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Monitoring
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Catfish 2010

Part I: Reference of Catfish Health and Production Practices in the United States, 2009

USDA:APHIS:VS:CEAH
NRRC Building B, M.S. 2E7
2150 Centre Avenue
Fort Collins, CO 80526-8117
(970) 494-7000
Email: NAHMS@aphis.usda.gov
http://nahms.aphis.usda.gov

#580.1210

Cover photo courtesy Stephen Ausmus,
Agricultural Research Service

Items of Note

The Catfish 2010 study is the third investigation of the industry by the National Animal Health Monitoring System. This study is a broad look at management, production, and health practices across the various facets of the catfish industry, including breeding, hatching, and foodsize-fish growout. This report focuses on the breeding and hatching components of the industry.

Breeding management

Catfish breeding is concentrated in a relatively small portion of the industry (8.8 percent of all operations). Channel catfish remains the primary species bred by the industry. Improvements in the reliability and cost effectiveness of artificial spawning of female channel catfish and male blue catfish have increased the availability of hybrid fingerlings for growout. Almost one-fifth of catfish breeders had blue catfish broodfish inventory in 2009. Ultimately, 12.9 percent of fry hatched in 2009 were channel x blue catfish hybrids. The percent of broodfish culled was 14.4 percent, even though more than one-half of breeding operations did not cull any broodfish. Overall, 17.0 percent of broodfish were lost to disease, predation, or other problems in 2009. Fighting, other causes (including catastrophic events such as flooding), and unknown causes played a much greater role in broodfish losses than did disease.

Hatchery operation

Not all of the catfish hatcheries in the four study States were operated in 2009. The hatcheries that were operated all had their own broodfish and likely produced their own eggs for hatching. Operations that did not use their hatcheries may have been seeking to reduce costs associated with breeding catfish and operating hatcheries or reacting to decreased demand for fry and fingerlings. The National Agricultural Statistics Service reported a 22 percent decline in water surface acres used for catfish production between January 1, 2009, and January 1, 2010, as well as a 41 percent decrease in fingerlings over the same time period.[1]

Egg health and management

About one-half of hatcheries treat egg masses to control bacterial and fungal infections prior to placing the egg masses in hatching troughs. A higher percentage of larger hatcheries compared with smaller hatcheries treat prior to placing egg masses. Regular turning of egg masses, adequate water circulation, and lower egg-mass densities in hatching troughs also aid in control of diseases. More than 80 percent of hatcheries use paddles to circulate water in hatching troughs. A small percentage of hatcheries (8.6 percent) stocked more than 30 egg masses per 100 gallons of water; almost one-half of operations (47.7 percent) stocked 1 to 15 egg masses per 100 gallons. Some of the water flow rates may also be inadequate in some hatcheries. Almost three-fourths of eggs survived to hatching in 2009; most losses were attributed to infertility, fungal infections, and bacterial egg rot.

Fingerling health and management

Fry were raised to fingerlings on 12.8 percent of catfish operations in the four study States. Fingerling operations tended to be smaller in the East region than in the West region (16.1 and 231.6 total surface acres of ponds, respectively) and in average number of fry stocked in 2009 (698,000 and 15,797,000 fry respectively). The regional difference likely results from the location of larger catfish operations in the Mississippi Delta area, which is in the West region. Vaccination for enteric septicemia of catfish (ESC) and columnaris was not widely practiced by fingerling producers (3.9 and 9.7 percent of operations, respectively). Approximately two-thirds of fry survived from stocking to harvest. Almost half (45.8 percent) of the fry/fingerlings lost prior to harvest were lost due to unknown causes, while ESC and columnaris each caused the loss of about one-fifth of the fry/fingerlings. Antibiotics were used to treat bacterial diseases on 28.9 percent of fingerling operations. Although three antibiotics were used to treat bacterial disease, Aquaflor® was used by the highest percentage of fingerling operations that used antibiotics (60.2 percent).

Reference

1.Catfish Production. National Agricultural Statistics Service, January 29, 2010.
http://usda.mannlib.cornell.edu/usda/nass/CatfProd//2010s/2010/CatfProd-01-29-2010.pdf

Acknowledgments

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

Thanks to the NASS enumerators who contacted catfish producers and collected the data. Their hard work and dedication were invaluable. Thanks also to 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.

Larry M. Granger
Director
Centers for Epidemiology and Animal Health

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Contacts for further information:
Questions or comments on data analysis: Dr. Bruce Wagner (970) 494-7000
Information on reprints or other reports: Ms. Abby Fienhold (970) 494-7000
Email: NAHMS@aphis.usda.gov

Feedback

Feedback, comments, and suggestions regarding the Catfish 2010 study reports are welcome. Please forward correspondence via email (to NAHMS@aphis.usda.gov) or submit feedback via online survey (at http://nahms.aphis.usda.gov; click on “FEEDBACK on NAHMS reports”).

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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 undertook its first national study of the catfish industry with the Catfish '97 study, which 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 is the third NAHMS catfish study and, like its predecessors, was designed to provide participating operators and the industry with valuable information on health and management practices on U.S. catfish operations. The third study 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 first 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 (latest available);
- 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: Reference of Catfish Health and Production Practices 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://nahms.aphis.usda.gov.

For questions about this report or additional copies, please contact

USDA–APHIS–VS–CEAH
NRRC Building B, M.S. 2E7
2150 Centre Avenue
Fort Collins, CO 80526-8117
970.494.7000

Study Objectives and Related Outputs

1. Investigate foodsize-fish production practices
   - Part II: Reference of Catfish Health and Production Practices in the United States, 2009, expected March 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 May 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 sheet, expected January 2011

Terms Used in This Report

Agitator: A vertical paddle that spins to aerate water in a small area (1/10 horsepower electric motor with a blade attached).

Air stones: Porous stones attached to an air source to create air bubbles.

Bacterial infection: Sometimes called bacterial egg rot. It often occurs when egg masses contain large numbers of infertile eggs or when egg hatching baskets are crowded, reducing water circulation. The condition is often recognized when egg masses begin to fall apart prematurely, before embryos develop eye spots. Infected egg masses also will feel slimy, which occurs when bacteria destroy the egg shell. If the problem progresses, prematurely hatched embryos without eye spots often will be found on the trough bottom.

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.

Degassing: The process of removing excess gas (particularly nitrogen) from water.

Egg mass: Eggs from a single female catfish, naturally held together by a gelatinous substance. Egg masses are sometimes referred to as spawns.

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

Fingerling: A 1- to 8-inch fish, generally larger than fry but smaller than foodsize fish.

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.

Fungal infection: Fungus growth on infertile or dead eggs that occurs when water temperature is below 78°F. Appears as a white or brown cotton-like growth.

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

Hardness: The quality in water that is imparted by the presence of dissolved salts, especially calcium sulfate or bicarbonate.

Hatchery: Portion of operation devoted to hatching 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 in aquariums and hatcheries and is characterized by white nodules on the skin that can coalesce, causing the skin to slough. Many affected fish die. Ich can also affect the gills.

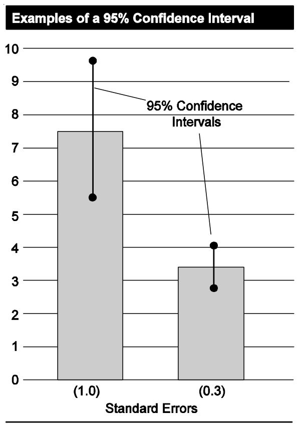
Krill: Species of small marine shrimp commonly dried and sold as fish food.

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 fry hatched in 2009 (shown on p 54) is calculated by summing the reported average number of fry hatched over all operations divided by the number of operations.

Paddles: Attached to a horizontal rotating bar over hatching troughs; promote water movement over eggs to simulate the natural fanning action of a male catfish's tail.

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.")

Examples of a 95% Confidence Interval



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 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 structure with a continual flow of water; used to hold fish.

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

Renovation: The draining and drying of ponds, followed by removal of accumulated sediments and 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.

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

Spawns: See egg masses.

Swim-up fry: Newly hatched fry that seek food by swimming to the water surface, typically 3 to 4 days after hatching.

Trough: Generally a flat-bottom wooden, fiberglass, or metal structure about 8 feet long, 2 feet wide, and 20 inches deep, with a water inlet at one end and drain at the other.

Vaccination: Only 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 I

Most catfish operations (94.1 percent) raised foodsize fish. Smaller percentages bred catfish for egg collection (8.8 percent), operated a hatchery (7.4 percent), and/or raised fry to fingerlings (12.8 percent).

More than two-thirds of catfish breeding operations maintained broodfish lines of pond-run channel catfish (69.4 percent). About one-fifth of breeding operations (19.4 percent) maintained broodfish lines of blue catfish; it is likely many of these operations produce channel x blue hybrid catfish. Maintained by 11.1 percent of operations, the Goldkist/ Harvest Select line is the most widely used distinct line of channel catfish.

Approximately one of seven (14.4 percent) broodfish was culled in 2009, relative to the January 1, 2010, inventory. Of broodfish culled in 2009, almost 7 of 10 (69.8 percent) were culled because of old age. Of broodfish on all operations, the majority (81.1 percent) are 3 to 5 years old, and only 2.6 percent are more than 6 years old.

More than one-half of catfish breeding operations (54.1 percent) did not cull any broodfish in 2009, while about one-tenth of operations (10.8 percent) culled 21 percent or more broodfish in 2009, relative to the January 1, 2010, inventory.

In 2009, 17.0 percent of broodfish were lost to disease, predation, or other problems. Broodfish losses were higher in the East region (43.5 percent) than the West region (15.8 percent).

Most catfish breeding operations stocked at least 1,000 pounds of broodfish per acre in spawning ponds (54.0 percent of operations, and 81.4 percent of broodfish). Although almost one-third of operations (32.5 percent) stocked less than 800 pounds of broodfish per acre, the percentage of all broodfish stocked at this density was relatively low (4.5 percent).

Overall, almost three-fourths of eggs (74.2 percent) brought into the hatchery survived to hatching. The percentage of all eggs typically surviving to hatching did not differ between small (80.6 percent) and large (73.3 percent) hatcheries.

Infertility accounted for the highest percentage of eggs (10.0 percent) brought into the hatchery that did not hatch in 2009 and affected almost one-half (48.3 percent) of operations. Fungal or bacterial infections accounted for the loss of 5.1 percent of all eggs brought into the hatchery.

The majority of hatcheries (74.0 percent) used chemicals to prevent fungal or bacterial infections in hatching troughs. A higher percentage of large hatcheries than small hatcheries (91.6 and 63.1 percent, respectively) used at least one chemical to prevent fungal or bacterial infections. Copper sulfate, formalin, Betadine®, and salt were each used by at least one-fourth of hatchery operations (38.4, 32.2, 28.8, and 26.0 percent, respectively).

In 2009, the average number of fry hatched per hatchery operation was 16,256,000. Large operations hatched an average of 38,673,000 fry, compared with 1,644,000 for small operations. Most fry produced at hatcheries were stocked on the operation (81.2 percent), as opposed to being sold (18.8 percent).

More than one-fourth of fingerling operations (27.0 percent) tested water quality in fry/fingerling ponds at least once a month in 2009. A higher percentage of large operations than small operations tested water quality at least once a month (37.7 and 17.9 percent, respectively). A higher percentage of small operations (42.8 percent) than large operations (24.9 percent) did not test water quality in fry/fingerling ponds in 2009.

Overall, 3.9 percent of fingerling operations vaccinated any fry against enteric septicemia of catfish (ESC) in 2009. On operations that vaccinated any fry for ESC, 12.3 percent of fry were vaccinated. All of the fingerling operations that vaccinated any fry for ESC vaccinated fry that were intended for sale as fingerlings, but only on customer request.

The columnaris vaccine became available for use by the catfish industry in 2009. Overall, 9.7 percent of fingerling operations vaccinated at least some fry for columnaris in 2009. Of fingerling operations that vaccinated any fry for columnaris in 2009, more than four-fifths (80.2 percent) vaccinated at least some of the fry that were intended for sale as fingerlings. About two-fifths (40.5 percent) vaccinated a portion of the fry for sale based on customer request, about one-fifth (19.8 percent) vaccinated a portion of the fry for sale regardless of customer request, and about one-fifth (19.9 percent) vaccinated all fry intended for sale.

Fry/fingerling losses were attributed to a number of causes. Nearly one-half of operations (48.0 percent) reported losses due to predation. About one-fifth of operations (19.3 percent) lost some fry to ESC, while 17.4 percent lost some fry to columnaris. Almost three-fourths of operations lost some fry to unknown causes (71.1 percent).

Three medicated feeds (Terramycin®, Romet®, and Aquaflor®) are approved by the Food and Drug Administration to treat disease problems in catfish. Aquaflor is the newest antimicrobial available for use in fingerlings and is the only antimicrobial approved for treatment of both ESC and columnaris. In 2009, 28.9 percent of fingerling operations fed medicated feed to fry. Of these operations, 60.2 percent fed Aquaflor, and a higher percentage of large operations than small operations used Aquaflor (75.2 and 42.9 percent, respectively).

Section I: Population Estimates

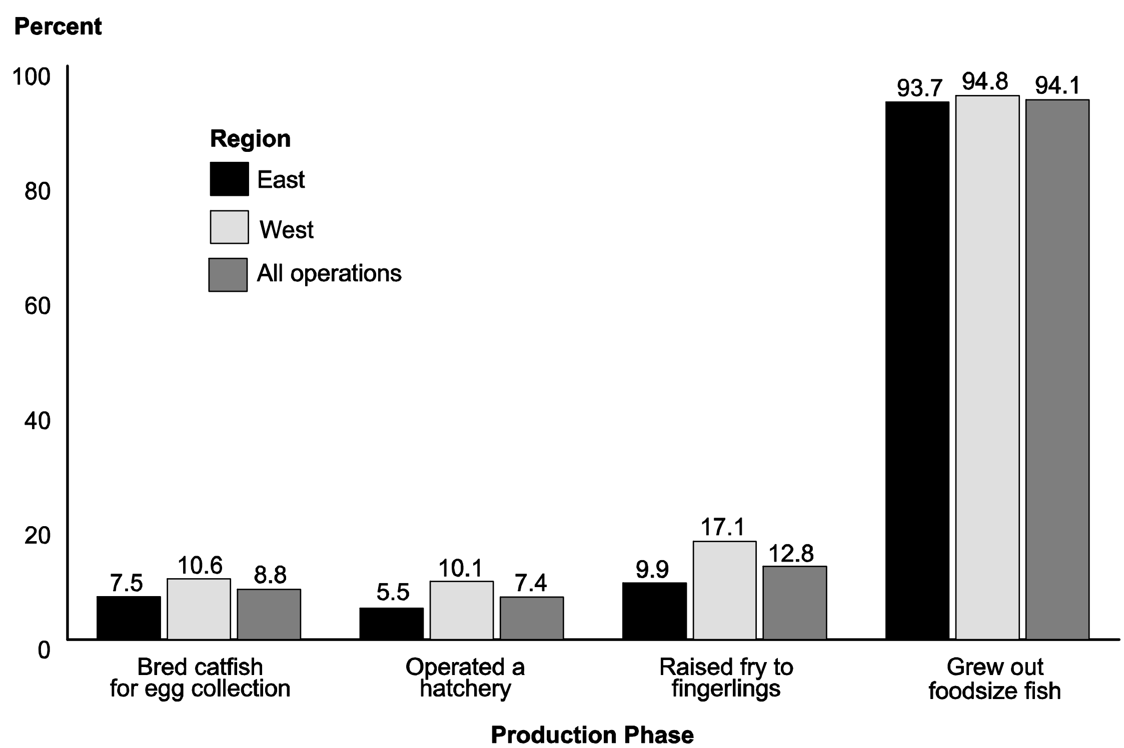
A. Distribution of Catfish Production Phases

During 2009, most catfish operations (94.1 percent) raised foodsize fish. 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, however, 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. Broodfish Management

Note: For this study, a breeding operation is defined as one that bred catfish for egg collection in 2009.

1. Broodfish lines

More than two-thirds of catfish breeding operations maintained broodfish lines of pond-run channel catfish (69.4 percent). Blue catfish lines were maintained on about one-fifth of breeding operations. The maintenance of blue catfish likely indicates these operations produce channel x blue hybrid catfish. The "other" catfish line included primarily unspecified lines. The Goldkist/Harvest Select line is the most widely used distinct line of channel catfish.

a. Percentage of breeding operations that had the following broodfish lines on January 1, 2010, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Broodfish)					
	Small (2,000 or Fewer)		**Large** (More than 2,000)		**All Operations**	
Broodfish Line	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
NWAC103	5.3	(0.0)	0.0	(--)	2.8	(0.0)
Kansas	0.0	(--)	5.9	(0.8)	2.8	(0.4)
Goldkist/ Harvest Select	10.5	(0.1)	11.8	(1.1)	11.1	(0.5)
Auburn	10.5	(0.1)	0.0	(--)	5.6	(0.1)
Blue catfish	21.1	(0.2)	17.6	(1.1)	19.4	(0.5)
Other channel catfish line	10.5	(0.1)	17.7	(1.1)	13.9	(0.5)
Pond-run channel catfish	63.2	(0.3)	76.4	(1.2)	69.4	(0.6)

The percentage of operations that maintained broodfish lines, with the exception of Auburn and blue catfish, was higher in the West region than in the East region.

b. Percentage of breeding operations that had the following broodfish lines on January 1, 2010, by region:

	Percent Operations			
	Region			
	East		West	
Broodfish Line	Percent	Std. Error	Percent	Std. Error
NWAC103	0.0	(--)	5.6	(0.1)
Kansas	0.0	(--)	5.6	(0.7)
Goldkist/Harvest Select	5.6	(0.7)	16.7	(0.8)
Auburn	11.1	(0.1)	0.0	(--)
Blue catfish	22.2	(0.2)	16.7	(1.0)
Other channel catfish line	11.1	(0.1)	16.7	(1.0)
Pond-run channel catfish	66.7	(0.6)	72.2	(1.0)

Pond-run channel catfish represent the highest percentage of broodfish maintained by catfish breeding operations (82.3 percent). In the East region, the Goldkist/Harvest Select line was the next highest percentage of broodfish. Blue catfish represented only 3.6 percent of all broodfish, but the species represented a higher percentage of broodfish in the East region (10.7 percent) than in the West region (3.0 percent).

c. Percentage of broodfish by broodfish line present on January 1, 2010, on all operations, and by region:

	Percent Broodfish					
	Region					
	East		West		All Operations	
Line	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
NWAC103	0.0	(--)	0.4	(0.0)	0.4	(0.0)
Kansas	0.0	(--)	1.6	(0.2)	1.5	(0.2)
Goldkist/Harvest Select	23.9	(2.5)	3.1	(0.3)	4.7	(0.4)
Auburn	2.0	(0.1)	0.0	(--)	0.2	(0.0)
Blue catfish	10.7	(0.4)	3.0	(0.2)	3.6	(0.2)
Other channel catfish line	0.6	(0.0)	7.9	(0.6)	7.3	(0.5)
Pond-run channel catfish	62.8	(2.1)	84.0	(1.1)	82.3	(1.0)
Total	100.0		100.0		100.0	

2. Broodfish by age

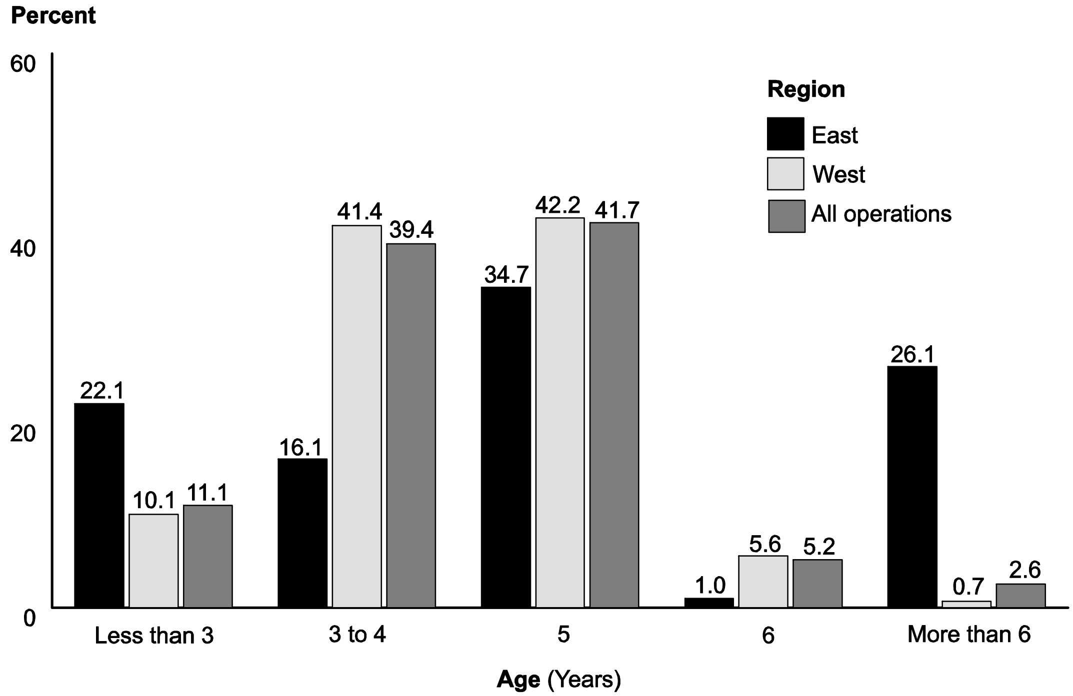
Channel catfish are able to breed at 2 years of age but breed more reliably at 3 years or older. Channel catfish more than 6 years old might produce fewer eggs per pound of fish, are more difficult to handle, and might not be able to adequately use spawning containers.

On all operations, 81.1 percent of broodfish are 3 to 5 years old. A higher percentage of broodfish in the East region than in the West region were less than 3 years old (22.1 and 10.1 percent, respectively) or more than 6 years old (26.1 and 0.7 percent, respectively).

Percentage of broodfish by age on all operations, and by region:

	Percent Broodfish					
	Region					
	East		West		All Operations	
Age (Years)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Less than 3	22.1	(0.7)	10.1	(0.6)	11.1	(0.5)
3 to 4	16.1	(0.2)	41.4	(1.1)	39.4	(1.1)
5	34.7	(1.8)	42.2	(1.3)	41.7	(1.2)
6	1.0	(0.0)	5.6	(0.4)	5.2	(0.3)
More than 6	26.1	(0.9)	0.7	(0.0)	2.6	(0.1)
Total	100.0		100.0		100.0	

Percentage of Broodfish by Age on All Operations, and by Region



3. Annual cycle rate (cull rate) of broodfish

The number of broodfish culled in 2009 represents about one-seventh (14.4 percent) of the January 1, 2010, inventory of broodfish. Considering the additional impact of death loss, these cull rates are consistent with few broodfish being more than 5 years old.

a. Percentage of broodfish culled in 2009 relative to January 1, 2010, broodfish inventories, and by size of operation:

Percent Broodfish Culled

Size of Operation (Number of Broodfish)

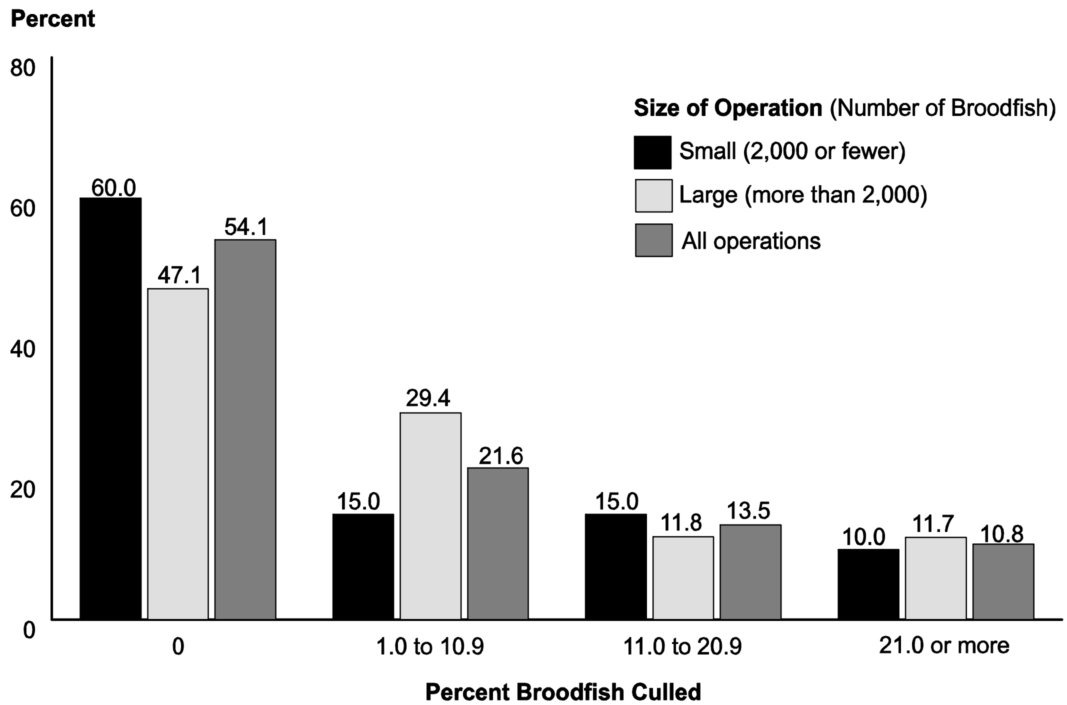
Small (2,000 or Fewer)		**Large** (More than 2,000)		**All Operations**	
Percent	**Std. Error**	**Percent**	**Std. Error**	**Percent**	**Std. Error**
14.2	(0.0)	14.4	(1.0)	14.4	(0.9)

More than one-half of breeding operations (54.1 percent) did not cull any broodfish in 2009. A higher percentage of small breeding operations (60.0 percent) did not cull any broodfish compared with large breeding operations (47.1 percent). Cull rates higher than 21 percent occurred on only 10.8 percent of breeding operations.

b. Percentage of breeding operations by percentage of broodfish culled in 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Broodfish)					
	Small (2,000 or Fewer)		**Large** (More than 2,000)		**All Operations**	
Percent Broodfish Culled	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
0	60.0	(0.4)	47.1	(1.4)	54.1	(0.7)
1.0 to 10.9	15.0	(0.1)	29.4	(1.4)	21.6	(0.7)
11.0 to 20.9	15.0	(0.6)	11.8	(0.8)	13.5	(0.5)
21.0 or more	10.0	(0.1)	11.7	(0.8)	10.8	(0.4)
Total	100.0		100.0		100.0	

Percentage of Breeding Operations by Percentage of Broodfish Culled in 2009, and by Size of Operation



4. Reasons for culling

Of broodfish culled in 2009, almost 7 of 10 (69.8 percent) were culled primarily because of old age. The primary reason for the next highest percentage of culled broodfish (23.3 percent) was poor appearance (conformation problems).

Percentage of broodfish culled in 2009 for the following primary reasons:

Reason for Culling	Percent Broodfish Culled	Std. Error
Old age	69.8	(2.5)
Weight	0.1	(0.0)
Poor health	0.1	(0.0)
Poor reproductive success	4.2	(0.3)
Business or financial reasons	2.5	(0.2)
Poor appearance (conformation problems)	23.3	(2.2)
Total	100.0	

5. Broodfish loss

Broodfish loss in the East region was extremely high compared with that in the West region. Catastrophic loss on some operations influenced the overall loss.

Combined, the 2009 broodfish loss (17.0 percent) and broodfish culling (14.4 percent; table B.3.a) equaled almost one-third of the January 1, 2010, broodfish inventory.

a. Percentage of broodfish lost to disease, predation, or other problems in 2009, and by region:

Percent Broodfish Lost					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
43.5	(2.9)	15.8	(0.5)	17.0	(0.5)

Fighting caused broodfish loss on more than one-third (34.6 percent) of operations and accounted for almost one-half (48.8 percent) of total broodfish loss. More than 15.0 percent of operations reported broodfish loss from unknown causes, other causes, and predation; each of these reasons for loss accounted for more than 10.0 percent of total broodfish loss. Within the “other” reason for loss, specific causes were related to either low oxygen or flooding problems. Two bacterial diseases, enteric septicemia of catfish (ESC) and columnaris, each caused broodfish loss on 11.5 percent of operations, but these diseases did not cause a high percentage of the total broodfish loss (0.9 and 1.4 percent, respectively).

b. For the listed reasons for loss, percentage of breeding operations that lost broodfish, percentage of broodfish lost, and percentage of total loss:

Reason for Loss	Percent Operations	Std. Error	Percent Broodfish Lost	Std. Error	Percent Total Loss	Std. Error
Enteric septicemia of catfish (ESC)	11.5	(0.7)	0.2	(0.0)	0.9	(0.1)
Columnaris	11.5	(0.7)	0.2	(0.0)	1.4	(0.2)
Proliferative gill disease (PGD)	0.0	(--)	0.0	(0.0)	0.0	(--)
Winter kill	3.8	(0.1)	0.1	(0.0)	0.5	(0.0)
Visceral toxicosis of catfish (VTC)	3.8	(0.1)	0.4	(0.0)	2.5	(0.1)
Fighting	34.6	(0.9)	8.3	(0.6)	48.8	(3.0)
Predation	15.4	(0.7)	1.8	(0.2)	10.9	(1.1)
Other	15.4	(0.5)	3.2	(0.2)	18.9	(1.5)
Unknown	23.1	(0.7)	2.8	(0.2)	16.1	(1.5)
Total			17.0	(0.5)	100.0	

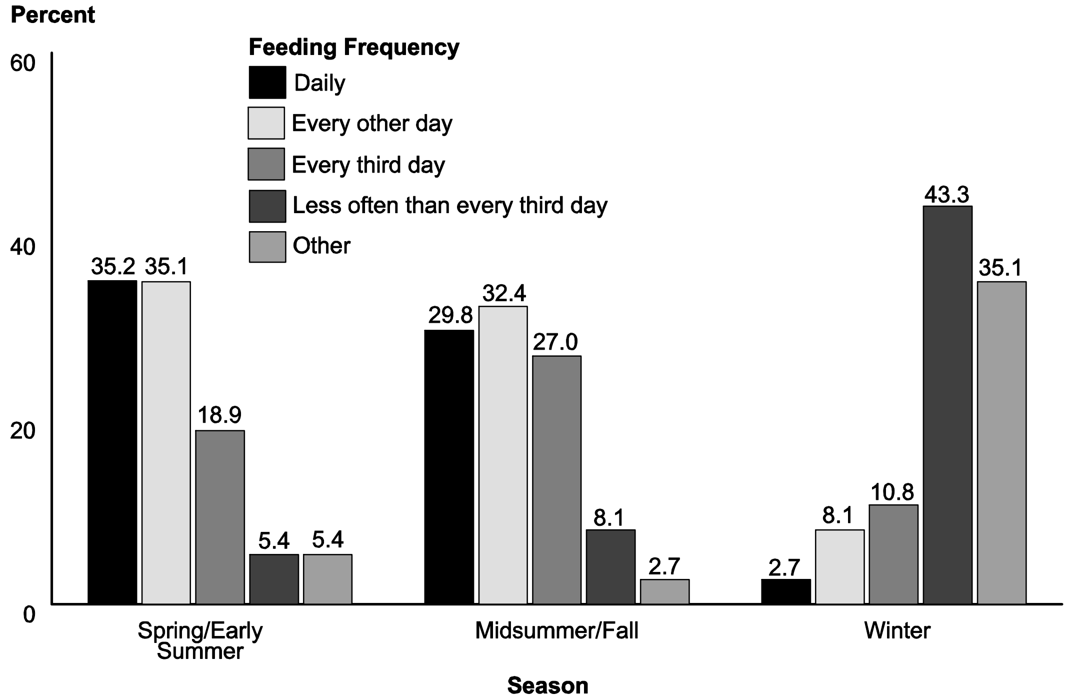
6. Seasonal feeding practices

The frequency with which breeding operations fed broodfish varied seasonally. In the spring through early summer (prespawning and spawning), the highest percentages of operations fed broodfish daily (35.2 percent) or every other day (35.1 percent). By midsummer and fall (postspawning), the percentage of operations that fed every third day increased to 27.0 percent from 18.9 percent in spring/early summer; this difference likely resulted at least in part from a reduction in the percentage of operations that fed daily. Over winter, the highest percentage of operations (43.3 percent) fed less often than every third day and the next highest percentage of operations (35.1 percent) fed according to an "other" feeding regimen; for winter, this primarily meant that no feed was fed.

Percentage of breeding operations by seasonal feeding frequency for broodfish:

	Percent Operations					
	Season					
	Spring/Early Summer		**Midsummer/Fall**		**Winter**	
Feeding Frequency	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Daily	35.2	(0.5)	29.8	(0.5)	2.7	(0.0)
Every other day	35.1	(0.7)	32.4	(0.7)	8.1	(0.4)
Every third day	18.9	(0.6)	27.0	(0.6)	10.8	(0.1)
Less often than every third day	5.4	(0.1)	8.1	(0.5)	43.3	(0.7)
Other	5.4	(0.1)	2.7	(0.0)	35.1	(0.7)
Total	100.0		100.0		100.0	

Percentage of Breeding Operations by Seasonal Feeding Frequency for Broodfish



7. Protein level of feed

More than two-thirds of breeding operations (69.4 percent) primarily fed broodfish feed that was 32 percent protein. More than 15.0 percent of operations (16.7 percent), however, fed broodfish feed that was only 28 percent protein, which is below some recommendations. Inadequate protein in the diet can result in poor egg quality and quantity.

Percentage of breeding operations by protein level **primarily** fed to broodfish in 2009:

Percent Protein Level	Percent Operations	Std. Error
28	16.7	(0.4)
32	69.4	(0.6)
35	5.6	(0.4)
Other	8.3	(0.4)
Total	100.0	

8. Stocking of forage fish

Stocked forage fish serve as a supplemental food source for broodfish. Almost one-half of breeding operations (48.7 percent) stocked some forage fish, and some operations stocked more than one species of forage fish. The highest percentage of operations (27.0 percent) stocked tilapia. Almost one-fifth of operations (18.9 percent) stocked “other” species of forage fish, which were mostly sunfish species. Threadfin shad were stocked by 16.2 percent of operations.

Tilapia, also a food fish, are prolific spawners, but they are tropical in nature and do not tolerate low temperatures. In fall, tilapia become lethargic; this makes them easy prey for broodfish. The inability of tilapia to overwinter is considered a benefit because a population cannot become established.

a. Percentage of operations that stocked the following species as food sources for broodfish:

Species	Percent Operations	Std. Error
Fathead minnows	5.4	(0.1)
Threadfin shad	16.2	(0.4)
Gizzard shad	2.7	(0.0)
Tilapia	27.0	(0.6)
Other	18.9	(0.3)
None stocked	51.3	(0.7)

A higher percentage of small breeding operations stocked forage fish than did large breeding operations, and a higher percentage of breeding operations in the East region stocked forage fish than did operations in the West region. These findings are likely influenced by the fact that 80.3 percent of the small breeding operations are located in the East region and 82.5 percent of the large operations are in the West region (data not shown).

b. Percentage of breeding operations that stocked forage fish in broodfish ponds as a supplemental food source for broodfish, and by size of operation:

Percent Operations					
Size of Operation (Number of Broodfish)					
Small (2,000 or Fewer)		**Large** (More than 2,000)		**All Operations**	
Percent	**Std. Error**	**Percent**	**Std. Error**	**Percent**	**Std. Error**
55.0	(0.4)	41.2	(1.4)	48.7	(0.7)

c. Percentage of breeding operations that stocked forage fish in broodfish ponds as a supplemental food source for broodfish, by region:

Percent Operations			
Region			
East		**West**	
Percent	**Std. Error**	**Percent**	**Std. Error**
63.2	(0.5)	33.4	(1.1)

Photo courtesy Peggy Greb, Agricultural Research Service

C. Spawning Management

1. Number of spawning ponds

Percentage of breeding operations by number of spawning ponds used in 2009:

Number Spawning Ponds	Percent Operations	Std. Error
1	27.1	(0.4)
2 to 3	24.3	(0.4)
4 to 5	24.3	(0.7)
6 or more	24.3	(0.7)
Total	100.0	

2. Draining and renovation of spawning ponds

Spawning ponds that are not new should be drained every year or two to improve water quality for breeding. Some experts believe ponds should be drained and dried every year, based on anecdotal evidence that suggests spawning success declines if fish are left in the same pond for more than a year.

More than three-fourths of large operations (76.5 percent) usually drain ponds every 1 to 3 years, whereas only one-half of small operations (47.4 percent) usually drain ponds that frequently. Nearly three-fourths of operations (74.2 percent) do not regularly renovate ponds (i.e., they wait 6 or more years between renovations), which is not surprising because the process is complex and expensive relative to draining and drying.

a. Percentage of breeding operations by usual number of years between draining and drying of spawning ponds and between complete renovations of ponds, and by size of operation:

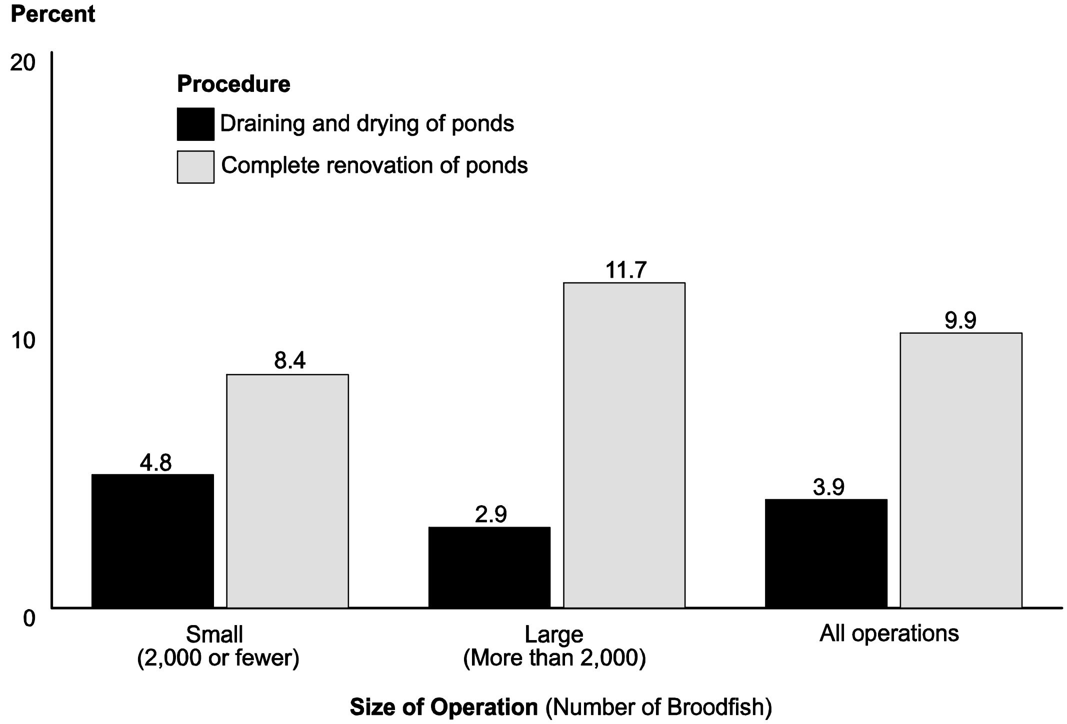
	Percent Operations					
	Size of Operation (Number of Broodfish)					
	Small (2,000 or Fewer)		**Large** (More than 2,000)		**All Operations**	
Number Years Between…	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Draining and drying of ponds						
1 to 3	47.4	(0.4)	76.5	(1.4)	61.1	(0.7)
4 to 5	15.8	(0.1)	0.0	(--)	8.3	(0.1)
6 or more	36.8	(0.3)	23.5	(1.4)	30.6	(0.6)
Total	100.0		100.0		100.0	
Complete renovations of ponds						
1 to 3	23.5	(0.2)	14.3	(0.4)	19.4	(0.3)
4 to 5	11.8	(0.1)	0.0	(--)	6.4	(0.1)
6 or more	64.7	(0.3)	85.7	(0.4)	74.2	(0.4)
Total	100.0		100.0		100.0	

For all breeding operations, the average interval between draining and drying of ponds is 3.9 years. With more than three-fourths of large operations draining and drying ponds every 1 to 3 years (table C.2.a), the average number of years between drainings is only 2.9 years. At 4.8 years, the interval between drainings for small operations is much higher, reflecting the fact that fewer small operations (47.4 percent, table C.2.a) drain and dry ponds every 1 to 3 years. The average time between complete renovations for all operations is almost 10 years.

b. Average number of years between draining and drying of spawning ponds and average number of years between complete renovations of spawning ponds, and by size of operation:

	Average Number of Years					
	Size of Operation (Number of Broodfish)					
	Small (2,000 or Fewer)		**Large** (More than 2,000)		**All Operations**	
Procedure	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Draining and drying of ponds	4.8	(0.0)	2.9	(0.1)	3.9	(0.1)
Complete renovation of ponds	8.4	(0.1)	11.7	(0.2)	9.9	(0.1)

Average Number of Years Between Draining and Drying of Spawning Ponds and Average Number of Years Between Complete Renovations of Spawning Ponds, and by Size of Operation



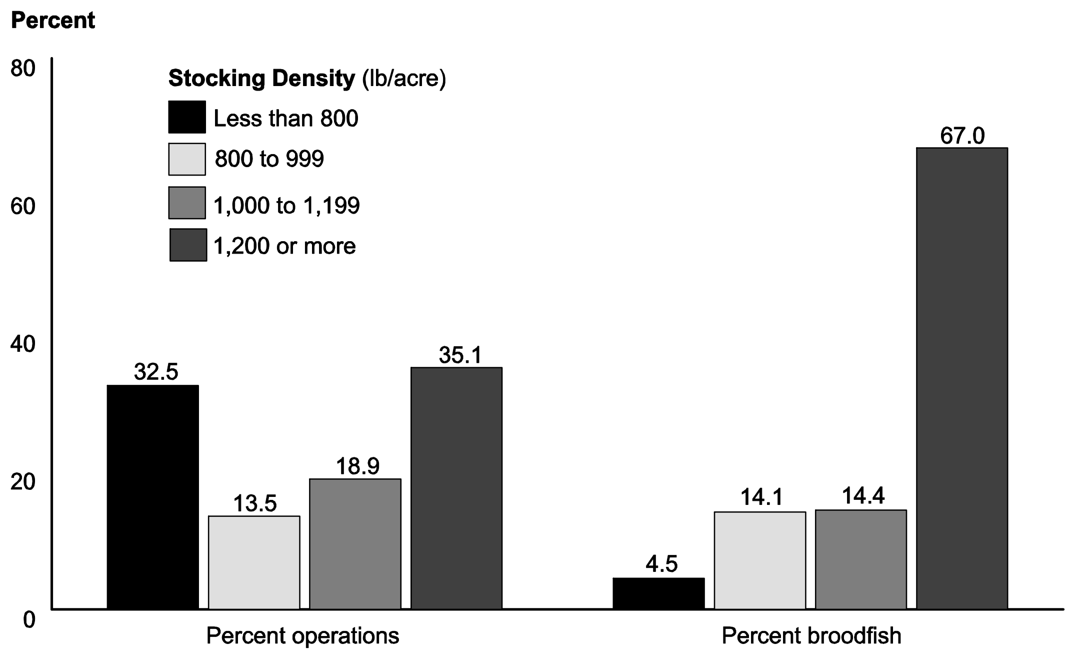
3. Broodfish stocking densities

Maximum recommended broodfish stocking densities are about 1,200 pounds per acre. Although one-third of all breeding operations (35.1 percent) stock broodfish at a density of 1,200 pounds per acre or more, two-thirds of all broodfish (67.0 percent) are on these operations. One-third of breeding operations (32.5 percent) stock at very low densities (less than 800 pounds per acre); consequently, these operations account for a low percentage of broodfish (4.5 percent).

Percentage of operations and percentage of broodfish by broodfish stocking density (pounds per acre):

Stocking Density (lb/acre)	**Percent Operations**	**Std. Error**	**Percent Broodfish**	**Std. Error**
Less than 800	32.5	(0.5)	4.5	(2.6)
800 to 999	13.5	(0.7)	14.1	(7.5)
1,000 to 1,199	18.9	(0.4)	14.4	(8.8)
1,200 or more	35.1	(0.7)	67.0	(12.5)
Total	100.0		100.0	

Percentage of Operations and Percentage of Broodfish by Broodfish Stocking Density



4. Female-to-male ratio in spawning ponds

Female-to-male ratios ranging from 1:1 to as high as 4:1 have been shown to have equal spawning success. More than 85 percent of all operations (86.1 percent) usually used female-to-male ratios between 1:1 and 3:1 in spawning ponds. About one-fifth of small breeding operations (21.1 percent) usually used an “other” ratio, compared with 5.9 percent of large operations. The survey did not capture data on “other” ratios used.

Percentage of breeding operations by typical female-to-male broodfish ratio in spawning ponds, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Broodfish)					
	Small (2,000 or Fewer)		**Large** (More than 2,000)		**All Operations**	
Female-to-Male Ratio	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
1 to 1	15.8	(0.1)	29.4	(1.3)	22.2	(0.7)
2 to 1	42.1	(0.4)	29.4	(1.2)	36.1	(0.6)
3 to 1	21.0	(0.2)	35.3	(1.4)	27.8	(0.7)
Other	21.1	(0.2)	5.9	(0.2)	13.9	(0.2)
Total	100.0		100.0		100.0	

D. Hatchery Management

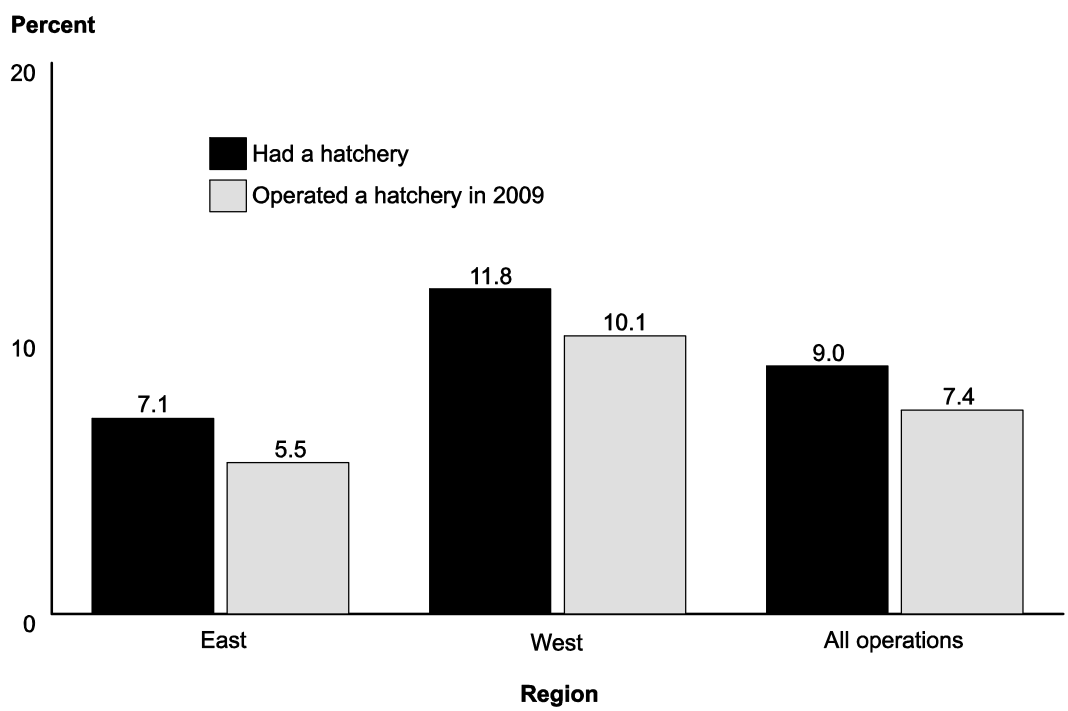
1. Egg masses

Overall, 9.0 percent of catfish operations had a hatchery, but only 7.4 percent of operations operated a hatchery in 2009. Operations that had a hatchery but did not operate it in 2009 might have purchased fry from another hatchery.

a. Percentage of catfish operations that had a hatchery for hatching catfish eggs and percentage of operations that operated a hatchery in 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Hatchery Status	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Had a hatchery	7.1	(0.5)	11.8	(0.7)	9.0	(0.4)
Operated a hatchery in 2009	5.5	(0.5)	10.1	(0.7)	7.4	(0.4)

Percentage of Catfish Operations that had a Hatchery for Hatching Catfish Eggs and Percentage of Operations that Operated a Hatchery in 2009, and by Region



All operations that operated a hatchery in 2009 had their own broodfish, so they likely produced the eggs that were hatched in the hatchery.

b. For operations that operated a hatchery in 2009, percentage of operations by broodfish inventory status:

Broodfish Inventory Status	**Percent Operations**	**Std. Error**
Hatchery with own broodfish	100.0	(--)
Hatchery with no broodfish	0.0	(--)

More than one-third of operations (35.6 percent) that produced catfish fry in 2009 placed 500 to 1,999 egg masses in the hatchery.

c. For operations that produced catfish fry in 2009, percentage of operations by number of egg masses brought to the hatchery for hatching:

Number of Egg Masses	**Percent Operations**	**Std. Error**
1 to 199	26.1	(0.5)
200 to 499	13.0	(0.2)
500 to 1,999	35.6	(0.7)
2,000 or more	25.3	(0.9)
Total	100.0	

In 2009, operations brought an average of 1,585 egg masses into hatcheries. Egg masses had an average weight of 1.9 pounds.

d. Average number of egg masses, average total pounds of eggs, and average pounds per egg mass for eggs brought to the hatchery for hatching in 2009:

Average Number of Egg Masses	Std. Error	Average Total Pounds of Eggs	Std. Error	Average Pounds per Egg Mass	Std. Error
1,585	(48)	2,680	(128)	1.9	(0.0)

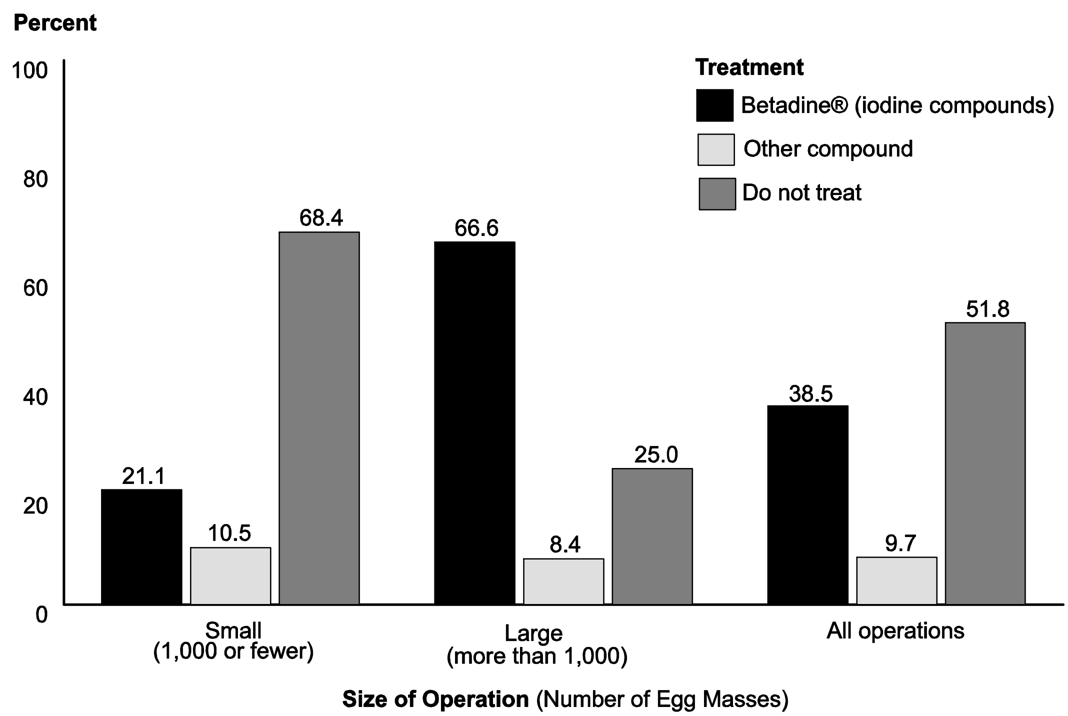
Treating egg masses with Betadine® or some other appropriate compound before they are placed in a hatchery helps control bacterial and fungal diseases. According to some recommendations, however, eggs should be treated immediately after they are placed in the hatching trough to reduce extra handling and associated problems.

Approximately one-half of all hatcheries (48.2 percent) typically treat egg masses before placing them in the hatching trough; however, two-thirds of small hatcheries (68.4 percent) do not treat egg masses before placement.

e. Percentage of operations by usual treatment of egg masses before they are placed into hatching troughs, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Egg Masses)					
	Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Treatment	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Betadine® (iodine compounds)	21.1	(0.6)	66.6	(1.7)	38.5	(0.8)
Other compound	10.5	(0.1)	8.4	(1.1)	9.7	(0.4)
Do not treat	68.4	(0.6)	25.0	(1.5)	51.8	(0.8)
Total	100.0		100.0		100.0	

Percentage of Operations by Usual Treatment of Egg Masses Before They are Placed into Hatching Troughs, and by Size of Operation



2. Hatchery water management

More than one-half of hatcheries (57.7 percent) used water obtained directly from a well. Compared with surface water, well water has the advantage of generally being free of diseases, wild fish, suspended matter, and pollutants. Water obtained directly from a well, however, can have issues associated with supersaturation of gases; 16.2 percent of hatcheries used well water that was stored in a holding pond, which prevents problems with supersaturated gases and also facilitates availability of water. Only 9.8 percent of hatcheries used water that was obtained from a creek or a watershed and subsequently stored in a holding pond.

a. Percentage of hatchery operations by primary source of water used in hatchery:

Water Source	Percent Operations	Std. Error
Well water stored in a holding pond	16.2	(0.4)
Water from a creek or a watershed, then stored in a holding pond	9.8	(0.1)
Water directly from a well	57.7	(0.7)
Mixture of water directly from a well and from a holding pond	13.0	(0.2)
Other	3.3	(0.4)
Total	100.0	

Well water may be supersaturated with gases or have a relatively low temperature. Of the hatcheries that used water directly from a well, about one-half degassed or heated the water before using it in the hatchery.

b. For hatchery operations that used water directly from a well, percentage of operations that degassed and/or heated water used in the hatchery:

Treatment	Percent Operations	Std. Error
Degassed	55.1	(1.1)
Heated	44.6	(1.2)

For a typical 100-gallon hatching trough, between 2 and 5 gallons of water should flow through the trough per minute; this flow rate provides adequate water exchange to maintain water quality. Overall, the average water flow rate in each hatching trough was 5.6 gallons per minute, with the average rate being 2 gallons per minute higher for small operations than for large operations.

c. Average water flow rate (gallons per minute) for each hatching trough, and by size of operation:

Average Flow Rate (Gallons per Minute)					
Size of Operation (Number of Egg Masses)					
Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Average	**Std. Error**	**Average**	**Std. Error**	**Average**	**Std. Error**
6.2	(0.0)	4.2	(0.0)	5.6	(0.0)

For 22.7 percent of operations, the average water flow rate in each hatching trough was 1 to 3 gallons per minute. If the hatching troughs on these operations are the usual 100-gallon size, then the flow may be inadequate. Trough size was not recorded in this study.

d. Percentage of hatchery operations by average water flow rate (gallons per minute) in each hatching trough:

Gallons per Minute	**Percent Operations**	**Std. Error**
1 to 3	22.7	(0.6)
4 to 5	49.8	(0.8)
6 or more	27.5	(0.6)
Total	100.0	

To circulate water, a higher percentage of hatcheries used paddles in hatching troughs (80.5 percent) than in fry troughs (9.7 percent). For fry troughs, the majority of hatchery operations (70.8 percent) used air stones to circulate water. The study did not collect information on “other” methods of circulating water.

e. Percentage of hatchery operations by method of circulating water in hatching troughs and fry troughs:

	Percent Operations			
	Hatching Troughs		Fry Troughs	
Method	**Percent Operations**	**Std. Error**	**Percent Operations**	**Std. Error**
Paddles	80.5	(0.3)	9.7	(0.4)
Air stones	35.4	(0.7)	70.8	(0.7)
Agitators	9.8	(0.1)	9.8	(0.4)
Other	25.9	(0.6)	25.9	(0.6)

Water with low mineral content is not recommended for use in hatcheries because low calcium levels can result in poor hatching and survival. Water hardness of at least 20 parts per million (ppm) is recommended, and about three-fourths of hatcheries (74.2 percent) used water with hardness of 20 ppm or more. (For water hardness levels, parts per million usually refers to 1 milligram of calcium carbonate per liter of water.)

f. Percentage of hatchery operations by water hardness (parts per million) used by hatcheries:

Hardness (ppm)	**Percent Operations**	**Std. Error**
1 to 19	25.8	(0.9)
20 to 50	17.5	(0.8)
51 or higher	56.7	(0.9)
Total	100.0	

The overall average water hardness for hatchery operations was 109.3 ppm. The average water hardness of hatcheries in the East region was higher than that for the West region (123.6 and 95.9 ppm, respectively). Consequently, it is not surprising to note that, during 2009, more than one-half of hatcheries in the West region (52.5 percent) added calcium to maintain water hardness, while only 14.3 percent of hatcheries in the East region added calcium.

g. Average hardness (parts per million) of water used by hatcheries, and by region:

Average Hardness (ppm)					
Region					
East		**West**		**All Operations**	
Average	**Std. Error**	**Average**	**Std. Error**	**Average**	**Std. Error**
123.6	(1.3)	95.9	(2.8)	109.3	(1.6)

h. Percentage of hatchery operations that added calcium to water during 2009 to maintain hardness, and by region:

Percent Operations					
Region					
East		**West**		**All Operations**	
Percent	**Std. Error**	**Percent**	**Std. Error**	**Percent**	**Std. Error**
14.3	(0.2)	52.5	(1.2)	35.1	(0.9)

Hatcheries need to maintain 5 to 6 ppm of dissolved oxygen in water in hatching troughs and fry troughs because eggs and fry have relatively high oxygen requirements. Hatcheries can oxygenate the water through some of the water circulation methods (table D.2.e), but they also can add liquid oxygen.

About one-fourth of hatcheries (25.6 percent) use liquid oxygen to help control dissolved oxygen. A higher percentage of hatcheries in the West region (41.0 percent) use this practice compared with hatcheries in the East region (7.1 percent).

i. Percentage of hatchery operations that use liquid oxygen in the hatchery to control dissolved oxygen, and by region:

Percent Operations					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
7.1	(0.1)	41.0	(1.3)	25.6	(0.8)

Photo courtesy David Nance, Agricultural Research Service

3. Density of egg masses in hatching troughs

Egg masses should not be overcrowded in hatching troughs. Overcrowding can inhibit water circulation, potentially causing problems with dissolved oxygen levels. Overlapping of egg masses can facilitate the transfer of bacterial or fungal diseases.

During 2009, most hatcheries (91.4 percent) placed fewer than 31 egg masses per 100 gallons. The average number of egg masses per 100 gallons was 19.8.

a. Percentage of hatchery operations by density of egg masses (number of egg masses per 100 gallons of water) in hatching troughs in 2009:

Density (Egg Masses per 100 Gallons)	**Percent Operations**	**Std. Error**
1 to 15	47.7	(0.9)
16 to 30	43.7	(0.9)
31 or more	8.6	(0.6)
Total	100.0	

b. Average density of egg masses (number of egg masses per 100 gallons of water) in hatching troughs in 2009:

Average Density (Egg Masses per 100 Gallons)	**Std. Error**
19.8	(0.2)

4. Turning of egg masses

Egg masses should be turned over on a regular basis to check for infected or dead eggs. A majority of hatcheries (53.0 percent) turned eggs at least three times daily during 2009.

Percentage of hatchery operations by number of times per day egg masses were turned in 2009:

Times per Day	Percent Operations	Std. Error
Not turned	10.1	(0.2)
1 to 2	36.9	(0.8)
3 or more	53.0	(0.8)
Total	100.0	

E. Egg Health Issues

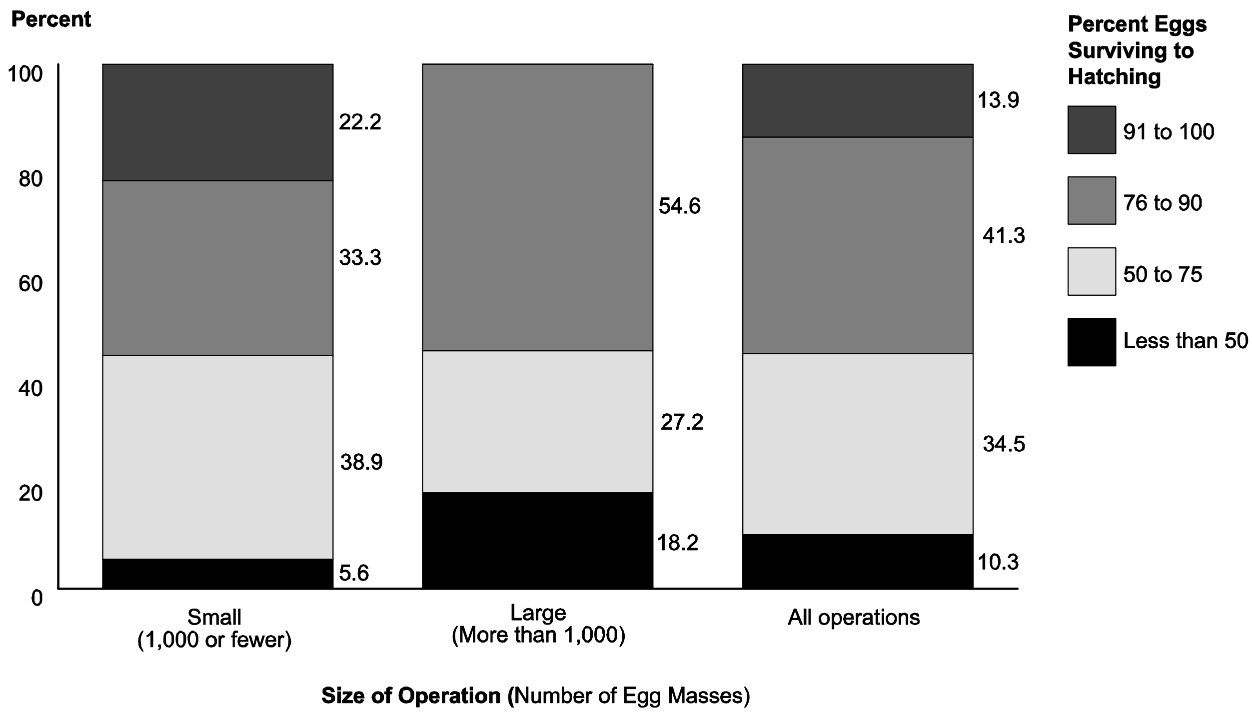
1. Survival of eggs until hatching

In 2009, at least 50 percent of eggs survived until hatching on the majority of hatchery operations (89.7 percent). On more than one-half of hatcheries (55.2 percent), more than 75 percent of eggs survived to hatching. More than one-fifth of small hatchery operations (22.2 percent) had more than 90 percent of eggs survive to hatching.

a. Percentage of hatchery operations by percentage of eggs brought to the hatchery that survived to hatching in 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Egg Masses)					
	Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Percent Eggs Surviving to Hatching	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Less than 50	5.6	(0.1)	18.2	(1.2)	10.3	(0.5)
50 to 75	38.9	(0.6)	27.2	(1.8)	34.5	(0.8)
76 to 90	33.3	(0.6)	54.6	(1.9)	41.3	(0.8)
91 to 100	22.2	(0.2)	0.0	(0.0)	13.9	(0.2)
Total	100.0		100.0		100.0	

Percentage of Hatchery Operations by Percentage of Eggs Brought to the Hatchery that Survived to Hatching in 2009, and by Size of Operation



Overall, almost three-fourths of eggs (74.2 percent) survived to hatching in 2009. The percentage of eggs that survived to hatching did not differ by size or region of hatchery operation.

b. Percentage of eggs brought into the hatchery operation (weighted by number of egg masses) that survived to hatching in 2009, and by size of operation:

Percent Eggs					
Size of Operation (Number of Egg Masses)					
Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Percent	**Std. Error**	**Percent**	**Std. Error**	**Percent**	**Std. Error**
80.6	(4.1)	73.3	(4.1)	74.2	(3.6)

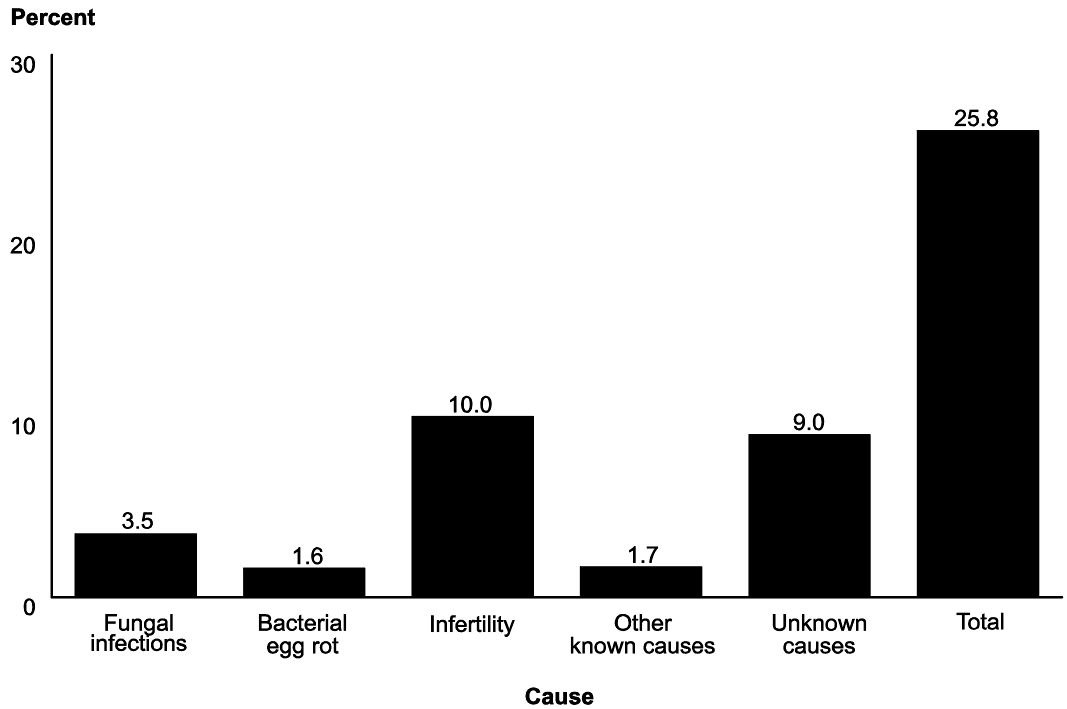
2. Causes of egg loss

Of all eggs brought into the hatchery, almost one-fifth failed to hatch because of infertility (10.0 percent) or unknown causes (9.0 percent). Combined, fungal and bacterial infections caused the loss of 5.1 percent of eggs brought into the hatchery.

a. Percentage of eggs brought into the hatchery operation (weighted by number of egg masses) that did not hatch in 2009, by cause:

Cause	Percent Eggs	Std. Error
Fungal infections	3.5	(2.1)
Bacterial egg rot (or other bacterial infections)	1.6	(0.7)
Infertility	10.0	(3.3)
Other known causes	1.7	(1.4)
Unknown causes	9.0	(4.5)
Total	25.8	

Percentage of Eggs Brought into the Hatchery Operation (Weighted by Number of Egg Masses) that did not Hatch in 2009, by Cause



About one-half of hatcheries reported egg loss due to unknown causes and infertility (55.0 and 48.3 percent of operations, respectively). Although fungal infections did not cause the loss of a high percentage of eggs, they did cause egg loss on 38.9 percent of operations. Bacterial egg rot caused egg loss on 25.7 percent of operations.

b. Percentage of hatchery operations with any eggs that did not hatch, by cause:

Cause	**Percent Operations**	**Std. Error**
Fungal infections	38.9	(0.7)
Bacterial egg rot (or other bacterial infections)	25.7	(0.7)
Infertility	48.3	(0.8)
Other known causes	9.6	(0.6)
Unknown causes	55.0	(0.8)

3. Fungal/bacterial prevention and treatment

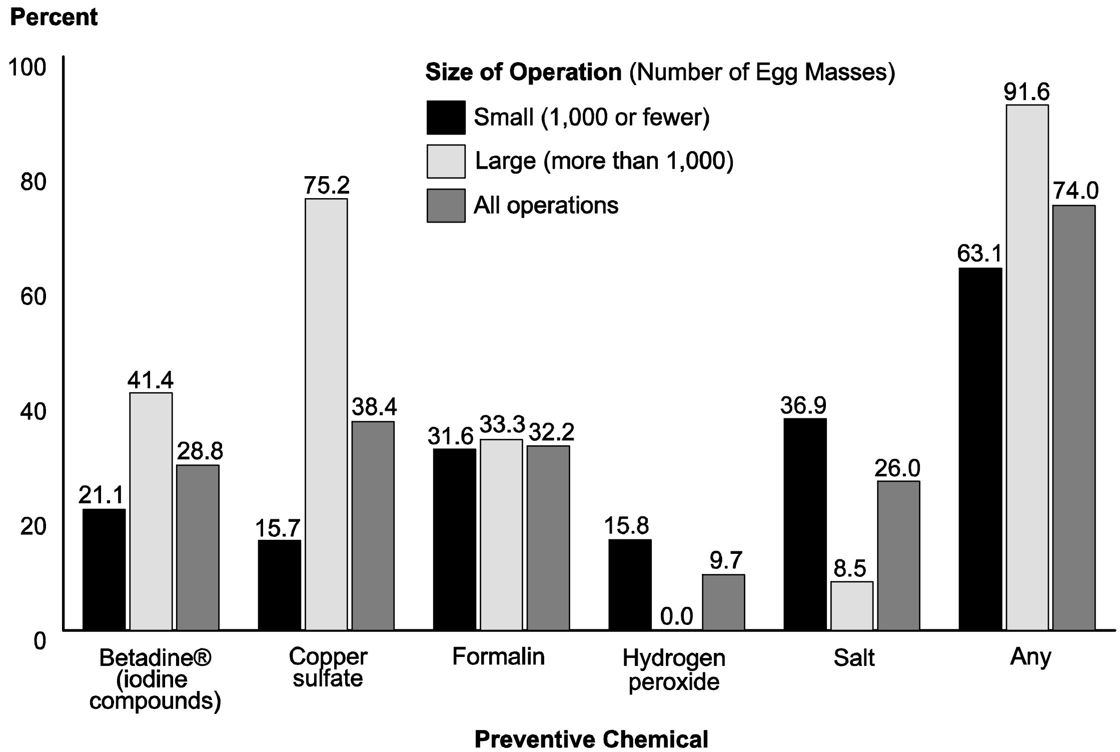
Measures to prevent disease in hatchery operations include a variety of practices, such as maintaining adequate water flow and quality (including dissolved oxygen levels) and keeping egg hatching baskets from being overcrowded. Additionally, chemicals can help prevent disease problems.

Three-fourths of all hatcheries (74.0 percent) used some type of chemical treatment to prevent fungal or bacterial infections in hatching troughs during 2009. Copper sulfate, formalin, Betadine®, and salt each were used by at least one-fourth of hatcheries. More than 90 percent of large hatcheries (91.6 percent) used some preventive chemical treatment compared with 63.1 percent of small hatcheries.

a. Percentage of hatchery operations that used chemicals to **prevent** fungal or bacterial infections in hatching troughs during 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Egg Masses)					
	Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Preventive Chemical	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Betadine® (iodine compounds)	21.1	(0.6)	41.4	(1.8)	28.8	(0.8)
Copper sulfate	15.7	(0.6)	75.2	(1.7)	38.4	(0.8)
Formalin	31.6	(0.3)	33.3	(1.7)	32.2	(0.7)
Hydrogen peroxide	15.8	(0.6)	0.0	(0.0)	9.7	(0.4)
Salt	36.9	(0.5)	8.5	(1.1)	26.0	(0.6)
Any	63.1	(0.4)	91.6	(1.1)	74.0	(0.5)

Percentage of Hatchery Operations that used Chemicals to Prevent Fungal or Bacterial Infections in Hatching Troughs during 2009, and by Size of Operation



On average, eggs were treated 1 to 1.5 times per day, depending on the chemical used. The number of times eggs were treated did not vary substantially by size or region of hatching operations.

b. Average number of times per day hatchery operations used chemicals to **prevent** fungal or bacterial infections in hatchery troughs during 2009, and by size of operation:

	Average Number of Times per Day					
	Size of Operation (Number of Egg Masses)					
	Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Preventive Chemical	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Betadine® (iodine compounds)	1.0	(0.0)	1.3	(0.2)	1.3	(0.2)
Copper sulfate	1.0	(0.0)	1.3	(0.2)	1.3	(0.2)
Formalin	1.3	(0.3)	1.6	(0.3)	1.5	(0.2)
Hydrogen peroxide	1.0	(0.0)	NA*		1.0	(0.0)
Salt	1.5	(0.4)	1.0	(0.0)	1.3	(0.3)

* Not applicable. No large operations used hydrogen peroxide to prevent fungal or bacterial infections in hatching troughs during 2009 (table E.3.a.).

The primary disease concerns for catfish eggs are bacterial and fungal infections, which can spread quickly once the disease-causing organisms are present. The pattern of chemical use for treatment of fungal infections is very similar to that for treatment of bacterial diseases (tables E.3.c and E.3.d), and the general pattern for chemical use for treatment also is similar to that for prevention (table E.3.a). Overall, more than three-fifths of hatchery operations used one or more chemicals to treat infections in hatching troughs during 2009—61.4 percent used them to treat fungal infections and 61.3 percent used them to treat bacterial infections. Almost 30 percent of operations used formalin or copper sulfate to treat fungal or bacterial infections, while about 20 percent used salt or Betadine.

A higher percentage of large operations than small operations used copper sulfate to treat fungal infections (58.5 and 10.5 percent, respectively). A higher percentage of small operations than large operations used salt (31.6 and 8.5 percent, respectively).

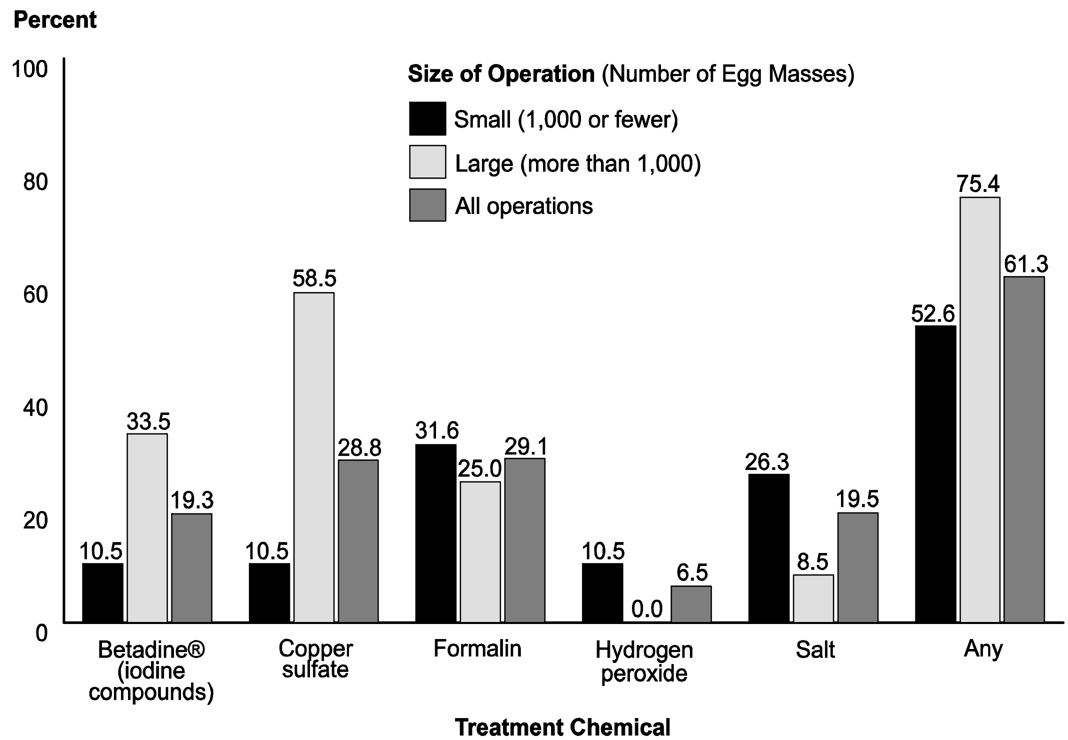
c. Percentage of hatchery operations that used chemicals to **treat fungal** infections in hatching troughs during 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Egg Masses)					
	Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Treatment Chemical	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Betadine® (iodine compounds)	15.8	(0.6)	25.0	(1.5)	19.3	(0.7)
Copper sulfate	10.5	(0.7)	58.5	(1.8)	28.8	(0.9)
Formalin	31.6	(0.3)	25.0	(1.7)	29.1	(0.7)
Hydrogen peroxide	10.5	(0.7)	0.0	(--)	6.5	(0.4)
Salt	31.6	(0.6)	8.5	(1.1)	22.8	(0.6)
Any	57.9	(0.4)	66.9	(1.7)	61.4	(0.7)

d. Percentage of hatchery operations that used chemicals to **treat bacterial** infections in hatching troughs during 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Egg Masses)					
	Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Treatment Chemical	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Betadine® (iodine compounds)	10.5	(0.7)	33.5	(1.7)	19.3	(0.8)
Copper sulfate	10.5	(0.7)	58.5	(1.8)	28.8	(0.9)
Formalin	31.6	(0.3)	25.0	(1.7)	29.1	(0.7)
Hydrogen peroxide	10.5	(0.7)	0.0	(--)	6.5	(0.4)
Salt	26.3	(0.6)	8.5	(1.1)	19.5	(0.6)
Any	52.6	(0.5)	75.4	(1.5)	61.3	(0.7)

Percentage of Hatchery Operations that used Chemicals to Treat Bacterial Infections in Hatching Troughs during 2009, and by Size of Operation



F. Fry Management

1. Number and species of fry hatched

In 2009, the average number of fry produced in a catfish hatchery operation was 16,256,000. On average, large hatcheries hatched over 23 times more fry than did small hatcheries (38,673,000 compared with 1,644,000).

a. Operation average number of fry hatched in 2009, and by size of operation:

Operation Average Number of Fry Hatched

Size of Operation (Number of Egg Masses)					
Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Average	**Std. Error**	**Average**	**Std. Error**	**Average**	**Std. Error**
1,644,000	(38)	38,673,000	(1,104)	16,256,000	(578)

The majority of fry hatched during 2009 were channel catfish (87.1 percent), with channel x blue hybrid catfish accounting for most of the rest (12.9 percent). More than 90 percent of hatcheries produced some channel catfish fry, while 9.5 percent of hatcheries produced channel x blue hybrids. Notably, 6.5 percent of hatcheries produced blue catfish fry, but these fry were a negligible percentage (less than 0.1 percent) of all fry hatched. This low percentage of blue catfish fry might indicate that these fish will be used as broodfish rather than as foodsize fish for market.

b. Percentage of fry hatched, by species, and percentage of operations that hatched the species during 2009:

Catfish Species	**Percent Fry**	**Std. Error**	**Percent Operations**	**Std. Error**
Channel	87.1	(1.0)	93.6	(0.1)
Channel x blue hybrid	12.9	(1.0)	9.5	(0.6)
Blue	0.0	(0.0)	6.5	(0.1)
Total	100.0			

2. Length of time fry left in fry troughs

Although fry with attached yolk sac can be stocked into fry/fingerling ponds, survival is likely better if fry are not stocked until they have fully absorbed the yolk sac and been fed for a brief period. About one-half of hatchery operations (51.7 percent) left fry in fry troughs for 4 to 7 days past swim-up. Only about one-fifth of hatcheries (19.3 percent) left fry in troughs 8 or more days. No operations in the West region released yolk-sac fry.

Percentage of hatchery operations by how many days fry were normally left in fry troughs past swim-up during 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Days Left in Fry Trough Past Swim-up	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Release sac fry	7.1	(0.9)	0.0	(--)	3.2	(0.4)
1 to 3	21.4	(0.3)	29.4	(1.2)	25.8	(0.7)
4 to 7	50.0	(0.7)	53.2	(1.3)	51.7	(0.8)
8 or more	21.5	(0.8)	17.4	(1.0)	19.3	(0.7)
Total	100.0		100.0		100.0	

3. Primary feed in fry troughs

The highest percentage of hatchery operations (51.7 percent) used catfish starter as the primary feed for fry in fry troughs during 2009. About one-third of operations (35.4 percent) fed fry primarily salmon/trout starter.

About 1 of 10 small hatchery operations (10.6 percent) used “other” feeds as the primary feed for fry in fry troughs. The majority of these “other” feeds were fines/meal. No large operations fed either “other” primary feeds or nothing to fry in fry troughs.

Percentage of hatchery operations by primary feed fed to fry in fry troughs during 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Egg Masses)					
	Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Primary Feed	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Catfish starter	52.6	(0.5)	50.1	(1.8)	51.7	(0.8)
Salmon/trout starter	31.6	(0.3)	41.6	(1.8)	35.4	(0.7)
Krill	0.0	(--)	8.3	(1.1)	3.2	(0.4)
Other	10.6	(0.1)	0.0	(--)	6.5	(0.1)
Nothing fed to fry in fry troughs	5.2	(0.7)	0.0	(--)	3.2	(0.4)
Total	100.0		100.0		100.0	

4. Number of feedings per day for fry

Two-thirds (66.3 percent) of the hatcheries that fed fry in fry troughs fed them five or more times per 24-hour period. The highest percentage of operations (46.2 percent) fed fry seven or more times per day.

For hatchery operations that fed fry in fry troughs during 2009, percentage of operations by number of times fry were fed in a 24-hour period:

Number Times Fed Per 24-hour Period	Percent Operations	Std. Error
1 to 2	13.5	(0.2)
3 to 4	20.2	(0.5)
5 to 6	20.1	(0.5)
7 or more	46.2	(0.8)
Total	100.0	

5. Fry trough disinfection

All large hatcheries typically disinfect fry troughs between batches of fry. A majority of small operations (78.9 percent) also typically disinfect troughs between batches of fry, but the remaining one-fifth of small operations either disinfect annually (10.6 percent) or do not disinfect troughs (10.5 percent).

Percentage of hatchery operations by frequency of fry trough disinfection, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Egg Masses)					
	Small (1,000 or Fewer)		**Large** (More than 1,000)		**All Operations**	
Frequency*	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Between batches of fry	78.9	(0.2)	100.0	(0.0)	87.0	(0.2)
Annually	10.6	(0.1)	0.0	(--)	6.5	(0.1)
Do not disinfect	10.5	(0.1)	0.0	(--)	6.5	(0.1)
Total	100.0		100.0		100.0	

* "Other" was also listed as an option for frequency of fry trough disinfection, but no participants chose that response.

6. Fry use

Most fry produced at hatcheries were stocked on the operation (81.2 percent).

Percentage of fry produced in 2009 that were sold or stocked on the operation:

	Percent Fry	Std. Error
Sold	18.8	(8.4)
Stocked on the operation	81.2	(8.4)

7. Raising of fry to fingerlings

Of all catfish operations, 12.8 percent raised fry to fingerlings during 2009 (see table, p 9). A higher percentage of operations raised fry to fingerlings in the West region than in the East region (17.1 and 9.9 percent, respectively).

Percentage of all catfish operations that grew any fry to fingerlings in 2009, and by region:

Percent Operations					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
9.9	(0.6)	17.1	(0.8)	12.8	(0.5)

G. Fry/Fingerling Pond Management Prior to Stocking

1. Placement of fry in raceways or tanks prior to stocking

Fry may be moved from the fry trough to another tank or trough before they are placed in a fry/fingerling pond. This practice gives fry more time to develop and grow before being placed in a pond. A small percentage of all fingerling operations (11.5 percent) used this practice, but it was used by a higher percentage of operations in the East region (17.4 percent) than in the West region (6.9 percent).

a. Percentage of fingerling operations that moved swim-up fry from fry troughs to raceways or tanks before stocking them into fry/fingerling ponds during 2009, and by region:

Percent Operations					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
17.4	(0.6)	6.9	(0.7)	11.5	(0.5)

Of operations that placed fry temporarily in tanks or raceways, two-thirds (66.7 percent of operations) moved the fry into the fry/fingerling ponds when they were an average of 8 to 14 days old.

b. For fingerling operations that placed fry in raceways or tanks during 2009, percentage of operations by average age of fry (days) when they were moved from the raceway or tank to fry/fingerling ponds:

Average Age (Days after Hatching)	Percent Operations	Std. Error
4 to 7	0.0	(--)
8 to 14	66.7	(2.1)
15 or more	33.3	(2.1)
Total	100.0	

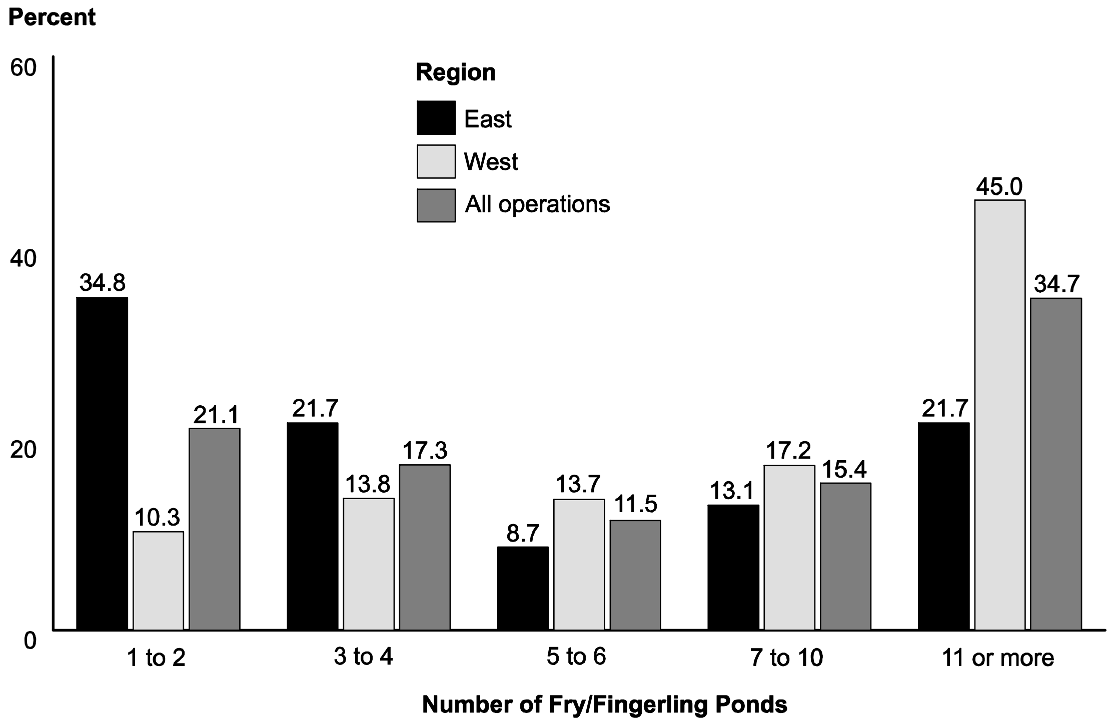
2. Number and size of fry/fingerling ponds

More than one-third (34.7 percent) of fingerling producers had 11 or more fry/fingerling ponds, whereas one-fifth (21.1 percent) had 1 to 2 ponds. A higher percentage of operations in the West region (45.0 percent) had 11 or more ponds compared to operations in the East region (21.7 percent). In the East region, the highest percentage of operations (34.8 percent) had one to two ponds.

a. Percentage of fingerling operations by number of fry/fingerling ponds used for production during 2009, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Number of Fry/Fingerling Ponds	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
1 to 2	34.8	(0.9)	10.3	(0.9)	21.1	(0.7)
3 to 4	21.7	(0.7)	13.8	(1.0)	17.3	(0.6)
5 to 6	8.7	(0.4)	13.7	(0.9)	11.5	(0.6)
7 to 10	13.1	(0.8)	17.2	(1.2)	15.4	(0.7)
11 or more	21.7	(0.8)	45.0	(1.5)	34.7	(0.9)
Total	100.0		100.0		100.0	

Percentage of Fingerling Operations by Number of Fry/Fingerling Ponds Used for Production During 2009, and by Region



During 2009, the average number of fingerling ponds in production per operation was 15.6. The average pond size was 8.7 surface acres, and overall, fingerling operations had an average total surface acreage of 136.5 acres. The average number of ponds and the average pond and total surface acres were higher for fingerling operations in the West region than for those in the East region. Fingerling ponds in the West region averaged 10.0 acres in size compared with 2.6 acres in the East region.

b. For fingerling operations, average number of ponds, average pond size (surface acres), and average total surface acres of ponds used for fingerling production in 2009, and by region:

	Average					
	Region					
	East		West		All Operations	
Parameter	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Number of ponds	6.1	(0.1)	23.2	(1.1)	15.6	(0.6)
Pond size (surface acres)	2.6	(0.1)	10.0	(0.2)	8.7	(0.2)
Total surface acres	16.1	(0.5)	231.6	(11.3)	136.5	(6.6)

3. Treatment of fry/fingerling ponds before stocking

Preparing fingerling ponds helps minimize predation problems and establish the proper zooplankton populations used as a food source. Ponds can be drained and dried or drained and poisoned to remove fish predators. Chlorine, rotenone, and antimycin A are all approved toxicants registered with the U.S. Environmental Protection Agency.

About 75 percent of all fingerling operations either drained and dried (45.0 percent of operations) or drained and poisoned (29.5 percent) their fingerling ponds prior to stocking in 2009. An additional 11.8 percent of operations poisoned ponds without draining them. A higher percentage of small operations than large operations drained and dried fingerling ponds (59.2 and 29.1 percent, respectively).

Percentage of fingerling operations by procedure that best describes the treatment of fry/ fingerling ponds before stocking in 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Treatment	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Drained and dried	59.2	(1.1)	29.1	(1.5)	45.0	(0.9)
Drained and poisoned	14.9	(1.0)	45.8	(1.6)	29.5	(0.9)
Poisoned but not drained	7.4	(0.6)	16.8	(1.0)	11.8	(0.6)
Neither drained nor poisoned	18.5	(0.8)	8.3	(0.7)	13.7	(0.5)
Total	100.0		100.0		100.0	

4. Stocking of fry/fingerling ponds

Fingerlings stocked in the spring can reach stocking size in 4 to 5 months, especially when stocked at lower densities. Consequently, many fingerlings can be moved to foodsize-fish production ponds after the summer growing season. Producers might keep some fingerlings over winter to meet spring stocking requirements or to produce larger fingerlings for stocking. Fingerlings also might be kept over winter because they did not sell.

Of the fingerling ponds in production in 2009, 73.2 percent were stocked with fry that hatched in 2009. Of the total water surface acres of ponds used for fingerling production in 2009, however, only 61.2 percent of surface acres were stocked with fry hatched in 2009.

a. Of fry/fingerling ponds used for production in 2009, percentage stocked with fry hatched in 2009, and by region:

Percent Ponds Stocked					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
81.6	(1.2)	71.5	(2.0)	73.2	(1.7)

b. Of total water surface acres of ponds used for fingerling production in 2009, percentage stocked with fry hatched in 2009, and by region:

Percent Water Surface Acres Stocked					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
64.7	(2.1)	61.0	(1.8)	61.2	(1.7)

The average number of fry stocked into fry/fingerling ponds on individual operations declined from about 11.5 million in 2008 to 9.7 million in 2009. More fingerlings were stocked on operations in the West region, where most of the overall decline occurred.

c. Operation average number of fry stocked into fry/fingerling ponds in 2008 and 2009, and by region:

	Operation Average Number of Fry (x1,000)					
	Region					
	East		**West**		**All Operations**	
Year	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
2008	859	(24)	18,106	(814)	11,493	(534)
2009	698	(17)	15,797	(797)	9,711	(502)

Stocking density affects health, growth rate, and survival of fish. More than one-half of fingerling operations (57.7 percent) stocked fewer than 100,000 fry per acre. This percentage was influenced strongly by the high percentage of fingerling operations in the East region that stocked at that rate (69.6 percent). In the West region, more than one-third of fingerling operations (34.6 percent) stocked fry at 200,000 or more per acre.

d. Percentage of operations by rate of stocking of fry/fingerling ponds in 2009, and by region:

	Percent Operations					
	Region					
	East		**West**		**All Operations**	
Stocking Rate (Fry/Acre)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Not stocked	0.0	(--)	3.4	(0.5)	1.9	(0.3)
Fewer than 100,000	69.6	(1.0)	48.3	(1.5)	57.7	(0.9)
100,000 to 149,000	21.7	(1.0)	37.9	(1.4)	30.8	(0.9)
150,000 to 199,000	8.7	(0.4)	13.8	(1.0)	11.5	(0.6)
200,000 or more	8.7	(0.4)	34.6	(1.4)	23.2	(0.8)

More than two-thirds of fry/fingerling ponds stocked in 2009 (67.5 percent) were stocked at a rate of fewer than 150,000 fry per acre.

e. Percentage of fry/fingerling ponds by stocking rate in 2009, and by region:

	Percent Ponds					
	Region					
	East		West		All Operations	
Stocking Rate (Fry/Acre)	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Fewer than 100,000	64.3	(1.1)	30.2	(1.5)	36.8	(1.3)
100,000 to 149,000	16.5	(1.0)	34.1	(2.0)	30.7	(1.6)
150,000 to 199,000	7.0	(0.3)	4.6	(0.4)	5.0	(0.3)
200,000 or more	12.2	(0.6)	31.1	(2.2)	27.5	(1.8)
Total	100.0		100.0		100.0	

5. Number of days between filling ponds and stocking

Newly filled ponds might not have the proper zooplankton bloom present to serve as a food source for fry. The zooplankton population develops over time, especially in the presence of fertilizer. If ponds are filled too long before being stocked, the potential increases for problems with predatory aquatic insects.

A majority of fingerling operations (55.6 percent) normally wait for 7 to 14 days after filling ponds before stocking fry, while one-fourth of operations (25.0 percent) normally wait for 15 or more days. A higher percentage of small operations than large operations (25.0 and 12.5 percent, respectively) normally wait less than 7 days before stocking.

a. For fingerling operations that drained fingerling ponds before stocking in 2009, percentage of operations by usual number of days between filling fingerling ponds with water and stocking with fry, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Days Between Filling and Stocking	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Fewer than 7	25.0	(1.1)	12.5	(1.3)	19.4	(0.9)
7 to 14	50.0	(1.3)	62.5	(1.9)	55.6	(1.1)
15 or more	25.0	(1.1)	25.0	(1.8)	25.0	(1.0)
Total	100.0		100.0		100.0	

On average, large fingerling operations normally wait 12.3 days between filling ponds with water and stocking fry, whereas small operations wait 17.8 days.

b. For fingerling operations that drained fingerling ponds before stocking in 2009, average usual number of days between filling fry/fingerling ponds with water and stocking fry, and by size of operation:

Average Number of Days					
Size of Operation (Number of Fry Stocked)					
Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Average	**Std. Error**	**Average**	**Std. Error**	**Average**	**Std. Error**
17.8	(0.4)	12.3	(0.3)	15.4	(0.3)

6. Number of years between complete renovations of fry/fingerling ponds

Almost four-fifths of fingerling operations (79.0 percent) normally wait 6 or more years between complete renovations of fry/fingerling ponds. On average, operations wait 9.3 years between complete renovations of fry/fingerling ponds.

a. Percentage of fingerling operations by usual number of years between complete renovations of fry/fingerling ponds:

Years Between Complete Renovations	**Percent Operations**	**Std. Error**
1 to 5	21.0	(0.8)
6 to 10	57.8	(1.1)
11 or more	21.2	(1.0)
Total	100.0	

b. Average usual time (in years) between complete renovations of fingerling ponds:

Average Time (Years)	**Std. Error**
9.3	(0.1)

7. Fertilization of fry/fingerling ponds

As noted above, fertilizing fingerling ponds promotes a bloom of beneficial zooplankton, providing food for fry. In 2009, 46.2 percent of fingerling operations fertilized fry/fingerling ponds. The percentage of operations fertilizing fingerling ponds did not differ between regions.

a. Percentage of fingerling operations that fertilized fry/fingerling ponds in 2009, and by region:

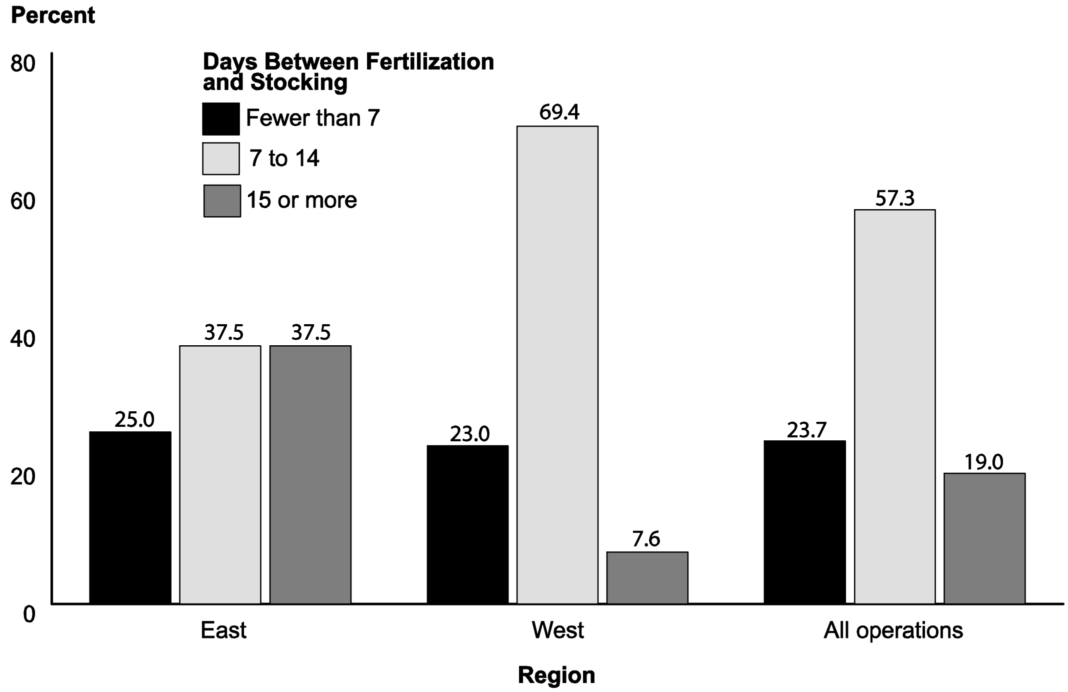
Percent Operations					
Region					
East		**West**		**All Operations**	
Percent	**Std. Error**	**Percent**	**Std. Error**	**Percent**	**Std. Error**
47.8	(0.9)	45.0	(1.5)	46.2	(0.9)

About three-fourths of operations that fertilized fingerling ponds in 2009 began fertilizing ponds at least 7 days before stocking fry (76.3 percent). The delay between fertilizing and stocking ponds provides time for zooplankton populations to develop in the ponds. More than one-third of operations in the East region (37.5 percent) fertilized 15 or more days before stocking, compared with only 7.6 percent of operations in the West region.

b. For operations that fertilized fry/fingerling ponds in 2009, percentage of operations by number of days between beginning fertilization and stocking ponds, and by region:

	Percent Operations					
	Region					
	East		**West**		**All Operations**	
Days Between Beginning Fertilization and Stocking	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Fewer than 7	25.0	(1.1)	23.0	(1.8)	23.7	(1.2)
7 to 14	37.5	(1.2)	69.4	(2.0)	57.3	(1.4)
15 or more	37.5	(1.2)	7.6	(1.2)	19.0	(1.0)
Total	100.0		100.0		100.0	

For Operations that Fertilized Fry/Fingerling Ponds in 2009, Percentage of Operations by Number of Days Between Beginning Fertilization and Stocking Ponds, and by Region



Of operations that fertilized fry/fingerling ponds in 2009, about three-fourths (75.1 percent) used inorganic fertilizers or a combination of organic and inorganic fertilizers. Measuring and controlling the amount of nutrients being put into the pond is easier with inorganic fertilizers than organic fertilizers.

c. For operations that fertilized fry/fingerling ponds in 2009, percentage of operations by primary fertilizer used in the ponds, and by region:

	Percent Operations					
	Region					
	East		West		All Operations	
Primary Fertilizer Used	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Organic (e.g., cottonseed, fish feed)	27.3	(0.9)	23.0	(1.9)	24.9	(1.1)
Inorganic (e.g., urea, ammonium nitrate)	27.3	(0.9)	61.7	(2.1)	46.0	(1.3)
Combination of organic/inorganic fertilizers	45.4	(1.1)	15.3	(1.5)	29.1	(1.0)
Total	100.0		100.0		100.0	

8. Insect control in fry/fingerling ponds

Newly stocked fry are small and vulnerable to predatory aquatic insects. Controlling aquatic insects can reduce predation losses. A higher percentage of operations in the West region (58.7 percent) than in the East region (26.1 percent) treated ponds to control insects.

Percentage of operations that treated ponds to control insects after filling the fry/fingerling ponds with water in 2009, and by region:

Percent Operations					
Region					
East		West		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
26.1	(0.9)	58.7	(1.4)	44.3	(0.9)

9. 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. Average chloride levels during summer months exceeded 100 ppm in both the East and West regions.

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

Operation Average Chloride Level (ppm)					
Region					
East		**West**		**All Operations**	
Average	**Std. Error**	**Average**	**Std. Error**	**Average**	**Std. Error**
194.6	(6.8)	138.1	(7.3)	153.5	(5.7)

10. Salt use

If chloride levels in ponds are not sufficiently high, fingerling producers can add salt. Almost one-third of fingerling operations (30.9 percent) routinely added salt to fry/fingerling ponds during 2009, and 7.7 percent added salt in response to health problems. A higher percentage of fingerling operations in the East region than in the West region did not add salt to ponds during 2009 (78.3 and 48.2 percent, respectively).

Percentage of fingerling operations by use of salt in fry/fingerling 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	13.0	(0.8)	44.9	(1.5)	30.9	(0.9)
Added salt only in response to health problems	8.7	(0.4)	6.9	(0.8)	7.7	(0.5)
Did not add salt	78.3	(0.8)	48.2	(1.5)	61.4	(0.9)
Total	100.0		100.0		100.0	

H. Fingerling Pond Management after Stocking

1. Fry feed type

During 2009, almost all fingerling operations (94.2 percent) provided some feed to fry before they accepted larger floating feeds. Fines or meals and crumbles were the primary feeds used by the highest percentages of operations (38.4 and 25.1 percent, respectively).

Percentage of fingerling operations by primary type of feed provided in 2009 to fry before the acceptance of floating feeds:

Feed Type	Percent Operations	Std. Error
Fines or meals	38.4	(0.9)
Crumbles	25.1	(0.9)
Pellets	11.5	(0.6)
Fry starter	17.3	(0.6)
Other	1.9	(0.1)
No feed provided	5.8	(0.5)
Total	100.0	

2. Fry feeding frequency

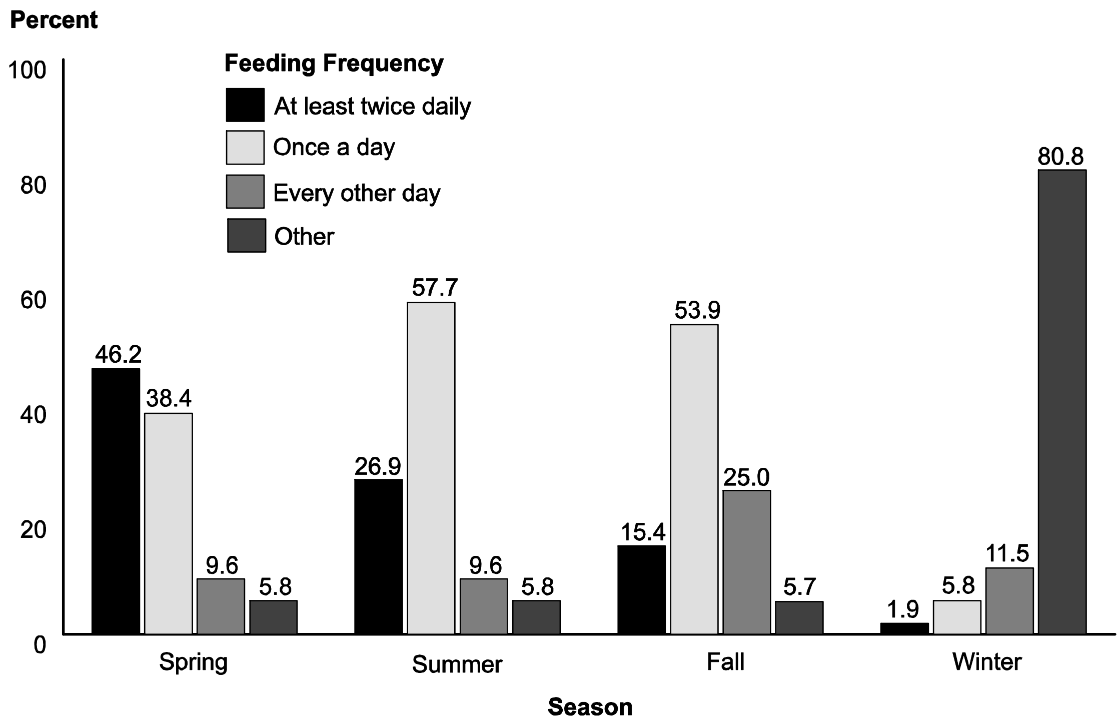
Fingerling feeding frequency during 2009 varied by season. In spring, when fry were present, almost one-half of operations (46.2 percent) usually fed fry at least twice a day. This percentage dropped to 26.9 percent of operations in the summer, 15.4 percent in the fall, and 1.9 percent in the winter. In the summer and fall, the highest percentages of operations usually fed once a day (57.7 and 53.9 percent, respectively).

Of operations that reported an “other” feeding frequency for winter (80.8 percent), about two-thirds either fed irregularly as needed or did not feed. Most of the remaining one-third fed between one time per week and one time per month.

Percentage of fingerling operations by how often fry/fingerlings were usually fed in each season during 2009:

	Percent Operations							
	Season							
	Spring		**Summer**		**Fall**		**Winter**	
Feeding Frequency	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
At least twice daily	46.2	(0.9)	26.9	(0.8)	15.4	(0.7)	1.9	(0.3)
Once a day	38.4	(0.9)	57.7	(0.9)	53.9	(0.9)	5.8	(0.3)
Every other day	9.6	(0.5)	9.6	(0.6)	25.0	(0.8)	11.5	(0.5)
Other	5.8	(0.4)	5.8	(0.5)	5.7	(0.3)	80.8	(0.6)
Total	100.0		100.0		100.0		100.0	

Percentage of Fingerling Operations by How Often Fry/Fingerlings Were Usually Fed in Each Season During 2009



3. Protein level of feed

Intermediate-sized fingerlings (greater than 2 inches but less than 5 inches long) can be fed higher protein levels (35 percent protein). Protein levels of 28 to 32 percent are suitable for fingerlings less than 2 inches or greater than 5 inches in length.

Almost one-half of fingerling operations (49.1 percent) primarily fed floating feed with 32 percent protein to fry/fingerlings in 2009. Roughly equal percentages of fingerling operations primarily fed floating feed with 28 percent protein, 35 percent protein, or “other” protein levels. The “other” protein levels specified by respondents were primarily a combination of 36 and 38 percent protein.

Percentage of fingerling operations by percentage of protein in the floating feed primarily fed to fry/fingerlings in 2009:

Percent Protein	Percent Operations	Std. Error
28	15.7	(0.7)
32	49.1	(0.9)
35	17.6	(0.7)
Other	17.6	(0.6)
Total	100.0	

4. Primary method for monitoring dissolved oxygen

Hand monitors were the only primary method fingerling operations used to measure dissolved oxygen in fry/fingerling ponds during 2009. Of all fingerling operations, 73.1 percent primarily used hand monitors to measure dissolved oxygen, while 26.9 percent did not regularly monitor dissolved oxygen levels. A higher percentage of small fingerling operations than large operations did not regularly monitor dissolved oxygen levels (35.7 and 16.6 percent, respectively).

Percentage of fingerling operations by primary method used to regularly monitor dissolved oxygen in fry/fingerling ponds during 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Monitoring Method	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Automated sensors	0.0	(--)	0.0	(--)	0.0	(--)
Hand monitor (oxygen meter)	64.3	(1.0)	83.4	(0.8)	73.1	(0.7)
Other	0.0	(--)	0.0	(--)	0.0	(--)
Did not regularly monitor dissolved oxygen levels	35.7	(1.0)	16.6	(0.8)	26.9	(0.7)
Total	100.0		100.0		100.0	

5. Horsepower of fixed aeration

Recommended fixed aeration rates range from 2 to 2.5 horsepower (hp) per acre, but the value varies with many factors, including stocking density and feeding rate. Overall, fingerling operations used 1.6 hp of fixed aeration per surface acre of fry/fingerling ponds. The average horsepower of fixed aeration was higher for large operations than for small operations (1.8 and 1.5 hp/acre, respectively).

Average horsepower of fixed aeration per surface acre of fry/fingerling ponds, and by size of operation:

Average Horsepower					
Size of Operation (Number of Fry Stocked)					
Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Average	**Std. Error**	**Average**	**Std. Error**	**Average**	**Std. Error**
1.5	(0.0)	1.8	(0.0)	1.6	(0.0)

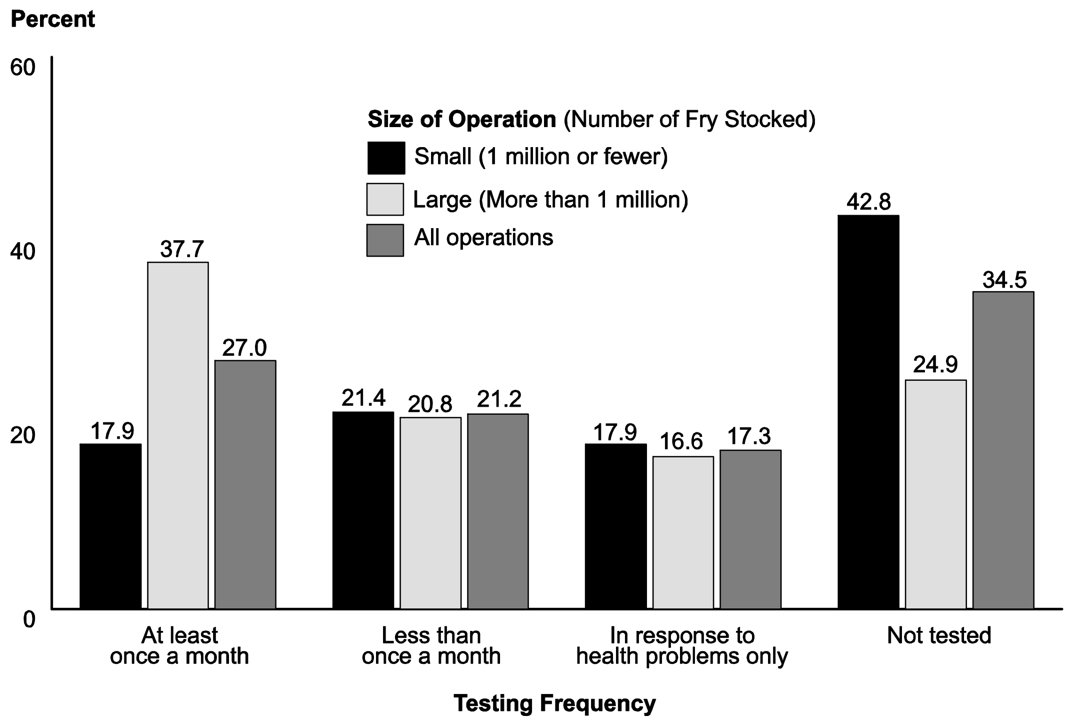
6. Water quality testing

More than one-fourth of fingerling operations (27.0 percent) tested water quality in fry/fingerling ponds at least once a month in 2009. A lower percentage of small operations (17.9 percent) tested water quality at least once a month compared with large operations (37.7 percent). A higher percentage of small operations (42.8 percent) than large operations (24.9 percent) did not test water quality in fry/fingerling ponds in 2009.

a. Percentage of fingerling operations by frequency of water quality testing in fry/fingerling ponds in 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Testing Frequency	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
At least once a month	17.9	(0.7)	37.7	(1.6)	27.0	(0.9)
Less than once a month	21.4	(1.0)	20.8	(1.3)	21.2	(0.8)
In response to health problems only	17.9	(0.8)	16.6	(1.2)	17.3	(0.7)
Not tested	42.8	(1.1)	24.9	(1.1)	34.5	(0.8)
Total	100.0		100.0		100.0	

Percentage of Fingerling Operations by Frequency of Water Quality Testing in Fry/Fingerling Ponds in 2009, and by Size of Operation



Of operations that tested water quality in fingerling ponds at least once a month in 2009, a higher percentage tested at least once a month for ammonia (92.4 percent) than for chloride (78.4 percent) or nitrite (85.8 percent).

b. For operations that tested water quality in fry/fingerling ponds at least once a month in 2009, percentage of operations by number of times per month fry/fingerling ponds were tested for specific chemicals:

	Percent Operations					
	Chemicals Tested					
	Ammonia		Chloride		Nitrite	
Times per Month	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
0	7.6	(0.6)	21.6	(1.4)	14.2	(0.8)
1 to 2	46.0	(2.1)	49.9	(2.0)	35.6	(1.8)
3 to 4	46.4	(2.1)	28.5	(1.9)	50.2	(2.0)
Total	100.0		100.0		100.0	

I. Fingerling Health Issues

1. Vaccination for enteric septicemia of catfish (ESC)

Only 3.9 percent of fingerling operations vaccinated any fry for enteric septicemia of catfish (ESC) in 2009. None of the small fingerling operations or East region operations vaccinated fry for ESC.

a. Percentage of fingerling operations that vaccinated any fry against ESC in 2009, and by size of operation:

Percent Operations					
Size of Operation (Number of Fry Stocked)					
Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Percent	**Std. Error**	**Percent**	**Std. Error**	**Percent**	**Std. Error**
0.0	(--)	8.5	(0.9)	3.9	(0.4)

b. Percentage of fingerling operations that vaccinated any fry against ESC in 2009, by region:

Percent Operations			
Region			
East		**West**	
Percent	**Std. Error**	**Percent**	**Std. Error**
0.0	(--)	7.0	(0.8)

On operations that vaccinated any fry against ESC in 2009, 49.1 percent of fry were vaccinated. The percentage of fry vaccinated for all fingerling operations was 12.3 percent.

c. For fingerling operations that vaccinated any fry against ESC in 2009, percentage of fry vaccinated:

Percent Fry	Std. Error
49.1	(1.2)

d. For all fingerling operations, percentage of fry vaccinated against ESC:

Percent Fry	Std. Error
12.3	(9.6)

2. Average age of fry at ESC vaccination

Fry should be at least 7 days old before they are vaccinated for ESC. On average, fry were vaccinated 15.1 days after hatching.

For fingerling operations that vaccinated any fry against ESC in 2009, operation average number of days after hatching that fry typically were vaccinated:

Operation Average Days	Std. Error
15.1	(0.6)

Photo courtesy of David Heiken, Agricultural Research Service

3. ESC vaccination of fry intended for on-farm growout

All of the fingerling operations that vaccinated any fry against ESC vaccinated a portion of the fry that were intended for growout on their operations.

For fingerling operations that vaccinated any fry against ESC in 2009, percentage of operations by vaccination practice for fry **intended for growout** on the operation:

Vaccination Practice	Percent Operations	Std. Error
All fry intended for growout on operation	0.0	(--)
A portion of the fry	100.0	(0.0)
None of the fry	0.0	(--)
No fry growout on this operation	0.0	(--)
Total	100.0	

4. ESC vaccination of fry intended for sale as fingerlings

All of the fingerling operations that vaccinated any fry against ESC vaccinated a portion of the fry that were intended for sale as fingerlings, but only on customer request.

For fingerling operations that vaccinated any fry against ESC in 2009, percentage of operations by vaccination practice for fry **intended for sale** as fingerlings:

Vaccination Practice	Percent Operations	Std. Error
All fry intended for sale	0.0	(--)
A portion of the fry for sale based on customer request	100.0	(0.0)
A portion of the fry for sale regardless of customer request	0.0	(--)
None of the fry intended for sale	0.0	(--)
No fry for sale	0.0	(--)
Total	100.0	

5. Outbreaks of ESC in ponds containing vaccinated fingerlings

Vaccination does not necessarily protect all vaccinated individuals against disease. All fingerling operations that vaccinated fry against ESC experienced outbreaks of ESC in ponds with vaccinated fingerlings. Additionally, all of these operations fed medicated feed to vaccinated fish in ponds and still had outbreaks.

a. For fingerling operations that vaccinated any fry against ESC in 2009, percentage of operations that had any outbreaks of ESC that year in ponds that contained fingerlings vaccinated for ESC:

Percent Operations	Std. Error
100.0	(0.0)

b. For fingerling operations that had any outbreaks of ESC in ponds that contained fingerlings vaccinated for ESC in 2009, percentage of operations that gave medicated feed to those vaccinated fish:

Percent Operations	Std. Error
100.0	(0.0)

Of operations that vaccinated any fry against ESC, about one-half of the operations (51.0 percent) said survival of fingerlings was better in ponds with vaccinated fish than in ponds without vaccinated fish, while the other one-half (49.0 percent) said survival was the same. Growth was reported to be the same regardless of vaccination status.

c. For fingerling operations that vaccinated any fry against ESC in 2009, percentage of operations by performance (survival and growth rates) of fingerlings in ponds with ESC-vaccinated fish compared with performance of fingerlings in ponds without ESC-vaccinated fish:

	Percent Operations								
	Performance Measure								
	Better		Same		Worse		Don't Know		
Rate	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Total
Survival	51.0	(5.6)	49.0	(5.6)	0.0	(--)	0.0	(--)	100.0
Growth	0.0	(--)	100.0	(0.0)	0.0	(--)	0.0	(--)	100.0

6. Columnaris vaccination

The columnaris vaccine became available for use by the catfish industry in 2009. Overall, 9.7 percent of fingerling operations vaccinated at least some fry for columnaris in 2009, with a higher percentage of large operations (16.8 percent) than small operations (3.6 percent) vaccinating fry. The percentage of operations vaccinating fry for columnaris did not differ by region.

a. Percentage of fingerling operations that vaccinated any fry against columnaris in 2009, and by size of operation:

Percent Operations					
Size of Operation (Number of Fry Stocked)					
Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Percent	**Std. Error**	**Percent**	**Std. Error**	**Percent**	**Std. Error**
3.6	(0.3)	16.8	(1.1)	9.7	(0.6)

b. Percentage of fingerling operations that vaccinated any fry against columnaris in 2009, by region:

Percent Operations			
Region			
East		**West**	
Percent	**Std. Error**	**Percent**	**Std. Error**
8.7	(0.4)	10.5	(0.9)

On operations that vaccinated any fry against columnaris in 2009, 39.6 percent of fry were vaccinated. For all fingerling operations, 17.0 percent of fry were vaccinated.

c. For fingerling operations that vaccinated any fry against columnaris in 2009, percentage of fry vaccinated, and by size of operation:

Percent Fry					
Size of Operation (Number of Fry Stocked)					
Small (1 Million or Fewer)		Large (More than 1 Million)		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
40.0	(0.0)	39.6	(8.4)	39.6	(8.3)

d. For all fingerling operations, percentage of fry vaccinated against columnaris, and by size of operation:

Percent Fry					
Size of Operation (Number of Fry Stocked)					
Small (1 Million or Fewer)		Large (More than 1 Million)		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
1.6	(1.6)	17.3	(8.7)	17.0	(8.6)

7. Average age of fry at columnaris vaccination

Fry should be at least 7 days old before they are vaccinated for columnaris, and some references recommend 10 days. On average, fry were vaccinated 20.6 days after hatching.

For fingerling operations that vaccinated any fry against columnaris in 2009, operation average number of days after hatching that fry typically were vaccinated:

Operation Average Days	Std. Error
20.6	(0.8)

8. Columnaris vaccination of fry intended for on-farm growout

Of fingerling operations that vaccinated fry for columnaris in 2009, about three-fifths of operations (60.3 percent) routinely vaccinated a portion of the fry that were intended for growout on their operations. About one-fifth (19.8 percent) routinely vaccinated all the fry intended for growout on their operations, and the remaining one-fifth (19.9 percent) did not grow out fry on the operation. Consequently, of fingerling operations that vaccinated for columnaris in 2009 and that grew out fry on the operation, all routinely vaccinated at least some of the fry intended for growout on their operations.

For fingerling operations that vaccinated any fry against columnaris in 2009, percentage of operations by routine vaccination practice for fry **intended for growout** on the operation:

Vaccination Practice	Percent Operations	Std. Error
All fry intended for growout on operation	19.8	(1.6)
A portion of the fry	60.3	(2.9)
None of the fry	0.0	(--)
No fry growout on this operation	19.9	(2.9)
Total	100.0	

9. Columnaris vaccination of fry intended for sale as fingerlings

Of fingerling operations that vaccinated for columnaris in 2009, more than four-fifths (80.2 percent) vaccinated at least some of the fry that were intended for sale as fingerlings. About two-fifths of operations (40.5 percent) vaccinated a portion of their fry intended for sale based on customer request, while one-fifth (19.8 percent) vaccinated a portion of the fry intended for sale regardless of customer request. Another one-fifth of vaccinating operations vaccinated all fry intended for sale (19.9 percent).

For fingerling operations that vaccinated any fry against columnaris in 2009, percentage of operations by vaccination practice for fry **intended for sale** as fingerlings:

Vaccination Practice	Percent Operations	Std. Error
All fry intended for sale	19.9	(2.9)
A portion of the fry for sale based on customer request	40.5	(3.2)
A portion of the fry for sale regardless of customer request	19.8	(1.6)
None of the fry intended for sale	19.8	(1.6)
No fry for sale	0.0	(--)
Total	100.0	

10. Outbreaks of columnaris in ponds containing vaccinated fingerlings

Columnaris outbreaks occurred in ponds containing vaccinated fingerlings on 40.5 percent of operations that had vaccinated fry in 2009. All operations that experienced columnaris outbreaks in ponds containing vaccinated fingerlings fed medicated feed to fish in those ponds.

a. For fingerling operations that vaccinated any fry against columnaris in 2009, percentage of operations that had any outbreaks of columnaris in ponds that contained fingerlings vaccinated for columnaris:

Percent Operations	Std. Error
40.5	(2.9)

b. For fingerling operations that had any outbreaks of columnaris in ponds that contained fingerlings vaccinated for columnaris in 2009, percentage of operations that gave medicated feed to those vaccinated fish:

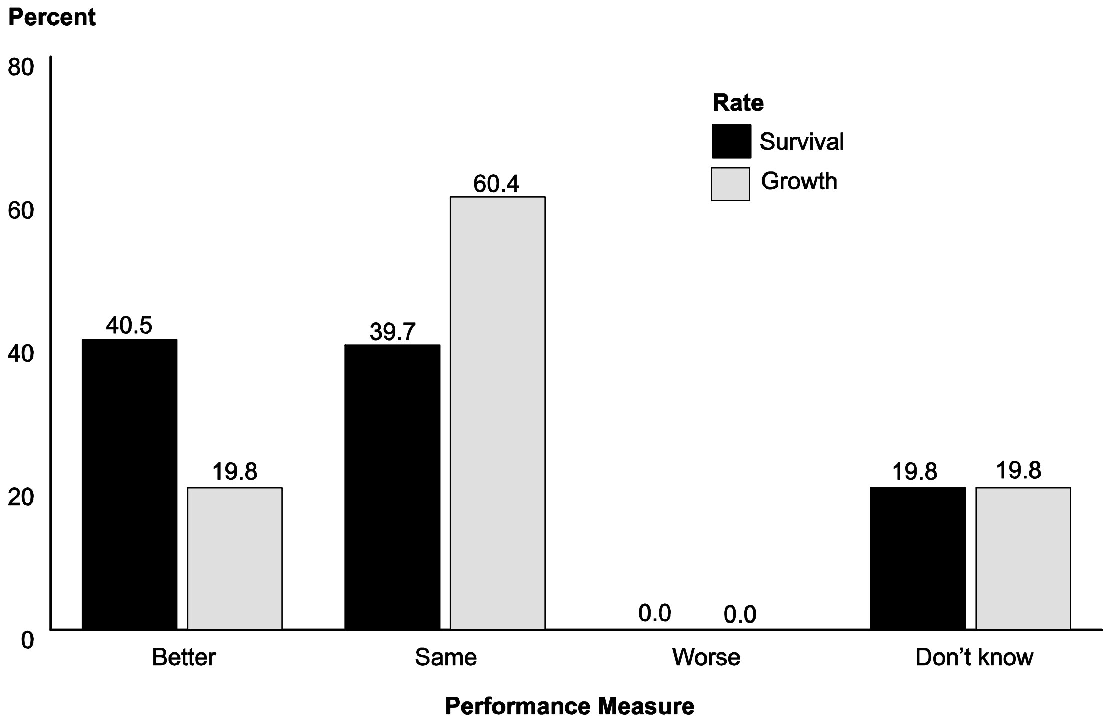
Percent Operations	Std. Error
100.0	(0.0)

Of operations that vaccinated any fry against columnaris in 2009, 40.5 percent said that survival was better in ponds with vaccinated fingerlings than in ponds without vaccinated fingerlings. A similar percentage of operations (39.7 percent) responded that survival was about the same. A majority of operations (60.4 percent) indicated that fingerlings in ponds with vaccinated fish and fingerlings in ponds without vaccinated fish had about the same growth rate. None of the operations responded that survival or growth was worse in ponds with vaccinated fingerlings than in ponds without vaccinated fingerlings. One-fifth of operations did not know how the performance of vaccinated fry compared with that of unvaccinated fry.

c. For fingerling operations that vaccinated any fry against columnaris in 2009, percentage of operations by performance (survival and growth rates) of fingerlings in ponds with columnaris-vaccinated fish compared with performance of fingerlings in ponds without columnaris-vaccinated fish:

	Percent Operations								
	Performance Measure								
	Better		Same		Worse		Don't Know		
Rate	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Total
Survival	40.5	(2.9)	39.7	(3.1)	0.0	(--)	19.8	(1.6)	100.0
Growth	19.8	(1.6)	60.4	(2.5)	0.0	(--)	19.8	(1.6)	100.0

For Fingerling Operations that Vaccinated any Fry Against Columnaris in 2009, Percentage of Operations by Performance (Survival and Growth Rates) of Fingerlings in Ponds with Columnaris-vaccinated Fish Compared with Performance of Fingerlings in Ponds Without Columnaris-vaccinated Fish



11. Survival of stocked fry until harvest

The operation average percent survival of fry stocked in 2009 until harvest as fingerlings was 66.7 percent. The percent survival of fry (weighted by the number of fry stocked in 2009) was similar (65.1 percent) to the operation average percent survival. Similarly, operation averages and fry averages by fingerling operation size were similar. These results indicate a fairly uniform fry survival rate across the breadth of fingerling operation sizes.

For stocked fry during 2009, operation average and fry average (weighted by the number of fry stocked in 2009) percent survival until harvest as fingerlings, and by size of operation:

	Average Percent Stocked Fry					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Survival	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
Operation average	64.4	(0.3)	69.4	(0.5)	66.7	(0.3)
Fry average	69.2	(4.2)	65.0	(4.4)	65.1	(4.4)

12. Causes of fingerling loss

Almost three-fourths of fingerling operations (71.1 percent) lost at least some fry/fingerlings in 2009 to unknown causes. With large numbers of fry being stocked in ponds and not readily visible, it can be very difficult to observe losses and identify some causes of fish loss. Almost one-half of operations (48.0 percent) lost fry/fingerlings to predation. Trematodes and gill parasites caused losses on a relatively low percentage of operations (1.9 percent each).

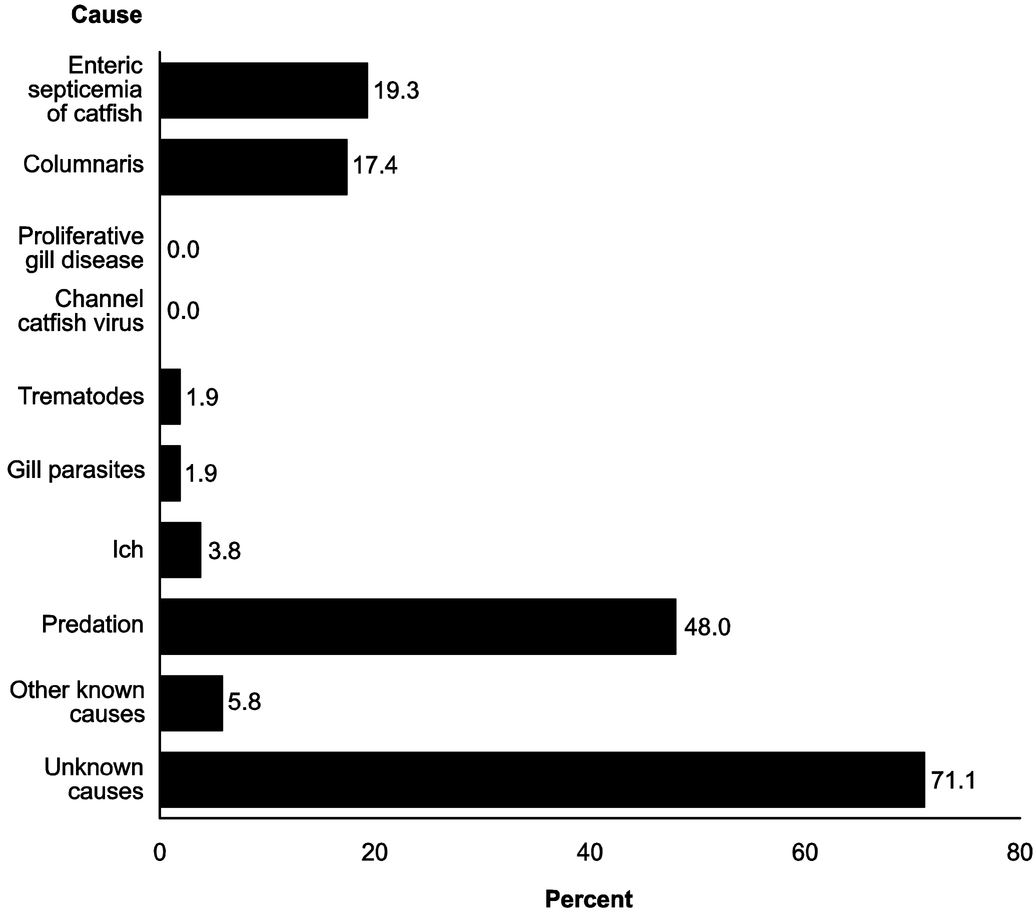
No losses were attributed to channel catfish virus (CCV) infection, which is surprising because CCV is a disease of young fish. On 38.5 percent of all fingerling operations, however, all fry/fingerling loss was attributed to unknown causes (data not shown).

A higher percentage of small fingerling operations than large operations lost fry/fingerlings to predation (57.2 and 37.4 percent, respectively). Conversely, a higher percentage of large operations lost fry/fingerlings to ESC (29.3 percent) and columnaris (21.0 percent) than did small operations (10.7 and 14.3 percent, respectively).

a. Percentage of fingerling operations that lost any fry/fingerlings to the following causes in 2009, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Cause	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Enteric septicemia of catfish (ESC, hole-in-head disease)	10.7	(0.8)	29.3	(1.5)	19.3	(0.8)
Columnaris	14.3	(0.7)	21.0	(1.3)	17.4	(0.7)
Proliferative gill disease (PGD, hamburger gill disease)	0.0	(--)	0.0	(--)	0.0	(--)
Channel catfish virus (CCV)	0.0	(--)	0.0	(--)	0.0	(--)
Trematodes	3.6	(0.3)	0.0	(--)	1.9	(0.1)
Gill parasites	3.6	(0.3)	0.0	(--)	1.9	(0.1)
Ich	7.1	(0.4)	0.0	(--)	3.8	(0.2)
Predation	57.2	(1.1)	37.4	(1.4)	48.0	(0.9)
Other known causes	3.6	(0.3)	8.4	(1.0)	5.8	(0.5)
Unknown causes	75.0	(1.0)	66.6	(1.4)	71.1	(0.8)

Percentage of Fingerling Operations that Lost any Fry/Fingerlings to the Following Causes in 2009



A much higher percentage of fingerling operations in the East region lost fry/fingerlings to predation than did operations in the West region (69.6 and 31.0 percent, respectively). ESC caused losses on 27.7 percent of operations in the West region compared with 8.7 percent in the East region. Conversely, columnaris caused losses on 21.7 percent of operations in the East region compared with 13.9 percent in the West region.

b. Percentage of fingerling operations that lost any fry/fingerlings to the following causes in 2009, by region:

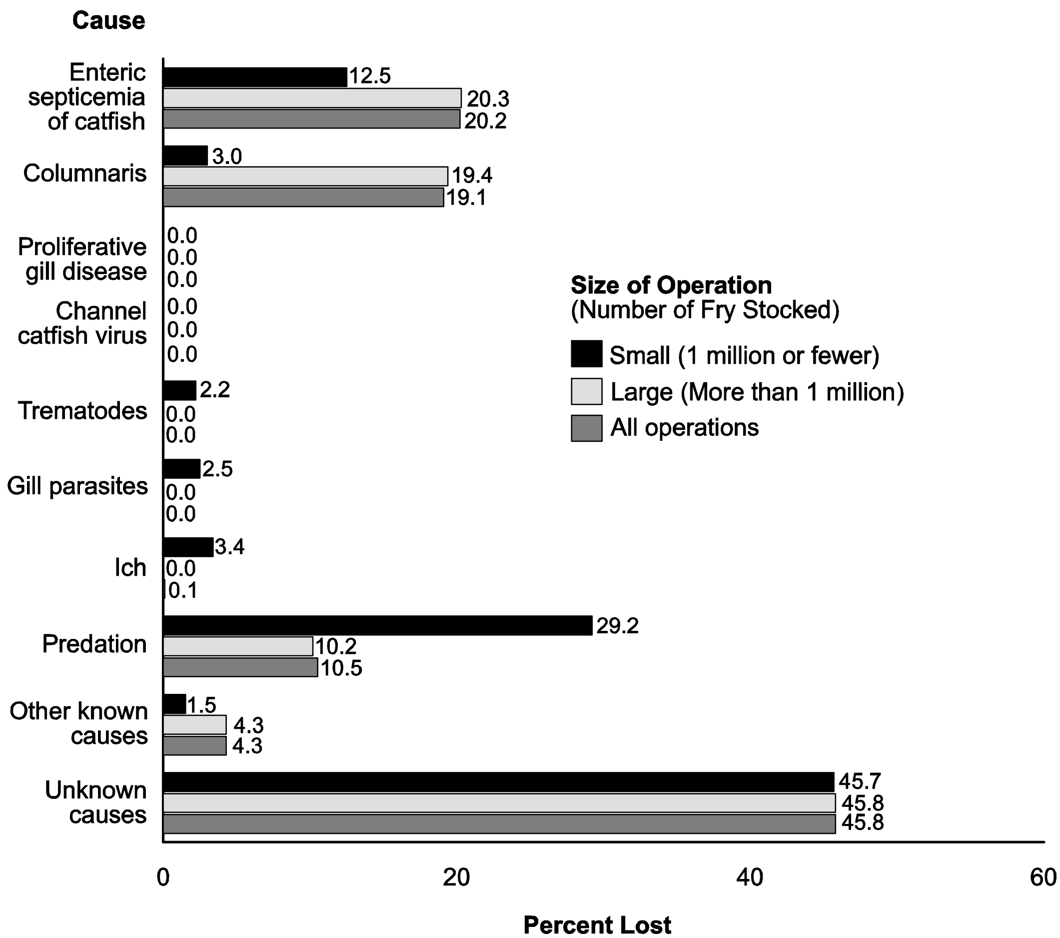
	Percent Operations			
	Region			
	East		West	
Cause	Percent	Std. Error	Percent	Std. Error
Enteric septicemia of catfish (ESC, hole-in-head disease)	8.7	(0.7)	27.7	(1.3)
Columnaris	21.7	(0.8)	13.9	(1.1)
Proliferative gill disease (PGD, hamburger gill disease)	0.0	(--)	0.0	(--)
Channel catfish virus (CCV)	0.0	(--)	0.0	(--)
Trematodes	4.3	(0.3)	0.0	(--)
Gill parasites	4.3	(0.3)	0.0	(--)
Ich	8.7	(0.4)	0.0	(--)
Predation	69.6	(0.9)	31.0	(1.3)
Other known causes	4.3	(0.3)	6.9	(0.8)
Unknown causes	65.2	(1.0)	75.7	(1.3)

The percentages of fry/fingerlings lost to specific causes present a much different picture than the percentages of operations that had losses due to specific causes. Although predation was observed on a high percentage of operations, only 10.5 percent of overall losses were attributed to that cause. The highest percentage of fry/fingerling loss (45.8 percent) was attributed to unknown causes. Two bacterial diseases, ESC and columnaris, combined to represent 39.3 percent of all fry/fingerling loss. Variability associated with these estimates of fry lost by cause makes it difficult to identify important differences in loss by operation size or region.

c. Percentage of fry/fingerlings (weighted by the number of fry stocked in 2009) lost to the following causes, and by size of operation:

	Percent Fry/Fingerlings Lost					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Cause	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Enteric septicemia of catfish (ESC, hole-in-head disease)	12.5	(9.4)	20.3	(11.3)	20.2	(11.2)
Columnaris	3.0	(1.6)	19.4	(11.5)	19.1	(11.4)
Proliferative gill disease (PGD, hamburger gill disease)	0.0	(--)	0.0	(--)	0.0	(--)
Channel catfish virus (CCV)	0.0	(--)	0.0	(--)	0.0	(--)
Trematodes	2.2	(2.2)	0.0	(--)	0.0	(0.0)
Gill parasites	2.5	(2.4)	0.0	(--)	0.0	(0.0)
Ich	3.4	(2.3)	0.0	(--)	0.1	(0.0)
Predation	29.2	(11.3)	10.2	(7.4)	10.5	(7.3)
Other known causes	1.5	(1.5)	4.3	(3.6)	4.3	(3.5)
Unknown causes	45.7	(13.0)	45.8	(18.4)	45.8	(18.2)
Total	100.0		100.0		100.0	

Percentage of Fry/Fingerlings (Weighted by the Number of Fry Stocked in 2009) Lost to the Following Causes, and by Size of Operation



d. Percentage of fry/fingerlings (weighted by the number of fingerlings stocked in 2009) lost to the following causes, by region:

	Percent Fry/Fingerling Lost			
	Region			
	East		West	
Cause	Percent	Std. Error	Percent	Std. Error
Enteric septicemia of catfish (ESC, hole-in-head disease)	12.6	(8.8)	20.4	(11.4)
Columnaris	18.7	(10.2)	19.1	(11.7)
Proliferative gill disease (PGD, hamburger gill disease)	0.0	(--)	0.0	(--)
Channel catfish virus (CCV)	0.0	(--)	0.0	(--)
Trematodes	1.5	(1.5)	0.0	(--)
Gill parasites	1.6	(1.7)	0.0	(--)
Ich	2.3	(1.7)	0.0	(--)
Predation	38.7	(10.3)	9.8	(7.4)
Other known causes	1.0	(1.0)	4.4	(3.6)
Unknown causes	23.6	(13.2)	46.3	(18.7)
Total	100.0		100.0	

13. Primary treatment for ESC outbreaks

As reported above (table H.12.a), about one-fifth of all fingerling operations (19.3 percent) lost some fry stocked in 2009 to ESC. Recent research suggests that feeding fish may increase mortality by increasing oral exposure to the pathogen, so some treatment approaches focus on feed type and feeding frequency.

When all operations were asked about their primary treatment for fry/fingerlings with ESC, about three-fifths of operations (59.6 percent; data not shown) reported that they had had no ESC outbreaks. For the 40.4 percent of operations (data not shown) that reported a primary treatment for fry/fingerlings with ESC, the highest percentage (66.7 percent) used medicated feed as the primary treatment for ESC. Another 28.5 percent of operations took fish off feed as the primary treatment for ESC.

For fingerling operations reporting a primary treatment for fry/fingerlings with ESC, percentage of operations by treatment:

Primary Treatment	Percent Operations	Std. Error
Medicated feed	66.7	(1.5)
Regular feed on alternate days (reduce feed)	0.0	(--)
Take off feed	28.5	(1.5)
Other	4.7	(0.7)
Total	100.0	

14. Laboratory diagnosis

Submitting samples to a diagnostic laboratory can help producers diagnose disease and identify potential remedial actions. Many producers, however, might have experience in identifying disease problems or think that diagnostic information will not help them choose a course of action.

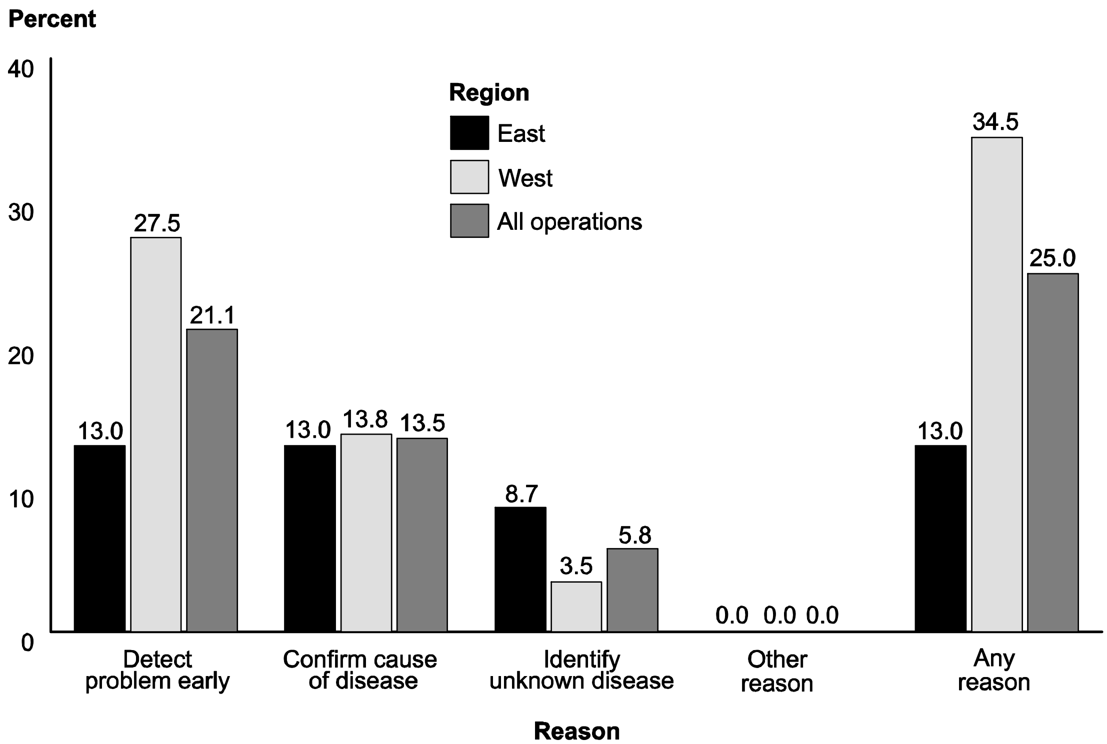
Only one-fourth of fingerling producers (25.0 percent) submitted any fingerling samples to a diagnostic laboratory, although the percentage that submitted a sample was higher in the West region than in the East region (34.5 and 13.0 percent, respectively).

The reasons for submitting samples cited by the highest percentages of operations were detecting a problem early (21.1 percent) and confirming a cause of disease (13.5 percent).

Percentage of fingerling operations that submitted any fingerling samples to a diagnostic laboratory, 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	13.0	(0.8)	27.5	(1.3)	21.1	(0.8)
Confirm cause of disease	13.0	(0.8)	13.8	(1.1)	13.5	(0.7)
Identify unknown disease	8.7	(0.4)	3.5	(0.6)	5.8	(0.4)
Other reason	0.0	(--)	0.0	(--)	0.0	(--)
Any reason	13.0	(0.8)	34.5	(1.4)	25.0	(0.9)

Percentage of Fingerling Operations that Submitted any Fingerling Samples to a Diagnostic Laboratory, by Reason for Submission and by Region



15. Use of medicated feed

Antimicrobial use in animal agriculture currently is receiving much attention. In the catfish industry, medicated feed is used to treat disease problems.

In 2009, 28.9 percent of fingerling operations fed medicated feed to fry. A slightly higher percentage of large operations than small operations used medicated feed (33.5 and 25.0 percent, respectively).

a. Percentage of fingerling operations that fed medicated feed to fry in 2009, and by size of operation:

Percent Operations					
Size of Operation (Number of Fry Stocked)					
Small (1 Million or Fewer)		Large (More than 1 Million)		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
25.0	(0.9)	33.5	(1.5)	28.9	(0.8)

Terramycin®, Romet®, and Aquaflor® are all approved by the Food and Drug Administration for use in catfish feed. Aquaflor is the newest antimicrobial available for use on fingerlings and is the only antimicrobial approved for treatment of both ESC and columnaris, the two most important bacterial diseases of catfish.

Of operations that fed medicated feed in 2009, 60.2 percent fed Aquaflor, and a higher percentage of large operations used Aquaflor compared with small operations (75.2 and 42.9 percent, respectively). About one-fourth of operations (26.6 percent) used Romet.

b. For operations that fed medicated feed to fry/fingerlings in 2009, percentage of fingerling operations by type of medicated feed used, and by size of operation:

	Percent Operations					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Medicated Feed	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Terramycin®	28.5	(1.5)	0.0	(--)	14.2	(0.8)
Romet®	28.5	(1.5)	24.8	(2.1)	26.6	(1.3)
Aquaflor®	42.9	(2.2)	75.2	(2.0)	60.2	(1.5)

Operations that fed Aquaflor to fry/fingerlings fed, on average, 26.2 tons of the medicated feed in 2009. Operations that fed the other medicated feeds to fry/fingerlings fed much smaller amounts in 2009: on average, 1.6 tons of Romet and 0.1 ton of Terramycin. Large operations fed 39.6 tons of Aquaflor during 2009, compared with 10.8 tons for small operations.

c. For operations that fed medicated feed to fry/fingerlings in 2009, average tons of medicated feed fed, and by size of operation:

	Average Tons					
	Size of Operation (Number of Fry Stocked)					
	Small (1 Million or Fewer)		**Large** (More than 1 Million)		**All Operations**	
Medicated Feed	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Terramycin®	0.3	(0.0)	0.0	(0.0)	0.1	(0.0)
Romet®	0.4	(0.0)	2.6	(0.4)	1.6	(0.2)
Aquaflor®	10.8	(1.2)	39.6	(3.4)	26.2	(2.0)

16. Snail control

Ramshorn snails are an intermediate host in the complex life cycle of the trematode *Bolbophorus* spp., an important parasite in the catfish industry. Snails must be present for the trematode to complete its life cycle in the catfish production environment, but the presence of snails does not necessarily mean that operations will have trematode problems. About one-fourth of fingerling operations (23.1 percent) reported having a problem with snails in fry/fingerling ponds in 2009.

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

Percent Operations					
Region					
East		**West**		**All Operations**	
Percent	**Std. Error**	**Percent**	**Std. Error**	**Percent**	**Std. Error**
26.1	(0.9)	20.7	(1.2)	23.1	(0.8)

All fingerling operations were asked if they used measures to control snails, regardless of whether they had reported a snail problem. No operations that did not report a snail problem used snail-control measures; consequently, the absence of snail problems was not directly due to control measures.

About one-fifth of fingerling operations (19.2 percent) used one or more measures to control snails. The highest percentages of operations used weed control (11.6 percent) and copper (11.5 percent) to control snails. Some operations with snail problems did not use any control measure, as evidenced by the percentage of operations with snail problems (23.1 percent, table I.16.a) compared with the percentage of operations that implemented any control measure (19.2 percent).

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

	Percent Operations					
	Region					
	East		West		All Operations	
Measure	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Lime	13.0	(0.5)	3.4	(0.6)	7.7	(0.4)
Copper	17.4	(0.8)	6.9	(0.8)	11.5	(0.6)
Weed control	8.7	(0.4)	13.8	(1.1)	11.6	(0.6)
Biological control	0.0	(--)	3.4	(0.6)	1.9	(0.3)
Any measure	21.7	(0.8)	17.3	(1.2)	19.2	(0.7)

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 agents, 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 from the NASS 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).

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 Foodsize-Fish 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
Grow out 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.