ASSOCIATION of FISH & WILDLIFE AGENCIES

The North American Conservation Education Strategy:

Value of Field Investigation Models to Natural Resource Conservation Education

A white paper of the Association of Fish & Wildlife Agencies' North American Conservation Education Strategy

Funded by a Multistate Conservation Grant of the Sport Fish and Wildlife Restoration Program

Produced by the Pacific Education Institute

SPORT FISH & WILDLIFE RESTORATION

Conservation Education = Conservation

Value of Field Investigation Models
To Natural Resource Conservation Education

By

Margaret Tudor

For the Association of Fish and Wildlife Agencies

Conservation Education Working Group

Developed By
Pacific Education Institute

Developed for
Association of Fish and Wildlife Agencies' North American Conservation Education Strategy

Funded by a Multistate Grant of the
Sport Fish and Wildlife Restoration Program

Introduction

The Association of Fish and Wildlife Agencies represents state natural resource agencies whose directors want to ensure that science education in schools includes the science of natural resource management. Much of the research supporting and informing resource management depends on rigorous scientific studies conducted in the field. Yet, there is no national consensus on the framework for science investigation in the field and how it relates to experimental design, the dominant inquiry taught to students. This issue has significantly impacted science education and science literacy. Because experimental design requires that variables in the experiment be controlled, it is best suited to studies conducted in a laboratory. It therefore represents only a portion of the research undertaken by scientists in the real world. Recognizing the importance of comprehensive science education, the Conservation Education Working Group's K-12 Initiative set out to assess the current status of field science education in schools, giving particular attention to the types of field investigations typically undertaken by field biologists.

This paper presents a summary of four studies conducted by the Pacific Education Institute on behalf of the Association of Fish and Wildlife Agencies. The studies were designed to assess the state of field science in formal K-12 science education by:

1. Examining state science education standards to determine whether and to what extent they address field study methodologies.
2. Consulting fish and wildlife biologists to determine whether the field investigation models articulated by Windschitl, Ryken, Tudor, Koehler and Dvornich (2007) accurately describe the research done by scientists in the field.
3. Exploring the value of providing field studies opportunities and guidance to K-12 students.
4. Understanding the needs of science education professors who are preparing future teachers to provide field studies.

What follows is a description of how these studies were conducted, the results, and their implications for K-12 science education.

Survey of Stakeholders

To assess the current status of science education and field investigation methodologies, the Pacific Education Institute gathered feedback and information through research, interviews, and surveys. This review of K-12 science education involved a total of 233 stakeholders from 47 states composed of 72 conservation educators from 38 states, 36 science education professors from 22 states, and 125 fish and wildlife biologists from 31 states.

State Education Standards: To determine whether state science standards address field investigation (descriptive, comparative, and correlative studies), the standards of all fifty-one states (including Washington D.C.) were downloaded from the various state department of education websites. The standards were then compared to the field investigation models described by Windschitl et al. 2007 (Rorie and Cox, 2007).

Field Science Inquiry in Practice: Through personal interviews and a survey of web sites, 196 agencies and organizations were consulted for examples of field based science investigation

(Wolfe and Cox, 2007). Results from a study of citizen science activities at state fish and wildlife agencies were included (Kertson, Grue, Pierce and Conquest, 2006).

Fish and Wildlife Biologists: Fish and wildlife scientists nationwide were invited to participate in an on-line survey. To ensure a broad response, requests for participation were sent out through the directors of state fish and wildlife agencies, the Wildlife Society e-mail list, and Project WILD coordinators. The objective of the survey was to understand the methodologies used in the field by fish and wildlife biologists and to assess the potential role of these biologists in K-12 field studies. One hundred and twenty-five natural resource scientists, from thirty one states, involved in a range of activities, responded.

State Conservation Education Professionals: Seventy two conservation educators from thirty eight states responded to the AFWA request to participate in an on-line survey. Using the national program e-mail list, the survey was sent to Project WILD, Project Learning Tree, and Project WET coordinators in every state.

Science Education Professors: Education professors who train future teachers to teach science were invited to participate in an on-line survey. To obtain a wide range of responses, the invitation to participate was extended to:

- Educators referred by state coordinators of Project WILD, Project WET, and Project Learning Tree programs.
- Deans of schools of education at state universities, who were asked to refer the invitation to their science education professors.
- Science education professors who attended the 2007 North American Association of Environmental Education (NAAEE) conference.

Thirty six science education professors responded to the invitation. In addition, 12 professors were interviewed at 12 teacher education institutions. The objective of the survey and interviews was to identify the role of field studies in teacher preparation (Wolfe and Cox, 2007).

Study Results and Implications

State Education Standards:

The review of state science education standards across the nation revealed that:

- No state standards currently describe field investigation specifically in terms of descriptive, comparative, and correlative scientific methodologies. (These three methodologies are outlined in the article by Windschitl et al. (2007) in the Appendix).
- Ninety five percent of states refer to natural resources in their science education standards. This is an opportunity to expand state science standards to include field investigation methodologies that are central to the study of natural resources.
- Of the 46 states that test science, 74 percent include science inquiry questions. Fifty percent of these states include natural resource related questions in short answer formats, which are ideal for inserting field investigation questions.

Implications: While national education standards call for multiple science investigation methodologies, no state's standards provide a complete description of the primary methodologies employed by scientists. The field methodologies (descriptive, comparative, and correlative) in particular are neglected, as most states continue to focus on experimental design. A few state standards refer to "other" science inquiry methods, but provide no guidance. These findings support the need to expand the definition of science inquiry to ensure that the techniques used to study macro-environments (as opposed to the cellular and atomic levels) are taught in schools. Fortunately, most state science standards can readily be adjusted to include field methodologies.

Field Science Inquiry in Practice

As a result of a comprehensive analysis nationwide, we found that agencies and organizations offering K-12 natural resource field study programs:

- Do not provide a consistent framework for field science investigation methodologies.
- Primarily offer descriptive field inquiry experiences, with fewer programs offering comparative inquiry and correlative inquiry experiences.

Implications: Agencies and organizations are actively involved with students in field based studies, and around 50 percent engage students in descriptive, comparative, and correlative types of investigations. These agencies and organizations can benefit from framing their studies in terms of the field investigation models outlined by Windschitl et al. (2007) and accompanying guidelines for teachers and students.

Fish and Wildlife Biologists

About ninety percent of the natural resource (fish and wildlife) biologists who responded rated the field investigation models in Windschitl et al. (2007) as adequate or better in describing the types of field studies they undertake. Over ninety percent of the respondents emphasized the need to provide field experiences to K-12 students, and 83.5 percent saw the need for field study guidelines. Finally, about eighty percent indicated that the field investigation models would help people understand their research, improve the quality of data contributed by citizen science projects, and help fish and wildlife agency educators work effectively with schools.

Implications: The survey of fish and wildlife biologists revealed that they support agency education efforts to involve K-12 schools in field studies. The scientists expressed a strong interest in becoming involved with K-12 field science studies, particularly those that contribute useful information to their research. The challenge for conservation education professionals is to maximize the value K-12 field science projects have for the research needs of agency scientists.

State Conservation Education Professionals

Most conservation educators indicated awareness of their state science standards and testing, but were unsure about testing inquiry. The educators also knew of field studies being conducted in schools, and approximately half were involved in such studies. They emphasized that the decision to undertake field studies depends greatly on:

- The efforts of individual teacher-leaders within the schools.

- The existence of partnerships between schools and outside groups that support field studies.

In those state agencies that conduct field studies, most educators agreed that the field investigation models outlined in Windschitl et al. (2007) effectively describe the types of field studies their scientists undertake. The educators also agreed that these models would help students understand their agency's research and improve the quality of citizen science. Likewise, they saw the need to provide both field study experiences and guidelines to students.

Implications: These findings suggest a significant role for conservation educators in K-12 education. Many conservation educators are also involved in pre-service programs in a number of states, primarily to deliver Project WILD, Project Learning Tree, and Project WET materials and services through workshops.

Conservation educators were discouraged by education reform, particularly the federal mandate to impose state science standards on schools. They observed that pressure to meet current standards has led many schools to reduce opportunities for hands-on activities and field research. They also reported that a few states encourage scientific investigation outdoors (e.g. AK, AR, IA, MO, NH).

Science Education Professors

The survey of teacher education institutions conducted by Wolf and Cox (2007) revealed that methods courses have no framework for scientific field investigations similar to the framework provided in Windschitl et al. (2007). Methods courses relied on instructional models (such as 5E, SCIS, learning cycles, discovery, experimental inquiry, guided instruction, classroom environmental research, field research extensions, and field based inquiry) for developing science inquiry competence. These courses did not provide methodologies for field science investigation, but instead relied upon the general science programs at their higher education institutions to expose future teachers to life science methodologies.

Science education professors responding to the AFWA on-line survey can be divided into two groups:

- The twenty eight professors not associated with the North American Association of Environmental Education (NAAEE) Conference in 2007 were not aware of guidelines available for experimental, correlative, comparative and descriptive investigation methodologies. About half of the professors were unsure how well the field investigation guidelines in Windschitl et al. (2007) fit the field science investigations of professional scientists. Eighty percent saw the need to provide field science experiences to students, but only half agreed that the field investigation guidelines would improve the quality of citizen science. Two thirds of the respondents indicated that the field investigation models will be used in their courses in the future.
- The eight science education professors who attended the 2007 NAAEE conference were generally (87 percent) not aware of field science investigation models or guidelines, but 85 percent felt the field investigation models described in Windschitl et al. (2007) fit the types of field studies conducted outdoors.

All 36 respondents saw the need to prepare teacher candidates to provide field study experiences to students and saw a need for field study guidelines for K-12 students. All but one professor agreed that these field investigation models will help students understand natural resource research, help students contribute high quality data to citizen science projects, and be useful for teacher preparation.

Implications: Teacher education institutions use instructional methodologies as a means to develop multiple inquiry approaches. Instructional methodologies are not science inquiry methodologies—teacher education institutions could benefit from the model of field investigation methodologies developed by Windschitl et al. (2007) and guidelines for teaching field investigation.

Currently, natural resource education in teacher preparation curriculum is limited, largely because it is not required for state standards testing. As long as state standards and testing exclude it, it has a minimal chance of being included in teacher preparation curriculum.

Reflecting on the lack of national consensus on the framework for science inquiry in the field, the professors acknowledged that the "scientific method" is often equated with a single methodology, experimental design. The professors saw the value of the field investigation models and guidelines for teachers and teacher preparation professors as these provide science methodologies better suited to research in the field.

Science education professors associated with NAAEE were clearly working with non-formal fish and wildlife educators to provide opportunities for students to conduct field studies that benefit fish and wildlife agency science.

Summary

The AFWA studies showed that the primary stakeholders for field investigation models and guidelines:

1. Recognized that field investigation models are not present in state standards, are not tested, and therefore are not taught in schools.
2. Saw value in involving K-12 students in field studies and agreed that students need field investigation models and guidelines.
3. Agreed that the Windschitl et al. (2007) field investigation models describe the kind of work professional scientists undertake in the field.

Discussion

The Need for Consistent Terminology

As a result of the nationwide peer review of the article "Understanding Field Inquiry," we have come to the conclusion that although the information contained in the article is useful to educators and scientists, the use of the term "inquiry" when referring to descriptive, comparative and correlative studies may be confusing to some. This is because the term "inquiry" can be used to describe both teaching and doing science. The National Science Education Standards (1996) note this dichotomy: *Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of

scientific ideas, as well as an understanding of how scientists study the natural world" (Colburn, 2000).
To avoid confusion, we recommend using the phrase “Field Investigation Models” to refer to the descriptive, comparative, and correlative methodologies described in Windschitl et al. (2007) and branding them as such for use in state education standards. The "Structured, Guided, Open and Learning Cycle" types of instructional methodologies to teach inquiry can then be used not only to understand chemistry or physics, but also natural resource science, which involves Field Investigation Models to guide research in the field.

Until the articulation of field investigation methodologies in the Windschitl et al. (2007) paper, government and non government providers delivered K-12 field studies without a common framework to help students understand the nature of science inquiry—in spite of the fact that national standards emphasize student understanding of the nature of science inquiry. The AFWA studies have demonstrated that both scientists and educators need some clarification of the nature of science inquiry. As a result of the field investigation models, practicing biologists report that they understand their own inquiry more clearly, and realize that random sampling is an element of experimental design and should not to be equated with experimental design. Practicing biologists have also learned to value the role of descriptive inquiry as the starting point of science inquiry.

Difficulties Created by Current Education Standards

The intent of the federal No Child Left Behind (NCLB) Act was to improve every student’s chance of succeeding in the twenty first century by ensuring that all students graduate with the requisite knowledge and skills. The implementation of the Act has resulted in explicit standards for each discipline in each state, with most states testing student performance. Teachers know their obligation is to prepare students for state tests; indeed, critics of NCLB accuse teachers of teaching to the tests.

Now in the eighth year of implementation of NCLB, state science standards reflect the National Research Council’s (NRC, 1996 and 2000) National Science Education Standards’ (NSES) emphasis on experimental design and include only a vague reference to multiple inquiry methodologies. No guidance is provided for multiple methodologies. Consequently, state curriculum directors and teachers equate scientific methodology with experimental design. This neglects a wide range of contemporary science inquiry in the macro-environment. Moreover, teachers find they cannot provide science inquiry in the outdoors because they cannot easily or ethically control a variable (as expected in experimental design).

Among many administrators and teachers preoccupied with meeting state standards, conservation education is considered an add-on. As a result, rigorous field inquiry is in danger of being lost to K-12 schools. Unless administrators see that conservation education helps students achieve on state tests, they will not support teachers to provide conservation education experiences to students. In spite of efforts by community groups to involve students in community field experiences that contribute to local science questions, students nation wide continue to have unequal access to field inquiry education (Wolf and Cox, 2007). Until state standards address this important area of science learning, many students will receive potentially poor and misleading field experiences that do not meet the national standards for rigorous scientific inquiry.

The Failure to Recognize Field Investigations as Legitimate Science

Classroom science often overemphasizes experimental investigations in which students actively manipulate variables and control conditions. While this type of investigation is well suited to studies conducted within a laboratory, it is generally less useful for studying the macro-environments of the natural world. It is difficult to manipulate variables and maintain "control" and "experimental" groups out in the natural environment, so field investigation scientists look for descriptive, comparative, or correlative trends in naturally occurring events. Yet, this contemporary approach to scientific investigation is not reflected in state standards, and many educators are unaware of the distinctions between experimental design and the methodologies suited to field research. Because they are unfamiliar with field methodologies, a number of people fail to recognize field studies as rigorous scientific investigations that yield reliable data.

State Fish and Wildlife Agencies and the Importance of Conservation Education

State fish and wildlife agencies have an obligation to maintain healthy fish and wildlife populations and to provide recreation opportunities. To ensure effective and sustainable stewardship of our natural resources, these agencies depend heavily on scientific investigations—largely conducted in the field—that expand and improve our understanding of the natural systems of our world. It is critical to the mission and mandates of natural resource agencies that conservation education be included in K-12 schools. Without it, students will not develop the knowledge and skills they will need to comprehend natural resource issues and make informed, responsible choices as citizens and as stewards. Moreover, including conservation education in schools allows students to make meaningful contributions to the research of state fish and wildlife agencies, and encourages young people to consider careers in the natural sciences—an area of increasing importance to communities across the globe.

Fish and wildlife agencies also recognize that other groups and organizations have long sought to influence how science education is approached and the areas of study that will receive the most attention. Given these realities, it is important that fish and wildlife agencies likewise present themselves as stakeholders in the education system, because it is this system that will produce the scientists and citizens of the future.

Project WILD, Project WET, and Project Learning Tree

These national education organizations rely primarily on state agency conservation education professionals to implement programs that also provide curriculum guides and professional development to teachers. The very concept of conservation education professionals was initiated by these organizations. They share their curriculum guides with the state agencies and organizations that fund a state coordinator, and actively support state agency educators. Now, however, state agency educators have competing demands on their time, as many other organizations have emerged since the success of the three national programs. Conservation education professionals are now faced with multiple education and recreation opportunities, many of which include funding. These compete with Project WILD, Project Learning Tree, and Project WET. These opportunities can be divided into two categories: Those that focus on K-12 formal education, on the one hand, and on the other, community based education (zoos, aquariums, outdoor learning centers) providing naturalist experiences and citizen science opportunities to volunteers, families with children, and after school programs.

A Vision for Conservation Education

Conservation education involves educating students and others about natural resources and natural resource issues. If successfully integrated into K-12 science education, it should include in-school and after-school programs and activities designed to help students develop the knowledge and skills they need to:

- Understand and actively participate in the stewardship of our natural resources.
- Appreciate that conservation and management of terrestrial and water resources are essential to sustaining fish and wildlife, the outdoor landscape, and the quality of our lives.
- Understand, accept or lawfully participate in outdoor activities including hunting, fishing, boating, wildlife watching, and other types of resource related recreation.
- Understand the need for, and actively support funding of, fish and wildlife conservation.
- Understand the value of our fish and wildlife resources as a public trust.

In order to realize this vision, conservation education professionals must work with the education, information, and communication components of their agencies to deliver the most effective education programs for K-12 education, teacher preparation, recreation, and conservation stewardship. Recommended goals for such programs include the following:

- Every K-12 student experiences fish and wildlife related outdoor education, recreation and conservation stewardship.
    - Conservation education is included at every grade level in schools throughout the U.S.
    - Every K-12 student experiences fish and wildlife related field studies outdoors.
    - Every student experiences at least two types of fish and wildlife related outdoor recreational activities.
    - Every student experiences at least two types of fish and wildlife related outdoor conservation stewardship activities.
- The teaching of conservation education and related outdoor recreational activities at every grade level is supported by schools, agencies, and tax payers.

Recommendations for Transition Steps

National Level

1. The Association of Fish and Wildlife Agencies adopts a K-12 education policy for field inquiry that reflects the three major field methodologies (described in Windschitl et al.) and includes the possibility for controlled experiments.
2. The North American Association of Environmental Education (NAAEE) adopts the field investigation methodologies as a component of their “Guidelines for Excellence.”
3. The National Research Council (NRC) revises the National Science Education Standards (NSES) to provide explicit guidelines for field inquiry as an example of multiple inquiry methodologies.

4. National conservation education programs (including Project WILD, Project Learning Tree, and Project WET) explicitly reference field inquiry methodologies in their curriculum guides and demonstrate how their lessons build field inquiry skills.

<u>State Level Opportunities</u> Assisted By Fish and Wildlife Agency Conservation Education Professionals

1. State departments of education incorporate the field inquiry methodologies into their standards with guidelines.
2. Fish and wildlife agency biologists, assisted by their agency conservation education professionals, provide study questions and protocols to teachers and students for outdoor field investigations that add value to agency research and management.
3. State fish and wildlife agency biologists develop work plan expectations that include a professional working relationship between agency scientists and agency educators. Wildlife Action Plans include the opportunity for citizen science using field investigation methodologies.
4. Teacher preparation colleges and universities provide teacher candidates with the methodologies and experiences to undertake fish and wildlife related studies outdoors.

<u>School and Community Level Opportunities</u> Assisted By Fish and Wildlife Agency Conservation Education Professionals

1. Outdoor learning centers and community providers of fish and wildlife field experiences assisted by the state Fish and Wildlife agency conservation education professional use the field inquiry framework to meet AFWA and NRC's NSES recommendations for science standards.
2. Teachers provide fish and wildlife field experiences and teach students field inquiry methodologies.
3. Students contribute their field study data to fish and wildlife agency science.

Necessary Resources

Advocacy by AFWA leadership to promote the inclusion of field investigation methodologies and opportunities in K-12 education and cultivate the support of national organizations advancing the interests of fish and wildlife and sound science education in the natural resources and formal education sectors.

Representation from AFWA state directors to state formal education leadership to urge:

- Incorporation of field investigation expectations in the science inquiry standards.
- Inclusion of guidelines for multiple science investigation methodologies.

Conclusion:

Conservation education allows our youth to experience the science inquiry methodologies used by fish and wildlife agency biologists to build our knowledge of the natural systems on which we all depend. This experience propels them into a lifetime of environmental inquiry in the community, teaching them to value natural resources such as fish and wildlife and encouraging them to participate in on-going interaction with the natural world via citizen science, watchable wildlife opportunities, hunting and fishing, and natural resource careers. By incorporating field inquiry/investigation recommendations into national standards, and expectations into state standards, *every* student will experience science inquiry in the outdoors—to the benefit of the student, the community, the environment, and the future.

References

Colburn, Alan. (2000). *An Inquiry Primer*. Science Scope. March, pp.42-44.

Kertson, B.N., Grue, C.E., Pierce, D.J., and L.L. Conquest. (2006). *Status of Citizen Science in State Natural Resource Management Agencies: Opportunities and Challenges.* Transactions of the 70th North American Wildlife and Natural Resources Conference.

National Research Council. (1996). *National Science Education Standards*. Washington, D.C. National Academy Press. Retrieved December 16, 2007, from http://www.nap.edu/readingroom/books/nses/html/.

National Research Council. (2000). *Inquiry and the national science education standards*. Washington, D.C. National Academy Press.

Rorie, C. T. and J. Cox. (2007). *State Science Standards and Field Investigation Models.* Pacific Education Institute Technical Report. October. Olympia, WA.

Ryken, A., Otto, P., Pritchard, K., and K. Owens. (2007). *Field Investigations: Using Outdoor Environments to Foster Student Learning of Scientific Processes.* Pacific Education Institute. Olympia, WA

Windschitl, M., Ryken, A., Tudor, M., Koehler, G., and K. Dvornich. (2007). *A Comparative Model of field Investigations: Aligning Standards for School Science Inquiry with the Practices of Contemporary Science.* Volume 107, Number 1, January. School Science and Mathematics.

Wolfe, D. and J. Cox. (2007). *Synthesis of Field Science Inquiry in School Science.* Pacific Education Institute Technical Report. October. Olympia, WA.

Appendix: Summary of K-12 Field Investigation Findings
Available upon request from AFWA or the Pacific Education Institute

Contents:

1. Field Investigation Models summarized in paper entitled "Understanding Science Inquiry." provided to all survey participants.

2. Original article describing Field Investigation Models entitled "A Comparative Model of Field Investigations" published in the School Science and Mathematics journal in January 2007, and made available to all survey participants through the web site: pacificeducationinstitute.org