2008 Project Abstract
For the Period Ending June 30, 2011

PROJECT TITLE: Updating the National Wetlands Inventory in Minnesota
PROJECT MANAGER: Steve Kloiber
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2008, Chap. 367, Sec. 2, Subd. 5(a)

APPROPRIATION AMOUNT: $550,000

Overall Project Outcome and Results
Over the past 100 years, about half of Minnesota's original 22 million acres of wetlands have been drained or filled. Some regions of the State have lost more than 90 percent of their original wetlands. Urban development, agricultural drainage, mining, road construction, and utility projects result in additional losses each year. The National Wetland Inventory (NWI) is the only comprehensive inventory of wetlands for Minnesota, but it is inaccurate in many places because it is 25-30 years out-of-date. Updating the NWI is a key component of the State's strategy to monitor and assess wetlands in support of efforts to assure healthy wetlands and clean water for Minnesota.

This project is the first phase of a multi-phase effort to update the NWI for all of Minnesota. Under this project, the project team:

(1) developed wetland mapping standards and quality control objectives to assure that the final product can meet the broad array of data needs for various stakeholders,
(2) developed a request for proposal that incorporates these standards and objectives,
(3) acquired high-resolution, spring, leaf-off, digital aerial photography for northeastern and east-central Minnesota (22,500 square miles),
(4) developed updated wetland mapping procedures for northeastern and east-central Minnesota that incorporate modern high-resolution digital imagery, radar imagery, and LiDAR elevation data,
(5) provided training to DNR and Ducks Unlimited staff (total of six people) on the application of the updated wetland mapping procedures, and
(6) performed initial data processing for updating NWI maps for east-central Minnesota and northern Koochiching County.

Subsequent phases of this project are focused on producing updated NWI maps for five different regions of Minnesota; east-central, southern, northeastern, central-lakes, and northwestern. These subsequent phases will also include the continuation of the imagery acquisition for the southern, northeastern, and central-lakes regions.

Project Results Use and Dissemination

The wetland mapping standards and quality assurance objectives developed through this project are presented in reports found on the project website (http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html). Imagery acquired as part of this project are freely available to the public through the Minnesota Geospatial Information Office website (http://www.mngeo.state.mn.us/chouse/wms/geo_image_server.html). The imagery for northeastern Minnesota receives an average of about 62,000 requests per month and the imagery for east-central Minnesota receives an average of more than 300,000 requests per month. Wetland mapping procedures based on pilot studies in northeast and east-central Minnesota are contained in two separate reports. Three hard copies and one electronic copy on CD have been submitted with the final project report to LCCMR. Presentations and workshops have been provided by the University of Minnesota regarding the updated wetland mapping methods as described above.

Environment and Natural Resources Trust Fund 2008 Work Program Final Report

Date of Report: August 31, 2011 *(Final Report)*
Date of Work program Approval: June 17, 2008
Project Completion Date: June 30, 2011

I. PROJECT TITLE: Updating the National Wetlands Inventory in Minnesota

Project Manager: Steve Kloiber
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Location: Acquisition of spring, leaf-off imagery was conducted for northeastern and east-central Minnesota (see figure 1) Pilot tests for wetland mapping were conducted for two selected sites representing different land cover types: Chanhassen, MN (urban/suburban) and the Fond du Lac Reservation (forested). Initial data processing for updating wetland maps was conducted for east-central Minnesota and northern Koochiching County.

Total Trust Fund Project Budget:	**Trust Fund Appropriation:**	$ 550,000
	Minus Amount Spent:	$ 542,476
	Equal Balance:	$ 7,533

Legal Citation: M.L. 2008, Chap. 367, Sec. 2, Subd. 5(a)

Appropriation Language:
$550,000 is from the trust fund to the commissioner of natural resources to begin updating the National Wetlands Inventory through standards development, mapping, training, and imagery acquisition. This is the first phase of an overall effort to update the inventory statewide. This appropriation is available until June 30, 2011, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. and III. FINAL PROJECT SUMMARY:

Over the past 100 years, about half of Minnesota's original 22 million acres of wetlands have been drained or filled. Some regions of the State have lost more than 90 percent of their original wetlands. Urban development, agricultural drainage, mining, road construction, and utility projects result in additional losses each year. The National

Wetland Inventory (NWI) is the only comprehensive inventory of wetlands for Minnesota, but it is inaccurate in many places because it is 25-30 years out-of-date. Updating the NWI is a key component of the State's strategy to monitor and assess wetlands in support of efforts to assure healthy wetlands and clean water for Minnesota.

This project is the first phase of a multi-phase effort to update the NWI for all of Minnesota. Under this project, the project team:

(1) developed wetland mapping standards and quality control objectives to assure that the final product can meet the broad array of data needs for various stakeholders,
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(5) provided training to DNR and Ducks Unlimited staff (total of six people) on the application of the updated wetland mapping procedures, and
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Subsequent phases of this project are focused on producing updated NWI maps for five different regions of Minnesota; east-central, southern, northeastern, central-lakes, and northwestern. These subsequent phases will also include the continuation of the imagery acquisition for the southern, northeastern, and central-lakes regions.

IV. OUTLINE OF PROJECT RESULTS*:*

Result 1: Standards Development and Quality Control

Description: The first result of the project focuses on clearly defining mapping objectives (e.g. minimum mapping unit, classification detail, positional accuracy, etc.) to assure the final product can meet the broad array of data needs for the project partners and other stakeholders. This task involves establishing an inter-agency technical advisory committee (TAC) to develop mapping standards and specifications that can be used to review options for map production. The TAC will be consulted throughout the project to provide technical feedback on data deliverables and quality control. A series of meetings will also be held involving end-users around the state to identify data needs. This project component will also entail development of a Request for Proposal for updating the NWI data in the initial 13-county project of east-central Minnesota area. A project coordinator will be hired by the DNR (0.65 FTE, funded over two years) to be responsible for convening and coordinating the efforts of the TAC, completing the deliverables for this Result, and coordinating the completion of Results 2 and 3. Additional tasks under this Result will include purchasing a computer specifically for this project and travel for stakeholder outreach, consultation with other wetland mapping professionals, and training.

Summary Budget Information for Result 1:	**Trust Fund Budget:**	**$85,080**
	Amount Spent:	**$80,682**
	Balance:	**$4,398**

Deliverable	**Completion Date**	**Budget**	**Status**
1. Data standards & specs	03/2010	$54,140	Complete
2. Prepare RFP & contract	09/2010	$30,940	Complete

Final Report Summary: The DNR hired a project manager to oversee the NWI update project. A technical advisory committee comprised of wetland and GIS mapping experts from various federal, state, and regional agencies was formed to provide advice and provide guidance on technical issues.

A comprehensive project plan was developed covering all phases of a complete, state-wide update of the NWI for Minnesota. A web-based survey was created to obtain input from end users of the NWI data in order to determine what their requirements are for an update of the NWI. Several individuals responding to the survey were contacted for detailed follow-up interviews. Information gained from the survey and interviews was incorporated into a document describing the user requirements for the NWI update. A detailed literature review was also performed on quality assurance procedures for wetland mapping. This information was used to develop a quality assurance project plan for the NWI update. The comprehensive project plan, the user requirements document, and the quality assurance project can all be found on the project website (http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html). This information was all summarized and presented to the technical advisory committee for review. Results were also presented at a stakeholder meeting held at Fort Snelling State Park (February 25, 2010) and at the Minnesota Wetland Professionals Annual Conference (January 19, 2011), to solicit feedback. Comments received were used to refine these documents.

The information from the user requirements document and the quality assurance plan were then incorporated into a formal request for proposal (RFP) for wetland mapping that was reviewed by the technical advisory committee. The final RFP provides a clear, detailed technical description of the wetland mapping standards for the NWI update. The RFP was noticed in the State Register in July 2010 to select a contractor to update the NWI for the first phase project area, 13 counties in east-central Minnesota. The NWI update work is currently underway, funded by the ENTRF through a subsequent grant.

The remaining balance of $4,398 for this result is largely due to lower than estimated costs for travel and equipment.

Result 2: Data Acquisition

Description: This Result focuses on acquisition of both imagery and field data. Funds for imagery acquisition will be directed toward obtaining high-resolution, leaf-off imagery for the high-priority mapping areas including three counties in northeast Minnesota and thirteen counties in east-central Minnesota. To preserve the imagery data, a data storage device will be purchased by the Minnesota DNR and copies of the data are also stored

off-site at the Minnesota Geospatial Information Office (MnGeo). This Result also includes the collection of field validation data to coincide with the imagery acquisition. At least 500 sites will be visited by the Univ. of Minn. Remote Sensing and Geospatial Analysis Laboratory (UMN) to provide an independent check on the accuracy of updated wetland maps created from the imagery. The cost of field data acquisition is $82,000.

Summary Budget Information for Result 2:	**Trust Fund Budget:**	**$196,344**
	Amount Spent:	**$194,007**
	Balance:	**$2,337**

Deliverable	**Completion Date**	**Budget**	**Status**
1. Statewide, high resolution, Summer CIR imagery	08/2008	$0	Complete
2. Spring leaf-off imagery for northeastern MN	08/2009	$10,867	Complete
3. Spring leaf-off imagery for east-central MN	12/2010	$77,018	Complete
4. Field validation data collection for northeast and east-central MN	12/2010	$89,107	Complete
5. Data storage for imagery	1/2011	$19,352	Complete

Final Report Summary: This task originally had only one deliverable and that was to partner with the USDA Farm Service Agency on a statewide summer aerial imagery acquisition project (1-meter spatial resolution) by providing funding to add color-infrared data to the acquisition. Through negotiations with the State, FSA agreed to add the color-infrared data at no cost to this project. This allowed the NWI project to redirect funding to acquiring spring imagery which is also important for accurately mapping wetlands.

A work plan amendment was approved to add the acquisition of spring leaf-off imagery (half-meter and one-foot spatial resolution) for northeastern Minnesota (15,400 square miles) and east-central Minnesota (7,100 square miles). The areas for which spring aerial imagery was acquired are shown in figure 1. This imagery was collected digitally with four spectral bands; blue, green, red, and near-infrared. Positional accuracy of the imagery was tested and found to be accurate within ±11.5 feet. This imagery is being made publicly available through a web mapping service provided by the Minnesota Geospatial Information Office. The imagery for northeastern Minnesota receives an average of about 62,000 requests per month and the imagery for east-central Minnesota receives an average of more than 300,000 requests per month. Matching funds provided

by federal, state and local partners covered 86% of this imagery acquisition costs. We were able to leverage $79,642 from the Environmental and Natural Resources Trust Fund to garner $495,672 in matching funds. Garnering matching funds for imagery acquisition was significantly enhanced by having funding from the Environmental and Natural Resources Trust Fund to serve as seed funding.

The success in attracting matching funds allowed further expansion of the goals for this result. Another amendment was requested and granted to acquire a network attached storage device and off-site data back-up for the State's investment. This amendment also included a task to acquire field validation data for northeastern and east-central Minnesota. This data will be used to assess the accuracy of the updated NWI maps in these areas. The UMN completed acquisition of the field validation data for both east-central Minnesota (975 points) and northeast Minnesota (1508 points). The data was delivered to the DNR in the form of GIS data files along with photos of each site. The data will not be shared with the wetland mapping contractor in order to preserve the integrity of a blind accuracy assessment.

The remaining balance of $2,337 for this result is largely due to lower than expected costs for image acquisition and data storage.

Result 3: Methods Development

Description: The goal of this Result is to develop cost-effective and reliable mapping methods that meet the requirements of the Minnesota National Wetlands Inventory (NWI) update project. The methods development effort will be led by the University of Minnesota Remote Sensing and Geospatial Analysis Laboratory.

Specific steps:

1. Pilot area selection – Minnesota contains a wide range of ecoregions, including mixed boreal forest, glaciated plains, western corn-belt plains, north central hardwoods, and the driftless area. These ecoregions contain different types of wetlands; for example, the "prairie potholes" of the western corn-belt plains and the forested wetlands of the boreal forest region. To develop mapping methods that account for these varied wetland types, representative pilot areas will be selected in the different ecoregions of the state. Areas for which appropriate data are already available will be favored.

2. Mapping methods assessment -- The science of wetland mapping is in flux. New image data types and approaches show promise for improving upon previous methods. A variety of image data types and mapping approaches will be evaluated for their suitability for wetland mapping in the pilot areas and the state as a whole. This process will result in mapping methods tailored to the different wetland types in Minnesota. Specific data types and mapping methods to be evaluated include:
    a. Radar image data – Radar data is particularly sensitive to soil moisture. Radar signals are also able to penetrate forest canopy. As such, radar data are well suited to identify wetlands that do not have standing water and also forested wetlands that might otherwise be obscured by forest canopy. The Canadian government has begun using radar data in combination with color infra-red

imagery for mapping wetlands as a part of the Canadian Wetland Inventory. The cost for radar imagery will be $6000.

b. LiDAR image data – Data from light detection and ranging (LiDAR) provides highly detailed elevation data for ground features. The inclusion of LiDAR data in the mapping process can assist in identifying areas that may contain wetlands. LiDAR data are currently available for some locations in Minnesota. This data was evaluated to determine the increase in wetland mapping accuracy, if any, that is provided by using LiDAR data.
c. NAIP image data – In the summer of 2008, the USDA National Agricultural Image Program (NAIP) will collect high-resolution, digital aerial images for Minnesota. The normal procedure in wetland mapping calls for using images collected during the period between snow-melt and leaf emergence, so as to be able to identify forested wetlands before they are covered by tree canopies. The NAIP images are not acquired during this optimal period; however, NAIP images could still be of use to wetland mapping efforts. The NAIP images will be evaluated to determine whether they are suitable for wetland mapping in the pilot areas either alone or in combination with other data types (e.g. radar data).
d. Image segmentation – A developing image analysis technique called image segmentation will be evaluated. Traditional image processing techniques are used to discriminate different cover types based on analysis of image pixels. Image segmentation involves partitioning an image into groups of adjacent pixels (segments) based upon spectral properties, shape, and texture. Image segmentation may be useful for wetland mapping in areas where the spectral parameters of wetland versus non-wetland areas are similar but the texture is different.
e. Wetland probability maps – The current MN NWI delineates wetlands with polygons, so an area is either wetland or it is not. This is problematic for two reasons. First, natural wetlands rarely have such sharp boundaries. Depending on geologic setting and land use, the wetland to non-wetland transition may be very gradual, exhibited by dryer and dryer soil and slowly changing vegetative species the further one moves from the center of a wetland. Second, due to the gradual edge of some wetlands, determining where to draw the polygon boundary may be difficult. A wetland probability map is a continuous surface representing the likelihood that a particular image pixel is a wetland. The probabilities are derived from factors such as slope, elevation, aspect, soil type, and vegetative species present. The main advantage of using a probability map is that wetland boundaries are flexible and can be identified based on the needs of a particular application. Wetland probability maps were created for the pilot areas and were compared with wetland boundaries derived from traditional mapping approaches. If the probability maps are accurate and valuable, it may be possible to use this technique to assist with the statewide mapping, depending on data availability.

Some of the above data types are available for parts of the state, while some will have to be newly acquired.

Existing data sets

There are several LiDAR data sets for Minnesota – particularly in the Metro area. Some of these are available at no cost and some are subject to “cost recovery” programs. No

new LiDAR imagery is planned to be acquired as a part of this effort. The Metropolitan Council has spring leaf-off, four-band imagery for the Twin Cities Metropolitan Area from 2005 with a 0.6-m resolution. These images are available at no cost to MetroGIS partners. The DNR has scanned film-based CIR photos at high resolution under fall leaf color conditions for the forested portions of the State. The time period varies by location.

New data acquisition
NAIP/FSA will be collecting 1-meter resolution 3-band, color imagery for Minnesota in 2008. A fourth band in the near infrared is a possible add-on. Also, we can request acquisition of imagery in the forested regions to occur during leaf-off conditions. The cost will be between $70,000 and $200,000 for adding the NIR band. We will acquire Radarsat images for this project. These will be Fine-Scale (8-meter), C-band, 50-km x 50-km images at a cost of $4000/image. There is a possibility of obtaining limited, free imagery through the USFWS.

3. Mapping of pilot areas -- Updated wetland inventory maps will be created for the pilot areas using the data type(s) and mapping method that provide the highest accuracy for each area. These inventory maps will be provided to stakeholders and the public on an interim basis until the statewide NWI update is complete. An additional 600-square mile area will be mapped to full national wetland mapping standards by the DNR with assistance and guidance from the UMN and Ducks Unlimited.

4. Protocol development -- The best performing wetland mapping protocols will be identified. Specific protocols will be recommended for the different areas of the state. The protocols and instructions will be documented and released to the mapping team and other appropriate parties.

5. Training workshop for mapping team -- A workshop will be held in which the mapping team will be trained in the use of the wetland mapping protocols to increase mapping efficiency and accuracy. Additional hands-on training will be conducted. The mapping team's performance will be assessed and improved until it reaches the level required for this project. From 2-4 DNR employees will be trained through an on-the-job program to develop updated wetland inventory maps that meet the national wetland mapping standards.

6. Technical support during mapping -- During the duration of funding support to the University of Minnesota, support to the mapping team will be provided to resolve technical issues that may occur during mapping. These issues could involve protocol clarifications, modifications, and additions.

Summary Budget Information for Result 3: **Trust Fund Budget: $268,576**
Amount Spent: $267,778
Balance: $798

Deliverable	**Completion Date**	**Budget**	**Status**
1. Wetland maps for two pilot areas	12/2009	$101,146	Complete
2. Wetland mapping protocols	09/2010	$115,134	Complete

3. Training workshop for mapping team	10/2010	$5,380	Complete
4. Training for RA staff and wetland map for third pilot	6/30/11	$46,916	Nearly Complete

Final Report Summary:
The University of Minnesota Remote Sensing and Geospatial Analysis Laboratory conducted two pilot tests on wetland mapping methods; one for an urban/suburban area (Chanhassen, MN) and one for a northern-forested areas (the Fond du Lac Reservation). This work also included a literature review and additional information on wetland mapping methods was also obtained through surveys and interviews of national wetland mapping experts. Reports documenting recommendations for wetland mapping procedures for urban/suburban areas and forested areas were provided.

The recommended methods employ a combination of object-oriented image analysis, automated classification (e.g. RandomForest™ or CART™ classifiers), and manual photo-interpretation. Image segmentation of high-resolution, 4-band, aerial photography from both spring and summer are used to extract wetland and upland feature boundaries. The geometry and spectral characteristics from the extracted features are combined with additional data including satellite radar, airborne LiDAR derived DEMs, and soils data to train an automated classification algorithm. Results from the Chanhassen pilot indicate that the initial automated wetland classification separates wetlands from uplands with an overall accuracy rate of about 93% and assigns wetland class with an overall accuracy rate of about 86%. Results for the Fond du Lac pilot show somewhat weaker predictive power, but further research is underway to improve the predictive power for the forest area wetland probability model. The recommendations conclude that the automated classification output should be further processed through manual photo-interpretation to create the final update wetland inventory. New wetland maps were completed for two pilot areas: Chanhassen, MN and the Fond du Lac area near Cloquet, MN (see UMN report). These data will be made available to the production wetland mapping contractor for incorporation into the final NWI update.

A workshop was held at the University of Minnesota to share information about wetland mapping technology with the vendor selected for wetland mapping updates in the second phase grant (Ducks Unlimited). This workshop included presentations on wetland classification, using LiDAR and radar data for mapping wetlands, discussions of available imagery and GIS data, and identifying issues that remain to be resolved regarding wetland mapping methods.

The wetland mapping methods developed by the University of Minnesota were subsequently adapted by the DNR and its wetland mapping contractor (Ducks Unlimited) for wetland mapping efforts in east-central Minnesota. Remaining project funds were redirected through an approved work program amendment to the DNR Resource Assessment Office to provide support for efforts to update the NWI maps for east-central Minnesota and northern Koochiching County. This area was selected because the original NWI data for it were not very accurate and it was the only region for which we had both recent spring, leaf-off imagery as well as LiDAR elevation data.

DNR Resource Assessment acquired available LiDAR elevation data for wetland mapping areas in east-central MN and northern Koochiching County project areas. Additional elevation data from other sources were incorporated as needed. These elevation data were processed to create multiple derivative products including slope, curvature, topographic position index, and compound topographic position index. Satellite radar data from Radarsat2 was also acquired and processed.

The LiDAR and radar derived products for east-central MN were provided to Ducks Unlimited to develop a wetland probability model using the RandomForest™ classification algorithm. Information from this process was transferred back to DNR Resource Assessment, so that the same process could be applied to the northern Koochiching County project area. DNR Resource Assessment also partnered with Ducks Unlimited to acquire field data to train and validate wetland probability models.

Due to an unforeseen delay in the technology transfer and a delay in hiring a staff position at DNR Resource Assessment, the wetland probability layer for the northern Koochiching County project area was not completed by June 30. This work will be completed by the DNR at its own cost and made available as specified under the LCCMR work program.

V. TOTAL TRUST FUND PROJECT BUDGET:

Staff or Contract Services: $357,316 [$104,399 for 0.65 FTE Project Coordinator at DNR (unclassified, new hire); $46,917 for service level agreement with DNR Resource Assessment Office for mapping support services; $206,000 for contract with Univ. of Minnesota to evaluate mapping technologies]
Equipment: $22,809
Travel: $7,000
Imagery Acquisition: $80,875 (Acquisition of high-resolution, 4-band, spring leaf-off aerial imagery for east central and northeastern Minnesota (see map)).
Field Data Acquisition: $82,000

TOTAL TRUST FUND PROJECT BUDGET: $550,000

Explanation of Capital Expenditures Greater Than $3,500:

VI. OTHER FUNDS & PARTNERS:

A. Project Partners:

Joe Knight, Ph.D., of the University of Minnesota, Remote Sensing Laboratory will receive $206,000 for this project for Result 3.

Other unfunded partners for this project include the Minnesota Pollution Control Agency, the Minnesota Board of Water and Soil Resources, the U.S. Fish and Wildlife Service, the Metropolitan Council, and the Minnesota Dept. of Administration, Land Management Information Center.

B. Other Funds Proposed to be Spent during the Project Period: The full cost of acquiring statewide, high-resolution, summer leaf-on aerial imagery for this project is $1.37 million. Of this cost, the Farm Services Agency will fund $900,000; other state sources will provide $450,000. We were also able to leverage $79,642 from the Environmental and Natural Resources Trust Fund to garner $495,672 in matching funds for spring, leaf-off imagery acquisition. Matching funds came from a variety of sources including; National Geospatial Intelligence Agency (via U.S. Geological Survey), Metropolitan Council, Minnesota Pollution Control Agency, National Oceanographic and Atmospheric Administration, St. Louis County, and Metropolitan Mosquito Control District.

The unfunded partners listed above will provide approximately $20,000 of in-kind staff time in support of this project.

C. Past Spending: In-kind staff time devoted to planning for this project amounts to approximately $5,000.

D. Time: This is the first phase of a long-term project to update the National Wetlands Inventory for all of Minnesota. The second phase of this project was funded through ENTRF starting July 1, 2010 and funds for a third phase will be made available on July 1, 2012. Three additional phases are anticipated to complete the statewide update of the NWI by 2019.

VII. DISSEMINATION: The comprehensive project plan, the user requirements document, and the quality assurance plan developed for this project are found on the project website (http://www.dnr.state.mn.us/eco/wetlands/nwi_proj.html). Imagery acquired for this project is freely available to the public through the Minnesota Geospatial Information Office (http://www.mngeo.state.mn.us/chouse/wms/geo_image_server.html). Wetland mapping procedures based on pilot studies in northeast and east-central Minnesota are contained in two separate reports. Three hard copies and one electronic copy on CD have been submitted with the final project report to LCCMR. Presentations and workshops have been provided by the University of Minnesota regarding the updated wetland mapping methods as described above.

VIII. REPORTING REQUIREMENTS:
Periodic work program progress reports were submitted on January 2009, July 2009, January 2010, July 2010, and January 2011. A final work program report and associated products was be submitted August 31, 2011 as requested by the LCCMR.

IX. RESEARCH PROJECTS: N/A

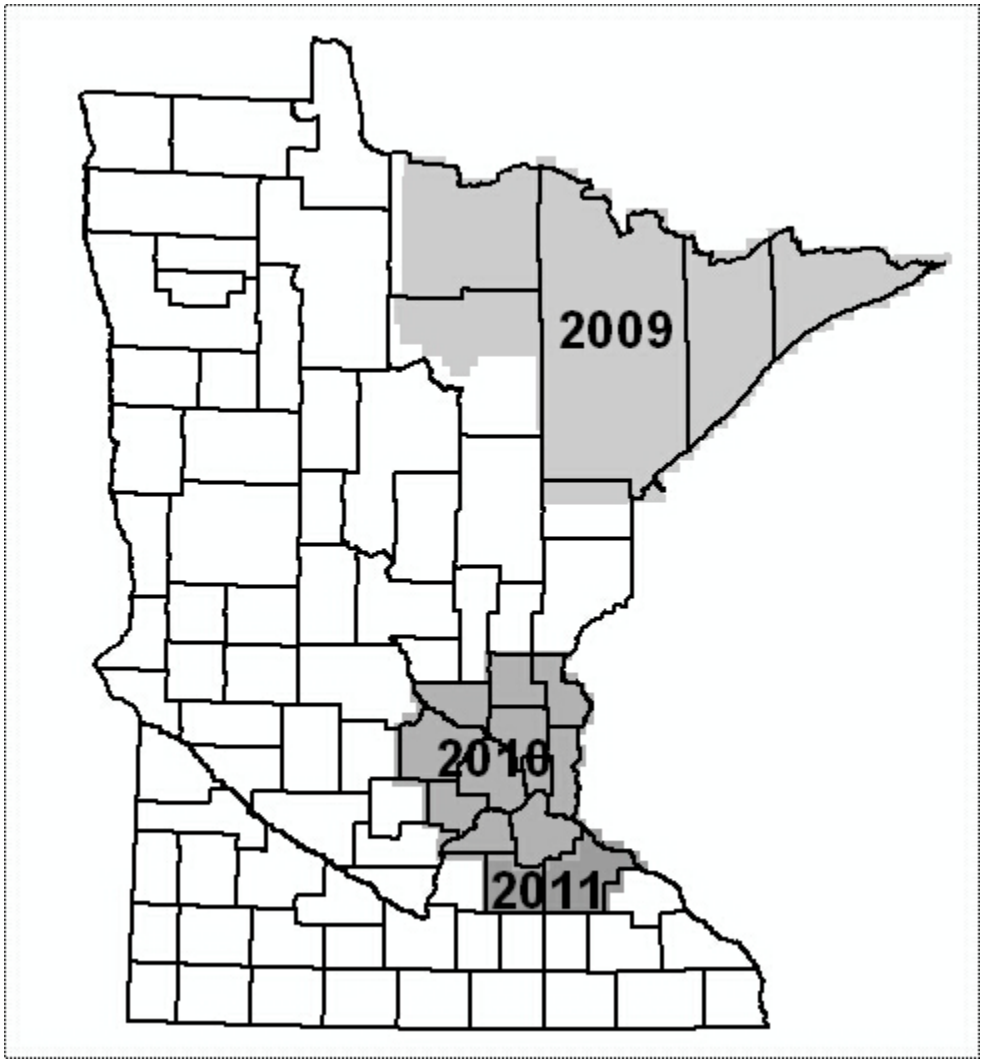

Figure 1: A map showing the areas for which high-resolution, spring, leaf-off imagery was acquired for this project.

Attachment A: Final Budget Detail for 2008 Project

Project Title: Updating the National Wetlands Inventory in Minnesota

Project Manager Name: Steve Kloiber

Trust Fund Appropriation: $550,000

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

2008 Trust Fund Budget	**Result 1 Budget:**	**Amount Spent** *(12/31/10)*	**Balance** *(12/31/10)*	**Result 2 Budget:**	**Amount Spent** *(12/31/10)*	**Balance** *(12/31/10)*	**Result 3 Budget:**	**Amount Spent** *(12/31/10)*	**Balance** *(12/31/10)*	**TOTAL BUDGET**	**TOTAL BALANCE**
	Standards Development and Quality Control			Imagery Acquisition			Methods Development				
BUDGET ITEM											
PERSONNEL: wages and benefits 0.65 FTE for Project Manager position at DNR	73,080	73,080	0	15,660	15,660	0	62,576	61,778	798	151,316	799
Contracts											
Methods Assessment -- Contract with Univ. of Minnesota, Remote Sensing Laboratory to evaluate various mapping technologies and identify the most cost-effective methods for this project.			0			0	206,000	206,000	0	206,000	0
Imagery acquisition -- Contracts for imagery for northeastern and east-central Minnesota. And imagery back-up from MnGeo.			0	80,875	79,750	1,125			0	80,875	1,125
Field Validation Data Collection -- Contract with Univ. of Minnesota, Remote Sensing Laboratory to collect field validation data for east-central and northeast MN.			0	82,000	82,000	0			0	82,000	0
Office equipment & computers - computer and GIS software unique to this project	5,000	4,770	230	17,809	16,597	1,212			0	22,809	1,442
Travel expenses in Minnesota -- Coordination with stakeholders and partners, training	5,000	2,832	2,168			0			0	5,000	2,168
Travel outside Minnesota -- Training and coordination with other wetland mapping professionals; locations unknown at this time	2,000	0	2,000			0			0	2,000	2,000
COLUMN TOTAL	**$85,080**	**$80,682**	**$4,398**	**$196,344**	**$194,007**	**$2,337**	**$268,576**	**$267,778**	**$798**	**$550,000**	**$7,533**