



### PROJECT HIGHLIGHTS

- Trimble GPS solutions and ESRI GIS software help two U.S. agencies combat invasive weed infestations
- Rugged Trimble GeoXT handheld computer ideal for airborne, aquatic and land data collection
- Efficient use of GPS and GIS technology saves time and money while providing a high accuracy database for developing and implementing an effective weed treatment plan

### PROJECT: Innovative Uses of GPS and GIS Technology for Invasive Weed Management

**PROJECT DATE:** May 2009

#### INTRODUCTION

The control of non-native invasive weeds is of great concern in current ecosystem management. These invaders are recognized by scientists and land managers as one of the primary causes of biodiversity loss as well as a critical threat to local ecosystem processes and plant community structure and composition.

Studies estimate invasive species cost the U.S. economy \$138 billion annually and \$4 to \$6 trillion globally. Invasive species are a principle factor in the listing of about 42 percent of species protected by the U.S. Endangered Species Act and cause the loss of more biological diversity than any factor other than habitat loss. Increased global trade and travel are significantly increasing the rate at which new species are intentionally and unintentionally introduced around the world.

As invasive weeds become established more rapidly in new areas, economic and environmental impacts will increase, and only through the use of innovative techniques can organizations manage this problem. This case study highlights two organizations that have successfully deployed GPS data collection and GIS mapping techniques to identify the presence and concentration of invasive weeds and to develop plans to combat these thorny foes.

#### Bonner County, Idaho Public Works Department

This northern Idaho County faces a severe threat from the noxious aquatic weed Eurasian Milfoil. Biologists believe that the weed was introduced to the United States during World War II when milfoil fragments were pumped into the ballast systems of navy ships. Once the ships returned to the U.S., the infected water was inadvertently discharged to make room for new supplies. Since that time,

Eurasian Milfoil has rapidly spread across the country from fragments left on boat trailers, moving from infested lakes to other bodies of water. This weed is thought to be particularly dangerous because it rapidly replaces native aquatic vegetation, harming local wildlife and fisheries. The dense weeds can grow up to one foot (30 centimeters) per week on the lake bottom, creating a high-risk environment for boaters and swimmers that impacts recreational usage and tourism.

The effects of Eurasian Milfoil encroachment was being severely felt at Lake Pend Oreille, a lake and river system located in Bonner County. This plant rapidly replaces native aquatic vegetation and the wildlife and fisheries causing severe degradation of water quality and habitat. The dense weed mats choke marinas and swimming beaches keeping tourists away and hurting the recreational economy of the area. Faced with this growing problem, local citizens called for the County to address the situation. Bonner County's Public Works Department hired aquatic weed control expert Aquatechnex to perform a combination of boat and aerial surveys to get a better idea of the exact extent of the infestations present and then develop a comprehensive treatment plan.

**Data Collection.** For the initial mapping of Lake Pend Oreille, Aquatechnex collected aerial photography, flying nearly 100 miles (161 kilometers) of shoreline to establish an accurate basemap. The aircraft was equipped with a Trimble® GeoXT™ handheld computer with integrated Global Positioning System (GPS) capabilities and a Nikon D70 Camera. The combination of these two systems turns the Nikon into a GPS camera, collecting an aerial image and a GPS location and linking the photograph to that GPS location. Flight protocols were designed and implemented to maximize water penetration and Aquatechnex



collected a seamless stream of images with a 30 percent overlap that covered the entire area of interest. The Aquatechnex team opted to use Trimble equipment because of their familiarity with the GeoXT handhelds, which they use for several client weed management projects, as well as its ruggedness and all-day battery life. The team was able to capture the precise flight line of the aircraft by automatically logging GPS data points every five seconds using Trimble TerraSync™ data collection software.

Geospatial Expert's GPS-Photo Link software then linked these GPS data points with the nearly 400 aerial photos collected during the flyover and dropped them into the ArcGIS project file exactly where they were collected along the flight line. These images are then available in ArcGIS as a "hot link" and can be viewed by clicking on an image point of the planes' flight line. Aquatechnex also used Trimble GPS Pathfinder® Office software to process the differential GPS corrections and to export the data to ESRI ArcPad GIS software for use of the resulting basemap in the field. This data gave the field team a more complete picture of the lake area and a comprehensive understanding of the location of the noxious weed. This innovative aerial mapping approach allowed the Aquatechnex team to survey, analyze, and report on nearly 100 miles (161 kilometers) of shoreline in only five days, saving the County tens of thousands of dollars over conventional mapping techniques.

"Anytime you're faced with a weed management issue and you're working on the water there are no reference points," said Terry McNabb, an aquatic biologist and owner of Aquatechnex. "That's why we had to develop an aerial shoreline analysis model using remote sensing, GPS, and GIS mapping technologies from Trimble and ESRI. It's really a highly accurate and

cost-effective way to map a sizeable weed infestation like this," said McNabb. "With the GeoXT handhelds, together with digital imagery, we were able to complete a very accurate survey for approximately \$6,000, in contrast to conventional aerial mapping and field methods which would have cost up to \$60,000."

Through this extensive yet efficient mapping process, Aquatechnex determined that approximately 4,000 acres (1,618 hectares) of the Lake Pend Oreille system was infested with Eurasian Milfoil, and was able to identify more than 100 specific locations of infestation from analyzing the aerial photos.

The next step in the project was to validate these findings by boat, using GPS to navigate to each of the locations where aquatic plant beds were observed and recorded. "The boat team accessed a data dictionary on the Trimble GeoXT handhelds to record and map the precise location of Milfoil beds and to accurately classify the presence of Milfoil at each location as "dense", "moderate/mixed", or "sparse." The team established an ESRI ArcGIS project file for the mission with a Geodatabase set up for weed mapping. Using the mapping software, they created polygons of probable Eurasian Milfoil beds and all aquatic plant communities that were visible in the county's photography as a map layer. The team created 143 polygons that gave an approximate dimension of each aquatic weed bed observed. This project background aerial imagery was moved onto a laptop computer system.

With the detailed location information collected, the mapping teams returned to the Aquatechnex offices where they downloaded and processed the location data using the Trimble GPS Analyst™ extension for ESRI ArcGIS Desktop software. By interpreting the aerial



imagery with the field GPS data, the polygons clearly delineated the location and density classification of the weeds.

**Treatment Plan.** With the detailed assessment of the extent of the weed invasion completed, Bonner County was able to submit a federal grant application and received funding of \$1.8 million to execute a comprehensive and sustainable weed management effort. By working with the county, the US Army Corps of Engineers and the Idaho Department of Agriculture, Aquatechnex biologists were able to develop a treatment plan to eradicate Eurasian Milfoil by focusing on four different aquatic herbicides that met the requirements of the U.S. Endangered Species Act protecting designated "critical habitat" zones for bull trout.

Using boats equipped with GeoXT handhelds, the Aquatechnex team was able to navigate to the exact location of each weed infestation quickly. Biologists then treated up to 1,000 acres (404 hectares) of the Eurasian Milfoil infestations per day, at a total cost of about \$430 per acre (\$1,062 per hectare). To monitor the effectiveness of the treatment plan, the State of Idaho hired an independent expert from Mississippi State University. A year after the initial weed management plan went into action the university confirmed that the 4,000 acres (1,618 hectares) of herbicide treatment areas experienced "Very Good to Excellent Control."

While the Eurasian Milfoil treatment costs were adequate for this scale of weed management project, McNabb believes Trimble's technology was instrumental in helping the county save resources and reduce expenses in the initial mapping stage of the project. By applying the innovative mapping technique outlined above, the team was able to survey, analyze, and report on the nearly 100 miles

(161 kilometers) of shoreline in only five days, saving tens of thousands of dollars over traditional mapping techniques.

### Alaska Association of Conservation Districts

The Alaska Association of Conservation Districts (AACD) is another organization that has implemented a successful and cost-effective weed management program with a combination of Trimble GPS equipment and ESRI GIS software.

Located in Wasilla, Alaska, the AACD is an organization that supports twelve statewide Soil and Water Conservation Districts. Funded by the EPA, the AACD is currently in the midst of a large-scale project aimed at mapping and controlling invasive reed canarygrass along the Kenai Peninsula. 'The Invasive Reed Canarygrass (RCG) Management Project is particularly important because these weeds are encroaching on river beds and wetlands, impacting streamflows, and causing degradation of salmon spawning beds and habitats.'

**Data Collection.** From the recommendation of team members with the Alaska National Parks Service Exotic Plant Management Team, the AACD opted to use Trimble equipment for this weed survey and management effort. An AACD weed scout used a GPS unit along with GPS Pathfinder Office and TerraSync software to collect highly-accurate data. In all, over 260 incidences of reed canarygrass locations, about 100 acres (40 hectares) were identified and mapped. Working with a very limited budget for this Reed Canarygrass project, the team was ecstatic that over the course of a summer, a single analyst was able to use Trimble GPS equipment to map the infected area. Once the data was collected the analyst used Trimble GPS Pathfinder Office software to

## THE EQUIPMENT USED ON THIS PROJECT INCLUDES

- GeoXT handheld
- GPS Analyst extension
- GPS Pathfinder Office software
- TerraSync software
- ESRI ArcGIS Desktop software
- ESRI ArcPad software
- Nikon D70 camera

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process the differential GPS corrections and to export the data to ESRI ArcGIS software.

Also the data collected was easily shared as part of the Alaska Exotic Plant Information Clearing House (AKEPIC) Mapping Project, which was served using Excel (<http://akweeds.uaa.alaska.edu/>). Gino Graziano, Invasive Weeds and Agricultural Pest Coordinator DNR, Division of Agriculture, believes this type of field collection and geographic data sharing effort is an important step in improving collaboration and treatment strategies of invasive weeds across the state.

"Other groups that we work with like the Alaska National Parks Service enthusiastically recommended that we use Trimble equipment for our weed management project—it was a no brainer" said Graziano. "With Trimble GeoXT handhelds we were able to survey the area with an extremely high-level of accuracy and we've prioritized seven streams that are critical in this effort. As management begins on infestations threatening key habitats, the high accuracy of Trimble GeoXT handhelds will allow for close monitoring and geographic display of progress in reduction of infestations size over time."

The group's long-term plan is to gather specific location and attribute data across the Kenai Peninsula such as habitat type, size of infestations to quantify risk of infestations with the reed canarygrass.

"With this data, we'll be able to load the information into our GIS and monitor success as a reduction in the number and size of infestations, using risk of infestation of key habitats as a metric that allows us to monitor and quantify the effectiveness of our treatment plan," said Graziano.

**Treatment Plan.** Partners of the AACD including the Kenai Watershed Forum

have used the data to implement control practices in priority areas on the Kenai Peninsula. The majority of management is being completed using Typar fabric as a weed barrier. The AACD has established plots to monitor effectiveness and cost of various control techniques including use of weed barrier and herbicide application. Whenever control work is performed careful notes are taken on handheld GPS units, and shared amongst partners. With high-accuracy data now recorded, the AACD is working to garner funding for management. The data collected demonstrates the unique opportunity to prevent impacts to key resources, over an area the size of many states, from invasive plant infestations.

## SUMMARY

These two examples clearly demonstrate the benefits of high-accuracy GPS mapping and navigation in the development of sustainable weed management programs. A key component of both projects was the efficient capture of weed infestation areas over very large areas, made possible through the use of state-of-the-art Trimble GPS solutions as well as ESRI GIS software. These organizations were able to save a significant amount of time and resources, in the tens-of-thousands of dollars-range, by gathering highly-accurate location-based information about weed infestations with Trimble technology.

Furthermore, detailed assessment and ultimately treatment of the affected areas also benefited from GPS and GIS solutions for navigation to the infested areas and high-accuracy delineation and classification. With this technology, private organizations as well as federal, state, and local agencies can successfully work together to control noxious weed infestations and restore natural habitats across the United States and beyond.