Explaining the Increasing Trend in Support for Underwater Cameras for Sturgeon Spearing on the Lake Winnebago System

A Technical Report to the
Bureau of Fisheries Management

from the
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Bureau of Environmental Analysis & Sustainability
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About This Report

This report presents the results of a survey of randomly sampled sturgeon spearing license holders. This study updates the current state of the Wisconsin DNR's understanding regarding participants' use of, and attitudes toward, underwater cameras and other emerging electronic devices. The Bureau of Fisheries Management requested this study to inform its management policies and regulations. This report presents the survey results and provides relevant context for the findings but does not include specific recommendations or policy prescriptions.

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Executive Summary

Technology is changing the sport of winter sturgeon spearing on the Lake Winnebago system in east central Wisconsin. Some participants have called upon the Wisconsin Department of Natural Resources (DNR) to ban the use of electronic devices, particularly underwater cameras. The Wisconsin DNR has been tracking spearers' opinions on this issue since 2013 and this study updates the current state of the department's understanding regarding participants' use of, and attitudes toward, underwater cameras and other emerging electronics.

Prior to the start of the 2022 Winnebago System sturgeon spearing season, we surveyed a random sample of sturgeon spearing license holders who held a license for either Lake Winnebago or the upriver lakes (Butte des Morts, Winneconne, and Poygan). Over one-quarter of the 2022 sturgeon spearing license pool received the survey either via email or by mail in November and December 2021. We received 1,568 responses for a 54% response rate. Survey results have a margin of error of plus or minus two percent.

In comparison to the prior survey conducted on this topic in 2018 (Holsman, 2019), spearers' support for underwater cameras for sturgeon spearing has increased by nine percent. The current results indicate that 50% of participants now support underwater camera use while 29% are opposed to underwater camera use. Support for cameras is strongly and inversely related to age. The number of electronics individuals use in other types of fishing also predicts support for camera use while sturgeon spearing. Supporters and opponents of underwater camera use hold very different beliefs about the impact of technology on the sport which are explored in detail within this report. Respondent opinions were mixed on the use of sonar technologies, slightly supporting basic sonar, and leaning slightly against both side-scanning and live 3-D units. Yet, there was not a majority consensus observed in any of those cases.

Other survey results indicate a high degree of trust in Wisconsin DNR staff and agency science regarding sturgeon management. A majority of spearers (61%) were "very" or "somewhat satisfied" with their experiences over the prior three seasons, despite the fact that 64% of respondents did not harvest a fish over that time span. Data confirm that participants identify strongly with the sport, tend to reside close to the fishery, and demonstrate considerable knowledge on topics presented in the questionnaire.

On policy matters, spearers do not favor removing the minimum length on sturgeon (currently 36 inches) nor do a majority want to see a catch and release, hook-and-line season established on the Lake Winnebago system. Among those applying for the upriver lakes sturgeon tags, 52% were satisfied with the current preference point

system and 58% preferred the current system to alternative ways of allocating tags. A majority of those applying for upriver tags favored the option of being allowed to continue spearing on Lake Winnebago with unused tags following season closure on the upriver lakes. However, most license holders who only spear Lake Winnebago opposed that idea.

Results of this survey differ from opinions expressed through recent public input platforms including statewide advisory votes cast at the 2020 Conservation Congress Spring Hearings. Eighty-two percent of survey respondents had not attended a Conservation Congress hearing in the past five years. Seventy-three percent of survey respondents said they preferred a passive or no role in lake sturgeon management decisions, meaning most participants are unlikely to seek out meetings to express opinions. These findings provide insights into the differences in attitudes measured through scientific surveys and those obtained through self-selected participants in public meetings. Survey respondents are representative of a cross section of the entire population whereas public meetings tend to skew toward older participants. Consequently, this survey provides a glimpse into the views and preferences of all sturgeon spearers which can help the Fisheries Management program better understand the full consequences to those who would be impacted by limiting technology during sturgeon spearing.

Introduction

Spearing lake sturgeon (*Acipenser fulvescens*) through the ice on the Lake Winnebago system is a highly cherished, local tradition pursued by a tight-knit and avid group of people (Kline et al., 2009). According to data we report here, 80% of participants told us that "many of their friends" share their interest in the activity. Additionally, 63% said sturgeon spearing is their favorite winter activity. Half of the spearers told us they travel 15 miles or less from their homes to participate in spearing which underscores the very local nature of the activity.

Though lake sturgeon spearing has always required some specialized equipment (e.g., ice shanties, ice cutting tools, decoys, spears, etc.), the relatively primitive nature of the sport and its associated culture is changing as technological innovations are being adopted by some participants. Interest in, and conflicts over, the use of underwater cameras has been ongoing for a decade. Some participants have called upon the Wisconsin Department of Natural Resources (DNR) to ban underwater cameras citing concerns over potential negative impacts to the sturgeon population, as well as ethical objections over fairness, potential wounding losses, and erosion of the traditional heritage of the sport. Other people have countered that cameras enhance their enjoyment and may serve to keep younger participants more engaged, while not substantially improving the odds of harvesting a fish.

The Wisconsin DNR's Lake Sturgeon Advisory Committee, comprised primarily of members of local fishing clubs on Lake Winnebago, voted 15-7 during a 2019 meeting to ask the department to pursue an Administrative Code change to ban the use of all electronics for sturgeon spearing. In addition, two separate questions posed at the Conservation Congress' statewide 2020 Spring Hearing suggested widespread public support for banning the use of cameras. These expressions of public sentiment prompted Wisconsin DNR staff to develop and receive approval for an Administrative Code scope statement to consider regulating the technology that can be used in the hole to aid in sturgeon spearing.

While monitoring public input received on this issue, the Wisconsin DNR has also carefully monitored scientific data—biological and sociological—pertaining to potential impacts of cameras on the harvest of lake sturgeon and on the preferences of participants. On the biological side, harvest success and the number of fish registered over the past decade continue to show that water clarity in any given winter remains the best predictor of the size of the harvest (Koenigs 2020). The minority of spearers presently using underwater cameras has not resulted in significant increases in harvest numbers or triggered early season closures from reaching the safe harvest cap (i.e., 5% of the adult fish) (Bruch, 2008). In fact, the season on Lake Winnebago has run the full 16-days (without hitting the harvest cap)

in ten of the past 12 years—a period that corresponds to the adoption of underwater cameras by some spearing participants.

Data from monitoring surveys during spring lake sturgeon spawning on the Wolf River have not indicated a decline in the population or size of an average lake sturgeon captured since the advent of camera use by some spearers (Koenigs, 2020). Consequently, fisheries biologists have concluded that there is not a biological need to regulate cameras because they are not currently impacting the sustainability of the system's sturgeon population (D. Boyarski, pers. comm).

With that settled, the issue is really an intragroup conflict about what constitutes the "right way" or most appropriate way to participate in this activity. Scientific surveys—where a random group of people are selected to respond to a questionnaire—are important for understanding the full picture of public opinion and are considered a more accurate and representative measure than public meetings that tend to self-select for members who are more motivated to express their opinions (Johnson et al., 1993). This report details the findings of a scientific survey of lake sturgeon spearers conducted in November and December 2021 and represents the third time the Wisconsin DNR has polled this audience regarding camera use since 2013. A 2013 survey found that more spearers opposed cameras than supported them, but the largest segment was indifferent indicating that most participants had little experience with or opportunities to form an opinion (unpubl. data). We tested the question again in 2018 and found the percentage of those who supported cameras was larger than the percentage of those who were opposed to their use as more spearers began to make up their minds (Holsman, 2019). We also found that support for cameras was more prevalent among younger participants while opposition increased among older spearers (Holsman, 2019). We repeated the study again in 2021 to assess if support for cameras (and other technology) had changed in the past three years. This report details the findings from our most recent survey effort.

Methods

We randomly sampled adults (18 years old and older) who purchased a 2022 sturgeon spearing license by the October 31, 2021, deadline. We selected 3,000 people overall representing approximately one-quarter of the sturgeon spearing population. We mailed an 8-page questionnaire to 1,200 people in our sample with a cover letter and a stamped, pre-addressed reply envelope during the second week of November. We sent a post card reminder to this group a week after our initial mailing. Three weeks later, we sent a second copy of the questionnaire to those who had not yet responded. We continued to accept returns through the first week of January 2022. Meanwhile, we sent email invitations to an additional 1,800 people in November 2021 directing them to complete the same questionnaire online in a closed-access format

(unable to forward to others). Those in the online group received three additional email reminders over the course of ten days. As with the mail survey, we accepted responses through the first week of January.

This dual mode of survey administration balances the propensity of different age groups to respond to each format while also reducing survey costs associated with postage. Overall, we received completed questionnaires from 1,568 spearers for a response rate of 54%. About half of our returns came from mail and half from online samples. We used SPSS-29 for data entry and analysis. After comparing the age of respondents, as well as, whether they had an email address to the known distribution of those two characteristics within the Wisconsin DNR's license database, we weighted response data to match the population. This study has a margin of error of plus or minus two percent.

Results and Discussion

Sturgeon Spearer Profile

About 7% of survey respondents indicated that 2022 was going to be their first time spearing lake sturgeon on the Lake Winnebago system. Approximately one-third of respondents had 1-10 years of experience and approximately one-quarter had 11-20 years of experience. The plurality of spearers (28%) had longevity in their participation in the activity and had participated for over 25 years (Figure 1).

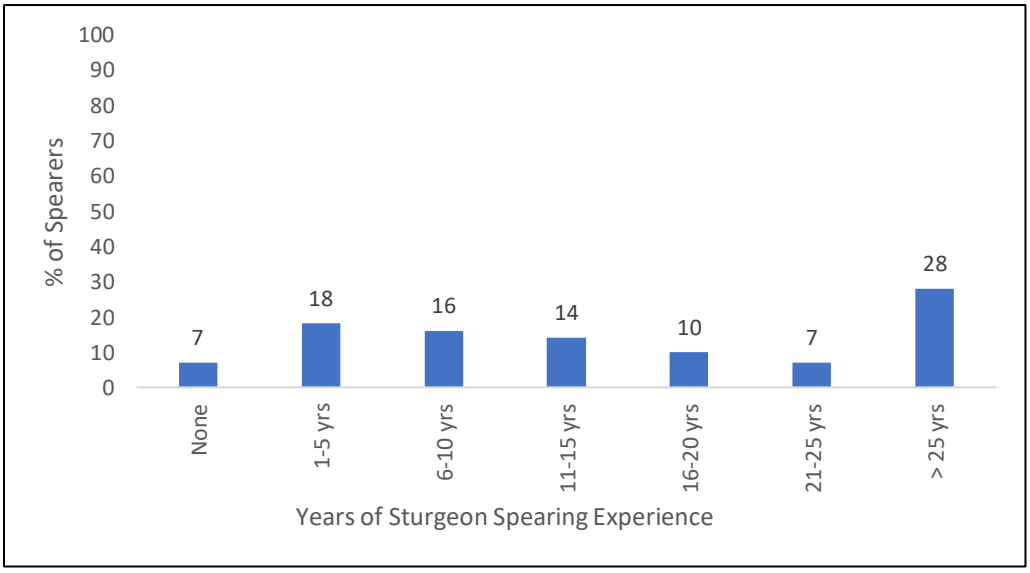


Figure 1. *Years of participation in sturgeon spearing among survey respondents (%).*

In addition to measuring the length of participation in an activity, we often find it instructive to ask questions that measure the extent to which an activity reflects someone's identity which can then be used as a proxy to represent avidity. It will come as no surprise to people engaged in sturgeon spearing that a majority of participants agreed–many strongly–that sturgeon spearing provides them with important personal and social identity; it is more than just a hobby (Table 1). Eight out of ten spearers agreed that many of their friends are connected to sturgeon spearing. Sixty-three percent said that they prefer spearing to any other winter activity.

Table 1. *Percentages (%) of survey respondents' agreement with identity measures.*

Identity measures	% who agreed or disagreed with statement				
	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Many of my friends are in some way connected to sturgeon spearing.	41	39	9	9	3
I would rather go sturgeon spearing than participate in other winter outdoor activities.	31	32	26	8	3
I exert considerable effort to be successful at sturgeon spearing whenever I have a tag.	41	33	17	7	3
Others who know me would tell you that sturgeon spearing is a big part of who I am.	23	26	27	13	11

Currently, the Wisconsin DNR allocates 500 harvest tags to the upriver lakes (i.e., Poygan, Buttes des Morts, and Winneconne). Success rates are much higher in these lakes because shallower water negates water clarity problems to an extent and because many of the sturgeon often overwinter in these lakes prior to their spring spawning migration up the Wolf River. Applicants for these limited upriver tags typically must wait eight or more years to accumulate enough preference points to be selected for a tag. Just over half (54%) of survey respondents indicated they were applying for upriver tags as of the 2022 season. Only three to four percent of the respondents indicated they speared in one of the upriver lakes during each of the past three seasons, which is on par with tag allocation numbers. By contrast, there is no limit on participation on Lake Winnebago where success rates are relatively low in comparison to the upriver lakes.

We measured the average one-way distance that participants travel from their residence to go spearing. One person reported traveling as far as from 500 miles away to participate in sturgeon spearing, but half of the survey respondents indicated they traveled 15 or fewer miles (Figure 2). The mean travel distance for participants was 25 miles.

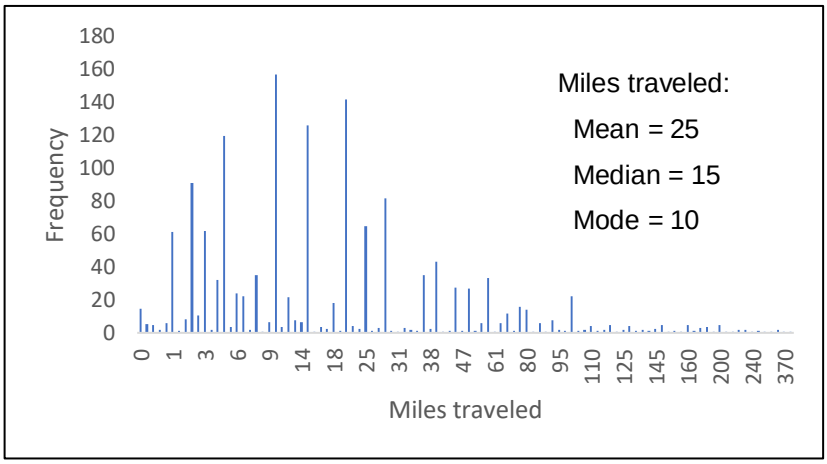


Figure 2. *Frequency of travel distances reported by respondents to go lake sturgeon spearing. Mileage values larger than two standard deviations from mean were treated as outliers.*

Trust in Wisconsin DNR Sturgeon Management

We conducted our survey soon after charges were filed in an investigation regarding the handling of sturgeon eggs by Wisconsin DNR and non-DNR staff. The investigation alleged that sturgeon eggs were improperly disseminated to members of the public and was extensively covered by state and national news media. As a backdrop for exploring attitudes toward technology, we felt it was also important to assess spearers' level of trust given the attention that the sturgeon egg case seemingly created for the program.

Despite the extensive media attention given the sturgeon egg issue, it appears that confidence in the Wisconsin DNR's sturgeon program remained very high among spearers (Table 2). Eight-five percent of survey respondents agreed that they trust the department's population estimates. Eighty-six percent agreed that staff "*are doing the right things to sustain the fishery*"—and half of respondents (51%) strongly agreed with this latter statement. Finally, nearly nine out of ten spearing participants considered the program to be a success. These findings suggest that the strong relationships that local fisheries biologists have forged with the sturgeon spearing community over decades have buffered the program's reputation despite the

sturgeon egg issue. In fact, there was a slight, but statistically significant, increase in trust the more respondents followed the news (Figure 3). Some survey comments suggested that some spearers did not think the sturgeon egg issue merited the attention it received, which in turn may have galvanized support for the work of the sturgeon program.

Table 2. *Survey respondents' agreement (%) with various measures of trust in the Wisconsin DNR's sturgeon management program.*

Trust statements	**% who agreed or disagreed with each statement**				
	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
I trust the science that the DNR uses to estimate sturgeon populations and set harvest caps.	48	37	11	3	1
I trust that DNR staff are doing the right things to sustain the sturgeon fishery.	51	35	10	3	2
The sturgeon management program on the Winnebago system is successful.	59	30	9	1	1

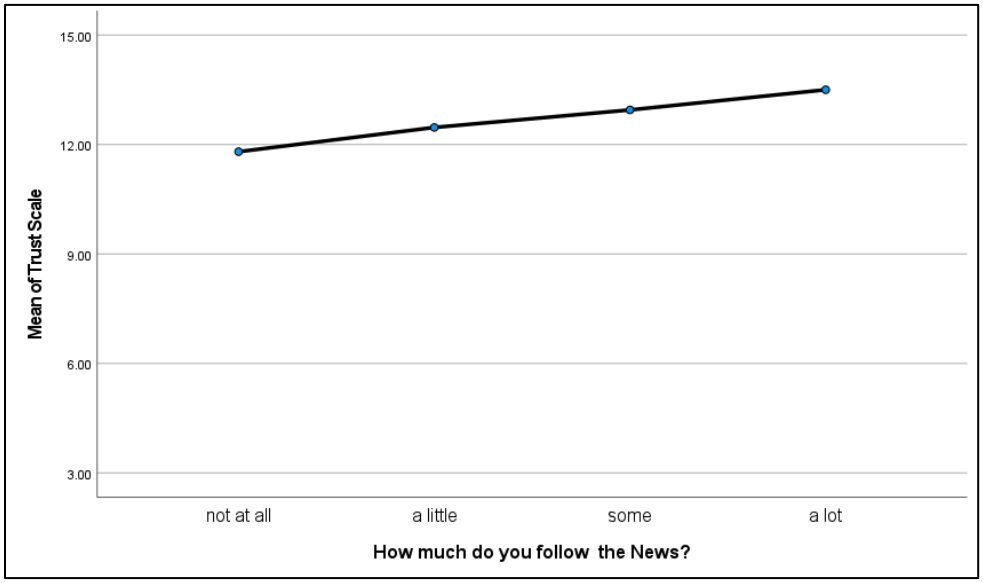


Figure 3. *Analysis of variance in mean differences in spearers' trust of the Wisconsin DNR compared to the extent to which they followed the news (F=18.9, 3 df, Sig=0.001).*

Spearer Engagement and Information Sources

When it comes to following the news about sturgeon spearing, 39% of respondents said they did so "a lot," and another 39% said they did so "somewhat." The leading source of information about spearing was other spearers, chosen by 64% of the survey respondents (Figure 4). The next most frequently selected information sources were the Wisconsin DNR website (58%) and the department's regulations booklet (51%). Wisconsin DNR staff, public meetings, and the Conservation Congress were the least frequently selected information sources about sturgeon spearing, each chosen by 16% of respondents. With respect to the Conservation Congress, we asked respondents how many of the past five years they had participated in the Spring Hearing. Eighty-two percent checked "zero;" only four percent indicated all five years.

We asked spearers to indicate at what level they prefer to be engaged in sturgeon management. Most preferred either no direct involvement (33%) or simply being informed (40%). Only 6% of participants chose the highest level of engagement which would include serving on committees. Forty-five percent of spearers said they belonged to a local fishing club. Not surprisingly, members of fishing clubs were significantly more likely to indicate wanting a higher level of involvement in management decisions than those who did not belong to clubs (Table 3).

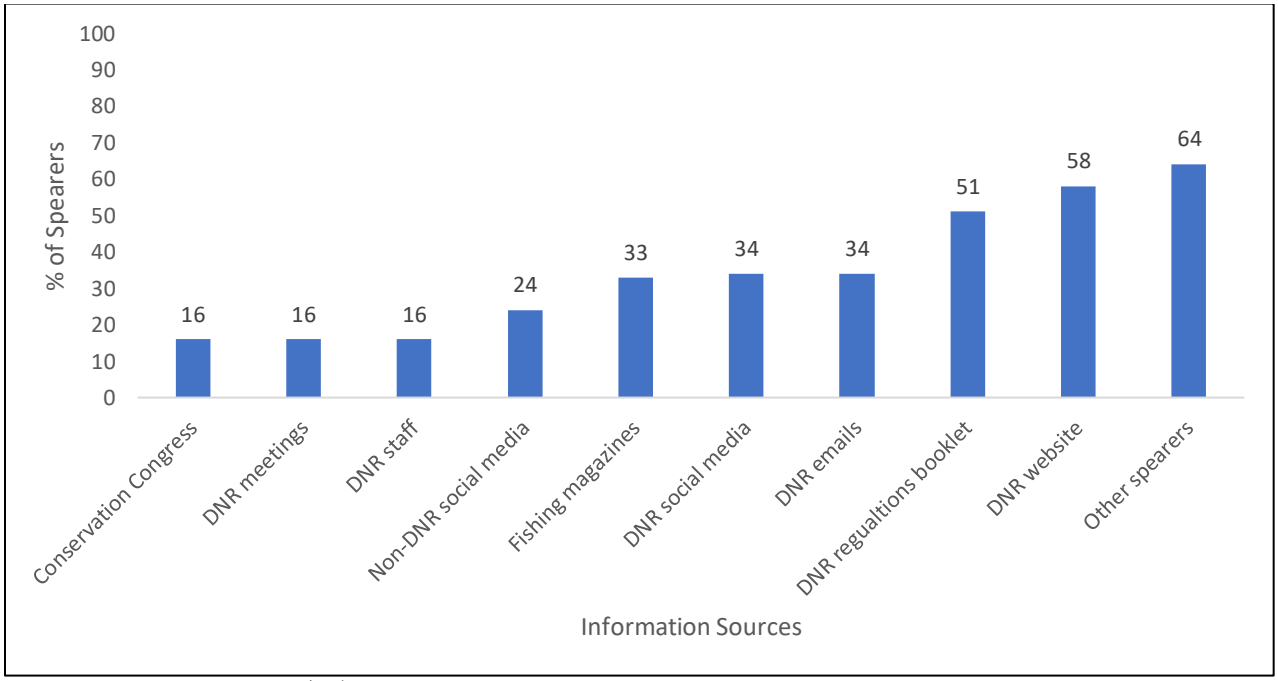


Figure 4. *Frequency (%) with which survey respondents indicated they get their information from various sources.*

Table 3. *Differences between fishing club members and nonmembers in their preferred level of involvement in sturgeon management (χ^2=95.5, Sig=0.001, Phi=0.26).*

Fishing club membership	% indicating a preference for level of engagement with sturgeon management program			
	None	Passive	Active	Engaged
Yes (45%)	22	40	38	10
No (55%)	42	39	17	2

The Three Most Recent Spearing Seasons

Eighty-eight percent of the respondents reporting spearing at least one season of the previous three years (2019, 2020 & 2021). Harvest success rates reported by respondents were slightly higher than those obtained using registration data from each of the three years but reflected the same year-to-year pattern of variation (Table 4). Success rates were reported to be highest in 2021, when over half of the participants saw at least one sturgeon during the season. Whereas during the 2019 and 2020 seasons, only 37% of spearers saw at least one sturgeon. Success and participation rates were lowest in 2019 and 2020, with some respondents commenting that ice conditions were somewhat limiting, and water clarity was generally lower.

Sixty-four percent of our respondents had not speared a sturgeon in the previous three seasons, but satisfaction in the sport remained high. Sixty-one percent of respondents said they were satisfied with recent sturgeon seasons (Figure 5).

Table 4. *Sturgeon spearing experience metrics from the 2019, 2020, and 2021 seasons as reported by survey respondents.*

Experience metrics among respondents	Year		
	2019	2020	2021
% participation rate	90	89	95
% success rate	10	10	22
% who saw at least one sturgeon	37	37	52

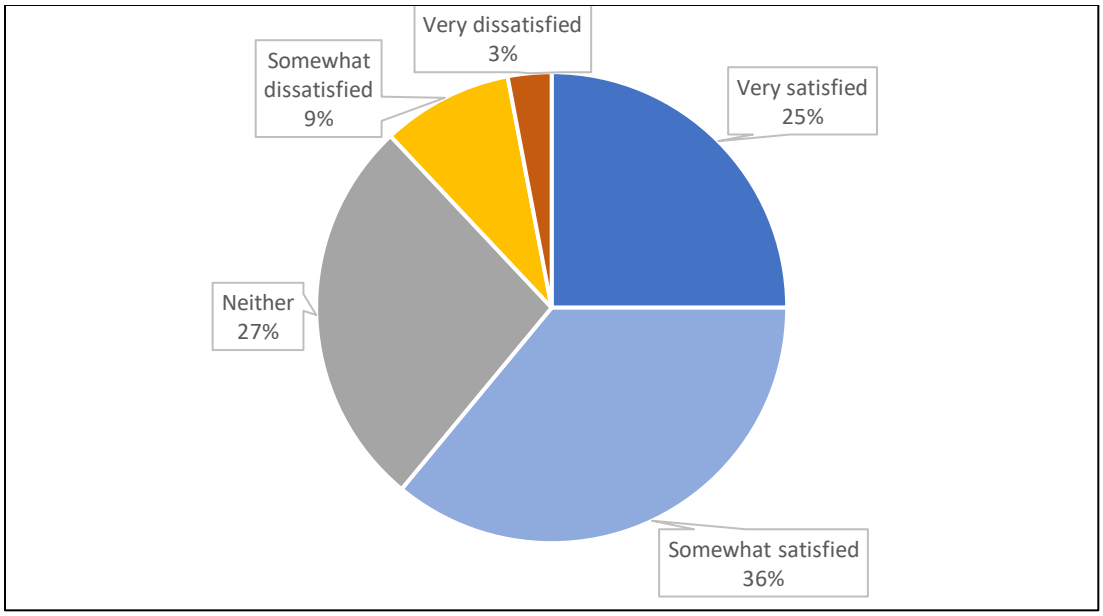


Figure 5. *Frequency (%) of survey respondents' satisfaction with the previous three sturgeon spearing seasons (2019, 2020, and 2021).*

The Use of Electronics in Sturgeon Spearing

While most of the attention has been focused on underwater cameras, we took the opportunity to ask those who spear about a wider range of electronics in this survey to be consistent with the 2019 vote of the Lake Sturgeon Advisory Committee asking for the ban of all types of fishing electronics. The types and definitions of electronic devices are shown in Figure 6, which was also included on the questionnaire for respondents to review before recording their answers.

The number of participants who used underwater cameras has hovered around one out of three from 2019 to 2021 (Table 5). These rates are consistent with what Wisconsin DNR conservation wardens have observed during their patrols and checks of ice shanties (C. Shea, pers comm.). Very few spearers reported using any other electronic aids in recent years (Table 5). It is interesting to note that use of all types of electronics in sturgeon spearing appears lower than might be expected given their rates of use in other types of fishing (Table 6). For example, a majority of respondents used basic sonar in their open water and conventional ice fishing, yet almost no one employed that technology in sturgeon spearing, presumably because it only reads depth and cannot distinguish the size and species of "marks" that sonar signals return. Just over a quarter of respondents (28%) used side scanning sonar in their open water fishing, but almost none of these anglers have applied those devices in spearing during the past three seasons (Tables 5 and 6). Similarly, live 3-D sonar was not commonly used while sturgeon spearing.

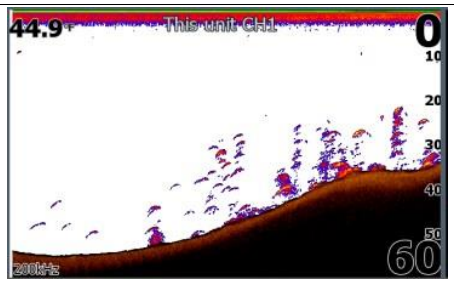
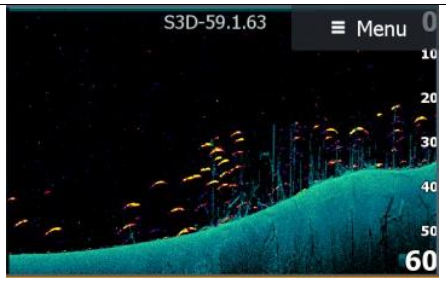
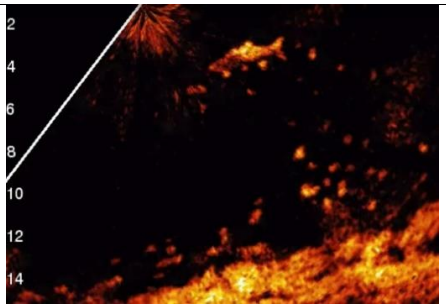
Underwater cameras	Devices that provide a real-time video of objects in the water column. Visual range limited by water clarity and depth.	
Basic sonar	Devices that return two-dimensional images of the lake bottom and of objects in the water column that are detected from the signal cone. Objects in the water column have indistinguishable characteristics and only relative size and approximate position can be interpreted. (e.g., 2D graphs or flashers)	
Imaging sonar	Devices that return three-dimensional images of the lake bottom and of objects below the water using down-scanning, side-scanning, or 360 sonar technology. Relative size and exact position of objects relative to the transducer can be interpreted. Detected images remain on screen until the scroll updates regardless of the objects' movement. (e.g., 3-D scanning technology)	
Live 3-D sonar	Devices that return three-dimensional images of the lake bottom and of objects below the water using down-scanning or side-scanning technology. Relative size and exact position of objects relative to the transducer can be interpreted. Images update continuously to show movement of fish and other objects in the water column. (e.g., real-time imaging technology)	

Figure 6. *Descriptions and depictions of electronic devices provided to survey respondents in measuring attitudes and current rates of use.*

Table 5. *Usage rates of fishing electronics among survey respondents over the previous three seasons.*

Category of electronics	% of those who used in…		
	2019	2020	2021
Underwater camera	33%	36%	34%
Basic sonar	3%	3%	3%
Side scan sonar	1%	1%	1%
3-D live sonar	1%	2%	3%

Table 6. *Usage rates (%) of electronics by survey respondents in other types of fishing.*

	Open water fishing	Ice fishing
Do not fish in…	15%	11%
Underwater camera	19%	40%
Basic sonar	55%	57%
Imagining sonar	28%	10%
Live 3-D sonar	9%	6%
Fish without electronics	18%	20%

Impact of Underwater Cameras on Spearing Experience

How much of an advantage cameras provide spearers in pursuit of lake sturgeon is one of the central questions surrounding their use. When we compared people who used cameras to those who did not over the past three seasons, it was clear that camera-users saw significantly more sturgeon (Table 7). In all three years, a majority of those with cameras reported seeing at least one surgeon. The 2020 season was only one of the three years where a majority of non-camera users reported seeing at least one sturgeon. The percentage of spearers who saw multiple sturgeon was both significantly and substantially higher among camera users in all three years (Table 7).

Table 7. *Comparisons of number of lake sturgeon seen by survey respondents who used underwater cameras and those who did not use cameras in the previous three spearing seasons.*

Sturgeon season	Camera use	Percentage (%) of sturgeon seen			Significance
		None	1 fish	2 or more fish	
2019	Yes	44	19	37	χ^2=158.7
	No	72	19	9	Sig.= 0.001
2020	Yes	41	10	49	χ^2=167.9
	No	48	21	31	Sig=0.001
2021	Yes	31	23	46	χ^2=149.8
	No	57	26	17	Sig=0.001

While camera use increased the odds of seeing fish, those increased sightings did not appear to substantially increase the chances of harvesting a fish (Figure 7). Reported success rates were much higher in 2021 (a clear water year) than either of the previous two seasons (cloudy water), but the rates were statistically the same among users and non-users of cameras. The only statistically significant difference in success rate based on camera use occurred in 2020 when camera users fared about four percent better than non-users. The apparent advantage of cameras seen in the data for the 2019 season was not statistically significant. These results indicate that increased sightings of sturgeon do not translate necessarily into increased harvest of fish. The sturgeon still need to swim past the spearers' hole and cameras may simply be alerting participants that fish are nearby while not presenting a spear throwing opportunity.

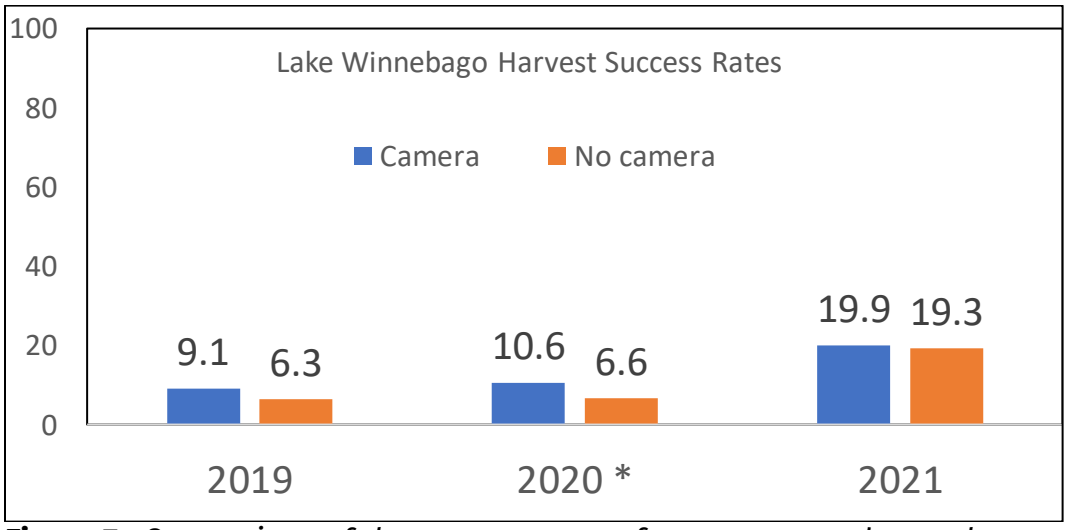


Figure 7. *Comparison of the success rates of survey respondents who used and did not use cameras on Lake Winnebago in the 2019-2021 seasons (* denotes the statistically significant difference in success rates observed in 2020).*

Attitudes Regarding Electronics

Half of the survey respondents supported the use of underwater cameras (Table 8). Twenty-nine percent were opposed to cameras. The result for the camera question in 2021 marks the first time since we asked the question in 2013 (unpubl. data) that a majority opinion has emerged and reflects a continued growth in support for camera use since that initial survey in 2013 (Figure 8). The results for other forms of electronics were mixed. Forty percent of respondents supported use of basic sonar compared to 31% who opposed its use. Both imaging and live 3-D sonars had a higher percentage of opponents than supporters (Table 8).

Table 8. *Percentages of support and opposition among survey respondents (%) for use of four types of fishing electronics as aids in sturgeon spearing.*

Technology	Strongly Support	Moderately Support	Neither Support nor Oppose	Moderately Oppose	Strongly Oppose
Underwater cameras	36	14	21	7	22
Basic sonar	27	13	29	9	23
Imaging sonar	24	11	29	10	28
Live 3-D sonar	23	10	27	10	30

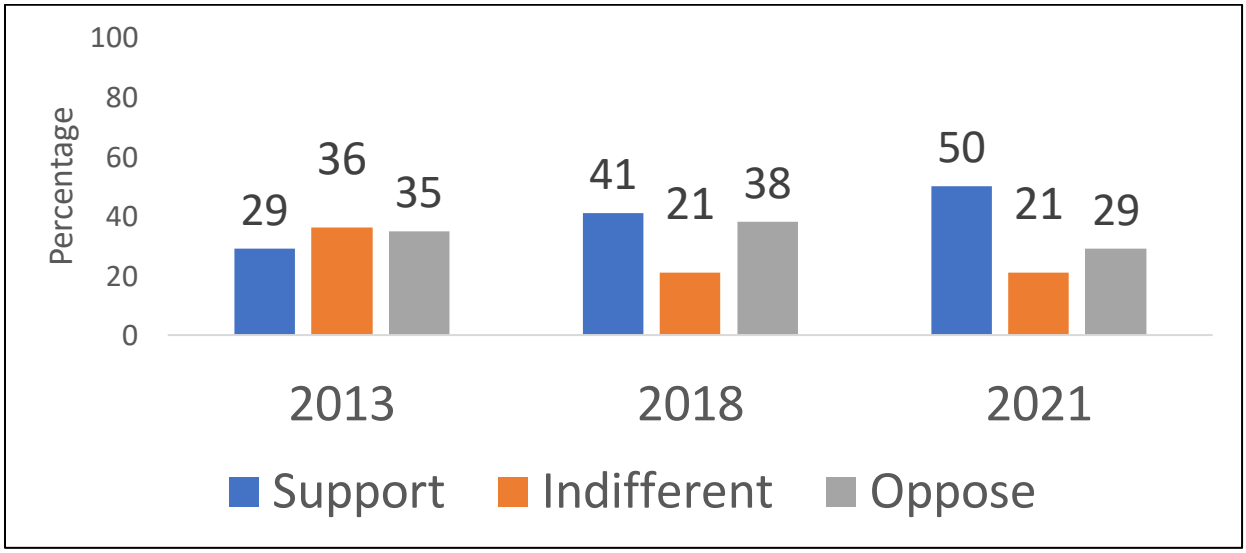


Figure 8. *Trends in survey respondents' support for and opposition to underwater camera use in sturgeon spearing between 2013 and 2021.*

Similar to our analysis from the 2018 survey, we found that respondent age was a significant predictor of support for or opposition to underwater camera use. In short, older participants were more likely to oppose camera use and the percentage of those supporting cameras increased among younger cohorts (Table 9). Over half (57%) of the members of the Silent generation (born 1925-1944) strongly opposed the use of underwater cameras in spearing sturgeon. This group comprises only 3 percent of the license pool. Baby Boomers (born 1945-1964)–who comprise three in ten of sturgeon spearers–were evenly divided in their support (39%) and opposition (39%). The remaining two-thirds of the spearing population contained a larger proportion of supporters than opponents (Table 9).

Table 9. *Comparison of camera attitudes by generation (years of birth) (χ^2= 112.0, Sig=0.001, Phi= 0.28).*

Generation	Proportion of all 2022 adult license holders	% support/opposition to use of underwater cameras while spearing sturgeon				
		Strongly support	Moderately support	Neither support nor oppose	Moderately support	Strongly oppose
Silent (1925-1944)	3%	20	9	3	11	57
Baby boomers (1945-1964)	30%	27	12	22	8	31
Generation X (1965-1980)	33%	32	15	23	8	22
Millennials (1981-1996)	29%	48	15	19	6	12
Generation Z (1997- 2003*)	6%	45	22	17	5	12
Overall	100%	36	14	21	7	22

* Denotes that proportion of group which is truncated by survey design; those under 18 were not included in our sample by design. This segment will increase in relative proportion of the license population as more age into it.

In addition to age being a significant factor in attitudes regarding cameras, prior investment and use of technology in fishing also predicted camera support. The greater the number of electronic devices used by an angler in other types of fishing, the more likely he or she was to support use of cameras (Table 10). For example, respondents who used four or more combinations of electronics in open water and/or conventional ice fishing were nearly two and half times more likely to support use of cameras in sturgeon spearing compared to those who used no electronics in their other fishing. Use of electronics in other types of fishing indicated: 1) that a respondent likely already invested in the equipment, and 2) that he/she had a propensity to accept technology as part of recreation.

There were also significant differences in the support for and opposition to underwater cameras based on whether a respondent belonged to a fishing club or not (Table 11). Fishing club members were slightly more likely to feel strongly—either in support of or opposition to cameras—than were non club members. Despite this observed tendency, there was majority (50%) support among both fishing club members and nonmembers (Table 11).

Table 10. *Comparison of camera attitudes by the number of different electronics that survey respondents reported using in open water fishing and/or conventional ice fishing (χ^2=112.0, Sig =0.001, Phi=0.28).*

Number of types electronics used in fishing/ ice fishing	Strongly support	Moderately support	Neither support nor oppose	Moderately oppose	Strongly oppose
0	22	16	28	10	23
1	26	12	22	9	31
2	32	15	21	7	25
3	42	14	21	6	16
4 or more	56	13	13	5	14

Table 11. *Comparison of camera attitudes (%) based on fishing club membership (X^2=23.4, Sig=0.001. Phi=0.13).*

Membership in fishing club	Strongly support	Moderately support	Neither support nor oppose	Moderately oppose	Strongly oppose
Yes	38	12	17	8	26
No	34	16	24	7	19

Supporters and opponents of underwater camera use were deeply polarized in their beliefs about the impacts of technology on the sport. It is not clear whether these beliefs have informed the opinions about camera use or have been constructed post-hoc as arguments to bolster one's position on the issue (Haidt, 2012). Regardless, the differences between camps was stark (Table 12). For example, 84% of camera supporters agreed that the safe harvest cap protects the overexploitation of lake sturgeon rendering the need to regulate methods moot. By contrast, only one in ten opponents of camera use agreed that the harvest cap alone will safeguard the fish. Biological data and recent season experience (e.g., spearers have not hit the harvest cap despite camera usage) have thus far agreed with supporters of camera use on this question. It is also interesting to note that one's stance on the harvest cap question was not influenced by trust in the agency's science. The percentage of camera opponents and supporters who trust the Wisconsin DNR's science in estimating sturgeon populations was not significantly different (Table 2). This suggests that those who disagreed that that harvest cap eliminates the need to regulate cameras means that camera opponents are using biological concerns as a proxy for their real concern about how technology is changing the sport's culture.

Table 12. *Differences in survey respondents' beliefs about positive and negative impacts of cameras between supporters and opponents of their use.*

Belief statements regarding impacts of electronics on the sport.	**% who agreed among…**		
	Those who support cameras	Those who oppose cameras	**% Difference**
The harvest cap is there to protect the sturgeon population, so it does not matter what type of electronics are allowed for sturgeon spearing.	84	10	74
Using electronics provides spearers with an unfair advantage over the fish.	13	87	74
The use of electronics threatens the long-term heritage and integrity of sturgeon spearing.	14	85	71
A speared sturgeon is more meaningful if speared without the aid of electronics.	22	91	69
I enjoy learning to use new technology such as how to use electronics for sturgeon spearing.	61	3	58
Using electronics to detect sturgeon not directly under the hole provides spearers with an unfair advantage over other spearers who do not use electronics.	29	86	57
Using electronics keeps sturgeon spearers engaged with the activity.	85	29	56
Using electronics decreases the spearing of undersized sturgeon through increased visibility for the spearer.	61	11	50
Using electronics attracts new people (e.g., a younger generation) to the activity of sturgeon spearing.	76	29	47
Using electronics decreases wounding loss of speared sturgeon by increasing visibility for the spearer.	48	7	41
Too many large sturgeon are being speared as a result of people using electronics.	6	47	41
The initial time and money investment of electronics for sturgeon spearing is not worth it to me.	23	64	41
Using electronics increases sturgeon spearer harvest success.	63	78	15
Electronics give less experienced spearers a better chance to harvest a sturgeon.	45	50	5
I feel I am less likely to spear a sturgeon if I do not use electronics.	34	33	1

Varying beliefs between camera supporters and detractors involved differing perspectives about what constitutes fair chase in maintaining the traditions of the sport. Nine of ten (91%) camera opponents agreed it means more to spear a fish without the aid of electronics; only 22% of supporters thought so. Most opponents of underwater cameras believed that "*electronics give spearers and unfair advantage over the sturgeon*" (87%) and "*threatened the integrity and heritage of the sport*" (85%). Very few camera supporters agreed with either of those statements (Table 12).

One statement to which a majority of both sides agreed was that camera use increases harvest success for users (Table 12). Ironically, data presented earlier on harvest rate comparisons would suggest that cameras have provided only a minimal advantage, if any, when it comes to harvesting a sturgeon (Figure 7). Camera use does, however, seem to increase satisfaction ratings with recent sturgeon seasons. Those who have used cameras in the last three years were satisfied with the seasons at a significantly higher rate (69% to 57%) than spearers who did not use cameras. This increase in satisfaction of camera users may reflect these spearers seeing more fish. In that way, the results may be analogous to numerous hunting studies that have shown seeing game while afield is an important influence on participant satisfaction (e.g., Heberlein, 2001).

If this speculation is correct, it may corroborate the beliefs of supporters of camera use that the device is an important tool for recruiting newcomers to the sport (Table 12). Three-quarters (76%) of camera supporters agreed that using electronics is important to attract younger generations, whereas only about three in ten (29%) camera opponents felt that way. Most (87%) of those who supported the use of cameras say their use "*keeps spearers engaged with the activity*." Further, 61% of cameras supporters reported that "*they enjoy learning new technology*" and applying it to spearing; only 3% of camera opponents agreed with that idea.

Other Policy Questions

Currently the minimum size limit for lake sturgeon is 36-inches. Undersized fish that are accidentally or intentionally speared and released likely exhibit high mortality rates. Removing the length limit would allow spearers to keep a smaller sturgeon but may lead to spearers targeting smaller fish. We asked respondents if they would support eliminating the minimum size limit requirement for sturgeon, but there was little support for that idea (Figure 9). Nearly two out of three (65%) spearers said "no" to eliminating a minimum size limit on sturgeon.

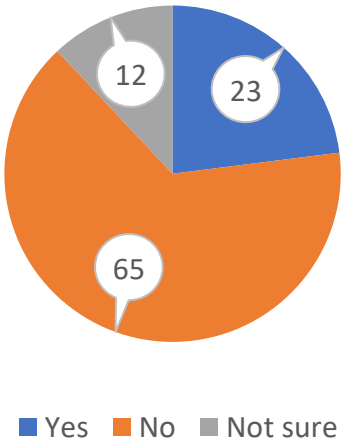


Figure 9. *Percentage of survey respondents who supported removal of the 36-inch minimum size limit.*

Open water, hook-and-line seasons for lake sturgeon currently occur elsewhere in the state (but not in the Lake Winnebago system) where harvest of one fish that meets size requirements is allowed with a valid tag. The idea of opening a catch-and-release only, hook-and-line season on the Lake Winnebago system has been suggested previously. We asked respondents if they would support establishment of such a season and a majority (50%) did not (Figure 10). Thirty-five percent of respondents did support the idea.

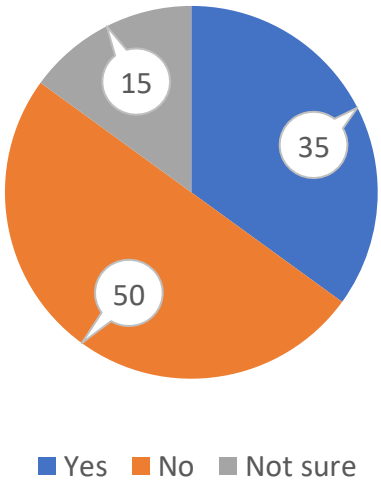


Figure 10. *Percentage of survey respondents supporting the establishment of a catch-and-release hook-and-line season on the Lake Winnebago system.*

As mentioned earlier, the high demand for sturgeon spearing opportunities on the upriver lakes of the Lake Winnebago system is governed by a preference point drawing system that currently produces wait times of approximately eight years. We asked those who are currently accruing preference points about their level of satisfaction or dissatisfaction with the preference point system. A majority (52%) of those currently in the application pool indicated they were satisfied with the preference point system (Figure 11). Fifty-eight percent of those who were applying favored the current model to alternative ways to allocate upriver tags (Figure 12).

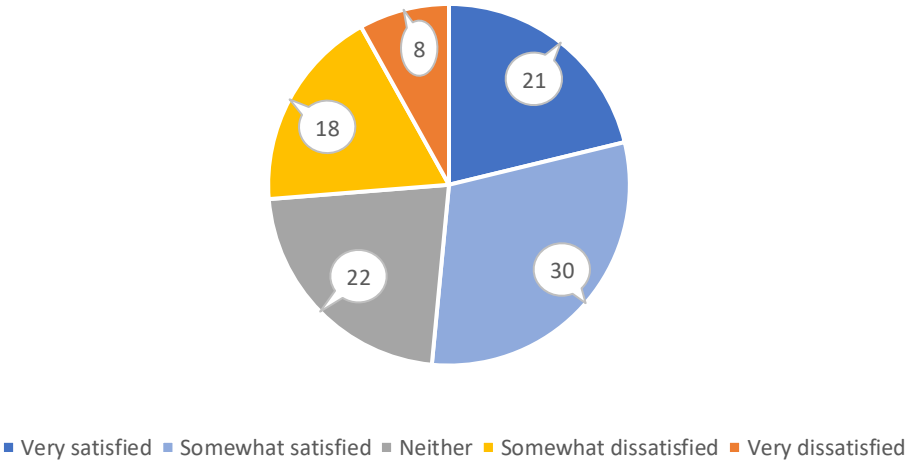


Figure 11. *Percentage of upriver tag applicants who are satisfied or dissatisfied with the current system of preference point allocation.*

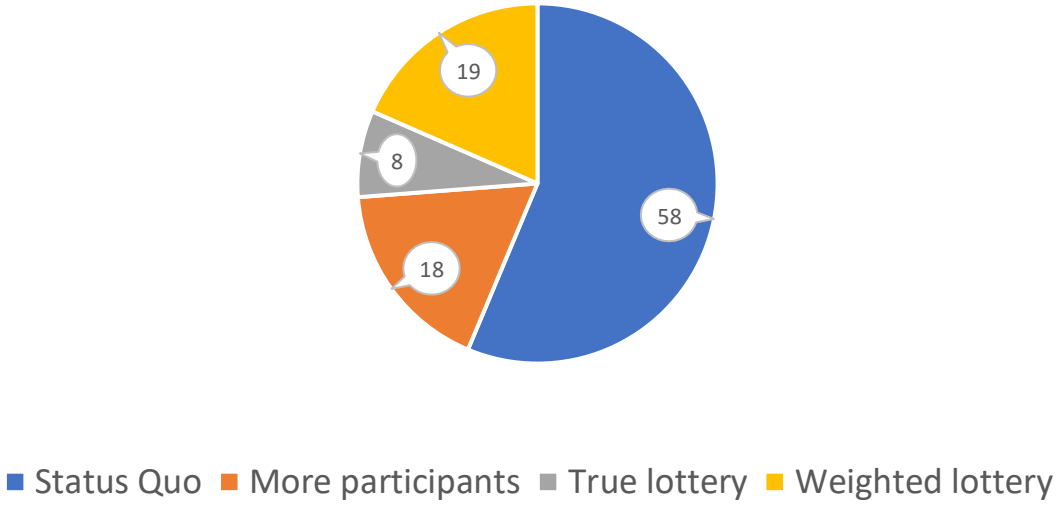


Figure 12. *Support of upriver tag applicants for alternative tag allocation systems.*

These results parallel a dynamic we also observed among bear hunting applicants who are also governed by a preference point system (Holsman et al., 2018). Though people may not like the wait times, they are reluctant to change the system once they have invested time in it. Consequently, more than three of four (77%) applicants who are satisfied supported use of the status quo (Table 13). Those who are dissatisfied with the preference point system, were split in their preference for an alternative between issuing more tags (for a shorter season; 32%) and moving to a weighed lottery draw (30%).

Table 13. *Comparison of tag allocation preferences (%) among upriver applicants based on their current level of satisfaction with the allocation system (χ^2=190.6, Sig.=0.001, Phi=.50).*

Satisfaction	% who prefer			
	Status Quo	More participants	True lottery	Weighted lottery
Satisfied	77	6	4	13
Neither	59	15	8	19
Dissatisfied	20	32	18	30

Since the upriver lakes normally reach a harvest quota and close early, there has been interest in allowing tag holders to continue their season on Lake Winnebago if they did not harvest a lake sturgeon on the upriver lakes. Overall, 54% of respondents supported that concept and 39% opposed it. There was a statistically significant difference in results when comparing those currently applying for upriver tags and those who currently spear Lake Winnebago only (Figure 13). Sixty-nine percent of upriver applicants supported being allowed to move to Lake Winnebago following closure of the upriver lakes. Fifty-three percent strongly supported the allowance. Meanwhile half of the respondents who currently spear on Lake Winnebago opposed the idea of upriver tag holders joining them when their opportunity closes upriver (Figure 13).

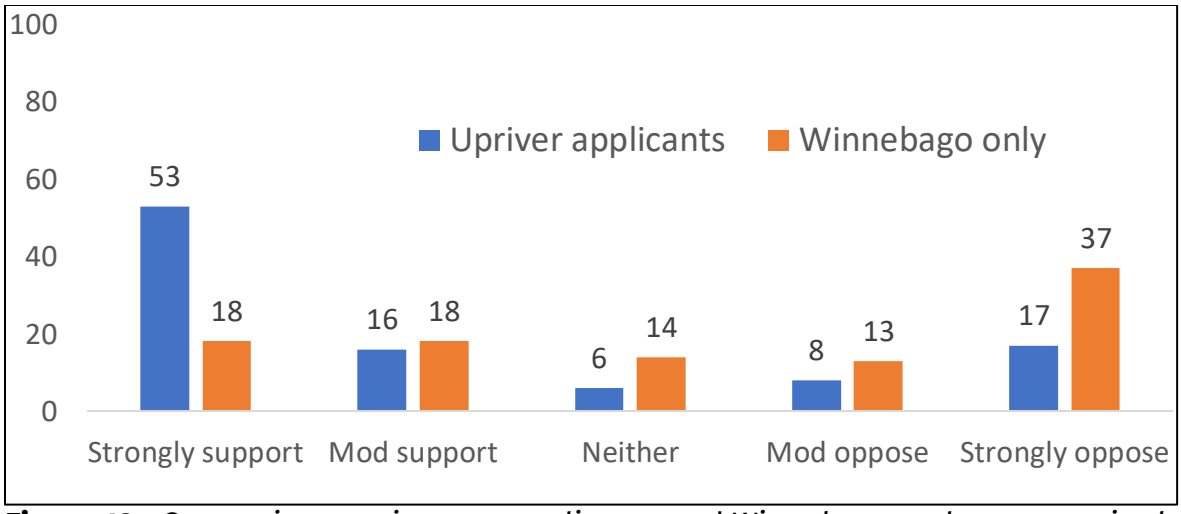


Figure 13. *Comparison upriver tag applicants and Winnebago-only spearers in their support for and opposition to allowing upriver tag holders to come to Lake Winnebago following the season closure on the upriver lakes.*

Information Awareness

We asked lake sturgeon spearers to respond to a series of true/false questions pertaining mostly to ecological and regulatory statements surrounding sturgeon spearing in the Lake Winnebago System. Much of the information within these statements had been shared with stakeholders through past communications (e.g., season summaries, regulation booklets, etc.) from the agency or is available on the Wisconsin DNR website. As such, these questions assessed the effectiveness and reach of the agency's communications.

Survey respondents could select whether each statement was "definitely false," "probably false," "probably true," or "definitely true." Anglers could also select a "not sure" option. Those who answered the question correctly were assumed to be more aware of the topic, and those who answered "definitely false" or "definitely true" were assumed to be more confident in their answer. Overall, respondents had a good understanding of these ecological and regulatory statements as at least half of all spearers answered nine of the ten statements correctly (Table 14, Figure 14). Respondents were most confident about important sturgeon diet items and that water clarity is the best predictor for harvest success each season. More than half of all spearers were also confident in the spear regulations and restrictions (i.e., width of spear head and the tines arrangement; Table 14, Figure 14), which is an important finding because these were recent regulatory changes. These results show that most spearers are keeping up to date with the agency's information about sturgeon and the harvest season, and that these communications have been effective in relaying information to spearers.

Respondents, however, did not have a good understanding about the harvest cap on the population. Nearly all respondents (85%) agreed that they trusted "the science that the Wisconsin DNR uses to estimate sturgeon populations and set harvest caps." However, only 39% of spearers were aware that the cap sets the harvest at 5% or less of the lake sturgeon population (Table 14). Half of all spearers (50%) reported being "not sure" on this statement. Including more background information about the harvest cap could be a topic to target in future communications since most spearers are not aware of these parameters.

Table 14. *Survey respondents' answers to a series of true/false statements regarding sturgeon and sturgeon spearing on the Lake Winnebago system. Statements are presented in order of the percentage of correct responses.*

Statement	Correct Answer	Respondents' answers (%)				
		Definitely false	Probably false	Not sure	Probably true	Definitely true
The best predictor of sturgeon spearer success and season length each year is water clarity.	True	1	1	3	27	68
Lakefly larvae and gizzard shad are important diet items for sturgeon.	True	1	1	6	18	74
The Winnebago system sturgeon population is supported by natural reproduction.	True	5	6	9	32	49
There is no maximum limit to the width of a spear head for sturgeon spearing.	False	65	14	11	5	5
Tines on the spear can only be arranged in a single straight line (i.e. no "X" shape).	True	5	5	16	24	51
Female sturgeon typically do not reach spawning maturity before twenty or more years of age.	True	1	5	25	44	26
The average weight of sturgeon harvested by spearers has declined every year since 1990.	False	33	28	28	10	1
Sturgeon typically are 8-12 years old before reaching the current minimum harvest size of 36 inches.	True	9	14	25	42	11
The Winnebago system is the only place in the U.S. where spearing of lake sturgeon through the ice is allowed.	False	43	7	13	19	18
The harvest cap maintains harvest at or below 5% of the sturgeon population.	True	6	5	50	28	11

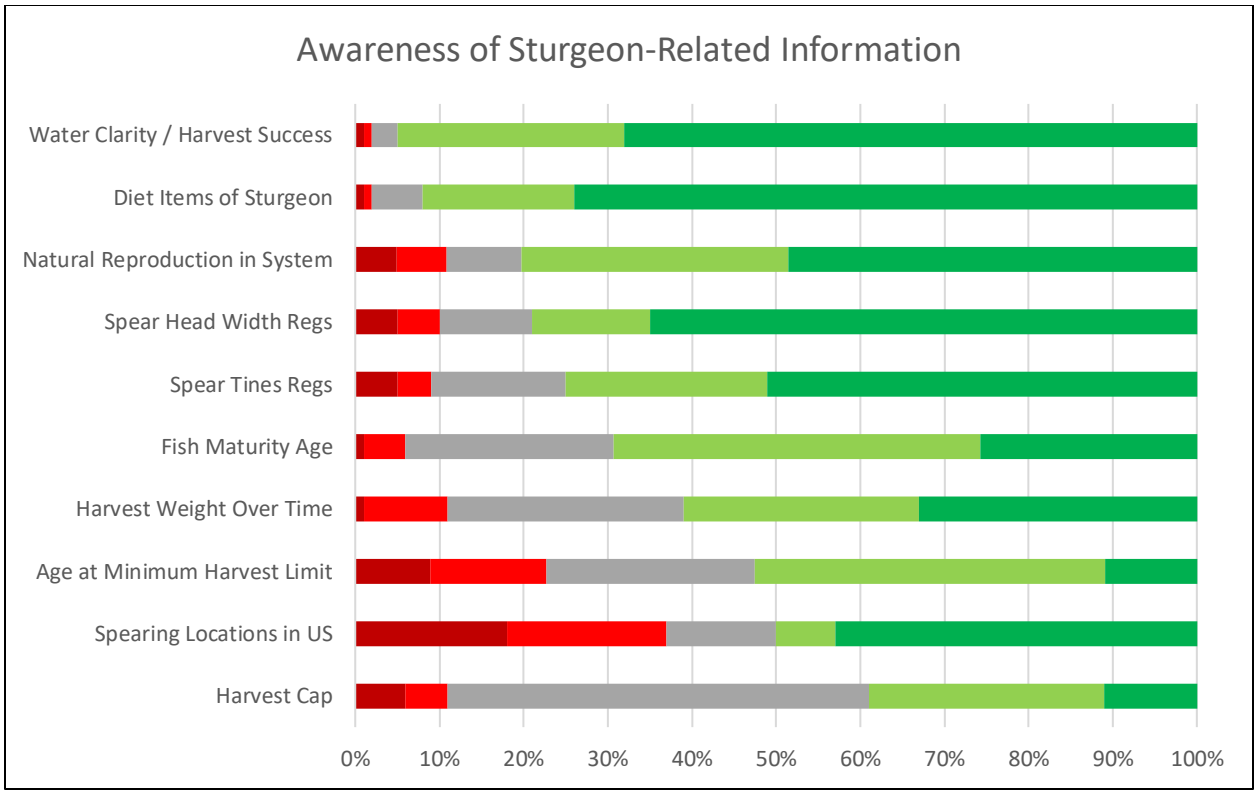


Figure 14. *Visual representation of the proportion of survey respondents who answered each statement correctly. Green represents those who answered each statement correctly, while red represents incorrect responses. The darker shades of each color are those who responded with "definitely false" or "definitely true."*

If responses to these statements were graded like a quiz (i.e., 1 point for every correct answer and 0 points for answering "not sure" or for answering incorrectly), then sturgeon spearers overall would receive a 69% score on their ecological and regulatory knowledge of sturgeon. On average, of spearers who responded to all 10 questions, spearers answered 6.9 of these statements correctly (Figure 15).

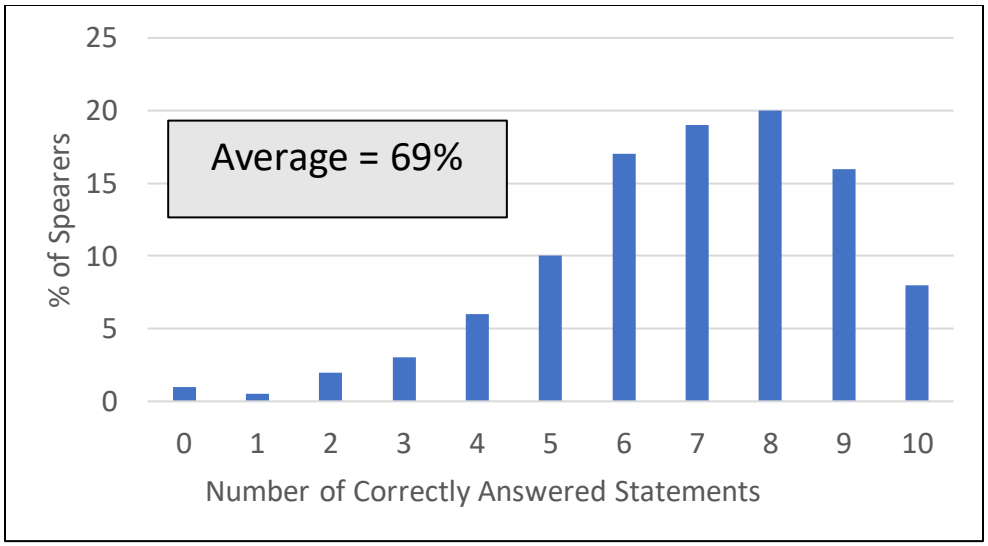


Figure 15. *Number of true/false statements survey respondents answered correctly.*

Correctly Answered Statements and Contributing Factors

Spearer experience on the Lake Winnebago system was associated with more correct answers in general (F=26.3, Sig=0.0001), and with fewer unsure answers (F=22.6, Sig=0.0001). For example, respondents with no prior experience (i.e., first-time spearers for the 2022 season) answered about five of the ten statements correctly and were unsure about three statements on average (Figure 16). Respondents who had participated for 26 or more years were unsure on very few questions on average (about one statement) and answered about seven of the statements correctly on average (Figure 16).

Following the news about lake sturgeon and sturgeon spearing on the Lake Winnebago system was also positively associated with more correct answers (F=47.9, Sig=0.0001) and fewer unsure responses (F=49. 8, Sig=0.0001). Respondents who did not follow the news at all were unsure on about four of the ten statements on average and answered about half (five) of the statements correctly (Figure 16). In contrast, spearers who followed the news a lot in the last five years, answered almost eight of the ten statements correctly on average and were only unsure on about one of the statements on average (Figure 16).

Respondents who were actively involved in local fishing or conservation clubs also answered more statements correctly on average than spearers not engaged in local clubs, though the practical difference was small (F=26.4, Sig=0.0001). On average, spearers active in local fishing or conservation clubs answered 7.3 statements correctly, compared to 6.6 statements answered correctly by those not belonging to a local club.

When taking a closer look at responses to each true/false statement by the extent the respondent reported following the news (Figure 17) or by the respondent's past experience sturgeon spearing (Figure 18), we found differences in how spearers answered each statement. Those who reported following the news about lake sturgeon "a lot" in the last five years were significantly more likely to answer each statement correctly, and also more likely to confidently answer each question correctly (Figure 17). However, even respondents who followed the news a lot about sturgeon were still the least knowledgeable about the harvest cap in comparison to the other statements. Only 18% of these respondents were confident that they answered the statement correctly, and 41% remained unsure if the statement was true or false (Figure 17). If spearers did not follow the news at all, two-thirds (66%) were unsure about this statement.

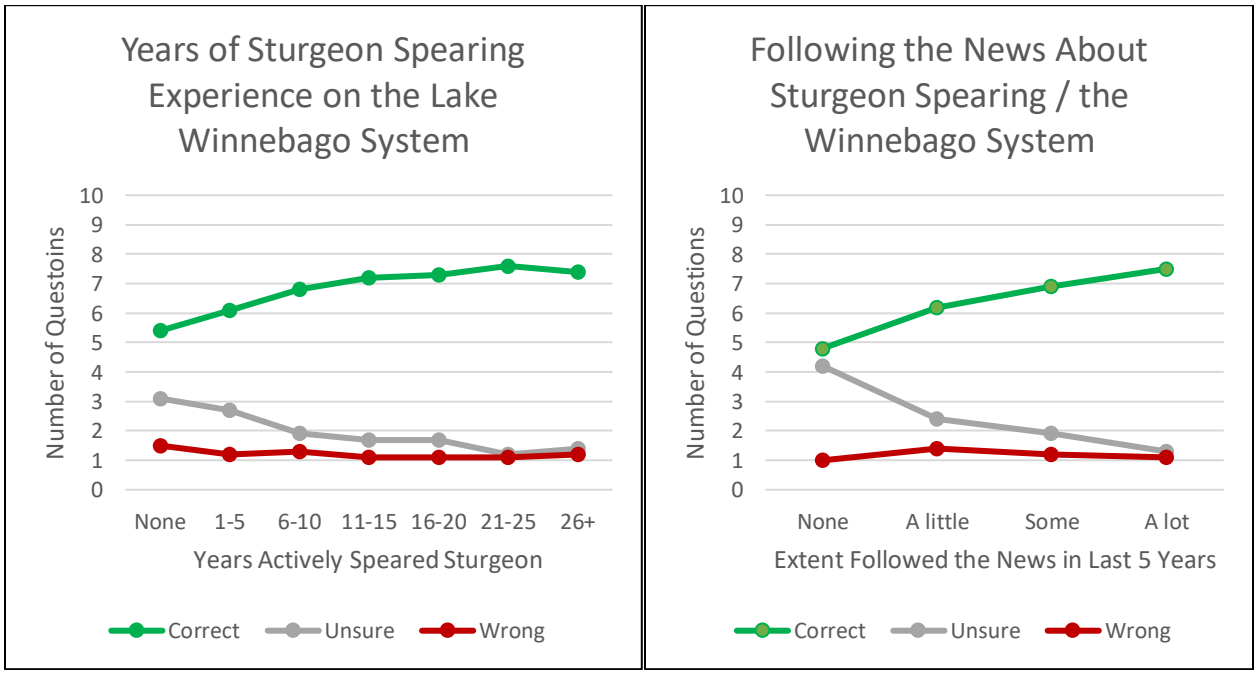


Figure 16. *Average number of true/false statements answered correctly, unsure, or wrong compared to years of experience spearing on the Winnebago system and compared to the extent to which respondents followed the news about lake sturgeon spearing over the last five years.*

Extent of prior experience actively sturgeon spearing also significantly influenced responses to each statement except for the statement: "*Sturgeon are typically 8-12 years old before reaching the current minimum harvest size of 36 inches*" (Sig=0.127; Figure 18). Forty-four percent of those with no prior experience (i.e., their first season would be the upcoming 2022 season) answered this statement correctly, as did 50% of those with 1-5 years of experience, and 52% of those with 26 or more years of experience. Generally, respondent confidence in answering each statement increased along with experience (Figure 18). Generally, less experienced spearers were more likely to report being unsure on the various topics as well.

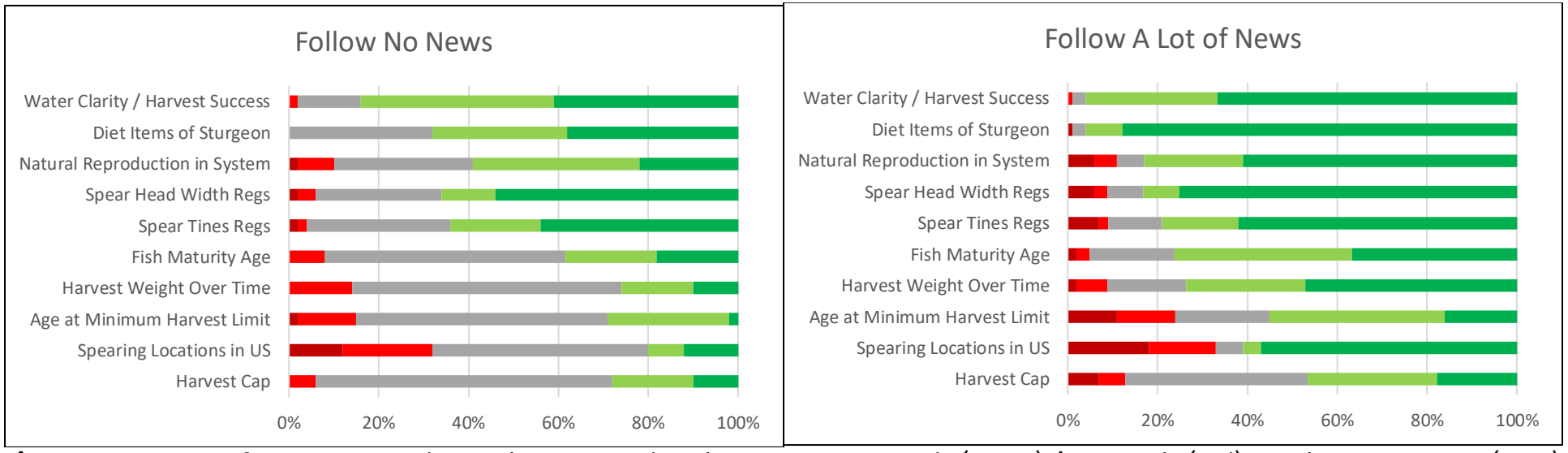


Figure 17. *Percent of survey respondents who answered each statement correctly (green), incorrectly (red), or who were unsure (gray) compared by the extent to which they reported following the news about sturgeon and sturgeon spearing over the last five years.*

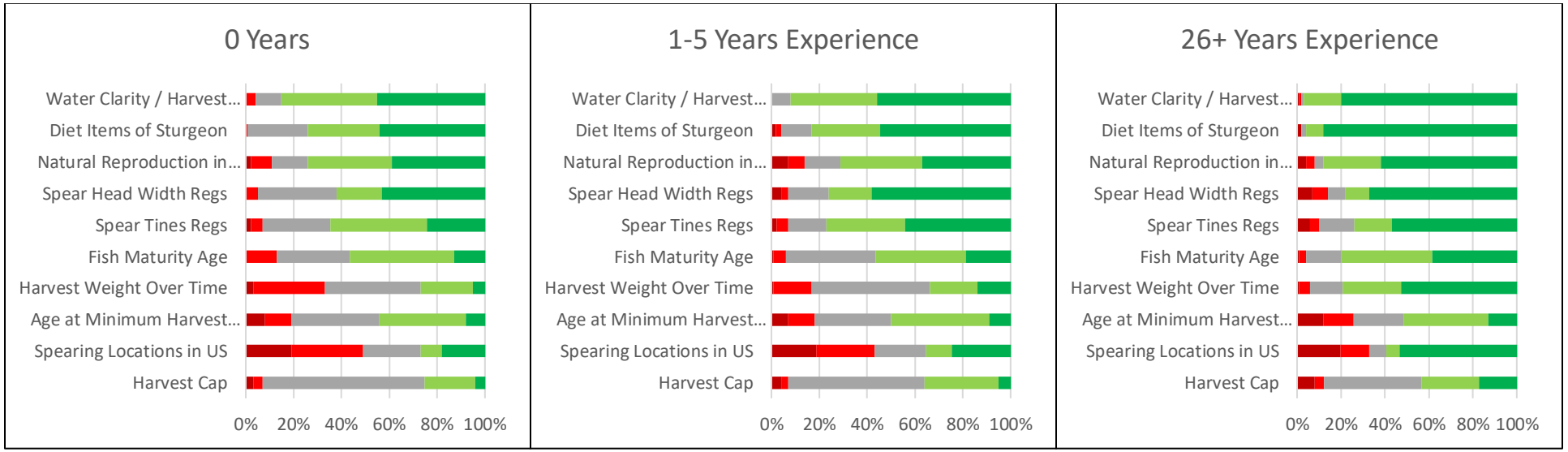


Figure 18. *Percent of survey respondents who answered each statement correctly (green), incorrectly (red), or who were unsure (gray) compared by years of experience actively sturgeon spearing. Those with 0 years of experience are spearers who are participating in the upcoming 2022 spearing season.*

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