An Analysis of Exploitation and Harvest of White Crappie in Poverty Point Reservoir, Louisiana

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Abstract: Because of growing angler concern regarding excessive crappie (*Pomoxis* spp.) harvest in Poverty Point Reservoir, Louisiana, exploitation rate of white crappie (*P. annularis*) was estimated from 1 January to 31 May 2009, and data were collected on angler characteristics throughout the year at this relatively new reservoir. A reward-tag approach was utilized to assess exploitation, while angler characteristics were determined through a stratified, random, access-point creel survey. White crappie ($n = 243$) were tagged from January–March 2009 with Floy T-bar anchor tags labeled with REWARD and a sequential tag number. A total of 135 tagged crappie were harvested and reported by anglers by 31 May 2009. Exploitation was estimated at 59.3% based on the assumption of a 10% non-reporting rate and no tagging mortality, but could have exceeded 70% if mortality or non-reporting were higher than estimated. The creel survey revealed that crappie anglers harvested 1.33 crappie per hour, with a mean total length of 290 mm. Angler effort for crappie was estimated at 21.8 h/ha within the eight-month creel period. Fishing mortality and harvest data obtained from this study will supplement future age and growth data to obtain an accurate assessment of total annual mortality, and be utilized in simulations to model the effects of various harvest regulations on the crappie population in Poverty Point Reservoir. This study will also be used as a model in the investigation of specialized crappie management in Louisiana.

Key words: crappie, reward tags, exploitation, harvest rate, creel survey

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In fisheries management, an accurate assessment of angler harvest of a fish population is a vital component to making informed management decisions (Boxrucker 2002). This is especially important when angling pressure is perceived to be high enough to influence the population dynamics of a species. Isermann et al. (2002) found that, generally, exploitation rates for various yield equilibrium models must be at least 40% to gain any size limit improvements on crappie (*Pomoxis spp*.) populations through special regulations. Historically, insufficient harvest of crappie has been a limiting factor in regulation effectiveness, rather than overharvest. However, an increase in the popularity of crappie fishing, greater efficiency of anglers, and year-round harvest opportunities has led to potentially excessive levels of angler harvest in some popular reservoirs known for crappie angling (Maceina et al. 1998, Boxrucker 2002). Annual crappie harvest rates of 18 lakes in the southeastern and midwestern United States averaged 48% (Allen et al. 1998), although Colvin (1991) has documented white crappie (*P. annularis)* harvest rates that exceeded 60%. Crappie populations are able to withstand high exploitation rates when growth rates are adequate and natural mortality is high. The significance of angling or any other compensatory type of mortality declines with an increase in natural mortality (Reed and Davies 1991, Allen and Miranda 1995). Crappie population dynamics can be adversely affected if angling selectivity and harvest are high (Miranda and Dorr 2000). Also, if the physical characteristics of a water body congregate fish, such as when preferred spawning habitat is limited, these features create the potential for excessive harvest by facilitating efficient angler harvest. A negative consequence of high harvest is a population with few older individuals (Redmond 1986), which can also mean few large or trophy fish available to anglers, especially when growth is slow.

Crappie have traditionally been a very important fish to anglers in Louisiana, and crappie consistently rank as the second most popular freshwater fish in Louisiana (Kelso et al. 2001). Louisiana has historically managed crappie with a liberal 50 fish daily creel limit, with Poverty Point Reservoir being the only waterbody entirely within the state to have a special regulation on crappie. Shortly after the lake was opened in 2003, angler concerns of overharvest led to a reduced daily creel of 25 fish and no length restriction. In recent years, concerned anglers and waterbody commissions throughout Louisiana, have requested special management for crappie in other systems to protect against potential overharvest and improve the overall quality of the fishery. Isermann et al. (2002) concluded that managing crappie fisheries within a state or region on a categorical basis may provide a more effective management strategy than the use of a single area-wide regulation. Guy and Willis (1995) also concluded that ecosystem-specific management may prove more beneficial for crappie than statewide management strategies. Poverty Point Reservoir (PPR), located in northeast Louisiana, was chosen as a study site to obtain an angler exploitation rate and subsequent effects on the crappie population. This reservoir is a popular fishing destination for crappie, which represented 57% of the total angler effort in a 2008 creel survey conducted by Louisiana Department of Wildlife and Fisheries

(LDWF) (R. Daniel, LDWF, unpublished data). Age and growth data from 2008 showed that few crappie older than age 2 existed in this impoundment (LDWF, unpublished data). Thus, the primary objective of this study was to estimate exploitation and harvest characteristics of white crappie in PPR to gain a better understanding of angler impacts on this population and to potentially use this information to more effectively manage crappie in PPR. Although black crappie (*P. nigromaculatus*) are present in the lake, past sampling and creel surveys performed by LDWF have shown that they compose <5% of the crappie population and thus were not included in this study. This study served as an initial step in the investigation of the use of a waterbody-specific or ecosystem-specific approach for managing crappie fisheries in Louisiana.

Study Area

Poverty Point Reservoir is a 1,092-ha eutrophic impoundment located in the alluvial valley of the lower Mississippi River. Construction was completed in 2001 and angling was first allowed in April 2003. The reservoir supports fisheries for largemouth bass (*Micropterus salmoides*), black crappie, white crappie, sunfish (*Lepomis* spp.), and channel catfish (*Ictalurus punctatus*). Angling pressure on crappie remains high, especially in the winter and spring months. The impoundment has an average depth of 2.3 m and very little bottom contour. Deeper water is primarily limited to two submerged oxbows, a single creek channel, and an inundated cypress brake on the north end, with maximum depth of 10 m. The lack of surrounding trees and flat topography causes the lake to be severely windswept and turbid, limiting the presence of aquatic macrophytes. Annual water-level fluctuation is normally less than 0.5 m from normal pool stage, partly due to a very small watershed (< 2:1 watershed:surface area ratio). Public access is limited to two boat ramps owned by Poverty Point Reservoir State Park, and several dozen private residences are also located on the reservoir.

Methods

Tag-Return Study

To estimate exploitation, white crappie were collected and tagged from 6 January to 9 March 2009. Crappie were collected at various locations with fyke nets, which were equipped with two 1.3-m diameter hoop nets with 2.5-cm mesh attached at each end of a 6.6 m lead. Additional fish were also collected using a prod pole from an electrofishing boat using pulsed DC current. Nets were checked and fish removed every 24 hours. All crappie greater than 200 mm in total length (TL) were double-tagged with orange Floy 68BCT-bar anchor tags inserted just below the rear half of the dorsal fin approximately 2 cm apart. All tagged fish were measured for TL (mm) and released at their capture location. Length frequencies of reported and unreported tagged fish were tested for difference with a Kolmogorov-Smirnov test with Microsoft Excel software. Mean lengths of reported and unreported tagged fish were compared using a two-tailed *t*-test with QuickCalcs online calculator by GraphPad Software.

To encourage angler reporting, all tags were labeled "REWARD." All anglers that reported a tagged fish were awarded a custom ball cap and entered into a drawing for a grand prize valued at $200, consisting of a custom crappie rod, reel, and tackle package. Large information signs were placed at the boat launches and state park facilities, and a press release was issued by LDWF to help encourage angler participation. Manned facilities at both entrances to the state park provided convenient opportunities to return tags. When anglers returned a tag, they were asked to complete a tag return form. Requested information included: tag number, the number of tags found on the fish, name and phone number of angler, and the date and general location of where the fish was caught.

Exploitation rate was estimated as the fraction of tags from fish caught by anglers by 31 May 2009, adjusted for tagging mortality, tag loss, and incomplete reporting. Tags were accepted until 31 December 2009. A mean return rate was calculated from the return rates of individual tagging dates, similar to the method described by Pegg et al. (1996). Rate of tag loss was estimated by the percentage of returned fish that had only one tag, while also accounting for the number of days since the fish were tagged. To further assess tag loss and tagging mortality, 10 double-tagged crappie were held in a hoop net on site for a period of one week, and an additional 15 crappie were placed into a 1-acre pond at the LDWF Monroe Hatchery for a six-week period. At the end of each period, nets were pulled or ponds were drained and all crappie were collected and examined for the presence of both tags. Non-reporting rate was estimated using information from overall return rate, communication with state park personnel manning exits, and anglers interviewed during creel surveys. When creel clerks interviewed anglers during associated creel surveys, the anglers were asked if they had caught tagged fish. If so, the clerks recorded the tag number as given by the angler, and then inspected fish in the angler's possession for the presence of tags, recording all tag numbers. Tag return data was later examined to see if any tags recorded during creel inspections had not been reported.

Creel Survey

A stratified random creel survey was used to collect data for estimating fishing pressure, harvest rate, total harvest, and angler opinions of the current crappie regulations at PPR. Surveys were only conducted of boating anglers and interviews were conducted on a party basis. Shoreline anglers were not surveyed due to the dif-

Table 1. Number of creel surveys conducted at each boat ramp (north or south) and day of week (PSU) for each month of the 2009 PPR creel study.

	PSU			
	Weekday		Weekend	
Month	North	South	North	South
January	1	1	1	3
February	1	1	3	1
March	1	1	4	0
April	1	1	3	1
May	1	1	3	1
October	1	1	2	2
November	1	2	0	2
December	1	1	0	5

ficulty associated with fishing location and determination of trip completion and because they have historically comprised only a small percentage of the total fishing pressure on PPR. Access point surveys, similar in design to other LDWF standardized creel surveys (LDWF 1994) were conducted at each of the two boat ramps throughout 2009. Six surveys were conducted each month, with the exception of June to September when none were conducted. Previous creel surveys performed by LDWF showed an insignificant amount of crappie angling during this period. Sampling was stratified by day of week, boat ramp location, and time period. The primary sampling unit (PSU) was day of week to account for differences in fishing pressure between weekends and weekdays. Four weekend days and two weekdays were chosen at random each month. The secondary sampling units (SSU) were boat ramp location and period of day (morning or evening). Each boat ramp was scheduled to be sampled one weekday per month, while the four weekend days were scheduled according to the ramp that received the greatest amount of lake access on a seasonal basis. Specifically, the south ramp was scheduled more frequently than the north ramp during the winter months (September to February) due to its close proximity to a popular deepwater area. The north ramp, on the other hand, was close to a major spawning location, thus it was scheduled more frequently during spring months (March to May). Each survey lasted 5 h, with the time of day (morning or afternoon) chosen at random. Morning surveys began 2 h after sunrise, and afternoon surveys began 4 h before sunset. Table 1 shows the day of week (PSU) and location (SSU) on a monthly basis for each survey performed in 2009. If there were less than three vehicles at the scheduled boat ramp, creel clerks were instructed to conduct the survey at the other boat ramp if at least three vehicles were present there.

All fishing parties were interviewed and a minimum of 10 crappie were randomly selected and measured from each boat which had crappie in possession. No other species were measured. The total number of fish harvested was recorded and the following information was recorded from each interview: distance in miles from residence to lake, time fished in hours, primary species fished for, species, and number of fish released; only crappie anglers were asked whether or not they were satisfied with the current crappie regulations on PPR. If the angler was not satisfied, the angler was asked for any recommendations. The satisfaction question was only asked of anglers who had not been previously surveyed during 2009. Anglers were specifically asked if they had caught a tagged crappie, with the tag number being recorded if they were presented a tag. Fishing pressure was determined by calculating mean number of crappie angler hours per creel survey for each ramp on both weekdays and weekends on a monthly basis. Mean rates were multiplied by two, assuming two (5-h) fishing periods per day, and applied accordingly for each month. Harvest rate (catch per h) was also determined on a monthly basis, and was calculated by dividing the total number of crappie harvested by the total angler h. Differences among monthly harvest rates were tested with a non-parametric Mann-Whitney *u*-test. The difference in monthly mean length of harvested crappie was determined using an ANOVA with Microsoft Excel software. Significance for all statistical tests in this study was set at $P < 0.05$.

Results

Tag-Return Study

A total of 243 crappie were tagged on six different days between 6 January 2009 and 9 March 2009. Most were captured in fyke nets, but 70 fish were collected by electrofishing on 9 March 2009. By the end of the study period, a total of 135 tagged fish had been reported by anglers, representing an overall return rate of 55.6%. The mean of the individual return rates for each of the six tagging efforts was 53.4% and ranged from 25.0%–70.8% (Table 2)

Mean length of the tagged crappie was 278.5 mm TL. Mean length of tagged crappie that were captured and reported by anglers was larger (285 mm) than those that were not (268 mm TL; $t = 3.7$, df = 239, $P = 0.0003$). Rate of return also increased with fish

Table 2. Return rate and number of white crappie tagged and returned for each tagging date on PPR in 2009.

Tagging date	Return rate	*n* returned	*n* tagged
6 January	70.8	51	72
7 January	62.5	10	16
14 January	28.6	16	56
3 March	69.2	9	13
4 March	25.0	4	16
9 March	64.3	45	70

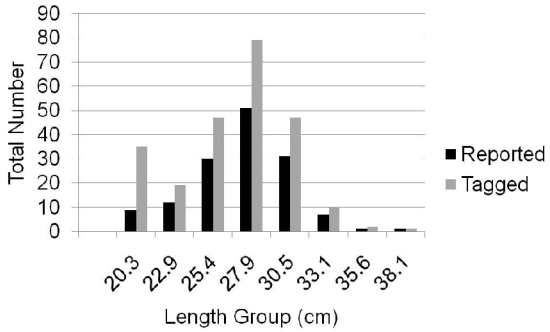

Figure 1. Length frequencies of tagged and reported crappie in PPR during 2009.

Table 3. Estimates of exploitation among various non-reporting rates for each tagging date from the 2009 PPR tag-return study. Zero mortality is assumed.

	Non-reporting rate		
Tagging date	**0%**	**10%**	**20%**
6 January	70.8	78.7	88.5
7 January	62.5	69.4	78.1
14 January	28.6	31.7	35.7
3 March	69.2	76.9	86.5
4 March	25.0	27.8	31.3
9 March	64.3	71.4	80.4
Mean	53.4	59.3	66.7

length: 29% for fish ≤ 225 mm, 33% for fish 226–250 mm, and 66% for fish > 250 mm. However, a Kolmogorov-Smirnov test revealed that there was no difference in length frequencies between reported and non-reported fish ($P = 0.52$, Figure 1).

Two returned fish had lost one of the two tags, for a mean tag loss rate of 1.5%. Because all fish were double-tagged, it was assumed that all tagged fish retained at least one tag until the end of the study period. Also, of the 15 double-tagged crappie that were placed into a hatchery pond for a six-week period, all six recovered crappies had both tags firmly attached, thus tag loss was assumed to be nil. The 10 white crappie held in a hoop net for one week were alive and appeared normal when released, thus tagging mortality was also considered to be nil. A precise estimate of non-reporting rate was not determined, but was believed to be <20%. Factors leading to this estimate include 1) a high actual return rate (> 62% for 4 of 6 tagging events), 2) conversation with State Park personnel and anglers revealing awareness and full support of the study, 3) the convenience of reporting tags, 4) no tags were observed on any checked crappie that the angler was unaware of, and 5) all of the seven tagged fish that were reported during the creel surveys were also turned in to the State Park for a reward. State Park personnel reported that they were concerned that some of the shoreline anglers may not have been aware of the study and may not have participated. However, based on observations made during the study the shoreline angling component was believed to be less than 5%. When assuming a non-reporting rate of 10%, with no tag loss or tagging mortality, the estimated exploitation rate was 59.3% (Table 3).

Creel Survey

A total of 348 interviews of crappie angling parties were conducted during the 48 surveys. Crappie angler interviews represented 67% of all angler interviews, and composed >70% of all anglers for seven of the eight months surveyed and >92% in four of those months. The boat ramp scheduled to be surveyed was changed on five occasions due to fewer than three vehicles present at the scheduled ramp. Five surveys were conducted in November and seven in December due to creel clerk scheduling conflicts. Mean party size was 1.6 and mean fishing trip duration was 4.7 h. The creel survey estimated total fishing pressure on white crappie by boating anglers at 23,866 angler h (21.8 h/ha) for 2009, assuming little angling occurred during the non-creeled months. On average, 6.3 crappie were harvested per angler trip, and the overall mean rate of harvest was 1.33 crappie/angler-h. On 11 occasions boat anglers possessed the maximum daily limit of 25 crappie per person per day, representing 3% of the crappie anglers interviewed. The monthly trends were similar for both total harvest and hourly harvest rate with success being highest in the months of November, December, and January (Table 4). Total harvest of white crappie was estimated to be 30,462. No difference was found among monthly harvest rates by the non-parametric Mann-Whitney *u*-test ($U = 13.000$, $P = 0.136$). The mean TL of harvested crappie was 290 mm over all months but was not similar among all months (ANOVA, $F_{7,687} = 6.97$, $P < 0.0001$). The mean duration of a fishing

Table 4. Number of interviews and monthly estimates of fishing pressure, hourly harvest rate, total harvest, and mean total length of harvested white crappie determined from the 2009 creel survey on PPR.

Month	***n* Interviews**	**Fishing pressure (total angler h)**	**Hourly harvest rate**	**Total harvest**	**Mean TL of harvested crappie**
January	38	2,758	1.6	4,413	292.8
February	50	2,973	0.76	2,260	289.5
March	70	5,611	1.22	6,845	291.0
April	53	4,464	0.78	3,482	276.7
May	5	356	0.65	231	262.0
October	23	1,070	0.85	910	288.5
November[a]	50	4,307	1.78	7,667	290.8
December[b]	57	2,327	2.00	4,654	294.1

a. 5 surveys
b. 7 surveys

trip was 4.7 h. When asked of their opinion of the current regulations for crappie on PPR, 89% of 230 responses indicated that they were satisfied. Of those not satisfied, 15 anglers requested a minimum length limit, with eight of those specifically mentioning a 254-mm minimum length limit. Four anglers requested a lower daily creel limit, while three wanted the statewide regulations (no minimum length and 50/d) to be re-imposed.

Discussion

The exploitation rate estimated for white crappie in PPR (59.3%) was higher than those reported from many other crappie studies. Allen et al. (1998) reported a mean of 48% for 18 lakes in the southeast and Midwest. Miranda et al. (2002) estimated annual harvest ranging from 17% to 54% for five lakes along the Mississippi River. Colvin (1991) estimated harvest to be around 60% for white crappie in four large Missouri reservoirs, though most previous studies estimated crappie harvest to range from 30% to 50%.

Tagging mortality and non-reporting rate, as with most studies of this type, were difficult to accurately estimate. The small control group did not reveal any problems with tagging mortality, with the nine missing fish from the hatchery pond likely explained by extremely cold temperatures and predation by otters (*Lutra canadensis*). Larson et al. (1991) reported up to 40% mortality with double-tagged crappie when temperatures exceeded 12.5 C, but water temperatures were mostly less than this during our tagging period. Also, double-tagging may negligibly increase tagging mortality, but considering the low probability of a fish losing two tags, especially with small sample sizes and a short term study, the benefit greatly outweighs this risk. There was some concern that the fish tagged on 14 January may have experienced significant capture and tagging mortality because these fish were collected from depths near 9 m and some of the fish did not immediately swim down. However, tags were returned for almost 30% of these fish, and the return rate of the tagging event on 4 March was also noticeably lower than other events, but these fish were not captured in deep water. If the 14 January fish had been omitted from analysis due to uncertainty of tagging mortality, the exploitation estimate would have risen from 59.3% to 64.8%, which are remarkably similar. Likely, non-reporting did not exceed 20% in this study due to the particular situation, including the small size of the reservoir, limited access points, and the ease of tag returns. Other literature suggests that a 20% non-reporting rate is very conservative. For example, Zale and Bain (1994) concluded that non-reporting rates in Alabama and Oklahoma were 33% to 36% using custom ball caps for rewards (as in the PPR study) and survey postcards as surrogate tags. By using a non-reporting rate of 10%, and assuming no tagging mortality, the exploitation rate of 59.3% in PPR is a conservative estimate of the minimum exploitation rate, which is still extremely high. Miller et al. (1990) reported negative effects on black crappie in Lake Okeechobee, Florida, when harvest was sustained near 65%.

The vast majority of the crappie harvested in 2009 appeared to be less than 2 yrs old and previous age and growth analysis revealed that very few fish over the age of 2 yrs were in the population during fall 2008 (R. Daniel, unpublished data). Colvin (1991) suggested that reservoirs could produce larger crappie if the harvest of younger fish was reduced. The current average size of PPR crappie, though, seems to be adequate for the anglers as it should be noted that no complaints concerning the size of the crappie were documented during the creel survey. The importance of harvest numbers rather than larger sizes generally distinguishes crappie fisheries from other sport fisheries (Hale et al. 1999). If PPR anglers were to desire larger crappie, harvest rates would need to be lowered to allow age 1 and 2 crappie to become older. The rapid growth of crappie in PPR may be partially a result of the high harvest rate, which leads to less competition and more availability of forage. It should be noted that rapid growth of fishes is common in new reservoirs, but growth rates and sportfish abundance often decline as reservoirs age (Kimmel and Groeger 1986). Poverty Point Reservoir is still very productive, but without any tributaries or flood events introducing nutrients, fertility levels and associated productivity may eventually decline. When growth rates are moderate to high, natural mortality is relatively low, and angler harvest is significant, harvest regulations have the most impact on crappie populations (Colvin 1991, Reed and Davies 1991, Allen and Miranda 1995). Crappie in PPR exhibit rapid growth, and are subject to high harvest rates, but natural mortality rates are still unknown and may be too high for harvest restrictions to have a positive influence on the population. Isermann et al. (2002) found that conditional natural mortality had to be ≤40% for length restrictions to provide benefits to crappie populations in Tennessee reservoirs. Allen et al. (2008) suggested that harvest acted in a compensatory manner in crappie populations up to approximately 40%, but was additive with natural mortality at higher levels. The current harvest rate on PPR may be acting in a compensatory manner, and not adding to the overall mortality, especially since fishing pressure and harvest have been consistent since the reservoir was opened.

With only one or two year classes composing the majority of the crappie population, consistent reproduction and recruitment becomes critical to having a viable fishery. Eder (1990) reported satisfactory fishing for black crappie persisted at an exploitation rate of 84% over a four-year period in Missouri primarily because recruitment was consistent. A population becomes vulnerable to collapse when dominated by only a few year classes. Thus far, it

appears that recruitment has been consistent in PPR, even though crappie populations have a reputation for being cyclical and inconsistent. Stable water levels and a high harvest rate most likely contribute to this stability in recruitment, as density dependence is believed to be a factor involved in reproductive success. Ideal spawning habitat is limited in PPR, thus it is essential that no major alterations to these areas occur. These areas are characterized by being fairly shallow, protected from the wind, and having abundant shallow cover in the form of wood structure and vegetation. Further development of lakeside properties, including seawalls and "cleaning up" of shoreline areas for aesthetics could possibly impair crappie reproduction. Reed and Pereira (2009), in a study on black crappie and largemouth bass nest site selection, found that black crappie were more likely to nest along undeveloped shorelines and near emergent vegetation. Shoreline property owners should be encouraged to leave potential spawning cover and maintain a more natural environment to provide for much needed quality spawning sites in the reservoir. Due to the high harvest rates observed in this study, and the truncated age structure of the crappie population, a decline in recruitment would likely result in rapid declines in fish abundance and angler success.

The creel survey provided revealing information about the angling and harvest of crappie in PPR. This study again confirmed that crappie fishing is the most popular activity on PPR. Fishing pressure and annual harvest estimates obtained from the creel survey were considered to be conservative, especially considering that shoreline anglers and those fishing from private piers were not surveyed and no interviews were conducted from June to September. However, personnel at Poverty Point Reservoir State Park reported very little angling for crappie during the summer months. The use of the boat ramps by anglers was most likely explained by wind intensity or direction, and accounted for the discrepancies between scheduled boat ramp location and location actually surveyed during the creel surveys. Strong northerly winds made it difficult for anglers to fish the south end of the lake, thus they sought protection from the wind on the north end and vice-versa. The creel survey also showed that the overwhelming majority of crappie anglers are satisfied with the current regulations set by LDWF. In fact, only 3% suggested a different daily creel limit. With the very low number of anglers observed possessing a daily limit, the current creel limit of 25 crappie/day is most likely not having a substantial impact on the population.

Sustaining the crappie fishery is very important to the State Park that encompasses PPR, as crappie not only are the most sought after fish species in the lake, they are responsible for a significant percentage of annual visitation. The reservoir is the centerpiece of the State Park, thus it is essential to maintain a quality fishery. Anglers appear to be having an impact on the crappie population, but harvest rates and crappie abundances remain high. When additional age and growth data is obtained, population dynamics modeling will be utilized along with these estimates of fishing mortality to predict effects of various management scenarios on the population. If any of these models suggest a significant positive effect due to regulation change, then an appropriate management alternative may be offered to help sustain this valuable resource.

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