Aquatic Education: Fishing for Answers

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Abstract: Sixth-grade students (N = 2,916) attending 127 Missouri public schools were surveyed (86% response) to determine their behaviors, attitudes, and knowledge about fishing and the aquatic environment. Data were collected using a stratified random sampling procedure. Most students enjoyed fishing (82%), although a few students did not want to fish again (7%). Student scores reflected a need for more education about aquatic ecology (67%), aquatic resource management (62%), and water topics (45%). An analysis of variance indicated students' knowledge scores significantly differed for gender, region, population, swimming ability, and parent's fishing experience. Although about one-third ascribed animal-rights philosophies to fish, students are more likely to develop "no kill" values than to avoid sport fishing. Because most sixth-grade students are interested in, knowledgeable about, and participate in fishing, aquatic education programs should take advantage of students' backgrounds and weave aquatic learning opportunities into the curriculum.

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Recent events compromising aquatic ecosystems have increased public awareness about conserving our limited aquatic resource. The Alaskan oil spill of 1989 crystallized national awareness of damage to the marine environment (Begley et al. 1989). Public interest about aquatic ecology has provided an opportunity for state agencies to infuse aquatic education into the schools.

Support for aquatic education has been available since 1984. The Dingell-Johnson expansion bill (also called the Wallop-Breaux Amendment) and the Federal Aid in Sport Fish Restoration Act supply funding opportunities for state aquatic

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education projects. The bill allows state agencies to use a variety of methods for promoting the public's understanding about the aquatic environment (Lemon et al. 1987).

In Missouri, the Department of Conservation has incorporated aquatic topics into its conservation education curriculum and workshops for many years. The conservation education program consists of the preschool through kindergarten "Conservation SEEDS Program," the first- through sixth-grade "Otis Program" with a newspaper and teacher activity guide, and seventh- through twelfth-grade curriculum guides including posters, lesson plans, and other support materials. The department provides teachers with equipment and assistance for a 1-day fishing trip. Teachers annually are offered aquatic education courses, workshops, and seminars for college credit during all 3 semesters. To unify aquatic education efforts, the Education Section's program coordinators are planning a comprehensive aquatic education program for elementary students. One component of this program was gathering baseline information about sixth-grade students to assist in development, evaluation, and revision of aquatic education programs.

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Methods

A general survey on aquatic ecology was completed by sixth-grade students attending Missouri public schools during April 1989. One hundred forty-seven schools were sampled from 5 geographical regions (Thom and Wilson 1980) and 5 population strata. The state divisions reflect differences in aquatic resources for comparing student knowledge and attitudes.

In a letter, principals were asked to list their sixth-grade teachers in alphabetical order and choose the teacher falling in the middle of the list. Principals forwarded materials to the chosen teacher who then surveyed his homeroom (or first) sixth-grade class on a convenient day. Besides student surveys, teachers received a cover letter, test instructions, and a questionnaire. The questionnaire asked teachers to rate the ability level of their class and comment about previous aquatic instruction. A list of curricula materials, which are free to all Missouri teachers, and survey results were offered on the questionnaire.

Objectives for survey topics were suggested by fisheries and education experts. Several objectives and items were adapted from the Missouri Core Competency and Key Skills curriculum guidelines (Mo. Dep. Elementary and Secondary Education 1986), Otis Conservation Education Program (Mo. Dep. Conserv. unpubl. data) and an aquatic education survey from Ohio State University (Fortner and Mayer 1983). The objectives were used to develop survey items testing aquatic knowledge, fishing attitudes and behavior.

Sixth-grade students were surveyed on demographics, fishing behaviors, attitudes, and knowledge. Students who fished were questioned about their fishing behaviors. Attitude, value, and opinion items focused on fish and fishing. Items testing knowledge were divided into 4 categories: aquatic ecology, fish ecology and characteristics, water quality and properties, and aquatic resource management.

Survey items were pretested on 51 sixth-grade students, checked for face validity by fisheries scientists and education specialists, and analyzed for reliability using confirmatory factor analysis (James et al. 1982, Mulaik 1982). The Flesch-Kincaid readability formula (Rightsoft Inc. 1987) indicated a sixth-grade reading level for the drafted survey. The final survey contained 4 dichotomous, 26 multiple choice, 8 Likert-type, and 1 open-ended items. Students' answers to knowledge items were scored 1 point for each correct response; incorrect responses received no points. Other items were coded to tabulate the number of students choosing that response. Development of multiple choice items followed published test construction principles (Schrock and Mueller 1982).

The survey was analyzed using SAS/PC software to calculate frequencies and analysis of variance. Frequencies indicated the number participating in fishing activities, prevalence of an opinion, and level of understanding. An analysis of variance (ANOVA) tested statistical differences of demographics and behavior compared with knowledge and attitudes. The PROC GLM command for unbalanced data was invoked for the ANOVA (SAS Inst. 1985). A significance level of 0.05 was used for all tests except where noted.

Results

After mailing the initial survey package and a follow-up letter, 127 schools returned 2,916 sixth-grade student surveys (86% response). More than 80% of the schools in each geographic/population strata responded to the survey, with the exception of in the rural river floodplains area where only half the sampled schools participated.

Teachers reporting class composition ($N = 116$) indicated the results may be slightly biased toward higher ability students. While most classes were average ability (80%), 9% of the sample were high-ability classes ($N = 12$). Only 1 low-ability class participated in the survey. Forty-eight teachers (38%) used various techniques to introduce aquatic education topics during the school year. The most popular method was lecture or discussion ($N = 31$). Three classes had participated in aquatic field trips before receiving this survey. Many teachers ordered free curriculum materials offered on the questionnaire (88%), and some were interested in reviewing the results (35%).

A like number of boys ($N = 1,422$) and girls ($N = 1,428$) was surveyed (66 unknown gender). One-third of the students (33%) owned an aquarium containing aquatic life. Eighty percent rated themselves as average or excellent swimmers. Seventeen percent reported their parents did not fish.

Fishing Behavior

A large number of students had fished sometime in their lives (89%); most students stated their parents fish (79%). In contrast, a 1985 survey of Missourian's outdoor participation (Missouri: 1985 Natl. survey of fishing, hunting and wildl. associated recreation 1989) reported 48% of 6- to 15-year-old children and 36% of the adults had fished that year. This discrepancy can be attributed to lifetime vs. current year fishing experiences.

Although most students had fished, not all students enjoyed fishing (7%). Twice as many girls (N = 150) than boys (N = 64) had fished but did not want to fish again. Three percent of the students had not fished and had no inclination to go; however, another 3% thought they would like to try. Students who enjoyed fishing scored significantly higher on knowledge than those who had not fished or disliked the activity. Almost half (48%) the anglers stated they fished more than 10 times per year. Fourteen percent practiced catch-and-release fishing (sometimes—44%, never—41%).

Eighty-five percent of the boys and 77% of the girls had fished and wanted to fish again. Boys preferred catching bass (40%) over catfish (31%), while girls preferred catfish (30%) over bass (24%). Twice as many girls (19%, N = 454) than boys (8%, N = 191) liked catching trout.

Fishing Values

Given 5 options about why they fish, most respondents chose to be outdoors with nature (34%), to be challenged by the sport (16%), or to catch the biggest or most fish (16%). Fewer students fished to be with a specific parent or relative (3%), or to use their fishing equipment (1%).

About one-fourth chose none of the given responses, and completed the "other" option with "to have fun" (20%) or "to catch fish to eat" (4%). Other students may have responded differently had these 2 statements been included on the survey. However, the definition of a value for "fishing to have fun" is elusive.

Attitudes

Five-scale Likert attitude statements (Isaac and Michael 1984) questioned students on the importance and beauty of fish, fishing techniques, and treatment of fish. Students overwhelmingly agreed fish are an important part of the environment (92%) and learning about fish would be fun (74%). Students were positive about baiting a hook with a worm (82%) and taking a fish off a hook (75%). The majority agreed fish in Missouri's rivers and lakes are pretty (51%) and it hurts a fish to hook it in the mouth (41%). Students disagreed with statements concerning scientists being allowed to kill fish for research (63%) and fish having feelings like people (37%).

Many students had no opinion on 3 of the 8 attitude items. When asked if fish living in Missouri's rivers and lakes are pretty, most students responded "don't know" (26%). More than one-third (35%) had no opinion about fish having feelings like people, and about one-fourth (24%) did not know if hooks hurt a fish's mouth.

Boys' and girls' attitudes were significantly different for all items except hooks

hurting a fish's mouth. Frequencies of boys' and girls' responses indicated large gender differences between willingness to bait a hook with a worm (boys—94%, girls—69%) and removing a fish from a hook (boys—91%, girls—58%).

An analysis of demographics and behaviors compared with attitudes indicated swimming ability was statistically significant for all 8 attitude items, and regional residence was significant for 7 items, excluding scientists using fish in research.

Opinion

The last survey item, an open-ended question, asked students "What do you think is an important problem that hurts water, water plants, and water animals?" Most students wrote pollution or water pollution (56%). More than one-fourth (27%) stated garbage, trash, and litter harmed the aquatic ecosystem. Oil spills were mentioned by 10% of the respondents, probably because the widely publicized Alaskan oil spill had occurred the week schools received survey materials.

Other concerns were toxic waste (6%), acid rain (5%), overharvesting fish (3%), and wastewater treatment (2%). One percent mentioned air pollution (N = 46) and human overpopulation (N = 43). Less than 1% noted poaching (N = 27), watershed contamination (N = 22), poison (N = 15), all-terrain vehicles (N = 12), draining lakes (N = 11), drought (N = 6), overabundance of aquatic plants (N = 6), nuclear waste (N = 6), water shortages (N = 5), and laundry detergent (N = 4).

Students' interpretations about the relative importance of particular aquatic problems revealed additional information about their aquatic knowledge. Some unusual responses were that walking, swimming, spitting, pouring beer or soda, or throwing food, dirt or rocks into the water caused pollution (N = 24). Others stated that motorboats or barges (N = 9) were an important problem; perhaps these students were referring to the Alaskan oil spill. One or 2 students each commented that thermal pollution, dam construction, overstocking fish, turning over of stratified pondwater, bacteria, the greenhouse effect, and thunderstorms were harmful to the aquatic environment. Eight students wrote they did not know of an important problem harming water and aquatic life. Forty-two responses (1%) were ambiguous or illegible. Twelve percent did not answer this item.

Knowledge

Student knowledge categories were determined as a percentage of the students with correct responses. Students were more knowledgeable (a higher percentage with correct responses) about fish ecology (73%), aquatic ecology (67%), and aquatic management (62%) than water quality and properties (45%). Students knowledge scores for the 20 items were moderate with an average score of 62%. A visual representation of knowledge categories (Fig. 1) illustrates the number of students correctly answering questions by category. Almost one-fourth (24%) correctly answered 5 items on fish ecology. In the lowest scoring category, water quality, most students correctly answered 2 or 3 of the 5 items.

The percentage of students correctly responding to each knowledge item ranged from 91% (algae is an aquatic plant) to 26% (<25% of earth's water is inland water)

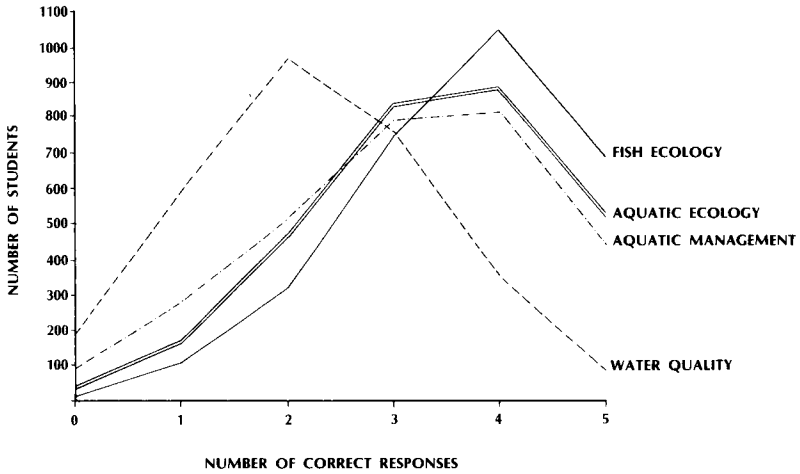

Figure 1. Number of students correctly answering items for each knowledge category (maximum = 5).

(Table 1). Although students scored highest on fish ecology, the lowest scoring item in that category revealed only 49% recognized bass and bluegill fry hatch from eggs. Many students (42%) did not know the Department of Conservation makes laws concerning aquatic life, even though teachers were instructed to announce the agency conducting the study.

Three items on the aquatic education survey were developed from state objectives by the Missouri Department of Elementary and Secondary Education (1986). In this survey, students were well aware of habitat requirements, with 80% of the students correctly identifying the components of fish habitat. Almost two-thirds identified the correct sequence of a simple 5-member aquatic food chain.

The item identifying plants as producers was developed from a "key skill" objective, which is tested annually by the state. The state's standardized test results of sixth-grade students in 1988 and 1989 was 41% and 45%, respectively. Results form the aquatic education survey on this item (42%) compare favorably with the state's standardized test score findings (W. Boulter, Dep. Elementary and Secondary Education, pers. commun., data from MMAT, 1989).

An analysis of variance revealed that gender, region, and population were significantly different from the total knowledge score. Males' knowledge scores were significantly higher than females' scores ($P < 0.0001$). Generally, a few more boys (0%–8%) than girls answered each knowledge question correctly. Students from the Glaciated Osage Plains answered more items correctly than those from Ozark Plateau and urban areas. Responses from students in schools located in rural areas of <2,000 residents were significantly different from those in large cities with >100,000 residents.

Swimming ability and parent's fishing experience were statistically significant in relation to the total knowledge score, while aquarium ownership was not signifi-

Table 1. Percent of correct responses to multiple choice knowledge items.[a]

Category[b]	Item concept	%
A	Algae is a plant that lives in water.	91
F	Fish breathe with gills.	86
R	Define catch-and-release fishing.	81
F[c]	Identify components of fish habitat.	80
F	Identify a simple fish structure.	78
A	Habitat is the place an animal lives.	75
W	Recognize effect of acid rain on aquatic life.	72
F	Fish do not have lungs.	69
A	Frogs lay eggs in water.	64
A[c]	Identify the correct order of a food chain.	63
R	People are draining marshes and swamps for land development.	61
R	Canoeing is less harmful to stream life than ATV's, littering, channeliziing, and erosion.	59
R	Identify agency that controls aquatic life.	58
W	Identify characteristics of water cycle.	53
R	Many older cities are found near rivers.	53
F	Bass and bluegill fry are hatched from eggs.	49
A[c]	Plants in a food web are called producers.	42
W	Recognize effect of pollutants in food chain.	41
W	Identify changes in a watercourse from adding a structure to a river.	33
W	Less than 25% of earth's water is fresh water.	26

[a] Additional data available from the authors.

[b] A = aquatic ecology, F = fish ecology and characteristics, W = water quality and properties, R = aquatic resource management.

[c] Item from state core competency objective (Mo. Dep. of Elementary and Secondary Education 1986).

cant. Excellent swimmers scored significantly higher than poor swimmers, but did not differ from those who lacked swimming skills. Students whose parents fish scored higher than those whose parents did not fish ($P < 0.01$).

Other research confirms that gender (Pomerantz 1977, LaHart 1981, Fortner and Mayer 1983, Kellert 1983, Kellert and Berry 1987), residence (Pomerantz 1977, Fortner and Mayer 1983, Kellert 1983), and swimming ability (Fortner and Mayer 1983) are related to knowledge about animals and the environment.

Discussion

Perhaps the most important finding from this survey is that 89% of the sixth-grade students had fishing experience. One possible explanation is the popularity of fishing among adults (36% of Missouri population, from Missouri: 1985 Natl. survey of fishing, hunting and wildl. associated recreation 1989), who in turn take their children fishing. Another possibility is that some students previously participated in Missouri's Aquatic Education Program. For almost 20 years, the Department of Conservation has conducted fishing field trips and provided fishing equipment at stocked sites.

The justification for continuing aquatic education programs is to teach aquatic

ecology concepts. While most students were knowledgeable about and interested in fish and fishing, they were less knowledgeable about the environment in which fish live. Specifically, students lacked knowledge about aquatic ecology, aquatic management, and water quality and properties. Although students scored highest on items about fish characteristics and ecology (73%), about half did not know that bass and bluegill fry hatch from eggs (49%).

Sixth-grade students were more aware of national rather than state or local issues dealing with the aquatic environment. Students need more practice applying ecological concepts (such as identifying a consumer or producer). An outdoor classroom fishing experience is an opportunity for students to learn and broaden their interest in the aquatic environment.

Gender Differences

Differences in boys' and girls' knowledge and attitudes about the aquatic environment were evident. Although statistically more boys correctly answered knowledge items, percent difference between boys and girls for each item (0%–8%) was low. The practicality of targeting programs toward females probably would yield minimal change and not be cost-efficient. However, recognizing girls' attitudes toward fishing may benefit instructors who train students about fishing techniques.

One finding indicates many girls (31%) and some boys (6%) are sensitive to baiting hooks with live bait. One possible hypothesis for why twice as many girls than boys prefer trout fishing may be the use of artificial flies or worms by trout anglers. An alternative hypothesis is easy access to streams and lodging associated with trout parks in Missouri. If trout fishing is preferred because of artificial bait, the anxiety associated with using live bait might be alleviated by appropriate role models. Offering artificial bait is an option for those whose anxiety may draw them away from fishing.

Attitudes About Fish Treatment

Students' attitudes about fishing techniques and treatment of fish are of interest to fisheries biologists and managers. Although only a few anglers practiced catch-and-release fishing (14%), most thought fish should not be killed for scientific purposes (73%). Perhaps students were reacting negatively to the word "kill" in the item, even though most apparently kept (and killed) the fish they caught.

This discrepancy of fishing behavior and attitudes also was evident by those attributing human characteristics to fish. A sizable minority thought fish have feelings like people (27%), and hooks hurt a fish's mouth (41%); however, this would seem to contradict their fishing behavior. Although about one-third ascribed animal rights or anthropomorphic philosophies to fish, it appears students are more likely to develop "no kill" values than to avoid sport fishing.

Aquatic Education Curricula

Clues for interpreting children's knowledge and attitudes toward animals have been studied in relation to psychological theories about stages of moral (Dunlap

1987) and cognitive development. Kellert (1983) proposed children undergo 3 stages of development. In the first stage, from second to fifth grade, children have a low emotional concern for animals. In the next stage, fifth- to eighth-grade children are searching for a "cognitive and factual understanding of animals."

Other research indicates students accumulate more environmental knowledge between elementary and junior high than from junior high to secondary levels (Kellert 1983, Hair and Pomerantz 1987, Stout et al. 1988). Eighth- to eleventh-grade students exhibit more ethical and moral reasoning abilities than younger students (Kellert 1983). Therefore, aquatic education curricula for elementary students should concentrate on increasing knowledge of ecological and water-related topics.

We recommend aquatic education curricula follow a long-term approach concentrating on the developmental needs of students. For sixth-grade students, aquatic education curricula should present factual aspects about the aquatic community. Because most sixth-grade students are interested in, knowledgeable about, and have participated in fishing, programs should take advantage of students' backgrounds and weave aquatic learning opportunities into the curriculum.

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