

Technology for Field Investigations

Scientist-Driven Technology Practices



A Project of the Association of Fish and Wildlife Agencies'
North American Conservation Education Strategy

Developed by the Pacific Education Institute

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Technology for K-12 Field Investigations: Scientist Driven Technology and Practices



Developed By
Pacific Education Institute
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Co-Executive Directors



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Association of Fish and
Wildlife Agencies'
North American
Conservation Education
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Preface

Technology used by natural resource scientists and managers to ensure a healthy environment for all life has change dramatically, which educators need to convey to K-12 students. The effort to reform science education in particular, through “A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas” (National Research Council, 2011) emphasizes the need to reflect scientific and engineering practices in the workplace in K-12 science education.

Natural resource agencies are engaged in managing for natural resource conservation and sustainability. The practices of natural resource scientists range from field studies, restoration and maintenance of natural resources and managing for outdoor recreation. The **Technology for K-12 Field Investigations: Scientist Driven Technology and Practices** describes the technology used by natural resource professionals and available to K-12 students, to conduct field investigations, problem solve through stewardship planning and projects, and participate in outdoor recreation.

Note: The web links and screenshots were current when this guide was created. Technology moves quickly, so please keep in mind that you may notice differences between guide information and instructions and the real-time web as you utilize this resource.

Acknowledgements

Technology for K-12 Field Investigation was generously supported through the input of 641 biologists from 23 state fish and wildlife agencies responding to an Association of Fish and Wildlife Agencies (AFWA) survey in Spring 2011. This guide was completed with expert assistance from Karen Dvornich of the *NatureMapping* Foundation, Eric Proctor, Environmental Education Coordinator for Arizona Game and Fish, Erica Baker and Lisa Eschenbach, consultants with the Pacific Education Institute. I am particularly grateful for the guidance provided by the AFWA K-12 Technology Committee, namely Laurie Evarts (Montana), Eric Proctor (Arizona), Theresa Alberici (Pennsylvania), Ginny Wallace (DJ Case) Breanna Trygg (Pacific Education Institute) and Charlie Fitzpatrick (Environmental Systems Research Institute).

Visionaries at the Washington Department of Fish and Wildlife, including Michael O'Malley, Watchable Wildlife Program Manager, Rocky Beach, Wildlife Diversity Program Manager, and John Pierce, Wildlife Research Program Chief Scientist, recognized the importance of bringing natural resource science and management practices to K-12 science education.

The Board of Directors of the Pacific Education Institute, consisting of the leaders in the formal education sector and natural resource agencies and organizations, recognized the need to provide guidelines for field studies. Their support was essential to making the **Technology for K-12 Field Investigations: Scientist Driven Technology and Practices** a reality.

The North American Conservation Education Strategy developed through the Association of Fish and Wildlife Agencies with support from the Sport Fish and Wildlife Restoration Program inspired and guided **Technology for K-12 Field Investigations**. The formal education sector benefits from the leadership of the directors of state fish and wildlife agencies who make up the Association of Fish and Wildlife Agencies and expect high quality real world education that sustains fish and wildlife.

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Introduction:

The following real world example demonstrates the power of students undertaking a field investigation focusing on a Species of Greatest Conservation Need in their community. Students guided by teachers and mentored by wildlife Geographical Information Systems (GIS) professionals used telemetry to observe the animals. They also used GIS to analyze the data, drawing conclusions that contribute to the state agency inventory and natural resource management decisions. By following field investigation methodologies and harnessing the power of GIS technology, students can provide original research that contributes to state agency missions to conserve natural resources.

Case Study: Waterville School District– Washington State

Waterville Elementary School has shown how students and local community members can provide new and important data about one species; its habitat use, food preference, distribution, and life history information. Diane Petersen has incorporated this project for the past 12 years into her 4th grade curriculum.

- Students are expected to become Pigmy Short-horned lizard (aka Horny toad) and ArcView experts in the 4th grade, and they take their responsibility seriously.
- They apply to present at coveted annual conferences that take them all over the country.
- They share their technical skills with other teachers/students in the school.
- They have attended public meetings with their parents and voiced concerns, for example, on the impact of wind farms in the lizard's range.

Through the study of one species, Diane integrates science, technology, math, social studies, art, writing, reading, and involves students with members of their community (see Appendix A for a full Case Study description, and view the video of students tracking Horny toads using radio telemetry on Edutopia).

All grade-level students at the Waterville School District now conduct an annual biodiversity inventory and compare data on multiple species annually, over an area of farmland. The students engage their parents, community members and local landowners to understand the status of biodiversity in their region.

Engaging Students in the Practice of Science through Citizen Science

The Waterville School District case study demonstrates how science education, using the tools and practices of scientists, can cultivate students scientific habits of mind, develop their capability to engage in scientific inquiry and teach them how to reason in a scientific context (Natural Resource Council (NAS) 2011, 3-1). The practices these students undertake reflect those of professional scientists, and result in professional level contributions to scientific knowledge.

Engaging students in the practices of science helps them understand how scientific knowledge develops. Today's technology provides the tools for informal and formal educators to involve students in the scientific enterprise, in and out of the classroom, and particularly through field investigations. The ability to inspire students to become curious about their natural world is enhanced by technology. Students can use technology in the field to observe and report phenomena and later to analyze their data and communicate their findings.

The advancement of technology allows students to provide professional scientists with data they need for their research, following protocols. The **Technology for K-12 Field Investigations: Scientist Driven Technology and Practices**, assumes that twenty-first century science education will engage students in the practices of science, and prepare students to conduct citizen science that informs professional scientists' questions. There are four ways a student can become involved in the practices of a scientist.

Levels of Public Participation in Science:

(Adapted from University of Washington's Coastal Observation and Seabird Survey Team (COASST) presentation, 2012)

Level 1: Public Engagement: Students engaged in the enterprise of field investigation for awareness and/or education

Level 2: Crowd Sourcing of Data: Students report data to websites or through mobile phone apps invited by organizations requesting data

Level 3: Citizen Science Projects: Students design and conduct their own investigation asking their own questions

Level 4: Participatory Citizen Science: Students conduct rigorous scientist supported investigations, reporting their data to scientists and analyzing their own data, making conclusions.

Through Level 1, students undertake field investigations; Level 2 students collect and report data to a website through mobile units or computers; Level 3 students conduct citizen science projects through their own investigation; and Level 4 students conduct investigations, come to conclusions and share their findings with scientists. The AFWA and PEI guides prepare students for these.

State natural resource agencies need information on water, fish, wildlife and invasive species on the landscape, and are asking the public, including our students, for help. These guidelines provide information on technology resources educators can access to assist state natural resource agencies and stakeholders in scientific investigations through public participation. These guidelines direct the educator to technology resources that natural resource scientists' use for their investigations.

Data Collection Form: for Field Investigation Science Inquiry

The Technology guidelines provide tools for students to design and conduct their own field investigations mirroring the practice of professional scientists. Part of the design for field investigations is deciding what data to collect and how. The data collection form below reflects typical data collected for wildlife studies, which includes the geographic location.

The NatureMapping Program has established a core data collection form, which requires basic data that can be used by any scientist. With an accurate latitude and longitude or other geographic coordinates (UTM's or Township Range and Section), field data reported by citizen researchers or students can be screened and verified through predictive models, and triangulated with expert data. For each of the data collection form sections, technology can be used to provide data: as demonstrated in the form shown below.

Date	Time	Temp	Species name Description:	How Observed? (Saw, heard, tracks, etc)	Latitude	Longitude	How many did you see?	Is this an estimate?	Habitat Code
Calendar App	Watch App	Thermometer App	Apps & websites	Binoculars Plaster casts Photos for verification	GPS	GPS	Visual Photo	Visual Photo	Visual Photo

Field data recorded in the data collection form above is transferred into a computer spreadsheet. Using the spreadsheet, scientists and students can manage and analyze their data using Geographical Information System (GIS) software. Researchers can ask questions or query through the GIS system of data layers, seeking correlations of target variables. Because of the geographic coordinates, attributes on the data collection form can be overlaid onto other georeferenced layers such as topography, roads, rivers, housing developments and so on. Recording the geographic locations in a field data report is essential for field research.

Table 1 shows how the methodology of Field Investigation (column 1) aligns with the eight practices of scientists and engineers essential for K-12 students (column 2) (A Framework for K-12 Science Education, 2011, referred to as the next generation science standard (NGSS)) and technology available to students and scientists alike to undertake these practices. A selection of these technology tools are described in the guidelines.

Table 1: Practices in Science for Field Investigation

1. Field Investigation Methodologies (AFWA/PEI)	2. Framework for K-12 Science Education (NGSS)	3. Technology tools
Formulating Investigative Question <ul style="list-style-type: none"> • Descriptive • Comparative • Correlative 	1. Asking Questions	Access State & National Fish and Wildlife Agency websites for relevant research & background Access online journals
Identify Setting within a System: Identify boundaries of study area and time frame, geographic scale of study	2. Developing and using models	Determine Latitude and Longitude using Maps, iPhones and websites with GPS, Google Earth, Bing, ArcMap etc functions.
Identify Variables of Interest <ul style="list-style-type: none"> • Observation 	3A. Planning investigation	Use Apps & Websites to assist observation
Collect and Organize Data	3B. Carrying out investigation	Mobile units Smartphones PDA's- Garmins Trimbles, iPAQ's with NatureTracker Laptops with desktop NatureTracker software Report data into excel spreadsheets (in NatureTracker) & report to online sites Mobile Units
Analyze Data	4. Analyzing and interpreting data 5. Using mathematics, information & computer technology, & computational thinking	Analyze Data Develop Spreadsheet and analyze using graphs or GIS for descriptive, comparative and correlative questions
Use Evidence to Support a Conclusion	6. Constructing explanations 7. Engaging in argument from evidence	Creating an explanation with: Google Earth ESRI ArcGIS Explorer
Discussion, Communicating Information	8. Obtaining, evaluating, & communicating information	Sharing Information: NatureMapping Foundation (All species), eBird (birds) Communicating Information: Webinars, blogs, Skype etc Citizen Science sites

Technology for K-12 Field Investigations: Scientist Driven Technology and Practices

The current practices of natural resource scientists and natural resource managers was determined through a survey conducted in 2011 by the North American Conservation Education Strategy. The survey results of 641 state agency natural resource professionals are reflected in each part of the document, indicating the technology they use in their field to measure the health of the natural environment (field investigation), and the technology they use to make decisions on how to manage the environment for human needs (engineer) or wants, including outdoor recreation.

Technology for K-12 Field Investigations guidelines provides information on the current practices of natural resource professionals for educators to apply to field investigations and problem solving through stewardship. This document is divided into four sections, each applying the information to field investigation, stewardship and outdoor recreation.

Section 1 summarizes current technology used to measure the environment for fish, wildlife and water quality.

Section 2 provides a list of websites used and recommended by natural resource professionals. Section 2 also provides “WebQuest” lessons educators can use. Students explore credible websites for natural resource information in preparation for developing scientific studies including: asking questions, finding models, planning and carrying out investigations, evaluating and communicating information.

Section 3 provides a list of mobile unit apps with descriptions recommended by the natural resource professionals surveyed by AFWA. The apps range from identifying birds, mammals and trees to finding a recreation area nearby. Important to field investigation is the app that can provide a point location for mapping, and a function to take a picture of the animal or plant of focus. Section 3 also provides an explanation of the mobile unit app or software, NatureTracker, available for desk top computers or mobile laptops at a minimal cost (\$50). The NatureTracker software, designed as a field notebook, uses icons for real world student or professional data collection. NatureTracker also teaches students through the data collection experience the taxonomy used by scientists to record species data.

Section 4 focuses on developing GeoLiteracy essential for field investigations by providing Geographic Information Systems (GIS) lessons, using free Google Earth and ArcGIS Explorer Online. Both are designed to help students grow in their ability to think spatially by using their own data in a spatial context.

Defining Terms

Technology for K-12 Field Investigations: Scientist Driven Technology and Practices refers to terms indicated below throughout the document. For clarity these terms are defined in the following way:

Technology is any modification of the natural world made to fulfill human needs or desires (8-11). Technologies extend the measurement, exploration, modeling and computational capacity of scientific investigations (NRC, 2011).

Engineering is a systematic and often iterative approach to designing objects, processes, and systems to meet human needs or wants (NRC, 2011).

An application of science is any use of scientific knowledge for a specific purpose, whether to do more science, to design a product, process, or medical treatment; to develop a new technology; or to predict the impacts of human actions (NRC, 2011).

Field Investigation refers to scientific methodologies field scientists use to answer questions about the macro-environment through descriptive, comparative and correlative designs (Windschitl, M., Ryken, A., Tudor, M., Koehler, G., and K. Dvornich, 2007).

Citizen Science refers to participation in the enterprise of science involving members of the public (students, teachers, parents and community members).

SECTION ONE:

Technology currently used to observe and measure the environment for fish, wildlife and water quality

In a survey conducted by the North American Conservation Education Strategy, in Spring 2011, 641 natural resource agency personnel from 23 states responded indicating an increasing trend in using technology for conservation management. A further summary of the survey results are reported in Appendix B.

Table 1: Careers in Natural Resource Agencies:

The range of careers respondents in the survey reported are indicated in the table below.

Wildlife Technician	Wildlife Area Manager
Wildlife Field Technician	Fish Program Manager
Agency Technician	Fish Hatchery Manager/ Superintendent
Hatchery Technician	Conservation Officer
Fish Passage Technician	Wildlife Biologist
Statistician	Lands and Facilitators Manager
Contaminants biologist	Program Planner
Agency Ecologist	Conservation Officer
Disease Manager	Fisheries Technician
GIS Specialist/Cartographer & Crime Analyst	Fish Culturalist
Wildlife Administrator	Information & Education Chief
Natural Resource Technician	Federal Assistance Coordinator
Wildlife Research	Hunter/Outdoor Skills Educator
Agency Researcher	Conservation Educator

Table 3: Field Technology Used by Natural Resource Professionals

General Technology	Aquatic Studies	Fish Studies	Wildlife Habitat Studies
GPS Units	Colorimeter	Gill nets	Measuring tape
Compass	DO meter	Hoop nets	Motion cameras
Cell phones	Underwater cameras	Sonar fish finders	Radio telemetry
Lap top computers	ADCP flow meters	Seine	Weigh scales
Digital Cameras	pH pen	Minnow traps	Radio collars
Aerial photos	Water temperature loggers	Electrofishing equipment	Binoculars/Monoculars
Range finders	Depth finders	Sampling gear	iPhone for animal ID, mapping,
GIS Mapping	YSI Water quality meter (DO, Salinity, Temp)	Passive Integrated Transponder (PIT) scanner	GPS
Radio telemetry		Anemometer	Spotting scopes/Night goggles
Ultrasonic telemetry			Hypsometer
Motion cameras			Clinometer
Weather monitoring equipment			Acoustic bat detectors

The table above provide a broad overview of tools that are consistently used by natural resource professionals. These tools are constantly being improved, becoming more available and economical as a result of technological advancements.

Educators can provide students with experiences using many of these tools to conduct field investigations and undertake problem solving projects (engineering) to improve the environment. Students undertaking field studies and problem solving for water, fish, wildlife, habitat and forests, are experiencing the practices of professionals in natural resource careers. In addition they are preparing for a lifetime of examining the impact of their personal and workplace habitats.

SECTION TWO:

Websites for field investigations, stewardship and outdoor recreation

Part 1: Websites recommended by natural resource professionals

Part 2: WebQuest Lessons

SECTION TWO Part 1: Websites recommended by natural resource professionals

Part 1 provides a list of websites currently used and recommended for field studies, stewardship or recreation by natural resource professionals nationwide. This is not an exhaustive list. Technology is changing at an exponential rate, and this list will need updating regularly. However the list indicates which conservation organizations have a track record of actively creating and improving their websites. Most of the organizations listed will continue to provide important assistance to natural resource professionals over the next decade. The value of each website is indicated through the following indicators:

- **Field observations** – where users receive assistance to identify their target
- **Field locations** – where users receive assistance to identify their specific geographic location
- **Stewardship** – citizen science – a site where users may contribute their data
- **Recreation** – where users may find locations for outdoor recreation

Table4: Websites recommended by natural resource professionals

Websites	
Nature Find Recreation	www.NatureFind helps you <i>find nature nearby</i> ...just enter a Zip or City, St
NatureServe Field observation help Background info	www.natureserve.org/ A network connecting science with conservation. Search the online encyclopedia of plants, animals, and ecosystems of U.S. and Canada. Projects focus on species and ecosystems assessments, conservation analyses, biodiversity information management.
Project Beak Background info	www.Projectbeak.org Bird Education and awareness for kids.
Finding Recreation Areas Recreation	www.Recareas.com Recareas.com seeks to unify the outdoor community. Single site that offers free information for users to find their outdoor recreational activities without registration or any payment.
Geocaching & EarthCaching Recreation	www.Geocaching.org Geocaching is a is a real-world outdoor treasure hunting game. Players try to locate hidden containers, called geocaches, using GPS-enabled devices and then share their experiences online. Real-world outdoor treasure hunting game. Players try to locate hidden containers, using GPS-enabled devices and then share their experiences online. www.earthcache.org/ <i>EarthCaches</i> are a type of <i>geocache</i> that are listed on <i>geocaching.com</i> Visiting an <i>EarthCache</i> site is a great outdoor activity the whole family can enjoy.
Birds of North America Field observation help Report Data Fee to Subscribe	www.bna.birds.cornell.edu/ Now as an online project of the Cornell Lab of Ornithology, Birds of North America is becoming a living resource. Account contents are updated frequently, with contributions from researchers, citizen scientists, and designated reviewers and editors. In addition, BNA Online contains image and video galleries showing plumages, behaviors, habitat, nests and eggs, and more. And most online BNA accounts now feature recordings of the songs and calls of their species, recordings selected from the extensive collection of Cornell's Macaulay Library of Natural Sounds.

Websites	
NOAA Tide schedules Data available	www.tidesandcurrents.noaa.gov/ Center for Operational Oceanographic Products and Services. CO-OPS provides tide, current, water level information. Website provides an online map to access data and products
NOAA Weather Data available	www.weather.gov/ NOAA National Weather Service. Warnings and Forecasts, Graphical Forecasts, National Maps, Radar, Water, Air Quality, Satellite, Climate
NOAA Marine Forecast Data available	www.nws.noaa.gov/om/marine/home.htm National Weather Service Forecast. Boating safety, rip currents, hypothermia, hurricanes, thunderstorms, lightning, coastal flooding, tsunami.
NOAA Buoy Data Data available	www.ndbc.noaa.gov/ Data from buoys detail winds, wave height, wave period, atmospheric pressure, air and water temperature, history
Salt water tides Data available	www.saltwatertides.com Low and high tide predictions for the U.S.
Water levels Data available	www.rivergauges.com Providing river gauge data for rivers, streams nationwide
USGS Water Resources websites Data available	www.water.usgs.gov/ USGS Water Data. View today's water conditions: streamflow, flood and high flow, drought, groundwater levels, surface water quality www.waterwatch.usgs.gov/new/ USGS Waterwatch – real time stream flow data
USGS Topo Maps	www.digital-topo-maps.com/ USGS Topographic Maps Online
USGS Bird Banding Laboratory Report Data	www.pwrc.usgs.gov/bbl/index.cfm Report a bird band or marked bird. Bird banding is a universal and indispensable technique for studying the movement, survival and behavior of birds.
USDA NRCS Soil Maps Data available	www.websoilsurvey.nrcs.usda.gov/app/ www.websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Cornell Ornithology Access to Journals	www.birds.cornell.edu/ The Cornell Lab of Ornithology (non profit with membership affiliated with Cornell University) advances the understanding of nature and engages people of all ages in learning about birds. Provides online Living Bird magazine, and BirdScope newsletter.
NatureInstruct Field observation help	www.natureinstruct.org/dendroica/ Dendroica is an interactive website developed to help students, volunteers and professionals improve their skills at identifying birds by sight or sound, so they can participate in nature survey and monitoring programs. Dendroica provides pictures and bird songs and calls.
eBird Report Data	www.ebird.org (sponsored by Audubon & Cornell lab of Ornithology) eBird provides tools for birders to record birds they see, keep track of birds, explore maps and graphs, share sightings with eBird community, contribute to science and conservation
Butterflies and Moths Report Data	www.butterfliesandmoths.org/ Butterflies and Moths of North America (housed at the Montana State University) brings verified occurrence and life history data into one accessible location. Citizen scientists submit photographs and observations.

Websites	
NatureMapping Foundation	www.naturemappingfoundation.org/ A citizen scientist program for K-12 and adult volunteers, accepts and analyzes volunteer data, provides online lessons for educators
Fisheries Journal Publications Access to Journals	www.fisheries.org/afs/publications American Fisheries Society Journal. Online journals available to membership: Transactions of the American Fisheries Society, Journal of Aquatic Animal Health, Fisheries, North American Journal of Fisheries management, North American Journal of Aquaculture, Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science
Wildlife Disease Study SCWDS Background info	www.vet.uga.edu/scwds/briefs.php Southeastern Cooperative Wildlife Disease Study – University of Georgia College of Veterinary Medicine SCWDS Brief newsletter online
FishBase Data available	www.fishbase.us/home.htm A global information system on fishes. FishBase is a relational database with information to cater to different professionals, fisheries managers, zoologists etc. FishBase was developed in collaboration with the Food and Agriculture (FAO) Organizations of the United nations.
Flyways.us Data available	www.flyways.us/ A collaborative effort of waterfowl managers across the continent. Using the <i>Bands Across America</i> search tools found on this site, you can query and map waterfowl banding data as recent as this past spring all the way back to 1914.
USFWS web based applications Data available	www.fws.gov/wetlands/Data/ The Wetlands Mapper integrates digital map data with other resource information to produce timely and relevant management and decision support tools.
USDA plants for ID after field work Data available	www.plants.usda.gov/java/ Natural Resources Conservation Service Plants Database. Receive and contribute information about plants in your state, region. Ecological descriptions of sties. Download data and posters.
USDA FSA Farm Imagery Data available	www.fsa.usda.gov/ National Agricultural Imagery Program (NAIP) acquires aerial imagery during agricultural growing seasons in the U.S.
The Wildlife Society Access to Journals	www.wildlife.org A membership organization for wildlife professionals and students interested in wildlife related careers. Access journals, newsletters, mentoring through membership.
National elevation datasets Data available	www.nationalatlas.gov The staff of the National Atlas at the U.S. Geological Survey is hard at work on new products and services. Whether you have a casual interest in the Nation’s geography or are a professional geospatial data user in development, the National Atlas will soon offer a new set of fundamental digital cartographic data at a scale of 1:1,000,000
Integrated Taxonomic Information System Field Observation Help	www.itis.gov/ Welcome to ITIS, the Integrated Taxonomic Information System! Here you will find authoritative taxonomic information on plants, animals, fungi, and microbes of North America and the world.
Biodiversity Heritage Library Data available	www.biodiversitylibrary.org/Default.aspx The Biodiversity Heritage Library (BHL) is a consortium of natural history and botanical libraries that cooperate to digitize and make accessible the legacy literature of biodiversity held in their collections and to make that literature available for open access and responsible use as a part of a global “biodiversity commons.”

Websites	
Eflora- plants of the world Data available	www.efloras.org/ collection of online floras. Source of Flora of North America – complete text online
ZipcodeZoo Data available	www.zipcodezoo.com/default.asp Based on the location of your ISP, ZipcodeZoo guesses where you live. Everyone will see info on invasive species, species that are threatened, and all species that live in this area. Visitors from the U.S. will also see zipcode demographics, local attractions for naturalists, and the local weather.

GIS Applications and Maps	
USDA FSA Data Set Viewer Data available	www.gis.apfo.usda.gov/gisviewer/ USDA Farm Service Agency (FSA) Aerial Photography Field Office (APFO). The Aerial Photography Field Office (APFO) has one of the largest collections of historical aerial photography in the nation.
USDA: NRCS: Geospatial Data Gateway Data available	www.datagateway.nrcs.usda.gov/ The Geospatial Data Gateway (GDG) is the One Stop Source for environmental and natural resources data, at anytime, from anywhere, to anyone. The Gateway allows you to choose your area of interest, browse and select data from our catalog, customize the format, and have it downloaded or shipped on CD or DVD.
USDA NRCS Soil Maps Data available	www.nrcs.usda.gov/wps/portal/nrcs/home United States Department of Agriculture: Natural Resource Conservation Service. With offices in nearly every county in the United States, NRCS works with landowners and communities to improve our soil, water, air, plants, wildlife, and energy use. Ensuring productive lands in harmony with a healthy environment is our vision.
Soil Maps USDA NRCS Data available	http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm United States Department of Agriculture (USDA): Natural Resource Conservation Service (NRCS). Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. The survey provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for 95% of the nations counties.

GIS Providers	
ESRI Online Free Data Data available	www.esri.com/data/free-data/index.html ArcGIS Online provides Basemaps with World Imagery, World Street Map, World Shaded Relief, World Physical Map, World Terrain Base, USA Topographic Maps and Ocean Basemap. Demographic maps with US population, average household size, median age, population density retail spending potential etc.
Google Earth Field locations	www.earth.google.com/ Google Earth lets you fly anywhere on Earth to view satellite imagery, maps, terrain, 3D buildings, from galaxies in outer space to the canyons of the ocean.
Bing Maps aerial imagery Field location	www.bing.com/maps
DNR Garmin	www.dnrgarmin.software.informer.com/ DNR Garmin was built to provide users the ability to directly transfer data between Garmin GPS handheld receivers and various GIS software packages.

SECTION TWO Part 2: WebQuests

SECTION TWO Part 2 provides “WebQuest” lessons educators can use. Students explore credible websites for natural resource information in preparation developing scientific studies including: asking questions, finding models, planning and carrying out investigations, evaluating and communicating information.

The WebQuests are designed to provide a structure for students to access websites with high natural resource information value, to determine how they can best provide support for student field investigations, stewardship and recreation. The WebQuest section provides the following:

Teacher Guide to using WebQuests with an evaluation rubric for:

Field Investigation:

1. Biodiversity: What Other Wildlife Lives Here?
2. Invasive Species Take Over
3. The Future for Shellfish Farming
4. Plants Wanted in Our Community

Stewardship:

5. Birds Belong: Creating Good Bird Habitat
6. Litter and It Will Hurt
7. Marine Debris Team

Recreation

8. Going Fishing
9. Hunting Trip

Teacher Guide to Using WebQuests

These WebQuests were designed for the Association of Fish and Wildlife Agencies by Pacific Education Institute, www.pacificeducationinstitute.org. These WebQuests were designed to be used by middle or high school students.

WebQuests focus your students' online research. Some of these WebQuests suggest that students use a web search to find particular sites. Use your state or school guidelines on safe student internet use.

The Process

Through these WebQuests, your students will develop a presentation for the class. These WebQuests are designed to be used by teams of 2-4 students, and they refer to teams of students. They can be used by individual students if you modify the description, or ask them to be a team of one. Teams should work collaboratively with the following guidelines:

- Every student should be an active partner. You can assign roles such as team quest guide, online navigator, and note-taker, or scribe.
- All team members should have a voice on the team. This is reflected in the evaluation matrix, so remind your students that you will be evaluating them on their participation and teamwork.
- Students should visit all of the recommended websites. It is important to use high-quality, respectable websites. They will need to read the sites carefully to get the information they need to present to the class.

Evaluation

Use the evaluation matrix to ensure that students are on-task and have read and processed the material. Student presentations should represent collaborative work and be well thought out and presented.

	Insufficient 1	Beginning 2	Accomplished 3	Exemplary 4	Score
Team worked together to research and write up their work	Team was disconnected and most team members were not involved.	Team worked together for part of the time. Not all members were engaged.	Team worked together and involved all team members.	Team used input from all members and worked as a team on research and presentation.	
Team designed a compelling presentation	Presentation of research reflected some thought on the part of the group.	Team presented relevant research with some organization.	Team presented research that will be helpful and interesting to others.	Team presentation was compelling and organized.	

Field Investigation WebQuest

1. Biodiversity: What Other Animals Live Here?

Introduction

You are going on a field trip to a local park. Your team is in charge of researching the wildlife that you may find in the area.

The Task

Your team will have to answer the following questions:

- Start by learning what animals live in your State.
- What are common mammals that live in your State?
 - Name three herbivores that eat grass and plants.
 - Name three carnivores that eat other animals?
 - Name three scavengers that eat dead animals.
- What Endangered Species live in your state? (List 5)

Organize your findings so you can present them to the whole group. Provide enough detail to answer all of the questions above.

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.

Websites

- Search for your state's Fish and Wildlife agency. Look for pages on wildlife, or animal or plant species.
- US Fish and Wildlife Service: www.fws.gov. Look for news about your state or region,
- Learn more about the animals that live near you through the National Wildlife Federation's Wildlife Library: www.nwf.org/Wildlife/Wildlife-Library.aspx.
- Research animals and habitats on this government site, National Biological Information Infrastructure: www.nbii.gov

Conclusion

As a result of your research, you should have a description of what animals live around you and how they fit into the natural environment. What kind of animals live around you, and what kind of animals are struggling, or endangered in your State?

Field Investigation WebQuest

2. Invasive Species Take Over

Introduction

You are interning at your State Department of Natural Resources. Your supervisor asked you to make a presentation on invasive plant and animal species in your state. Invasive species are non-native species that aggressively push native species out. Some invasive species are more aggressive than others.

The Task

You and your team are in charge of preparing a presentation on invasive species in your State. To do that, you are going to have to answer the following questions:

- The following species have been identified as particularly aggressive. Do any live in your state?
 - **West Nile virus** and **purple loosestrife** (Northeast)
 - **Kudzu, water hyacinth, nutria, and fire ants** (Southeast)
 - **Zebra mussels** and **leafy spurge** (Midwest)
 - **Salt cedar, Russian olive, and Africanized honeybees** (Southwest)
 - **Yellow star thistle, Asian clams, and sudden oak death** (California)
 - **Cheatgrass** and **knapweeds** (Great Basin)
 - **Whirling disease** of salmonids (Northwest)
 - Hundreds of species like **Coqui frogs** (Hawaii)
 - The **brown tree snake** (Guam)
- What other species are threats to your state?
- You should check for plants, wildlife and aquatic species.
- Are there native species that are threatened by invasive species?
- What are some things that private landowners and citizens can do to prevent the spread of invasive species?

Organize your findings so you can present them to the whole group. Provide enough detail to answer all of the questions above.

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.

Websites

- Go to your state's fish and wildlife website. Search for "Invasive Species". Record the results.
- The National Biological Information Infrastructure organizes sites from a number of federal organizations such as www.science.gov.
- Learn about Introduced, Invasive, and Noxious Plants on the U.S. Department of Agriculture's plant site: <http://plants.usda.gov/java/>
- You can search for your state at the Global Invasive Species Database: www.issg.org/database/welcome/.
- Answer any remaining questions at this US Department of Agriculture site: www.invasivespeciesinfo.gov/.
- Look for invasive plants at: www.invasiveplantatlas.org/.

Conclusion

As a result of your research, you should have a description of invasive species and how it affects local plant and animal species. What did you learn that surprised you?

Field Investigation WebQuest

3. The Future for Shellfish Farming

Introduction

You are a fifth generation shellfish farmer in Willapa Bay in Washington State. Your father has asked you to use the “Internet” to research ocean acidification and its possible effects on your business over the next 20-30 years.

The Task

- Your family’s company would like to know:
- Is ocean acidification a problem in your region?
- What is the best and the worst-case scenarios?
- Is there is anything that could be done to protect your shellfish beds?
- What about ocean acidification hurts shellfish?
- Are there any solutions?

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.
- Start with the National Oceanic and Atmospheric Administration website: www.noaa.gov and search for ocean acidification. Also be sure to check, www.nmfs.noaa.gov/ocs/mafac/meetings/2009_05/docs/stein_oa_mafac.pdf.
- Look at the Ocean Acidification Fact Sheets at Data in the Classroom: www.pmel.noaa.gov/co2/story/Ocean+Acidification.
- Since we are limited on time, organize your presentation in bullets. Try to answer all of your family’s questions.

Conclusion

As a result of your research, you should be able to describe the impact of ocean acidification on your family’s shellfish farm.

Field Investigation WebQuest

4. Plants Wanted in Our Community

Introduction

You are going to plant a small native plant garden near your school. Your team is in charge of researching the plants you may grow that are native to your area.

The Task

Your team will have to answer the following questions:

- Plants grow well in some areas and not in others. Groups of native plants that thrive in an area are called a plant community. Examples of plant communities include: marshes, forests, and wetlands.
 - Find at least three different plant communities that exist in your State.
 - What native plants grow in those communities?
- What five plants do you want to find on your trip?
 - Is there anything special about those plants?
 - Were any of the plants you want to grow used as medicine?
- What Endangered Plants live in your state?

Organize your findings so you can present them to the whole group. Provide enough detail to answer all of the questions above.

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.

Websites

- Search for your state on the website “Plant Native” and learn about wild plants that grow near you: www.plantnative.org/.
- Learn more about develop schoolyard or wildlife gardens through the National Wildlife Federation’s website: www.nwf.org/Get-Outside/Outdoor-Activities/Garden-for-Wildlife.aspx.

Conclusion

- As a result of your research, you should have a description of plants that you want to grow in your schoolyard garden and what makes those plants special?

Stewardship WebQuest

5. Birds Belong: Creating Good Bird Habitat

Introduction

Your class was given some money to buy plants that encourage birds to live in your schoolyard. Your team is in charge of researching birds that you may find near your schoolyard. You will also find out what those birds need to live and thrive.

The Task

Your team will have to answer the following questions:

- Learn about birds that live in your state or region.
- Why are birds important in your area?
- What types of plants provide food for birds?
- What plants in a garden helps protect birds?
- What five birds do you hope will move into your garden? Is there anything special about those birds?

Organize your findings so you can present them to the whole group. Provide enough detail to answer all of the questions above.

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.

Websites

- Search for your state's Fish and Wildlife agency website. Look for pages on bird species.
- Cornell has a site dedicated to birds and those that love them, called birders: <http://www.allaboutbirds.org/>.
- Learn more about developing schoolyard or wildlife gardens through the National Wildlife Federation's website: www.nwf.org/Get-Outside/Outdoor-Activities/Garden-for-Wildlife.aspx.
- Audubon Birding Basics: http://web4.audubon.org/bird/at_home/bird_watching/index.shtml

Conclusion

- As a result of your research, you should have a description of the garden that you plan to build and how it will attract birds. What did you learn that surprised you?

Stewardship WebQuest

6. Litter and it will Hurt

Introduction

You are going on a field trip to a creek in your area, and you want to clean up garbage as part of a community service project.

The Task

You and your team are in charge of preparing your class for a service learning project trip to clean up a local creek. To do that, you are going to have to answer the following questions:

- What are at least three problems caused by littering?
- How long does a styrofoam cup, cigarette butt and aluminum take to break down?
- Litter also affects our oceans. What is the effect of littering on ocean ecosystems?
- What can people do to prevent littering?

Organize your findings so you can present them to the whole group. Provide enough detail to answer all of the questions above.

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.

Websites

- <http://extra.mdc.co.gov/nomoretrash/facts>
- Also, check out Keep America Beautiful: www.kab.org.
- Look up “Litter” in Wikipedia to learn why litter matters: www.en.wikipedia.org/wiki/Litter.

Conclusion

As a result of your research, you should have a description of littering and how it affects our environment. What did you learn that surprised you?

Stewardship WebQuest

7. Marine Debris Team

Introduction

You are going on a field trip to the ocean, and you want to collect marine plastic litter as part of your community service hours.

The Task

You and your team are in charge of preparing your class for a service learning project trip to the coast. To do that, you are going to learn more about marine debris in the ocean. Collect background facts, learn about marine debris in your state, and describe for your classmates other efforts to clean up marine debris.

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.
- Start with a site from the NOAA www.marinedebris.noaa.gov/.
- Also, check out a non profit that coordinates clean up efforts: <http://www.oceanconservancy.org/healthy-ocean/clean-beaches-clean-water/>
- Organize your findings so you can present them to the whole group. Provide enough detail so other students will know what to expect on the field trip.

Conclusion

As a result of your research, you should have a description of the marine debris issue in our oceans and in your state in particular. What did you learn that surprised you?

Recreation WebQuest

8. Gone Fishing

Introduction

You've decided to go fishing for the first time with your friends. You are going to work together to plan the trip.

The Task

To get ready for your trip, you are going to have to answer the following questions:

- How do people fish (tools and gear) and where?
- What three kinds of fish do you think you may find?
- What kind of fish can you catch at this time of year?
- What do you need to go fishing? What kind of bait or lures will you use?
- Find a nearby lake, stream or ocean beach to go for your fishing trip.
- Are you visiting a private, county, state or federal site? Is there adequate access to the water?
- Learn the fishing regulations for where you are going. Private, county and state sites use state fishing regulations. Tribal lands and federal sites such as national parks have their own regulations, plus marine waters have special rules and license requirements.

Organize what you've learned so you can present to the whole group. Provide enough detail to answer all of the questions above.

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.

Websites

- www.takemefishing.org . Search for safety.
- www.fishing.com/
- Use Google Earth, or another mapping site to look for good fishing spots.
- Search for your state Fish and Wildlife agency. What is special about fishing in your state? What are your state regulations?
- Learn more about fish around the world at National Geographic's Megafish page: environment.nationalgeographic.com/environment/freshwater/megafishes/.

Conclusion

As a result of your research, you should have a plan for your fishing trip and a description of fishing in your area. What did you learn that surprised you?

Recreation WebQuest

9. Hunting Trip

Introduction

You are taking your kids hunting. Your daughter Jordan is 12 and Joseph is 14. Each is bringing a friend. You want to prepare for the trip. First check the hunting regulations for your state and have a short safety talk prepared. You are also going to decide what to hunt for and where to go.

The Task

Your team will have to answer the following questions:

- What are you going hunting for? It could be a bird or a mammal.
- What season can you hunt for that bird or mammal?
- What safety tips do you want to talk about with your kids before you start?
- What hunting regulations do you need to follow?
 - Do the kids have to attend a hunting safety class?
- Why do we have hunting regulations?

Organize your findings so you can present them to the whole group. Provide enough detail to answer all of the questions above.

The Process

- Work collaboratively with your team to answer the questions above.
- You may not use open search sites like *Google* until you check all of the sites below.

Websites

- Search for your state's Fish and Wildlife agency. Look for pages on hunting.
- Check out safety and other hunting information at National Shooting Sports Foundation: www.nssf.org/.
- U.S. Fish and Wildlife Agency: www.fws.gov/hunting/.

Conclusion

- As a result of your research, you should have all the information you need to prepare for a hunting trip. What did you learn that surprised you?

SECTION THREE: Mobile Units: Apps and software for field studies, stewardship and outdoor recreation

Part 1: Smart Phones in Science Education:

Eric Proctor, New Mexico Fish and Game

Part 2: Apps for Mobile Units in the Field: Cell phones, Tablets, Mobile Computers

Part 3: Example Of Mobile Computing data collection software: NatureTracker

Section 3, Part 1 provides teachers with guidance on Android Phone applications for science educators teaching conservation education both in the classroom and the field.

Section 3, Part 2 provides a list of apps recommended by 641 natural resource professionals through a survey conducted in Spring 2011. These natural resource professionals indicated that the apps listed were important for their field investigations, stewardship decisions and recreation. These apps provide assistance for species identification and geographic location of their observations. In addition, natural resource professionals, who are also responsible for managing land for multiple purposes, including recreation, offered apps that indicated geographical locations of lands available for recreation nearby.

Section 3, Part 3 provides an explanation of the NatureTracker software, designed as a field data notebook for students and professionals by the NatureMapping Foundation that can be used with smart phones, mobile computer units and desktop computers. The North American Conservation Education Strategy created a desktop version of NatureTracker for schools to use in classrooms to practice using the icon driven data collection software, while reporting observations in the school setting (representing one geographic location). Part 3 describes the use of the NatureTracker software (total of \$50 per school for all laptops and desktops) by individuals or schools to develop the capacity to report species using mobile units in the field.

SECTION THREE Part 1

Smart Phones in Science Education

Eric Proctor, Environmental Education Coordinator, Arizona Game and Fish Department

General Apps for Smart Phones

These are ideas for useful apps that teachers and students should consider. A quick search of the market will reveal too many apps to list. Decisions should be based on personal preference.

- **Cameras** – both still and video cameras can be used to capture observations and other data while in the field. If these images are GPS tagged, then they can be added to Google Earth and similar mapping programs.
- **First Aid** – there are a limited number of free and a larger number of fee-based apps that will provide information about correct first aid and emergency response procedures. This could be useful for teachers and students working in the field.
- **Measurement** – there are a variety of free and fee-based apps that allow for a number of different measurements. These include standard rulers, protractors, compasses, levels, and timers. Students can use these while in the field. Perhaps consider a lab to compare the accuracy of these virtual tools with the real things. There are also apps that allow conversions of units into different formats. A variety of different calculators (from basic to scientific) are also available.
- **Voice Recorders** – these apps allow people to record the spoken word. Smaller recording times can be used to capture quick thoughts and reminders. However, apps that allow longer recording could allow students to interview scientists or record classroom lectures. Consider an app that saves recordings in an easy to use format (like .wav or .mp3) and allows email sharing of the files. Then, students could access and edit these files back in the classroom and add to web sites or create their own podcasts.

Specific Apps for Android Phones

These are specific apps designed for Droid phones that seem to have good functionality. Since this printing, however, there may be new apps that have become available, as well. Search the market for updates.

- **CamScanner:** Uses the camera as a basic scanner. Images can be quickly captured, cropped, and shared. It is also useful in capturing information on a white board, business cards, etc. This maybe an excellent way to capture lecture notes for making available at a later time.

- **GeoReader:** Originally designed to locate historical markers along a travel route and to read the information to the user while driving. However, this program allows users to input their own points of interest and share them with select individuals or the public as a whole. This is a great way to create a self-guided tour of an outdoor space like a park or zoo. Property owners can create unique points and guide visitors on how to retrieve them on their phones using this app. Teachers can also visit an area ahead of time and create their own points to share with students during a field trip.
- **Google Docs:** An app that allows remote access to this online document program developed by Google. Users are able to create generic versions of Word, Excel, and PowerPoint. These documents are saved on a server and can be shared with others. Students can potentially have an online data sheet. If it is shared between multiple students in a group, they can all add information to the same sheet while in the field. This can then be accessed back in the classroom and downloaded to Excel or Word.
- **Latitude:** Allows users to send a notification of their location to other people. This can be a great way for teachers to keep tabs on their students. Every so often, students may be required to send a notification so the teacher knows where they are even if they can't be seen directly.
- **Layar:** This app is a little complex but has a lot of potential. The app uses Augmented Reality technology which pushes GIS information to another level. It allows users to select various layers on their phone. Then, while scanning a landscape with their camera, icons will pop up. Students can select the icon and get additional information. Project NOAH is one of the layers that is available.
- **Project Budburst:** A citizen science project that is documenting life cycle events of plants around the country. Users can submit photos and information so these events can be tracked.
- **Project NOAH:** Allows users to submit pictures and information about animals and plants they see. This information is then added to a local map. Users can also see what other people have posted. Students can create a “field guide” of their campus or a park that they are visiting. They may be required to identify species and learn about them.

Web Sites

If internet access is available, students can also use the Android phone to access relevant web sites. This is particularly useful for citizen science programs that do not have phone apps yet, like the two examples below:

- **Project Squirrel** – allows users to submit squirrel sightings: www.projectsquirrel.org.
- **eBird** – allows users to submit bird sightings: www.ebird.com.

SECTION THREE Part 2: Applications for field observations, field location, stewardship and recreation

Part 2 provides a list of mobile unit apps currently used and recommended for field studies, stewardship or recreation by natural resource professionals nationwide. This is not an exhaustive list. Technology is changing at a dramatic rate, and this list will need updating on a regular basis. However the list indicates which conservation organizations have a track record of actively creating and improving apps for mobile units. Most of the organizations listed will continue to provide important assistance to natural resource professionals over the next decade. Some of the apps are free and some have a cost – which will vary over time. The specific use for each app is indicated through the following indicators:

- **Field observations** – where users receive assistance to identify their target
- **Field locations** – where users receive assistance to identify their specific geographic location
- **Stewardship** – citizen science – a site where users may contribute their data
- **Recreation** – where users may find locations for outdoor recreation

Table 5: Apps recommended by natural resource professionals for field investigations, stewardship and recreation.

Applications	Function	Cost & Platforms
Leafsnap Field Observation Recreation	Leafsnap is an electronic field guide developed by Columbia University, University of Maryland, & Smithsonian Institution. The mobile app uses visual recognition software to help identify tree species from photographs of their leaves. Take picture of leaf to ID.	Free iPad, iPhone, iPod touch
iBird lite Field Observation Recreation	iBird Lite: free sample of 30 species with illustrations, photos and range maps with songs & spectrogram.	Free-iBird Lite iPad, iPhone, iPod touch
Ibird explorer plus Ibrid explorer pro By WhatBird Field Observation Recreation	iBird: Interactive field guide to Birds of North America: bird songs & their features via spectrogram, illustrations, photos and range maps (models): Good range maps, ID, natural history, photos, drawings, connection to flicker, birdapedia, similar birds, smart search features plus Internet connection, explorer manual, glossary, language.	Plus - \$13.00 Pro-\$19.99 iPhone, iPad, iPod touch
birdJam Field Observation Recreation	Novice and expert birders use birdJam to learn birdsongs and validate what they are hearing in the field. Photographs and range maps (models) also available.	Free iPhone, iPad, iPod touch

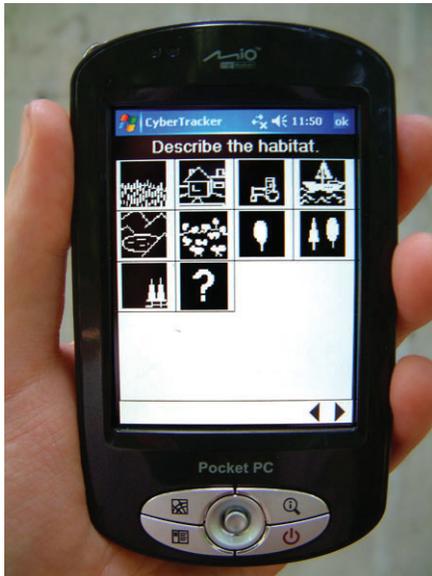
Applications	Function	Cost & Platforms
Audubon Trees Field Observation Recreation	Ultimate field guide on trees. You can identify 890 North American trees with color photographs, range maps (models), and authoritative information. Use for backyard or hikes in the wild.	Cost \$9.99 iPhone, iPad, iPod touch
Audubon reptiles and amphibians Field Observation Recreation	A field guide to North American Reptiles and Amphibians – new journal feature for recording sightings & keeping notes; range maps (models).	\$9.99 iPad & iPhone, iPod touch
Scats & Tracks of North America Field Observation Recreation	Falcon Guides: Scats & Tracks of North America is a field guide to the signs of nearly 150 Wildlife species. Samples available, black & white.	\$6.99 iPhone, iPad, iPod touch
Backyard Scat & Tracks Field Observation Recreation	Falcon Guide: A Field guide to the signs of 15 common critters that may live in your backyard (ponds, creeks, parks). Illustrations of scats, tracks, gait patterns and other signs. Built in ruler, Identification key, color images with built in links with Flickr and Google images.	Free iPhone, iPad, iPod touch
The North Face Trailhead Field Location Recreation	The North Face Trailhead app finds trails, hikes, bike routes and more based on your location. Trailhead tracks your route, distance, speed and elevation in real-time. You can take pictures of the trip, create maps and post your trip.	Free iPhone, iPad, iPod touch
Chesapeake Bay Field Guide Field Observation Recreation	Interactive field guide includes all the wild animals & plants of the Chesapeake Bay and its watershed, for novices and experts. Animals include birds, mammals, reptiles amphibians, butterflies trees and seashore creatures. Endangered species and Poisonous Species. Photos, in depth descriptions, audio, field marks.	Free iPhone
Wild Mushrooms of North America & Europe Lite and Complete Field Observation Recreation	Rogers Mushroom guide: this Lite version provides photographs from a selection of over 1560 Wild Mushrooms and other fungi for identification. The Complete version provides the complete series of mushrooms. Both versions have descriptive keys, details of size, shape, color and habit plus edibility.	Lite version Free –with a selection mushrooms, iPhone & iPad Complete version \$1.99 with complete series of mushrooms iPhone and iPad
NatureFind Recreation	Created by the NatureValley company: a guide to find nature places and events nearby. Descriptions, interactive maps, photos are included.	Free iPhone, iPad, iPod touch

Applications	Function	Cost & Platforms
Motionx-GPS Field Location Recreation	Maps and navigation instruments you need for your outdoor life: walking, hiking, sailing, off-roading, flying, geocaching, or exploring. See your position and tracks anywhere worldwide on topographic and road maps.	\$0.99 GPS Drive \$2.99 GPS HD iPhone and iPad
Peterson Feeder Birds of N.A. Field Observation Recreation	Peterson Feeder Birds has illustrations & details of 160 backyard birds and includes downloadable Bird Finder lists from pertersonguides.com showing birds for every US & Canada county.	Free iPad & iPhone
Fungi Field Observation Recreation	Mushroom identification application.	Cost \$1.99 iPhone & iPad
Project Noah Field Observation Stewardship-citizen science Recreation	Project Noah is a tool that nature lovers can use to explore and document local wildlife and a platform to harness the power of citizen scientists everywhere.	Free Iphone, iPad, iPod touch and android
MyNature Animal Tracks Field Observation Recreation	Illustrations of fore and hind feet, track measurements, gait patterns use trail widths and animal life cycles. Color images tracks and scat, animal vocalizations.	\$6.99 iPhone, iPad, iPod touch Android
Sibley eGuide to Birds of North America Field Observation Recreation	All the content of the Sibley Guide to birds illustrated in flight and perched, every variation of age, season, sex, songs and calls, maps showing winter and summer range (models) , migration, measures of length, wingspan and weight.	\$29.99 iPhone, iPad, iPod touch, Android, Blackberry
What's Invasive! Field Observation Stewardship – citizen science Recreation	UCLA, USFWS, USFS, NPS supported Community Data collection. Report Invasive species - they are a threat to native plants, animals, crowding natives, consuming food sources and promote fire hazards. School and community groups running campaigns are effective at locating invasive species.	iPhone Android

General Interest

Applications	Function	Cost & Platforms
MapQuest 4 Mobile Recreation	Voice guided turn-by-turn, GPS navigation for iPhone. Walking & driving directions.	Free: iPhone Android
The Weather Channel Field Observation Recreation	The Weather Channel: get local accurate local conditions, severe weather alerts, animated radar, video center, hourly & 10 day forecasts.	Free: iPhone, iPad, iPod touch Android
Google Earth Field Location Recreation	Google Earth for iPhone, iPad and iPod touch. Navigate the world, with global satellite and aerial imagery available in desktop version of Google Earth.	Free iPhone iPad, iPod touch
gone trekking Field Location Recreation	Gone Trekking Safety Outdoors is a location aware safety notification application for outdoor adventurers. Using GPS, maps, calendars and camera features of iPhone, user records departure, destination and waypoint info to email or post, making time in outdoors safer.	\$1.99 iPhone, iPad, iPod touch
pUniverse Recreation	Pocket Universe: Virtual Sky Astronomy is an easy-to-use app that help you to identify learn constellations, bright stars and planets. Hold the iPhone in front of you and the sky view will add names and information.	\$2.99 iPhone, iPad, iPod
Star Walk Recreation	Star Walk enables you to point you iPad at the sky and see what stars, constellations, and satellites you are looking at in real-time.	\$2.99- \$4.99 iPad, iPhone, iPod touch
ParkFinder Recreation	Oh Ranger! ParkFinder. Search for a park nearest you with the activities you want to do. Use zipcode to find a park nearby.	Free iPhone, iPod touch & iPad free
What Knot to Do in the Great Outdoors Recreation	Columbia sportswear Company provides a guide to 70 knots to meet every outdoor need. Illustrations and step-by-step instructions.	Free iPhone

SECTION THREE Part 2: NatureTracker



NatureTracker

NatureTracker software has been designed to function as a field notebook. NatureTracker is used to gather and map fish, wildlife, insects, and plant data. The data may be reported to the public data set housed at the *NatureMapping* Foundation. This public data is shared with professional scientists and citizen scientists alike to determine field investigation questions, confirm predictive models (e.g. range maps) and to look for correlative patterns through GIS investigations. NatureTracker is also a simplified GIS program. Data can be viewed by dates, by individual species over topographic maps and/or aerial photographs.

The Association of Fish and Wildlife agencies funded the development of the “New Sightings” feature as part of the North American Conservation Education Strategy. This feature is useful for educators and their students monitoring in the same location (same latitude and longitude) and for users who wish to use desktop devices for practice and data collection. Users enter their data directly into their personal computers (PC’s, laptops or desktops) and the screens look the same as on a handheld-icon driven mobile unit (Trimble, Garmin, laptop).

NatureTracker Technology

The basic data collection software, *CyberTracker*, was developed by the nonprofit CyberTracker Conservation. The *CyberTracker* software is a database management program that allows programmers to develop their own data collection “sequence” consisting of screens, data fields and icons.

NatureTracker is a data collection “sequence” using CyberTracker International’s underlying software that works on PDA’s, Pocket PC’s and smart phones. NatureTracker was developed for *NatureMapping* to allow consistent data collection throughout the US and for immediate feedback by viewing data over aerial photos. The license is held by the NatureMapping Foundation.

The *NatureMapping* Program currently has NatureTracker sequences created for twelve states (AK, AR, CA, IA, MA, MI, NY, OR, PA, TX, VA, and WA). The only difference between the sequences is the list of wildlife species are state-specific. The NatureMapping Foundation has created consistent codes for species and habitats nationwide, enabling seamless examination of data across the landscape.

All the sequences are in the same program, so when for example, you cross the border from Oregon into California, all you have to do is change the state and continue collecting data. For teachers and students wishing to use the NatureTracker software, living in a state without a sequence, choose a state nearest you, and report data, skipping the county screen.

The mobile unit version is the same as the desktop version. There are purposes and advantages of the desktop version. NatureTracker “New



Sightings” for the desktop, can be used on any computer anywhere. Students can take laptop computers into the school yard to collect data over time. The school yard represents one Latitude (Lat) and Longitude (Lon) within 60 feet or one second of Lat and Long.

However educators may want students to become familiar with the screens before collecting data in the field. Also, the screens provide a summary of how field biologists make decisions on what field data to collect.

NatureTracker Software “How-to-Use” Information is available on the NatureMapping Program website:

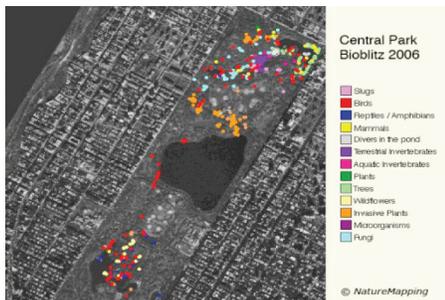
- You don't need a handheld unit to collect data from the same area! See Support below.
- **NatureTracker Simulator**
Provides a preview of the simulator that runs on Pocket PC's and smart phones (Android application for specific areas will be available soon).
- **Field Research**
is a step-by-step process of how data are collected and displayed.
- **Using NatureTracker for a Bioblitz**
provides examples from bioblitzes where 50-160 people collect data, using only two laptops to display, and finalize data.
- Order form or online

What is CyberTracker?

CyberTracker software is a database management program that allows programmers to develop their own data collection “sequence” (i.e. NatureTracker) consisting of screens, data fields, and icons. *Cybertracker Conservation* developed the software and its mammal tracking data collection “sequence” was designed to preserve the ancient tracking skills of Bushmen in the Kalahari for posterity. It allows Bushmen to record when and where wildlife is seen by pressing icons on the screen that represent different animal species and behaviors. Data points are displayed over maps as shown for the Central Park Bioblitz

Cybertracker adds new features to their software based on requests and funding from users. NatureTracker users can download the upgrades without any harm to existing data.

NatureMapping invites students and professionals to provide data through online data entry locating the mapping site for reporting your NatureMapping observations. Citizen reported data will be added to the NatureMapping database after a Quality Assurance Quality Control (QA/QC) review.



One of NatureMapping Foundations's goals is to create a biodiversity database and build layers of information about birds, mammals, reptiles, amphibians, fish, terrestrial and aquatic insects and plants in a way that when combined gives the public a picture of the biological health of an area...a neighborhood, city, county, and state.

The table below highlights the difference between the use of apps, websites and the NatureTracker software AFWA has made available for desktop computers and mobile laptops. Students can report their observations to websites through apps. However NatureTracker provides a field notebook function, and internal GIS function, and an icon driven platform, to assist the observer to identify and attach a code to their observation. Put simply NatureTracker is a complete packager for data collection, analysis and reporting. The NatureTracker software is a data logger, with GPS ability to determine location. NatureTracker also provides icon driven state specific species lists with graphic and GIS capabilities to analyze the data. The NatureTracker software reflects the practices of professional scientists. The data observations recorded using NatureTracker are ready to be used by scientists following their tests for Quality Assurance and Quality Control (QA/QC).

Table 6: Comparing NatureTracker, Websites and Apps.

	NatureTracker	Websites	Apps
Format	A complete field investigation package : Designed to function as a field notebook for professionals but appropriate for students. Allows users to customize data collected. Simplified GIS functions professionals use	Websites Designed as field guides and a limited repository for data. No customizing data collection available ArcGIS online and Google Earth have minimal GIS functions	Apps Designed mostly as a field guide to help identify species etc. No customizing data collection available. Have no GIS functions
Public use	Collect personal or project data with a large selection of attributes to report and review	Standardized reporting and viewing:	Standardized reporting and viewing
Maps	Multiple scale and ability to store specific maps	Global, national Google type maps	Usually street maps
Geographic locations	Handheld units, stored maps on PC for GPS coordinates	Point and click for estimate GPS locations	Cell tower coordinates - estimated
Data Collection	Collects data, & manages data in simplified GIS program	Crowd Sourcing Data Collection	Crowd Sourcing Data Collection

	NatureTracker	Websites	Apps
Data Usage	Data automatically entered into a database for editing, analysis, or exported as tables.	Data defined by web managers	Data defined by app managers
Data Repository	User and NatureMapping Foundation manages data as a public data set accessible to all	Website Limited data access – difficult to retrieve data	App manager Limited data access – mostly a field guide to look and learn
Sharing Data	NatureMapping provides attribute data requested	If available, usually straight database download (e.g., for eBird, no selection of attributes possible)	Sharing dependent upon app manager
Spreadsheet capability	Full user can build own queries to export into spreadsheet	No spreadsheet capability on websites	No spreadsheet capability
Graphing	Spreadsheet makes links to graphing to analyze and summarize data	Some websites have limited graphing ability	
GIS	Export spreadsheet into GIS	No link to users GIS	No link to users GIS
Photos	Can upload photos to a GPS location & add data.	Can upload photos	Use apps to attach a photo

Using NatureTracker: An Example, From Start to Finish

Select how you want these species groups displayed. Data cannot be collected if none of the options are chosen.

- Birds: alphabetized list
- Birds: use ID key
- Fishes: enter number
- Fishes: use ID key
- Land Invert.: enter number
- Land Invert.: use ID key
- Marine Invert.: enter number
- Marine Invert.: use ID key

This story is an example of how to collect, edit, and export data to a spreadsheet for analysis and submission to The NatureMapping Program. The steps are explained in detail within this manual.

You have been watching birds, a river otter, and dragonflies in and around a riverside park in your town.

Step 1: Complete the Start Screens. The responses you enter will be repeated on every NatureTracker record.

Turn on your handheld and open NatureTracker.

Select “Customize Data Collection” and select:

- Birds, alphabetized list
- Birds, use ID key
- Land invert: use ID key



A riverside municipal park



NatureTracker hardware: a PC, a PDA and a digital camera (optional).

Select a tracker number			
1	2	3	4
5	6	7	8
9	10	11	12
TEST			

Select a Tracker number. A Tracker number can be used multiple ways:

1. There are two groups with you today. One group can be Tracker 1 and the other Tracker 2
2. There are multiple groups and two are only recording birds and others dragonflies. Each taxonomic group is assigned the same Tracker number.
3. You are alone and want to see your path to and from the car. You assign a Tracker number going out and another coming back in.

You have either been assigned an ID code at a *NatureMapping* workshop or have requested one from the Washington/National website. You enter your ID 1234.53 (“53” is the state code Washington).

If there is more than one of you, you can all use one person’s ID number.

Note: ID codes can be assigned for a regularly visited place rather than for a single person.

Select your state and then the county you are currently in.

What state are you in?

AR	CA	CO	IA
MA	MI	NY	PR
TX	VA	WA	

What county are you in?

Adams	Asotin
Benton	Chelan
Clallam	Clark
Columbia	Cowlitz
Douglas	Ferry
Franklin	Garfield
Grant	Grays Harbor
Island	Jefferson
King	Kitsap
Kittitas	Klickitat

Enter NatureMapping ID #

1234.53

7	8	9	<
4	5	6	.
1	2	3	0

Next you build the three-digit habitat code for *NatureMapping*

1. You select the “Wetland/Streams” icon because it is a river park
2. You are walking along the edge of the river, so the next selection is “Riparian”
3. There are mowed lawns and trails but there is more vegetation than development and “Development – light” is selected
4. The digits “538” are displayed on the handheld and you enter the numbers into the calculator.

Describe the habitat.

All wetland vegetation types
Submerged / floating aquatic plant
Emergent herbs / shrubs
Trees - deciduous
Trees - conifer
Mixed deciduous / conifer
Development - heavy
Development - medium
Development - light

5 3 8

Enter 3-digit code above

538.

7	8	9	<
4	5	6	.
1	2	3	0

What are you recording?

Habitat leads to animals & plants. Location, Weather, & Following do not.

Habitat: build the code	
Habitat: code known	
Location (if no GPS)	
Weather observation	
Following (object)	

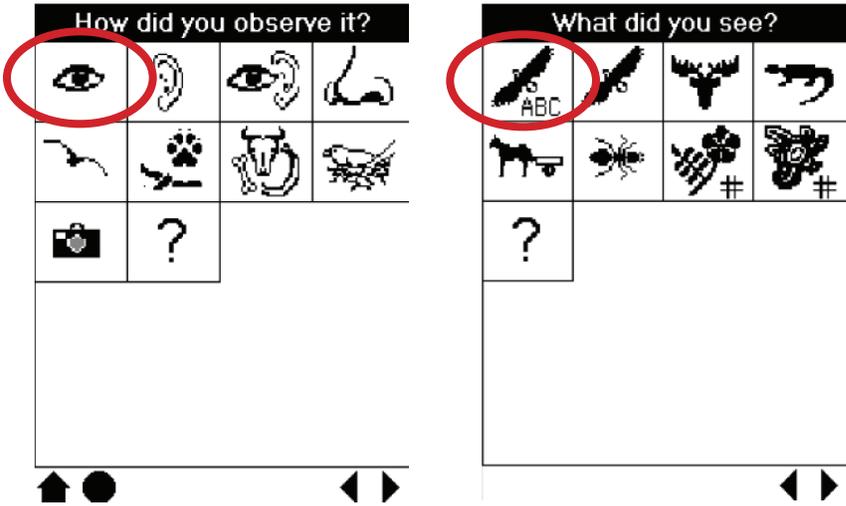
Describe the habitat.

All wetlands types
Estuarine marsh
Fresh water marsh
Riparian
Vernal pools
Ocean beach - vegetated
Intermittent streams

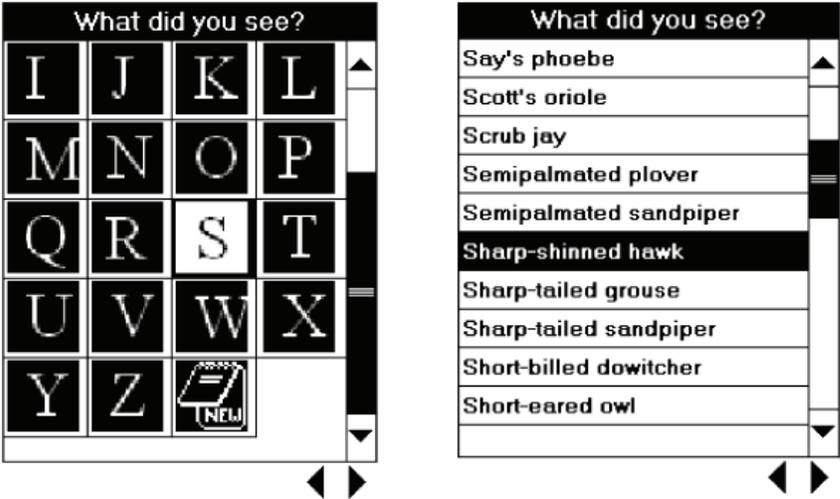
The Start Screens are now complete. All the above information will be included in every record during your data collection session without being asked again.

Step 2: You are now ready to enter your first sighting. There are about twenty Barn swallows mobbing a Sharp-shinned hawk and other birds in the bushes.

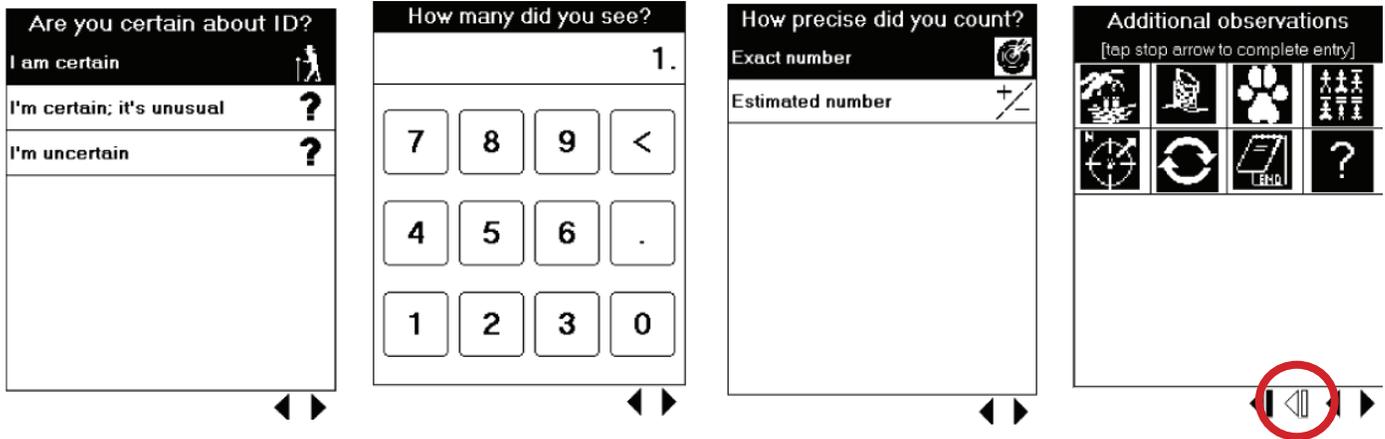
Your first entry is the Sharp-shinned hawk. Selecting the “eye” icon brings you to the “What did you see?” screen and since you know it is a Sharp-shinned hawk, you select the bird ABC icon.



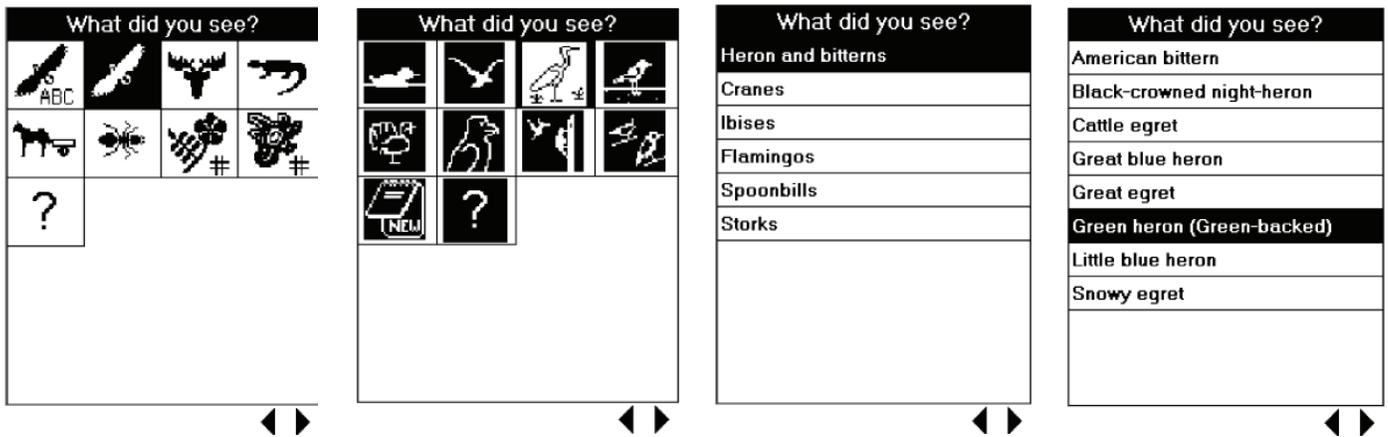
Scroll down the screen to the “S” and select Sharp-shinned hawk.



You are certain of the species name and enter a “1” in the quantity screen. It is an exact number. Complete the record by pressing the open arrow with a bar to take a GPS location.



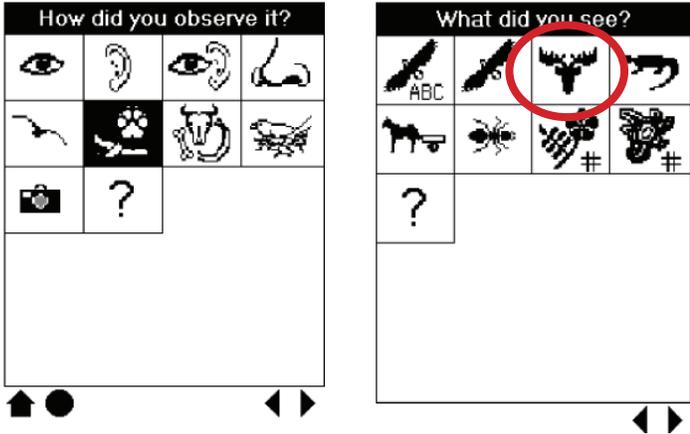
You repeat the process for the 20 Barn swallows, but there is one bird you are not sure about the name, but know it is in the heron family. This time you select the Bird without the ABC icon and select “Long-legged waders”, then “Heron and bitterns”. There it is, “Green heron” and continue the process.



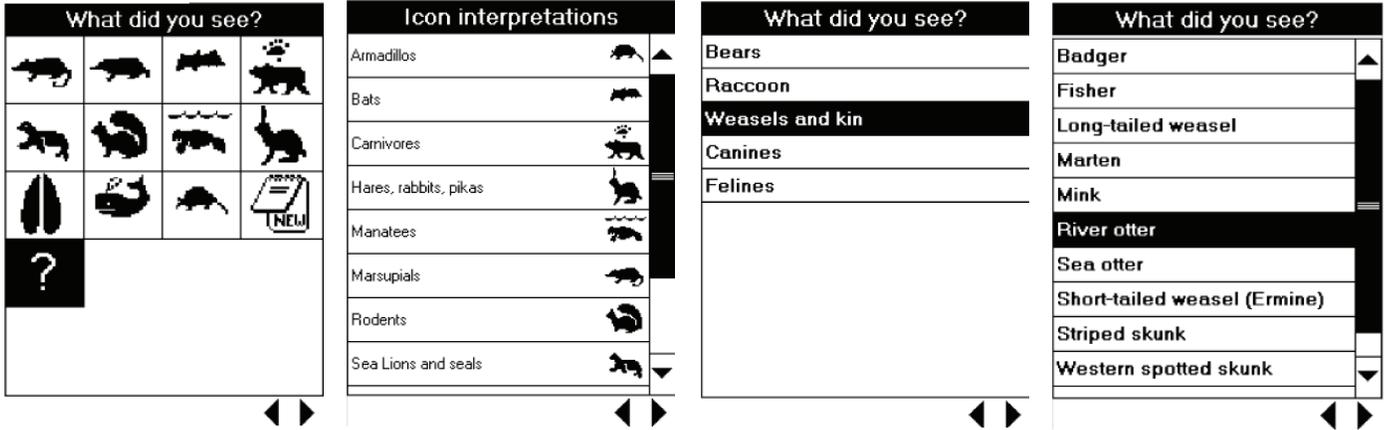


Later, you find the tracks of a river otter that had come ashore in the early morning.

- You take a picture of the otter tracks with your digital camera
- You didn't see the otter, so select "sign" then mammals



- You are not familiar with mammal families, so you press the "?" to list all the icons and descriptions
- An otter is a carnivore, and is listed under "Weasels and kin"

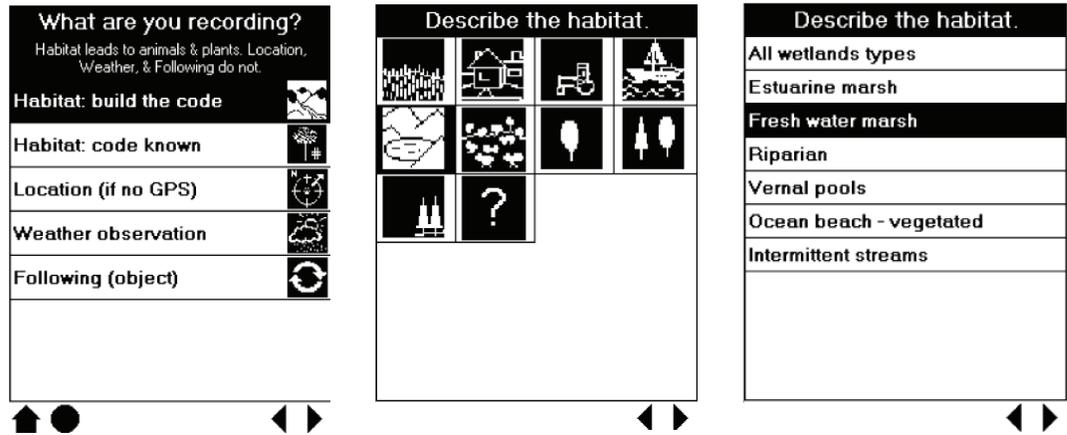


- You are sure of its identity, and put "1" in the quantity screen, and it is an exact number.
- Press on the solid arrow and bar to get your GPS location and return the screen to the Habitat Code screen because you are changing habitats....you are going into a marsh.



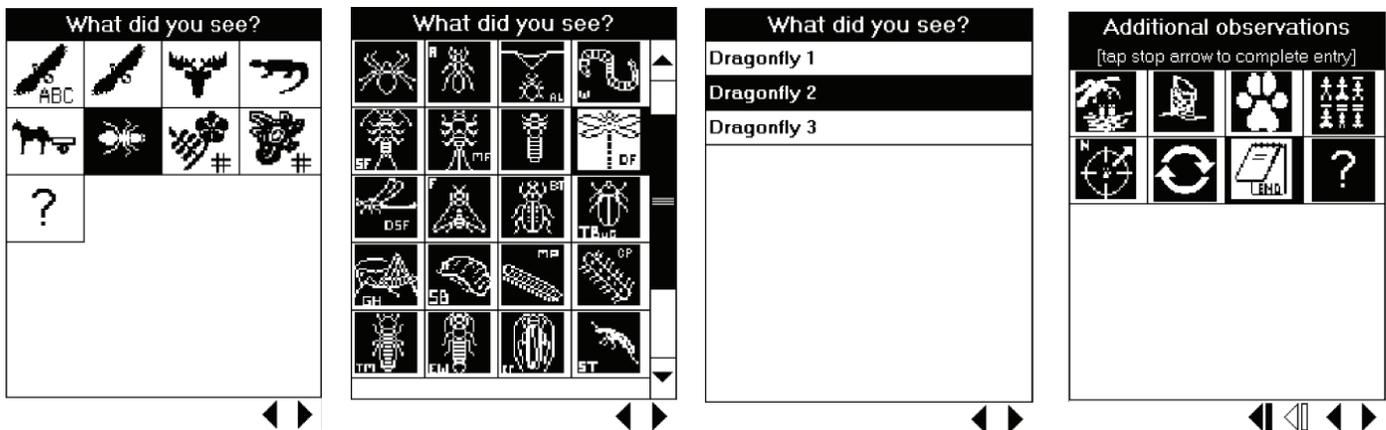
Note: The only time you want to get back to the Start Screens is when you change habitats or finishing up for the day

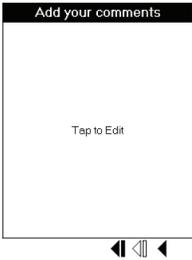
Change the habitat In the Start Screens to a freshwater marsh, and proceed.



Dragonflies are invertebrates and invertebrates are very hard to identify at a species level.

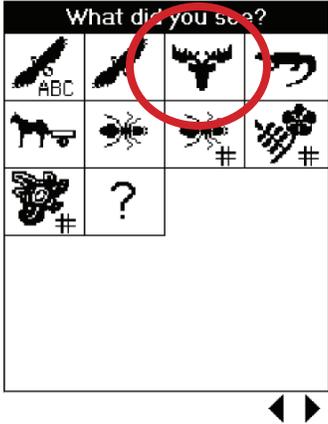
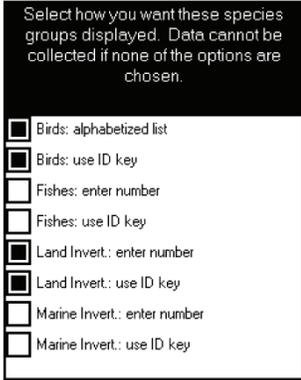
- Select invertebrate, then scroll down to “dragonflies”.
- You have already recorded one dragonfly, but this one is different in size and color.
- Continue through the screens and where you would select the “arrow/ bar” to take a GPS point, select the “Notebook” which allows you to write comments describing the dragonfly.





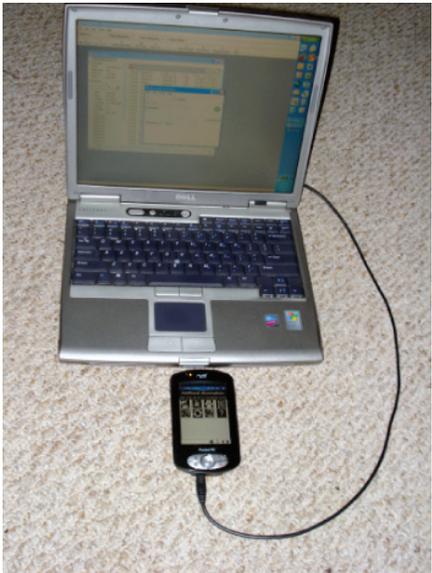
IMPORTANT NOTE: Describing the invertebrate precisely or collecting the insect for later identification will allow you to change the “dragonfly 2” record to one with an ID code.

Experts can select the “Invertebrate use number” icon when they have a list of species with identification numbers.

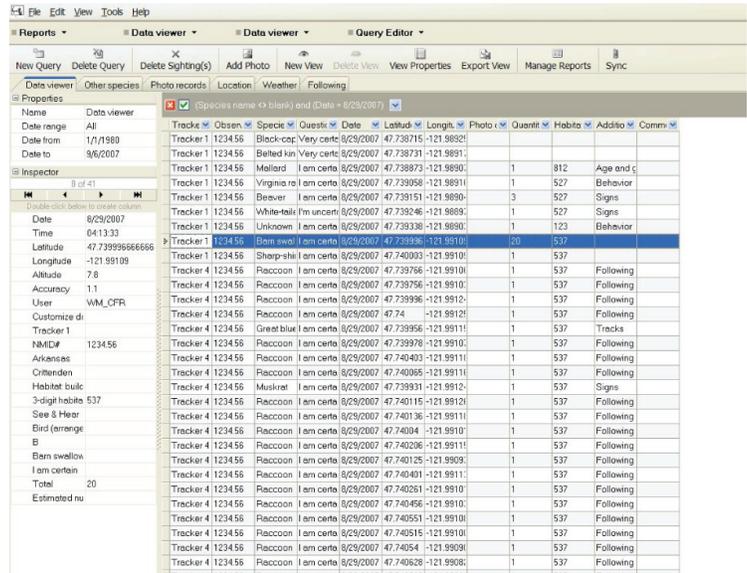
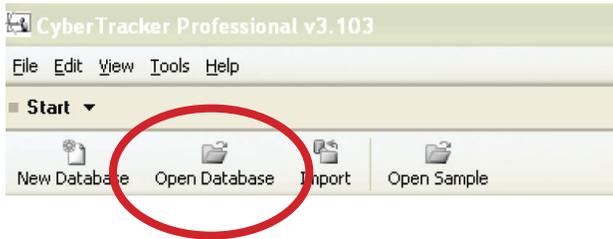


Step 3: You are done for the day...

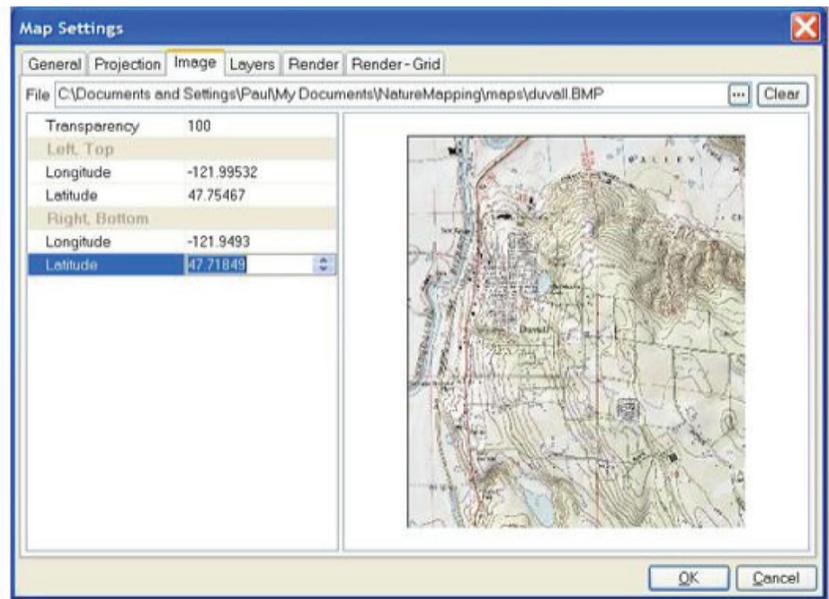
1. Set the PDA back to NatureTracker’s first screen by hitting the “house” at the bottom of the “eye” or “habitat” screen
2. Connect the handheld to your computer and download your sightings.
3. Download the digital camera.



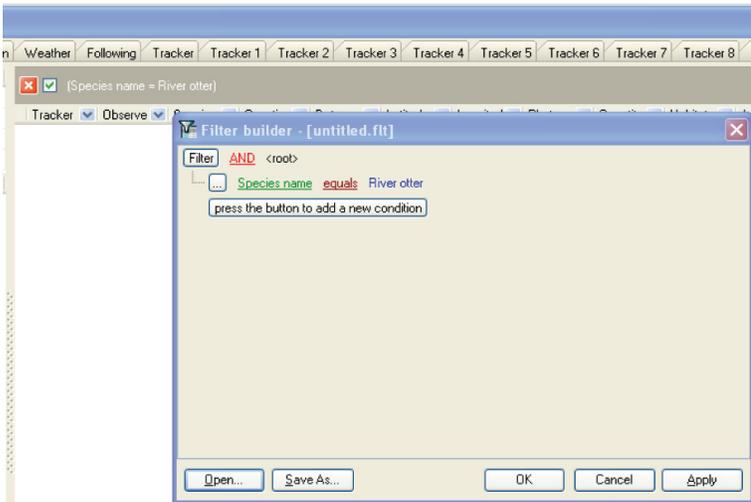
Step 4: Open the NatureTracker database on the computer and display today’s sightings on a table in “Data Viewer”.



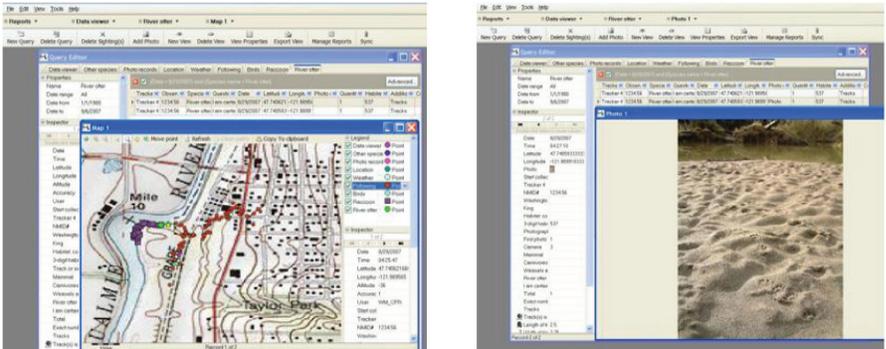
Step 5: You want to view your data on a map. You make a topographic map of your local park using mapping software or have ordered a map from *NatureMapping*. Write down the latitude and longitude of each map edge. In your database, click “New View” and add the map image and enter the appropriate latitude and longitude numbers.



Step 6: Edit the “Animal Query” tab to view otter sightings separately.



Step 7: Add your digital photo of the otter tracks to the river otter sighting.



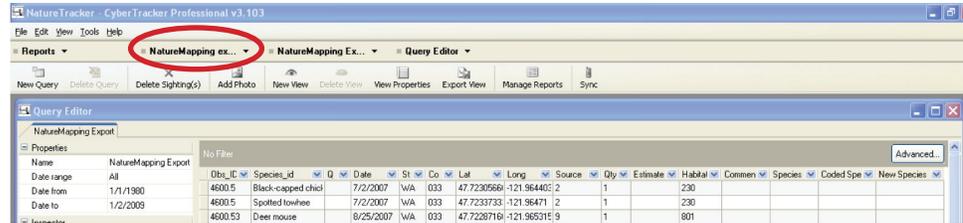
Step 8: Correct any mistakes in your sightings

If lat/long are missing or 1000, the records must be fixed. Without a location, the record will not appear on maps.

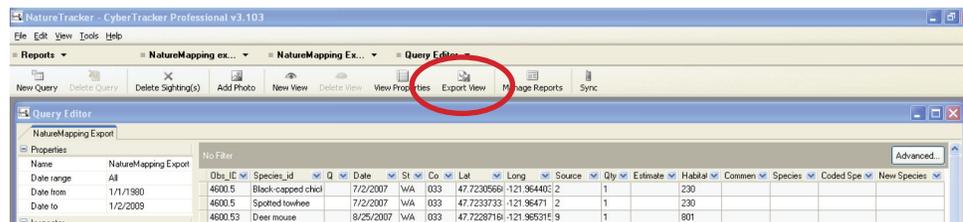
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Line Num	Tracker	Observer ID	Bird	Questionable	Date	State	County	Latitude	Longitude	Source	Qty	Estimate	Habitat	Short Hab
2		Tracker 2	2990	RIRI	?	4/1/03	WA	32	47.074533	-117.89600E	2	3	Y		612
3		Tracker 2	2990	PIPI	?	4/1/03	WA	32	47.074617	-117.89500E	6	11	Y		612
4		Tracker 2	2990	HALE	?	4/1/03	WA	32	47.075883	-117.89490E	2	1	Y		612
5		Tracker 2	2990	BRCAMII	?	4/1/03	WA	32	47.075867	-117.89497	3	1	Y		612
6		Tracker 3	2990	ANRUBE	?	4/1/03	WA	32	47.078083	-117.9014E	2	3	Y		12.6
7		Tracker 2	2990	AISP	?	4/1/03	WA	32	47.0747	-117.9055E	3	100	Y		612
8		Tracker 2	2990	ANAL	?	4/1/03	WA	32	47.073833	-117.9075E	3	100	Y		612
9		Tracker 6	1029	AGPH	?	4/1/03	WA	38	47.074117	-117.8969E	3	3	Y		
10		Tracker 6	1029	BRCAL	?	4/1/03	WA	38	47.074167	-117.8969E	3	4	Y		
11		Tracker 6	1029	PIPI	?	4/1/03	WA	38	47.07445	-117.89677	5	1	Y		
12		Tracker 6	1029	BUJA	?	4/1/03	WA	38	47.074467	-117.8967E	5	1	Y		
13		Tracker 6	1029	BUJA	?	4/1/03	WA	38	47.074583	-117.8962E	5	1	Y		
14		Tracker 6	1029	BUJA	?	4/1/03	WA	38	47.074567	-117.8962E	6	1	Y		
15		Tracker 6	1029	PIPI	?	4/1/03	WA	38	47.074483	-117.8955E	5	1	Y		
16		Tracker 6	1029	PIPI	?	4/1/03	WA	38	47.07455	-117.8955E	5	1	Y		
17		Tracker 6	1029	AGPH	?	4/1/03	WA	38	47.074517	-117.8951E	5	1	Y		520
18		Tracker 6	1029	BUJA	?	4/1/03	WA	38	47.075617	-117.894E	5	1	Y		602
19		Tracker 5	513	ERAL	?	3/31/03	WA	32	47.411717	-117.5310E	2	1	Y		930
20		Tracker 5	513	ANPL	?	3/31/03	WA	32	47.409967	-117.5329E	6	1	Y		930
21		Tracker 5	513	BRCAL	?	3/31/03	WA	32	47.409967	-117.5329E	2	5	Y		930
22		Tracker 5	513	ANPL	?	3/31/03	WA	32	47.411233	-117.5359E	3	2	Y		
23		Tracker 5	513	AGPH	?	3/31/03	WA	32	47.413383	-117.5351E	6	1	Y		
24		Tracker 5	513	AGPH	?	3/31/03	WA	32	47.413783	-117.5347E	6	3	Y		
25		Tracker 5	513	BRCAL	?	3/31/03	WA	32	1000	1000	2	5	Y		930
26		Tracker 5	513	ANPL	?	4/1/03	WA	38	47.07415	-117.897	3	2	Y		
27		Tracker 5	513	ANPL	?	4/1/03	WA	38	47.074083	-117.89687	6	3	Y		
28		Tracker 5	513	ZEMA	?	4/1/03	WA	38	47.07445	-117.89577	2	1	Y		
29		Tracker 5	513	AGPH	?	4/1/03	WA	38	47.0746	-117.8950E	6	30	Y		520
30		Tracker 4	2990	BUJA	?	4/1/03	WA	38	47.075183	-117.8975E	3				
31		Tracker 4	2990	BRCAL	?	4/1/03	WA	38	47.074283	-117.89957	3				

Step 9: Select “NatureMapping export” displaying data in the NatureMapping format.

The *NatureMapping* export query is designed for importing into The *NatureMapping* Program statewide database.



1. Select the records you want to submit by modifying the Date Range.
2. Do not use “File Save as” or “Export Data” from the File menu. Use “Export View” and save as an Excel file.



3. Open the NatureTracker export file in Excel or other spreadsheet programs.
4. Adjust the column widths
5. Format the lat/long columns to show 6 decimal places
6. Make any other corrections. **NOTE:** Sometimes it is easier to change a lot of records in Excel rather than in NatureTracker because CyberTracker only allows you to change one record at a time. For example, if you couldn't get a good GPS fix and most of the records are at the same lat/long. *NatureMapping* needs a location with each of the records.
7. The files are ready to submit to The *NatureMapping* Program via the website.

IMPORTANT NOTE:

- You repeat this process the next time that you visit your park, and your personal data rapidly grows. Viewing your data over time will show areas that you might have missed in your visits, “hot spots” of wildlife activity, and seasonal changes.
- NatureTracker is a simplified GIS program. Data can be viewed by dates, by individual species over topographic maps and/or aerial photographs.
- Data Views can be exported as “Comma separated values” that can be read into more sophisticated GIS software.

For further information, visit the *NatureMapping* website for handouts explaining how to:

- Summarize your data by month, year, and/or species
- Create graphs that automatically change when you add additional data
- Using aerial photos and how to find maps for your projects
- New techniques and NatureTracker updates.

SECTION FOUR: Geospatial Literacy: Use of Geographical Information systems with Field Investigation

Part 1: Using PowerPoint

Part 2: Using Google Earth

Part 3: Using ArcGIS Explorer Online

The Field Investigation Model gets students outside conducting rigorous science field studies. This section provides several different ways to introduce the value of Geographical Information Systems (GIS) to field investigation, by assisting in managing data collection and enabling analysis of the data. The range of tools described will allow teachers to introduce the spatial understanding and analysis provided by GIS that natural resource professionals use to conduct their own field research.

The Environmental Systems Research Institute (ESRI) now offers free licenses for professional software **ArcView** to state departments of education and districts until 2014. Current states and school districts participating are found at the following website: www.esriurl.com/k12schoollicenses.

Part 1: Using a **PowerPoint** tutorial, located on the NatureMapping Foundation website, students develop a GIS layer of an area where they plan to collect data, learning the concept of points and polygons. The tutorial shows how to develop a GIS layer of data collection sites and define habitat areas on an aerial photo. The tutorial then applies the GIS spatial terms where each data collection site is defined as a GIS point and the outlined habitat areas are defined as GIS polygons.

Part 2: A **Google Earth** exercise engages students in simulating a response to an oil spill off the coast of Western Canada and USA using NOAA data.

Part 3: Environmental Systems Research Institute (ESRI) has recently launched the **ArcGIS Explorer Online**, which is ideal for upper elementary, middle and high school students to develop story lines with maps. In the example provided a third grader tells the story of the migration of salmon using the ArcGIS Explorer Online maps.

SECTION FOUR Part 2: Geospatial Analysis using Google Earth

An Introduction to Geospatial Analysis using Google Earth

The following Oil Spill simulation requires the user to download Google Earth (no cost), and create an activity with NOAA data that predicts oil spill behavior off the Washington State coast.

This activity is particularly useful for educators with the objective to develop the spatial analysis and GIS skills for middle and high school students.

All relevant data is available to educators once they access the Google Earth site. The instructions describe how to access data and how to analyze the data.

Olympic Coast Oil Spill Simulation

An Introduction to Geospatial Analysis through Google Earth

Written by Erica Baker, Pacific Education Institute

Funding Provided by NOAA's Bay-Watershed Education Training (B-WET) Program

ArcGIS and Google Earth Project Collaborators: Tricia Kirkman and Dwight Barry, Peninsula College

Working and Response Maps by Dwight Barry, Peninsula College

Special thanks to the Korey Champe and Brynn Lacabanne with PASCO Scientific and the experts and specialists at the Olympic Coast National Marine Sanctuary and NOAA: Liam Antrim, Jacqueline Laverdure, and Nancy Wright

Introduction

Several months before the April 20, 2010, Deepwater Horizon oil spill, the first version of the *Olympic Coast Oil Spill Simulation: An Introduction to Geospatial Analysis* was presented to teachers at a workshop in Aberdeen, Washington. The original intent of this project was to teach students basic GIS skills through the context of a simulated oil spill response. Within weeks, the Deepwater Horizon incident gave a new meaning to this activity. Through revisions and collaborations, the *Olympia Coast Oil Spill Simulation* educates students about the complexities of oil spill response while developing or enhancing basic GIS skills. Students learn to use technology and problem-solve while considering a real-world issue facing our environment.

New oil spills are making headlines even as we finalize this document. As you work with your students on this project, be sure to access the wealth of resources, articles and information about current and relevant oil spill events impacting students today.

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Task 2 – Taking a Closer Look at the Washington Coast

Task 3 – Looking at the Predicted Trajectory of the Oil Spill

Task 4 – Locating Sensitive Habitats

Task 5 – Locating Critical Animal Populations

Task 6 – Researching Equipment and Materials for Oil Spill Response

Task 7 – Making Recommendations

Student Pages

Coastal Oil Spill Response Plan

Potential Spill Zone Working Map

Washington Coast Working Map

Animal Descriptions

Oil Spill Recovery Options/Equipment

Sources and Resources

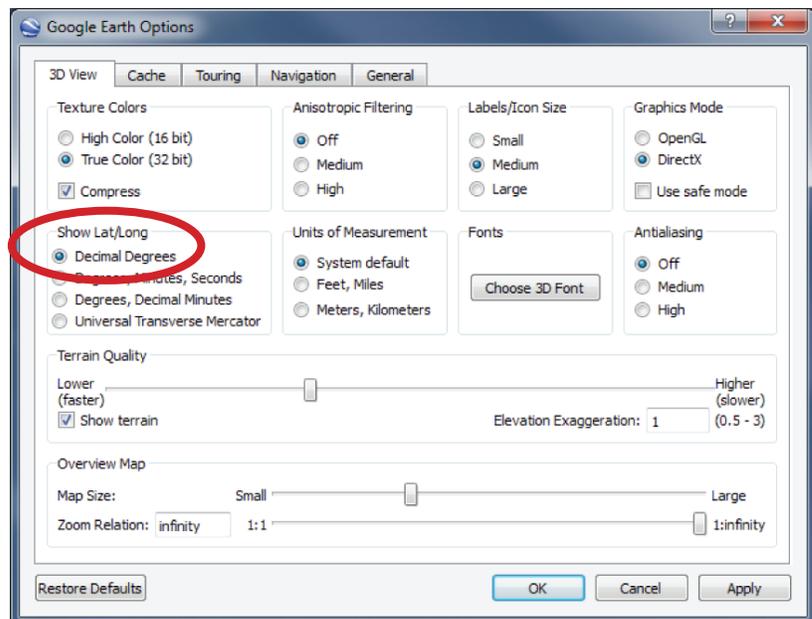
Set-Up Instructions and Information

To download the project file/layers (.kmz file) for Google Earth and a digital copy of these instructions, go to: <https://pacifieducationinstitute.box.com/GoogleEarthOilSpillSim>

Before working with your students, please see the tips and recommendations below:

- Always run through the steps on a similar computer to ensure the basemap, layers and links operate correctly.
- Have each computer set up GE to be in Decimal Degrees

Tools → Options → 3D view → Show Lat/Long



- Have Layers pre-set up to show Borders and Labels, Roads, and (if desired) 2 Ocean sublayers. Once Google Earth is closed with these four boxes checked, the next time Google Earth is opened it will show these same layers.
- A one page cheat sheet for the Google Earth interface is at http://serc.carleton.edu/files/sp/library/google_earth/examples/google-earth-tip-sheet.v2.pdf.
- A complete overview/walkthrough is available at <http://support.google.com/earth/?hl=en>.

Olympic Coast Oil Spill Simulation

An Introduction to Geospatial Analysis through Google Earth

The Situation

Welcome to this emergency meeting of key natural resource protection personnel of Washington State. You are here today, representing your agency, organization or business, to help us with a situation of great importance.

At 0500 hours (5 am) today, May 12th, a United States tanker, the *I.M.A. Krasher*, struck an unidentified navigational hazard at 48.4696° N, 124.9465° W. The damage includes multiple fractures (large cracks) in the hull. Experts are predicting that up to 13,200 barrels (554,400 gallons) of crude oil will flow into the ocean.

According to NOAA's oceanographic model (a computer simulation created by oceanographers using data such as ocean currents and prevailing winds) and the incident meteorologist, the oil will reach the coast in less than 48 hours.

You will be put into teams of specialists to develop a ***Coastal Oil Spill Response Plan*** that will protect Washington's shorelines and must determine the following:

- Where are the **Sensitive Habitats**?
- Where are the **Critical Animal Populations**?
- What are the most important **Areas to be Protected**?
- What **Types and Numbers of Equipment and Materials** should be used?
- How will the equipment and materials be **transported to the Areas to be Protected**?

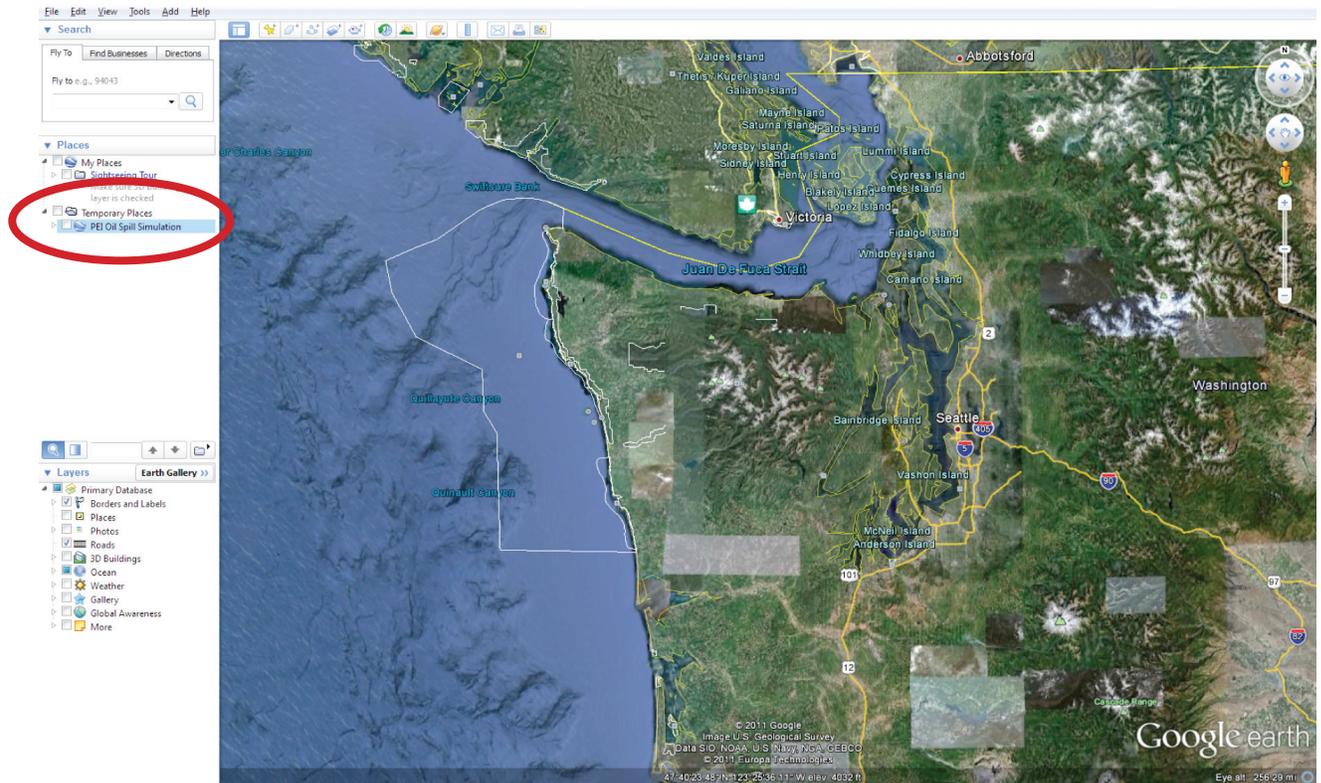
Your team will be given the following resources:

- Computers with active Internet connections
- Google Earth with the ***PEI Oil Spill Simulation*** Project File (PEI Oil Spill Simulation.kmz)
- Working Map (paper map covered with thin plastic) and erasable markers for planning
- ***Coastal Oil Spill Response Plan*** – a blank document to be filled out and turned in
- Reporting Map – a paper copy of the Working Map to be marked and labeled when a final plan of action has been determined

***Note:** If at any time during the simulation, you accidentally modify the project file and/or can't figure out what you have done to the project file, EXIT from the program and DO NOT SAVE (click "Discard") the file. You can then re-open the file, choose the proper layers, and continue with the simulation.

Task 1: Find the location of the tanker off the west coast of Washington.

- A. To begin this project, find the Google Earth file titled **PEI Oil Spill Simulation**. Double click on the icon or file name to open it.
- B. This project has already been constructed. Once Google Earth has zoomed into the northwest coast of the United States, your screen should look something like this:



- C. To create a map showing the simulation area and the location of the oil tanker you will need to make some of the simulation layers visible.

***Note:** If at any time you want to return to the starting view screen, you can double click on the PEI Oil Spill Simulation in the Places box.

1. Click the open folder arrow (not the box) to the left of the **PEI Oil Spill Simulation** title in the Places box to expand the list of available layers. Use the bar on the right side of the Places window to scroll down to the bottom of the list of layers. The names listed under the **PEI Oil Spill Simulation** folder are the names of the layers for this activity, organized into three subfolders. To start, click in the box for **Coastline Response Area**. A thick red line will appear showing the region of the coast that could be affected by this spill.

2. There are also many built-in layers within Google Earth, located in the **Layers** box, beneath the **Places** box. Depending on your settings, the Borders and Labels, Roads, and some of the Ocean layers could be already activated. Take a moment to see what sort of information is available; for example, you can click on the circle icon at the far northwestern tip of Washington State and see a popup on seabirds in the Marine Sanctuary. You can turn these built-in layers on and off as needed as you go through this simulation.

Google Earth has a variety of tools available to reposition your view, which are located in the upper right side of your screen, which allow you to change your view (direction and tilt, top circle), pan around the view (second circle), see a street view (where available, the person icon), and zoom in or out (the zoom bar). Note: If you get lost in the view because of moving and panning around, you can always press the N button on the keyboard to rotate the screen to orient the top of the screen to North, or you can press the R button to simultaneously orient to North and look straight down on the Earth's surface.



Before moving on, answer the question: What is a point? on your *Coastal Oil Spill Response Plan* document.



Task 2: Take a Closer Look at the Washington Coast

- A. Turn off the built-in Ocean layer if you have it on. Looking at the outline of the basic Washington State boundary layer (the one turned on from the built-in layers under “Borders and Labels”), the coastline looks very straight as compared with the land image.

Now turn on the **Olympic Peninsula Streams and Shorelines** layer and double click on it to move to its snapshot view. To take a closer look at this layer, you need to zoom in closer. To zoom in quickly, you can double-click on the map directly over the feature or area you wish to zoom toward. Zoom in toward an area on the western coast until you can see how the image of the coast in Google Earth compares with the **Streams and Shorelines** layer.

- B. As you get closer, you will see the built-in Borders outline will fade out. Notice that the two layers don’t match up, nor does the new layer match the basemap imagery exactly, either.

Consider:

Why might there be a difference between these layers?

What would be an advantage for using the less accurate layer?

What would be an advantage for using the more accurate layer?

Write your answers to these questions on your *Coastal Oil Spill Response Plan* document.

Write your answers to these questions on your Coastal Oil Spill Response Plan document.

- C. Turn off the **Streams and Shorelines** layer.
- D. Now, verify the location of the tanker. To determine its longitude and latitude in Google Earth, double click on **Vessel Location** in the Places box. Hover your mouse pointer over the center of the icon and write down its coordinates.

Write your answer on your Coastal Oil Spill Response Plan document.

You are now ready to look at the oceanographic model that shows the path the oil will likely take as it heads to the Washington coast.

Task 3: Observe the Predicted Trajectory (Path) of the Oil.

***For NOAA's video that demonstrates how an oil spill response is managed and how a trajectory is determined: <http://1.usa.gov/12zILII>, or download the video from <https://pacificeducationinstitute.box.com/GoogleEarthOilSpillSim>**

- A. The path spilled oil will probably take as it travels to the Washington coast can be predicted by looking at oceanographic information such as ocean currents, wind patterns, and weather.

Using this type of data, a team of experts used a *model* to create layers containing **polygons**. A **polygon** is a shape or an area fully surrounded by a series of connected lines.

- B. Now it's time to look at the predicted trajectory of the spilled oil using these model-created polygons*. To do this, you will work in chronological order, starting at 2 hours after the spill with the **2 Hours** layer. Continue turning on the **Oil Spill** layers in order until you reach the **72 Hours** layer.

*Remember these polygons were created using data related to ocean currents, winds, and weather.

- C. Another name for spilled oil that is floating on the surface of water is a slick. If you zoom in to the shoreline at the edge of the predicted trajectory of the oil slick, you will notice that a number of key features and areas are labeled. Other features are visible but are not labeled (such as a yellow boundary polygon to the northwest of Lake Ozette), but can be identified by clicking on them.

List names of the areas on the map that will be impacted by the oil slick in the first 72 hours on your Coastal Spill Response Plan document.

4. The land area where the oil is predicted to hit and the areas immediately to the north and south are within the **Potential Impact Area**.

Turn on the **Potential Impact Area** layer. This will be your region of focus as you begin to determine the habitat and animal populations that need to be protected. (As you continue to look at features in this area, you may need to turn off the oil spill trajectory layers. When those layers are off, this layer's snapshot view will help you remember where the oil slick will be reaching the coast.)

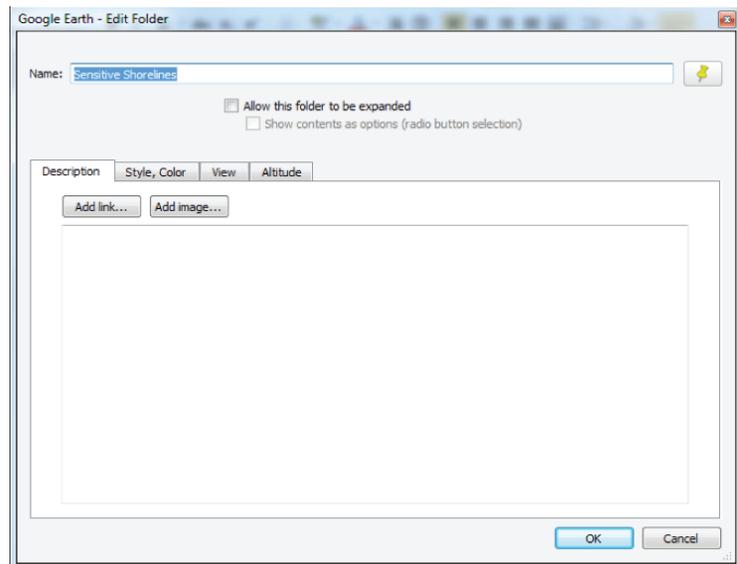
Answer the following question on your *Coastal Oil Spill Response Plan* document: Why are oceanographic models (like the one that was used to create the trajectory polygons for this simulation) important?

Task 4: Locate Sensitive Habitats.

***Note: As you work through the next portion of this exercise, the projected Oil Spill trajectory layers can be turned off and on, as needed**

For this project, a **Sensitive Habitat** is an area that is more easily damaged by oil slicks and is harder to clean up. The oil that reaches a sensitive habitat tends to persist (last) longer in that environment, causing more harm to the animal and plant species that live there.

- A. The first sensitive habitat to consider is obviously the coastline or shoreline. However, some coastlines are at higher risk because they are harder to clean up and oil persists (or lasts) for a longer period of time. These include **estuary wetlands, mudflats, and sandy beaches**. To see the different types of sensitive coastline habitats in the **Potential Impact Area**, turn on the **Sensitive Shorelines** layer.
- B. The **Sensitive Shorelines** layer may be hard to see. To make the layer stand out more, you can change the size and/or color of the line that “traces” the shoreline:
 1. To open the **Symbol Selector** box for the **Sensitive Shorelines** layer, right click on the layer name and choose Properties. A box should appear that looks like this:



2. Locate the **Style, Color** tab and click on it.
3. You can now edit the line width you desire by clicking in Color or Width boxes. The line will get wider if you make the width value larger. Change the size and color to something that stands out for you.

***Answer the following question on your *Coastal Oil Spill Response Plan* document: What is a benefit of being able to change the line width or color of a layer?**

- C. Look for any shorelines within the **Potential Impact** zone that should be protected. Mark those shorelines on your Working Map.
- D. In addition to the shoreline, areas **where any streams or rivers empty into the ocean** are important. Turn on the **Olympic Peninsula Streams and Shorelines** layer. This layer contains all the streams in northwest Washington State. You may zoom in and out to look at these streams.

Keep these questions in mind as you look: Where does each stream come from? Where does each stream go?

Answer this question in your Coastal Oil Spill Response Plan document: Why might it be important to protect the streams that empty into the potential spill area?

and

Mark any streams that empty into the Potential Impact area on your Working Map.

***You have now designated the Sensitive Habitat areas to be protected.**

- E. The **Olympic Peninsula Streams and Shorelines** layer can be overwhelming, as there are many streams in the region. Since your focus is on the streams that empty into the ocean along the potentially impacted coast, turn on the **Potential Impact Area** layer and turn off **Streams and Shorelines**. This will help eliminate “clutter” as you continue.
- F. Additionally, you will notice a number of lakes in the **Potential Impact** area. Turn on the **Washington Lakes** layer.
- G. In addition to a variety of important shoreline habitats, Washington has a multitude of islands. In fact, there are over 900 islands off the Washington coast. Turn on the **Coastal Islands** layer to see all of the islands that are within the Potential Spill Zone.

(Don't forget, you can temporarily turn off the **Oil Spill** layers to get a better view of the islands.)

While many of these islands are essentially big rocks, a number of the islands are of considerable size and importance. You will further research the importance of these areas as you move to your next task.

Before you proceed, answer the following question in your Coastal Oil Spill Response Plan document: Why might these islands be important?

Task 5: Locate Critical Animal Populations.

The species of birds and mammals that can be severely impacted by an oil spill are called *Critical Animal Populations* for this activity. The animals that are affected by an oil spill vary according to the time of year. This is due to animal behaviors and activities that occur at specific times, such as breeding and molting.

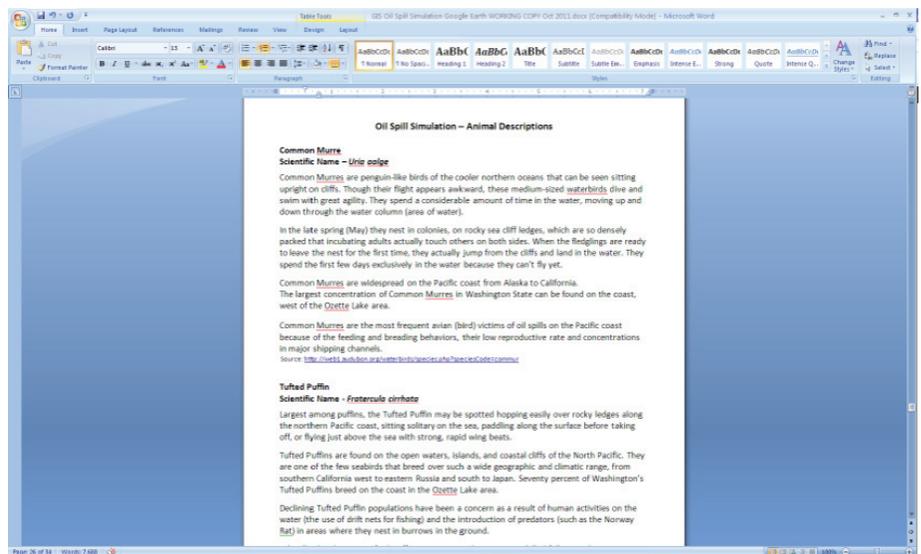
Critical Bird Populations

- A. This incident occurs in May. During this time of year, several bird species can be dramatically affected: the Common Murre and the Tufted Puffin.

To see where these bird populations are located within the **Potential Impact** area, turn on the **Common Murre Colonies** and the **Tufted Puffin Colonies** layers. The Common Murre colony locations will be marked with large orange circles and the Tufted Puffin colony locations will be marked with small green circles. You may need to turn other layers off to see these locations more clearly.

- B. You may be wondering what a Common Murre or a Tufted Puffin look like. To see photos of these animals, turn on the Images and Links folder in the Places box. Several camera icons will appear in the ocean to the northwest of Ozette Island. If you click on the camera icons you will be taken to images of either the Common Murre or Tufted Puffin, with links to find out more information about these animals. The links open a web browser within Google Earth, so you do not even need to open a new window. Once you are done looking at the pictures you may close the websites and return to Google Earth.

- C. Read the short paragraphs about these two bird species in the *Animal Descriptions* document.



- D. Now that you know more about these birds, take a closer look at the locations of their colonies. Notice where they overlap. Choose an area where they overlap and zoom in. (You may turn off the **Coastal Islands** layer, if desired.) Notice that the colony points and islands don't necessarily match up exactly (some areas are better matched than others).

Answer this question on your Coastal Oil Spill Response Plan document: What might be a reason that the layers/points don't match up?

- E. If you haven't already, zoom to the entire **Potential Impact** area.
- F. Looking at the points within the **Potential Spill** box, you only see the locations of Tufted Puffin and Common Murre Colonies. However, you do not know the number of birds in these colonies. As you narrow down the areas that are to be protected, knowing numbers is important.

To see the actual population numbers for each colony:

1. Make sure that the **Common Murre** and **Tufted Puffin Colonies** layers are active.
2. Click on any Tufted Puffin Colony, or Common Murre Colony point. (You may need to zoom in or zoom out before you choose a point.)
3. Once you click on a point, an information box will appear. You will find a variety of information including the name of the island/rock (if there is one), the location (latitude and longitude) and a list of all bird species that might be found in the area. You are looking for the: Common Murre = **CMURR** and the Tufted Puffin = **TPUFF**.
4. Spend a few minutes looking at the different colonies and numbers.

Make notes on your Working Map about the areas with higher populations of these two bird species. Also make note of areas of overlap between the two species.

and

Answer the questions about the bird populations and locations on your Coastal Oil Spill Response Plan document.

Critical **Mammal** Populations

- A. In addition to the Tufted Puffin and Common Murre, several mammals can be dramatically impacted by an oil spill. Two species in particular are the Harbor Seal and the Northern Sea Otter. To see where these populations are located, first zoom (if necessary) to see the entire **Potential Impact** area. You may click on the related camera icons to the southwest of Ozette Island to see pictures of the Harbor Seal and the Northern Sea Otter, as well as links to more information about them.
- B. Now that you know what the animals look like, read paragraphs about them on the **Animal Population Descriptions** document.
- C. Take a look at the locations of the **Mammal Haul-outs** by turning on that layer. As with the bird colonies, the population numbers of animals can be found by clicking on a point. There are many more mammal haul-outs as compared with the Bird Colonies, and clicking on each point for information is time consuming. Unfortunately, only more advanced GIS programs can make this task simpler. So click through the haul-outs in the **Potential Impact Area** to determine which areas have the most seals (the Field ID in the pop-up table is called "COUNT").

- D. Next, take a look at areas where **Sea Otters** have been sighted. There is no population estimate here, but areas where they are sighted provide good habitat for them, so you can assume the areas near where they are sighted are important to them.
- E. Take some time to really look at the populations of harbor seals and the sea otter sighting locations. Be sure to look at places where mammal populations overlap with bird populations, as well as areas of high numbers for any of these four species that may not overlap. Also consider the sensitivity of the mammal species to oil spills (i.e., they can't fly away) when deciding the important areas to protect.

Make notes on your Working Map about the areas with higher populations or sightings of these two mammal species. Also make note of areas of overlap between the two species, as well as between all four mammal and bird species.

***You have now designated the areas of Critical Animal Populations to be protected.**

Task 6: Research the Equipment and Materials for Oil Spill Response.

A network of agencies, organizations and businesses with an interest in protecting Washington's coasts have pooled together their equipment for use during natural resource response process for this oil spill.

Read the documents titled **Oil Spill Response Option/Equipment** to learn more about the specialized equipment you can use to protect the coast from the oil spill.

and

Answer the related question in your *Coastal Oil Spill Response Plan* document.

You have access to the following equipment and materials:

Equipment or Materials	Quantities		Location(s)
Oil Containment Booms: For general containment or burning	50 ft Sections	100 ft sections	
	15	40	Port of Grays Harbor
	10	20	Coast Guard Station in Neah Bay
	15	30	Coast Guard Station in Port Angeles
Skimmers:	10	10	Westhaven Cove
	9 – various types		
		4	Port of Grays Harbor,
		1	LaPush
Dispersing Agents *22.5 gallons of dispersing agents can treat approximately 1 acre of oil-contaminated water. [There are 43,560 square ft in an acre. So, if a perfect square, it is 208.71 ft wide by 208.71 ft long.]		2	Coast Guard Station near Neah Bay Marina
	1500 gallons		
		750 gallons	Coast Guard Station near Neah Bay Marina
Boats:		750 gallon	Coast Guard Station in Port Angeles
	12 of various sizes:		
		4	Port of Grays Harbor
		2	Coast Guard Station in Neah Bay
		4	Coast Guard Station in Port Angeles
		1	LaPush
Airplanes: Military Single Engine “Tanker” (Can hold 800 gallons of liquid) Reconnaissance aircraft (For aerial observations/reports) Cessna Caravan single-prop aircraft (For transporting people and equipment)		1	William R. Fairchild Intl. Airport in Port Angeles
		2	Coast Guard Airstrip in Port Angeles
		4	1 - Quillayute Airport 1 - Forks Airport 1 - Seiku Airport
			1 - William R. Fairchild Intl. Airport in Port Angeles
Helicopters	3 standard helicopters		2 - Coast Guard Airstrip in Port Angeles
			1 – Quillayute Airport
Trucks and vans	Unlimited supply from partners.		Various locations throughout region.
*Assume you have enough paid personnel and volunteers to transport and distribute all equipment and materials.			

Task 7: Make Recommendations - Coastal Oil Spill Response Plan.

- A. Now that you know what equipment and materials are available to you for protecting the areas you have designated as **Sensitive Habitats** and **Critical Animal Populations**, you are ready to finalize your *Coastal Oil Spill Response Plan*.
- B. Look at your Working Map and your computer map in Google Earth to determine the **TOP THREE** areas that should be protected and the order in which they should be protected.

Keep in mind the following questions:

- Where do crucial habitat and populations of species to be protected overlap?
- Where are the greatest concentrations of species to be protected or sensitive habitats?

Number and create a name (for example, “Twin Creek Estuary Protection Zone”) for each of the three most important areas on your Working Map in order of importance – with 1 being the first area to protect.

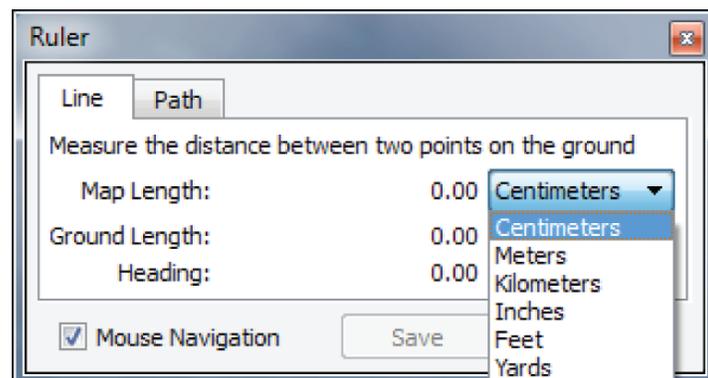
- C. Now you can determine the **Equipment and Materials** that should be used in each of those areas. The sizes of areas to be boomed, sprayed, and even skimmed can be determined using the **Ruler Tool**.

Click on the **Ruler Tool**. It will appear on your screen.



When using the **Ruler Tool** you first must determine the units you want to use for measurement (feet, meters, miles...). To change the units of measurement:

1. Click the dropdown arrow on the right side of the box.

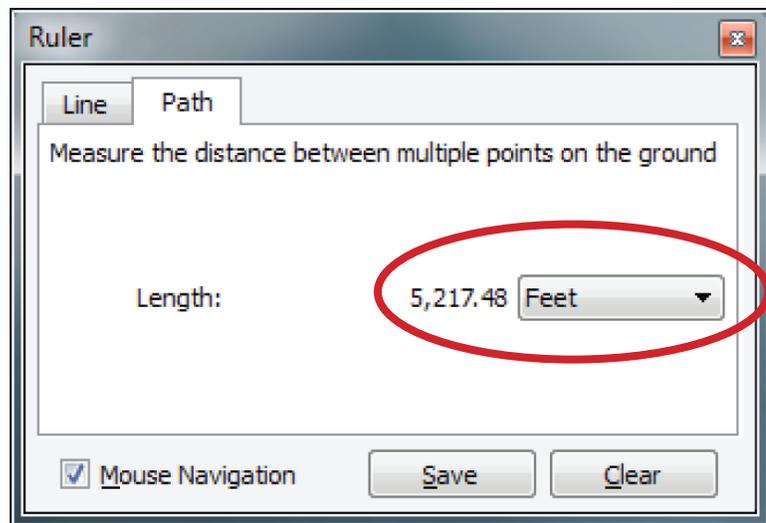


2. The measurement units can be changed as needed while you determine the size and distance of the areas you wish to protect (which units are most useful for this simulation?).
- D. You are now ready to measure an area.

To measure:

1. Zoom in on an area, as needed.
2. Click on the **Ruler Tool** in the toolbar. Select the Path tab in the Ruler box and make sure you have the appropriate units selected.
3. Place the crosshairs over the location where you want to begin your measurement. Click once and release the mouse button.
4. Move the mouse to a new point and click again. You will see a line form on your screen.
5. To create an enclosed area or a line with one or more bends in it, move the crosshairs, stop where you want the line to bend or turn, click once and move the mouse to the next bend or end of the line.

To end a line, double-click with the mouse when you have the crosshairs over the ending point. The total distance of the line(s) can be found in the box.



6. Be sure to write down your measurements on your Working Map and/or Coastal Oil Spill Response Plan.

Fill out your *Coastal Oil Spill Response Plan* document as you determine the numbers (and lengths or amounts if needed) of equipment and materials.

- E. You now have a list of equipment and materials. But, how are you going to get them to the **Areas to Be Protected**?

You need more layers to answer that question. Turn on and off the following as needed:

Layer Name	Description
Pedestrian/Vehicle Access Points	Areas where cars or people on foot can easily access the coast/shoreline.
Ports	A port is a location on the coast or shore with harbors where ships can dock, load, and unload.
Airports	Small-scale airports. The runways are not long enough to support very large aircraft.
Roads	The main roads in the area.
Tribal Reservations	These are areas for the 4 coastal treaty tribes: Hoh, Makah, Quileute, and Quinault Nations.

- F. Use the layers and GIS tools within Google Earth to help answer key questions for Task 7 on your *Coastal Oil Spill Response Plan* document and create your actual plan: the **Coastal Oil Spill Response Plan – Response Plan Recommendations Table**.

- G. If needed, **create a Response Plan Map** by using your Response Map if the working map is too difficult to read/understand (which it probably is, if you've been making good notes as you go along).

Once you have completed your *Coastal Oil Spill Response Plan*, you may exit from Google Earth. You may click **File** in the upper left and click **Exit**. When prompted to save, click "Discard."

****DO NOT SAVE CHANGES TO THE PROJECT FILE!*****

Student Page: Coastal Oil Spill Response Plan

Team Member Name(s):

Your team has been asked to develop a *Coastal Oil Spill Response Plan* that will protect Washington's coastline from the oil slick that will reach the coast within 72 hours. Use this document to answer project questions and develop your *Response Plan*.

Task 1: Find the location of the tanker off the west coast of Washington.

What is a point in GIS?

Task 2: Take a Closer Look at the Washington Coast

Notice that the two layers (Washington boundary and Olympic Peninsula Streams and Shorelines) don't match up along the coastline.

Why might there be a difference between the two layers?

- What is an advantage for using the "less accurate" (less detailed) layer?

- What is an advantage for using the "more accurate" (more detailed) layer?

What is the (approximate) longitude and latitude of the tanker?

Task 3: Observe the Predicted Trajectory (Path) of the Oil.

What is a polygon in GIS?

List the labeled areas/features that will be impacted in the first 72 hours of the oil spill:

Student Page: Coastal Oil Spill Response Plan

Why are oceanographic models (like the one that was used to create the trajectory polygons in this simulation) important?

Task 4: Locate Sensitive Habitats.

What is a benefit of being able to change the line width or color of a layer?

Why might it be important to protect the streams that empty into the potential spill area?

Why might the islands off the Washington Coast be important?

Task 5: Locate Critical Animal Populations.

What might be a reason the points/layers (bird and island) don't match up?

What is the population of:

- Common Murres at 124.735°W, 48.1343°N?
- Tufted Puffins at 124.6855°W, 47.9313°N?
- Harbor Seals at 124.6851°W, 48.0204°N?

How many different areas have you designated on your map as having **Critical Animal Populations** to be protected?

Task 6: Research and Determine Equipment and Materials for Oil Spill Response.

*Note: Weather can influence the type of equipment chosen for oil spill response. Frequently storms create strong winds and high waves. *For this simulation, the weather is mild with calm seas (there are still waves, but not high seas).* Weather assumptions: Winds at 5mph, partly cloudy, slight chance of showers.

What type(s) of equipment might not be effective for oil spill response during a strong storm?

Student Page: Coastal Oil Spill Response Plan**Task 7: Make Recommendations**

Take a closer look at your map. As you determine the **TOP THREE- Areas to be Protected**, keep in mind the following questions

Where do crucial habitat and populations of species to be protected overlap?

Where are the greatest concentrations of species to be protected?

Use your map to answer the following questions **FOR ONLY THE FIRST AREA TO BE PROTECTED**.

- A. What is the name/code for the first **Area to be Protected**?
- B. Why was this area chosen to be the first area to protect?
- C. What is the distance between the first **Area to be Protected** and the closest port?
- D. What is the distance between the first **Area to be Protected** and the closest airfield?
- E. What is the distance between the first **Area to be Protected** and the last **Area to be Protected**?

Then fill out the **Coastal Oil Spill Response Plan Recommendation Table** on the next page for **ALL THREE- Areas to be Protected**.

Coastal Oil Spill Response Plan – Response Plan Recommendations Table				
Area to be Protected (Write the name or code you gave it on your map)	Total Length or Perimeter Measurement (for Booms, Dispersants...)	Type of Equipment or Materials Needed or Protecting Area	Number or Amount of Equipment or Materials Needed	Method of Transport and Original Location (Include name of port, airfield, road type, etc.)

Student Page: Potential Impact Area Working Map



Student Page: Oil Spill Response Map



Oil Spill Simulation – Animal Descriptions

Common Murre

Source: <http://birds.audubon.org/species/commur>

Tufted Puffin

Source: <http://birds.audubon.org/species/tufpuf>

Northern Sea Otter

Sources: www.montereybayaquarium.org/cr/cr_sorac/sorac_risk.aspx
www.vanaqua.org/education/aquafacts/seaotters.html

Harbor Seal

Sources: www.wdfw.wa.gov/wildwatch/sealcam/

Sources for Oil Spill Recovery Options/Equipment:

www.ceoe.udel.edu/oilspill/cleanup.html

<http://science.howstuffworks.com/environmental/green-science/cleaning-oil-spill.htm>

[http://archive.orr.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id\(entry_subtopic_topic\)=225&subtopic_id\(entry_subtopic_topic\)=8&topic_id\(entry_subtopic_topic\)=1](http://archive.orr.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id(entry_subtopic_topic)=225&subtopic_id(entry_subtopic_topic)=8&topic_id(entry_subtopic_topic)=1)

[http://archive.orr.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id\(entry_subtopic_topic\)=226&subtopic_id\(entry_subtopic_topic\)=8&topic_id\(entry_subtopic_topic\)=1](http://archive.orr.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id(entry_subtopic_topic)=226&subtopic_id(entry_subtopic_topic)=8&topic_id(entry_subtopic_topic)=1)

www.epa.gov/emergencies/content/learning/oiltech.htm

Sources and Resources

NOAA's Office of Response and Restoration – This is a very valuable site with a wealth of resources. The Oil Spills: A Guided Tour provides a good summary.

[http://archive.orr.noaa.gov/topic_subtopic.php?RECORD_KEY%28subtopics%29=subtopic_id&subtopic_id\(subtopics\)=8](http://archive.orr.noaa.gov/topic_subtopic.php?RECORD_KEY%28subtopics%29=subtopic_id&subtopic_id(subtopics)=8)

International Tanker Owners Pollution Federation Limited

www.itopf.com/

Document: Shoreline Assessment and Environmental Impacts from the M/T Westchester Oil Spill in the Mississippi River.

www.epa.gov/OEM/docs/oil/fss/fss02/michelpaper.pdf

A company website that describes different technologies utilized during oil spill recovery.

www.mavideniz.com.tr/product/product.html

A great site for educators is at:

http://serc.carleton.edu/sp/library/google_earth/index.html

The shipwreck icon used for this simulation is an official US Government map icon for an active shipwreck incident. Other federal incident icons can be found online at this link.

www.fgdc.gov/HSWG/ref_pages/Incidents_ref.htm

SECTION FOUR Part 3: ArcGIS Explorer Online Instructions

Learning Objectives:

As a result of the ArcGIS Explorer Online lesson students will be able to

1. Create a Map
2. Make a Slide Presentation
3. Upload Field Investigation Data

Overview

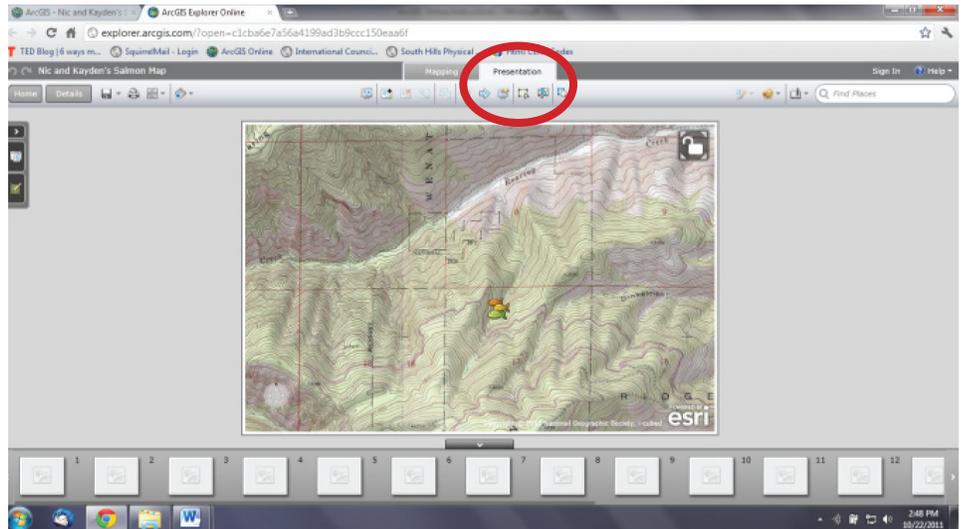
ArcGIS Online has made creating maps very easy. You will learn how to watch a slide presentation online, create your own map and slide presentation, then

1. Watch 3 slide presentations online
2. Make a map and then a “slide presentation” that can be viewed by the public, or selected groups such as schools, project funders, or parents using online GIS software
3. Upload data from the NatureMapping spreadsheets or NatureTracker data to view on your map.

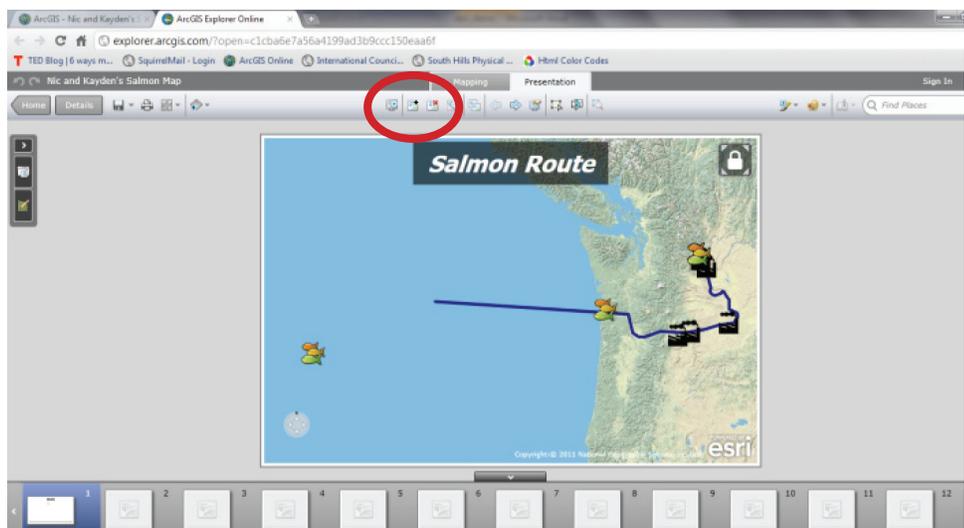
Watch a Slide Presentation and Make Your Own

1. You need “Silverlight” on your computer. You can download this for free from Microsoft.
2. www.arcgis.com/explorer/ - Bookmark this page
3. In the upper corner “Find Maps and Groups” type in the names on the maps below. There are two maps created by 3rd graders studying the migration of salmon and their life cycle.
 - a. Nic and Kayden’s Salmon Map (search “Nic and Kayden”)
 - b. Gannon, Riley, Joclyn Salmon Map (search “Gannon, Riley, Joclyn”)

4. The following is Nic and Kayden's map. Click on the Presentation button



5. Click on the Start Presentation button to see the slideshow.



Note: You can select full-screen mode to watch the slide show.

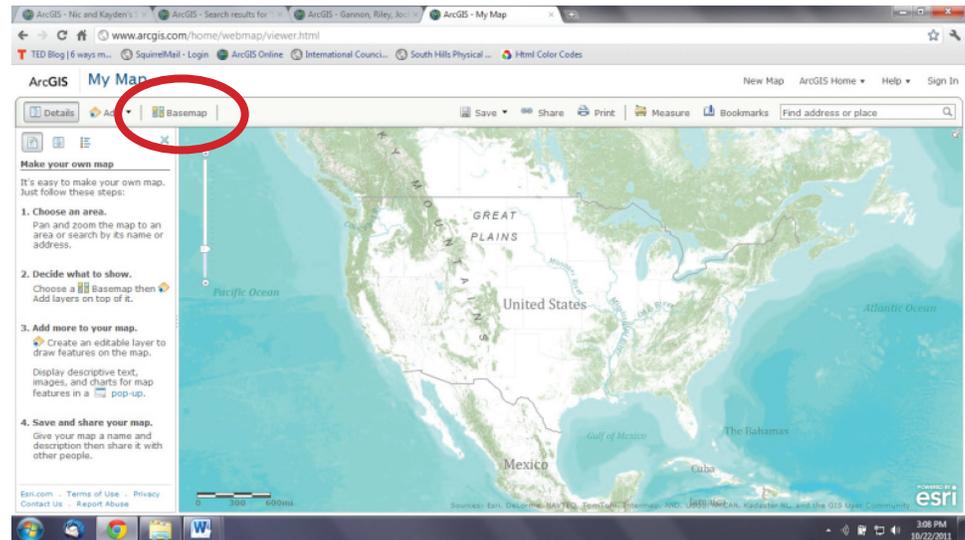
Press the spacebar to advance the slides

Pause between them – it may take a while for the photos to come on the screen.

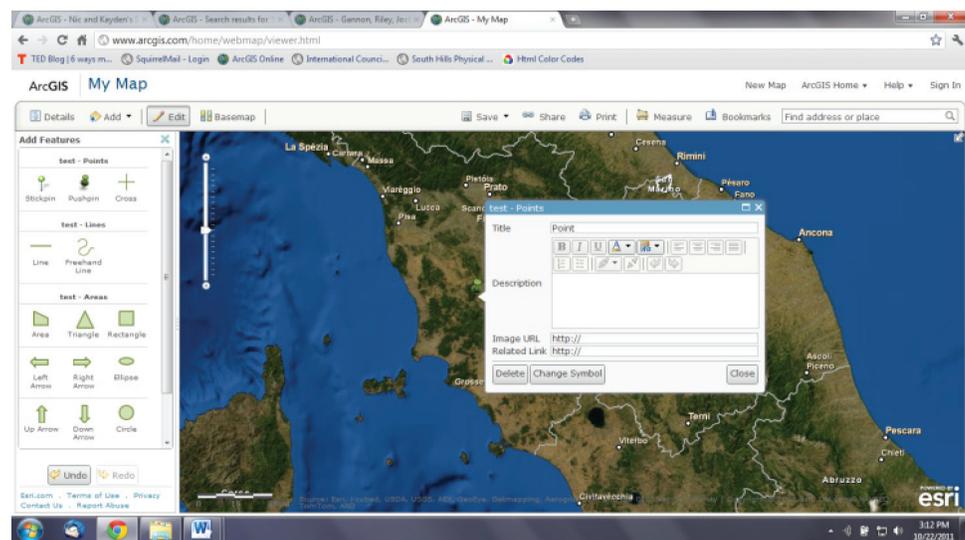
6. Notice the lines drawn and distance measured by the students.
7. After reviewing the 2 salmon map presentations, click on the Home button on the left side of the screen.
8. Search for Seattle Aquarium.
9. Start the presentation using the same instructions.
10. In this presentation, you are given some example of what a school or group of schools can do to develop a map.

Make Your Own Map and Slide Presentation

1. You must sign in and create a password. You can save the map as public (for the world to see) or just for a group.
2. Start at the beginning: www.arcgis.com/explorer/ and scroll down to Make A Map



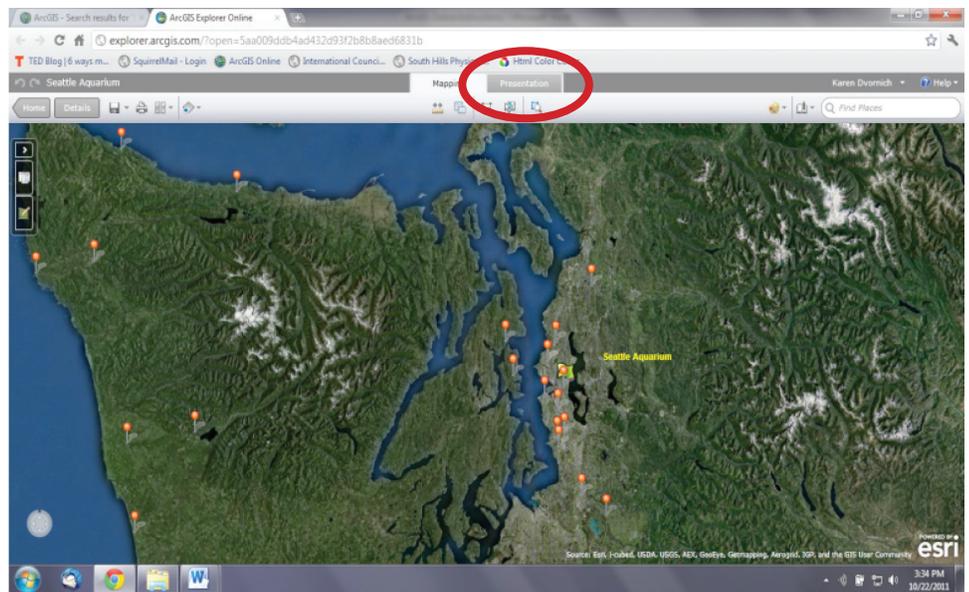
3. Click on the Basemap option to see all the different types of maps you can use.
4. There are instructions on the left side of the screen.
5. Add an Editable Layer and give it a name
6. Select a Push pin and a location on the screen and you will be given options



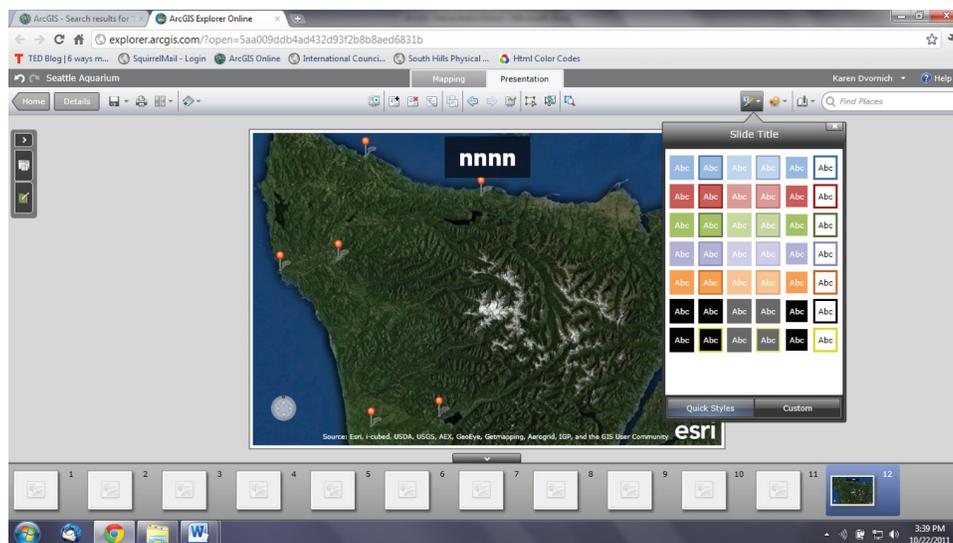
7. You can put in the name of your school, type in the description, add a picture and a link to your school's website.
8. Open another Internet window and go to your school's website.
9. Copy the url and paste it into the pop-up box "link to url" line.
 - a. If you don't have a school website, NatureMapping can help by creating a school page to link to and put pictures you want to display in the pop-up there too.
10. Select a picture from your school website (right click) and copy the picture location and paste in the pop-up window.
11. Add monitoring sites
12. Save your map.

Create a Slide Presentation

1. Once your map is saved you can select Presentation to create slides.



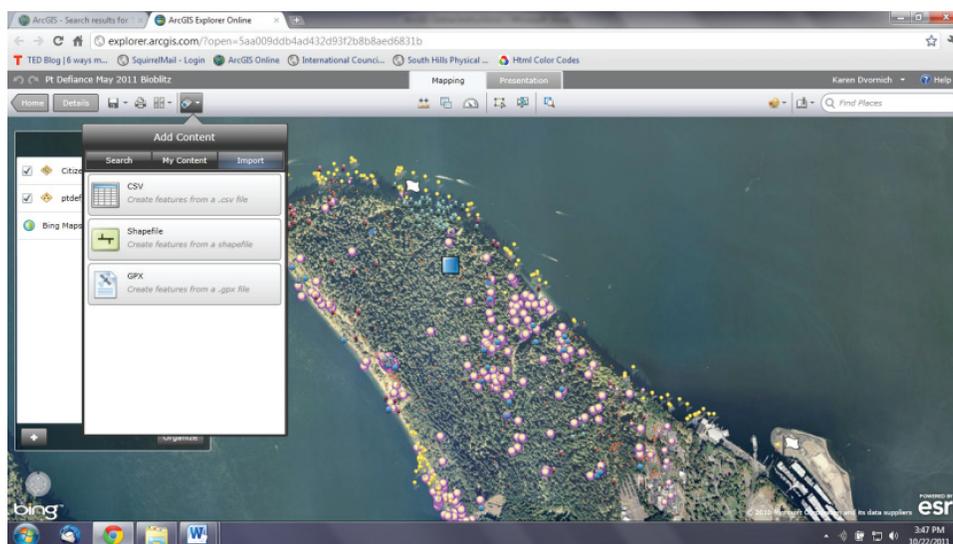
2. Learn about the icons by slowly moving your mouse over them.
3. Select New Slide
4. It will prompt you to add a title
5. You can format the slide title



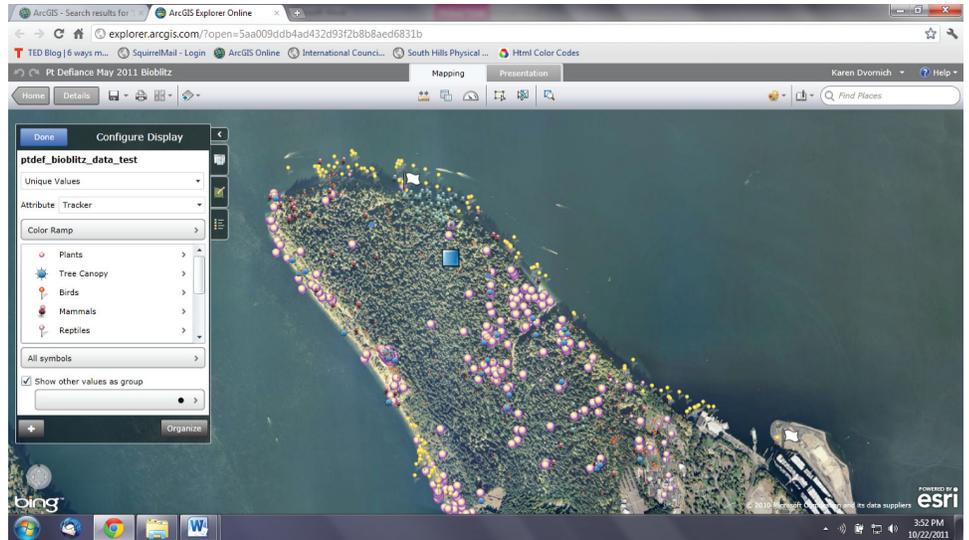
6. Remember to save your map.

Upload Field Investigation Data

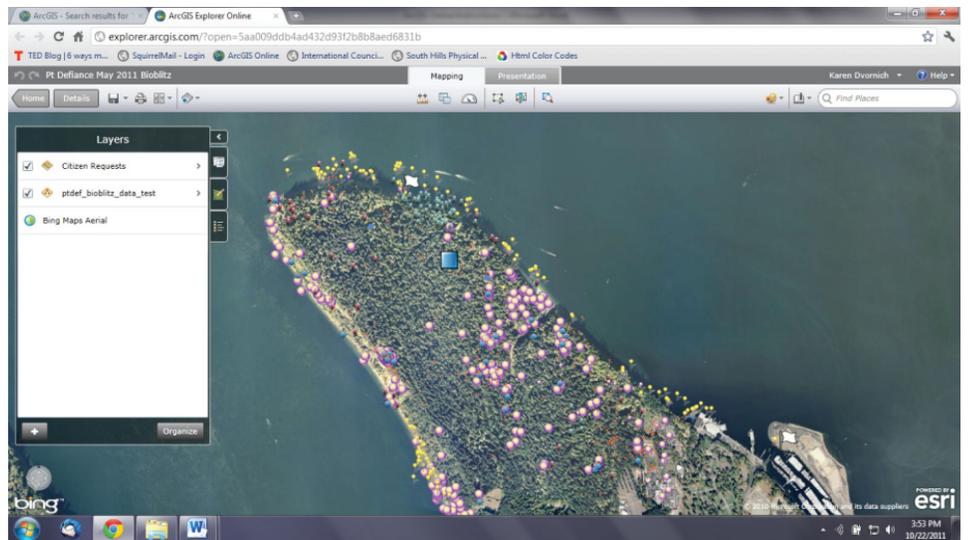
1. This is an example of data collected at a bioblitz at Pt. Defiance Park in May, 2011. The data was collected using NatureTracker software and exported as a .csv file.



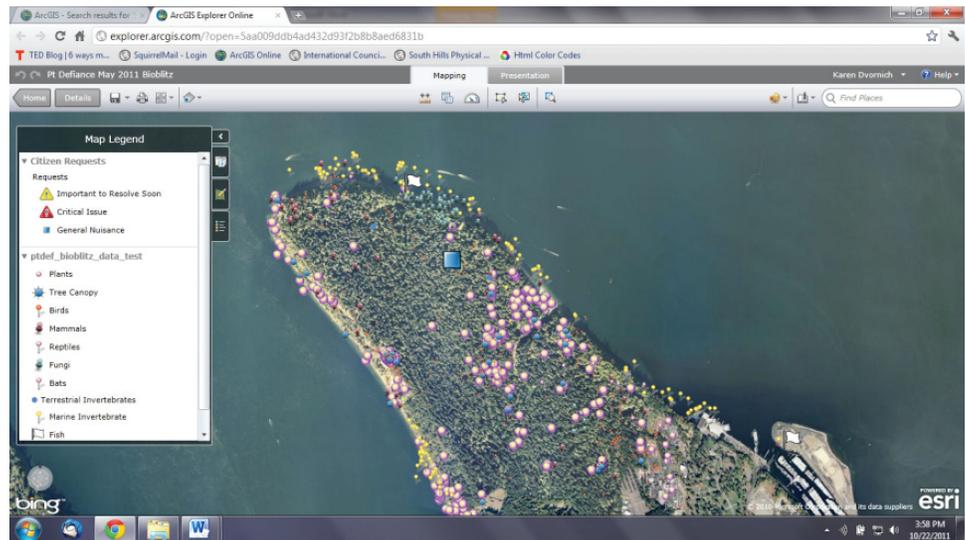
2. Adding Contents – using the .csv option brought up the points.
3. The different taxonomic groups are illustrated as different colors/shapes.



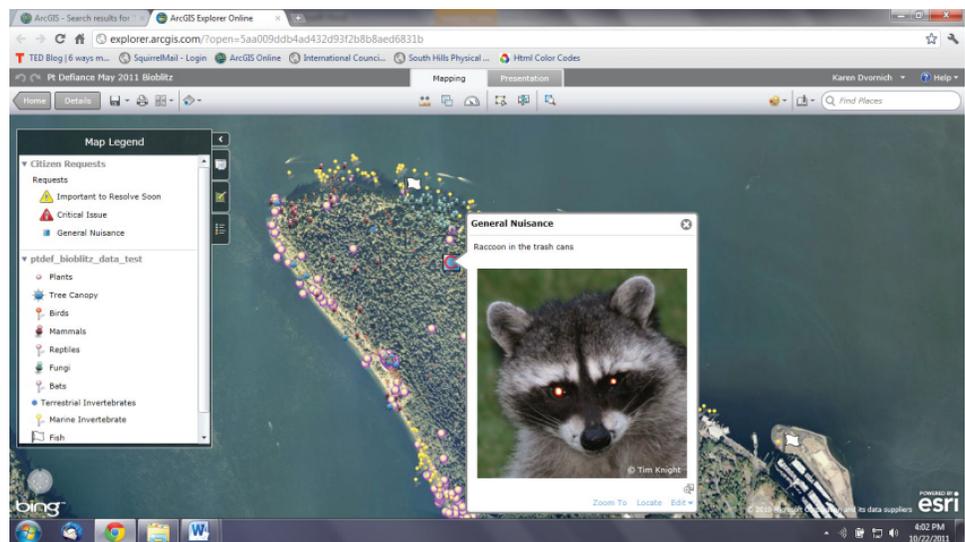
4. Clicking on the > to the right of the name allows you to change the colors, etc.



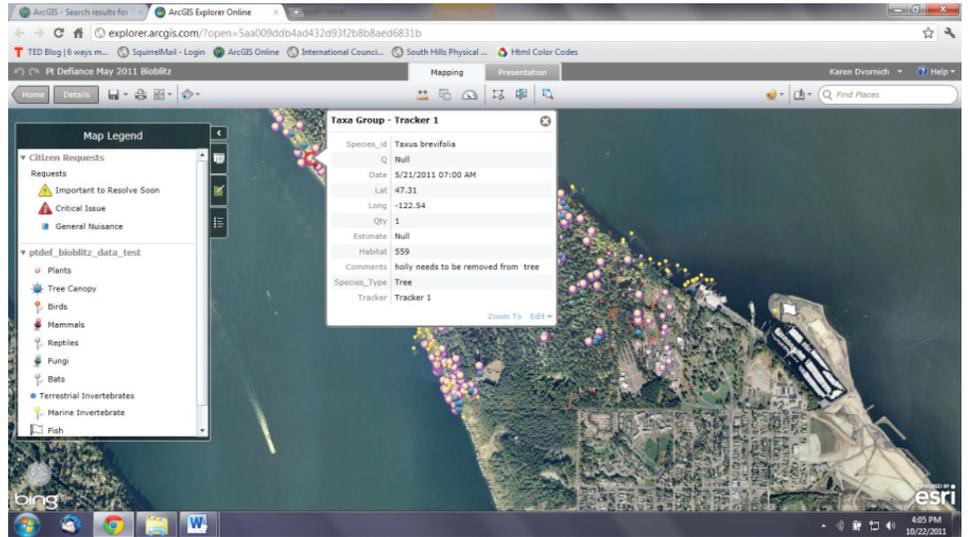
5. Save the file – do this frequently.
6. The small tabs on the right of the of “Layers” allows you to see the Legend



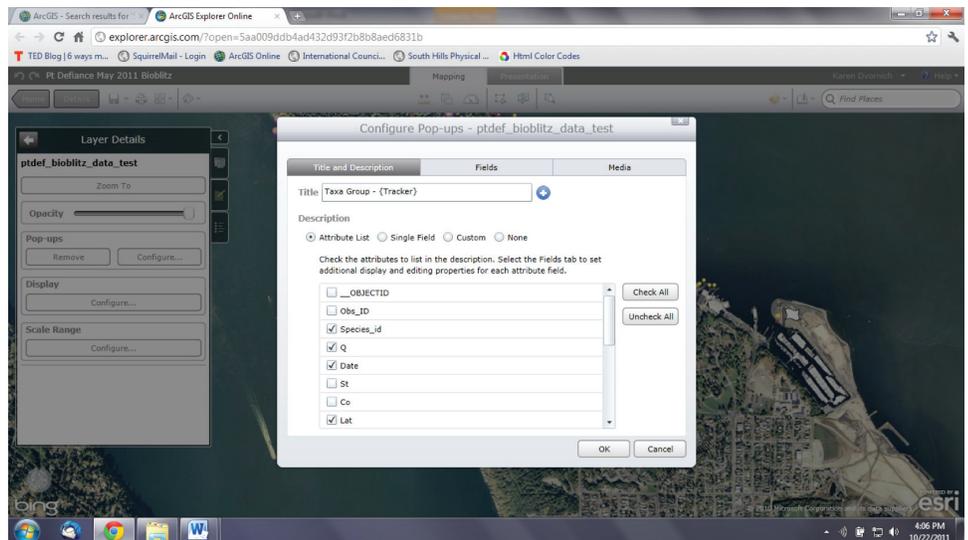
7. Citizen Requests can be selected by Adding Features. The blue box is an example of an added point – not part of the bioblitz data.



8. You can select what attributes of the data points you want to show on the popup.



9. By changing the Popup Configuration



Save your map!!

Bibliography:

- Association for Supervision and Curriculum Development (ASCD). 2010. Curriculum 21: Essential Education for a Changing World. Edited by Heidi Hayes Jacobs. ASCD, Alexandria, VA.
- Edutopia. 2006. NatureMapping Takes Kids -- and Technology -- Outside and into Active Learning. <http://www.edutopia.org/naturemapping>
- Glenrose Watershed Gazette. 2000. Chase Middle School NatureMapping Students. Vol.3. No. 1. <http://naturemappingfoundation.org/natmap/publications/glenrose/2000/>
- National Research Council (NRC). 2006. Learning to think spatially: GIS as a support system in the K-12 curriculum. National Academy of Sciences, Washington, D.C..
- International Technology Education Association (ITEA). 2007. Standards for Technological Literacy: Content for the Study of Technology. Third Edition. ITEA Reston, VA.
- International Society for Technology in Education (ISTE). 2008. National Educational Technology Standards and Performance Indicators for Students. ISTE Eugene, OR
- Malone, L., Palmer, A., Voigt, C., Napoleon, E., and Feaster, L. 2005. Mapping Our World: GIS Lessons for Educators. ArcGIS Desktop Edition. ESRI Press, Redlands, CA.
- Moursund, D. 1999. Project-Based Learning Using Information Technology. International society for Technology in Education, Eugene, OR.
- National Research Council (NRC). 2011. A Framework for K-12 Science Education: Practices, Crosscutting concepts, and Core Ideas. Washington, D.C: National Academies Press.
- Papritz, M., Tudor, M., E. Baker., and L. Ferguson. 2011. Landscape Investigation Guidelines: Challenging K-12 Students to Engage in Social Science Inquiry by Applying Spatial Thinking to Real World Situations. Pacific Education Institute and Association of Fish (www.pacificeducationinstitute.org) and Wildlife Agencies (www.fishwildlife.org)
- Ryken, A., Otto, P., Pritchard, K., and K. Owens. 2007. Field Investigation: Using Outdoor Environments to Foster Student Learning of Scientific Processes. Pacific Education Institute and Association (www.pacificeducationinstitute.org) of Fish and Wildlife Agencies (www.fishwildlife.org)
- 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.

Appendix A:

Case Study: Waterville School District – Washington State

Waterville Elementary School has shown how students and local community members can provide new and important data about one species; its habitat use, food preference, distribution, and life history information. Teacher, Diane Petersen has incorporated this project for the past 12 years into her 4th grade curriculum.

- Students are expected to become Pigmy Short-horned lizard (aka Horny toad) and ArcView experts in the 4th grade, and they take their responsibility seriously.
- They apply for the coveted annual conferences that take them around the country.
- They share their technical skills with other teachers/students in the school.
- They have attended public meetings with their parents and voiced s, for example, on the impact of wind farms in the lizard's range.

In other words, the study of one species integrates science, technology, math, social studies, art, writing, reading, and involves students with members of their community.

Because of GIS integration into the classroom, Diane has taken the study of one species to a professional level, where the data :

1. Incorporating all aspects of data collection and various forms of analysis:
 - a. Entering data into Excel spreadsheets
 - b. Graphing – from simple bar graphs to sophisticated comparative 3-variable graphing when multiple years of data were available
 - c. Power point for the website, presentations, and posters of their work
 - d. ArcView GIS to augment points on paper maps, creating maps for their farmers, and to answer questions about Horny toad distribution
 - e. Using ArcGIS Online for other subjects, such as history
2. Gathering new information and sharing it with a variety of professionals:

Wildlife Professionals poster and presentations (Annual Wildlife Society National Meeting; Pacific Northwest Herpetological Society; Wildlife seminar at the University of Washington; Washington Biodiversity Council Conference)

 - a. Educators and Policy Makers (Washington Association of Principals; National Forum on Education Policy; National Parks' River Mile Symposium; George Lucas Education Foundation – online video)
 - b. GIS professionals (2005 ESRI User's Conference Plenary Session; NW GIS Users Meeting; 2010 WAURISA annual conference)
 - c. Community and Funders (Washington Conservation District's Annual Meeting; Waterville Historic Society Meeting; Waterville City Council; Douglas County Commissioners)

One school, with the leadership of a 4th grade teacher over the past 12 years has involved 190 students, their parents, and community members presented at 20 state and national conferences and meetings.

Appendix B: Survey results of Natural Resource Professionals

Survey of Use of Technology by Fish and Wildlife Professionals, July 2011

In a Survey conducted by the North American Conservation Education Strategy, in Spring 2011 (15th of July 2011), 641 agency personnel from 23 states responded.

1. What is your position? 77.8% (499) Agency Biologists, 4.1% (26) Conservation Educators, 1.4% (9) Hunter/Outdoor Skills Educators, 107 (16.6%) Other

Wildlife Technician	Wildlife Area Manager
Wildlife Field Technician	Fish Program Manager
Agency Technician	Fish Hatchery Manager/Superintendent
Hatchery Technician	Conservation Officer
Fish Passage Technician	Wildlife Biologist
Statistician	Lands and Facilitators Manager
Contaminants biologist	Program Planner
Agency Ecologist	Conservation Officer
Disease Manager	Fisheries Technician
GIS Specialist/Cartographer & Crime Analyst	Fish Culturalist
Wildlife Administrator	Information & Education Chief
Natural Resource Technician	Federal Assistance Coordinator
Wildlife Research	Hunter/Outdoor Skills Educator
Agency Researcher	Conservation Educator

2. What state do you work in? Twenty three states responded.

3. What technological tools do you use most often in the field?

The respondents (88%) indicated that they use GPS units and digital cameras most often in the field (430). To a lesser extent, respondents used radio telemetry (25% or 124), tools for observing aquatic life and habitat (24% or 115) and trail cameras (22% or 109). In the other categories, biologists cited the following technological tools:

General Technology	Aquatic Studies	Forestry Studies	Fish Studies	Wildlife Habitat Studies
GPS Units	Colorimeter	hypometer	Gill nets	Measuring tape
Compass	DO meter	clinometer	Hoop nets	Motion cameras
Cell phones	Underwater cameras		Sonar fish finders	Radio telemetry
Lap top computers	ADCP flow meters		Seine	Weigh scales
Digital Cameras	pH pen		Minnow traps	Radio collars
Aerial photos	Water temperature loggers		Electrofishing equipment	Binoculars/ Monoculars
Range finders	Depth finders		Sampling gear	iPhone for animal ID, mapping,
GIS Mapping	YSI Water quality meter (DO, Salinity, Temp)		Passive Integrated Transponder (PIT) scanner	GPS
Radio telemetry			Anemometer	Spotting scopes/ Night goggles
Ultrasonic telemetry				Hypsometer
Motion cameras				Clinometer
Weather monitoring equipment				Acoustic bat detectors

4. Is there an emerging technology that you are looking forward to using?

Over a third of the respondents indicated that emerging technologies they hoped to use were: Greatest interest was expressed for a smart phone or tablet computer (iPad) style mobile unit equipped with digital functions like GPS, Google Earth, Terrain Navigator, camera, phone and data recorder for electronic data collection in the field, making it possible to map and plot information in the field. Respondents wanted portable laptops big enough to read taxonomic keys, to hold useful illustrations, playback bird songs, compass installed, and collect and download observations directly into conservation databases. Respondents specified touch pad computers for collecting field data, that has GPS installed and can run mapping software such as Arc Pad. In addition, they preferred realtime PDA uploads from the field into centralized databases.

Terrestrial: Respondent expressed a need for remote monitoring of animal movements for small and large species over longer time periods, through further advancements in satellite/GPS technology and automation of field-related work. Respondents specified the following:

- Remote aerial imaging, specifically in the infrared spectrum: for example thermal infrared scopes, infrared cameras for aerial surveys.
- Howl boxes for wolf deterrent, trail cameras to monitor wildlife trends

- Satellite imagery to identify mammal etc activity (beaver) Lytro Cameras – better ability to capture wildlife in photography.
- GPS collars that transmit locations via SIM cards. Iridium satellite technology to track animals in real time and adapt studies by reprogramming collars already deployed on animals.
- PDA's for data entry.
- Use of CyberTracker or other spatial data incorporated into traditional annual wildlife surveys to allow density measures and regional association with weather and habitat.
- Smaller longer lasting telemetry equipment.
- Affordable GPS enabled digital cameras.
- Satellite telemetry small enough for bats, and software to analyze bat calls.
- GPS linked to GIS platform for tracking aerial surveys and recording big game survey data electronically.
- Acoustic detectors that can be run for months on solar setups, and requiring less maintenance.

Aquatic: Respondents expressed a need for the following:

- Advanced 2D & 3D hydrologic models to help biologists plan for changes in aquatic habitat.
- QR codes phone apps for anglers to access site specific fisheries information
- Side-scan sonar to allow for digital viewing and image capture of underwater habitat features.
- Non-invasive genetic analysis (to determine species presence by genetic material in water).
- Field data loggers for entering fish sampling data that also have GPS capabilities.
- Hydro acoustic mapping and biomass assessments.

General: Respondents expressed interest in the following:

- Unmanned Aerial Vehicles (UAV'S) to map the extent of existing conditions (e.g. vegetation type and cover)
- GPS units with integrated GIS and database entry/capture to streamline field data collection
- GPS enabled cameras or smart phones (iPhone, Android)
- Digital data recorders, GIS on smartphones, using iPads in the field for data collection and maps(aerial surveys) with a GPS showing location on that map – reducing need for paper maps
- Use of trail cameras to monitor wildlife trends; critter cams to identify critical habitats not captured through traditional radio-telemetry
- Satellite imagery to identify beaver activity and estimate population
- Customized phone apps that allow people using state wildlife areas to learn about agency properties
- Apps on iPhones to identify flora and fauna and for data entry

5. What websites or web-based resources prepare you to go into the field (e.g. eNature website, ID tools, Google Earth, ESRI Online)?

The websites or web-based resources 384 respondents used to prepare to go into the field overwhelmingly include Google Earth.

Fifty percent (50%) of all respondents indicated that they used Google Earth. The Environmental Systems Research Institute's ArcGIS and ESRI online are pervasive. Federal Government websites used included NOAA for tides, USGS real time weather data, USGS Waterwatch & Surface Flow Data, NRCS soil maps, USDA's plants database.

6. If you were to give a student one technology tool to get them engaged in field science and the outdoors, what would it be? Why?

Respondents (392) suggested that students would be engaged by using the following technologies:

- Binoculars & field guides, digital cameras
- Trail cameras as a non-intrusive device for observing animals
- Combination of a GPS data collection unit with Google Earth and training on ArcMap to get people excited
- Birding smartphone

7. Does your Agency website offer data that teachers and students can access for use in the classroom?

Regarding agency websites, 41% or 198 respondents indicated that their agency website offers data that teachers and students can access for use in the classroom.

Some examples are:

- Camcorders of species (Falcon, eagle, shad)
- Summary fisheries and wildlife data,
- Fact sheets,
- GIS data downloadable from website
- WildlifeMapping citizen science data
- Fish and wildlife harvest data
- Interactive mapping with fish ID, habitats, places to fish
- Interactive maps for hunting planning.

8. Do you use Apps for a Smartphone in the field or to assist your work?

Only 11% or 56 respondents listed apps they use for a smartphone in the field or at work.

Some examples are: Evernote- tags each photo or recording with time and location data, Audubon Owls, iBird Explorer and iBird PRO, Accue Weather, Google Earth, NatureTracker, GaiaGps, what.bird.com

Appendix C:

International Standards for Technology Education - National Educational Technology Standards (ISTE, 2008)



1. Facilitate and Inspire Student Learning and Creativity

Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments. Teachers:

- a. promote, support, and model creative and innovative thinking and inventiveness.
- b. engage students in exploring real-world issues and solving authentic problems using digital tools and resources.
- c. promote student reflection using collaborative tools to reveal and clarify students' conceptual understanding and thinking, planning, and creative processes.
- d. model collaborative knowledge construction by engaging in learning with students, colleagues, and others in face-to-face and virtual environments.

2. Design and Develop Digital-Age Learning Experiences and Assessments

Teachers design, develop, and evaluate authentic learning experiences and assessment incorporating contemporary tools and resources to maximize content learning in context and to develop the knowledge, skills, and attitudes identified in the NETS•S. Teachers:

- a. design or adapt relevant learning experiences that incorporate digital tools and resources to promote student learning and creativity.
- b. develop technology-enriched learning environments that enable all students to pursue their individual curiosities and become active participants in setting their own educational goals, managing their own learning, and assessing their own progress.
- c. customize and personalize learning activities to address students' diverse learning styles, working strategies, and abilities using digital tools and resources.
- d. provide students with multiple and varied formative and summative assessments aligned with content and technology standards and use resulting data to inform learning and teaching.

3. Model Digital-Age Work and Learning

Teachers exhibit knowledge, skills, and work processes representative of an innovative professional in a global and digital society. Teachers:

- a. demonstrate fluency in technology systems and the transfer of current knowledge to new technologies and situations.
- b. collaborate with students, peers, parents, and community members using digital tools and resources to support student success and innovation.

- c. communicate relevant information and ideas effectively to students, parents, and peers using a variety of digital-age media and formats.
- d. model and facilitate effective use of current and emerging digital tools to locate, analyze, evaluate, and use information resources to support research and learning.

4. Promote and Model Digital Citizenship and Responsibility

Teachers understand local and global societal issues and responsibilities in an evolving digital culture and exhibit legal and ethical behavior in their professional practices. Teachers:

- a. advocate, model, and teach safe, legal, and ethical use of digital information and technology, including respect for copyright, intellectual property, and the appropriate documentation of sources.
- b. address the diverse needs of all learners by using learner-centered strategies providing equitable access to appropriate digital tools and resources.
- c. promote and model digital etiquette and responsible social interactions related to the use of technology and information.
- d. develop and model cultural understanding and global awareness by engaging with colleagues and students of other cultures using digital-age communication and collaboration tools.

5. Engage in Professional Growth and Leadership

Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources. Teachers:

- a. participate in local and global learning communities to explore creative applications of technology to improve student learning.
- b. exhibit leadership by demonstrating a vision of technology infusion, participating in shared decision making and community building, and developing the leadership and technology skills of others.
- c. evaluate and reflect on current research and professional practice on a regular basis to make effective use of existing and emerging digital tools and resources in support of student learning.
- d. contribute to the effectiveness, vitality, and self-renewal of the teaching profession and of their school and community.



November 27

It's early. Like, birds-aren't-even-chirping-yet early. But the way the grass crunches under my feet in this frost almost makes 7 a.m. bearable.

Using the GPS device to tell our group we're exactly 2,912 ft. above sea level definitely makes it worth it. We hike north with our instructor - I announce our exact longitude and latitude - into deep forest. Signs are all around us. Signs, the instructor says, of cougars. We all laugh nervously. Everyone works together.

We collect evidence - cougar evidence - that we'll use in our classroom labs over the next few weeks.

We're not only learning how cougars hunt and live and survive, but we're actually using math and science to figure it all out.

Best of all, my work could actually help make a difference for the cougars.