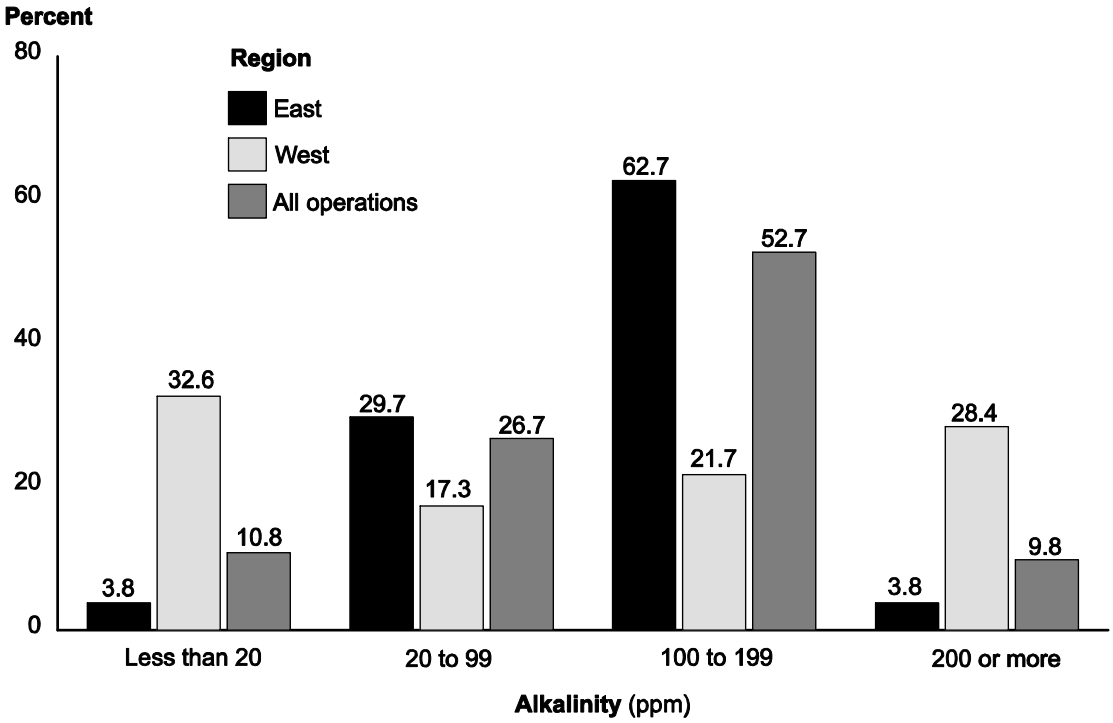
Although catfish can be raised in water with alkalinity as low as 5 ppm to more than 400 ppm, less than 20 ppm is not desirable. Higher alkalinity helps reduce the toxicity of dissolved metals to fish, makes control of pH easier, and can improve the effectiveness of fertilization.

Almost 90 percent of all foodsize-fish operations had alkalinity levels in excess of 20 ppm in water used in growout ponds. However, almost one-third of foodsize-fish operations in the West region (32.6 percent) had alkalinity levels less than 20 ppm, compared with 3.8 percent of operations in the East region. Higher percentages of operations in the East region than in the West region had levels of 20 to 99 ppm or 100 to 199 ppm, while a higher percentage of operations in the West region had alkalinity of 200 ppm or more. No operations had an alkalinity of less than 5 ppm (data not shown).

a. Percentage of foodsize-fish operations by alkalinity (ppm) of the water used in growout ponds, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Alkalinity (ppm)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Less than 20	3.8	(0.4)	32.6	(1.6)	10.8	(0.6)
20 to 99	29.7	(1.1)	17.3	(0.4)	26.7	(0.8)
100 to 199	62.7	(1.1)	21.7	(0.7)	52.7	(0.9)
200 or more	3.8	(0.4)	28.4	(1.1)	9.8	(0.4)
Total	100.0		100.0		100.0	

Percentage of Foodsize-fish Operations by Alkalinity of the Water Used in Growout Ponds, and by Region



Overall, average alkalinity was 117.9 ppm and did not differ between the two regions.

b. Operation average alkalinity (ppm) of water used in growout ponds, and by region:

Operation Average Alkalinity (ppm)					
Region					
East		West		All Operations	
Average	Std. Error	Average	Std. Error	Average	Std. Error
116.9	(1.2)	119.8	(0.9)	117.9	(0.8)

Operations might add calcium (typically in the form of agricultural lime, hydrated lime, or gypsum) to their ponds to maintain a desired alkalinity or water hardness. Generally, more than two-thirds of all foodsize-fish operations (66.7 percent) do not add calcium to their ponds to maintain alkalinity. In the East region, 45.8 percent of foodsize-fish operations add calcium either regularly or in response to health problems, compared with 13.5 percent of operations in the West region.

c. Percentage of foodsize-fish operations by method of adding calcium (e.g., agricultural lime, hydrated lime, or gypsum) to ponds to maintain alkalinity, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Method	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Routinely add calcium to maintain desired alkalinity and hardness	15.2	(0.6)	1.8	(0.2)	10.0	(0.4)
Add calcium only in response to health problems	30.6	(0.8)	11.7	(0.3)	23.3	(0.5)
Do not add calcium to growout ponds	54.2	(0.8)	86.5	(0.4)	66.7	(0.6)
Total	100.0		100.0		100.0	

4. Water quality testing

Maintaining good water quality can help prevent specific diseases in catfish as well as reduce stress levels that can contribute to disease problems. About one-third of operations (35.2 percent) tested water quality at least once a month during 2009, and another 28.7 percent tested water quality less than once a month. A higher percentage of the largest operations (47.5 percent of operations with 150 or more surface acres for foodsize fish) tested water quality at least once a month compared with smaller operations. Overall, only one of five operations (20.2 percent) did not test water quality during 2009, although more than one-half of operations with 1 to 19 surface acres for foodsize fish did not test water quality during 2009.

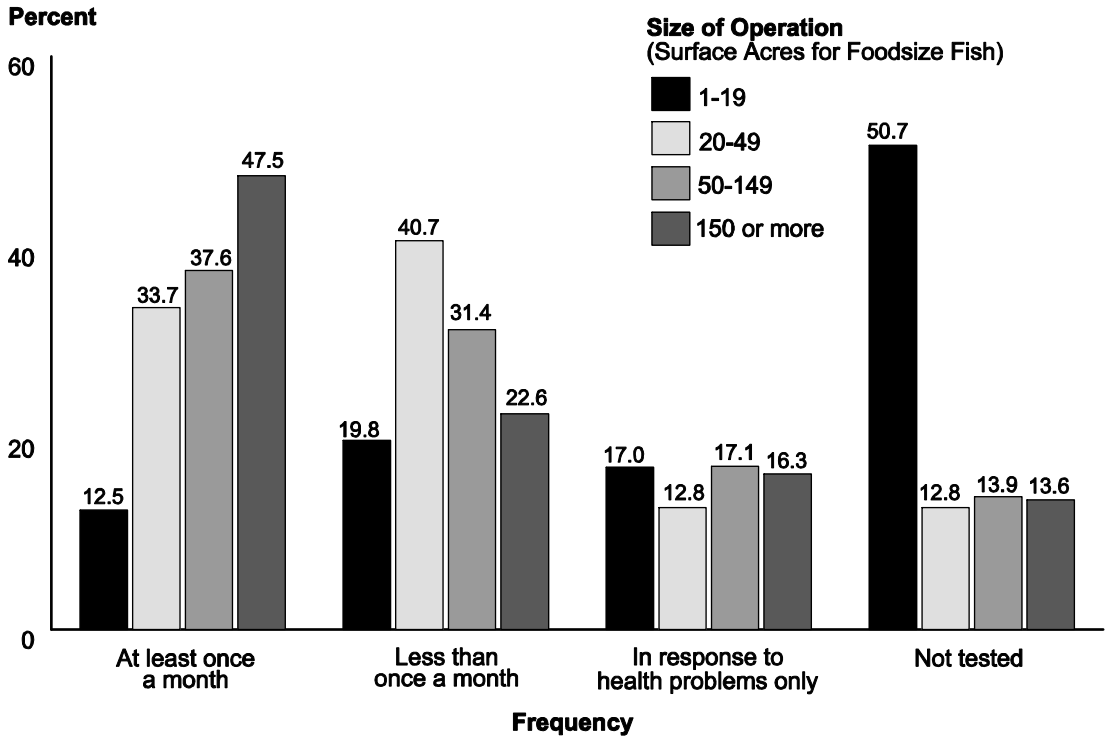
a. Percentage of foodsize-fish operations by frequency of water quality testing in growout ponds during 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Frequency	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
At least once a month	12.5	(0.9)	33.7	(1.4)	37.6	(1.1)	47.5	(1.0)	35.2	(0.6)
Less than once a month	19.8	(1.2)	40.7	(1.4)	31.4	(1.0)	22.6	(0.9)	28.7	(0.6)
In response to health problems only	17.0	(1.1)	12.8	(0.8)	17.1	(0.9)	16.3	(0.6)	15.9	(0.4)
Not tested	50.7	(1.4)	12.8	(1.0)	13.9	(0.6)	13.6	(0.5)	20.2	(0.4)
Total	100.0		100.0		100.0		100.0		100.0	

Percentage of Foodsize-fish Operations by Frequency of Water Quality Testing in Growout Ponds during 2009, and by Size of Operation



More than four-fifths of operations that tested water quality at least once a month during 2009 tested for ammonia, chloride, and nitrite once or twice a month. About one-tenth of operations tested more than twice a month for these three water quality characteristics.

b. For operations that tested water quality of growout ponds at least once a month during 2009, percentage of operations by number of times per month growout ponds were tested, and by water quality characteristic:

	Percent Operations					
	Water Quality Characteristic					
	Ammonia		Chloride		Nitrite	
Times per Month	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
0	2.1	(0.2)	5.8	(0.4)	2.2	(0.3)
1 to 2	85.5	(0.8)	85.5	(0.7)	83.2	(0.8)
3 to 4	10.9	(0.8)	7.2	(0.6)	12.4	(0.8)
5 to 7	0.0	(—)	0.0	(—)	0.0	(—)
8 or more	1.5	(0.3)	1.5	(0.3)	2.2	(0.3)
Total	100.0		100.0		100.0	

5. Algae management

Overgrowth of algae can lead to problems with low dissolved oxygen. Certain types of algae also cause some off-flavor problems.

Two-thirds of foodsize-fish operations (65.7 percent) typically either prevent algae overgrowth with a control program or control the bloom in response to problems. More than one-half of operations in the East region (54.8 percent) prevent algae overgrowth with a control program, whereas only about one-fifth of operations in the West region (19.1 percent) have a control program.

a. Percentage of foodsize-fish operations by usual algae management practice, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Algae Management Practice	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Prevent algae overgrowth with a control program	54.8	(0.8)	19.1	(0.7)	40.9	(0.6)
Control bloom only in response to problems such as off-flavor	24.5	(0.7)	25.2	(0.8)	24.8	(0.5)
No algae control treatments	20.7	(0.6)	55.7	(0.8)	34.3	(0.5)
Total	100.0		100.0		100.0	

On operations that typically have algae control programs, most ponds were included in the program (91.6 percent) during 2009.

b. For operations that typically use algae control programs, percentage of growout ponds included in the control program during 2009, and by size of operation:

Percent Growout Ponds									
Size of Operation (Surface Acres for Foodsize Fish)									
1–19		20–49		50–149		150 or More		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
97.9	(0.5)	98.6	(0.2)	97.9	(0.3)	88.7	(1.6)	91.6	(1.2)

A high percentage of operations with algae control programs used copper sulfate (82.0 percent) or Diuron (78.1 percent) to control algae during 2009. A higher percentage of operations in the East region (44.3 percent) than in the West region (19.2 percent) used biological control methods.

c. For operations that typically use algae control programs, percentage of operations by control method during 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Algae Control Method	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Copper sulfate ($CuSO_4$) or other copper formulation	84.5	(0.7)	70.3	(2.2)	82.0	(0.7)
Diuron	76.8	(0.9)	84.0	(1.0)	78.1	(0.7)
Biological control (e.g., threadfin or gizzard shad)	44.3	(1.1)	19.2	(1.5)	39.7	(0.9)
Other	5.4	(0.5)	0.0	(—)	4.4	(0.4)

Almost 90 percent of algae control programs (89.8 percent) were begun in the 4-month period March through June, when warmer weather and longer days promote algae growth. Conversely, programs were ended as the weather cooled, with most programs ending in September, October, or November (84.3 percent).

d. For operations that used copper sulfate (or other copper formulation) or Diuron during 2009 to control algae, percentage of operations by month that the program began and ended:

	Percent Operations			
	Month Begun		Month Ended	
Month	Percent	Std. Error	Percent	Std. Error
January	4.1	(0.4)	0.0	(—)
February	0.7	(0.2)	0.0	(—)
March	16.4	(0.8)	0.0	(—)
April	29.0	(0.9)	0.0	(—)
May	24.6	(0.9)	0.0	(—)
June	19.8	(0.9)	0.0	(—)
July	5.4	(0.4)	2.7	(0.4)
August	0.0	(—)	8.1	(0.6)
September	0.0	(—)	18.1	(0.8)
October	0.0	(—)	42.0	(1.0)
November	0.0	(—)	24.2	(0.9)
December	0.0	(—)	4.9	(0.5)
Total	100.0		100.0	

Diuron is approved for weekly use on ponds but cannot be applied more than nine times per year. Use of copper sulfate is not restricted if the chemical is applied according to manufacturer recommendations. More than 90 percent of operations that used Diuron or copper sulfate in algae control programs waited three weeks or less between pond treatments.

e. For operations that used copper sulfate (or other copper formulation) or Diuron during 2009 to control algae, percentage of operations by number of weeks between algae control treatments:

Number Weeks Between Treatments	Percent Operations	Std. Error
1 week	59.4	(1.1)
2 to 3 weeks	31.6	(1.0)
4 to 5 weeks	8.3	(0.6)
6 weeks or more	0.7	(0.1)
Total	100.0	

6. Snail control

Ramshorn snails are an intermediate host for trematodes. The presence of snails does not necessarily mean that the pond will have trematode-related problems, but the absence of snails can help prevent disease.

About one-tenth of operations (11.1 percent) had a problem with snails in any growout ponds during 2009. There was no difference by region in the percentage of operations having a problem with snails during 2009.

a. Percentage of operations that had a problem with snails in any growout ponds in 2009, and by region:

Percent Operations					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
11.5	(0.5)	10.4	(0.5)	11.1	(0.4)

Operations were asked about their snail-control practices. The highest percentage of operations (9.4 percent) used copper to control snails, and a higher percentage of operations in the West region than in the East region used copper (12.9 and 7.2 percent, respectively). Lime (most likely hydrated lime) was used by a higher percentage of operations in the East region (5.5 percent) than in the West region (1.8 percent).

b. Percentage of operations that used the following measures to control snails in growout ponds, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Snail Control Measure	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Lime	5.5	(0.4)	1.8	(0.2)	4.1	(0.2)
Copper	7.2	(0.4)	12.9	(0.4)	9.4	(0.3)
Weed control	3.0	(0.3)	4.3	(0.3)	3.5	(0.2)
Biological control	3.0	(0.2)	3.1	(0.0)	3.0	(0.2)
Any	11.5	(0.5)	15.3	(0.5)	13.0	(0.4)

G. Feeding Practices

1. Tons of feed fed

On average, operations fed 994.9 tons of feed to foodsize-fish during 2009. As expected, the total amount of feed fed increased with operation size. Overall, operations fed an average of 5.5 tons of feed per surface acre. The smallest operations (1 to 19 surface acres) fed the lowest amount of feed per acre (3.4 tons). If feeding occurred over a 200-day growing period, 5.5 tons per acre translates to an average of 55 pounds of feed per acre per day.

Average tons of feed fed to foodsize fish per operation and per acre during 2009, and by size of operation:

Average

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Tons of Feed Fed	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Average per operation	25.5	(1.1)	171.4	(3.1)	486.6	(6.7)	2,704	(119.0)	994.9	(39.2)
Average per acre	3.4	(0.1)	5.5	(0.1)	5.8	(0.1)	5.5	(0.1)	5.5	(0.1)

2. Protein in feed

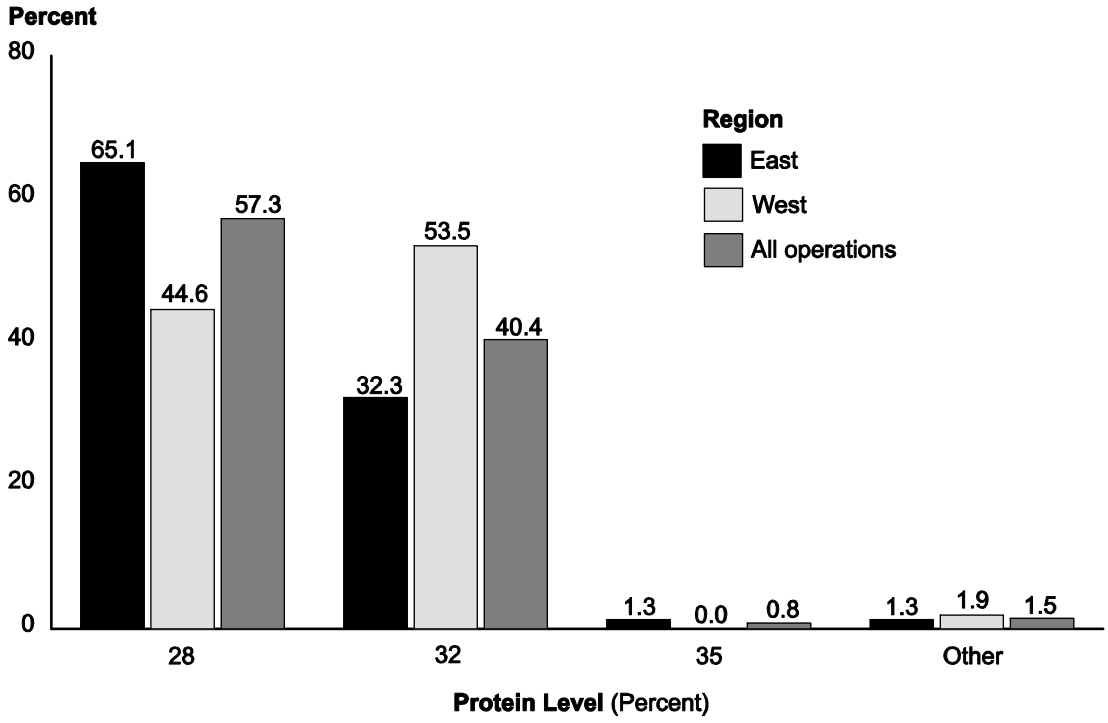
Producers select a protein level in feed for foodsize fish to balance cost and feeding rate with production goals. Protein levels of 28 percent have been shown to be adequate for foodsize fish, but levels as high as 36 percent are fed. Higher protein levels may improve product quality by reducing body fat.

Although 32 percent protein in feed was considered standard in the industry in the past, 57.3 percent of foodsize-fish operations primarily used feed with 28 percent protein during 2009. A substantially higher percentage of operations in the East region than in the West region primarily used feed with 28 percent protein (65.1 and 44.6 percent, respectively).

Percentage of foodsize-fish operations by protein level (percent) in feed primarily fed to foodsize fish during 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Protein Level (Percent)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
28	65.1	(0.7)	44.6	(0.8)	57.3	(0.6)
32	32.3	(0.7)	53.5	(0.8)	40.4	(0.6)
35	1.3	(0.2)	0.0	(—)	0.8	(0.1)
Other	1.3	(0.2)	1.9	(0.3)	1.5	(0.2)
Total	100.0		100.0		100.0	

Percentage of Foodsize-fish Operations by Protein Level (Percent) in Feed Primarily Fed to Foodsize Fish during 2009, and by Region



3. Feed conversion ratio

Calculating the direct feed conversion ratio (pounds of feed fed per pound of fish harvested) is problematic under typical production conditions. Consequently, three approaches to deriving the value are presented here.

1. The operation average (first line of table below) is based on a direct question to producers concerning their estimated feed conversion ratio. Based on producers' answers, an operation average was calculated. For this calculation, the pounds fed and the pounds of fish produced by each operation were not used.
2. The weighted average (second line) is the operation average accounting for the pounds of fish harvested by each operation in 2009.
3. The gross average (third line) is the total weight of feed fed by all operations divided by the total pounds of fish harvested by all operations (ratio estimate).

The three approaches to calculating feed conversion rate provided very similar overall estimates. The gross average was slightly lower than the operation average and weighted average for the smallest operations (1.9 compared with 2.3 and 2.1, respectively). In contrast, gross feed conversion was slightly higher for the foodsize-fish operations with 50 to 149 surface acres.

Average pounds of feed fed per pound of fish harvested during 2009, and by size of operation:

Average (lb feed/lb fish harvested)

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Average	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
Operation average	2.3	(0.0)	2.2	(0.0)	2.1	(0.0)	2.2	(0.0)	2.2	(0.0)
Weighted average*	2.1	(0.0)	2.1	(0.0)	2.1	(0.0)	2.2	(0.0)	2.2	(0.0)
Gross average	1.9	(0.1)	2.2	(0.0)	2.4	(0.0)	2.0	(0.0)	2.1	(0.0)

*Operation average weighted by pounds of fish harvested.

4. Seasonal feeding practices

Catfish feed consumption is related to water temperature. Feeding may be inconsistent at temperatures below 70°F.

A majority of producers fed catfish on alternate days during the typically cooler months of March and April (67.6 percent) and September and October (58.9 percent). From May through August, 71.1 percent of foodsize-fish operations fed catfish every day. During all seasons in 2009, a higher percentage of operations fed catfish to satiation than fed to a maximum feeding limit. The "other" feeding practices were varied. Many of the other responses were feeding two or three times a week. Some operations that provide fee fishing stated they fed to attract fish for anglers.

a. Percentage of foodsize-fish operations by seasonal feeding method most commonly used in 2009 for foodsize fish:

	Percent Operations					
	Season					
	March–April		May–August		September–October	
Feeding Method	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Every day to satiation (all they can eat)	7.9	(0.3)	46.1	(0.6)	18.8	(0.5)
Every day but with a maximum feeding limit	8.9	(0.3)	25.0	(0.5)	12.1	(0.4)
Alternate days to satiation	48.1	(0.6)	16.2	(0.4)	38.1	(0.6)
Alternate days with a maximum feeding limit	19.5	(0.5)	8.2	(0.3)	20.8	(0.5)
Other	15.6	(0.5)	4.5	(0.3)	10.2	(0.4)
Total	100.0		100.0		100.0	

Overall, when producers feed foodsize catfish at a fixed rate, they use an average of 4.4 percent of fish body weight to calculate the amount of feed.

b. For fixed-rate feeding, percentage of fish body weight used to calculate the amount to feed, and by size of operation:

Average Percent Fish Body Weight

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
6.1	(0.5)	3.7	(0.1)	4.3	(0.1)	4.3	(0.1)	4.4	(0.1)

Catfish feeding behavior declines during winter, but there is debate concerning the need to feed during winter months. Some evidence suggests that some feeding, when temperatures are appropriate, can help catfish maintain body weight and condition during winter.

More than one-half of operations (56.8 percent) feed foodsize fish zero days per week on average during the winter. About one-third of operations (37.3 percent) feed 1 to 3 days per week. Compared with larger operations, a lower percentage of the smallest operations (1 to 19 surface acres) feed zero days per week on average during winter.

c. Percentage of operations by average number of days per week foodsize fish are fed from December through February, and by size of operation:

Percent Foodsize-fish Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Average Number Days per Week	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
0	42.4	(1.5)	54.7	(1.4)	60.0	(1.1)	63.7	(0.9)	56.8	(0.6)
1 to 3	43.1	(1.4)	39.4	(1.4)	35.2	(1.1)	34.6	(0.9)	37.3	(0.6)
4 or more	3.0	(0.4)	0.0	(—)	0.8	(0.0)	0.0	(—)	0.8	(0.1)
No food fish on hand in winter	11.5	(0.8)	5.9	(0.5)	4.0	(0.3)	1.7	(0.2)	5.1	(0.2)
Total	100.0		100.0		100.0		100.0		100.0	

The amount of feed fed daily during the highest feeding month reflects the intensity of production. Operations with 50 to 149 acres had the highest average daily pounds of feed fed per acre (135.9 lb/acre/day) during 2009, which is consistent with the average tons of feed fed per acre annually (see table G.1). On average, the foodsize-fish operations with 1 to 19 surface acres had a lower daily average of feed fed per acre (78.2 lb/acre/day) than did larger operations. This low average may result in part from this group having some operations that feed very irregularly because they are primarily fee-fishing operations.

d. Operation average pounds of feed fed per acre, per day, to foodsize fish in all ponds during the highest feeding month during 2009, and by size of operation:

Operation Average (lb/acre/day)

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
78.2	(1.7)	126.6	(1.3)	135.9	(1.0)	124.1	(0.9)	120.0	(0.6)

The East region had a higher average daily feeding rate during the month of highest feed use during 2009 than the West region.

e. Operation average pounds of feed fed per acre, per day, to foodsize fish in all ponds during the highest feeding month during 2009, by region:

Operation Average (lb/acre/day)

Region

East		West	
Average	Std. Error	Average	Std. Error
125.2	(0.9)	111.2	(0.7)

The highest daily feeding rate for any single growout pond on operations averaged 161.1 pounds per acre in 2009. Operations with 50 to 149 surface acres had the highest value for highest daily feeding rate (187.8 lb/acre), followed by operations with 150 or more surface acres (174.0 lb/acre).

f. Operation average **highest daily** feeding rate during 2009 for any single growout pond, and by size of operation:

Operation Average Highest Daily Feeding Rate (lb/acre)

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
99.7	(3.0)	157.1	(2.0)	187.8	(1.6)	174.0	(1.3)	161.1	(1.0)

Operations in the East region were higher in average highest daily feeding rates than operations in the West region.

g. Operation average **highest daily** feeding rate during 2009 for any single growout pond, by region:

Operation Average

Region

East		West	
Average	Std. Error	Average	Std. Error
164.7	(1.4)	155.0	(1.0)

5. Feed selection

For more than two-fifths of foodsize-fish operations (41.3 percent), price of feed is the most important reason for deciding which feed to buy. About one-fourth of operations (23.1 percent) use past performance of feed as the most important reason for choosing a feed, and 16.9 percent of operations use quality of feed as the most important reason in feed selection. Price is the most important reason in selecting a feed for a higher percentage of the largest operations (50.9 percent) compared with smaller operations. Past performance of feed is the most important reason for selecting feed for a lower percentage of the largest operations (17.0 percent) than for smaller operations.

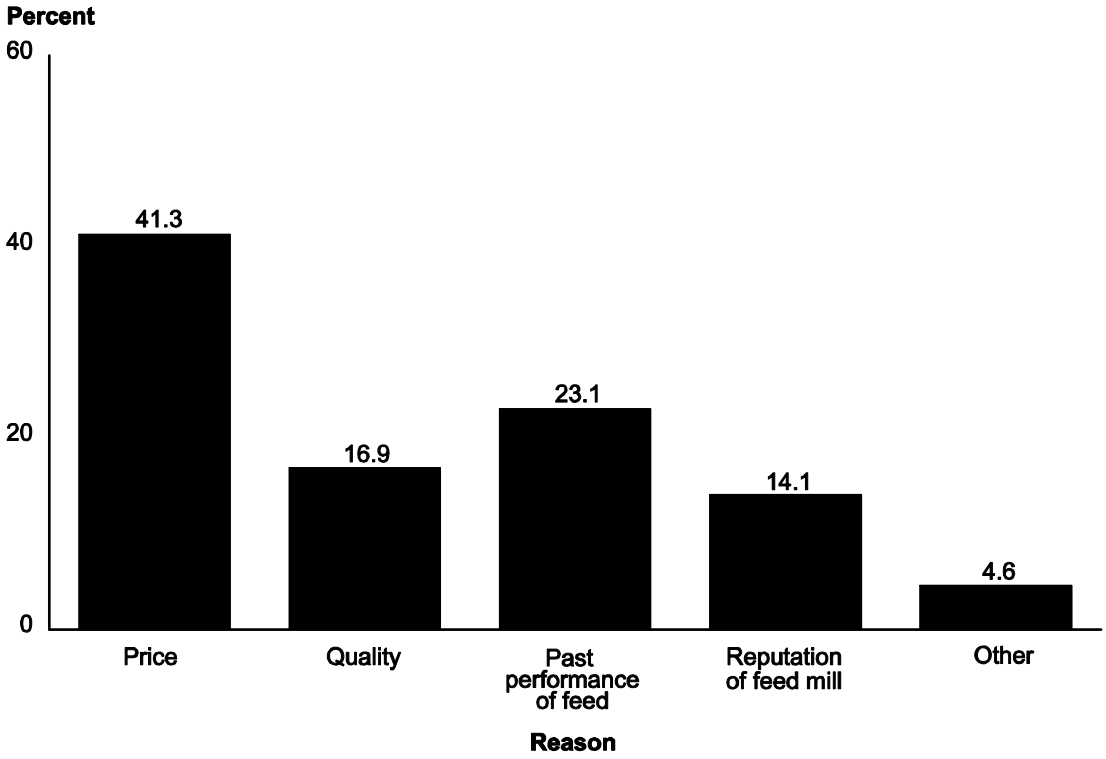
Percentage of foodsize-fish operations by most important reason for deciding which feed to buy, and by size of operation:

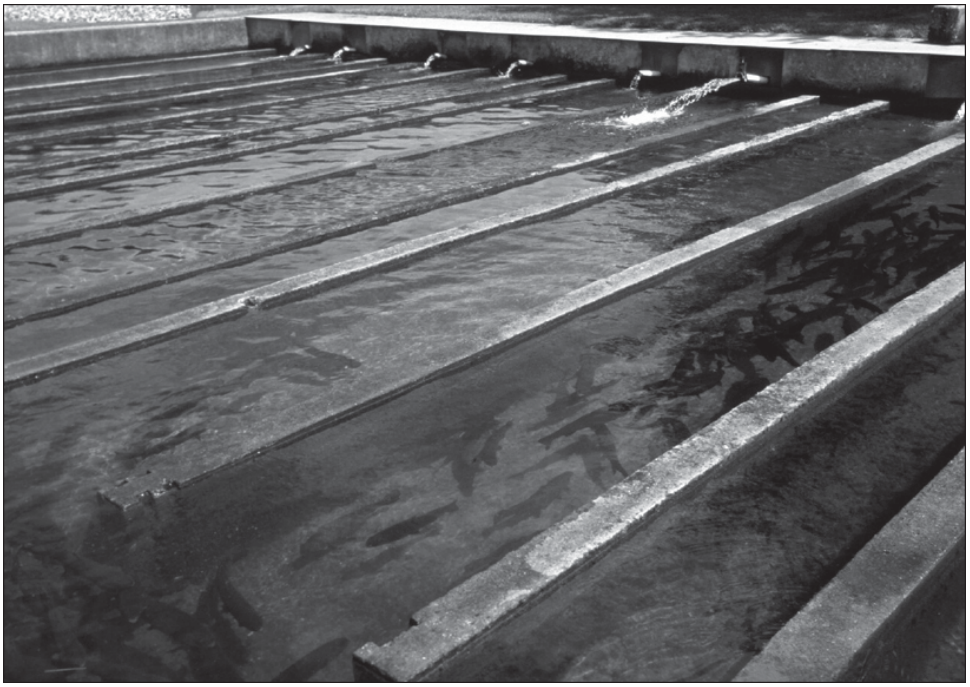
Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Reason	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Price	32.8	(1.4)	41.7	(1.4)	36.6	(1.1)	50.9	(1.0)	41.3	(0.6)
Quality (e.g., premium, standard, economy)	18.4	(1.0)	14.1	(0.9)	16.4	(0.8)	18.4	(0.7)	16.9	(0.4)
Past performance of feed	30.2	(1.3)	27.3	(1.2)	22.1	(1.0)	17.0	(0.8)	23.1	(0.5)
Reputation of feed mill	8.6	(0.9)	15.7	(1.1)	20.0	(1.0)	10.4	(0.7)	14.1	(0.5)
Other	10.0	(0.8)	1.2	(0.4)	4.9	(0.5)	3.3	(0.3)	4.6	(0.2)
Total	100.0		100.0		100.0		100.0		100.0	

Percentage of Foodsize-fish Operations by Most Important Reason for Deciding Which Feed to Buy





Photograph courtesy of Anson Eaglin, USDA.

H. Vaccination

Note: Some of the following data, along with additional analyses and interpretation, are in review for publication in the *Journal of Aquatic Animal Health* as Bebak, J., and B. Wagner, "Use of Vaccination by the U.S. Catfish Industry."

1. Enteric septicemia of catfish (ESC)

For the most cost-effective use of this immersion vaccine, producers who plan to vaccinate catfish against ESC should do so when the fish are in the fry stage.

Overall, 6.2 percent of foodsize-fish operations stocked any fish that had been vaccinated against ESC. A higher percentage of the largest operations (150 surface acres or more) stocked any ESC-vaccinated fish compared with smaller operations. Of fish stocked into growout ponds in 2009 on all foodsize-fish operations, an operation average of 4.9 percent were vaccinated against ESC. Operations with 150 or more surface acres stocked a higher percentage of ESC-vaccinated fish (8.7 percent) compared with smaller operations. Operations with 20 to 49 surface acres did not stock any fish vaccinated for ESC in growout ponds in 2009.

a. For foodsize-fish operations, percentage that stocked any ESC-vaccinated fish in 2009 and operation average percentage of fish stocked that were vaccinated, and by size of operation:

Percent

	Size of Operation (Surface Acres for Foodsize Fish)									
	1–19		**20–49**		**50–149**		**150 or More**		**All Operations**	
	Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Operations that stocked vaccinated fish	5.6	(0.7)	0.0	(—)	5.8	(0.6)	11.4	(0.7)	6.2	(0.3)
Stocked fish vaccinated, operation average	4.6	(0.6)	0.0	(—)	4.9	(0.5)	8.7	(0.6)	4.9	(0.3)

In 2009, a higher percentage of operations in the East region than in the West region stocked any ESC-vaccinated fish (7.7 and 3.8 percent, respectively). Of fish stocked into growout ponds in 2009 on all foodsize-fish operations, a higher percentage in the East region were vaccinated against ESC than in the West region (6.8 and 1.9 percent, respectively).

b. For foodsize-fish operations, percentage that stocked any ESC-vaccinated fish in 2009 and operation average percentage of fish stocked that were vaccinated, by region:

	Percent			
	Region			
	East		West	
	Percent	Std. Error	Percent	Std. Error
Operations that stocked vaccinated fish	7.7	(0.4)	3.8	(0.4)
Stocked fish vaccinated, operation average	6.8	(0.4)	1.9	(0.3)

On operations that stocked ESC-vaccinated fish in 2009, not all fish stocked were vaccinated. Based on an operation average percentage of foodsize fish stocked on operations that vaccinated, 79.2 percent of fish stocked were vaccinated. Based on the number of fish stocked on operations that vaccinated fish, 50.6 percent of fish stocked were vaccinated. The operation average percentage of fish stocked was much higher than the fish percentage for operations with 1 to 19 surface acres for foodsize fish, indicating that larger operations tended to stock a lower percentage of vaccinated fish.

c. For operations that stocked any ESC-vaccinated fish in growout ponds in 2009, operation average percentage and percentage of total fish stocked that were vaccinated for ESC, and by size of operation:

Percent Foodsize Fish

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Operation average for fish stocked that were vaccinated	82.6	(4.4)	0.0	(—)	84.0	(2.7)	75.7	(1.9)	79.2	(1.5)
Fish stocked that were vaccinated, based on total number of fish	29.2	(3.8)	0.0	(—)	76.6	(9.5)	50.4	(14.3)	50.6	(14.1)

Vaccinations may not entirely protect animals from disease. Overall, ESC outbreaks occurred in ponds that contained foodsize fish vaccinated for ESC on 46.6 percent of operations in 2009. The percentage of operations with outbreaks in ponds containing foodsize fish vaccinated for ESC was highest on operations with 1 to 19 surface acres (74.4 percent).

d. For operations that stocked any ESC-vaccinated fish in growout ponds in 2009, percentage of operations that had any outbreaks of ESC that year in ponds containing vaccinated fish, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
74.4	(5.0)	NA		14.5	(3.9)	55.2	(3.2)	46.6	(2.5)

The percentage of operations that had outbreaks in ponds with foodsize fish vaccinated for ESC was similar by region.

e. For operations that stocked any ESC-vaccinated fish in growout ponds in 2009, percentage of operations that had any outbreaks of ESC that year in ponds containing vaccinated fish, by region:

Percent Operations

Region

East		West	
Percent	Std. Error	Percent	Std. Error
44.9	(2.8)	51.8	(5.5)

More than one-half (53.6 percent) of all operations that had ESC outbreaks in ponds containing foodsize fish vaccinated for ESC provided medicated feed to those fish.

f. For operations that had any outbreaks of ESC in growout ponds containing fish vaccinated for ESC in 2009, percentage of operations that gave medicated feed to those vaccinated fish:

Percent Operations	Std. Error
53.6	(3.7)

About 4 of 10 operations (41.9 percent) that stocked vaccinated fish thought survival was better in ponds containing vaccinated fish than in ponds without vaccinated fish. A majority of operations said growth in ponds containing vaccinated fish was the same as growth in ponds without vaccinated fish or did not know (41.4 and 45.9 percent, respectively).

g. For operations that stocked any ESC-vaccinated fish in growout ponds in 2009, percentage of operations by perceived performance (survival and growth rates) of foodsize fish in ponds with ESC-vaccinated fish compared with performance of foodsize fish in ponds without ESC-vaccinated fish:

	Percent Operations								
	Perceived Performance								
	Better		Same		Worse		Don't Know		
Performance Measure	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Total
Survival rate	41.9	(2.5)	20.6	(2.1)	0.0	(—)	37.5	(2.5)	100.0
Growth rate	12.7	(1.5)	41.4	(2.5)	0.0	(—)	45.9	(2.5)	100.0

2. Columnaris

The columnaris vaccine became available to the catfish industry in March 2005. In 2009, 3.9 percent of operations stocked any fish that had been vaccinated against columnaris into growout ponds. Of fish stocked into growout ponds in 2009 on all operations, an operation average of 2.7 percent of fish stocked were vaccinated against columnaris. Across size categories there were few differences, except that no operations with 20 to 49 surface acres used columnaris vaccine.

a. For foodsize-fish operations, percentage that stocked any columnaris-vaccinated fish in 2009 and operation average percentage of fish stocked that were vaccinated, and by size of operation:

Percent

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Operations that stocked vaccinated fish	5.6	(0.6)	0.0	(—)	3.3	(0.4)	6.3	(0.5)	3.9	(0.2)
Stocked fish vaccinated, operation average	3.8	(0.4)	0.0	(—)	2.9	(0.4)	3.6	(0.4)	2.7	(0.2)

Similar to regional stocking patterns for ESC-vaccinated fish in 2009 (see table H.1.b), a higher percentage of operations in the East region than in the West region stocked any columnaris-vaccinated fish (5.2 and 2.0 percent, respectively). Of fish stocked into growout ponds in 2009 on all operations, a higher percentage in the East region were vaccinated against columnaris than in the West region (4.0 and 0.6 percent, respectively).

b. For foodsize-fish operations, percentage that stocked any columnaris-vaccinated fish in 2009 and operation average percentage of fish stocked that were vaccinated, by region:

Percent

Region

	East		West	
	Percent	**Std. Error**	**Percent**	**Std. Error**
Operations that stocked vaccinated fish	5.2	(0.3)	2.0	(0.3)
Stocked fish vaccinated, operation average	4.0	(0.3)	0.6	(0.1)

On operations that stocked columnaris-vaccinated fish in 2009, the operation average percentage of stocked fish that were vaccinated was 67.9 percent. The percentage of stocked fish that were vaccinated against columnaris was 48.2 percent.

c. For operations that stocked any columnaris-vaccinated fish in growout ponds in 2009, operation average percentage and percentage of total fish stocked that were vaccinated for columnaris, and by size of operation:

Percent Foodsize Fish

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
	Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Operation average for fish stocked that were vaccinated	67.2	(4.1)	NA		87.5	(3.1)	57.6	(3.2)	67.9	(2.2)
Fish stocked that were vaccinated, based on total number of fish	25.6	(0.5)	NA		82.9	(10.8)	48.0	(14.6)	48.2	(14.4)

Overall, columnaris outbreaks occurred in ponds that contained foodsize fish vaccinated for columnaris on almost three-fifths of operations (59.2 percent) in 2009.

d. For operations that stocked any columnaris-vaccinated fish in growout ponds in 2009, percentage of operations that had any outbreaks of columnaris that year in ponds containing vaccinated fish, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
74.4	(4.8)	NA		50.0	(6.4)	56.2	(4.3)	59.2	(2.9)

All of the operations in the West region that had fish vaccinated for columnaris had outbreaks of the disease in ponds containing vaccinated foodsize fish in 2009. It should be noted, however, that only 2.0 percent of operations in the West region stocked fish vaccinated for columnaris in 2009 (see table H.2.b). In the East region, where a higher percentage of operations stocked fish vaccinated for columnaris (5.2 percent, see table H.2.b), about one-half of the operations (49.4 percent) had outbreaks of columnaris in ponds containing vaccinated fish.

e. For operations that stocked any columnaris-vaccinated fish in growout ponds in 2009, percentage of operations that had any outbreaks of columnaris that year in ponds containing vaccinated fish, by region:

Percent Operations

Region

East		West	
Percent	Std. Error	Percent	Std. Error
49.4	(3.3)	100.0	(0.0)

Two-thirds of operations (66.6 percent) that had outbreaks of columnaris in ponds containing foodsize fish vaccinated for columnaris fed medicated feed to those fish. One-half of the operations in the East region (50.2 percent) and all operations in the West region (100.0 percent) fed medicated feed in response to columnaris outbreaks in ponds containing vaccinated fish.

f. For operations that had any outbreaks of columnaris in growout ponds containing fish vaccinated for columnaris in 2009, percentage of operations that gave medicated feed to those vaccinated fish, and by region:

Percent Operations

Region					
East		West		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
50.2	(4.9)	100.0	(0.0)	66.6	(4.0)

Almost one-half of operations (46.2 percent) that stocked any fish vaccinated for columnaris in 2009 believed survival was better in ponds containing columnaris-vaccinated fish than in ponds without vaccinated fish. A similar percentage (46.9 percent) believed that growth rate was the same for the two types of ponds. More than one-third of operations did not know whether survival or growth rate was different for ponds with vaccinated fish and ponds without vaccinated fish.

g. For operations that stocked any columnaris-vaccinated fish in growout ponds in 2009, percentage of operations by perceived performance (survival and growth rates) of foodsize fish in ponds with columnaris-vaccinated fish compared with performance of foodsize fish in ponds without columnaris-vaccinated fish:

Percent Operations

	Perceived Performance								
	Better		Same		Worse		Don't Know		
Performance Measure	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Total
Survival rate	46.2	(3.1)	14.1	(2.3)	0.0	(—)	39.7	(3.0)	100.0
Growth rate	13.4	(1.9)	46.9	(3.1)	0.0	(—)	39.7	(3.0)	100.0

3. Vaccination plans for 2010

According to producer responses regarding vaccination plans for 2010, an operation average of 5.7 percent of the fish to be stocked in 2010 would be vaccinated against ESC. This value is similar to the operation average percentage of fish stocked in 2009 that were vaccinated for ESC (4.9 percent, see table H.1.a). For columnaris, however, an operation average of 3.7 percent of fish to be stocked in 2010 would be vaccinated, which is slightly higher than the 2.7 percent reported for fish stocked in 2009 (see table H.2.a). This slight increase may reflect some increased use of this relatively new vaccine.

a. Operation average percentage of foodsize fish to be stocked in 2010 that would be vaccinated for ESC or columnaris, and by size of operation:

Operation Average Percent Foodsize Fish

Size of Operation (Surface Acres for Foodsize Fish)

	1-19		20-49		50-149		150 or More		All Operations	
Vaccination	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
ESC	6.8	(0.7)	4.0	(0.5)	5.3	(0.5)	6.6	(0.5)	5.7	(0.3)
Columnaris	5.3	(0.6)	2.0	(0.3)	3.3	(0.4)	4.5	(0.4)	3.7	(0.2)

Almost all operations planned to stock fish that would not be vaccinated for ESC or columnaris (93.0 and 95.0 percent, respectively). Of operations that planned to stock fish vaccinated for ESC or columnaris in 2010, the majority planned to vaccinate all stocked fish.

b. Percentage of operations by percentage of fish vaccinated for ESC or columnaris to be stocked in 2010:

	Percent Operations			
	Vaccination			
	ESC		Columnaris	
Percent Vaccinated	Percent	Std. Error	Percent	Std. Error
0	93.0	(0.3)	95.0	(0.3)
1 to 10	0.0	(—)	0.3	(0.1)
11 to 20	0.0	(—)	0.0	(—)
21 to 50	2.1	(0.2)	1.5	(0.2)
51 to 99	0.3	(0.1)	0.0	(—)
All fish	4.6	(0.3)	3.2	(0.2)
Total	100.0		100.0	

Vaccination can prevent substantial losses from disease and be cost-effective for the producer. However, millions of catfish fry are likely to be vaccinated at any one time and many factors affect development and maintenance of post-vaccination immunity. Therefore, 100% of vaccinated fish may not be protected. However, if enough fish become immune to the disease, vaccination can still prevent substantial losses from the disease.

All respondents were asked what percentage of fish they would expect to be protected from disease if they were to stock fingerlings vaccinated against ESC or columnaris. Overall, operations expected 92.4 percent of vaccinated fish to be protected from disease. More than one-half of operations, however, expected all fish to be protected (52.4 percent of operations).

c. Percentage of fingerlings that producers would expect to be protected from disease if they were to stock fingerlings vaccinated against ESC or columnaris, and by size of operation:

Percent Fingerlings

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
93.4	(0.5)	92.0	(0.3)	92.6	(0.2)	92.0	(0.4)	92.4	(0.2)

d. Percentage of operations by percentage of fish vaccinated against ESC or columnaris that producers would expect to be protected from the disease:

Percent Vaccinated Fish Protected	Percent Operations	Std. Error
1 to 50	2.9	(0.2)
51 to 70	1.8	(0.1)
71 to 89	16.4	(0.4)
90 to 99	26.5	(0.6)
All fish	52.4	(0.6)
Total	100.0	

I. Health Issues

1. Major mortality loss

Discerning mortality and tracking losses along with their causes in catfish ponds is difficult, especially in large ponds that are harvested and understocked for many years.

Operations were asked about ponds that had major mortality events (5 percent or more of inventory lost over a period of up to 2 weeks) in 2009. Both the percentage of growout ponds and the percentage of surface acres involved in these major mortality events were 12.2 percent. Operations with 50 to 149 acres had a higher percentage of ponds involved in mortality events than operations in the two smaller size categories.

a. Percentage of all growout ponds and percentage of growout-pond surface acres with major mortality losses (5 percent of inventory or more over a period of up to 2 weeks) in 2009, and by size of operation:

Percent

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Percent ponds	10.7	(0.6)	10.1	(0.5)	13.6	(0.4)	12.2	(0.8)	12.2	(0.6)
Percent growout-pond surface acres	9.6	(0.7)	12.9	(0.6)	12.4	(0.4)	12.1	(0.8)	12.2	(0.6)

Both the percentage of ponds and the percentage of surface acreage with major mortality losses were higher in the East region than in the West region. The reason for the difference is not known.

b. Percentage of all growout ponds and percentage of growout-pond surface acres with major mortality losses (5 percent of inventory or more over a period of up to 2 weeks) in 2009, by region:

Percent

Region

	East		West	
	Percent	Std. Error	Percent	Std. Error
Percent ponds	16.0	(1.2)	10.2	(0.7)
Percent growout-pond surface acres	17.2	(1.3)	9.8	(0.6)

Operations with major mortality losses were asked about pounds of fish sold per acre from ponds with major losses; also, all operations were asked about pounds sold per acre from ponds without major losses.

For ponds without major losses, the operation average and average adjusted for surface acres were 4,443 and 4,894 pounds per acre, respectively. The difference in these two values reflects the higher pounds sold per acre on larger operations than on operations with 1 to 19 surface acres. For pounds of fish sold per acre for ponds with major losses, the operation average and average adjusted for acreage were close to each other (3,335 and 3,405 pounds per acre, respectively).

Based on the operation average, ponds without major losses produced 1,108 more pounds sold per acre than ponds with major losses. Based on the average adjusted for surface acres, this difference between ponds without and with major losses was 1,489 pounds sold per acre.

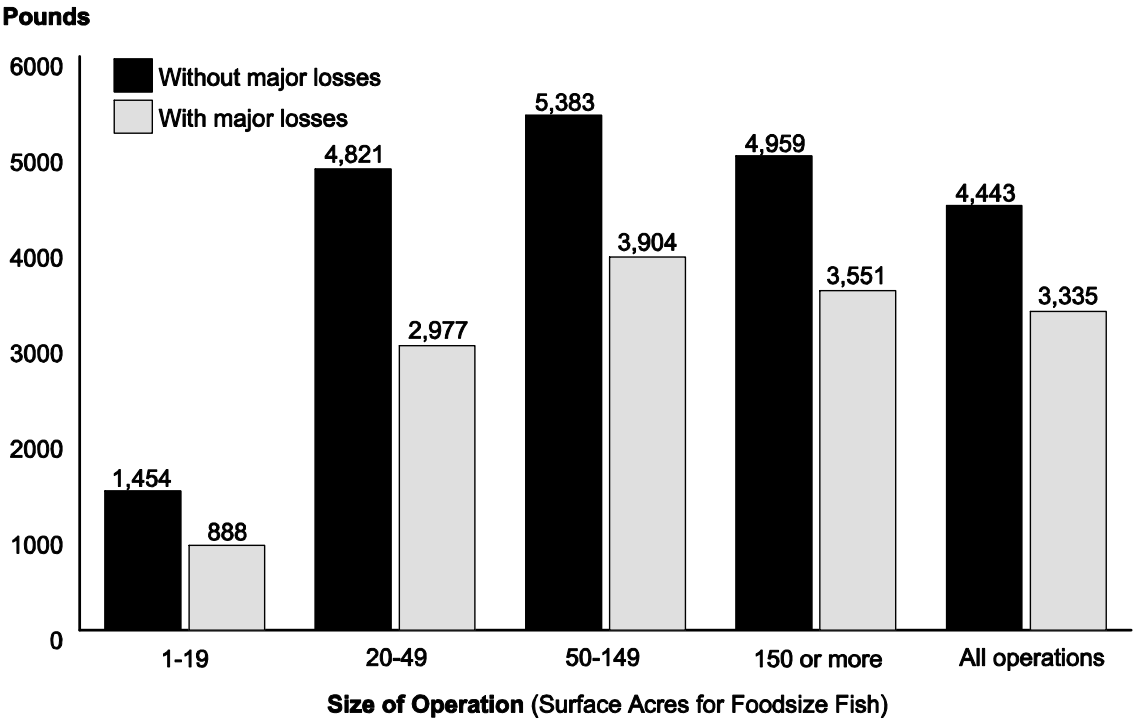
c. Operation average and acreage-based average for pounds of fish sold per acre from ponds without major losses and from ponds with major losses, and by size of operation:

Pounds Sold per Acre

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
Without major losses										
Operation average	1,454	(59)	4,821	(96)	5,383	(74)	4,959	(55)	4,443	(40)
Acreage average	1,997	(200)	4,844	(262)	5,190	(211)	4,873	(183)	4,894	(153)
With major losses										
Operation average	888	(92)	2,977	(126)	3,904	(100)	3,551	(78)	3,335	(54)
Acreage average	1,242	(635)	3,229	(373)	4,125	(427)	3,203	(342)	3,405	(271)

Operation Average Pounds of Fish Sold per Acre from Ponds Without Major Losses and from Ponds With Major Losses, and by Size of Operation



Harvest from ponds without major losses and from ponds with major losses was higher in the East region than in the West region for the operation average. Based on the operation average pounds sold per acre, however, there was a larger difference in harvest from ponds without major losses and ponds with major loses in the East region (1,278 pounds per acre, or 25.5 percent) than in the West region (707 pounds per acre, or 20.5 percent).

d. Operation average and acreage-based average in pounds of fish sold per acre from ponds without major losses and from ponds with major losses, by region:

	Pounds Sold per Acre			
	Region			
	East		West	
	Average	Std. Error	Average	Std. Error
Without major losses				
Operation average	5,013	(59)	3,455	(36)
Acreage average	6,636	(265)	4,120	(177)
With major losses				
Operation average	3,735	(82)	2,748	(57)
Acreage average	3,835	(531)	3,025	(237)

2. Causes of foodsize-fish loss

Almost four-fifths of foodsize-fish operations (79.2 percent) lost some foodsize fish to disease outbreaks, low dissolved oxygen, or predation in 2009. Predation by birds and other animals caused loss on the highest percentage of operations, affecting more than one-half of all foodsize-fish operations (53.9 percent). Two bacterial diseases, ESC and columnaris, each caused fish loss on more than one-third of all operations (36.6 and 39.0 percent, respectively). The causes of loss affecting the next highest percentages of operations were low dissolved oxygen and winter kill (28.1 and 20.6 percent, respectively).

In general, the causes of loss listed in the following table affected a lower percentage of the smallest operations (1 to 19 surface acres) compared with the larger operations. A higher percentage of the largest operations (150 or more surface acres) lost foodsize fish because of low dissolved oxygen compared with the smaller operations. A higher

percentage of operations in the two smaller size categories lost fish to ich than operations in the two larger size categories. For the “other” loss category, respondents specified causes such as *Aeromonas*, heat, and algal toxins, although many did not specify a cause.

a. Percentage of foodsize-fish operations that lost any foodsize fish to the following causes in 2009, and by size of operation:

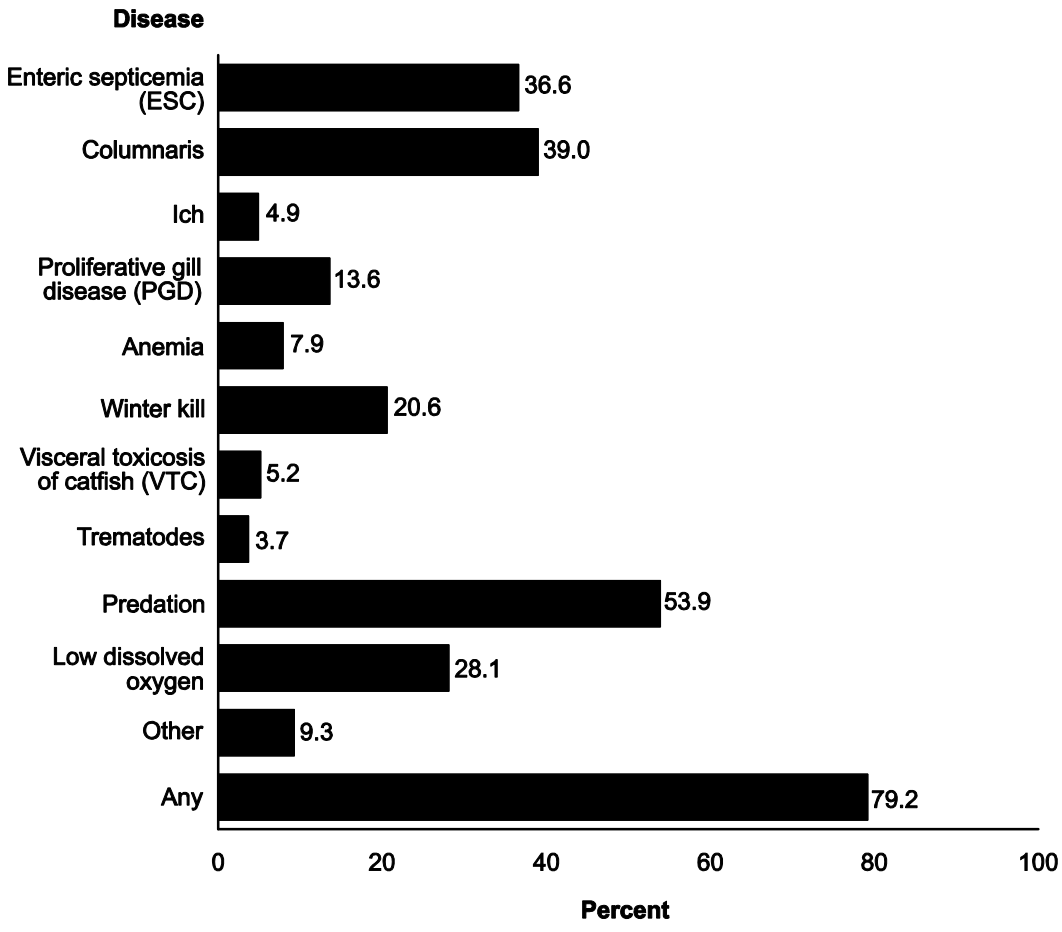
Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Cause of Loss	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Enteric septicemia of catfish (ESC, hole-in-head disease)	21.3	(1.2)	42.4	(1.4)	42.3	(1.1)	35.8	(1.1)	36.6	(0.6)
Columnaris	18.6	(1.2)	42.9	(1.4)	43.0	(1.1)	44.5	(1.0)	39.0	(0.6)
Ich	8.5	(0.7)	8.4	(0.8)	3.3	(0.5)	1.8	(0.3)	4.9	(0.3)
Proliferative gill disease (PGD, hamburger gill disease)	5.7	(0.7)	13.4	(1.0)	15.5	(0.8)	16.4	(0.8)	13.6	(0.4)
Anemia (white lip, no blood)	0.0	(—)	9.7	(0.9)	9.9	(0.7)	9.6	(0.7)	7.9	(0.4)
Winter kill (*Saprolegnia* fungus)	5.6	(0.6)	24.2	(1.3)	25.6	(1.0)	22.0	(0.9)	20.6	(0.5)
Visceral toxicosis of catfish (VTC, twisted gut, botulism)	1.3	(0.0)	4.8	(0.6)	6.3	(0.4)	6.9	(0.4)	5.2	(0.2)
Trematodes	1.4	(0.3)	3.7	(0.6)	4.7	(0.4)	4.2	(0.5)	3.7	(0.2)
Predation (birds or other animals)	30.8	(1.3)	54.6	(1.4)	58.3	(1.1)	63.4	(1.0)	53.9	(0.6)
Low dissolved oxygen	12.4	(0.7)	20.4	(1.2)	28.3	(1.0)	43.4	(1.0)	28.1	(0.5)
Other*	2.9	(0.5)	7.2	(0.7)	9.7	(0.6)	14.2	(0.7)	9.3	(0.3)
Any	51.3	(1.4)	87.0	(0.9)	84.3	(0.9)	85.5	(0.7)	79.2	(0.5)

*Values for “other” likely underestimate losses due to other causes (see table I.5.b).

Percentage of Foodsize-fish Operations that Lost Any Foodsize Fish to the Following Causes in 2009



The percentages of operations with losses attributed to ESC or columnaris were higher in the East region than in the West region. Similarly, higher percentages of operations in the East region than in the West region lost foodsize fish to ich, PGD, anemia, or “other” causes. Higher percentages of operations in the West region than in the East region reported losses associated with VTC, trematodes, predation, and low dissolved oxygen.

b. Percentage of foodsize-fish operations that lost any foodsize fish to the following causes in 2009, by region:

	Percent Operations			
	Region			
	East		West	
Cause of Loss	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Enteric septicemia of catfish (ESC, hole-in-head disease)	43.3	(0.8)	25.4	(0.8)
Columnaris	47.1	(0.8)	25.5	(0.7)
Ich	6.8	(0.4)	1.9	(0.3)
Proliferative gill disease (PGD, hamburger gill disease)	14.9	(0.6)	11.4	(0.5)
Anemia (white lip, no blood)	8.9	(0.5)	6.4	(0.5)
Winter kill (*Saprolegnia* fungus)	21.6	(0.7)	18.8	(0.7)
Visceral toxicosis of catfish (VTC, twisted gut, botulism)	3.0	(0.3)	8.9	(0.3)
Trematodes	2.5	(0.3)	5.6	(0.4)
Predation (birds or other animals)	51.3	(0.8)	58.3	(0.8)
Low dissolved oxygen	23.8	(0.7)	35.2	(0.8)
Other*	11.5	(0.5)	5.6	(0.3)
Any	78.9	(0.6)	79.7	(0.7)

*Values for “other” likely underestimate losses due to other causes (see table I.5.b).

Predation caused fish losses in 42.5 percent of ponds, while ESC and columnaris caused losses in 14.3 and 13.9 percent of ponds, respectively. Low dissolved oxygen caused losses in almost one-tenth of ponds (9.5 percent).

For many of the listed causes of loss, the two middle size categories (20 to 49 and 50 to 149 surface acres) had losses in a higher percentage of ponds than operations in the smallest and largest size categories. Notable exceptions, however, included winter kill, for which the smallest operations had a similar percentage of affected ponds to the two middle size categories, and ich, for which the two smallest size categories had similar levels of affected ponds.

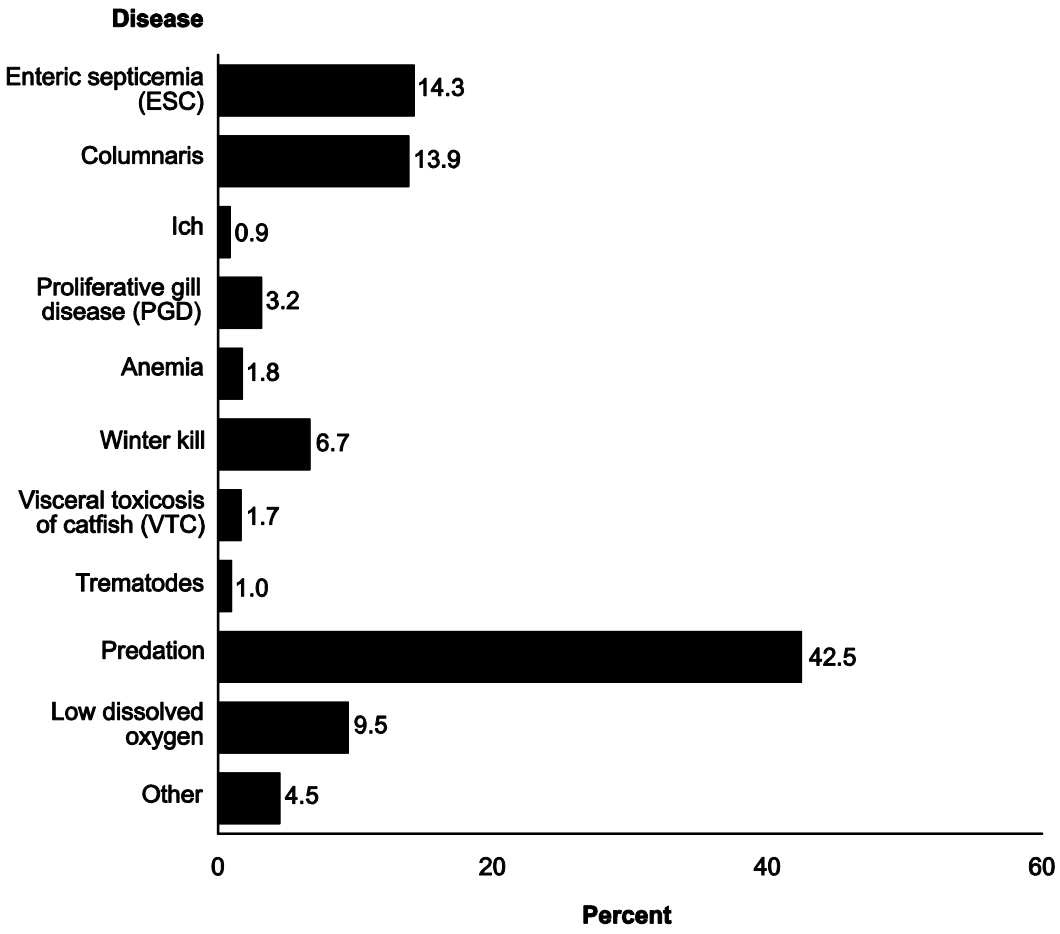
c. Percentage of growout ponds that lost any foodsize fish to the following causes in 2009, by size of operation:

Percent Ponds

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Cause of Loss	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Enteric septicemia of catfish (ESC, hole-in-head disease)	10.5	(0.8)	21.5	(1.0)	22.9	(0.8)	11.9	(0.7)	14.3	(0.5)
Columnaris	9.6	(0.8)	20.9	(1.0)	20.3	(0.8)	12.1	(0.6)	13.9	(0.5)
Ich	4.7	(0.5)	5.6	(0.7)	1.9	(0.3)	0.1	(0.0)	0.9	(0.1)
Proliferative gill disease (PGD, hamburger gill disease)	2.4	(0.3)	8.0	(0.8)	4.6	(0.3)	2.6	(0.2)	3.2	(0.2)
Anemia (white lip, no blood)	0.0	(0.0)	6.1	(0.8)	3.5	(0.3)	1.2	(0.2)	1.8	(0.1)
Winter kill (*Saprolegnia* fungus)	11.8	(1.9)	15.1	(1.0)	11.1	(0.6)	4.8	(0.3)	6.7	(0.2)
Visceral toxicosis of catfish (VTC, twisted gut, botulism)	0.4	(0.0)	5.0	(0.7)	2.9	(0.3)	1.2	(0.2)	1.7	(0.1)
Trematodes	2.4	(0.5)	4.3	(0.7)	2.8	(0.4)	0.2	(0.0)	1.0	(0.1)
Predation (birds or other animals)	37.2	(1.8)	50.4	(1.3)	53.5	(1.1)	39.6	(2.0)	42.5	(1.5)
Low dissolved oxygen	9.1	(0.6)	21.2	(0.8)	14.7	(0.5)	7.4	(0.7)	9.5	(0.5)
Other	1.4	(0.3)	4.5	(0.6)	6.6	(0.4)	4.2	(0.5)	4.5	(0.4)

Percentage of Growout Ponds that Lost any Foodsize Fish to the Following Causes in 2009

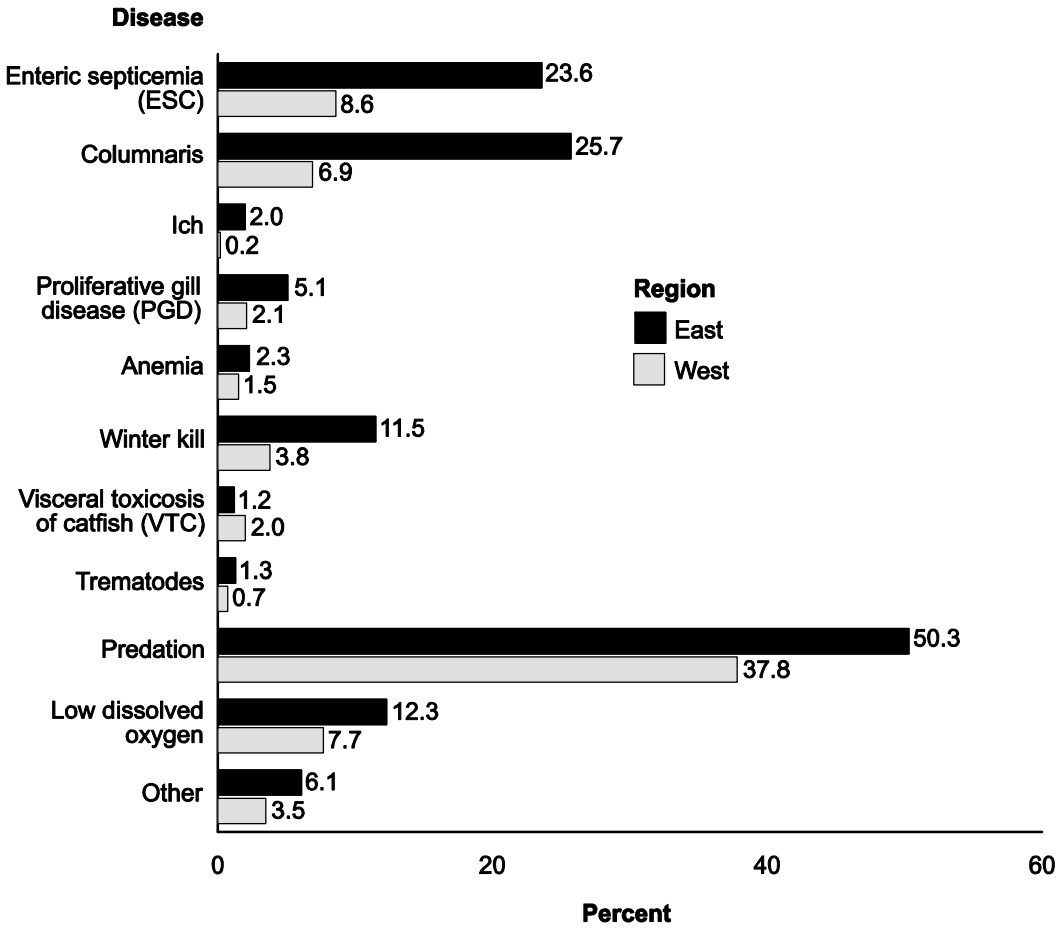


In general, the listed causes of loss affected higher percentages of ponds in the East region than in the West region.

d. Percentage of growout ponds that lost any foodsize fish to the following causes in 2009, by region:

	Percent Ponds			
	Region			
	East		West	
Cause of Loss	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Enteric septicemia of catfish (ESC, hole-in-head disease)	23.6	(1.0)	8.6	(0.5)
Columnaris	25.7	(1.0)	6.9	(0.4)
Ich	2.0	(0.2)	0.2	(0.1)
Proliferative gill disease (PGD, hamburger gill disease)	5.1	(0.3)	2.1	(0.2)
Anemia (white lip, no blood)	2.3	(0.2)	1.5	(0.2)
Winter kill (*Saprolegnia* fungus)	11.5	(0.6)	3.8	(0.2)
VTC (twisted gut, visceral toxicosis, botulism)	1.2	(0.2)	2.0	(0.2)
Trematodes	1.3	(0.2)	0.7	(0.1)
Predation (birds or other animals)	50.3	(1.4)	37.8	(2.1)
Low dissolved oxygen	12.3	(1.2)	7.7	(0.4)
Other	6.1	(0.3)	3.5	(0.5)

Percentage of Growout Ponds that Lost any Foodsize Fish to the Following Causes in 2009, by Region



Although producers may be aware of fish losses caused by disease, predation, or low dissolved oxygen, they may not have a precise estimate of fish losses attributable to an event. Producers were asked to categorize the estimated average loss per mortality event as light, moderate, or severe based on the number of pounds of fish lost.

More than one-half of operations categorized the average fish loss per event as light for each listed cause, with the exceptions of low dissolved oxygen and “other” causes. More than one-fifth of operations reported average losses per mortality event as severe for anemia, trematodes, low dissolved oxygen, and “other” causes (26.1, 26.6, 22.8, and 53.2 percent, respectively). More than two-thirds of “other” losses that were severe were reported to be *Aeromonas* (data not shown).

e. For operations that lost fish in growout ponds to the following causes of loss in 2009, percentage of operations by severity of average loss (in pounds of fish per operation) per mortality event:

	Percent Operations						
	Average Loss per Event (lb)						
	Light (Less than 200)		**Moderate** (200-2,000)		**Severe** (More than 2,000)		
Cause of Loss	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Total**
Enteric septicemia of catfish (ESC, hole-in-head disease)	68.9	(1.0)	24.7	(0.9)	6.4	(0.5)	100.0
Columnaris	58.0	(1.0)	31.3	(1.0)	10.7	(0.7)	100.0
Ich	89.4	(1.5)	5.3	(1.1)	5.3	(1.1)	100.0
Proliferative gill disease (PGD, hamburger gill disease)	74.3	(1.5)	14.7	(1.1)	11.0	(1.2)	100.0
Anemia (white lip, no blood)	54.9	(2.4)	19.0	(1.9)	26.1	(2.2)	100.0
Winter kill (*Saprolegnia* fungus)	69.2	(1.3)	18.3	(1.1)	12.5	(1.0)	100.0
VTC (twisted gut, visceral toxicosis, botulism)	71.0	(1.7)	9.1	(0.4)	19.9	(1.7)	100.0
Trematodes	60.6	(3.2)	12.8	(2.4)	26.6	(2.9)	100.0
Predation (birds or other animals)	67.2	(0.7)	27.7	(0.7)	5.1	(0.3)	100.0
Low dissolved oxygen	49.4	(1.1)	27.8	(1.0)	22.8	(1.0)	100.0
Other	27.4	(1.8)	19.4	(1.4)	53.2	(1.9)	100.0

Examining the percentage of ponds affected by loss and the severity of loss is another way—in addition to looking at the percentage of operations by severity of fish loss events—to assess the impact of mortality.

Of the causes of loss, predation occurred in the highest percentage of ponds (100-57.5=42.5 percent). Severe losses caused by predation occurred in 5.2 percent of ponds. The next highest percentages of ponds were affected by ESC and columnaris (14.3 and 13.9 percent, respectively). Columnaris caused severe losses in 3.5 percent of ponds. “Other” losses also had a relatively high percentage of severe losses (1.7 percent), especially given that only 4.5 percent of ponds had “other” losses. *Aeromonas*, which was specified by some respondents as a cause of “other” losses, has been reported to cause severe losses in portions of the industry.

f. Percentage of all growout ponds by severity of average loss (in pounds of fish per operation) per mortality event in 2009:

	Percent Ponds								
	Average Loss per Event (lb)								
	None		**Light** (Less than 200)		**Moderate** (200–2,000)		**Severe** (More than 2,000)		
Cause of Loss	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Total**
Enteric septicemia of catfish (ESC, hole-in-head disease)	85.7	(0.5)	8.3	(0.4)	4.8	(0.5)	1.2	(0.2)	100.0
Columnaris	86.1	(0.5)	6.7	(0.3)	3.7	(0.3)	3.5	(0.4)	100.0
Ich	99.1	(0.1)	0.9	(0.1)	0.0	(0.0)	0.0	(0.0)	100.0
Proliferative gill disease (PGD, hamburger gill disease)	96.8	(0.2)	2.3	(0.1)	0.7	(0.1)	0.2	(0.0)	100.0
Anemia (white lip, no blood)	98.2	(0.1)	0.9	(0.1)	0.1	(0.0)	0.8	(0.1)	100.0
Winter kill (*Saprolegnia* fungus)	93.3	(0.2)	5.0	(0.3)	0.8	(0.1)	0.9	(0.1)	100.0
VTC (twisted gut, visceral toxicosis, botulism)	98.3	(0.1)	1.0	(0.1)	0.0	(0.0)	0.7	(0.1)	100.0
Trematodes	99.1	(0.1)	0.7	(0.1)	0.1	(0.0)	0.1	(0.0)	100.0
Predation (birds or other animals)	57.5	(1.5)	22.7	(0.9)	14.6	(0.8)	5.2	(0.5)	100.0
Low dissolved oxygen	90.5	(0.5)	5.9	(0.5)	2.3	(0.1)	1.3	(0.1)	100.0
Other	95.5	(0.4)	1.2	(0.1)	1.6	(0.3)	1.7	(0.1)	100.0

Attributes ascribed to the channel x blue hybrid catfish include increased growth rates and better disease resistance. Of operations raising both channel catfish and the hybrid, the vast majority (85.5 percent or more) did not know if one catfish type was more resistant to disease than the other; this finding might be because the hybrid's widespread introduction into production is relatively recent.

The percentage of operations considering the hybrid to be more resistant than the channel catfish was at least double the percentage that thought the channel was more resistant. Among the diseases, ESC had the highest percentage of operations (8.2 percent) responding that the hybrid was more resistant than the channel catfish.

g. For operations growing **both** channel catfish and channel x blue hybrid catfish, percentage of operations by their perception of the catfish type's resistance to (ability to avoid) the following diseases:

	Percent Operations								
	Perceived Resistance								
	Channels More Resistant		Hybrids More Resistant		No Difference		Don't Know		
Disease	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Total
Enteric septicemia of catfish (ESC, hole-in-head disease)	1.1	(0.1)	8.2	(0.4)	5.2	(0.3)	85.5	(0.5)	100.0
Columnaris	1.1	(0.1)	6.1	(0.4)	5.2	(0.3)	87.6	(0.5)	100.0
Proliferative gill disease (PGD, hamburger gill disease)	1.1	(0.1)	4.6	(0.3)	5.3	(0.3)	89.0	(0.4)	100.0
Edwardsiella tarda	1.1	(0.1)	2.2	(0.2)	4.2	(0.2)	92.5	(0.3)	100.0

In recent years, two new problems associated with flesh discoloration—red flesh and yellow flesh—have been seen at the time of processing. The underlying causes of the discolorations are not well understood. Some people have suggested that red flesh is a harvest problem and that yellow flesh is associated with feed, but no definitive answers have been found.

Overall, 13.3 percent of operations had dockage at processing during 2009 because of red flesh. Higher percentages of larger operations (50 to 149 and 150 or more surface acres) than smaller operations had dockage because of red flesh. Only 3.2 percent of operations had dockage during 2009 because of yellow flesh in fish. A higher percentage of operations in the largest size category (150 or more surface acres) than operations in the smaller categories had dockage due to yellow flesh.

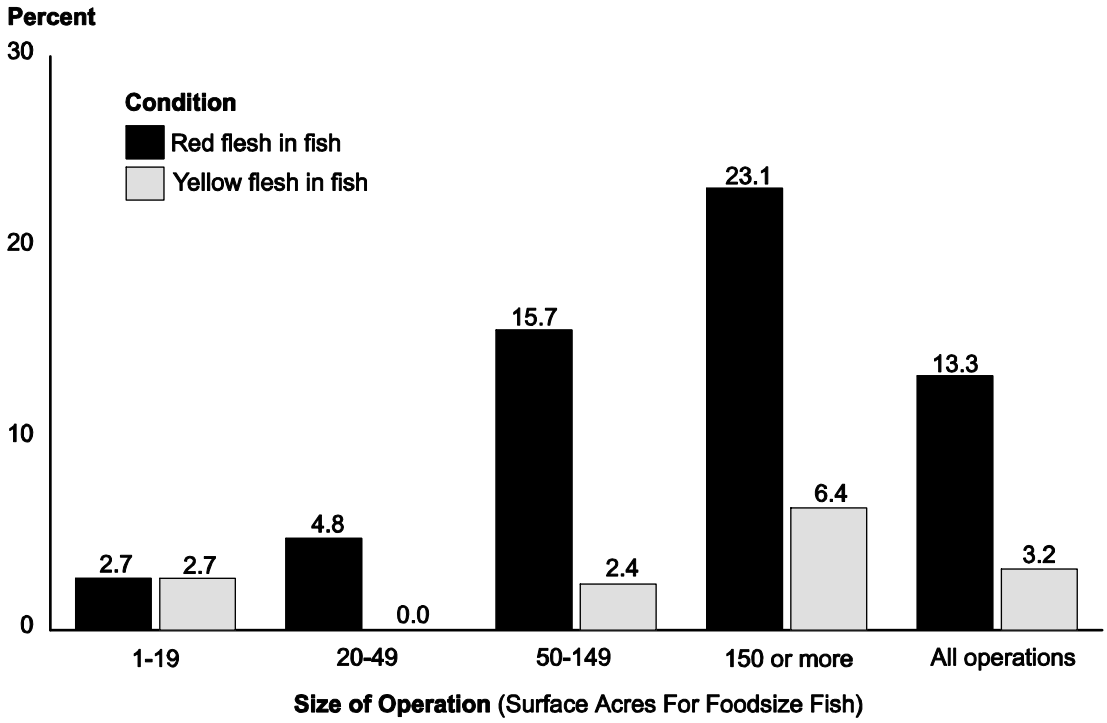
h. Percentage of operations having dockage due to the following flesh discoloration conditions in 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Condition	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Red flesh in fish	2.7	(0.5)	4.8	(0.7)	15.7	(0.8)	23.1	(0.8)	13.3	(0.4)
Yellow flesh in fish	2.7	(0.5)	0.0	(—)	2.4	(0.3)	6.4	(0.5)	3.2	(0.2)

Percentage of Operations Having Dockage Due to the Following Flesh Discoloration Conditions in 2009, and by Size of Operation



3. Algal toxins

Algal toxins are organic molecules produced by both freshwater and marine algae. When toxins reach high levels in ponds, they can lead to decreased feeding and growth, as well as mortality.

Overall, 13.6 percent of operations had fish health problems associated with algal toxins in the 3 years previous to the study interview. A lower percentage of smaller operations (1 to 19 and 20 to 49 surface acres) than larger operations had fish health problems related to algal toxins.

Percentage of operations having fish health problems related to algal toxins during the previous 3 years, by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
8.6	(0.9)	10.9	(0.9)	18.0	(0.8)	14.1	(0.6)	13.6	(0.4)

4. Use of medicated feed

Medicated feed was fed to foodsize fish by 8.2 percent of operations during 2009. There was no consistent trend in use of medicated feed across size categories.

a. Percentage of operations that fed medicated feed to foodsize fish during 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

1–19		20–49		50–149		150 or More		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
9.9	(0.8)	6.1	(0.7)	9.8	(0.6)	7.1	(0.6)	8.2	(0.3)

One-half of operations (50.2 percent) that used medicated feed used Romet®. More than one-third of operations (36.3 percent) used Aquaflor®, and about one-fourth of operations (26.0 percent) used Terramycin®.

Among the largest operations (150 or more surface acres), the highest percentage of operations (71.1 percent) fed Aquaflor. Romet was used by more than three-fourths (76.0 percent) of operations with 50 to 149 surface acres and three-fifths of operations with 20 to 49 acres. No operations with 20 to 49 acres used Aquaflor. In contrast, the highest percentage of the smallest operations (1 to 19 surface acres) fed Terramycin (50.8 percent).

b. For operations that fed any medicated feed to foodsize fish during 2009, percentage of operations by type of medicated feed used, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Feed	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Terramycin®	50.8	(4.9)	40.0	(5.4)	17.1	(2.4)	12.4	(2.5)	26.0	(1.8)
Romet®	29.0	(3.8)	60.0	(5.4)	76.0	(3.4)	25.0	(3.4)	50.2	(2.1)
Aquaflor®	16.7	(3.3)	0.0	(—)	41.1	(3.5)	71.1	(3.7)	36.3	(2.1)

On average, operations that fed Aquaflor to foodsize fish fed 22.3 tons of the medicated feed in 2009. Operations that fed the other medicated feeds to foodsize fish fed smaller amounts (on average, 10.8 tons of Romet and 2.8 tons of Terramycin).

c. For foodsize-fish operations that fed the specific type of medicated feed to foodsize fish during 2009, operation average tons of medicated feed fed:

Operation Average Tons

Medicated Feed	Average	Standard Error
Terramycin®	2.8	(0.1)
Romet®	10.8	(0.5)
Aquaflor®	22.3	(2.3)

5. Diagnostic laboratory testing

Overall, about one-third of operations (32.1 percent) submitted foodsize-fish samples to a diagnostic laboratory in 2009. This percentage did not differ by region. The highest percentage of operations (21.6 percent) submitted foodsize-fish samples to a diagnostic laboratory to confirm a cause of disease. “Other” reasons for submissions primarily included health inspections.

a. Percentage of operations that submitted any foodsize-fish samples to a diagnostic laboratory during 2009, by reason for submission and by region:

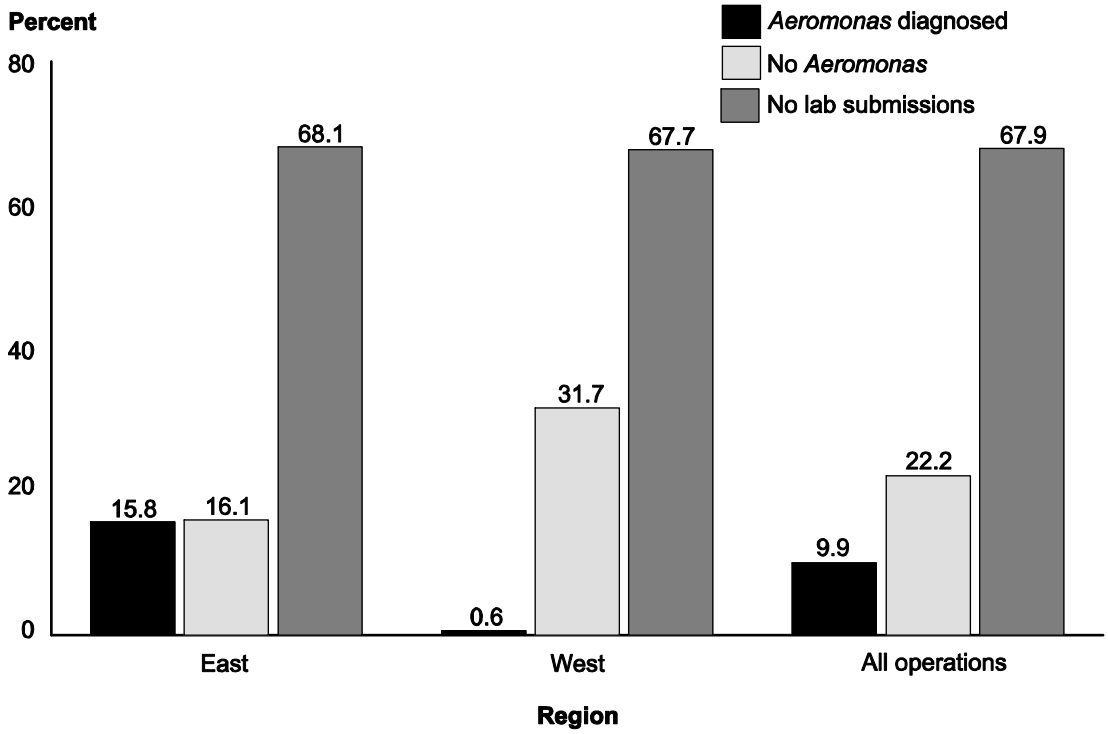
	Percent Operations					
	Region					
	East		West		All Operations	
Reason	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Detect problem early	13.6	(0.5)	22.3	(0.7)	17.0	(0.4)
Confirm cause of disease	22.5	(0.7)	20.1	(0.7)	21.6	(0.5)
Identify unknown disease	18.3	(0.6)	12.4	(0.5)	16.0	(0.4)
Other	0.4	(0.1)	1.8	(0.0)	1.0	(0.1)
Any	31.9	(0.7)	32.3	(0.8)	32.1	(0.5)

Almost 10 percent of operations (9.9 percent) had fish mortalities primarily due to *Aeromonas* that were diagnosed by a diagnostic laboratory; the vast majority of the losses occurred in the East region compared with the West region (15.8 and 0.6 percent, respectively). Producers could have included *Aeromonas* as an “other” cause of loss in tables I.2.a and I.2.b for percentage of operations; some operations reported diagnostic confirmation of *Aeromonas* but did not report it as an “other” cause of mortality.

b. Percentage of operations that had any fish mortalities primarily due to *Aeromonas* diagnosed by a diagnostic laboratory during 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
***Aeromonas* Diagnosis**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Aeromonas diagnosed	15.8	(0.5)	0.6	(0.0)	9.9	(0.3)
No *Aeromonas* diagnosed	16.1	(0.6)	31.7	(0.8)	22.2	(0.5)
No lab submissions	68.1	(0.7)	67.7	(0.8)	67.9	(0.5)
Total	100.0		100.0		100.0	

Percentage of Operations that had any Fish Mortalities Primarily due to *Aeromonas* Diagnosed by a Diagnostic Laboratory, and by Region



Of operations that did not submit foodsize-fish samples to a diagnostic laboratory during 2009, nearly three-fourths (72.4 percent) did not submit samples because they did not have substantial disease problems. About one of five operations (19.1 percent) did not submit samples because they already knew what the disease was.

c. For operations that **did not** submit foodsize-fish samples to a diagnostic laboratory for testing during 2009, percentage of operations by primary reason for **not** testing and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Reason	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Inconvenient	4.4	(0.5)	3.7	(0.5)	4.1	(0.4)
Information rarely of use (does not help control disease)	0.6	(0.2)	2.7	(0.5)	1.5	(0.2)
Already knew what the disease was	20.9	(0.9)	16.4	(0.5)	19.1	(0.6)
No substantial disease problems	72.2	(1.0)	72.7	(0.8)	72.4	(0.7)
Other	1.9	(0.2)	4.5	(0.3)	2.9	(0.2)
Total	100.0		100.0		100.0	

J. Harvesting Practices

1. Ponds harvested

Operations harvested foodsize fish from 85.8 percent of ponds used for foodsize-fish production during 2009. Operations in the West region harvested fish from a slightly higher percentage of foodsize-fish production ponds compared with operations in the East region (88.1 and 81.7 percent, respectively).

Percentage of growout ponds from which foodsize fish were harvested during 2009, and by region:

Percent Ponds					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
81.7	(0.7)	88.1	(0.7)	85.8	(0.5)

2. Channel catfish and channel x blue hybrid catfish

Improved capability for producing channel x blue hybrid catfish fry has created an opportunity for catfish producers to culture the hybrid on a broad scale. Some experimental evidence indicates that the channel x blue hybrid catfish may have some growth and yield advantages over the channel catfish.

During 2009, the majority of operations (88.3 percent) harvested channel catfish, and 12.7 percent of operations harvested channel x blue hybrid catfish. A lower percentage of the smallest operations (1 to 19 surface acres) harvested channel catfish compared with larger operations; this difference apparently reflects the lower overall percentage of operations in that size category that harvested either type of catfish.

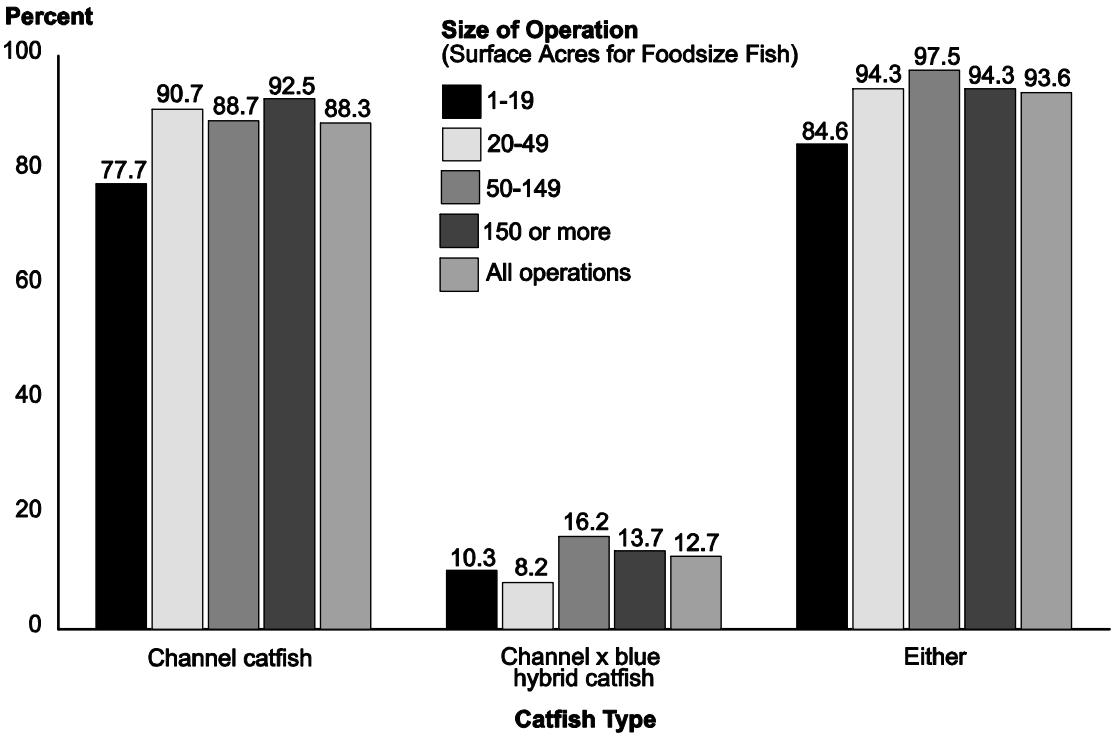
a. Percentage of operations that harvested foodsize channel or channel x blue hybrid catfish during 2009, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Catfish Type	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Channel catfish	77.7	(1.2)	90.7	(0.5)	88.7	(0.6)	92.5	(0.4)	88.3	(0.3)
Channel x blue hybrid catfish	10.3	(0.9)	8.2	(0.6)	16.2	(0.7)	13.7	(0.6)	12.7	(0.4)
Either	84.6	(1.0)	94.3	(0.3)	97.5	(0.4)	94.3	(0.4)	93.6	(0.3)

Percentage of Operations that Harvested Foodsize Channel or Channel x Blue Hybrid Catfish During 2009, and by Size of Operation



A slightly higher percentage of operations in the East region than in the West region harvested channel catfish (89.6 and 86.3 percent, respectively). A similar percentage of operations in the two regions harvested channel x blue hybrid catfish.

b. Percentage of operations that harvested foodsize channel or channel x blue hybrid catfish during 2009, by region:

Percent Operations

Region

	East		West	
Catfish Type	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Channel catfish	89.6	(0.5)	86.3	(0.4)
Channel x blue hybrid catfish	12.1	(0.5)	13.6	(0.4)
Either	94.9	(0.3)	91.5	(0.3)

Of the total pounds of catfish harvested during 2009, only 7.7 percent were channel x blue hybrid catfish, whereas 92.3 percent were channel catfish. Operations with 50 to 149 surface acres had a higher percentage by weight of hybrid catfish harvested than operations in the other size categories.

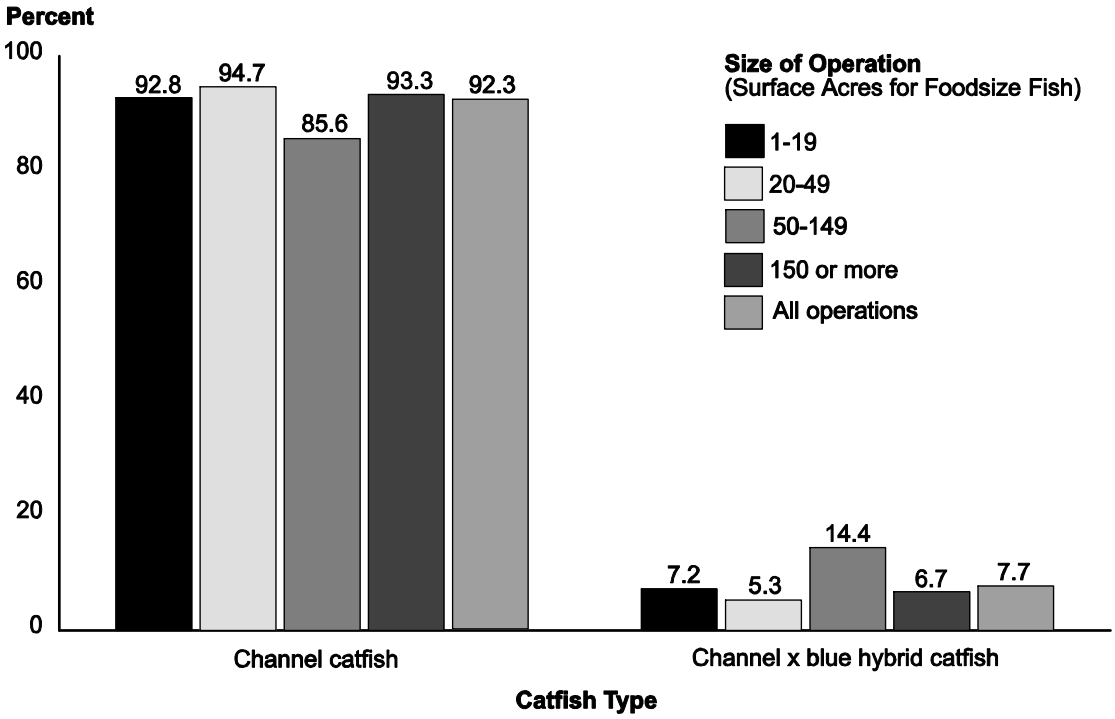
c. Percentage of total pounds of foodsize channel or channel x blue hybrid catfish harvested in 2009, and by size of operation:

Percent Total Pounds Harvested

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Catfish Type	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Channel catfish	92.8	(1.2)	94.7	(0.7)	85.6	(1.0)	93.3	(0.5)	92.3	(0.5)
Channel x blue hybrid catfish	7.2	(1.2)	5.3	(0.7)	14.4	(1.0)	6.7	(0.5)	7.7	(0.5)
Total	100.0		100.0		100.0		100.0		100.0	

Percentage of Total Pounds of Foodsize Channel or Channel x Blue Hybrid Catfish Harvested During 2009, and by Size of Operation



A higher percentage of total pounds of catfish harvested in the East region was channel x blue hybrid catfish, compared with the West region (11.4 and 5.1 percent, respectively).

d. Percentage of total pounds of foodsize channel or channel x blue hybrid catfish harvested in 2009, by region:

	Percent Total Pounds Harvested			
	Region			
	East		West	
Catfish Type	Percent	Std. Error	Percent	Std. Error
Channel catfish	88.6	(0.9)	94.9	(0.5)
Channel x blue hybrid catfish	11.4	(0.9)	5.1	(0.5)
Total	100.0		100.0	

Overall, the average weight of channel x blue hybrid catfish harvested in 2009 was 2.3 pounds, compared with 1.9 pounds for channel catfish. This average is influenced by the relatively high average weight (2.5 pounds) of the hybrid catfish harvested on the largest operations (150 or more surface acres). This result might be affected by several factors, including the potential for faster growth by hybrids and the prevailing practices of single-batch harvest for the hybrids and multibatch production for channel catfish (see table J.2.g).

e. Average weight per foodsize channel or channel x blue hybrid catfish harvested in 2009, and by size of operation:

Average Weight per Fish Harvested (lb)

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Catfish Type	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Channel catfish	1.9	(0.0)	2.0	(0.0)	1.9	(0.0)	1.8	(0.0)	1.9	(0.0)
Channel x blue hybrid catfish	1.8	(0.1)	1.9	(0.0)	1.9	(0.0)	2.5	(0.1)	2.3	(0.1)
All channel and channel x blue hybrid catfish	1.9	(0.0)	2.0	(0.0)	1.9	(0.0)	1.9	(0.0)	1.9	(0.0)

For channel catfish, hybrids, and all fish, the average weight of fish harvested in the East region was higher than that for fish harvested in the West region.

f. Average weight per foodsize channel or channel x blue hybrid catfish harvested in 2009, by region:

Average Weight per Fish Harvested (lb)

Region

	East		West	
Catfish Type	**Average**	**Std. Error**	**Average**	**Std. Error**
Channel catfish	2.0	(0.0)	1.8	(0.0)
Channel x blue hybrid catfish	2.7	(0.2)	1.9	(0.0)
All channel and channel x blue hybrid catfish	2.0	(0.0)	1.8	(0.0)

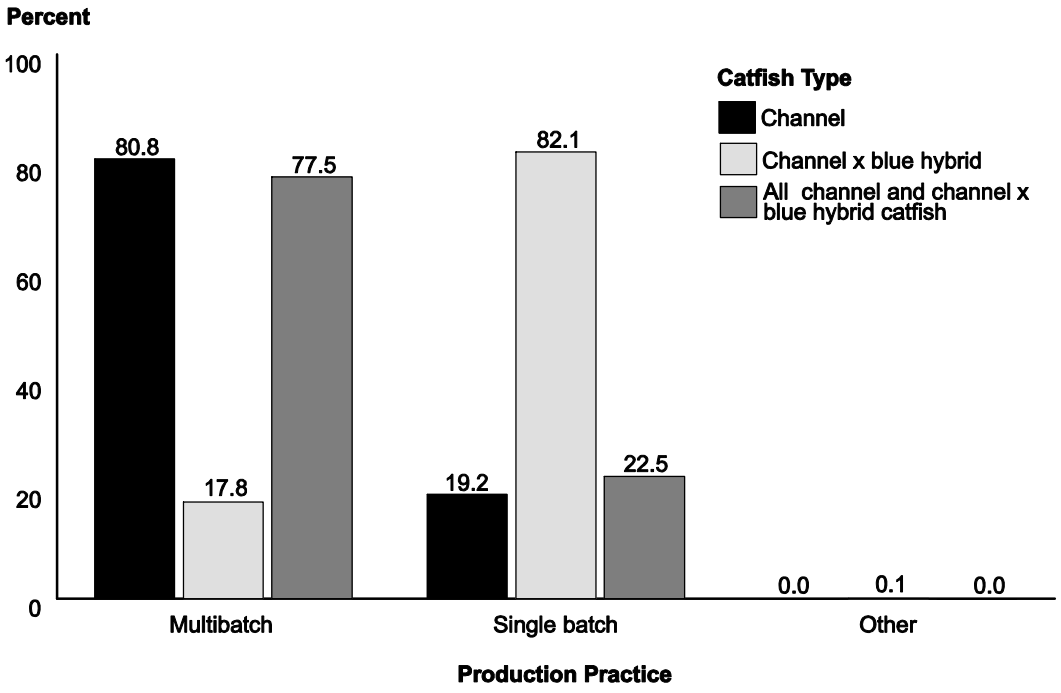
The head of a channel x blue hybrid catfish is generally smaller than the head of a channel catfish. Consequently, hybrids tend to become more entangled in nets, which creates problems with sorting fish by size at harvest. Although new harvest methods are being investigated, the primary approach has been to implement a single-batch harvest for hybrids. Because channel catfish do not have this problem during harvest, producers can still realize the advantages of multibatch harvesting for channel catfish.

For channel catfish, the operation average percentage of fish harvested (84.1 percent) and the percentage of fish harvested by weight (80.8 percent) indicate that channel catfish primarily were harvested from multibatch systems during 2009. For the hybrid, the operation average percentage harvested was only 41.2 percent by single batch (with 51.4 percent harvested from multibatch systems), but the percentage of fish harvested by weight by single batch was 82.1 percent. The difference between the operation average and the percent fish by weight is likely because operations with more hybrids use single-batch systems compared with operations that raise fewer hybrids.

g. Operation average percentage of fish harvested and percentage of pounds of fish harvested, by production practice and by catfish type:

	Percent Harvest					
	Catfish Type					
	Channel		Channel x Blue Hybrid		All Channel and Channel x Blue Hybrid Catfish	
Production Practice	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Operation Average						
Multibatch	84.1	(0.5)	51.4	(1.4)	82.4	(0.5)
Single batch	12.4	(0.4)	41.2	(1.4)	13.8	(0.4)
Other	3.5	(0.2)	7.4	(0.6)	3.8	(0.2)
Total	100.0		100.0		100.0	
Percent Fish by Weight						
Multibatch	80.8	(5.2)	17.8	(4.8)	77.5	(5.0)
Single batch	19.2	(5.2)	82.1	(4.9)	22.5	(5.0)
Other	0.0	(0.0)	0.1	(0.1)	0.0	(0.0)
Total	100.0		100.0		100.0	

Percentage of Pounds of Fish Harvested, by Production Practice and by Catfish Type



3. Primary harvesters

Custom harvest crews primarily harvest the foodsize fish on 42.9 percent of the operations. A higher percentage of operations with 20 to 49 acres (60.7 percent) rely on custom harvest crews compared with operations in the other size categories. More than 85 percent of operations in the two middle size categories (20 to 49 and 50 to 149 surface acres) rely either on custom harvest or processing plant harvest crews. Approximately one-third of the largest operations (150 or more surface acres) primarily have their own employees do the harvesting. Although fee fishing is the primary harvest method for almost two-fifths (39.7 percent) of the smallest operations (1 to 19 surface acres), a low percentage of operations in the larger size categories primarily harvest fish in this manner.

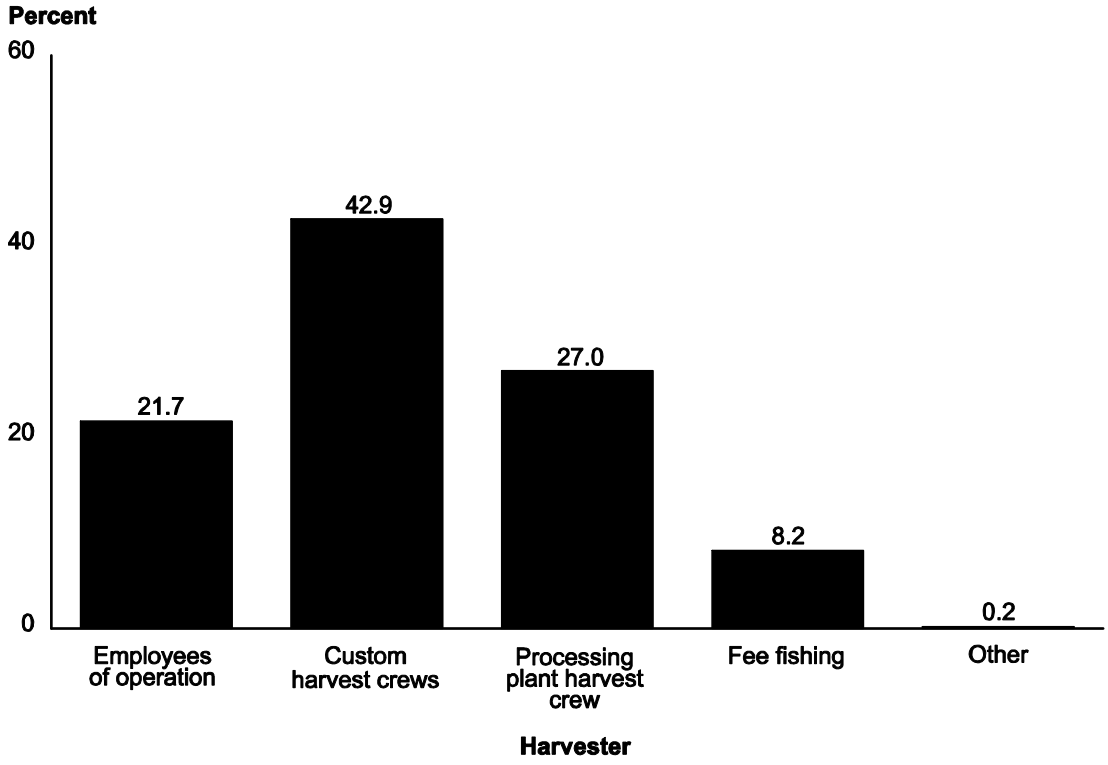
Percentage of foodsize-fish operations by primary harvester of foodsize fish, and by size of operation:

Percent Operations

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Harvester	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Employees of operation	26.9	(1.2)	10.3	(0.7)	12.4	(0.5)	36.3	(0.9)	21.7	(0.4)
Custom harvest crews	17.8	(1.2)	60.7	(1.3)	44.5	(1.1)	43.8	(1.0)	42.9	(0.6)
Processing plant harvest crew	14.2	(1.1)	25.4	(1.3)	42.3	(1.1)	19.9	(0.8)	27.0	(0.6)
Fee fishing (angling)	39.7	(1.3)	3.6	(0.4)	0.8	(0.2)	0.0	(—)	8.2	(0.3)
Other	1.4	(0.4)	0.0	(—)	0.0	(—)	0.0	(—)	0.2	(0.1)
Total	100.0		100.0		100.0		100.0		100.0	

Percentage of Foodsize-fish Operations by Primary Harvester of Foodsize Fish



K. Off-flavor Management

1. Delayed harvest

During 2009, 80.7 percent of all operations experienced harvest delays because of off-flavor problems, and harvest was delayed on 48.1 percent of ponds. The percentage of operations affected by off-flavor problems increased with increasing operation size. In contrast, the percentage of ponds with delayed harvest was highest for operations with 20 to 49 surface acres.

a. Percentage of operations and percentage of ponds on operations from which foodsize fish were harvested that experienced any harvest delays in 2009 because of off-flavor problems, and by size of operation:

Percent

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Percent	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Operations	55.3	(2.4)	75.2	(1.3)	83.0	(0.7)	88.6	(0.5)	80.7	(0.5)
Ponds	34.9	(2.1)	68.9	(1.2)	54.4	(0.9)	45.8	(1.9)	48.1	(1.6)

The percentage of operations that experienced harvest delays and the percentage of ponds with harvest delays due to off-flavor were higher in the East region than in the West region.

b. Percentage of operations and percentage of ponds on operations from which foodsize fish were harvested that experienced any harvest delays in 2009 because of off-flavor problems, by region:

Percent

Region

	East		West	
Percent	Percent	Std. Error	Percent	Std. Error
Operations	86.8	(0.7)	72.0	(0.6)
Ponds	56.6	(1.2)	43.9	(2.1)

2. Treatment of harvest-delayed ponds

Metabolites from algae are among the most common reasons for off-flavor in catfish. Consequently, off-flavor treatments are largely related to algae control. Both Diuron and copper sulfate are used to control algae in catfish production ponds.

Overall, about one-third of foodsize-fish operations (36.5 percent) used both Diuron and copper sulfate on ponds that had delayed harvest because of off-flavor problems. A similar percentage of operations (33.1 percent) did not treat ponds for off-flavor, instead relying on natural processes to change algal dynamics.

Processors will not process fish from off-flavor ponds. While producers with many ponds can harvest fish from a pond that is on-flavor and let off-flavor ponds recover, smaller operations with fewer ponds have fewer options for finding fish to harvest. Consequently, the relatively low percentage (7.2 percent) of operations with 1 to 19 surface acres that did not treat off-flavor ponds was consistent with the need to treat ponds to ensure on-flavor ponds are available for harvest.

a. For ponds with delayed harvests because of off-flavor problems, percentage of ponds that were treated with the following chemicals, and by size of operation:

Percent Ponds

Size of Operation (Surface Acres for Foodsize Fish)

	1–19		20–49		50–149		150 or More		All Operations	
Chemical	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Diuron only	23.0	(3.6)	3.3	(0.7)	9.9	(0.9)	28.7	(2.7)	23.7	(2.1)
Copper sulfate only	11.9	(2.4)	14.8	(1.0)	15.9	(0.9)	3.8	(0.2)	6.7	(0.3)
Both Diuron and copper sulfate	57.9	(4.0)	48.4	(1.6)	57.9	(1.5)	30.2	(1.8)	36.5	(1.5)
No treatment	7.2	(1.1)	33.5	(1.2)	16.3	(1.2)	37.3	(2.0)	33.1	(1.5)
Total	100.0		100.0		100.0		100.0		100.0	

Producers were asked how many days the planned harvest date was delayed because of off-flavor problems for the pond with the shortest delay, the pond with the longest delay, and the average delay. In 2009, for the pond with the shortest harvest delay, the highest percentage of operations (43.0 percent) experienced a 7- to 14-day delay because of off-flavor problems. The next highest percentage of operations (34.5 percent) experienced a 15- to 30-day delay in harvest on the pond with the shortest delay.

For the pond with the longest delay, the highest percentage of operations (26.8 percent) experienced a 31- to 60-day delay in harvest, and 21.1 percent of operations experienced a delay of 500 or more days. The average delay of harvest was 15 to 30 days on 37.9 percent of operations and 31 to 60 days on 31.8 percent of operations.

b. For operations with ponds that had delayed harvests in 2009, percentage of operations by ponds with the shortest and longest delays, and by average delay:

	Percent Operations					
	Pond with Shortest Delay		Pond with Longest Delay		Average Delay	
Days Harvest Delayed	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
1 to 6	3.8	(0.3)	0.0	(—)	0.4	(0.1)
7 to 14	43.0	(0.8)	4.1	(0.3)	9.6	(0.4)
15 to 30	34.5	(0.8)	17.9	(0.6)	37.9	(0.8)
31 to 60	14.6	(0.6)	26.8	(0.7)	31.8	(0.8)
61 to 100	1.7	(0.2)	11.7	(0.5)	13.2	(0.6)
101 to 499	2.0	(0.2)	18.4	(0.6)	4.1	(0.3)
500 or more (or ongoing)	0.4	(0.1)	21.1	(0.6)	3.0	(0.3)
Total	100.0		100.0		100.0	

L. General

1. Record-keeping practices

More than four-fifths of operations (84.9 percent) maintain some written or computerized records related to catfish production. The highest percentages of operations keep records on harvesting, feeding, or stocking (81.1, 75.0, and 73.1 percent of operations, respectively). About one-half of all operations (48.5 percent) keep records on water quality, and less than one-third (30.1 percent) maintain disease records.

Percentage of operations that keep the following types of written or computerized records:

Record Type	Percent Operations	Std. Error
Stocking	73.1	(0.7)
Harvesting	81.1	(0.6)
Disease	30.1	(0.7)
Feeding	75.0	(0.6)
Water quality	48.5	(0.8)
Breeding	12.1	(0.5)
Other	1.7	(0.2)
Any	84.9	(0.5)

Section II: Methodology

A. Needs Assessment

NAHMS develops study objectives by exploring existing literature and contacting industry members about their information needs and priorities during a needs-assessment phase. The planning for the Catfish 2010 study involved an extensive effort to obtain input from representatives of producer organizations, universities, State and Federal catfish health and production personnel, and others allied with the industry.

Three focus group meetings—one each in Arkansas, Alabama, and Mississippi—were held in January 2009. Producers, extension, university researchers, and other State and Federal employees were invited to participate in focus groups in their respective States. These groups were asked to identify broad study objectives and to begin prioritizing topics. Discussions with participants and other individuals continued after the meetings to help finalize study objectives.

Specific objectives for the NAHMS Catfish 2010 study:

1. Investigate foodsize-fish production practices. Management practices for foodsize fish are continually evolving as producers refine their methods and adjust to changes in market demands. Areas of investigation to meet this objective include stocking practices (use of stocker ponds, stocking size, strain of fish, and timing of stocking); feeding practices (protein level, seasonal feeding, especially in the fall); pond management (draining, pond size, and maintenance schedule); and general practices (aeration, oxygen and water quality monitoring, harvesting). Use of channel x blue hybrid catfish, vaccination practices, and trends over time also were points of focus.
2. Describe fingerling production practices, specifically broodfish management, hatchery management, vaccination practices, fingerling pond management, fingerling stocking, and feeding practices.
3. Address a broad range of fish health issues, including estimation of operation- and pond-level prevalence of reported foodsize-fish disease problems (columnaris, enteric septicemia, proliferative gill disease, winter kill, ich, anemia, visceral toxicosis of catfish, and trematodes); fingerling disease problems (columnaris, enteric septicemia, channel catfish virus, and ich); control practices; treatment practices; and risk factors.
4. Quantify the magnitude of the problem of off-flavor in terms of the percentage of ponds annually affected by off-flavor and the duration of off-flavor episodes. Assess the use of diuron and copper sulfate as pond treatments.

B. Sampling and Estimation

1. State selection

NASS publishes catfish production estimates annually. NAHMS contracts with NASS to provide a statistically reliable sample form its sample frames. A goal for NAHMS national studies is to include States that account for at least 70 percent of the animal and producer populations in the United States. The initial review of States identified four major States (Alabama, Arkansas, Louisiana, and Mississippi) as having 91.5 percent of the inventory (as measured by sales for 2009) and 53.5 percent of all U.S. catfish operations on January 1, 2008 (latest available at the time).

2. Operation selection

Through NASS, operations were selected in the four participating States (Alabama, Arkansas, Louisiana, and Mississippi). Essentially all catfish producers on the list sampling frame were selected. This list frame provided complete coverage of catfish producers in the four States on January 1, 2010. There were 695 operations selected for the study.

3. Population inferences

Inferences from data collection cover the population of producers with any catfish in the four study States. These States accounted for 53.5 percent of all catfish operations in the United States as of January 1, 2008, and 91.5 percent of all catfish sales in the United States (see Appendix II). Census data were used to adjust for response and nonresponse within each State and size group to allow for inferences back to the original population from which the sample was selected.

C. Data Collection

1. Phase I

NASS enumerators in each of the four States administered the General Catfish Management Report (GCMR) from January 2 to January 29, 2010. The interview took just under 1 hour to complete.

D. Data Analysis

1. Validation and estimation

Initial data entry and validation for the GCMR were performed in the individual NASS State offices. Data were entered into a SAS data set. NAHMS staff in Fort Collins, CO, performed additional validation on the entire data set after data from all States were combined.

2. Response rates

Of the 695 operations on the NASS list sampling frame, 67 had no catfish on January 1, 2010, and were therefore ineligible for the NAHMS Catfish 2010 study. Of the remaining 628 operations to be contacted, 424 operations participated in the Catfish 2010 study, and only 78 operations (11.2 percent of the total sample) refused to participate in the study.

			Measurement Parameter		
Response Category	**Number Operations**	**Percent Operations**	**Contacts**	**Usable[2]**	**Complete[3]**
No catfish on January 1, 2010	67	9.7	x	x	
Out of business[1]	92	13.2	x	x	
Refusal	78	11.2	x		
Survey complete	424	61.0	x	x	x
Out of scope (research farm, etc.)	4	0.6			
Inaccessible	30	4.3	x	x	
Total	695	100.0			
Percent of total operations			95.1	83.9	61.0

[1]Operations that sold land and/or catfish and had no intention of returning to catfish business.
[2]Usable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[3]Survey complete operation—respondent provided answers to all or nearly all questions for at least one operation.

Appendix I: Sample Profile

A. Responding Operations

1. Responding operations by pond size

Size of Growout Pond (Acres)	**Number of Responding Operations***
1 to 19	71
20 to 49	84
50 to 149	124
150 or more	120
Total	399

* Twenty-five responding producers did not raise foodsize fish.

2. Responding operations by region

Region	**Number of Responding Operations**
East	252
West	172
Total	424

3. Responding operations by State

State	**Number of Responding Operations**
Alabama	127
Arkansas	77
Louisiana	13
Mississippi	207
Total	424

4. Responding operations by operation type

Operation Type	Number of Responding Operations*
Breed catfish	37
Operate hatchery	31
Raise fry to fingerlings	54
Growout foodsize fish	399

*Sum is greater than 424 because a number of operations are of multiple types.

Appendix II: U.S. Catfish Acreage Inventory and Operations

A. Regional Summary

State	Number Surface Acres Intended for Use January 1–June 30, 2010			Water Surface Acres Used/Intended for Production Jan 1–Jun 30		2009 Total Sales (x$1,000)	January 1, 2008, Number of Operations[4]
	Foodsize	Fingerlings	Broodfish	2009	2010		
Alabama[1]	19,200	380	120	22,100	19,800	90,688	252
Arkansas[1]	16,600	2,200	250	25,000	19,200	44,914	155
California	1,100	190	80	2,400	1,500	8,074	55
Louisiana[1]	1,700	50	0	6,300	1,800	8,395	31
Mississippi[1]	52,000	9,700	1,300	80,200	64,000	196,787	427
North Carolina	1,600	200	50	2,200	1,900	5,495	53
Texas	2,600	190	70	3,800	2,900	12,644	149
Other States[2]	1,900	1,300	370	4,900	3,700	5,570	495
Total[1] Percent of U.S.	89,500 (92.6%)	12,330 (86.8%)	1,670 (74.6%)[3]	133,600 (90.9%)	104,800 (91.3%)	340,784 (91.5%)	865 (53.5%)
Total U.S.	96,700	14,210	2,240	146,900	114,800	372,567	1,617

[1] Study States.
[2] States whose estimates are not shown and States suppressed because of disclosure concerns.
[3] Excluding Louisiana.
[4] Source: NASS Catfish Production report, January 30, 2009 (most recent State-level publication for number of operations).

January 1, 2009, U.S. operations equaled 1,306; January 1, 2010, U.S. operations equaled 994.