

FEATURE: FISHERIES MANAGEMENT

Paddlefish caught in gill nets in the warm waters at the beginning and end of the fishing season experience high mortality. This paddlefish (missing its rostrum) was alive (but barely) when tagged with a radio transmitter and released as bycatch; it subsequently died. Photo by Phil Bettoli.

Protecting Paddlefish from Overfishing: A Case History of the Research and Regulatory Process

ABSTRACT: A commercial fishery for paddlefish (*Polyodon spathula*) in the Tennessee River was largely unregulated through the 1990s. Beginning in 2002, attention devoted to the plight of caviar-yielding species around the world resulted in much more scrutiny of the Tennessee paddlefish industry. This article describes the stock assessment of a paddlefish stock and the approach taken to present research findings to state and federal regulators and a skeptical fishing community. The end result for the fishery, and lessons learned from a series of public, facilitated, and state commission meetings are discussed. The need to compromise with the fishing industry meant that not all of the measures proposed to protect the fishery from overfishing were enacted; however, the fishery entered the 2006-2007 season with more regulations in place than ever before and with a promise by the regulatory commission that more restrictive regulations will be imposed in the future if warranted.

Protegiendo al “pez espátula” de la sobrepesca: historia de la investigación y el proceso regulatorio

RESUMEN: La pesca comercial del “pez espátula” (*Polyodon spathula*) en el Río Tennessee se mantuvo sin regulación durante la década de 1990. A principios de 2002, la atención dedicada a las especies productoras de caviar a nivel mundial dio como resultado un mayor escrutinio de la industria del “pez espátula” en Tennessee. En este artículo se describe la evaluación pesquera de una población de “pez espátula” y el enfoque adoptado para presentar los resultados de la investigación a las agencias estatales y federales de regulación y a la escéptica comunidad pesquera. También se discute el resultado final para la pesquería, las lecciones aprendidas por diferentes tipos de público y las reuniones de las comisiones estatales. La necesidad de compromiso con la industria pesquera significa que no se han puesto en marcha todas las medidas propuestas para evitar la sobrepesca; sin embargo, la pesquería comenzó la temporada 2006-2007 con más regulaciones que nunca antes y con la promesa de la comisión reguladora de que en el futuro se impondrá un control más estricto.

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When the Convention on International Trade in Endangered and Imperiled Species of Flora and Fauna (CITES) designated paddlefish (*Polyodon spathula*) an Appendix II species in 1992, export of their caviar fell under the regulatory authority of the U.S. Fish and Wildlife Service's (FWS) Division of Management Authority (DMA). Although trade in products of any animal designated an Appendix II species is allowed under international law, CITES requires that the relevant management authority ensure that “trade will not imperil the survival of the species in the wild.” In other words, the DMA is authorized to grant export permits to paddlefish caviar wholesalers and retailers if state fisheries personnel demonstrate to the DMA that the stocks within their state boundaries are healthy enough to withstand commercial fishing.

For at least a decade, DMA personnel were concerned over the number of export permits requested by purveyors of Tennessee paddlefish caviar. Tennessee was one of seven states that still allowed commercial harvest of paddlefish for their roe and Tennessee often led the nation in the amount of paddlefish caviar exported (Marie Maltese; DMA; pers. comm.); more than 17,000 kg of wild-caught paddlefish roe were exported from the United States between 2001 and 2005 (DMA 2006). Additionally, the successful prosecution in 2002 of three Tennessee wholesalers for violations of the Lacey Act, in which more than 3,500 kg of illegally obtained paddlefish roe were seized, revealed a flourishing illegal trade in paddlefish caviar. In Tennessee, most paddlefish are harvested from Kentucky Lake,

Tennessee-Kentucky, a 65,000-hectare reservoir on the lower Tennessee River; therefore, the DMA was particularly interested in any stock assessments of the Kentucky Lake population.

When national attention began to focus on the Kentucky Lake fishery early in this century, little was known about the status of paddlefish in the Tennessee River. University researchers had assessed the age structure, size structure, and commercial exploitation of paddlefish in Kentucky Lake in the 1980s and early 1990s (Hoffnagle and Timmons 1989; Timmons and Hughbanks 2000), but no fishery independent data were collected in those studies, and little information existed other than numbers of fish harvested in the years between 1999 and 2003. In the absence of stock assessment data, the DMA is supposed to deny export permits, and some permits from Tennessee were denied in recent years (Marie Maltese; DMA; pers. comm.). It was clear to regulatory parties (i.e., DMA, Tennessee Wildlife Resources Agency [TWRA]) in 2001 that a stock assessment should be conducted at the earliest opportunity.

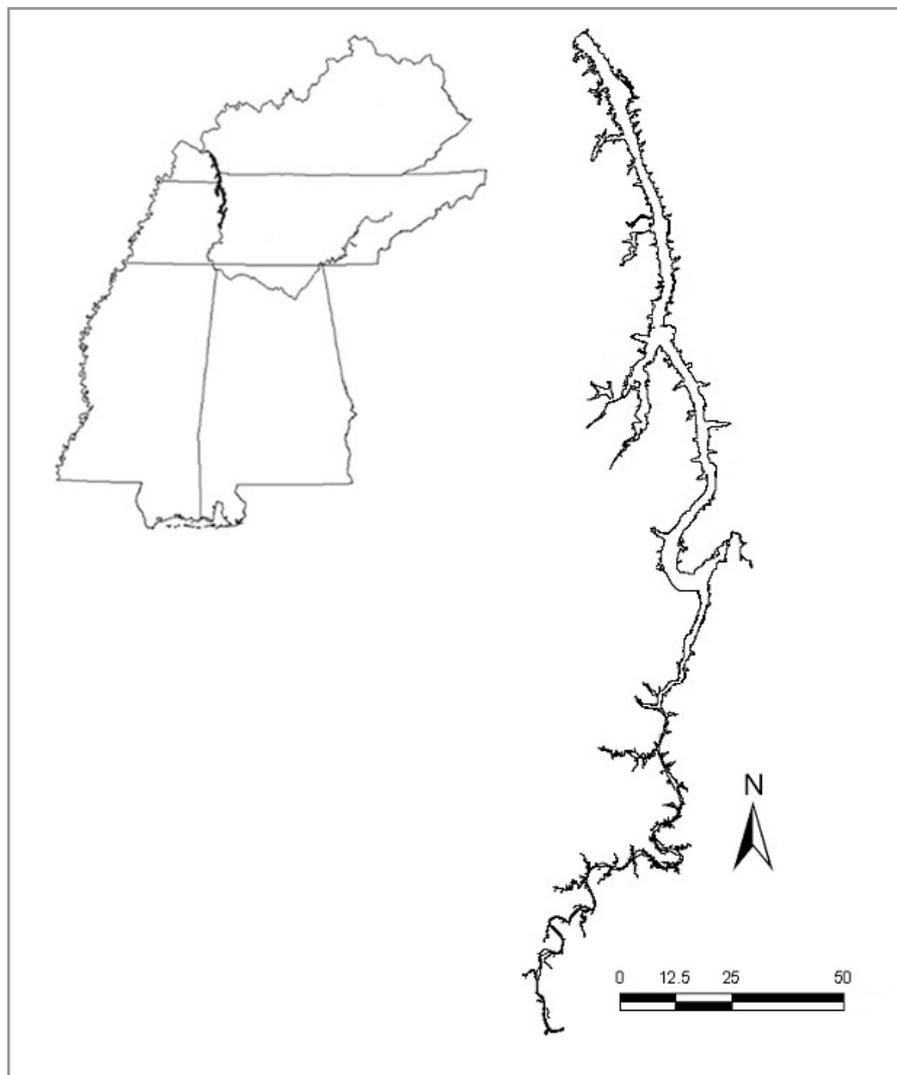
This article summarizes our stock assessment activities and the strategies we employed to convey our recommendations to the fishing industry, TWRA biologists, and the governing board of the TWRA, the Tennessee Wildlife Resources Commission (TWRC). We discuss what regulations were and were not enacted by the TWRC, and how a compromise was eventually reached to balance the state's mandate to conserve fisheries resources with the legitimate economic interests of private businesses. Finally, we discuss what the future might hold for Tennessee paddlefish in light of recent harvest trends.

STUDY AREA AND THE COMMERCIAL FISHERY

Kentucky Lake is the last impoundment on the Tennessee River before its confluence with the Ohio River (Figure 1). The lacustrine, downlake reach of the reservoir provides excellent habitat for paddlefish; whereas, the narrow, riverine headwaters serve as ideal fishing grounds for commercial fishers deploying gill nets during the winter and spring spawning migrations.

Before 2002, fishers harvesting paddlefish were required to possess a commercial fishing license (US\$125) and a free paddlefish permit. The season ran from 1 November through 23 April and there were no quotas or other harvest restrictions other than a 813-mm eye-fork-length (EFL) minimum length

Figure 1. Kentucky Lake, a mainstream impoundment on the lower Tennessee River, is where most of the paddlefish harvested in Tennessee originate.



limit. During drought conditions in 1999 and 2000, the reported harvest from Kentucky Lake exceeded 10,000 paddlefish each year (compared to about 4,500 fish in years with high rainfall). Amid growing concerns that the stock in Kentucky Lake was being overfished, the commercial season in 2002 started two weeks later, fishers were required to use nets with at least 152-mm bar measure netting, and the minimum length limit was increased to 864-mm EFL. Despite these more restrictive regulations, federal authorities at the DMA requested more information on the exploited paddlefish stock in Kentucky Lake and a fishery independent assessment began in the fall of 2002 (Figure 2).

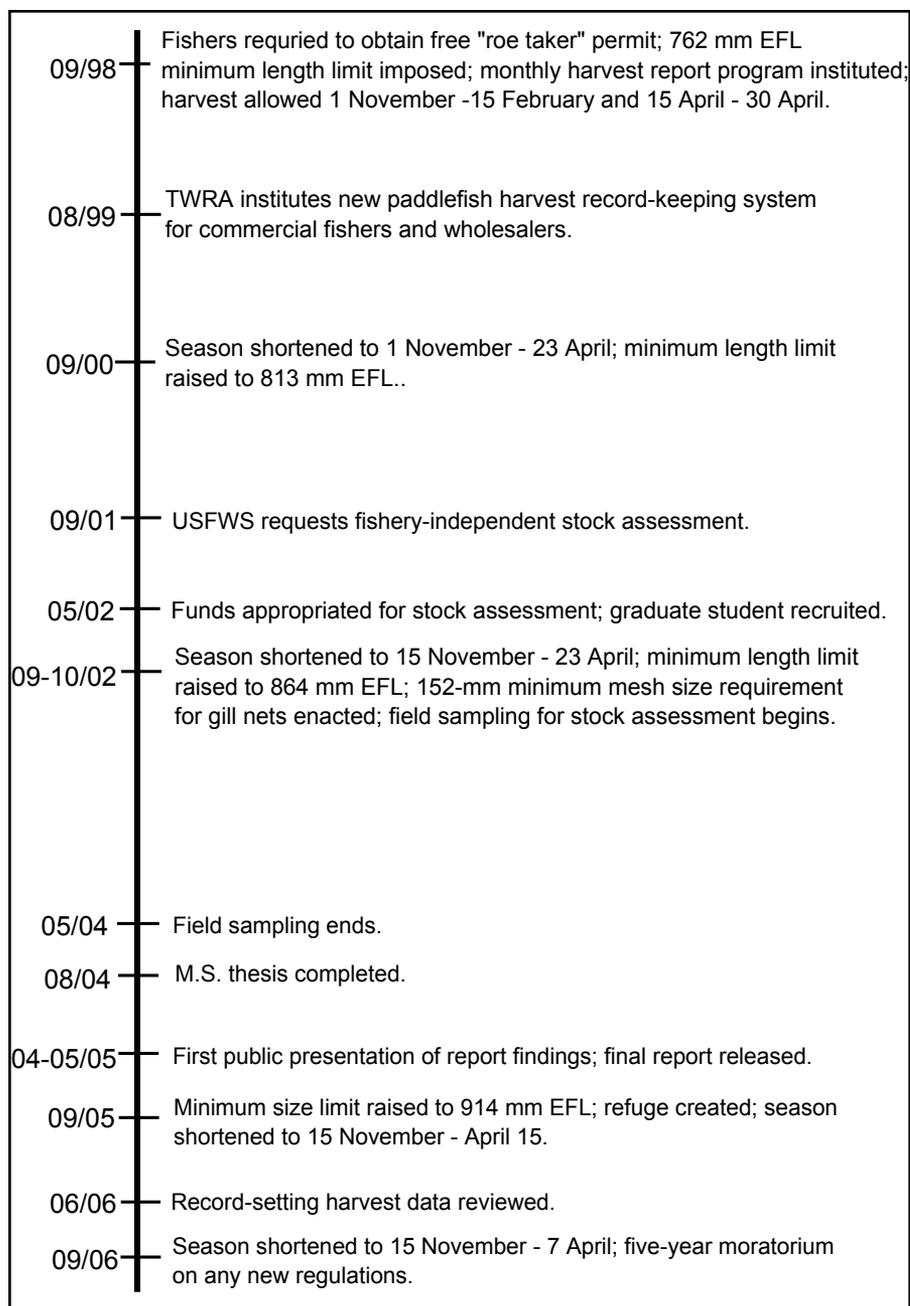
FISHERY ASSESSMENT

Research objectives, field sampling methods, and data analyses were presented by Scholten and Bettoli (2005) and Bettoli and Scholten (2006) and will not be repeated in detail here. In short, random samples of paddlefish in Kentucky Lake were collected with experimental gillnets before and after the commercial fishing season in two consecutive years. We also accompanied commercial fishers to sample their catch for additional ovary and dentary bone samples and record data on bycatch rates and initial mortality.

It was only after we established working relationships with several fishers concerned about overfishing that we tapped into their "Traditional Ecological Knowledge" (Price and Rulifson 2004). Under their tutelage, we fabricated new gear and altered where and how we fished our experimental gill nets. Most importantly, we learned that commercial fishing activity was linked to the amount of water discharged from Pickwick Dam. Commercial fishers avoid setting their nets at high flows (e.g., ~ 850 m³/sec or more) because the nets catch too much debris and are damaged, the nets do not fish properly, or for both reasons.

By the spring of 2004 we were able to collect or observe enough paddlefish ($n = 1,615$) to meet our primary project objectives, which were (1) mathematically assess whether the population was experiencing recruitment or growth overfishing, and (2) determine whether the new harvest regulations were sufficient to protect the population from both forms of overfishing. Our findings were presented in a M.S. thesis in August 2004 (Scholten 2004) and in a final report submitted to the DMA in May 2005. Given the likelihood that our results would be scrutinized by a skeptical commercial fishing community, we delayed submitting our final

Figure 2. Timeline of key events in the regulation of the paddlefish fishery in Kentucky Lake.



report and posting it on the Internet until our key findings had been subjected to the peer-review process. Scholten and Bettoli (2005) concluded (1) the population was experiencing growth overfishing (i.e., the average size of harvested fish was less than the size that would maximize yield-per-recruit), and (2) severe recruitment overfishing (i.e., the adult stock is overfished to the point that it does not have the reproductive capacity to replenish itself) would occur whenever weather conditions (i.e., dry winters) allowed heavy fishing activity. These findings were not unexpected because species that can be harvested at a young age, but mature at an old age (which is

true for paddlefish), are vulnerable to overfishing (Myers and Mertz 1998). The final report and subsequent publications (Bettoli and Scholten 2006; Scholten and Bettoli 2007) noted that for every mature (i.e., egg-laden) female paddlefish that was harvested, about 12 immature females and male paddlefish were captured by gill nets. More importantly, paddlefish bycatch (i.e., males and juvenile females; regulatory discards) suffered high rates of mortality at warm water temperatures (≥ 15 °C) at the end of the fishing season. Additionally, the hobbled gill nets used in this fishery did not exhibit size selectivity; thus, increasing the minimum mesh size regulation

in 2002 to 152-mm did not reduce bycatch of juvenile paddlefish.

PUBLIC MEETINGS AND THE DECISION-MAKING PROCESS

The problem of overfishing—and how to fix it—was not a “messy problem” (McCool and Guthrie 2001) because (1) there was general agreement in the scientific community about the validity of the scientific data, and (2) the goal for the fishery (i.e., manage the stock for sustained roe harvest) was understood by all. The problem was going to be convincing fishers to participate in solving the problem. To that end, TWRA administrators sought public involvement in the decision-making process via the consultative group approach described by Vroom and Yetton (1973), as adapted by McMullin (1996). Informational presentations would be made at open public meetings to heterogeneous audiences and questions and comments would be solicited. A more structured advisory meeting would follow and its agenda would be established by comments received from the open public meetings. The process loosely resembled “Fishbowl Planning” as discussed by McMullin (1996) because it was an iterative process of seeking inputs from stakeholders, redefining and communicating management goals and objectives, then seeking additional inputs from the public to produce a management plan that would be widely supported.

A schedule was drawn up for meetings at which the final report findings and recommendations would be presented to TWRA biologists and stakeholders (i.e., fishers, processors, caviar retailers, and politicians). The key recommendations that appeared in the final report to the USFWS (and TWRA) were to:

1. Immediately raise the length limit from 864 to 965-mm EFL;
2. Ban the use of monofilament gill nets (because they were shown to be more lethal to paddlefish released as bycatch than multifilament nets);
3. Establish a “no fishing” refuge in Kentucky Lake’s largest embayment (because it was habitat used by immature fish, not mature fish, during the fishing season); and
4. End the season 16 days sooner in the spring (to avoid warm water temperatures and high bycatch mortality rates).

The first official PowerPoint presentation of project findings and recommendations was given to senior TWRA administrators

at their headquarters in April 2005; the talk was not open to the public. Each PowerPoint presentation started off with a brief discussion of the two biggest threats to marine fisheries identified by high-profile commission reports (Pew Oceans Commission 2003; U.S. Commission on Ocean Policy 2005); namely, overfishing and bycatch. Problems in marine fisheries management were presented to make the point that the issues surrounding paddlefish exploitation and management were not unique. That “Director’s Meeting” talk was followed two weeks later by a similar presentation to the commissioners of the TWRC, which was open to the public.

The final report of the stock assessment was posted on the Internet in early May 2005 (www.tntech.edu/fish/PDF/Paddlefish.pdf) and a presentation was made to a meeting of TWRA biologists in mid-May 2005. The biologists were not necessarily aware of the findings presented in the two earlier talks; thus, this talk gave them the opportunity to comment.

Public meetings targeting commercial fishers were presented in three Tennessee cities in late June 2005. Each meeting was hosted by the chief of fisheries for TWRA (WCR) and was attended by TWRA regional managers and biologists. Only seven commercial fishers, as well as a lawyer, stenographer, and videographer hired by a commercial fisherman, attended the first meeting in a pavilion on the banks of the Tennessee River in Chattanooga, about 400 km upstream of Kentucky Lake. Most of the local fishers in attendance targeted other commercial fish species besides paddlefish (e.g., Ictaluridae, *Ictiobus* spp.). After the presentation, commercial fishers took the opportunity to voice their anger over TWRA policies relating to commercial fishing and sport fishing. Most comments relating to paddlefish management revolved around opening up new waters to paddlefish harvest.

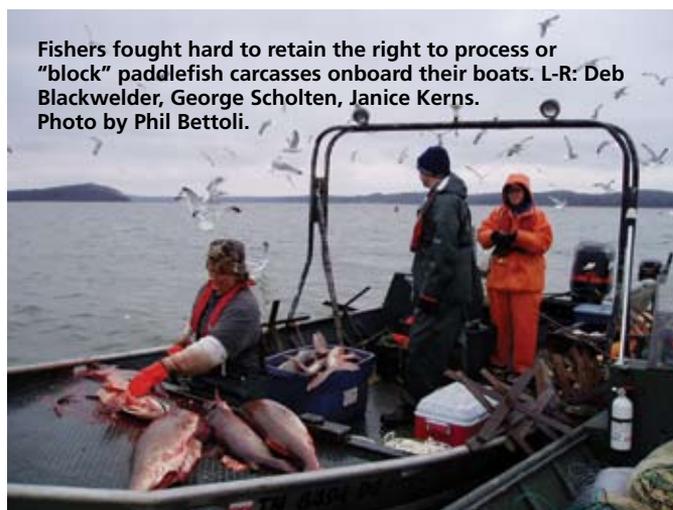
The next public meeting was held the following night in a west Tennessee city (Jackson) that was much closer to Kentucky Lake and most Tennessee roe buyers. Approximately 30 commercial fishers were in attendance, as well as two elected representatives from

the Tennessee State House, several TWRC commissioners, and uniformed wildlife officers. The questions that followed the presentation left little doubt that no common understanding of the problem or potential solutions would be achieved that night. Questions covered a wide range of topics only distantly related to the issue of what steps should be taken to reduce overfishing and ensure the sustainability of the resource. Audience participation was largely limited to a handful of charismatic speakers, which is not uncommon at large public meetings.

The final meeting in the series was held three days later in Nashville. Only four commercial fishers attended and the most meaningful dialogue between biologists and fishers occurred at that meeting. Two fishers noted that the paddlefish they exploited in the Mississippi River matured at a smaller size than those in the Tennessee River. One fisher pointed out that a ban on monofilament netting would be unnecessary if fishing was restricted to the coldest months, when the lethality of the two types of net did not differ (according to Bettoli and Scholten 2006).

After three public meetings in five days, we learned that (1) opposition to all recommendations was strong and organized, (2) the possibility of important biological differences among paddlefish stocks should be considered when proposing new regulations, and (3) open public meetings are not conducive to problem solving. We also noted that fewer than 35% of the holders of free paddlefish permits attended any of the meetings.

The public meetings were followed by a TWRC meeting in late July 2005 at which the third author (as chief of fisheries) responded to an earlier request to open up more waters to commercial harvest of rough fish and paddlefish; proposed new paddlefish regulations were also unveiled. At least 23 commercial fishers



Fishers fought hard to retain the right to process or “block” paddlefish carcasses onboard their boats. L-R: Deb Blackwelder, George Scholten, Janice Kerns. Photo by Phil Bettoli.

were present, as well as representatives from various sport fishing and conservation groups. One common theme among proponents of opening up new waters was that removing rough fish is good for sport fish. Opponents opined that (1) the interests and economic impact of sport anglers in those reservoirs dwarfed the benefits that might be accrued by a handful of commercial fishers, and (2) those waters were too crowded with recreational boaters to permit widespread deployment of gill nets. The commissioners subsequently opted to keep the commercial fishing ban in effect in the upper Tennessee River and not open additional waters.

Following the July 2005 TWRC meeting, all ($n = 112$) fishers holding a free paddlefish permit were invited to attend a facilitated meeting in Nashville in August 2005. (Note: Beginning in March 2006, paddlefish and sturgeon permits previously issued by TWRA at no charge were replaced with a roe fish permit costing US\$1,000 and the fee for a commercial fishing license was increased from US\$125 to US\$200; fishers were required to purchase a roe fish permit and commercial fishing license if they wanted to harvest paddlefish or shovelnose sturgeon *Scaphirhynchus platyrhynchus*.) Forty-two fishers attended and they were instructed (in their invitation letters) to choose seven of their peers to represent their views. The purpose of the meeting was to obtain the opinions of fishers on the proposed regulation changes (Table 1), but in a more structured environment than the open public meetings. The panel was seated and the facilitator (the personnel director of the TWRA) explained the rules of the meeting. Fishers not on the panel would not be allowed to speak until the panel addressed each regulation.

Despite the best efforts of the facilitator, panelists did not limit their comments to each regulation as each was considered. When the “no fishing refuge” recommendation was presented for discussion, few comments were directed at the idea of a refuge itself. Most fishers eventually agreed that it would not

be a burden. After about an hour, the panel agreed to consider the next regulation.

Limited entry was not recommended in the final report but the TWRA included that option in their list of recommendations. That is, TWRA would be willing to limit the number of new roe fish permit holders to some percentage above the number that purchased this new permit before the end of the 2005–2006 fishing season. The panel was unanimously in favor of limited entry, which clearly benefited them and their colleagues.

The discussion on shortening the season was brief. TWRA staff indicated at the July 2005 TWRC meeting that they wanted to close the season on 31 March. The final report recommended moving the end of the season from 23 April to 7 April. A comment to “split the difference” between 7 April and 23 April (i.e., April 15) was met with approval by the full panel of seven commercial fishers. The brevity of their comments was surprising, considering how important season length was to their ability to make a living.

The ban on monofilament netting met with opposition from some fishers, particularly those fishing the Mississippi River. Many fishers prefer monofilament netting because it snags less debris (e.g., filamentous algae and other detritus) and shakes clean easier than multifilament netting.

The subsequent recommendation that fishers be prohibited from “blocking” paddlefish onboard their boats met with strong opposition. Removing the head, tail, and fins was commonplace, but this made the use of a minimum length limit (the next item up on the agenda) problematic. In the past, a fisher could keep an intact paddlefish longer than the minimum EFL limit, or a blocked carcass longer than a length calculated by TWRA officials to represent the minimum EFL length limit. For instance, when the minimum length limit was 864-mm (34”) EFL, the blocked carcass had to be at least 635-mm (25”) long. Allowing fishers to use either approach had long troubled TWRA enforcement officers because of the potential

of fish being blocked in such a way as to make an illegal fish legal.

The discussion concerning blocking fish was followed by strong opposition to increasing the length limit from 864-mm EFL to 965-mm EFL over four years, with the option of going to a 1,016-mm EFL limit if the population did not show signs of recovering from overfishing. The panel generally agreed that a 914-mm length limit could be tolerated, but a 965-mm length limit would hurt business too much; raising the minimum size to over 1,000-mm EFL was totally unacceptable. The floor was subsequently open to comments from all fishers in attendance. Most comments revisited topics that had earlier been taken off the table (e.g., opening new waters to commercial paddlefish harvest; stocking fingerlings to mitigate for overfishing).

A regularly scheduled TWRC meeting in Knoxville in September 2005 followed the August 2005 “invitation only” facilitated meeting. This was the “Proclamation Meeting” at which new paddlefish regulations would be voted on by the commission. As chief of fisheries, the third author listed each proposed regulation change that the TWRA fisheries staff had crafted after considering three months of public meetings and comments; the audience was then allowed to speak to each proposed change. The TWRC received few complaints from the audience when they voted to establish the proposed refuge. In fact, when one commissioner questioned whether a refuge was necessary, a commercial fisher spoke up and defended the concept of a refuge.

The stepwise increase in the length limit (immediately raise the length limit from 864 to 914-mm EFL, then raise it to 965-mm EFL over a three-year period) was not debated on its merits by four fishers who opposed that change. For instance, the oft-repeated claim came up again that the researchers did not know what they were doing until they (the commercial fishers) helped them (the researchers) catch fish. The TWRC was not swayed by those arguments against the mini-

Table 1. Potential regulations presented for discussion by a Tennessee Wildlife Resources Agency facilitator to a panel of seven representatives of the commercial paddlefish fishing industry at a facilitated meeting in Nashville, Tennessee, August 2005. Another 35 fishers were in attendance.

Regulation	Rationale/justification
Establish a no-fishing refuge	Reduce bycatch rates and mortality by reducing encounters between juvenile paddlefish and gillnets.
Limited Entry	Prevent the number of fishers targeting paddlefish from increasing with ever-increasing roe prices.
Shorten Season	Reduce harvest and prevent fishing when high water temperatures will cause high bycatch mortality.
Ban monofilament nets	Reduce bycatch mortality.
Prohibit the blocking ¹ of carcasses onboard	Improve the ability to enforce minimum length regulations.
Increase the minimum length limit	Reduce growth overfishing and eliminate concerns over recruitment overfishing.

¹ Removing the head, tail, fins, and viscera to facilitate storage and chilling of the carcass.

imum length limit increases and that regulation change was subsequently enacted.

The proposal to shorten the season and end it on 31 March was met with comments from fishers that the commission should not confuse academic research with reality and that shortening the season and raising the length limit at the same time would hurt their businesses too much. The TWRC agreed with the latter assertion and amended the proclamation to end the season on 15 April. TWRA staff biologists were confident that the TWRC would approve the 31 March closure; thus, they did not propose a monofilament ban. Upon learning that the season would end two weeks later than proposed, an attempt was made to convince the commissioners that a later closure date should be accompanied by a monofilament ban, but that request was denied.

The regulation to ban blocking of carcasses was opposed, as expected, by the fishing industry and several fishers spoke forcefully to the issue. Several TWRA staff countered that sport anglers are not allowed to process their catch onboard and commercial fishers should not be treated any differently. The TWRC was unconvinced by that argument and voted to allow fishers to block their catch. The final recommendation (limited entry) met with no opposition and the TWRC voted to limit the number of roe fish permits that would be issued during future seasons to 115% of permit sales during the 2005–2006 license year.

In summary, the TWRC enacted two regulations (establish a refuge and limit the number of roe fish permits) that would help keep fishing pressure from rising higher than the Kentucky Lake stock was currently experiencing. However, those two regulations would do little to reverse the trend of declining size- and age-structure of the population. The new minimum length limit regulation that passed was intended to increase the average age and size of fish in the population, and reduce the likelihood of growth and recruitment overfishing. The higher minimum length limits also satisfied the desire to allow at least some female paddlefish to spawn at least once before they were vulnerable to harvest, a common theme in marine fisheries management plans (Myers and Mertz 1998). However, the efficacy of the higher minimum length limit regulation was in question because (1) already high bycatch rates would climb under the higher length limit, and (2) shortening the season by only eight days (and not banning monofilament netting) might not reduce bycatch mortality to acceptably low rates.



Large, mature female paddlefish, like this one being held by Janice Kerns, represent a small percentage of all paddlefish caught in commercial gillnets. Photo by Phil Bettoli.

With these new regulations in place (refuge area, cap on permits, higher minimum length limit, slightly shorter season), the 2005–2006 commercial season commenced. When fishery harvest data were tallied after the season ended in April 2006, it was clear that the 2005–2006 season was exceptional. Rainfall and river flows were modest, fishers had ample opportunity to deploy their gear, and the reported statewide harvest of egg-bearing paddlefish ($n = 7,277$ fish) and the egg harvest (12,827 kg) were the highest ever recorded by TWRA. Coupled with an increase in prices that fishers were getting for paddlefish eggs (approaching US\$200/kg), such high harvests prompted TWRA to redouble their efforts to shorten the season to their original target of 31 March.

Another facilitated meeting was held in June 2006 to present the previous season's harvest data and discuss possible regulation changes; in particular, shortening the season from 15 April to 31 March. As before, the fishing industry chose seven representatives to represent its interests. Fishers were adamant in not wanting to shorten the season any further for the same reasons voiced at earlier meetings. The fishers themselves put forth several proposals, most notably to cease fishing when a certain temperature was reached and to ban the use of monofilament netting after 31 March. These two recommendations were an acknowledgment by fishers that bycatch mortality is problematic when waters are warm and that monofilament netting is more injurious than multifilament netting. These recommendations were proposed to

forestall what the fishers probably suspected was inevitable: shortening the season yet again to further reduce harvest.

The TWRA representatives responded by stating (1) closing the season when a certain temperature is reached might have some merit, and (2) the possibility of a monofilament ban was taken off the table last year and should not be brought up again at this time. When asked to rank the various management options discussed at this meeting, the fishers ranked "No change" (which was not an option) as number 1, followed by ending the season when a specific temperature was reached, and closing the fishery each year on 7 April (8 days sooner). After a heated debate, a consensus was reached among the fishers that closing the season on 7 April was acceptable. That consensus was reached after one fisher noted that the TWRC would view them very unfavorably if they failed to act responsibly and agree to do something to reduce what many agreed (either privately or publicly) was an unsustainable harvest.

At the regularly scheduled TWRC monthly meeting in September 2006, the commissioners saw one more PowerPoint presentation. The high harvest numbers from the previous season were discussed and it was recommended (again) that the paddlefish season should end on 31 March each year. It was also proposed that the number of roe fish permits should be limited to 80 each year (this was 115% of 2005–2006 permit sales). The 16+ commercial fishers in the audience argued many points, in particular that they had already given up enough and that they

couldn't and shouldn't be asked to give up any more. The full commission subsequently compromised and proclaimed that the season would end on 7 April each year, one week later than TWRA biologists proposed, but eight days sooner than the fishers might have hoped. Additionally, everyone agreed that no new paddlefish regulations would be proposed (except for the Mississippi River paddlefish fishery where possible regulation changes were still being discussed with border states) until after the 2009–2010 fishing season and the effects of the new regulations were evaluated.

LESSONS LEARNED

Initial discouragement following several of the open public meetings turned out to be unjustified. Although two of three public meetings were unproductive in terms of having a meaningful dialogue, they allowed us to gather the information needed to subsequently host more productive, facilitated meetings. Secondly, we suspect that forgoing the open public meetings and moving right to a facilitated meeting would have been a mistake: many fishers were angry that their industry was being closely scrutinized and they wanted to make their feelings publicly known. Thus, the open meetings were a perfect forum for publicly voicing opposition to the government (in general) and fisheries scientists (in particular). Of course, managers should not think that simply hosting a few boisterous public meetings and letting stakeholders vent their anger or frustration will make a "messy problem" go away. The TWRA made that mistake in the 1990s when a controversy erupted over management of a trophy striped bass (*Morone saxatilis*) fishery, which pitted anglers targeting that transplanted species against anglers pursuing native species

such as walleyes (*Sander vitreus*) and crappies (*Pomoxis* spp.; Churchill et al. 2002).

The fact that commercial paddlefish fishers and industry representatives were given multiple opportunities in different settings to participate in the regulatory process (Table 2) was clearly not lost on members of the TWRC. Although not all of the regulations proposed by the TWRA staff were adopted, the TWRC's actions at the September 2005 meeting collectively represented the largest steps ever taken by the TWRC to conserve the resource. Additional proposals to further restrict fishing were also entertained (and compromise versions were enacted) by the TWRC at their September 2006 meeting. Although the regulations currently in effect will probably not help rebuild the stock of paddlefish in the lower Tennessee River, the TWRC noted that stronger measures to rebuild the stock would be considered if future sampling indicates such measures are necessary.

How did the USFWS and its DMA staff react to what was (or was not) accomplished to protect paddlefish in the lower Tennessee River? The DMA was kept apprised during the regulatory process and indicated that (1) the regulations passed in September of 2005 and 2006 were positive first steps towards conserving the resource, and (2) export permits would be provided to purveyors of Tennessee paddlefish caviar (M. Maltese, DMA, pers. comm.). The DMA also indicated that future requests for export permits would not be automatically granted.

The 2005–2006 and 2006–2007 commercial paddlefish seasons in Tennessee proceeded against the backdrop of a recent ban on the importation into the United States of caviar from beluga sturgeon (*Huso huso*), followed by a CITES ban (albeit temporary) on the exportation of other sturgeon products (e.g., sevruga caviar from *Acipenser stellatus*) from

Caspian Sea states. Perhaps not coincidentally, the wholesale prices for paddlefish roe in Tennessee jumped from around US\$110/kg in 2004–2005 to US\$143–187/kg during the 2005–2006 season; in some locales during the 2006–2007 season, fishers were receiving more than US\$200/kg for paddlefish roe taken from Tennessee waters. In other words, negotiations to more tightly regulate paddlefish harvest in Tennessee occurred at a time when a single large female carrying 3.5 kg of roe was worth more than US\$650 wholesale (and twice that or more at retail prices). The new Tennessee regulations, coupled with rising prices for paddlefish roe, may be contributing to increased commercial fishing activity on the Ohio River, particularly by Tennessee residents (D. Henley, Kentucky Department of Fish and Wildlife, pers. comm.). These observations serve as justification for biologists throughout the Mississippi River basin to continue to work together to monitor their respective paddlefish fisheries, and for the DMA to continue to scrutinize requests for export permits for paddlefish roe, especially if unambiguous signs of overfishing exist.

In conclusion, our approach to assessing the likelihood of overfishing, communicating research findings, and moving paddlefish management and conservation in Tennessee into the twenty-first century yielded positive results. Our approach could be summarized as (1) conduct a fishery independent stock assessment that can withstand peer-scrutiny, (2) interact with fishers and provide them with opportunities to participate in data collections, (3) carefully schedule how, when, and where research findings and management recommendations will be presented to the industry and decision makers, (4) provide ample and varied opportunities for fishers to learn about the research and participate in crafting new regulations, and (5) take what-

Table 2. List of presentations and meetings during the regulatory process with commercial paddlefish fishers, the Tennessee Wildlife Resource Agency (TWRA) staff, and the Tennessee Wildlife Resource Commission (TWRC). A PowerPoint presentation was made at every meeting except the August 2005 facilitated meeting.

Date	Audience and Type of Meeting	Objective or Action
April 2005	TWRA administrators and senior staff	Presented final report findings and recommendations.
April 2005	TWRC monthly meeting	Presented final report findings and recommendations to commissioners and the public.
June 2005	Open Public meeting Tennessee; solicited comments.	Presented final report findings and recommendations to commercial fishers in and around Chattanooga,
June 2005	Open Public meeting solicited comments.	Presented final report findings and recommendations to commercial fishers in and around Jackson, Tennessee;
June 2005	Open Public meeting Tennessee; solicited comments.	Presented final report findings and recommendations to commercial fishers in and around Nashville,
July 2005	TWRC monthly meeting	Argued against opening up new waters to paddlefish harvest; unveiled proposed new regulations.
August 2005	Facilitated meeting	Proposed new harvest regulations to commercial fishers and solicited their comments; sought consensus.
September 2005	TWRC monthly meeting	Commissioners voted on proposed new regulations.
June 2006	Facilitated meeting to further restrict harvest.	Reviewed past season's harvest data and sought consensus on management actions that should be proposed
September 2006	TWRC Monthly meeting	Commissioners voted on proposed new regulations

ever time is necessary to educate commercial fishers and decision makers on the issues.

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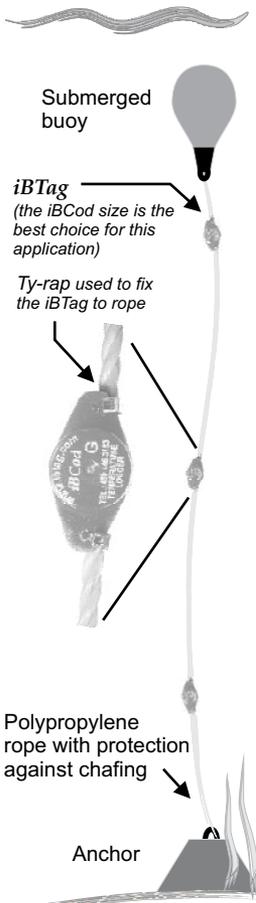
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