Flathead Catfish Age and Size at Maturation in Texas

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Abstract.—One hundred ninety-nine flathead catfish *Pylodictis olivaris*, ranging in total length from 290 to 999 mm, were collected from 31 Texas reservoirs to determine the relationship between size and age at sexual maturation. Logistic regression indicated that length, age, and geographic location of capture were significantly related to sexual maturity. Weight was significantly related to maturity only if length was not included in the model. There was no difference between males and females in length at maturity. Five models were developed to predict the proportion of mature fish within a population. A length-only model derived for predicting sexual maturity indicated that 50% of flathead catfish reached sexual maturity at 390 mm. This information was used to help establish new statewide length limit regulations based on the desired level of protection of the sexually mature population.

Flathead catfish *Pylodictis olivaris* was the preferred sport fish of an estimated 30,000 Texas anglers in 1987 (Ditton et al. 1991). Flathead catfish anglers in Texas fish more frequently, are more specialized, and have a greater consumptive orientation than anglers for other catfish (Wilde and Riechers, in press). In 1989, flathead catfish management in Texas consisted of harvest regulations (five-fish daily bag limit and 229-mm minimum length limit) and stocking. There is little life history information available to develop strategies to manage for the unique aspects of this fishery. Information on the size, age, and reproductive biology of flathead catfish is needed to refine management practices and maintain viable fisheries.

Sexual maturation of flathead catfish may be related to size, age, or both. Some work has been done on flathead catfish reproduction (Evermann 1893; Minckley and Deacon, 1959; Henderson 1965; Schoumacher 1968; Summerville and Crawley 1970; Turner and Summerfelt 1971a; Bamberg 1973; Gholson 1975; Perry and Carver 1979; Garrett and Kulzer 1981), but the relationships between maturation and size and age have not been investigated.

There is little information on weight at sexual maturation, though lower limits have been suggested. Perry and Carver (1979) used a length-weight relationship to estimate weight at maturity in flathead catfish from southwest Louisiana, and they found that females begin to mature at a body weight of about 1.5 kg and that 50% were mature at 2.4 kg. Spawning studies conducted by Summerville and Crawley (1970), Gholson (1975), and Garrett and Kulzer (1981) do not identify the onset of maturity because the fish used in those studies were fish larger than 1.7 kg. Henderson (1965) reported that flathead catfish successfully spawned at 1.4–2.7 kg.

Total length at sexual maturity has been reported by several researchers. Barnickel and Starrett (1951) and Minckley and Deacon (1959) found that male and female flathead catfish became sexually mature by the time they were 350 mm. Evermann (1893) reported that no fish under 356 mm and only a few under 432 mm spawned. Turner and Summerfelt (1971a) found that females began to mature at total lengths of about 450 mm, whereas males matured at 406–421 mm. Perry and Carver (1979) indicated that female flathead catfish begin maturing at about 490 mm and 50% were mature at 589 mm. Bamberg (1973) found that 577–749-mm female flathead catfish were mature.

Flathead catfish age at sexual maturity also has been studied (Forbes and Richardson 1920; Barnickel and Starrett 1951; Beckman 1953; Harlan and Speaker 1956; Koster 1957; Minckley and
Deacon 1959; Henderson 1965; Turner and Summerfelt 1971b). The bulk of the available information indicated that flathead catfish reach maturity at some point between ages 3 and 5, though most researchers specified age 4. Schoumacher (1968) reported that flathead catfish matured at ages 4-5, whereas Turner and Summerfelt (1971a) found that males matured at ages 4-5 and females at ages 5-7.

Most studies indicate that flathead catfish mature at age 4, but this species shows considerable variation in length at age 4. The mean total length of age-4 flathead catfish collected from the Salt River, Missouri, was 427 mm (Punkett 1958). Age-4 fish from Oklahoma reservoirs ranged from 259 to 493 mm (Schoumacher 1968). Statewide growth data from Texas showed that length of age-4 flathead catfish ranged from 343 to 660 mm (Texas Parks and Wildlife Department, unpublished data).

The objective of this study was to determine the relation between sexual maturity and age and size of flathead catfish in Texas reservoirs, to aid in evaluating length limit regulations.

**Methods**

From April through June 1989, flathead catfish were collected from 31 reservoirs throughout Texas with monofilament experimental gill nets. Nets were 60.7 m long and 2.4 m deep, and consisted of 7.6-m sections with square mesh of different sizes (ranging from 12.7 to 101.6 mm, in increments of 12.7 mm). The nets had a 19-mm-diameter float line and an 8-mm-diameter lead line. Nets were fished from approximately sunset to sunrise.

Total length (mm) and weight (g) were recorded for each flathead catfish captured. Sex and stage of sexual maturation were determined by direct observation of the sex organs. When sex of the fish could be determined, the stage of maturation was determined according to characteristics described by Nikolsky (1963). Stage-I fish, those that have never spawned and have gonads of very small size, were classified as immature; all fish exhibiting more-advanced stages (II–VII) of gonadal development were categorized as mature. The timing of our sampling, which coincided with the spawning season of flathead catfish in Texas, facilitated the classification of fish as immature or mature.

Fish were aged by examination of pectoral spines. The pectoral spines were collected, sectioned, and polished as described by Jearld (1983), except that the spines were embedded in acrylic casting resin. The resin was allowed to harden 24 h before sectioning to reduce splintering of the spine. Because the articulating process was damaged on many of the spines, embedded spines were sectioned at the distal end of the basal recess. A compound microscope was used at 40 × magnification to count annuli to determine age at time of capture. Use of sectioned spines to determine age of flathead catfish with sectioned spines has been validated by Turner (1982), who reported, however, that erosion in the lumen of the spine could lead to underestimation of age. To reduce the possibility of underestimating age, multiple sections were cut until the lumen was not obvious in at least one section. Crumpton et al. (1987) found this “midspine” section to be accurate in determination of catfish age.

Data were analyzed with logistic regression (Agresti 1990) by using the SAS CATMOD procedure (SAS Institute 1985). A model that had length, age, weight, sex, and location of capture as explanatory variables was developed to predict the proportion of sexually mature fish. Initial analysis was done with a saturated model and data on sex determinations. Fish of undetermined sex were omitted from initial analysis. The saturated model included length, age, weight, sex, location (reservoir and latitude) and all possible two-, three-, four-, and five-way interactions. A model was fitted and the one term with the largest $P$ value greater than 0.05 was deleted. The model was refitted and the procedure repeated until $P$ values for all terms in the model were less than 0.05. We used analysis of deviance, a generalization of analysis of variance (McCullagh and Nelder 1989), to assess the significance of variables affecting maturity.

**Results and Discussion**

In all, 199 flathead catfish were collected. Total lengths ranged from 290 to 999 mm and weights from 272 to 15,436 g. Ages of fish ranged from 2 to 11 years.

Length, weight, age, and location of capture were significant ($P \leq 0.03$) univariate predictors of maturity in flathead catfish. There was no difference ($P = 0.32$) between males and females in size and age at maturity; therefore, data for males, females, and fish of undetermined sex were pooled for analysis.

In combination, length, age, and location of capture explained 63% of the variation (deviance) in maturity of flathead catfish (Table 1). Forty percent of the variation in maturity of flathead catfish
was related to location of capture (Table 1). Location of capture was decomposed into latitude and general among-lakes effects: latitude explained 7% of location effects and local differences in study reservoirs accounted for the remainder.

Maturity was significantly \((P < 0.01)\) related to weight, but only if length was not already included in the analysis. Because length is a marginally better predictor of maturity (Table 2), it is easier to measure, and is more useful for setting fishing regulations, we emphasized length in our analyses.

Maturity of flathead catfish was estimated based on the variables in Table 1. However, the 30 predictive equations (one for each lake, not presented herein) derived from this analysis include lake-specific coefficients; consequently, predictions are applicable only to those reservoirs included in the analysis. To develop predictive equations with greater generality, we modeled maturity as a function of (1) latitude, age, and length; (2) age and length; (3) latitude and length; and (5) weight.

Latitude, age, and length (Table 2, model 1) explained 24% of the variation in maturity. The negative coefficient for latitude indicates that maturity was directly related to length of growing season (number of days with air temperatures \(\geq 0^\circ C\)), which increased from 206 d in our northernmost reservoir to 327 d in our southernmost reservoir. Based on the range of latitudes spanned by study reservoirs, this model is valid only between latitudes of 26°08'N and 35°10'N.

Maturity of flathead catfish was directly related to both age and length (models 1 and 2); flathead catfish from faster-growing populations (i.e., those that reach a given length at an earlier age) matured at an earlier age and at a greater length (Figure I) than those from slow-growing populations. In combination, length and age (model 2) accounted for 17% of the variation in maturity.

The most-general models of maturity (models 3 and 5), based on length or weight only, explained 13 and 10% of the variation in maturity. Of the various models reported herein, model 3 is probably most useful for setting statewide length limits (Figure 2). Model 4, which includes latitude and length, might be useful in setting length limits over smaller geographic areas.

### Table 1.—Analysis of deviance of factors affecting maturity of flathead catfish in Texas reservoirs.

<table>
<thead>
<tr>
<th>Source of deviance</th>
<th>df</th>
<th>Deviance</th>
<th>Mean deviance</th>
<th>F-ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among lakes</td>
<td>29</td>
<td>70.72</td>
<td>2.44</td>
<td>6.12</td>
<td>0.0001</td>
</tr>
<tr>
<td>Latitude</td>
<td>1</td>
<td>4.79</td>
<td>4.79</td>
<td>12.04</td>
<td>0.0007</td>
</tr>
<tr>
<td>Lake effect excluding latitude</td>
<td>28</td>
<td>65.93</td>
<td>2.35</td>
<td>5.90</td>
<td>0.0001</td>
</tr>
<tr>
<td>Length</td>
<td>1</td>
<td>34.20</td>
<td>34.20</td>
<td>85.93</td>
<td>0.0001</td>
</tr>
<tr>
<td>Age</td>
<td>1</td>
<td>7.35</td>
<td>7.35</td>
<td>18.47</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>167</td>
<td>66.52</td>
<td>0.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>198</td>
<td>178.79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 2.—Model equations predicting proportion of mature flathead catfish \((p_m)\) with total length (mm), weight (g), age (years), and latitude (degrees + [min/60]) as explanatory variables. Model equations were derived through logistic analysis, and percent of variation of \(p_m\) was determined through analysis of deviance.

<table>
<thead>
<tr>
<th>Model</th>
<th>Equation</th>
<th>(R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(p_m = \frac{(e^{13.97 - 0.5960 \text{latitude} + 0.008416 \text{length} + 0.4183 \text{age})}}{1 + (e^{13.97 - 0.5960 \text{latitude} + 0.008416 \text{length} + 0.4183 \text{age})}})</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>(p_m = \frac{(e^{-3.180 + 0.004601 \text{length} + 0.5421 \text{age})}}{1 + (e^{-3.180 + 0.004601 \text{length} + 0.5421 \text{age})}})</td>
<td>0.17</td>
</tr>
<tr>
<td>3</td>
<td>(p_m = \frac{(e^{2.944 + 0.007540 \text{length})}}{1 + (e^{2.944 + 0.007540 \text{length}})</td>
<td>0.13</td>
</tr>
<tr>
<td>4</td>
<td>(p_m = \frac{(e^{-5.63 - 0.6468 \text{latitude} + 0.01090 \text{length})}}{1 + (e^{-5.63 - 0.6468 \text{latitude} + 0.01090 \text{length})}})</td>
<td>0.22</td>
</tr>
<tr>
<td>5</td>
<td>(p_m = \frac{(e^{0.1925 + 0.0004297 \text{weight})}}{1 + (e^{0.1925 + 0.0004297 \text{weight}})</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Although models 1–5 explain rather small portions of the total variation in maturity \( (R^2 = 0.10–0.24) \), all factors included are statistically significant \( (P < 0.05) \), and various diagnostic plots and statistics support the appropriateness of the types of models used. The low explanatory power of the models is largely the result of local differences among reservoirs (Table 1) and the limitations of \( R^2 \)-type statistics when applied to binary response variables, such as maturity as coded in this study (Agresti 1990). For various combinations of latitude, age, and length or weight, our models predict mean maturity within a population; however, individual fish are constrained to the classification of either mature or immature and, consequently, residual (unexplained) variation can be quite large.

Data from this study showed that flathead catfish in Texas reservoirs become sexually mature between ages 2 and 5. All but one fish over age 5 were mature. Model 5 indicated that 50% of 1.88-kg flathead catfish are mature. This weight at maturity is lower than that indicated by Perry and Carver (1979) but within the ranges indicated in other studies. Flathead catfish began to mature when they reached age 2 and were between 290 and 635 mm total length. Model 2 indicated that 50% of flathead catfish are mature by age 3. Five-year-old immature fish ranged in total length from 610 to 788 mm. Model 3 showed that 50% of flathead catfish are mature at 390 mm. These results are within the ranges, though on the low end, of most lengths at maturity reported in the literature. The exception is again with Perry and Carver (1979), who indicated that 50% would be mature at 589 mm. These results are similar to those of other studies, except that some Texas flathead catfish reached sexual maturity 2 years earlier than has been reported for other geographic areas.

Management Implications

Many length limits are designed to allow fish to spawn at least once before they are harvested. Schoumacher (1968) found that harvest could decrease the average size of flathead catfish and suggested a 331-mm minimum length limit. Kuhne (1939) suggested a minimum length limit between 381 and 508 mm for flathead catfish in Tennessee. Our results, based on model 3, indicate that 390-mm and 534-mm minimum length limits would allow 50 and 75% of flathead catfish in Texas to
mature and spawn at least once before they could be harvested. This information was used by the Texas Parks and Wildlife Department to justify an increase in the minimum length limit for flathead catfish from 229 to 610 mm, allowing 84% of flathead catfish to spawn at least once before being harvested. The 610-mm length limit was selected over one that would provide total protection, because such a stringent regulation would have little additional reproductive benefit but could potentially have excessive socioeconomic impacts.

Further research is needed to determine whether lengths and ages at maturity differ significantly between reservoir and river populations of flathead catfish. Preliminary results (C. R. Munger, unpublished data) indicate that river populations may mature at a larger size and an older age than those in reservoirs. However, data are available for only a limited number of rivers; consequently, we cannot determine whether the apparent differences are site-specific or indicative of a general difference between river and reservoir populations. If flathead catfish reach maturity at a greater size and age in rivers, regulations based on results for reservoir populations may not provide the intended degree of protection. This consideration is especially important in Texas, because flathead catfish anglers spend 53% of their angling days, all or in part, on streams and rivers (Wilde and Riechers, in press).

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References


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