

USDA Biomass Crop Assistance Program

Project Area 10 New York State Shrub Willow

Annual Report 2015



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Contents

1. Crop Area	3
2. Crop Utilization	6
3. Administration	7
4. Meetings with Stakeholders and Developers	8
5. Supply Chain Development	9
6. Extension Services	10
7. Education and Outreach	14
8. Future Activities	20

1. Crop Area

There are currently 1188 acres of willow biomass crops enrolled in USDA BCAP project area 10 in central and northern New York State (Figure 1, Table 1). Of these 1187 acres, 836 were planted in 2013, and an additional 351 acres of previously established crops (planted 2008 and prior) were also enrolled in the program. Mature crops on 130 previously established acres were harvested in 2013. In 2014, about 40 acres of mature crops were harvested across two sites, but wet ground conditions followed by early snowfall at the second site near Ava, NY, limited the harvest season. Harvesting resumed again on the same site in August of 2015, and about 90 planted acres of willow (not including headlands) was cut with assistance provided ESF including the use of the ESF harvester provided by Case New Holland America, operator and technical support. The biomass feedstock harvested in 2015 was delivered to the ReEnergy Lyonsdale biomass facility and combined with forest residue chips to produce renewable power and industrial process steam for an adjacent paper mill. Wet ground conditions limited access to the site in 2105,

leaving about 30 more acres to be cut at the site in 2016.

Approximately 40 acres of previously established crops near Cape Vincent, NY, were ready to be harvested in 2015, but will be cut in 2016 instead as the Celtic Energy forage harvester was allocated to other harvest sites in central Pennsylvania in partnership with the NEWBio Project for the remainder of 2015. Other willow crops in the BCAP region will also be ready to harvest in 2016,

including some new acreage established in 2013, and some previously established acreage harvested in 2013.

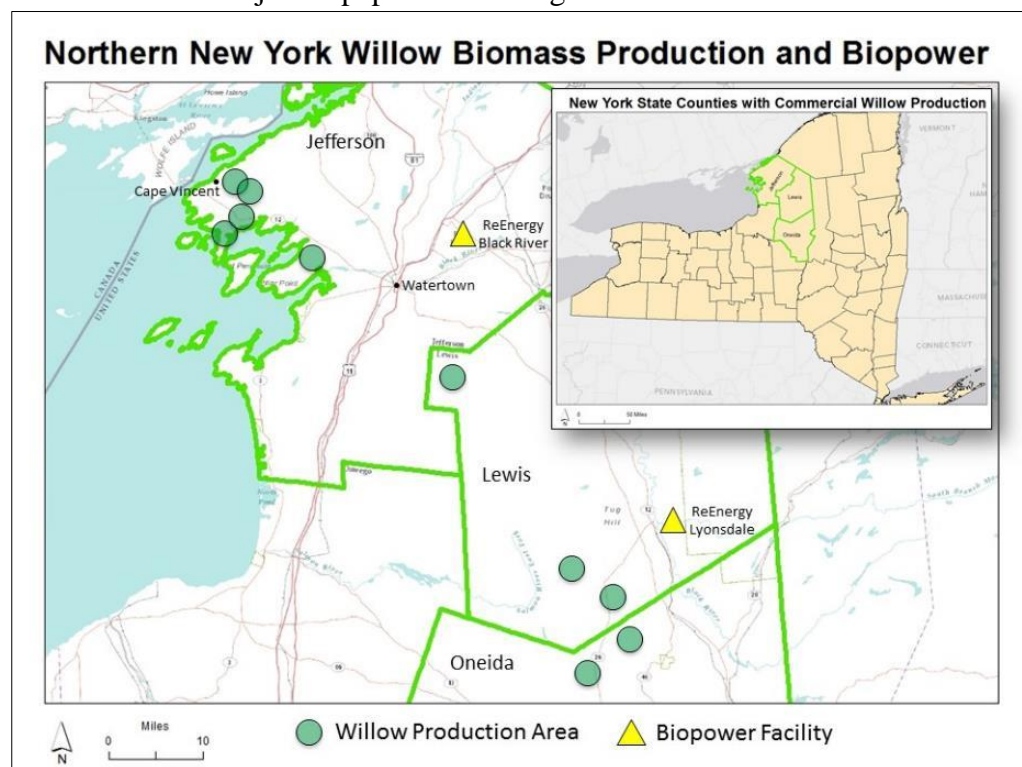


Figure 1: Willow biomass production areas enrolled in USDA BCAP project area 10 and ReEnergy biopower facilities in central and northern New York.

As more acreage matures to harvest readiness, the amount of acreage harvested annually will need to increase. With 1188 acres in the project area, about 300 acres per year will need to be harvested on a four-year rotation, or 400 acres per year on a three-year rotation. This scale-up of harvesting operations will require and catalyze improvements in logistics and efficiencies; studies of the optimal timing of willow harvests; studies on the impact on operations and feedstock quality of harvesting willow leaf-on; and prioritization of certain harvests based on site conditions, crop status and seasonal weather patterns.

These efforts will be aided by the recent grant funding secured by ESF and a number of partners from the U.S. Department of Energy to further study and optimize the use of the woody crops harvesting technology developed by Case New Holland in partnership with ESF from 2008-2012.

	Area Contracted	Planted 2013	Harvested 2013	Harvested 2014	Harvested 2015
New Acreage	837	837	0	0	0
Previously Established Acreage	351	0	130	40	90
Total	1,188	837	130	40	90

Table 1: Summary of willow biomass crops enrolled in the USDA BCAP project area in northern NY State.

New Acreage

The majority of new acreage (planted 2013) in the New York willow BCAP project area is on track to be harvested on three- to four-year rotations (Figure 2), with the first harvests likely to occur in 2016 and 2017. The majority of new crops were coppiced (cut back) by growers over the winter and early spring of 2014, in accordance with the recommended practice, to encourage more stems per plant and more vigorous growth. Some newly established crop areas have been affected by weed and pest pressures since planting, but crop monitoring efforts by ESF and timely action of growers to implement appropriate management activities have limited detrimental impacts on the crop.



Figure 2: The majority of newly established crops in the BCAP project region are healthy and on track to be harvested on the expected three- to four-year rotation, such as this field near Cape Vincent, NY, showing willow crops in June, 2015, with a 2+ year-old root system and 1+ year-old above ground stems (planted 2013, coppiced winter 2014, stems regrown 2014 plus a couple months in 2015).

Other areas in the project region totaling about 70 acres, for which a replanting request was filed with USDA FSA in 2014, have exhibited poor survival and growth due to a variety of factors including late establishment and unfavorable weather conditions (hot followed by dry) around the time of planting. Subsequent monitoring and analyses conducted in 2014 and 2015 have shown that the crops in these areas continue to underperform, and will not be ready to harvest on the normal three- or four-year rotation, and may not support substantial willow biomass production in a reasonable time frame without replanting and/or other remediation efforts due in part to poor soil conditions such as excessive or inadequate drainage, nutrient deficiency, low pH and shallow depth to bedrock; as well as additional pressure from competing vegetation and pests like leaf sawfly.

Previously Established Acreage

About 130 acres of mature crops (planted 2008 and prior) contracted under this BCAP application were harvested and delivered to the ReEnergy Lyonsdale facility in 2013. Coppice regrowth on these harvested fields was monitored throughout 2014 and 2015 by ESF. Regrowth from the cut stools and well-established root system was vigorous and quickly filled in the willow canopy controlling competing vegetation in 2014 and allowing the willow to dominate the site and maximize productivity. At the end of the 2015 growing season, the majority of crops on these previously harvested acreages were 12-18 feet in height (Figure 3), on par with expected growth rates, with good branch density and high plant survival. No major incidents of competing vegetation, pests or diseases were identified, although some small pockets (<3 acres each) of underperforming crops were identified and will be monitored again in 2016. The majority of crops on previously harvested acreage are now on target to be harvested again on a regular three- or four-year rotation cycle.



Figure 3: This field of previously established willow in near Booneville, NY, in the BCAP project area was harvested in 2013. This picture was taken in June of 2015, representing a 6+ year-old root system and 1+ year-old above ground stems (planted 2008, harvested in fall 2013, stems regrown in 2014 plus a couple months in 2015).

2. Crop Utilization

Willow harvested from about 90 acres managed by Celtic Energy in the BCAP project region was delivered to the ReEnergy Lyonsdale facility and combined with forest residue chips (Figure 4) to produce renewable power and industrial process steam in 2015. The 2015 harvest produced 1,750 green tons of willow, or about 19.4 green tons per planted acre on average. This does not include losses that occur along the system such as material dropped in the field or left on the ground to minimize soil contamination in the delivered chips, or to improve site conditions in certain areas. The resulting delivered biomass is a good yield for this site, which is marginal land and was not well established or managed under the previous land managers. Future harvests should produce even better yields per acre now that the plants have been coppiced. Chip samples were collected by ESF at the field edge and by ReEnergy at the plant gate. Preliminary results show moisture content at the higher end of, but within, the range from previous harvests, despite this harvest beginning earlier in the season when leaves still persisted on the willow plants. Ash content is also expected to be slightly higher, but in the same range as previous harvests due to the leaf matter. ReEnergy incorporated this year's willow crop with their other woody feedstocks. It was piled separately in the yard this year and combined with other chips using a loader.

The first willow feedstock delivered to ReEnergy in 2013 (2,477 green tons) was piled separately while plant operators gained experience with willow for the first time and carefully mixed the willow with other feedstocks. Willow delivered in 2014 (about 540 green tons) was combined with other feedstocks upon arrival on the main chip pile in the wood yard, which also did not result in any operational challenges. The early harvest with leaves still on the willow in 2015 was reason enough to pile the willow feedstock separately and experiment again, carefully mixing the willow with other feedstocks. Because no operational challenges were encountered with the willow feedstock in 2015, and the quality characteristics are in the same range as previous leaf-off harvests, it can be expected that the willow will not be handled as a separate feedstock in need of special handling in 2016 and beyond.



Figure 4: A trailer of forest residue chips is dumped on the lift at the ReEnergy Lyonsdale biomass facility in September, 2015, around the time when willow feedstock was being delivered and incorporated into the facility operations to generate renewable power and steam.

3. Administration

- In January, ESF and ReEnergy compiled a 15-page annual report for 2014 and submitted it to USDA BCAP administrators in Washington, D.C and Syracuse, NY. The second annual report from the project region detailed all related willow activities occurring in 2014, extension and outreach efforts by ESF, and prospects for expanded production if more BCAP funding were to be released in the future to expand the project. A copy of the report was made publicly available at <http://www.esf.edu/willow/bcap.htm>.
- In January, ESF was the lead organization on a \$5.8 million grant application to the U.S. Department of Energy under the sustainable landscape design for bioenergy systems FOA entitled: “Expansion and integration of shrub willow crops with forest biomass and other landscape elements for bioenergy, bioproducts and bioremediation”. The grant was not awarded to ESF, but only \$9 million of the announced \$18 million was awarded, to one project led by the Antares group. ESF will continue to monitor opportunities to engage in this type of applied research for integrated landscape-scale planning and optimization of willow bioenergy systems that includes multi-stakeholder engagement, extension services, multiple-use and value-added systems, and comprehensive sustainability analyses on commercial acreage.
- On February 27th, the USDA officially announced a request for comments on the new rules of BCAP in accordance with legislation of the 2014 Farm Bill. ESF drafted and submitted a response to this request in collaboration with ReEnergy, Cato Analytics, and New York willow growers.
- In March and April, ESF had several in-person meetings and conference calls with senior staff at ReEnergy on the prospect of expanding willow biomass production in the project region if more BCAP funding were to become available.
- In June, ESF facilitated a phone conference with USDA FSA offices in Syracuse and Washington D.C. and ReEnergy regarding the possible expansion of the willow BCAP project. All parties agreed to a target of expanding current production area up to 2,500 acres.
- In September, a series of eight meetings were held in the project region to provide information to landowners and stakeholders interested in participating in BCAP. Four events were held at county USDA offices with support from USDA FSA staff, and four events were held at willow field locations in cooperation with Celtic Energy. Meeting dates, times and locations were sent to about 75 individuals via email, many of whom distributed the information further. Despite efforts to advertise the events, turnout was low, given the available notice time of about a week, and the fact that USDA FSA offices did not receive official correspondence to advertise the program. Two informational webinars were also held in September to support enrollment in cooperation with NEWBio, ReEnergy and USDA. Unfortunately, no new acreage was able to be enrolled during the sign-up period in 2015. However, there were some positive interactions with landowners in the region and they expressed interest in pursuing willow if there was more time to work out details with the program and potential custom operators for planting and harvesting.
- In December, ESF began working with NEWBio to evaluate past and potential future opportunities and challenges of expanding USDA BCAP for the NY willow project region. The short enrollment window, most recently just a few weeks’ time in September 2015, has been a barrier for ESF and USDA staff to implement a comprehensive outreach and enrollment program. It is also considered to be a barrier to potential landowners and growers who would benefit from more time to consider investing in the relatively high startup costs and long-term payback of willow, which is still largely a novel energy crop despite years of research and more

recent outreach, education and extension efforts. These challenges are magnified by the uncertainty of funding availability, funding amounts, timing, duration, and other details leading up to official BCAP announcements.

These barriers were evident during and after the last sign-up period when one prospective willow producer attended information meetings and subsequently contacted ESF with interest/intent to enroll up to 800 acres of land in BCAP, but was apparently unable to do so under the deadline. Vertically-integrated business models that transfer crop management and risk from individual landowners to businesses appear to be an emerging model for the industry, but it is challenging for new businesses, if relying on BCAP incentives, to be formed around such narrow enrollment windows of opportunity and uncertainty of funding. ESF and NEWBio are documenting and evaluating these and other barriers and engaging with a range of commercial partners to develop potential strategies to overcome them.

4. Meetings with Stakeholders and Developers

- Throughout 2015, ESF met with growers in the field and conversed via phone and email as necessary to support crop management and harvesting activities
- Throughout 2015, ESF engaged with several developers and regional stakeholders interested in heating, power, bioremediation and other applications of willow at different scales. ReEnergy is currently a stable primary market for willow in the region, especially the ReEnergy Black River facility which has a 20-year power purchasing agreement with the Fort Drum U.S. Army installation, but developing additional markets and working with potential end users is important to the overall expansion of the willow industry, and ReEnergy is supportive of these efforts.
- In March, ESF met with a willow stakeholder focus group in Watertown, NY, as part of ongoing research on the human dimensions of bioenergy conducted by the Department of Environmental Studies at ESF. Stakeholders represented included local environmental councils, extension agents, economic development council members, agricultural professionals, etc.
- In May, ESF hosted a phone conference with BCAP growers on harvesting logistics for the upcoming season and plans for integrating operations with new ESF's DOE-funded research grant.
- In August, ESF met with various academic and industry stakeholders in the willow and bioenergy field at the NEWBio annual meeting in Morgantown, WV. Here ESF and other NEWBio collaborators held a group meeting with Case New Holland to begin planning use of Celtic Energy and ESF equipment to harvest numerous willow sites in NY and PA, beginning in August.
- In October, ESF met with scientists from the Army Corps of Engineers at the ESF research station in Tully, NY and conversed by phone and email regarding a bioremediation project using willow in the Buffalo, NY area.
- In November, two loads of willow harvested from an ESF yield trial in the project region was provided for test burns to a local stakeholder interested in heating with, and growing willow. A follow-up meeting with the stakeholder about his experiences with the willow feedstock indicated he was happy with the quality of the material and able to integrate it into his biomass boiler (used to heat a 16,000 sq. ft. building) and easily mix it with other woody biomass feedstocks available in the area.

- In December, discussions were held with a group that is exploring repowering the Huntley power plant in western New York to include biomass. Information on willow crop potential and anticipated job creation associated with willow biomass crops was shared by ESF with organizations developing this idea.
- In December, ESF traveled to Penn State University to meet with the NEWBio project leadership team to facilitate and provide feedback on lifecycle and techno-economic analysis scenarios modeling willow supply chains in the BCAP project region.

5. Supply Chain Development

- Project staff continued the evaluation of land potentially available for willow biomass in central and northern New York. The initial analysis of suitable land based on contiguous tax parcels has been further refined this year based on filters including land cover type, land use classification, slope, etc. This analysis will enhance future efforts by ESF and other stakeholders to garner support for the expansion of bioenergy plantings in the region, predict potential yields, analyze potential impacts of land-use change, conduct targeted outreach, and move towards spatially explicit optimization and integration of willow on the landscape. A large land base exists within the ReEnergy feedstock supply-shed that is suitable to grow willow in a variety of land cover types other than row crops, potentially making productive use of idle land in the region. The map to the right (Figure 5) shows the suitable land around the ReEnergy Black River facility. The same analysis was also conducted for the ReEnergy Lyonsdale facility.

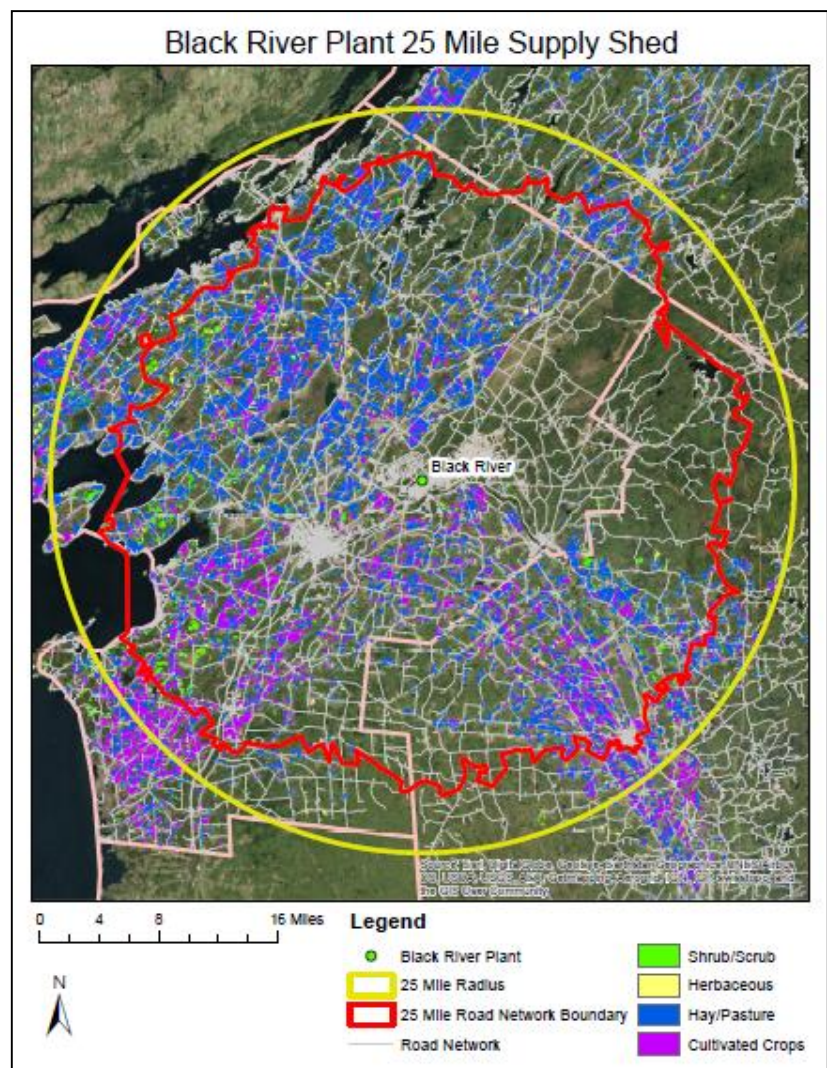


Figure 5: Map produced by ESF analysis showing suitable land for willow production around the ReEnergy Blackriver biopower facility. This analysis showed that there are about 170,000 suitable acres within this 25 mile road network. The majority (110,000 acres) is currently in hay or pasture.

- ESF is contributing LCA and TEA by the NEWBio group, providing researchers with information about the logistics of BCAP willow operations in central and northern New York, assumptions, and other details necessary for analysis. ESF will contact ReEnergy and other stakeholders to obtain other necessary information. These scenarios will evaluate the production and use of willow, using economic and environmental metrics, along with other regional bioenergy crops through various supply chains and conversion processes.

6. Extension Services

To assist BCAP growers and other stakeholders in the expanding willow industry in New York State, ESF, with support from NYSERDA and NEWBio, is providing a range of technical, analytical and educational extension services. Some highlights of these activities from 2015 are provided below.

Willow Equipment Access Program

- ESF continues to manage the willow equipment access program for NEWBio, coordinating the use of harvesting equipment owned by Celtic Energy Farm and ESF. Updates of the program are discussed on a monthly NEWBio conference call, bimonthly updates are provided to stakeholders by email, and regular email and phone conversations are conducted to coordinate the use of machinery. Links to online documents containing updates and notes about these operations and a list of sites and progress has been circulated to stakeholders. These documents are updated regularly as necessary, and stakeholders can check them at any time for the latest news.
- About 140 acres were harvested in 2015 across four sites using the Celtic and ESF harvesters (including over 90 acres across two sites in the BCAP project region). The Celtic harvester was moved to Rockview, PA at the end of 2015 to cut another 30-acre site, managed by Penn State, in early 2016. ESF most recently completed harvesting a 30-acre site near Syracuse, NY (Figures 6 and 7). ESF has another 30-acre site in Syracuse to cut, and is working with New Holland and Canadian agricultural firm AGRINOVA to arrange harvest of 50 acres of willow and several acres of hybrid poplar in Quebec. A summary of all harvest operations conducted in 2015 is available on the NEWBio blog.
<http://nebioenergy.blogspot.com/2015/12/willow-harvesting-updates.html>



Figure 6: Harvesting a willow vegetative-cap site near Syracuse, NY, in November 2015.



Figure 7: Unloading a wagon of willow chips from a harvest near Syracuse, NY, in November, 2015.

Crop Scouting

- As part of ongoing extension services being provided to the willow bioenergy industry in central and northern New York State, ESF, in partnership with NYSERDA and NEWBio, are providing crop scouting services to willow growers. Several student research assistants were trained in 2014 and spring of 2015 to perform scouting on commercial willow crops and conducted these operations throughout the 2015 growing season. Crop scouting of willow includes assessments of coppice regrowth, overall plant health and vigor, pressure from competing vegetation (weeds), incidence of pests and disease and other observations. Eleven sites were visited encompassing about 1,050 acres of willow fields. Observations were recorded in written notes and in photos using GPS-enabled cameras. Areas of particularly low growth were mapped using hand-held GPS units for further analysis of the underlying soil characteristics and possible insights into soil-related factors contributing to low growth. Full reports of these efforts were made available to growers periodically throughout the season, along with Google Earth files which allowed growers to view geo-tagged photos of the crop in the precise locations the photos were taken in the field. Management recommendations based on observations were provided in reports, and in discussions with growers.

Overall, the condition of the willow crops is good and on track to be harvested on normal three- to four-year rotations. Some areas of low growth, high weed or pest pressure will be managed accordingly based on recommendations by ESF at the grower's discretion. GIS analysis of low growth areas is being conducted by students with oversight of research staff at ESF to determine if there are any significant correlations between low-growing areas and soil properties identified by soil sampling and NRCS data, which could lead to further management prescriptions for the crop. The primary pest encountered thus far in two years of crops scouting has been leaf sawfly which has caused defoliation and delayed some crops, although not substantially in most cases. The worst impact of this pest has been on already low-growing areas that are suffering multiple stressors and may not be able to produce harvestable biomass in a reasonable timeframe without replanting or more intense management, although this acreage is small relative to the project area of 1188 acres. No major incidence of disease has been spotted, although cankers have been observed sporadically.

- ESF began testing the DJI Phantom 3 model unmanned aerial vehicle (UAV) for crop scouting the interiors of large commercial willow fields, which cannot otherwise be seen from the ground once the crop grows above eye level. The UAV was tested on willow at the ESF research station in Tully, NY. A few images and videos were able to be recorded during test flights (Figure 8). Preliminary analysis of the test-flight video and photographs indicated that this UAV will be a valuable tool for crop scouting commercial willow fields and other related purposes and provide vantage points for observation that would otherwise be unattainable. The UAV will be used more extensively in spring and summer of 2016 to continue crop scouting large willow fields and parcels, 50-250 acres in size.



Figure 8: Example of aerial image of shrub willow plantings taken using a UAV at the ESF research station in Tully, NY. This photo of a cultivar yield trial was taken from a height of about 75 feet.

- The UAV was used for crop scouting the interiors of large commercial willow fields was utilized at a willow vegetative cap site near Syracuse, NY to scout a 25-acre planting that has not grown as expected, and has experienced a high level of weed completion. Based on the crop scouting videos and photos taken, parts of the planting and will likely need to be replanted in spring 2016.

Financial Analysis Tool

In 2014, ESF's economic model for willow production, EcoWillow 2.0, was comprehensively updated along with supporting documentation. In 2015, ESF worked with several stakeholders in the project region who were considering willow production and BCAP enrollment to use the model and evaluate their own potential production scenarios. Over the course of 2015, the model was downloaded by about 140 unique users. An hour-long instructional webinar on how to use the model was conducted by ESF and hosted by NEWBio in February, 2015. About 50 people attended the live webinar and the video recording posted to YouTube has since been viewed about 140 times. ESF is continuing to gather feedback from stakeholders for future improvements to the model, and noting areas that can be updated and improved from the latest research and observations of commercial willow production in the BCAP project region. An article about the model was also published in the Willow and Poplar Newsletter of the International Poplar Council (citation below). In December, ESF began working with a group from

Argonne National lab to run EcoWillow scenarios that model the use of willow as a dedicated crop and in combination with corn as a buffer crop in the Midwestern U.S.

7. Education and Outreach

To assist BCAP growers and to support and grow the knowledgebase of current and potential willow stakeholders, ESF continues to provide a variety of educational and outreach programming in and around the project region. The following is a summary of the content produced and activities undertaken in 2015.

Extension Publications

1. **Case Study:** “Double A Willow Strengthens Biomass Supply Chain by Providing Willow Plantings to Biofuels Industry”
 - <http://www.extension.org/pages/72990/>
2. **Case Study:** “New Holland Agriculture Expands Offerings for Biomass Harvest and Handling”.
 - <http://www.extension.org/pages/73015/>
3. **Fact Sheet:** “Introduction to Shrub Willow”.
 - <http://www.esf.edu/willow/documents/1IntroToShrubWillow.pdf>
4. **Fact Sheet:** “Willow Bioenergy in New York State”
 - <http://www.esf.edu/willow/documents/2NewYorkWillow.pdf>
5. **Fact Sheet:** “Site Selection for Willow Bioenergy Crops”
 - <http://www.esf.edu/willow/documents/6CropProductionCycle.pdf>
6. **Newsletter Article:** Heavey JP and Volk TA, 2015. EcoWillow 2.0: Economic Analysis of Willow Bioenergy Crops. Willow and Poplar News: Issue 5, July 2015. International Poplar Council, Food and Agriculture Organization of the United Nations.
 - http://www.esf.edu/willow/documents/newsletterEN_July2015.pdf

Northeast Bioenergy Blog

- Throughout 2015, twelve blog posts on various willow-related topics.
 - <http://nebioenergy.blogspot.com/>
- **Social Media**
 - Continued regular contributions to the NEWBio Twitter feed with dozens of willow-related tweets in 2015
 - <https://twitter.com/NEWBioProject>

Digital Commons at ESF

- ESF worked with library staff to create a page for The Willow Project on ESF’s digital commons institutional repository to serve as an archive of publications, student work and other media that is publically accessible and searchable in numerous ways including key words. This will create a long term home for many files such as theses and conference proceedings and provide additional content not available on the willow website.
 - <http://digitalcommons.esf.edu/willow/>

Willow Website

- Maintenance and updates to the ESF willow website (www.esf.edu/willow) continued throughout 2015 and site traffic remained steady. Highlights from this year include:
 - 10,552 total page views.
 - 1,285 downloads of the popular new willow brochure.
 - 1,157 views of the publications page
 - 842 views of the EcoWillow page
 - 581 views of the projects page
 - 250 views of the BCAP page

Stakeholder E-News Letter

- Regular contributions and announcements featured in the NEWBio electronic newsletter.

Videos

1. The previously recorded webinar on EcoWillow has been viewed over 140 times in less than one year since it was posted. <https://www.youtube.com/watch?v=4Mf8T46Mbvq>
2. Other previously recorded webinars also continue to draw viewers. “Willow Biomass Harvest and Quality” (October 2014) has been viewed over 530 times since first uploaded just over a year ago. <https://www.youtube.com/watch?v=9wv1PIw-DOA>
3. In April, ESF facilitated a video crew from the US DOE for a weeklong visit to New York with various stops in the BCAP project region, including ReEnergy Lyonsdale. The video produced by this effort is now available from DOE and highlights willow activities among other bioenergy production areas across the country. The video has been viewed over 3,250 times since being posted to YouTube in late July. <https://www.youtube.com/watch?v=e3mXOt2a5uI&feature=youtu.be>

Field Tours and Events

1. Willow biomass crop tour. 45 minute tour and discussion of willow biomass crops for undergraduate biomass energy class at SUNY-ESF, 38 participants.
2. Willow Bioenergy Workshop. First 90-minute classroom and field tour for SUNY Cortland students. Tully, NY. March 24, 2015. 20 participants.
3. Willow Bioenergy Workshops. Second 90-minute classroom and field tour for SUNY Cortland students. Tully, NY. March 26, 2015. 20 participants.
4. Willow Bioenergy Workshops. Third 90-minute classroom and field tour for SUNY Cortland students. Tully, NY. March 26, 2015. 20 participants.
5. Syracuse Symposium on Energy Conference. Tour of Willow and Woody Biomass Research at ESF. Syracuse, NY. April 17, 2015. 7 participants.
6. Celebrate the Earth by Going Green. Museum of Science and Technology. Willow brochures and cuttings handed out. Syracuse, NY. May 16, 2015. 40 participants.
7. Guinness World Record Attempt: Most Trees Planted in One Hour. Hosted by ReEnergy and the Sustainable Forestry Initiative at Sand Flats State Forest in willow BCAP project area, Boonville NY. May 22, 2015. 50 participants.

8. Field Tour: Woody Biomass Production and End Use for Renewable Bioenergy. Booneville and Port Leyden, NY. June 12, 2015. 5 participants.
9. Willow Bioenergy Workshop. Project Engage: Sustainability and Alternative Energy. Two-hour classroom and field event hosted at ESF for STEM summer camp. Syracuse, NY. July 16, 2015. 40 participants (Figure 9).
10. Willow biomass crops for bioenergy and environmental applications. Presentation and field tour of willow biomass crops to Northeast State Foresters meeting. Tully, NY, Oct. 7, 2015. 20 participants.
11. Willow biomass crops as a source of renewable energy and for agroforestry applications. Presentation to Indian Foresters Institute, Fenner, NY, October 12, 2015. 40 participants.
12. Willow Biomass Production and End Use. South Jefferson High School, Cornell Cooperative Extension and ReEnergy. Booneville and Lyonsfalls, NY. November 5, 2015. 25 participants.
13. Willow Biomass Production and End Use. Copenhagen High School, Cornell Cooperative Extension and ReEnergy. Booneville and Lyonsfalls, NY. November 13, 2015. 25 participants.

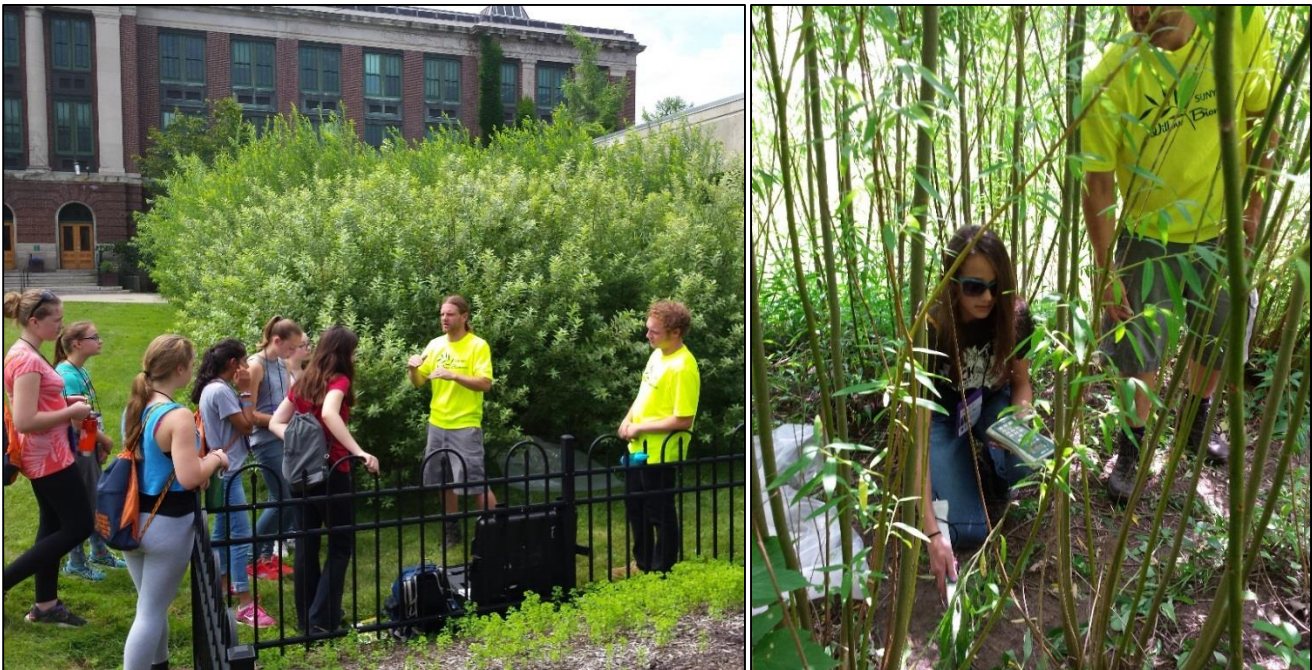


Figure 9: Students learning about willow and scientific data collection as part of the Project Engage summer camp activity on bioenergy and sustainability hosted at ESF in July.

Regional Presentations

1. Heavey, J.P. and Volk T.A. Willow Biomass and Bioenergy. Willow focus group. Watertown, NY. May 13-14, 2015. 7 participants.
2. Volk, T.A, M.H. Eisenbies and J.P. Heavey. Bioenergy Potential in NY. Adirondack Research Consortium Annual Conference. Lake Placid, NY. May 13-14, 2015. 100 participants.
3. Heavey, J.P, T.A Volk and M.H. Eisenbies. Willow Bioenergy and Environmental Benefits. Oswego County Management Council. Oswego, NY. May 22, 2015. 7 participants.

4. Volk, T.A. Panel Moderator: Sustainability of the Forest Resource and Long Term Outlook for Biomass Heating in NY. 2015 Clean Energy Economy Conference. Utica, NY. June 11-12. 40 participants.
5. Volk, T.A. Sustainability and Energy. Project Engage: Sustainability and Alternative Energy, SUNY-ESF. July 6, 2015. 40 participants.
6. Heavey, J.P. Willow Biomass and Bioenergy. SUNY Oneonta, Careers for Environmental Professionals Class. November 19, 2015.

National Presentations

1. Volk, T.A. and M.H. Eisenbies. 2015. Improved advanced biomass logistics utilizing woody feedstocks in the Northeast and Pacific Northwest. DOE Panel Review Meeting, Alexandria, VA, March 23-26, 2015
2. Volk, T.A. and M.H. Eisenbies. 2015. Development and deployment of a short rotation woody crops harvesting system based on a Case New Holland forage harvester and SRC woody crop header. DOE Panel Review Meeting, Alexandria, VA, March 23-26, 2015.
3. Rials, T., B. Berguson and T.A. Volk. 2015. Regional feedstock partnership: Woody crop. DOE Panel Review Meeting, Alexandria, VA, March 23-26, 2015.
4. Eallanardo, A., T.A. Volk, L.P. Abrahamson, D. Daley, C. Calkins and M. Markert. 2015. Development of a willow based evapotranspiration cover system. Society of American Military Engineers, Kansas City, MO. March 30-31, 2015.
5. Heavey, J.P., T.A. Volk, and M.H. Eisenbies. 2015. Willow Bioenergy: Extension approaches to common questions and challenges". 2015 National Energy Extension Summit. Seattle, WA. Poster Presentation. April 8, 2015 (Poster).
6. Volk, T.A. 2015. Sustainability of bioenergy systems. Department of Biological and Environmental Engineering, Cornell University, Ithaca, NY, April 29, 2015.
7. Green, V., S. Boggess, N. Sleight and J. Griswold. Biomass Crop Assistance Program (BCAP): Incentives for New Land Enrollments. NewBio Webinar, April 30, 2015.
8. Dale, V.H., K.L. Kline, T.A Volk, C.T. Smith and I. Stupak. 2015. Incorporating Bioenergy into Sustainable Landscape Designs Informs Opportunities, Barriers, and Paths Forward, US DOE Bioenergy 2015, Washington, DC, June 23-24, 2015 (Poster).
9. Eisenbies, M.H., T.A. Volk and J. Posselius. 2015. Chip quality and the performance of a New Holland short-rotation woody crop harvesting system in willow biomass crops. US DOE Bioenergy 2015, Washington, DC, June 23-24, 2015 (Poster).
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Research Support

ESF continued to conduct and support various research projects in and around the willow BCAP project area (Figures 10 and 11) including harvesting and logistics, willow chip quality and variability, use of willow by insect pollinators, feedstock improvement, GIS supply chain analyses, life cycle and techno-economic analyses, willow vegetative caps, water quality and greenhouse gas emissions.



Figure 10: Active research in the project region, willow stems are weighed in a cultivar yield trial to determine biomass production (and disease and pest resistance) of improved varieties on a range of sites and conditions.



Figure 11: Active willow research in the project region, a water quality/quantity and greenhouse gas emissions study conducted on commercial willow of various ages and nearby corn and hay fields.

8. Future Activities

ESF will continue to assist BCAP growers with crop scouting, crop management and harvesting in 2016 and provide information and technical assistance as necessary. Efforts will continue, with support from NYSERDA and NEWBio, to provide a variety of extension services and disseminate the latest information and educational materials. Ongoing research projects at ESF to support commercial willow production will continue and additional projects will likely be undertaken as well. ESF will continue to work closely with ReEnergy and other potential end users for the expansion willow industry in the region. If additional BCAP funding to expand the project area should become available in 2016, ESF will again engage with ReEnergy to review the possibility of contracting for increased acreage. If an opportunity exists, ESF will work with USDA FSA and project partners to publicize the program availability, hold field and classroom events, and facilitate signups in any way possible. ESF will continue work on supply-chain development and seek out opportunities for collaborative, landscape-level assessments and stakeholder engagement to grow the base of support for willow in the region and increase efficiencies and profits across the supply chain. Numerous opportunities exist for expanding the regional willow industry and making it more profitable for producers and users. These include the development of increased integration and synergies with other feedstocks for power, steam, heat and cogeneration systems; the development of additional markets and end-use applications such as pellet production and biorefinery pathways; bioremediation of municipal wastes and former industrial sites; an expanded and strengthened network of regional stakeholders; further innovations across the supply chain; applied research projects; and further integration with other elements of the regional bioeconomy for multiple environmental, economic and social benefits.