FARMING FOR WILDLIFE:
BUILDING A MODEL FOR SUSTAINABLE WETLAND ROTATIONS AND LONG TERM STEWARDSHIP

FINAL REPORT TO NRCS' CONSERVATION INNOVATION GRANT

SEPTEMBER 2013

Grantee Name:	The Nature Conservancy
Grant Number:	NRCS 69-3A75-9-132
Award Letter Date:	July 10, 2009
Grant Amount:	$345,415
Project Title:	Farming for Wildlife Phase II
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Cover Photo: Sharp-tailed sandpiper on the Soltes farm, September 2010

EXECUTIVE SUMMARY

Over the past six years, The Nature Conservancy has worked with Skagit Valley farmers in Washington to test the feasibility of integrating wetland habitat rotations into commercial crop production on working farms, in an innovative project known as "Farming for Wildlife." A pilot study from 2006 through 2009 evaluated the effects of saturated soils on soil fertility and microbiology and assessed how these wetlands may benefit shorebird species. Farming for Wildlife Phase II, was funded through a Conservation Innovation Grant from NRCS, and further refined the ecological and agronomic benefits of wetland rotations, and developed a model for implementing the rotation.

Data from the pilot project demonstrated that wetland rotations can attract a diversity of shorebird and waterfowl species and may also improve soil health for farmers. These findings generated excitement and momentum among local stakeholders, agriculturalists and conservationists alike, who have indicated interest in adopting the Farming for Wildlife concept on a broader scale. The project's success has received national media attention, with stories appearing in the Associated Press, *Orion Magazine*, the *New York Times*, National Public Radio's "Living on Earth" series, and *National Geographic News*.

"Farming for Wildlife" is a local proof-of-concept project with a direct link to NRCS' Wildlife Habitat and Incentives Program (WHIP) and Environmetal Quality Incentives Program (EQIP). NRCS is the primary office responsible for implementing national farm bill programs, and therefore a key partner for developing long-term sustainable funding and influencing implementation of Farming for Wildlife on a broad scale. To date, our local NRCS office has supported trial wetland rotations at two sites through the Wildlife Habitat Incentives Program, with more planned for the future. We published a paper in the Environmental Law Institute's *National Wetlands Newsletter* illustrating the importance of farm bill programs for supporting wetland rotations.

Funding from this Conservation Innovation Grant was instrumental in supporting our work in developing the strong ecological, agronomic, and economic underpinnings for a Wetland Rotation Model. Results from the research supported through this grant have already been published in the American Journal of Potato Research, and as a Washington State University Extension Manual. The Farming for Wildlife Project has also published an Introductory guide and brochure on the practice of Temporary Floooding Rotations, which accompany this final report.

PROJECT ACTIVITIES

The Farming for Wildlife project tested the feasibility of integrating wetland habitat rotations into crop production on working farms. Farming for Wildlife – Phase II is the culmination of the innovative work introduced by USFWS in the Klamath Basin and recent pilot studies in the Skagit Valley of Washington. This innovative project is a market-based approach to conservation in working landscapes, and through this grant has demonstrated and quantified the multiple values (ecologic, agronomic and economic) of wetland rotations. In addition, the Farming for Wildlife model is one of the first conservation strategies in our state to restore wetland habitat without taking farmland permanently out of production. Our goal was to create a program model that is economically viable, feasible for farmers to implement, and exportable to new landscapes; we believe we have achieved all of these goals. Over the last three years, we field tested and researched how to implement wetland rotations in order to achieve the best habitat, agronomic and economic benefits. Outlined below is a brief summary of activities conducted under each task included in this grant.

TASK 1: IMPLEMENT WETLAND ROTATION DEMONSTRATION SITES IN THE STILLAGUAMISH, SKAGIT, AND SAMISH RIVER DELTAS OF PUGET SOUND, WA

Over the past three years, The Nature Conservancy and local farmers have maintained four wetland demonstration sites: two in the Skagit river delta, one in the Stillaguamish delta, and one in the Samish river delta (Figure 1). These sites were largely wet through the fall and spring migration periods and overwinter, and dried out during the summer period. When sites began to dry out in July the vegetation was managed where possible, before reflooding the sites for fall migration. Shorebird use of the wetland sites was monitored weekly during spring and fall migrations. TNC, in collaboration with WSU soil scientist Dr. Lynne Carpenter-Boggs also collected extensive soil samples at each site during the dry summer period.

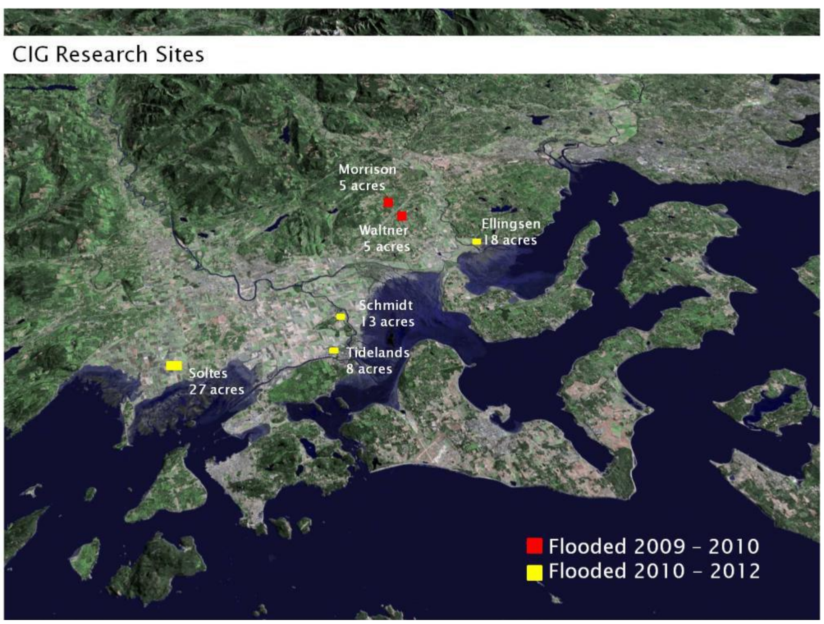

Figure 1. Location and size of the wetland rotation demonstration sites.

TASK 2: IDENTIFY MANAGEMENT PRACTICES THAT MAXIMIZE THE ECOLOGICAL AND AGRONOMIC VALUE OF FARMLAND/WETLAND ROTATIONS AT DEMONSTRATION SITES

		2010				2011				2012				2013		
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Task 2. Test Management Practices																
Manage vegetation*			X				X				X					
Monitor shorebirds				X		X		X			X					
Soil Sampling		X		X		X		X		X		X				
Water Sampling				X		X		X		X						
Other (bird feces/algae)						X				X						

Table 1. Timeline of monitoring activities conducted for Task 2. *Vegetation management practices were limited in fall 2011 and spring 2012 due to the wet conditions, see Table 2 below for actual implementation schedule.

Shorebirds were observed at the wetland rotation demonstration sites during both the spring and fall migration periods from August 2010 through May 2012 (Table 1). Surveys were conducted by the same expert observer during the two years of study and were estimated total censuses of each treatment at each demonstration site (not measured to be a proxy for density). Treatments were designed to test whether vegetation management practices (mowing and disking) affected the habitat quality of the wetland rotation, using shorebird abundance as the indicator for habitat quality. However several of the sites remained too wet during the growing season to implement the vegetation management practices as designed, and thus excludes a rigorous comparison of shorebird use by treatment. Table 2 below summarizes the treatments implemented over the two year.

	FALL 2010		**SPRING 2011**		**FALL 2011**		**SPRING 2012**	
	MOW	DISK	MOW	DISK	MOW	DISK	MOW	DISK
ELLINGSEN	Planted barley	✓	barley	✓	Disked, planted barley	✓	barley	✓
SCHMIDT	✓	✓	✓	✓	Too wet to mow, bird detection probability low	Too wet to disk	Treatment not applied previous season, detection probability low	Treatment not applied previous season
SOLTES	✓	✓	✓	✓	✓ Most of it mowed	Too wet to disk	✓	Treatment not applied previous season
TIDELANDS	✓	✓	✓	✓	✓	✓	✓	✓
✓ = treatment implemented as designed in original research plan								

Table 2. Vegetation management treatments as implemented during the 2 year research period.

Soil samples were collected and analyzed from four subplots within each treatment of the wetland rotation site at three points throughout the rotation period: i.) prior to flooding, ii.) after 1 year of flooding, and iii.) after 2 years of flooding. Soil samples were taken at 0-15, 15-30 and 30-60 cm depths in the dry period during summers of 2010, 2011, and 2012. Soils were analyzed for total C and N, 15/14N, ammonium (NH_4^+), nitrate (NO_3^-), readily mineralizable N, pH, and electrical conductivity. In 2010 and 2012 0-15 and 15-30 cm samples were also analyzed for extractable P (Bray method), K, Ca, Mg, Na, S, B, Zn, Mn, Cu, Fe, and Al. Incoming water was sampled in August of 2010 and 2011, and standing water was sampled in March of 2011 and 2012. Water samples including floodwater inflow, pre- and post-migration periods were subjected to analyses of pH, electrical conductivity, nitrate, and ammonium.

TASK 3: DEVELOP AN ECONOMIC FEASIBILITY MODEL FOR FARMLAND/WETLAND ROTATIONS

With increasing economic pressure from rising input costs, rising land costs, stiff competition, and barriers to market entry, farmers must yield net gains in order to participate in habitat rotations programs. For the Farming for Wildlife project, economists from Washington State University evaluated the economic costs and benefits for farmers participating in the project. The principal goal of the analysis was to ascertain the costs of wetland rotations in the Skagit Valley and what increase in crop yields would be required for farmers to see net gains. Increased yields could result from improved soil fertility or lower levels of soil-borne pathogens and therefore reduced input costs (fumigants, etc.).

One of the constraints of this study was the small sample size, with just three farmers participating. In addition, the flooding costs varied substantially among producers. The enterprise budget estimated the annual costs for creating a wetland to range between $343 and $1,016 per acre (including land rent and overhead). Costs per acre declined if the rotation was maintained for more than one year. Despite the high costs of a wetland rotation, profits could be realized if the rotation resulted in an increase in yields (Figure 3). In the Klamath Basin of California and Oregon, wetland rotations have produced a 20 percent increase in yields.

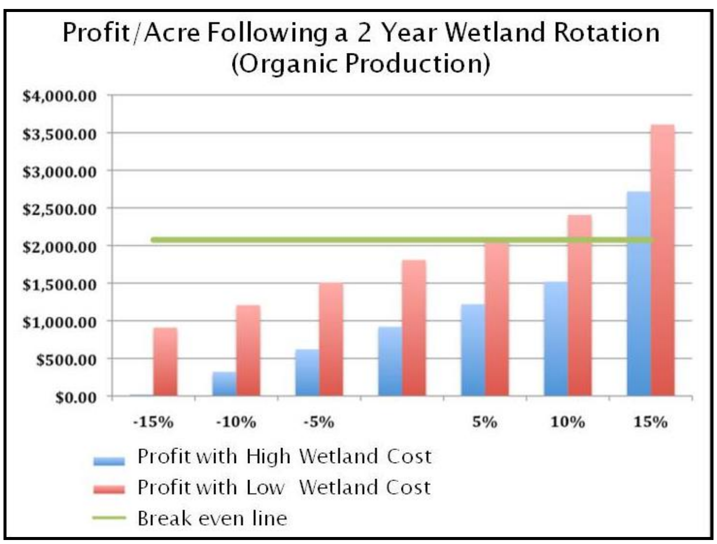

Figure 3. Enterprise budgets were used to estimate the costs of wetland rotations and evaluate tradeoffs farmers face in choosing rotation practices. The cost of wetland rotations varied dramatically between producers. However, even for the most expensive scenarios, a 15 percent increase in crop yields could offset the costs.

TASK 4: DETERMINE THE EFFECTS OF WETLAND ROTATIONS ON CROP PATHOGENS

Wetland rotations are an ancient practice used around the world for controlling crop diseases caused by soil-borne pathogens. Lack of oxygen and high levels of carbon dioxide in the soil are believed to kill pathogens, making wetland rotations a useful method for controlling some plant diseases.

The Farming for Wildlife project, in partnership with Washington State University, has conducted studies in the Skagit Valley to evaluate its potential effectiveness in controlling potato pathogens for the past five years. Scientists have conducted experiments both in a greenhouse and in small outdoor plots to evaluate the effects of flooding on six different common soil-borne pathogens in Western Washington.

Under this grant, greenhouse and field microplot studies were done at the WSU-Mount Vernon Northwestern Washington Research & Extension Center (NWREC) to investigate the effect of soil flooding on three pathogens present in potato production in western Washington: *Colletotrichum coccodes* (the cause of black dot), *Sclerotinia sclerotiorum* (the cause of white mold), and *Verticillium dahliae* (the cause of Verticillium wilt). Greenhouse experiments and field trials on *Rhizoctonia solani* are ongoing.

TASK 5: DEVELOP A WETLAND ROTATION MODEL PROGRAM AND EXPORT MODEL TO KEY IMPLEMENTATION PARTNERS[1]

To facilitate exporting the project results to agencies and agriculture industry groups, a professional communications firm, Waterview Consulting was selected for producing final communication products. A wetland rotation model and conceptual diagram was developed and final outreach material produced. Lessons learned and research results were shared during a lab and field tour on May 8th, 2013. Over 30 representatives from various agencies including NRCS, WDFW, Ducks Unlimited, and US Fish and Wildlife Service participated. Additionally, Farming for Wildlife has been presented at numerous international and national conferences. Select presentations are listed below:

Knight, K. 2011. Farming for Widlife: Creating wetland rotations on working farms. Soil and Water Conservation Conference, Conservation Innovation Grant Showcase. Washington, DC.

Morse, J. 2011. Farming for Wildlife: Integrating habitat conservation and crop production. Salish Sea Ecosystem Conference. Vancouver, BC. Canada.

Inglis, D.A. February 17, 2012. "Soil flooding for controlling soilborne potato pathogens in western Washington." 27th Annual Western Washington Potato Workshop. WSU Mount Vernon NWREC, Mount Vernon, WA.

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[1] Final outreach materials produced under this grant are included with this final report. Additional copies of the Farming for Wildlife guidebook are available upon request.

Inglis, D.A. June 22, 2012. "Field flooding for controlling soilborne potato pathogens in western Washington." Annual Meeting of the Pacific Division of the American Phytopathology Society. Sacramento, CA.

Inglis, D. February 22, 2013. Presentation of all 2012 soil flooding project data during "Potato research findings of 2012." 31st Annual Western Washington Potato Workshop, Mount Vernon, WA.
Knight, K. 2013. Farming for Widlife: Creating habitat rotations on working farms. Presentation to the NRCS Northwest Local Working Group. Port Townsend, WA.

Salamone-Kaltenbaugh, A. March 27, 2013. Brief laboratory demonstration on assessing soil anaerobic conditions as part of TNC project on "Soil flooding for controlling soilborne potato pathogens in western Washington." WSU-organized tour for Congresswoman Delbene, and invited stakeholders. WSU Mount Vernon NWREC, Mount Vernon, WA.

Salamone-Kaltenbaugh, A. and Gundersen, B. May 8, 2013. "Soil flooding for controlling soilborne potato pathogens in western Washington." TNC-organized tour for governmental agencies on Farming for Wildlife project. WSU Mount Vernon NWREC, Mount Vernon, WA.

I. RESULTS

Shorebirds

The abundance and diversity of species was generally greatest during the fall migration season. However, the overall greatest abundance was outside the monitoring periods as a large flock of more than 10,000 Dunlin were observed for several weeks in November 2010 at the Soltes site. There was no apparent trend in shorebird use over the two years of monitoring. However, it is interesting to note the Schmidt farm had very little use in the 2nd year of the study.

During spring migrations, a total of 9 species of shorebirds were observed at the sites with Least Sandpiper and Dunlin being the most common. Sites were used extensively over the winter and spring period by waterfowl with Green winged Teal, American Widgeon, and Northern Shoveler being the most common ducks. During the fall migration, 19 different species of shorebirds were observed on the wetland sites – this represents very high diversity of species for this region and includes several uncommon species.

As noted above, we were not able to implement treatments as designed due to an unusually wet summer in 2011 and this excluded conducting a rigorous analyses to assess the use of mowed vs. disk treatments. However, it is interesting to note that in the first year when treatments were applied, shorebird use was substantially higher in disked areas than mowed areas at all 4 sites during fall migration. But this trend did not hold into the spring migration. This would suggest that flooding immediately after disking an area provides better habitat than mowing, presumably because it provides a muddier substrate, and could bring more invertebrates to the surface. Spring use in general was lower and therefore harder to detect a difference between treatments, but was likely more influenced by water depth than vegetation management practices in the previous seasons. Most shorebird species utilize habitats with less than <10 cm water depth and areas with little or no vegetation. It can be difficult to maintain areas of shallow water during wet Western Washington springs; several of the wetland rotation sites provided better habitat for waterfowl than shorebirds during the spring periods.

Table 2. Number of shorebird surveys conducted in each season and maximum count of each species.

Fall migration 2010		**Spring migration 2011**		**Fall migration 2011**		**Spring migration 2012**	
104 surveys		47 surveys		95 surveys		58 surveys	
Species	Max count	Species	Max count	Species	Max count	Species	Max count
Baird Sandpiper	4	Black Bellied Plover	11	Baird Sandpiper	6	Dunlin	505
Black Bellied Plover	140	Dunlin	48	Black Bellied Plover	46	Greater Yellowlegs	13
Greater Yellowlegs	28	Greater Yellowlegs	11	Dunlin	7	Killdeer	9
Killdeer	63	Killdeer	4	Greater Yellowlegs	12	Least Sandpiper	932
Least Sandpiper	80	Least Sandpiper	52	Killdeer	45	Long billed Dowitcher	4
Long-billed Dowitcher	880	Peeps (unk sp)	10	Least Sandpiper	128	Semipalmeted Sandpiper	2
Lesser Yellowlegs	13	Short-billed Dowitcher	3	Long-billed Dowitcher	67	Short-billed Dowitcher	2
Pectoral Sandpiper	67	Western Sandpiper	9	Lesser Yellowlegs	24	Western Sandpiper	542
Sanderling	10	Wilson's Snipe	1	Pectoral Sandpiper	33		
Semipalmated Plover	24			Short billed Dowitcher	2		
Sharp tailed Sandpiper	1			Semipalmated Plover	54		
Solitary Sandpiper	5			Semipalmated Sandpiper	1		
Spotted Sandpiper	1			Sharp tailed Sandpiper	1		
Stilt Sandpiper	2			Solitary Sandpiper	1		
Western Sandpiper	1390			Spotted Sandpiper	1		
Wilson's Phalarope	2			Stilt Sandpiper	1		
Wilson's Snipe	66			Western Sandpiper	970		
				Wilson's Snipe	20		
				Wood Sandpiper	1		

Nitrogen and soil nutrients[2]

Wetlands can serve as both sources and sinks for nitrogen. Inputs of N occur (1) when atmospheric nitrogen (N_2) is converted to NH_4^+ through biological N fixation by specialized bacteria; (2) when incoming water, sediments, or organic matter (OM) transport N into a wetland; (3) and when mobile animals deposit excreta containing N imported from offsite. Nitrogen can be lost through (1) volatilization and diffusion, (2) leaching, (3) export of water, sediments, or OM, (4) departure of animals that have incorporated biological N from the wetland, and (5) denitrification in which N_2O serves as a terminal electron acceptor for bacteria in anaerobic substrates (Murkin et al., 2000; Reddy and Patrick, 1984; van der Valk, 2012). These processes are influenced by water levels (Baldwin and Mitchell, 2000).

Total soil organic Nitrogen in this study tended to increase in the flooded areas as well as control areas. On average, control areas had 66 kg N ha^{-1} more in 2012 than in 2010, whereas mowed fields had 287 kg N ha^{-1} more, and disked fields had 181 kg N ha^{-1} more. However, the change in total soil Nitrogen was not statistically different among mowed, disked, or control treatments.

Crop Pathogens[3]

WSU greenhouse and microplot studies on the survival of the sclerotia of three soilborne potato pathogens demonstrated that flooding may be useful in western Washington under certain soil temperature conditions for eliminating soilborne inoculum of C. coccodes (black dot) and S. sclerotiorum (white mold), but it is not effective against V. dahliae (Verticillium wilt). Further, flooding to control black dot and white mold should be part of an integrated disease management program, since both C. coccodes and S.sclerotiorum are capable of producing airborne spores which theoretically could be re-introduced from infected neighboring fields after flooding has been employed. Although soil fumigation is not often used in western Washington potato production (unlike in eastern Washington), the same precaution regarding lack of control for airborne inoculum would also apply if fumigation was used to eliminate soilborne inoculum, and flooding is regarded as a more environmentally sensitive practice than soil fumigation.

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[2] A full report written by Dr. Lynne Carpenter-Boggs detailing results of the soils study is available upon request.

[3] Full research results have been published in the following manuscripts:

Niem, J., Gundersen, B., and Inglis, D. A. 2013. Effect of soil flooding on survival of *Sclerotinia sclerotiorum* and *Verticillium dahliae*. American Journal of Potato Research. Published online July 26, 2013; DOI 10.1007/s12230-013-9332-1.

Inglis, D.A., Gundersen, B., Niem, J., and Morse, J. 2013. Field flooding for controlling soilborne potato pathogens in western Washington. Washington State University Extension Manual: EM062E.

Initial results indicate *R. solani* has very limited or no survival ability in either sterile water or flooded soil. In Test I, the fungus in the rapeseed inoculum form survived only in soil at field capacity for 3 months or in dry soil for 6 months. The reference control inoculum was still viable at 6 months, indicating a fair test. Similarly, *R. solani* did not survive in sterile water or flooded soil in Test II either. However, in Test II, the reference control inoculum was not recovered at 3 months, and survival at 3 months was noted only for the field capacity treatment. Given this variation between the two tests in the survival times for field capacity, dry soil, and reference inoculum treatments, additional experiments with a different inoculum form now are in progress.

II. TRANSFERABILITY OF RESULTS

In other countries around the world, the practice of temporary flooding has been used traditionally for centuries. However, the practice has not been widely used in the United States. It was originally tested as part of the "Walking Wetlands" program in the Klamath Basin in CA. It is now being tested extensively by rice growers in the Central Valley of CA with practices incentives from NRCS and broad support from the California Rice Commission. NRCS also supported the practice in Louisiana and other Southern states following the Gulf Oil Spill, in an effort to provide migratory birds with alternative stopover and nesting habitats to their oil-fouled habitats.

The practice of using wetland rotations for shorebird and waterfowl habitat has broad relevance throughout the world. Particularly in coastal regions, natural wetland habitats have been greatly lost due to development and conversion to agriculture. In these regions, working farmland may provide the best alternative habitat, as full restoration is unlikely on a scale large enough to support shorebird populations. Results of our studies examining the effect of flooding on soilborne pathogens suggest that the practice may be most beneficial in warmer climates as the survival of pathogens was closely correlated with warmer water temperatures.

III. CONCLUSIONS

The wetland rotation model has multiple benefits for farmers and wildlife. These studies conducted on farms in western Washington showed that farmers who use wetland rotations can improve soil health, reduce crop pathogens, and provide an economically feasible transition to organic status. At the same time, temporarily flooded fields provided vital habitat to migrating shorebirds and wintering waterfowl. The Natural Resources Conservation Service (NRCS) may offer financial support to help farmers cover the costs.

Broader adoption of the practice of temporary flooding rotation will provide important benefits. The research supported under this Conservation Innovation Grant has quantified the most important benefits of a wetland rotation, as summarized below:

Bird Habitat

- Four to six times as many shorebird species use flooded fields compared to traditional rotational crops.
- Wetland rotations can provide habitat for thousands of waterfowl and dunlin in the winter

Crop Pathogen Control

- In western Washington, flooding appears effective against black dot and white mold.
- Studies are ongoing, but flooding also may prove useful against black scurf and silver scurf.
- Flooding is an alternative to soil fumigation, although neither blocks infection by spores from outside sources.

Soil Health

- In two independent studies, total inorganic nitrogen increased on all flooded fields. Farmers gained an average of 44 pounds per acre of inorganic nitrogen on flooded fields.
- Corn, cereals, and other high-demand crops planted after a flooding rotation can best retain the newly available nitrogen.
- Purposely cultivating algae on flooded fields can further enhance soil fertility.
- Studies show no evidence that flooding causes soil compaction.

Economic feasibility

- The cost of temporary flooding rotation is highest in the first year because of berm construction. After that, site maintenance averages $300 per acre annually.
- Flooding costs depend on soils and availability of water. Typically, a year of flooding costs $200 per acre.
- The rotation could lead to savings on fertilizers and pesticides, partially or fully offsetting the cost.
- Financial incentives for temporary flooding rotations may be available from the Natural Resources Conservation Service (NRCS), enabling farmers to generate income during a transition to organic status.

APPENDIX I: MEDIA SUMMARY

HabitatSeven Educational Video: http://vimeo.com/31569313

Skagit Valley Herald, "New Project Brings Conservationists, Local Farms Together," 12/21/2006

New York Times, "Farmers and Conservationists form a Rare Alliance," 12/27/2006, http://www.nytimes.com/2006/12/27/us/27farm.html?_r=1&scp=1&sq=Farmers percent20and percent20Conservationists percent20form percent20a percent20rare percent20alliance&st=cse

KUOW Radio: "Flooding Fields to Help Shorebirds" -12/29/2006 http://kuow.org/program.php?id=12001

Nature Conservancy magazine, "Back to the Birds," Summer 2007, http://www.nature.org/magazine/summer2007/misc/art20866.html

All Bird Bulletin, "Shorebird Farming in Washington's Skagit Delta," 6/2007

NPR Living on Earth program, "Making Room for Shorebirds," 6/29/2007

KUOW Radio: "Shorebirds get a Boost from Skagit Valley Farmers," 7/2/2007 http://kuow.org/program.php?id=13105

Washington Wildlands, "Farming for Wildlife Project Gets a Boost," Spring/Summer 2008, http://www.nature.org/wherewework/northamerica/states/washington/files/aroundthestate.pdf

KUOW Radio: "Restoring the Skagit" - 8/27/2009, http://kuow.org/program.php?id=18279

National Geographic News: "'Walking Wetlands' help declining birds, boost crops." 8/18/2009, http://news.nationalgeographic.com/news/2009/08/090818-farmers-shorebirds.html

Cool green science blog: http://blog.nature.org/2009/09/skagit-river-bald-eagle-farm-wildlife-dave-mehlman/

Associated Press, Farmers Find Flooded Fields Can Help Birds, Crops, 5/17/2010 — this story went out on the Associated Press's national wire and appeared in more than 200 outlets around the country, including the Los Angeles Times, MSNBC.com, many local papers and television outlets, for a combined circulation of more than 78 million people. http://www.mynorthwest.com/?sid=321774&nid=11

KING TV, Farmers Flooding Fields to Help Birds, Crops, 5/18/2010 — after the AP story appeared, local television station KING-TV (an NBC affiliate) sent a crew out to do their own story - http://www.king5.com/news/environment/Farmers-flooding-fields-to-help-birds-crops-93935789.html

Orion Magazine, "Economics of Estuary," 9/1/2010 — Major article in national magazine about Farming for Wildlife, focusing on the questions of economic value that natural systems provide and how to quantify it. http://www.orionmagazine.org/index.php/articles/article/5828/

Benj Drummond Blog, "The Economics of Estuary," 9/28/2010 — blog post by the photographer Benj Drummond about photographing the story for Orion Magazine, with links to story and photo gallery. http://bdsjs.com/blog/2010/09/the-economics-of-estuary-for-orion-magazine/

Videos, TNC's: http://www.youtube.com/watch?v=hhLTlnrSYoo

Martin Bueller's (avid birder): http://www.youtube.com/watch?v=y_G_K5TU8cQ

Appendix II: List of Supporting Documents

We will be happy to provide any of these documents to NRCS upon request.

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Carpenter-Boggs, L., and B. Weddell. 2012 Farming for Wildlife: Can Periodic Shallow Flooding of Farmland Benefit Shorebirds and Farmers? Final Report to The Nature Conservancy, Seattle, WA

Inglis, D.A., Gundersen, B., Niem, J., and Morse, J. 2013. Field flooding for controlling soilborne potato pathogens in western Washington. Washington State University Extension Manual: EM062E.

Mehlman, D., J. Morse, and K. Morse. 2011. Farming for Wildlife: Using the Farm Bill to create wetland habitat on working farms. *National Wetlands Newsletter* 33(1): 20-22.

Morse, J. A., R. Fuller, and J. Lange. *Draft*. Integrating wetland habitat into crop rotation practices: a case study from Western Washington and the effects on migratory shorebirds. To be submitted to *Agriculture, Ecosystems, Environment*.

Niem, J., Gundersen, B., and Inglis, D. A. 2013. Effect of soil flooding on survival of *Sclerotinia sclerotiorum* and *Verticillium dahliae*. American Journal of Potato Research. Published online July 26, 2013; DOI 10.1007/s12230-013-9332-1.

Saez, H., and S. Gehr. 2010. Analysis of USDA conservation programs: paying for temporary wetlands in the Skagit Valley. Final Report to The Nature Conservancy, Seattle, WA

Saez, H., and S. Gehr. 2010b. A market approach to sustain temporary wetlands: payment for ecosystem services in the Skagit delta. Final Report to The Nature Conservancy, Seattle, WA

Saez, H., R. Nelson, and H. Winter. 2010. Enterprise budgets for wetlands and red potatoes in the Skagit Delta. Final Report to The Nature Conservancy, Seattle, WA

Slater, G.L. and R.R. Borkhateria. 2010. Space Use and habitat selection by Dunlin in estuarine and agricultural habitats of the Skagit and Stillaguamish River deltas, WA. Final report to The Nature Conservancy, Seattle, WA

Slater, G.L. and J.D. Lloyd. 2010. Farming for Wildlife: effects of flooding, forage harvest, and grazing on shorebirds, soil invertebrates, and vegetation on agricultural fields in the Skagit River delta. Final report to The Nature Conservancy, Seattle, WA

Slater, G.L. and J.D. Lloyd. 2010b. Farming for Wildlife: effects of flooding, forage harvest, and grazing on soil properties and weed abundance on agricultural fields in the Skagit River delta. Final report to The Nature Conservancy, Seattle, WA