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The Golden Shiner Grading Assessment Model

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Abstract Golden shiners *Notemigonus crysoleucas* are typically graded in concrete vats having a rectangular cross section. Aluminum frames fitted with panels of uniformly spaced, vertical rods (bar graders) are used to separate golden shiners having similar weight and length from a mixed-size aggregation. Investigation revealed that no quantitative method for estimating bar grader effectiveness existed, so a Microsoft© Excel application was developed. The golden shiner assessment model presents product quality information for graded golden shiners *Notemigonus crysoleucas*. Quality assurance data includes an estimate of the number of fish per kilogram (kg), weight in kg per 1,000 fish, and an assessment of grading effectiveness. Standard weight calculations give benchmark weight to length criteria for graded golden shiners, whereas relative weight provides a general indicator of health, and a means to estimate the effectiveness of a feeding regimen. This model serves as an assessment tool for researchers, a management tool for producers, and a source of important product information for purchasers.

Keywords Golden Shiner, Grading, Management, Standard Weight

1. Introduction

1.1. Typical Grading Practice

Golden shiners are typically raised in levee-style earthen ponds (1), and are harvested with fine-mesh seines. Each catch is transported by truck to an on-farm minnow shed, and held in a rectangular concrete vat for 18-24 hours (h) before being graded into size/weight categories. Grading is accomplished by pulling rectangular panels comprised of uniformly spaced, vertical aluminum rods (bar graders) through a vat (Figures 1 & 2). These bar graders are used to separate golden shiners having a selected target weight (W_t) (kilogram (kg) per 1,000 fish) from a mixed-size catch. Producers select pairs of grader panels so that post-graded mean weight is approximately *x* kg per 1,000 fish. The upper and lower boundaries of an acceptable graded grouping are somewhat flexible as farmers and distributors must cooperate to sell available fish (1). Golden shiners are sold on a weight basis, but length and robustness are used by anglers as indicators of baitfish quality. In 2005, U.S. baitfish producers sold 2,267 metric tons of golden shiners *Notemigonus crysoleucas* for $17,100,000. Arkansas (1,750 metric tons), Mississippi (94 metric tons), and Minnesota (55 metric tons), accounted for 83% of production (2). Grading effectiveness is frequently estimated by collecting a small number of graded golden shiners and visually assessing them.

1.2. The Assessment Model

Figure 1. A number 15 grader of the type used to sort golden shiners into size-weight classes. The inch-pound system is used by U.S. baitfish farmers, and grader spacing is indicated in 64th inch increments. In a 15 grader, aluminum rods having diameter of 0.1875 inch are set on 0.4219 inch centers to provide a 15/64 (0.2344) inch space between adjacent rods. SI units: In a 5.96 mm grader, aluminum rods having diameter of 4.76 mm are set on 10.72 mm centers to provide a 5.96 mm space between adjacent rods

Review of relevant literature indicated that no quantitative method for estimating bar grader effectiveness existed, so we developed a Microsoft© Excel application. Estimates of grading effectiveness and quality indicators were developed by combining empirical methods used by golden shiner producers with techniques supported by scientific research. The model may be useful as a management tool for golden shiner producers, a source of quantitative product quality

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information for purchasers, and as an evaluative tool for scientists conducting applied research in grading and feeding studies.

Figure 2. Workers grade golden shiners with a panel having 20/64 in (7.94 mm) rod spacing

2. Methods

2.1. Field Work

We conducted 53 grading events at a commercial bait fish farm in April, May, June, and December 2006. After each grading event, we obtained the wet weight (g) and measured the maximum total length (mm) of each individual from one sample of 20 golden shiners.

2.2. Model Development

The Golden Shiner Grading Assessment Model was programmed as a Microsoft© Excel application (Table 1). Weight (g) and total length (mm) for each element of a sample of graded golden shiners (n = user defined) and user-selected W_t (kg per 1,000 golden shiners) and range ($\pm 0.x W_t$) are required for computations. The model computes grading efficiency, standard weight, and relative weight for each grading event. Excel programming code for the (n = 20) model is presented in Table 2.

Table 1. An example of The Golden Shiner Grading Assessment Model. This table shows an example grading event with the Maximum Total Length (MTL), Weight (W), Standard Weight (Ws), Relative Weight (Wr), kg per 1,000 fish, and the number of fish that fall into the target size category (On Target) or are bigger (Above Target), or smaller (Below Target) than the target size category

	A	B	C	D	E	F	G	H	I
1	Grading Event	999							
2	Harvest Date	123106							
3	Pond ID	100							
4	#1 Bar Space (mm)	10.7							
5	#2 Bar Space (mm)	9.1							
6	Target Weight (kg)	9.1							
7	Range (kg)	1.8							
8									
9		MTL	W	Ws	Wr	kg/	Above	On	Below
10	Sample Element	(mm)	(g)	(g)	--	1,000	Target	Target	Target
11	1	104	9.9	11.7	85	9.9	0	1	0
12	2	89	7.6	7.0	109	7.6	0	1	0
13	3	102	9.8	10.9	90	9.8	0	1	0
14	4	91	7.7	7.5	103	7.7	0	1	0
15	5	99	9.3	9.9	94	9.3	0	1	0
16	6	89	6.8	7.0	97	6.8	0	0	1
17	7	102	9.7	10.9	89	9.7	0	1	0
18	8	89	6.5	7.0	93	6.5	0	0	1
19	9	89	6.5	7.0	93	6.5	0	0	1
20	10	94	6.8	8.4	81	6.8	0	0	1
21	11	91	7.2	7.5	96	7.2	0	0	1
22	12	91	7.3	7.5	97	7.3	0	1	0
23	13	91	8.2	7.5	109	8.2	0	1	0
24	14	91	7.8	7.5	104	7.8	0	1	0
25	15	91	7.2	7.5	96	7.2	0	0	1
26	16	89	6.6	7.0	95	6.6	0	0	1
27	17	104	9.8	11.7	84	9.8	0	1	0
28	18	89	7.4	7.0	106	7.4	0	1	0
29	19	91	7.9	7.5	105	7.9	0	1	0
30	20	94	8.5	8.4	102	8.5	0	1	0
31									
32	Mean	94	7.9	8.3	96	7.9			
33									
34						Total	0	13	7
35						Percent	0	65	35

Table 2. Microsoft© Excel programming code for the golden shiner grading assessment model

Column	Row	Excel Programming Code
A	1-7	descriptions are entered by the user
B	1-7	data are entered by the user
A-I	9-10	descriptions are entered by the user
A	11-30	sample element numbers or identifiers are entered by the user
B	11-30	golden shiner length (mm) is entered by the user
C	11-30	golden shiner weight (g) is entered by the user
D	11	=10^(-5.593+(3.302*LOG10(B11)))
D	12-30	select cell definition for D11, then drag it through the selected range
E	11	=(100*(C11/D11))
E	12-30	select cell definition for E11, then drag it through the selected range
F	11	=C11 note: only units change when W(g) is converted to kg · 1,000
F	12-30	select cell definition for F11, then drag it through the selected range
G	11	=IF(F11>(B6+B7),1,0)
G	12-30	select cell definition for G11, then drag it through the selected range
H	11	=IF(AND(G11=0,I11=0),1,0)
H	12-30	select cell definition for H11, then drag it through the selected range
I	11	=IF(F11<(B6-B7),1,0)
I	12-30	select cell definition for I11, then drag it through the selected range
A	32	description is entered by the user
B	32	=AVERAGE(B11:B30)
C-F	32	select cell definition for B32, then drag it across the selected range
F	34-35	descriptions are entered by the user
G	34	=SUM(G11:G30)
H-I	34	select cell definition for G34, then drag it across the selected range
G	35	=100*(G34/(A30))
H-I	35	select cell definition for G35, then drag it across the selected range

3. Results and Discussion

3.1. The Grading Efficiency Score

For demonstration purposes, the model classifies elements from a sample of graded golden shiners (n = 20) into three weight classes: above, on, and below target, and then computes a grading efficiency score (0, 100) for that event. A grading event was considered efficient if 70 percent of sample elements from that event were in the range $\pm 0.25W_t$.

3.2. Quality Assessment Indicators

Species specific equations for standard and relative weight provide quality assessment indicators. Standard weight calculations give benchmark weight to length criteria for graded golden shiners, whereas relative weight provides a general indicator of health, and a means to estimate the effectiveness of a feeding regimen. Results include an estimate of the number of fish per kg and weight in kg per 1,000 fish.

3.2.1. Standard Weight

Standard weight (W_s) is a length-specific value predicted by a weight-length regression constructed to represent a given species (3). The regression equation for golden shiners (4), $\log_{10}(W_s) = -5.593 + 3.302(\log_{10}TL)$, where TL is total length (mm), provides benchmark weight to length criteria. Liao (4) stated that this W_s equation was valid for golden shiners having minimum length of 50 mm. McNulty (5) showed that the equation is valid for carefully weighed and measured golden shiners having maximum total length (3) of from 29 to 76 mm.

3.2.2. Relative Weight

Relative weight describes the inherent shape of a fish in good condition (3), and provides a means to estimate the effectiveness of a feeding regimen (5). The equation, $W_r = 100(W/W_s)$, where W = the weight of an individual (g), and W_s = standard weight for golden shiners (g) (4) is used in the model. A W_r value $\approx$ 100 indicates a fish in good condition. A higher value indicates increased plumpness, whereas a lower value indicates a fish in poor condition (3).

3.3. Target Weight

Various pairs of bar graders were used to obtain golden shiners in selected size classes during this study. If, for example, the target weight was 9.1 kg per 1,000 golden shiners, then bar graders with spacing of 10.7 mm and 9.1 mm, respectively, were used. The bar grader with spacing of 10.7 mm was pulled first. Golden shiners larger than the desired size should have been separated from those $\leq$ to the required size. After a blocking screen was set, the 9.1 mm grader was pulled through the vat section holding the remaining fish. Golden shiners smaller than the target weight, were expected to swim through the bars, but those in the target range should have been held by the grader. A second blocking screen was set. The original mixed-size aggregation was divided into three groups, which were separated by the blocking screens. Golden shiners that passed through the 10.7 mm grader, but that were held by the 9.1 mm grader were deemed ready for sale. Those above the target weight could be graded again, or returned to a production pond. Producers typically place golden shiners below target weight in grow out ponds.

3.4. Weight Classes

Three weight classes (above target, on target, and below target) were used to evaluate grading effectiveness. A sample element was on target if its weight (g), when converted to kg · 1,000 identical sample elements, fell within $\pm 0.25W_t$. An acceptable grading event was defined as one in which 70 percent of sample elements (n = 20) from that event were on target.

3.5. Results

Table 3. Selected data from 19 events having grading efficiency scores of less than 70 percent

Sample Date	Grading Event	Mean Weight (g)	Mean Standard Weight (g)	Mean Relative Weight (n/a)	Percent Above Target	Percent On Target	Percent Below Target
42606	6	2.2	2.3	96	5	60	35
42606	9	2.3	2.5	92	5	60	35
51706	19	2.1	2.2	96	0	60	40
52506	24	2.1	2.0	103	0	60	40
121206	49	2.3	2.7	88	5	60	35
42506	3	3.5	3.4	105	45	55	0
42606	4	2.3	2.4	93	5	55	40
42606	5	2.4	2.4	102	10	55	35
52506	30	1.3	1.5	88	0	55	45
61006	38	3.9	4.7	84	0	55	45
61406	40	6.6	6.5	102	40	55	5
51706	21	1.9	2.2	86	0	50	50
42606	8	2.2	2.2	104	15	45	40
42706	13	2.1	2.4	87	0	40	60
52506	27	1.9	2.1	92	0	40	60
51706	20	1.7	2.1	82	0	30	70
51706	22	1.8	2.0	92	0	30	70
52506	25	1.7	2.1	80	0	25	75
61006	35	3.0	3.9	79	0	15	85

Thirty-four of 53 events received effectiveness scores ≥ 70 percent. Scores for the remaining 19 events (Table 3) ranged from 15 to 60 percent. A large fraction of below target golden shiners in 36% of the grading events suggested that worker training, with emphasis on proper grading technique, was needed. The mean relative weight for samples collected during eight events (13, 20, 21, 25, 30, 35, 38, and 49) ranged from 79-88. Low W_r values raised questions concerning fish condition and/or feed problems. Examination of stock and evaluation of feed quality-feeding regimen was indicated.

4. Conclusions

The Golden Shiner Assessment Model is a Microsoft© Excel application that provides information regarding grading effectiveness by comparing actual individual fish weight to a scientifically based indicator of robustness or general health and to an estimator of the efficacy of a given feeding regimen. Model output may be useful as an evaluation tool for researchers, a management tool for producers, and as a source for quantifiable product quality information for purchasers of graded golden shiners (wholesalers and retailers).

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