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Survey Evaluation of Florida's Freshwater Fisheries Long-Term Monitoring Program

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Abstract: Natural resource monitoring programs benefit from routine evaluation. Here, Florida's statewide Freshwater Fisheries Long-Term Monitoring (LTM) program is used to show how stakeholder surveys can be integral to this process. In 2022, an online questionnaire was sent to internal stakeholders, i.e., state agency personnel who collect, enter, or use freshwater fisheries data for fisheries and habitat management purposes. The survey's primary objective was to evaluate the program at its 15-year mark; secondary objectives were to compare results with a similar survey conducted at the 4-year mark, compare results among respondents based on experience and functional role, and develop recommendations for strategic initiatives to further improve the program. The survey consisted of 43 questions across six sections of program evaluation: demographics; field sampling; data entry, summary, and reporting; management decision support; programmatic views; and additional input. Respondents generally had positive views of the LTM program, but the survey revealed differences among respondents with different functional roles (e.g., fisheries researchers and managers viewed the decisional value, priority, and sample sizes of LTM data more favorably than habitat managers) while highlighting high-priority future initiatives (e.g., database development). Our results demonstrate the utility of stakeholder surveys as an important step in evaluating monitoring programs.

Keywords: survey; long-term monitoring; evaluation

Key Contribution: We demonstrated how perspectives on the LTM program became more favorable over time and differed among stakeholders, particularly by functional role (e.g., research or management). Our research offers important insights for sustaining and enhancing the LTM program while providing an approach for evaluating other natural resource monitoring programs using stakeholder surveys.

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1. Introduction

Long-term monitoring programs serve many purposes, including generating knowledge, assessing ecological status (e.g., species, population, ecosystem), and producing information for management decision making [1,2]. However, conservation monitoring programs are often criticized for lacking clear, precise, or practical objectives [3]. In addition, such programs are often constrained by limited resources (e.g., time, money, personnel), making it difficult to minimize costs and effort while maximizing statistical power to address defined objectives and provide reliable, useful information [4]. Recent efforts have also emphasized the need for the broad-scale standardization of sampling methods used in monitoring programs, not just within natural resource agencies but also among agencies, to facilitate information sharing [5]. Legg and Nagy [3] summarized important criteria for sustainable long-term monitoring programs that included long-term logistical support, personnel training, defined but flexible goals, and periodic program evaluation and adjustments.

The sustainability of long-term monitoring programs is linked to how useful they are, and how useful they remain over time. These conditions can be gauged through regular monitoring-program evaluations, which are valuable for characterizing program outcomes (e.g., how frequently and in what ways data are being used) and optimizing program design and delivery. Within the context of natural resource conservation, Stem et al. [1] identified four primary approaches for evaluating monitoring programs: basic research, accounting and certification, status assessment, and effectiveness measurement. There are multiple ways to evaluate and inform a monitoring program, including quantitative (e.g., statistical power analyses) and qualitative (e.g., stakeholder engagement) approaches [6,7]. One such method involves the use of stakeholder or user-group surveys [8]. Results from these surveys can be used to identify the strengths and weaknesses of a program, pinpoint options for addressing current and future needs of data users, assess programmatic changes over time, and provide a mechanism for accountability and communication between user groups and decision makers. For example, Pärli et al. [8] used an online stakeholder survey to identify the needs, interests, and concerns associated with developing a genetic diversity monitoring program for fishes, amphibians, insects, and other taxa in Switzerland. Overall, surveys can be a powerful step in a comprehensive evaluation that engages stakeholders and ensures the incorporation of stakeholder input into the evaluation process.

In 2006, the Florida Fish and Wildlife Conservation Commission (FWC) implemented a statewide Freshwater Fisheries Long-Term Monitoring (LTM) program. The primary goal of the LTM program was to track changes in sportfish populations and fish communities in select lakes, rivers, and canals across Florida, and thereby inform fisheries management and conservation efforts in the state. The FWC is charged with managing Florida's fish and wildlife resources, and its organizational structure follows a science-based management model. Thus, the LTM program was designed and is housed in the Freshwater Fisheries Research Section of FWC's Fish and Wildlife Research Institute (FWRI-FFR), which works closely with freshwater resource managers of the agency to achieve scientifically sound management of the state's resources. Developers of the LTM program designed it to be adaptive, accommodating adjustments based on periodic evaluations. For instance, program developers acknowledged that circumstances, from funding to data needs, will inevitably change, and knowledge about study systems will grow over time.

The LTM program currently includes the routine monitoring of twenty-eight lakes, ten rivers, and one canal across Florida (Figure 1). Fish and aquatic habitat sampling is performed using standard methods [9]. Sportfish populations are sampled primarily using electrofishing and otter trawl, fish communities are primarily surveyed by electrofishing, and aquatic habitats are mapped using sonar and point-intercept species data. The LTM program uses sampling targets that account for variability in the fish metrics and overall numbers of fish necessary for assessing management-relevant aspects of fish populations and communities [9]. For example, current sample sizes in the LTM program are based on power analyses for fish community parameters such as diversity and species composition [10,11], individual fish catches and catch rates [11], presence–absence data for different combinations of gear types [12], and sportfish population metrics [13–15].

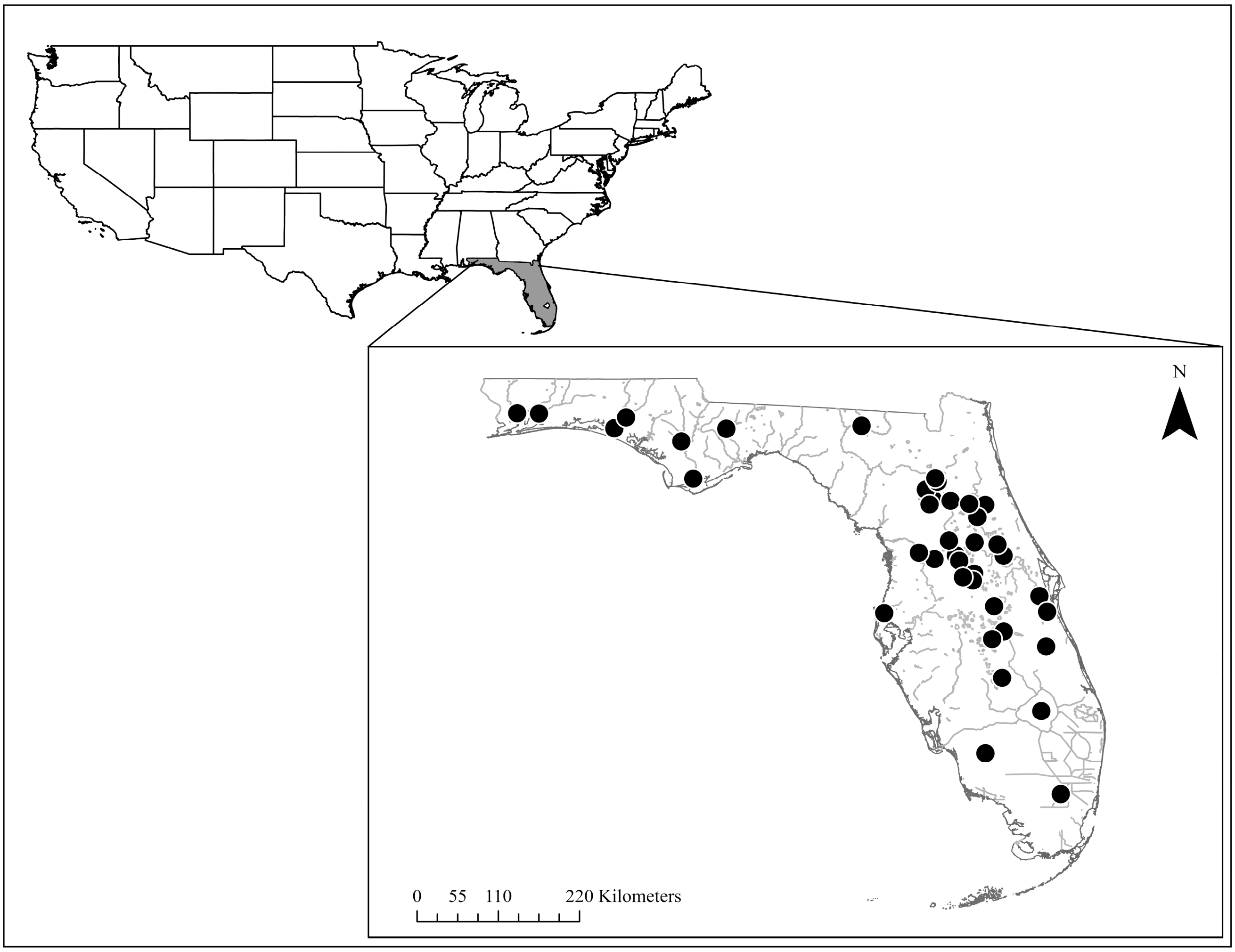

Figure 1. Map of waterbodies (black dots) currently included in Florida's statewide Freshwater Fisheries Long-Term Monitoring program.

Although the original foundation remains intact, the LTM program has undergone many changes during its 16 years of existence. Since 2006, protocol evaluations have been performed, e.g., [10,11], and prioritizations based on funding constraints [12] and management needs have been conducted to keep the program relevant within the confines of limited resources. For example, river sampling and lake-wide habitat mapping were added in 2009 and 2015, respectively, whereas the number of systems was reduced and sampling gears were streamlined in 2013. Today, the LTM program has an annual budget of approximately USD 700,000 and has become a core element of the work performed by dozens of fisheries scientists across all 11 FWC field offices in Florida. However, the LTM program has yet to be comprehensively and simultaneously evaluated from multiple perspectives (e.g., fish ecology, sampling methods and trade-offs, statistical design, program delivery). Such an evaluation is necessary to ensure that the LTM program is best positioned to produce meaningful insights for fisheries management and conservation now and in the future.

Here, we describe a stakeholder survey designed to be the first step in a multifaceted evaluation of the LTM program. Our primary objective was to use the survey to evaluate, from a stakeholder perspective, the LTM program in its current state. Our secondary objectives were to compare these results with a previous stakeholder survey conducted early in the program's development, compare results among respondents with different experience levels and functional roles, and show how survey responses can be used to yield insights for further improving the program in the future.

2. Materials and Methods

2.1. Survey

In 2011, FWC surveyed internal staff to assess the utility and perceptions of different LTM program components and obtain feedback from personnel who collect, enter, or use LTM data for fisheries and habitat management purposes, hereafter referred to as internal stakeholders. This information was useful in growing the young (then 4-year-old) program (FWC, unpublished data). Building upon this effort, a more comprehensive follow-up survey of internal stakeholders was conducted in 2022 as the program was nearing completion of its 16th season.

An online questionnaire was developed in SurveyMonkey®, and the survey link was emailed to freshwater fisheries and habitat (i.e., plant) biologists and decision makers within the FWC. Survey participants included personnel from FWC's Division of Freshwater Fisheries Management (DFFM), the Freshwater Fisheries Research Section of FWC's Fish and Wildlife Research Institute (FWRI-FFR), and the Invasive Plant Management and Aquatic Habitat Conservation and Restoration Sections within FWC's Division of Habitat and Species Conservation (HSC). The functional roles of personnel in these divisions and sections vary and can be broadly grouped as fisheries research (FWRI-FFR), fisheries management (DFFM), and habitat management (HSC). The survey was sent to a total of 144 individuals through the agency's group listservs. Combined, these group listservs included everyone who uses LTM data, but these people had different roles and responsibilities; thus, some individuals who received the survey link would not be considered part of our target internal stakeholder group. Although the resulting response rate would be less than the "true" value, it was important to distribute the survey widely and keep it anonymous in order to accurately and reliably capture all perspectives on the LTM program. The survey was open for responses for three weeks from 28 January to 18 February 2022. In addition to the original notification, two follow-up email reminders were sent out on 8 and 15 February 2022.

The survey consisted of 43 questions split into six main sections (Table 1; Survey S1). Skip logic, or conditional branching, was applied wherever possible to reduce the length of the survey and make the most efficient use of respondents' time. This feature allowed respondents to skip sections that were not relevant to their roles. It also allowed information to be collected from individuals specifically involved with each component of the monitoring program, including field sampling and management decision making. Nine questions from a similar survey conducted at the 4-year mark of the LTM program were repeated in the 15-year survey to assess decadal changes in satisfaction, utility of different aspects of the LTM program, and LTM-related issues and concerns. The previous survey, conducted in February and March 2011, also used SurveyMonkey® and was sent via email to FWC personnel involved in the collection and use of LTM data. In the 15-year survey, respondents were also asked to rate their levels of agreement with 21 statements based on open-ended comments received from the 4-year survey. These statements were divided into five topic areas in the questionnaire (Data and Reports [n = 7 statements], LTM Sampling Protocol [n = 5], LTM Program [n = 3], Needs [n = 2], and Resources [n = 4]). Several demographic questions were also asked, most notably experience level (<1, 1–5, 6–10, and >10 years) and functional role, for which the FWC division/section was used as a proxy.

Table 1. Major components of the 15-year survey of Florida's statewide Freshwater Fisheries Long-Term Monitoring (LTM) program. An asterisk (*) indicates a component that included at least one question that was repeated, at least in part, from a similar survey conducted at the 4-year mark of the LTM program. QA/QC = Quality Assurance/Quality Control.

Section	Description
Demographics	Experience level, functional role in agency, region of work
Field sampling	Extent to which standard protocols are used and referenced, both within and outside the core set of 39 water bodies
	Reasons protocols are not used *
	Ratings of standard protocols for trawl, electrofish, fish health, and creel sampling *
	Ratings of program and services, including program efficiency, staff and field support, and online information resources *
Data entry, summary, and reporting	Ratings of data entry, QA/QC procedures, queries, summary and analysis tools, reports, and online information resources *
	Data-related issues
	Extent to which data are shared and data requests tracked
	Utility of data summary information
	Importance of different data summary information as related to sportfish populations, fish community structure, creel surveys, fish health, and aquatic plants
	Selection of important data summary metrics for dissemination, split into broad categories of sportfish (e.g., lake mean total catch rate), fish community (e.g., diversity index), habitat (e.g., list of aquatic species observed), and creel surveys (e.g., total angler effort by species group)
Management decision support	Reasons monitoring data are not used in making management decisions *
	Importance of different monitoring data for making management decisions
Programmatic views	Level of agreement with 21 statements related to data and reports, sampling protocol, program, needs, and resources
Additional input	Ratings and rankings of future initiatives (automated summaries and reports, database development, restructured online and electronic resources, trainings, evaluations)
	Open-ended questions for specific trainings needed and additional input

2.2. Summary and Analysis

Responses were either binary (yes/no), ratings on a Likert-type scale, or open-ended text (Survey S1). Any "I don't know" or "Unsure" responses were treated the same as unanswered responses and not included in the analyses. Binary data were compared among groups using a chi-square test or, where sample sizes were small (<5), either a Fisher's exact test (for two groups) or Freeman–Halton test (for more than two groups). Ratings data were compared between two groups with a Mann–Whitney U test or among more than two groups with a Kruskal–Wallis test where appropriate. Experience-level analyses were conducted using two groups (short-tenured, $\leq$5 years; long-tenured, >5 years). For functional roles, analyses involved three groups (i.e., fisheries research, fisheries management, habitat management) or two groups in cases where one role had insufficient sample size. Type I error rate was set at 0.100, with associated p-values suggesting strong (<0.010), moderate (0.010–0.049), or weak (0.050–0.099) evidence for an effect [16]. All tests were performed using the FREQ or NPAR1WAY procedure in SAS Enterprise Guide v.7.1 [17].

For questions related to future monitoring efforts, data were summarized using two approaches. One set of questions presented respondents with 51 metrics that could be included in future summary reports (e.g., species richness, mean fish length at age, mean fish relative weight, angler effort, angler catch rate). Respondents were asked to choose metrics they would include, and the percentage of respondents who selected each metric was used to define its priority as high (≥70% of respondents), moderate (50–69%), or low (<50%). To help provide a direction for future monitoring efforts, another set of questions had a defined priority using a weighted-ranking system. Respondents were first asked to rate six categories of metrics or future initiatives (Tables 2 and 3) on a scale of 1 (not at all important) to 5 (extremely important) and then rank them relative to each other. The rating was converted to a scale of 1 (i.e., rating of 1 = 0.20; rating of 5 = 1) and then multiplied by its rank on a corresponding scale from 1 (least important) to 6 (most important) for each respondent. These values were summed over all respondents to calculate a weighted ranking score; high scores indicated high-priority metrics or initiatives, whereas low scores indicated low-priority metrics or initiatives.

Table 2. Weighted rank of importance of six future initiatives with data pooled (all) and organized by experience level (short-tenured, S, ≤5 years; long-tenured, L, >5 years) and functional role (fisheries management, FM; fisheries research, FR; habitat management, HM). For ease of interpretation, priority is listed here in order from 1 (largest weighted ranking value and highest priority) to 6 (smallest weighted ranking value and lowest priority).

Future Initiative	All	Experience Level		Functional Role		
		S	L	FM	FR	HM
Database development	1	2	1	1	1	3
Automated summary reports	2	1	2	2	2	1
Annual training on standard protocols	3	3	3	3	3	2
Standard protocol evaluation	4	4	4	4	4	4
Updated standard sampling manual	5	6	5	6	5	6
Reorganized web-based program resources	6	5	6	5	6	5

Table 3. Weighted rank of importance of six categories of metrics for freshwater resource management with data pooled (all) and organized by experience level (short-tenured, S, ≤5 years; long-tenured, L, >5 years) and functional role (fisheries management, FM; fisheries research, FR; habitat management, HM). For ease of interpretation, priority is listed here in order from 1 (largest weighted ranking value and highest priority) to 6 (smallest weighted ranking value and lowest priority).

Management Metric	All	Experience Level		Functional Role		
		S	L	FM	FR	HM
Sportfish abundance, size structure, and condition	1	1	1	1	1	1
Lake-wide plant coverage and composition	2	5	2	5	3	2
Fish community metrics	3	2	4	4	2	3
Creel estimates	4	4	3	2	4	6
Sportfish growth and mortality	5	3	5	3	5	4
Fish health data	6	6	6	6	6	5

3. Results

3.1. The 4-Year and 15-Year Survey Comparison

There were 46 and 73 respondents to the 4-year and 15-year surveys, respectively. The total number of personnel who received the 4-year survey is unknown and thus the response rate cannot be determined. For the 15-year survey, 73 respondents corresponded to an overall response rate of 51% (73/144). Given that not all individuals who received the 15-year survey use LTM data or are familiar with the LTM program, response rates varied among functional roles. As expected, fisheries researchers and managers had a much higher response rate (72%) than those in the habitat management group (23%). Respondents to both surveys participated in the LTM program in similar proportions relative to field sampling (83% and 86% of respondents to the 4- and 15-year surveys, respectively), data entry and summarization (78% and 79%), and management decisions (46% and 55%). Similarly, the top reasons respondents cited for not using LTM standard sampling remained the same over time: non-LTM sampling objectives (39% and 49% of respondents) and previously established non-LTM protocols (27% and 36%). However, respondents to the 15-year survey were more satisfied with LTM program components, rated the program as more cost- and time-efficient, and used program tools and resources more frequently than respondents to the 4-year survey (Table 4). In addition, the percentage of respondents stating that other data sources outside of the LTM program were more useful for making management decisions decreased over time, from 90% to 67%. Notably, the percentage of respondents involved in making habitat management decisions increased by 62% over time, rising from 32% (4-year survey) to 94% (15-year survey).

Table 4. Temporal comparison of ratings of Florida's statewide Freshwater Fisheries Long-Term Monitoring (LTM) program between the 4-year and 15-year surveys. Ratings range from 1 [very poor] to 5 [very good]), whereas annual use, type of management decisions, and reasons for using other (i.e., not LTM) data have binary responses (either 0 [option not selected or not typically used] or 1 [option selected or typically used]). The table includes the direction of change between the 4-year and 15-year surveys (increase [up arrow], decrease [down arrow]), statistical test, test statistic, degrees of freedom (*df*), number of respondents to the 4-year survey (n_4) and 15-year (n_{15}) surveys, and *p*-value. Comparisons show moderate to strong evidence of change ($p < 0.049$). Only comparisons considered to have broad applicability are shown here.

Comparison	Direction of Change (4-Year to 15-Year)	Test	Test Statistic	*df*	n_4, n_{15}	*p*-Value
Rating						
Satisfaction of standard sampling protocols	↑	Mann–Whitney *U*	1171.0	–	36, 55	<0.001
Cost and time efficiency of standard sampling program	↑	Mann–Whitney *U*	1345.0	–	36, 61	0.001
Process required to access data	↑	Mann–Whitney *U*	830.0	–	27, 45	0.045
Annual use						
Standard sampling manual	↑	Chi-square	39.8	1	39, 63	<0.001
Online data entry form for LTM data	↑	Chi-square	5.6	1	38, 58	0.018
Online data entry form for other (i.e., not LTM) data	↑	Chi-square	6.1	1	35, 58	0.014
Retrieve LTM data from database	↑	Chi-square	23.5	1	38, 58	<0.001
Retrieve other (i.e., not LTM) data from database	↑	Chi-square	13.6	1	34, 58	<0.001
Type of management decisions made by respondents						
Habitat management	↑	Chi-square	21.0	1	39, 34	<0.001
Reasons for using other (i.e., not LTM) data						
Non-LTM data sources more useful for making management decisions	↓	Fisher Exact	0.011	–	36, 40	0.022

3.2. The 15-Year Survey Responses

3.2.1. Experience Level

Most respondents either had more than 10 years of experience (36%) or 1–5 years of experience (32%) (Figure 2A). Long-tenured and short-tenured personnel offered similar responses to 21 statements related to data access, quality and utility, program efficiency, protocol implementation and consistency, and staff resources and needs. Regardless of experience level, median responses of "agreed" (4) or "strongly agreed" (5) were observed for all statements, except the statement "There are other data that should be prioritized over what we collect now", which received a median score of 3 ("neither agree nor disagree"). Further, with the exception of lower importance ratings for fish health data (i.e., physical abnormalities such as lesions) and fish community data, long-tenured and short-tenured personnel offered "good/important" (4) or "very good/important" (5) ratings for the various program components and data types (Table 5). Short-tenured personnel offered slightly higher ratings than long-tenured personnel for field protocols in general (but not within individual components) and slightly higher ratings for the importance of sportfish catch, creel, fish community, and habitat data for management decision making, although statistical support for these differences was weak or lacking (Table 5).

3.2.2. Functional Roles

Of the three functional roles compared in the 15-year survey, more respondents were associated with fisheries research (51%) than fisheries management (30%) or habitat management (19%) (Figure 2B). The level of agreement with statements about the LTM program varied by functional role for six of twenty-one statements (Table 6). Agreement with these statements—relating to the decisional value, priority, and sample sizes of LTM data and the availability of program information and staff support—was generally higher for fisheries researchers and managers than habitat managers. Likewise, fisheries researchers agreed more than managers did with a statement describing the importance of annual LTM training or refresher courses (Table 6).

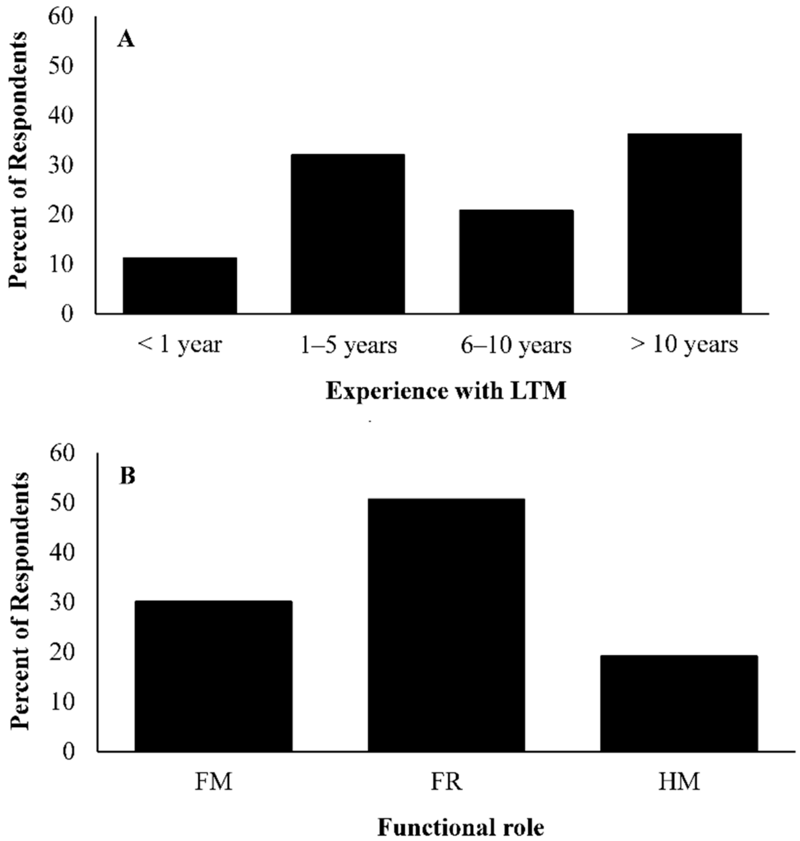

Figure 2. Demographics of respondents to an email survey about Florida's statewide Freshwater Fisheries Long-Term Monitoring (LTM) program. Panels depict the percentage of respondents based on (**A**) experience with the LTM program and (**B**) functional role (fisheries management, FM; fisheries research, FR; and habitat management, HM).

Table 5. Ratings of Florida's statewide Freshwater Fisheries Long-Term Monitoring (LTM) program by short-tenured (S, ≤5 years) and long-tenured (L, >5 years) personnel. Ratings encompass LTM program components (ranging from 1 [very poor] to 5 [very good]) and the importance of different data types (ranging from 1 [not at all important] to 5 [extremely important]). The table includes results of Mann–Whitney *U* tests comparing median ratings of S and L personnel; N denotes little to no evidence of differences, and n_S and n_L denote the number of S and L respondents, respectively.

Category	Program Component or Data Type	Rating		Mann–Whitney *U*		n_S, n_L
		S	L	*U*	*p*-Value	
Field protocols	Overall	5	4	312.5	0.065	15, 19
Field logistics	Overall	4	5	N	N	17, 28
Individual sampling protocols	All gears	4	4	N	N	13–26, 20–28
	Habitat	4	4	N	N	24, 32
	Fish health	4	4	N	N	23, 30
	Creel	4	4	N	N	21, 24
Program attributes	Efficiency	4	4	N	N	28, 33
	Staff support/assistance	5	5	N	N	27–28, 29–31
	Sampling manual	4	4	N	N	24, 30
	Online resources	4	4	N	N	19–23, 21–24
Importance	Creel data	5	4	N	N	11, 20
	Fish community data	4	3	N	N	11, 19
	Habitat maps and estimates	5	4	N	N	12, 21
	Sportfish catch data	5	4	218.5	0.065	11, 20
	Sportfish age data	4	4	N	N	11, 19
	Fish health data	3	3	N	N	10, 19

Table 6. Level of agreement with statements about Florida's statewide Freshwater Fisheries Long-Term Monitoring (LTM) program compared among respondents' functional roles (fisheries management, FM; fisheries research, FR; and habitat management, HM). Kruskal–Wallis tests were performed to evaluate overall functional-role differences, followed by Mann–Whitney *U* tests for pairwise comparisons if differences existed. Inequalities reported under "Group relationships" denote relative levels of agreement (e.g., FR > HM indicates that fisheries researchers agreed with the statement more than habitat managers). The number of FM, FR, and HM respondents is denoted by n_{FM}, n_{FR}, and n_{HM}, respectively. The survey included 21 statements, but the 6 statements with functional-role differences are reported here.

Statement	Kruskal–Wallis			Mann–Whitney *U*		Group Relationships	n_{FM}, n_{FR}, n_{HM}
	Chi-Square	df	*p*-Value	*U*	*p*-Value		
LTM data can be used to provide evidence for a management action	7.413	2	0.025	222	0.009	FR > HM	22, 36, 13
There are other data that should be prioritized over what we collect now	5.606	2	0.061	406.5	0.067	FR < HM	21, 37, 14
The sample size recommendations are adequate for my needs	5.027	2	0.081	180.5 244	0.048 0.041	FM > HM FR > HM	22, 37, 13
I know where to find LTM program resources and information that I need	17.184	2	<0.001	129.5 185.5	0.021 <0.001	FM > HM FR > HM	22, 36, 14
We are provided enough LTM staff help to complete our LTM sampling each year	5.834	2	0.054	265	0.029	FR > HM	22, 37, 14
We should have annual training or refresher courses to stay current on LTM protocols	5.199	2	0.074	528	0.030	FR > FM	22, 37, 14

Fisheries researchers and managers used standard sampling protocols and resources more frequently than habitat managers, but fisheries managers used them more frequently than researchers for non-LTM systems (Table 7). Fisheries managers rated the quality of the field-crew scheduling tool and vegetation mapping protocol lower than fisheries researchers did, and the importance of creel data higher than habitat managers did (Table 7).

Table 7. Frequency of use and ratings of standardized sampling procedures and resources associated with Florida's statewide Freshwater Fisheries Long-Term Monitoring (LTM) program compared among respondent functional roles (fisheries management, FM; fisheries research, FR; and habitat management, HM). Main-effect tests for frequency of use (chi-square, CHI; Freeman-Halton, FH) and ratings (Kruskal–Wallis, KW) and their associated test statistics (degrees of freedom where appropriate) and *p*-values are reported. Results of pairwise comparisons with either chi-square or Fisher's tests (frequency of use) or Mann–Whitney *U* tests (ratings) are also included. Inequalities reported under "Differences" denote relative use and ratings (e.g., FR > HM indicates that fisheries researchers used a resource more frequently, or rated it more favorably, than habitat managers). Ratings range from 1 (very poor) to 5 (very good) and importance ranges from 1 (not at all important) to 5 (extremely important), whereas annual use is either 0 (not typically used) or 1 (typically used). "Evidence" denotes strength of evidence for each comparison, strong (S, $p < 0.010$), moderate (M, $p = 0.010$–0.049), or weak (W, $p = 0.050$–0.099), and n denotes number of respondents for each group. An asterisk (*) indicates that two groups rather than three were included in the analysis due to the importance of comparing management roles. The number of FM, FR, and HM respondents is denoted by n_{FM}, n_{FR}, and n_{HM}, respectively. Only comparisons considered to have broad applicability are shown here.

Program Component	Main-Effect Test			Pairwise Tests		n_{FM}, n_{FR}, n_{HM}
	Test	Test Statistic	*p*-Value	Differences	Evidence	
Annual use						
Standardized sampling manual for LTM sampling activities	FH	<0.001	0.004	FM > HM < FR	S	20, 35, 8
Standardized sampling manual for other (i.e., non-LTM) sampling activities	FH	<0.001	<0.001	FR < FM > HM FR > HM	S W	20, 35, 8
Standardized sampling protocol for LTM sportfish sampling	CHI	6.3 (2)	0.043	FM > HM FM > FR	M W	20, 35, 8
Standardized sampling protocol for other (i.e., non-LTM) sportfish sampling	FH	<0.001	<0.001	FR < FM > HM FR > HM	S M	20, 35, 8
Standardized sampling for LTM fish community sampling	FH	<0.001	0.002	FM > HM FR > HM	S M	20, 35, 8
Standardized sampling for other (i.e., non-LTM) fish community sampling	FH	<0.001	<0.001	FR < FM > HM FR > HM	S W	20, 35, 8
Standardized sampling for LTM aquatic plant sampling	FH	0.002	0.024	FM < HM > FR	M	20, 35, 8
Rating						
Vegetation mapping protocol	KW	4.684 (2)	0.096	FM < FR	W	13, 18, 8
Importance for making management decisions						
Creel data	MW	47.5	0.007	FM > HM *	S	18, 7

3.2.3. Future Directions

Respondents ranked database development (e.g., for fish age and creel data) as the highest-priority future initiative, followed by automating summary reports (Table 2). In contrast, reorganizing web-based collaboration tools and updating the LTM sampling manual were the lowest-priority initiatives (Table 2). Although there were slight differences in the priority of future initiatives between short-tenured and long-tenured personnel and among employees with different functional roles, the top three and bottom three initiatives were consistent regardless of experience level or role.

For metrics of importance for freshwater resource management, fisheries researchers, fisheries managers, and habitat managers all ranked sportfish abundance, size structure, and condition as the highest-priority metrics and fish health data as a low-priority consideration (Table 3). However, the priority of other metrics varied among groups. For example, fisheries researchers ranked fish community metrics as second priority, whereas fisheries managers ranked creel estimates and habitat managers ranked plant coverage/composition as the second priority (Table 3). Similarly, rankings of management metrics varied by experience level, with the exception of the highest-priority (sportfish) and lowest-priority (fish health) metrics (Table 3). Interestingly, long-tenured personnel ranked lake-wide plant coverage and creel data as the second and third priorities, respectively, whereas short-tenured personnel ranked fish community metrics and sportfish data as the second and third priorities (Table 3).

Of the 51 metrics for potential inclusion in future summary reports, 13 metrics were high priority and 17 metrics were moderate priority, spanning sportfish, fish community, creel, and habitat categories (Table 8). Respondents also provided suggestions for improving the LTM program, such as including spatial data (e.g., maps, watershed-level metrics) for sportfish, fish community, creel, and habitat categories and listing new species encountered during sampling events. In various parts of the survey, respondents were asked to provide additional input on monitoring efforts broadly summarized as concerns (e.g., more water bodies need to be sampled, data entry is time consuming) and suggestions (e.g., incorporate data on non-native fishes, develop educational opportunities for internal and external stakeholders) (Box S2).

Table 8. List of priority metrics representing at least 50% of respondents. Note that several of the moderate-priority metric descriptions encompass more than one metric.

Priority	Category	Metric	Description
High (≥ 70%)	Sportfish	Abundance	Lake mean total catch rate
		Size structure	Length frequency of sportfish
		Condition	Mean relative weight of sportfish
		Growth	Mean length at age of sportfish
		Temporal trend	5-year lake trends of sportfish metrics
	Fish community	Richness	Number of species observed in fish community
	Creel	Catch rate	Total angler catch rate by species group
		Harvest rate	Total angler harvest rate by species group
		Effort	Total angler effort by species group
		Temporal trend	5-year lake trends in creel metrics
	Habitat	Presence	List of aquatic species observed
		Volume/area coverage	Percent area coverage (PAC) and percent volume infested (PVI) estimates for submersed species
		Spatial distribution	Plant distribution map by species
Moderate (50–69%)	Sportfish	Abundance	Lake mean catch rate by size group
		Statewide comparison (2 metrics)	Statewide average total and size-specific catch rates
		Age structure	Mean number per age
		Size structure	Proportional size distribution (PSD)
	Fish community	Community structure (3 metrics)	Percent composition by number/weight for species and species groups; mean catch rate by number for each species
		Temporal trend	5-year lake trends of fish community metrics
		Presence (2 metrics)	List of species observed (current year, all years of record)
		Diversity	Diversity index
	Creel	Catch	Total angler catch by species group (standardized by days and lake size)
		Statewide comparison (2 metrics)	Statewide average angler catch/harvest by species group (standardized by days and lake size)
	Habitat	Community structure	Percent occurrence of aquatic plant species
		Temporal trend	5-year lake trends in aquatic habitat metrics

4. Discussion

Freshwater fishes are notably underrepresented in monitoring programs, and issues of data inaccessibility and a lack of published program information have been raised [18]. In the United States, long-term monitoring programs for freshwater fishes are relatively common for single systems (e.g., the Hudson River Biological Monitoring Program [7]), but larger (e.g., statewide or regional) programs are more limited [19,20] and may be split, in a loosely coordinated fashion, among multiple agencies (e.g., [21]). Despite the importance of routinely assessing monitoring programs [1,22], and the value of stakeholder surveys in this process, monitoring-program evaluations emphasizing stakeholder perspectives are uncommonly performed and rarely published [7]. Caughlan and Oakley [22] provided a framework for designing, testing, and implementing monitoring programs, highlighting the importance of periodically assessing whether data are meeting program objectives. Our survey, an important step in the evaluation process following 15 years of implementing FWC's LTM program, was useful for assessing the program and developing recommendations to guide future evaluations and initiatives. Respondents generally had a positive view of the LTM program and its components. For instance, they reported higher satisfaction with and higher ratings of program components, greater engagement with program tools and resources, and greater use of LTM data for making management decisions than respondents to an earlier survey conducted at the program's 4-year mark. Although these findings provide a reason for optimism, the survey also offered a tangible opportunity to explore differences among groups of respondents and prioritize future initiatives and evaluations to better meet management needs.

Survey results indicated that nearly all personnel (94%) are currently involved in making habitat management decisions, compared to 32% 11 years ago. This trend is explained by an increasing focus on habitat decisions and the integration of LTM data into habitat management efforts within the FWC. Multiple factors may account for this trend. For example, an increasing catch-and-release mentality among Largemouth Bass *Micropterus salmoides* anglers, e.g., [23], the formation of interdisciplinary lake management and habitat-related project review teams, and the movement toward statewide regulations—Florida implemented a statewide bass regulation in 2016—likely shifted the fisheries management focus to habitat manipulation efforts. With reduced flexibility to tailor regulations to a particular fishery or a reduced ability to influence exploitation levels through regulations, habitat manipulation becomes an increasingly valuable, demonstrative tool for fisheries management. Further, habitat degradation due to altered hydrology, land-use changes, and issues with invasive plants requires habitat management actions such as extreme drawdowns, mechanical removals, or herbicide treatments to meet sportfish-related habitat targets, which entails increased collaboration between fisheries and habitat managers [24].

We noted differences among respondents based on experience level and functional role. For instance, long-tenured personnel generally viewed LTM program components less favorably than short-tenured personnel. Observing the LTM program since its inception, most long-tenured personnel likely experienced various changes and growing pains that inevitably occurred as the program was implemented and expanded. Further, in that time period, the program underwent changes, primarily reduced sampling effort, as a result of external constraints (e.g., funding). However, short-tenured personnel were introduced to a program that had become better established and, as young professionals focused on establishing their careers, they may not have been as critical of the program. Likewise, familiarity with the program and its administrators likely fostered more confidence among personnel in the fisheries research group compared to the two management groups. The LTM program is housed within the research division of FWC, so it is reasonable that fisheries researchers generally had more confidence in the data and more familiarity with program resources. However, fisheries managers use the sampling guidance and tools within the LTM program for systems outside the program, which demonstrates the program's broad utility for managers. Additional efforts to increase communication between fisheries researchers and the two management groups would enhance familiarity with and use of LTM program components and resources.

Providing stakeholders with "report cards" can be useful for relaying complex information and conveying the relevance of a program to non-technical audiences while motivating action when necessary [1]. However, different components of report cards may be ill-defined, ranked subjectively, or equally weighted, making it important to carefully create and use report cards. In our survey, 13 high-priority and 17 moderate-priority metrics were identified by survey respondents for inclusion in future LTM reports. This list could help inform the process of creating a "report card" for Florida's freshwater fisheries. Alternatively, the three FWC divisions represented in the survey mention sustaining or ensuring the health of Florida's freshwater fisheries in their mission statements, but "health" is not explicitly defined. "Healthy" fish populations can be defined in multitudinous ways, such as genetic or species diversity, nativity (e.g., native vs. non-native), contaminant or disease prevalence, and age and size structure of sportfish populations, among others. Without engagement with biologists to define the parameters that constitute "healthy" fish populations, assessments of the current monitoring program and decisions regarding the future direction of the monitoring program will have limited applicability. Our survey highlighted differences among personnel in fisheries research, fisheries management, and habitat management with regard to the importance and utility of different metrics for freshwater resource management, future needs, and use of LTM resources and protocols. These differences likely reflect dissimilar goals and job responsibilities among agency divisions and sections. Future research exploring why personnel with distinct functional roles view the LTM program differently and assessing potential differences between survey respondents and non-respondents would provide insights for optimizing the LTM program to ensure continued relevance and utility for fisheries management and conservation. Overall, our results indicate the importance of including representatives from multiple user groups when creating a health index or report card that will be broadly relevant to freshwater resource management.

In addition to specific metrics, respondents also provided important information about how LTM program data can be collected, summarized, and reviewed. Specifically, respondents prioritized 5-year trends for reporting summary data, along with formal assessments for each LTM water body at a frequency of every 5 years. Thus, although many researchers and planners evaluate monitoring programs over longer periods (e.g., 10 years [7]), managers may focus more on short-term uses of program data. Furthermore, data users reported interest in accessing, summarizing, and visualizing data in a quicker, more interactive, and more appealing way. Our survey highlights the importance of investing in efforts to enhance the data access and visualization needs of managers and other data users (e.g., GitHub pages, R-Markdown documents, decision support tools).

Identifying 5-year trends and priority metrics can also help LTM administrators reevaluate monitoring objectives and assess how well the LTM program is meeting these objectives. In fact, Lindenmayer and Likens [2] listed "failure to properly articulate what to monitor, and why it is important to monitor targeted entities" as one of the four main reasons for ineffective or failed monitoring programs. Of the 51 data summary metrics included in our survey, respondents prioritized only 30 (59%). In addition, respondents voiced concerns about the amount of data and insufficient number of water bodies monitored in the LTM program. Current sample sizes in the program are based on published literature or power analyses on simulated data for fish community parameters, catches and catch rates of individual species, or presence–absence data [10–15]. For example, our current sampling target is set to detect 90% similarity, species richness, evenness, and diversity when compared to whole-lake values, or 80% of the species each year, for fish community data [9]. For sportfish, the targets are a total catch of 400 individuals and enough samples to achieve a statistical power of 0.80, detection level of 50%, and Type I error rate of 0.05 for mean total catch rate [9]. These types of criteria, as well as the parameters and spatiotemporal scales of priority to managers, are important quantitative measures for evaluating the effectiveness of monitoring programs [25]. Thus, the results of our survey will be important for informing future quantitative evaluations of the LTM program and ensuring that the program remains effective for freshwater resource management.

Another purpose of our survey was to prioritize future initiatives and evaluations. On a broad scale, respondents were tasked with ranking the importance of different initiatives. They ranked database development, automation of data summary reports, and annual training as the top three initiatives. These priorities, along with other feedback and open-ended responses (Box S2), will be vital in moving the LTM program forward and making it more relevant to data users and their management needs. For example, a decision analysis framework, e.g., [26] or simulations, e.g., [27] can be used to evaluate the trade-offs between different sampling frequencies and types of data collected to maximize the number of systems sampled under different funding and effort-cap scenarios. In addition to addressing some of the reported concerns, bringing different groups (e.g., fisheries researchers and managers) together into the planning process can increase dialogue and result in a more efficient and relevant monitoring program [28].

Financial costs will always be a limiting factor in any long-term monitoring program. Changes in funding often motivate evaluations that inform difficult decisions to be made in maintaining long-term monitoring programs, e.g., [7,12]. For example, a series of large funding cuts to the LTM program in 2012–2015 led to programmatic changes (e.g., a reduction in gears and water bodies sampled annually) and the creation of new partnerships and funding channels to help buffer similar situations in the future. However, some of the "costs" of opportunities lost can be hard to assess. Within the conservation community, biologists often refer to long-term monitoring data as an "insurance policy" that can play an incredibly important role in future as-yet-undefined scenarios. Florida's long-term monitoring data have been used to assess changes in sportfish populations and fish communities resulting from both natural and anthropogenic forces (e.g., hurricanes [29], lake drawdown [30], species range expansion [31]) and have the potential to inform future decisions while serving other purposes (e.g., legislative action; see overview provided in Lindenmayer and Likens [2]). Caughlan and Oakley [22] highlighted some of the costs associated with monitoring programs and the importance of evaluating costs and benefits for program success. Ultimately, the benefits received from a monitoring program need to justify the costs spent to run it [22,25].

Although our survey focused on FWC personnel, we made attempts to reach across divisional boundaries to include personnel involved not only in the collection of LTM data but also application of those data for freshwater fisheries and habitat management. Outside the FWC, LTM data are routinely requested by individuals and organizations for myriad purposes from water management to fisheries research. Additional insight could be gained from these external stakeholders (e.g., public citizens, academic and nonprofit organizations, governmental agencies) who may have different uses for LTM data. Nevertheless, FWC is the management agency for Florida's fish and wildlife resources, and the primary goal of the LTM program is to provide data for the scientifically sound management of those resources. As such, our survey offers unique insights into future directions for the LTM program and freshwater resource management across Florida. It can also provide valuable lessons for the future evaluation and direction of other monitoring programs.

5. Conclusions

Long-term monitoring programs can be ineffective or unsustainable for a multitude of reasons that include, among others, a lack of clear direction or purpose [2]. However, monitoring programs can benefit from a management feedback loop focused on assessing the success of different actions in achieving and refining objectives, and ultimately driving future initiatives [1]. Despite the tendency to resist change, ensuring that monitoring programs are flexible and routinely assessed is important for fulfilling program objectives and data-user needs [3,32]. At the same time, it is important that the core structure of the program be maintained in order to preserve the long-term record that makes monitoring data so valuable. Surveys like ours can be an important step in the evaluation process of any monitoring program, providing valuable stakeholder input for gauging progress and planning for future management needs. In addition to characterizing differences among stakeholder groups, particularly their functional roles, we were able to identify priority metrics and needs that will aid future evaluations for increasing monitoring-program efficiency (e.g., via new technologies or different sampling schedules) and relevance (e.g., via the creation of visual tools for communicating monitoring data to the public). Taking this step can be beneficial in helping to ensure the success of other long-term monitoring programs.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/fishes8040216/s1, Survey S1: Online survey administered to internal stakeholders; Box S2: List of suggestions for future monitoring efforts.

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