Prevalence of ROPS-Equipped Tractors in U.S. Aquaculture

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ABSTRACT. *Aquaculture involves the production of plant and animal products that are cultured in water. The principal freshwater fishes raised in the U.S. are catfish (raised mainly in ponds) and trout (raised mostly in concrete raceways), and the principal crustaceans grown are shrimp, crayfish, oysters, and clams. Tractors are used on aquaculture farms mostly in pond culture. Ponds present overturn hazards because of the slopes of levees, slippery conditions, and nighttime driving. Protection is afforded to the tractor operator when a rollover protective structure (ROPS) is attached to the tractor. The purpose of this study was to analyze and describe the prevalence of ROPS-equipped tractors on farms engaged in aquaculture in the U.S. The analysis concluded that 78% of tractors used in aquaculture were equipped with a ROPS, in contrast with the prevalence of ROPS at 49% for all of agriculture. Moreover, 91% of the tractors in the South used for aquaculture were equipped with a ROPS. The national sample for aquaculture included 75 farms and 137 tractors, which is small, but nonetheless, several hypotheses can be generated as a result of this descriptive study.*

Keywords. *Aquaculture, Fish farming, Rollover protective structures, ROPS, Tractors.*

The USDA conducted the first Census of Aquaculture in 1998 (USDA, 1998). Aquaculture is defined as the farming of fish, shellfish, aquatic plants, etc., in a natural or controlled environment. In the census, an aquaculture farm is defined as any place in which $1,000 or more of aquacultural products were raised and sold, or raised for restoration, conservation, or recreational purposes. Aquaculture farmers raise fish in ponds, tanks, flow-through raceways, closed recirculation tanks, cages, or a combination of these.

In Mississippi, five to eight deaths per year are related to pond maintenance. Although these pond-related deaths may or may not involve fish farming, they have accounted for about one-fourth of farm tractor and machinery-related deaths in that state each year. The primary cause of these pond-related deaths were tractor overturns on steep levees or soft pond banks, and no death regarding these overturns was recorded when a rollover protective structure (ROPS) was present and when a seat belt in the

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presence of a ROPS was in place and used (Willcutt, 2002). ROPS may be either of a post-frame type or built into the tractor cab (Myers, 2000). A cab-type ROPS is shown in figure 1, which protected the operator when this tractor overturned.

Overturns can occur when operating a tractor on pond banks or levees. These include mowing grass on pond banks, positioning paddlewheel aerators into ponds, and driving at night (Durborow, 1999). Another cause of overturns is the improper hitching of towed implements. Environmental conditions can also pose overturn hazards, such as slippery mud and erosion cuts in the tractor pathways on levees (Durborow, 1997). Aquaculture work is outdoors in all weather and varies in intensity depending on the time of year. It can involve regular weekend and evening duties and emergency callouts (Steeby et al., 1999).

Tractors are also used to build, repair, and refurbish fish ponds (Stone, 1999; Steeby et al., 1998). Ponds that leak or seep may require draining the pond and sealing the leak or pond surface. Sealing may involve disking the pond and embankment surfaces, using a fertilizer spreader to disperse chemical additives to promote clay dispersion into the pond bed, and disking the additives into the soil. The pond surface requires compaction, and a tractor may be used to tow a "sheepsfoot" roller. In addition, ponds require renovation every eight to ten years. The embankment slopes on these ponds are potential overturn hazards.

Of 4,309 farms engaged in aquaculture production in 2005, the operators' average hours of work per week was 30 hours. These hours ranged from an average of 15 hours per week on nine farms in Vermont to 53 hours per week on three farms in Delaware. However, as shown in table 1, the range of average hours worked per week by the farm operator in the ten states with the most farms ranged from 24 hours in North Carolina to 41 hours in Arkansas (USDA, 2005a).

Figure 1. Photograph of a tractor overturn into a pond (source: Mississippi State University, available at: www.cdc.gov/nasd/docs/d001701-d001800/d001756/d001756.html, accessed 8 April 2007).

Table 1. Number of workers engaged in animal aquaculture in states with more than 100 farms, 2005.[a]

State	Operator Work		Unpaid Workers		Paid Workers				Farms with Payroll
					≥150 days		<150 days		
	Farms	Hours/ week	Farms	No.	Farms	No.	Farms	No.	
Louisiana	873	31	430	721	158	565	492	1,255	555
Mississippi	403	36	127	216	177	938	169	438	242
Florida	359	31	158	262	95	478	143	315	195
Alabama	215	36	96	191	86	237	83	166	121
Arkansas	211	41	82	174	107	511	86	229	139
Washington	194	28	80	174	67	834	86	450	114
North Carolina	186	24	70	128	35	74	62	116	77
Massachusetts	157	25	71	116	12	49	59	174	64
Virginia	147	26	62	97	35	259	69	226	83
California	118	35	45	93	54	450	41	121	71
National total	4,309	30	1,935	3,623	1,105	5,653	1,789	4,866	2,276

[a] Source: 2005 Census of Aquaculture, USDA National Agricultural Statistics Service.

There were an average of 1.87 unpaid workers per farm, 5.12 paid workers employed for more than or equal to 150 days per year, 2.72 paid workers employed for less than 150 days, and 53% of the farms had a payroll. Counting the farm operator, unpaid workers, and paid employees, each farm had an average of 4.28 workers per farm in 2005.

In 2001 and again in 2004, the National Institute for Occupational Safety and Health (NIOSH) assisted by the USDA conducted the Occupational Injury Survey of Production Agriculture (OISPA). The OISPA was designed to estimate the frequency and types of occupational injuries occurring on farms in the U.S. In addition, the surveys collected information on an identical set of farm demographic, worker, and tractor variables. Variables included industry subsector farm type (including aquaculture), acreage, full-time or part-time principal operator status, U.S. geographical region, total hired adults, total resident youth working on the farm, total hired youth, total number of tractors, number of tractors with ROPS protection (post-frame and cab-type pooled), and annual value of sales.

The purpose of this article is to describe the presence of tractors and ROPS status on farms engaged in aquaculture. The findings that result from the NIOSH/USDA data are important to understanding which farm types and which cohorts of farmers are at greatest risk of injury from tractor overturns of non-ROPS tractors. These types of findings have direct implications for future surveillance, intervention, and policy research efforts.

Methods

The USDA National Agricultural Statistical Services (NASS) conducted the OISPA surveys for NIOSH. For these surveys, a farm was defined as any operation with $1,000 or more of gross agricultural production within a calendar year. The only farms excluded from the 2001 and 2004 OISPA surveys were very large swine confinement operations. Participation in OISPA surveys was voluntary. Sampling weights were calculated based on the number of farms responding within three broad "value of sales" categories (<$10,000, $10,000 to $99,999, and >$99,999) and nine geographical regions. Farm counts within the 27 strata were obtained from farm numbers published

by the USDA (2002, 2005b). Results were then combined into four major U.S. regions, as described below.

The two OISPA surveys provide information about the number of tractors on farms and the distribution of these tractors by ROPS status in 2001 and 2004. Data about the number of tractors on farms and their ROPS status can be cross-tabulated with the other farm variables to determine differences in the frequency and distribution of ROPS tractors by farm type, size, value of sales, and U.S. region. The variables collected in the 2001 and 2004 survey were identical and classified the farm by type, one of which was aquaculture. Each variable is defined below and was reported by the farm operator for the calendar year of the survey:

- Acreage by six categories (land and water areas combined), collapsed into two categories for this study:
  - ≤100 acres
  - 101 acres or more.
- Full-time or part-time farm operation as defined by the farm operator.
- Region code as defined by the U.S. Bureau of Census (states are identified by U.S. Postal Service abbreviations):
  - Northeast: CT, ME, MA, NH, NJ, NY, PA, RI, VT
  - Midwest: IL, IN, IA, KS, MN, MI, MO, OH, NE, ND, SD, WI
  - South: AL, AR, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV
  - West: AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, WY.
- Farm workers who worked on the farm during the calendar year of the survey, excluding contract labor:
  - Number of hired workers >19 years of age
  - Number of hired adolescents <20 years of age
  - Number of youth <20 years of age, who lived in the farm household and worked on the farm.
- Tractors used on the farm, excluding lawn tractors, antique or similar collectibles, and tractors not used on the farming operation:
  - Number of tractors in use on the farm
  - Number of tractors that had a ROPS or ROPS cab.
- Value of sales in three categories:
  - <$10,000
  - $10,000 to $99,000
  - ≥$100,000.

NIOSH has defined youth as those individuals less than 20 years of age. The analytical method is to determine the proportion of ROPS-equipped tractors on U.S. aquacultural farms and changes in these proportions when analyzed by each variable collected in the two surveys. For the analysis, the two datasets were pooled to provide a larger sample size. SAS was used as the analytical software. In addition, the data for two regions, Midwest and West, were combined because of small numbers in the results of certain variables.

This study was not aimed at extrapolating to the general population engaged in aquaculture. Rather, based on a nationwide survey by NASS, it was aimed at identifying patterns from which future research can be guided. In addition, two survey results were combined with 24 fish producers that responded to the 2001 survey and 51 pro-

ducers that responded in 2004. The possibility of double-counting respondents was unlikely since the total population numbered more than 4,000. Nevertheless, we compared the demographic data between both surveys to ensure that no double-counting occurred.

Results

The 2001 survey randomly sampled 12,873 farms, and the 2004 survey sampled 14,408 farms. Aquaculture was one of 15 industry subsectors for which these data were collected. Table 2 shows the data related to aquaculture from these two surveys from a pooled sample of 75 farms, which is small.

Table 3 shows that most of the farms that do not use tractors are located in the South, numbering an estimated 1,020, although the Northeast had the lowest percentage of the aquaculture farms, using 120 tractors (29.3%). This could be due to offshore operations in this region of the U.S. (e.g., salmon in net pens, and not land-based farming). Small farms, as measured by the value of sales (less than $10,000 per year), account for the highest estimated number of farms, followed by the largest farms ($100,000 annual sales or more). The largest operations also account for the majority of the aquaculture operations that report using tractors.

Of the 8,260 tractors used on aquacultural farms in the U.S., 77.8% were ROPS-equipped, as shown in figure 2. However, 90.7% of ROPS-equipped tractors in the South were reported as ROPS-equipped, whereas the tractors used on aquaculture farms in the other regions had ROPS-equipped percentages of only 37.4% in the Northeast and 52.8% in the Midwest and West.

The two NIOSH surveys collected information on three categories of workers on the farms, as shown in table 4, which excluded contracted employees. Farms on which hired workers more than 19 years of age were employed had an average of 91.3% of their tractors equipped with ROPS. Farms that employed workers less than 20 years of age averaged 77.8% of their tractors with ROPS. Finally, farms with resident workers who were less than 20 years of age reported an average of 72.6% of their tractors being equipped with ROPS.

Table 2. Aquaculture survey data from the 2001 and 2004 NIOSH OISPA surveys.

Year of Survey	Sample	Estimated Farms (95% CI)	Estimated Tractors (95% CI)	Estimated Farms with Tractors (95% CI)	Estimated Tractors with ROPS (95% CI)
2001	24	3290 (±1530)	2760 (±1800)	51.1% (±20.0%)	75.3% (±17.3%)
2004	51	5590 (±2030)	13760 (±6790)	73.3% (±12.1%)	78.7% (±11.2%)
Weighted average	--	4440 (±1170)	8260 (±3510)	65.1% (±15.3%)	77.8% (±13.3%)

Table 3. Number and percentage of aquaculture farms in four regions (Midwest and West combined) that reported tractor use, 2001 and 2004.

Tractor Use	Northeast (95% CI)	South (95% CI)	Midwest and West (95% CI)	Total (95% CI)
No tractors	290 (±140)	1020 (±680)	240 (±190)	1550 (±720)
With tractors	120 (±80)	1380 (±650)	1390 (±660)	2890 (±920)
Total	410 (±160)	2400 (±930)	1630 (±680)	4440 (±1170)

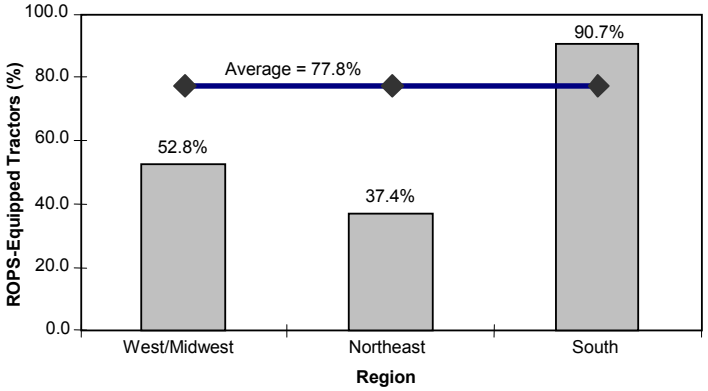

Figure 2. Percentage of ROPS-equipped tractors on aquaculture farms by region.

Table 5 shows the difference in ROPS prevalence between full-time and part-time aquaculture production operations. The prevalence of ROPS-equipped tractors was 82.7% on full-time farms but was 68.1% on part-time farms.

Table 6 summarizes the prevalence of ROPS-equipped tractors on aquacultural farms by each of the variables collected in the two NIOSH surveys. This table also shows the corresponding prevalence of ROPS-equipped tractors from these surveys for all agricultural sectors in the U.S. For the aquaculture sector nationally, the lowest prevalence of ROPS-equipped tractors (62.4%) was reported on farms that were less than or equal to 100 acres in size. The highest prevalence of ROPS-equipped tractors (91.3%) was on farms with hired adult workers. It is noteworthy that farms that employed either adult workers (>19 years of age) or youth workers had a high prevalence rate of ROPS-equipped tractors (91.3% and 77.8%, respectively).

Of the 4,440 estimated aquaculture farms, 3,010 were reported to be less than or equal to 100 acres in size. In this category of farms, 62.4% of the tractors were ROPS-equipped, compared to 38.6% for all U.S. farms of this size. Aquaculture farms greater

Table 4. Characteristics of the work environment on aquacultural farms by age of hired workers and resident workers less than 20 years of age.[a]

	Hired Workers' Age		Resident Workers' Age
Parameter	≤19 years (95% CI)	≥20 years (95% CI)	≤19 years (95% CI)
Number of workers	960 (±610)	8050 (±4160)	1530 (±1090)
Number of farms	540 (±350)	1480 (±510)	910 (±600)
Number of tractors	850 (±680)	4930 (±3170)	1080 (±900)
Percentage ROPS-equipped	77.8% (±18.6%)	91.3% (±14.5%)	72.6% (±34.3%)

[a] Excludes other resident family members and contract employees.

Table 5. Number and percentage of ROPS on tractors on farms engaged in aquaculture by type of operation, 2001 and 2004.

	Farms		Number of	ROPS
Type of Operation	Total (95% CI)	With Tractors[a] (95% CI)	Tractors (95% CI)	Percentage (95% CI)
Full-time	1670 (±590)	1320 (±540)	5500 (±3150)	82.7% (±17.2%)
Part-time	2770 (±520)	1570 (±380)	2770 (±1580)	68.1% (±21.0%)
Total	4440 (±720)	2890 (±920)	8260 (±3510)	77.6% (±13.3%)

[a] One was unreported.

than 100 acres in size had a ROPS prevalence of 86.1%, which was higher than the national estimate for farms of this size group (61.5%).Within the aquaculture subsector, the operations in the South had a uniformly greater prevalence of ROPS-equipped tractors than aquaculture operations in other regions of the U.S. and those reported for U.S. farms as a whole. Overall, the South has a prevalence rate of 90.7% of ROPS-equipped tractors, as compared to 50.6% for the non-southern regions. The largest difference was in part-time farms (as defined by the farmer), with respondents in the South reporting all of their tractors being ROPS-equipped while respondents in the other three regions reported a ROPS prevalence rate of only 44.5%. Furthermore, the South had more than twice the number of tractors per aquacultural operation (4.1) when compared to aquacultural operations in the rest of the U.S. (1.8). The other three regions (Northeast, Midwest, and West) had 100% of their tractors equipped with ROPS when youth were employed on the farm.

When comparing the aquaculture subsector with the agriculture sector that includes aquaculture, agriculture has a higher percentage of farms with tractors (84.7%), as compared to aquaculture (65.1%). However, aquacultural farms have a higher average number of tractors per farm than the overall agriculture sector (2.9 and 2.3 tractors per farm, respectively). Moreover, aquaculture has a higher percentage of ROPS-equipped tractors (77.8%) than the agriculture sector (48.8%). This higher percentage is primarily due to the high prevalence of ROPS-equipped tractors on aquacultural operations in the South. The aquacultural farms in the non-southern regions have a similar per-

Table 6. Percentage of ROPS-equipped tractors in the aquaculture subsector as compared to the agriculture sector, pooled data from 2001 and 2004.[a]

	Aquaculture Subsector			Agriculture Sector
Parameter	U.S. (95% CI)	South (95% CI)	Non-South (95% CI)	(95% CI)
Number of farms	4440 (±1170)	2400 (±930)	2040 (±700)	2135630[b]
Percentage of farms with tractors	65.1% (±15.3%)	57.5% (±27.4%)	74.0% (±17.2%)	84.7% (±0.6%)
Average No. of tractors on those farms	2.9 (±1.2)	4.1 (±2.4)	1.8 (±0.9)	2.3 (±0.02)
Percentage of ROPS-equipped tractors	77.8% (±13.3%)	90.7% (±8.2%)	50.6% (±19.6%)	48.8% (±0/8%)
In the Northeast	37.4% (±28.0%)	--	37.4% (±28.0%)	40.1% (±1.7%)
In the South	90.7% (±8.2%)	90.7% (±8.2%)	--	52.2% (±1.7%)
In the Midwest and West	52.8% (±26.6%)	--	52.8% (±26.6%)	47.3% (±1.2%)
By farm size, ≤100 acres	62.4% (±19.2%)	84.5% (±27.8%)	46.5% (±23.0%)	38.6% (±1.0%)
By farm size, ≥101 acres	86.1% (±19.2%)	92.4% (±22.2%)	57.7% (±36.6%)	61.5% (±1.5%)
On part-time farms	68.1% (±21.0%)	100.0%[b]	44.5% (±27.0%)	39.3% (±1.1%)
On full-time farms	82.7% (±17.2%)	88.2% (±24.8%)	59.8% (±27.7%)	59.0% (±1.3%)
<$100,000 annual sales	65.5% (±19.2%)	81.2% (±28.0%)	46.2% (±24.4%)	40.6% (±1.0%)
≥$100,000 annual sales	87.9% (±17.1%)	96.1% (±16.9%)	58.1% (±32.2%)	65.3% (±1.5%)
On farms that employ workers >19 years old	91.3% (±14.5%)	91.5% (±19.9%)	86.7% (±25.1%)	58.9% (±1.6%)
On farms that employ workers <20 years old	77.8% (±36.5%)	75.6% (±48.6%)	100.0%[b]	56.2% (±2.6%)

[a] Source: NIOSH National Farm Tractor Surveys, 2001 and 2004. Two variables were not included in this table because of low numbers: farms with less than $10,000 sales, and farms with household workers less than 20 years old.

[b] Sampling error is 0.

centage of ROPS-equipped tractors as the overall agriculture sector. An important difference between the aquaculture subsector and the agriculture sector is the higher prevalence of ROPS-equipped tractors on aquacultural farms that employ workers (91.3% for those with adult employees and 77.8% for those with youth employees) than for the agriculture sector (58.9% for those with adult employees and 56.2% for those with youth employees). This higher percentage holds true for both the South (91.5% and 75.6%, respectively) and for the other three regions of the country (86.7% and 100%, respectively).

Discussion

Predictors of the prevalence of ROPS-equipped tractors on aquacultural farms based on the results of this study include the following:

- Region of the country, where the South had a prevalence of 91% of ROPS-equipped tractors (n = 25 farms) as compared to the other regions (n = 50 farms), which ranged from 37% to 53%.
- Full-time farm operations, i.e., more serious endeavors, with a prevalence of 83% of ROPS-equipped tractors, whereas part-time operations had a prevalence of 68%.
- Farms with annual sales of less than $10,000 had a prevalence of 66% of ROPS-equipped tractors, whereas farms with $\geq$$100,000 annual sales had a prevalence of 88%.
- Farms with hired workers more than 19 years of age had a prevalence of ROPS-equipped tractors of 91%.
- Farms with hired workers 19 years of age and younger had a prevalence of ROPS-equipped tractors of 78%.

The implications of these predictors include the need to better understand the reasons for a low prevalence of ROPS-equipped tractor in regions other than the South and the characteristics of the farms in the South that lack ROPS on their tractors. The reason for the high prevalence of ROPS-equipped tractors in the South may be because they are newer farming operations purchasing newer tractors manufactured after 1985, when all U.S. manufacturers made ROPS standard equipment on tractors. This would be consistent with the recent growth of the aquaculture production industry in the South. The South may also have larger farms and farms with higher revenue, both of which may affect the higher prevalence of ROPS-equipped tractors. Moreover, the higher average number of tractors on aquaculture farms compared to agriculture in general is probably due to the use of tractors on aquacultural operations next to ponds to provide power-take-off powered aeration.

The three non-southern regions (Northeast, Midwest, and West) reported 100% of their tractors equipped with ROPS when youth were employed on the farm. Tractors owned by part-time farmers in the South also reported all their tractors being ROPS-equipped. These results should be viewed cautiously because of the small number of aquaculture farms in the sample; however, these percentages represent the ultimate goal of tractor safety and can serve as a benchmark for offering protection against overturn-related injuries in aquaculture as well as in the agriculture sector.

Even when a tractor is equipped with a ROPS, an overturn can pin the operator underwater and result in a drowning. Alternatively, an operator may be in a cab-equipped

tractor that overturns with the door facing down, become trapped inside as water fills the cab, and drown as a result; such was the case in a track-type tractor overturn into a fish pond in Wyoming (MacCollum, 1993). The Scandinavian nations provide for an alternative escape from the tractor cab through the top of the cab, and many modern tractors with cabs provide for a second emergency exit by designing a kick-out window in the rear of the cab.

The number of farms in this study is small; thus, confidence in making comparisons is limited. Nevertheless, the results can be used to generate research questions such as the following:

- What type of aquacultural farms use tractors and what type do not?
- Why are ROPS-equipped tractors more prevalent on fish farms in the South than in the rest of the country?
- How are tractors used differently on small farms as compared to larger farms as measured by sales revenue?
- Why do part-time farms have a higher prevalence of ROPS-equipped tractors than full-time farms in the South?
- Why do farms that hire workers have a higher prevalence of ROPS-equipped tractors than farms that do not employ workers?
- How are tractors used on aquacultural farms?

One limitation of the study is that the participants only reported the main type of farming enterprise they were operating, which does not differentiate other farm activities, such as growing crops in conjunction with the aquaculture operation. A second limitation is that the NIOSH survey excluded contractors and contract employees; in aquaculture, this may be an important population regarding pond refurbishing, feed delivering, fish transporting, and fish harvesting.

Conclusion

The aim of this study was to analyze and describe the prevalence of ROPS-equipped tractors on aquacultural farms in the U.S. Several results are important observations:

- The South has a higher prevalence of ROPS-equipped tractors on aquacultural farms than other regions of the country or as compared to agriculture as a whole.
- Aquacultural farms that employ workers have a higher prevalence of ROPS-equipped tractors than those that do not.
- Aquacultural farms in the Midwest, Northeast, and West that employ youth reported all of their tractors ROPS-equipped, as did part-time farms in the South.

In addition, several issues were identified for further research. These included determining reasons for the high prevalence of ROPS under some circumstances, barriers to ROPS retrofits, and the need to understand the use of tractors in aquaculture, including use by contractors and contract employees.

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References

Durborow, R. M. 1997. Aquacultural hazards. In *Safety and Health in Agriculture, Forestry, and Fisheries*, 659-679. R. L. Langley, R. McLymore, W. J. Meggs, and G. T. Roberson, eds. Rockville, Md.: Government Institutes.

Durborow, R. M. 1999. Health and safety concerns in fisheries and aquaculture. *Occup. Med.* 14(2): 373-406.

MacCollum, D. V. 1993. *Crane Hazards and Their Prevention*, 53-54. Des Plaines, Ill.: American Society of Safety Engineers.

Myers, M. L. 2000. Prevention effectiveness of roll-over protective structures: Part I. Strategy evolution, 2000. *J. Agric. Safety and Health* 6(1): 29-40.

Steeby, J. A., N. Stone, H. S. Killian, and D. K. Carman. 1998. Repairing fish pond levees. SRAC Pub. No. 104. Stoneville, Miss.: Mississippi State University, Southern Regional Aquaculture Center.

Steeby, J., C. D. Minchew, H. S. Killian, and C. Breden. 1999. Safety for fish farm workers (brochure). Publication FFS Brochure-English 01 (10-99). Stoneville, Miss.: Mississippi State University Extension.

Stone, N. 1999. Renovating leaky ponds. SRAC Publication No. 105. Stoneville, Miss.: Mississippi State University, Southern Regional Aquaculture Center.

USDA. 1998. 1998 census of aquaculture. Washington, D.C.: USDA National Agricultural Statistics Service.

USDA. 2002. Farms and land in farms, February 2002. Report No. Sp Sy 3 (02). Washington, D.C.: USDA National Agricultural Statistics Service.

USDA. 2005a. 2005 census of aquaculture. Washington, D.C.: USDA National Agricultural Statistics Service.

USDA. 2005b. Farms, land in farms, and livestock operations, 2004 summary, January 2005. Report No. Sp Sy 4 (05). Washington, D.C.: USDA National Agricultural Statistics Service.

Willcutt, H. 2002. *Farm Pond Safety*. Publication rep-5M-02-03. Starkville, Miss.: Mississippi State University Extension Service.