PINEMAP Year 2 Interim Report 2
November 2012
Aim 4—Economics & Policy

Outcomes/Impacts

Describe how Aim-level activities, results, findings, techniques, or products contribute to project-level outcomes and impacts.

Aim 4 activities contribute to project-level outcomes and impacts by providing the economic analysis that will underpin land manager decision-making in future management and climatic conditions. From the stand- to the regional-scale, economic impacts of disturbance, climate, management, and policy alternatives must form the basis of any viable and sustainable management change. Policy analysis will enable PINEMAP stakeholders to better assess management responses to future policy changes. Quantification of different ecosystem services will lead to a better understanding of tradeoffs among carbon, timber, and biodiversity. Finally, the life cycle assessment (LCA) carried out in this Aim will provide the framework necessary to analyze the stand to regional carbon sequestration implications of changes in management regimes.

Outputs

List ***Products*** developed/completed January 2012-current (including published, in press, or in review peer-reviewed publications; other written materials such as white papers, research summaries, fact sheets, or popular press articles; audio or video products; etc.).

Aim 4 Peer-reviewed Publications (January-November 2012)

Abt, K., R. Abt, and C. Galik. 2012. Effect of bioenergy demands and supply response on markets, carbon and land use. *Forest Science* 58(5): 523-539. doi: http://dx.doi.org/10.5849/forsci.11-055

Dwivedi, P., J. Gan, R. Bailis, M. Khanna. 2012. Large capacity forest biomass power plants may or may not reduce greenhouse gas emissions. *Environmental Science & Technology*, in review.

Galik, C.S. and R.C. Abt. 2012. The effect of assessment scale and metric selection on the greenhouse gas benefits of woody biomass. *Biomass and Bioenergy* 44: 1-7.

Gan, J., C.T. Smith, and J.W.A. Langeveld. 2012. Effects of considering greenhouse gas consequences on fertilizer use in loblolly pine plantations. *Journal of Environmental Management.* doi: http://dx.doi.org/10.1016/j.jenvman.2012.09.015

Gruchy, S.R., D.L. Grebner, I.A. Munn, O. Joshi, and A. Hussain. 2012. An assessment of nonindustrial private forest landowner willingness to harvest woody biomass in support of bioenergy production in Mississippi: A contingent rating approach. *Forest Policy and Economic*s 15: 140-145. doi: http://dx.doi.org/10.1016/j.forpol.2011.09.007

Henderson, J., I.A. Munn, D.L. Grebner, and S. Roberts. A comparison of loblolly pine growth and yield models. *Southern Journal of Applied Forestry*, in review.

Joshi, O., D.L. Grebner, A. Hussain, and S.C. Grado. Landowner knowledge and willingness to supply woody biomass for wood-based bioenergy: Sample selection approach. *Journal of Forest Economics*, in review.

Joshi, O., D.L. Grebner, I.A. Munn, and A. Hussain. Determinants of forest landowners' choice for preferred harvesting methods to supplying woody biomass in Mississippi. *Forest Science*, in review.

Kreye, M.M., D.C. Adams, and F.J. Escobedo. The value of forest conservation for water quality protection. *Forest Policy and Economics*, in review.

Nepal, P., Grala, R.K., and D.L. Grebner. 2012. Financial feasibility of increasing carbon sequestration in harvested wood products in Mississippi. *Forest Policy and Economics* 14(1): 99-106. doi: http://dx.doi.org/10.1016/j.forpol.2011.08.005

Nepal, P., R.K. Grala, and D.L. Grebner. 2012. Financial implications of enrolling to Mississippi forest landowners in carbon offset programs. *Southern Journal of Applied Forestry* 36(1): 5-10. doi: http://dx.doi.org/10.5849/sjaf.09-067

Nepal, P., R.K. Grala, D.L. Grebner, and R. Abt. Impact of harvest-level changes on carbon accumulation and timber stumpage prices in Mississippi. *Southern Journal of Applied Forestry*, in press.

Perez-Verdin, G., J.J. Navar-Chaidez, D.L. Grebner, and C. Soto Alvarez. 2012. Availability and production costs of forest biomass as a feedstock for bioethanol production. *Forest Systems* 21(3): 526-537. doi: http://dx.doi.org/10.5424/fs/2012213-02636

Susaeta, A.I., D.R. Carter, S.J. Change, and D.C. Adams. The impact of hurricane risk on optimal forest management in southern U.S. pine plantations: Application of a generalized Reed model. *Canadian Journal of Forest Research*, in review.

Susaeta, A.I., D.R. Carter, and S.J. Change. Economics of carbon sequestration under fluctuating economic environment, forest management and technological changes: an application to forest stands in the southern United States. *Journal of Forest Economics*, in review.

Susaeta, A.I., C.A. Gonzalez-Benecke, D.R. Carter, T.A. Martin, and E.J. Jokela. 2012. Economical sustainability of pinestraw raking in slash pine stands in the southeastern United States. 2012. *Ecological Economics* 80: 89-100. doi: http://dx.doi.org/10.1016/j.ecolecon.2012.05.010

Timilsina, N., W. Cropper, Jr., F. Escobedo, and J. Tucker. Predicting species richness in forest inventories using regression tree analyses: Implications for assessing ecosystem service trade-offs (To be submitted).

Timilsina, N., F. Escobedo, W. Cropper, Jr., T. Brandeis, S. Delphin, and S. Lambert. A framework for identifying carbon hotspots and forest management drivers. *Journal of Environmental Management*. doi: http://dx.doi.org/10.1016/j.jenvman.2012.10.020

Wojcik, D.J., M.C. Monroe, D.C. Adams, and R.R. Plate. Message in a bottleneck?: Attitudes and perceptions of climate change in the U.S. Cooperative Extension Service. *Climatic Change*, in review.

Summarize ***Events/Activities*** (January 2012-current) as follows:

→ Provide a bulleted list of presentations (oral and poster) given at meetings or conferences. The format for citing presentations is as follows: Presenter(s)/Author(s). Date. Name/title of meeting/conference, location.

Adams, D.C., "Integrating Biophysical and Economic Values of Wetlands: Recent Advances in Ecosystem Service Valuation." 9th INTECOL International Wetlands Conference, Orlando, FL (USA), June 4, 2012.

Adams, D.C., J. Soto, and F. Escobedo. "Estimating the Supply Of Forest Carbon Offsets: A Comparison Of Best-Worst And Discrete Choice Valuation Methods." Paper accepted for presentation at the ACES and Ecosystem Markets conference, Ft. Lauderdale, FL, December 10-14, 2012.

Grebner, D.L., O. Joshi, I.A. Munn, S.R. Gruchy, and A. Hussain. Are non-industrial private forest landowners willing to support woody biomass harvesting for bioenergy? Paper presented at 18th international symposium on Society and Resource Management (ISSRM) conference, The University of Alberta, Edmonton, Canada. June 17-22, 2012.

Joshi, O., D.L. Grebner, I.A. Munn, A. Hussain, and S.R. Gruchy. Analyzing landowners' preferred harvesting methods for supplying feedstock to potential wood-based bioenergy industries: A choice experiment approach. Paper presented made at Society of American Foresters National Convention, Spokane, Washington, October 24-28, 2012.

Joshi, O., D.L. Grebner, A. Hussain, and S.C. Grado. Landowner knowledge of and willingness to supply woody biomass for bioenergy in Mississippi. Paper presented at IUFRO 4.05.00-Managerial economics and accounting annual symposium, Knoxville, Tennessee. June 6-9, 2012.

Joshi, O., D.L. Grebner, I.A. Munn, S.C. Grado, R.K. Grala, and J.E. Henderson. An econometric analysis of utilizing unused woody biomass from wood processing facilities in Mississippi. Paper presented at Southern Forest Economics Workers Meeting, Charlotte, North Carolina, March 19-22, 2012.

Joshi, O., D.L. Grebner, I.A. Munn, S.C. Grado, R.E. Grala, and J.E. Henderson. An econometric analysis of utilizing unused wood biomass from wood processing facilities in Mississippi. Paper presented at the Fourth International Faustmann Symposium, Saariselkä, Lapland, Finland, September 9-12, 2012.

Khanal, P. N. and D.L. Grebner. Willingness of nonindustrial private forestland owners to practice optimum carbon sequestration regimes in Mississippi. Pine Integrated Network: Education, Mitigation, and Adaptation project (PINEMAP) annual meeting, May 15-16, Atlanta, GA.

Khanal, P. N. and D.L. Grebner. A preliminary effort to evaluate the willingness of nonindustrial private forestland owners to practice optimum carbon sequestration regimes in Mississippi. Southern Forest Economists' Workshop, March 20-21, Charlotte, NC.

Khanal, P., D.L. Grebner, I.A. Munn, S.C. Grado, J.E. Henderson, O. Joshi., and R.K. Grala. Determining Optimum Carbon Sequestration Strategies for Pine Plantations in Nonindustrial Private Forestlands of Mississippi. Poster presented at Society of American Foresters National Convention, October 24-28, 2012, Spokane, WA.

Kreye, M.M., D.C. Adams, F. Escobedo, and J. Soto. "Using best-worst scaling choice experiments to measure preferences for forest conservation programs that protect water quality." Paper accepted for presentation at the ACES and Ecosystem Markets conference, Ft. Lauderdale, FL, December 10-14, 2012.

Soto, J.R. and D.C. Adams. "Estimating the Supply of Forest Carbon Offsets: A Comparison of Best-Worst and Discrete Choice Valuation Methods." Agricultural & Applied Economics Association Meeting, Seattle, WA, August 12-14, 2012.

Soto, J.R. and D.C. Adams, "Attitudes and Willingness to Accept Compensation for Carbon Offset Production in Florida: Application of Best-Worst Choice Modeling." Western Agricultural Economics Association Meeting, Park City, Utah, June 20-22, 2012.

Susaeta, A.I., D.R. Carter, S.J. Change. "A generalized economic model for carbon sequestration: Implications for sustainability of forestlands in the U.S. South". The 2nd Forest Science Forum: Forest Management Adapting to Climate Change. Beijing, China, October 13-16, 2012.

Susaeta, A.I., D.R. Carter, S.J. Change, and D.C. Adams. "The impact of hurricane risk on optimal forest management in southern U.S. pine plantations: Application of a generalized Reed model". The Fourth International Faustmann Symposium**:** Forest Economics under Multiple Challenges. Tunturihotelli, Saariselkä, Lapland, Finland, September 9-12, 2012.

Kreye, M.M., D.C. Adams, T. Borisova, and F. Escobedo, "Valuing forest conservation and water quality protection programs: A meta-analysis of willingness-to-pay scenarios." PINEMAP Annual Meeting, Atlanta, GA, May 15-17, 2012.

Soto, J.R., D.C. Adams, and F. Escobedo, "Estimating the supply of forest carbon offsets: A comparison on best-worst and discrete choice valuation methods." PINEMAP Annual Meeting, Atlanta, GA, May 15-17, 2012.

Timilsina, N., W. Cropper Jr., and F. Escobedo, "Assessing trade-offs among different ecosystem services in pine flatwoods of the southeastern coastal plain." Pinemap Annual Meeting, Georgia Tech Hotel & Conference Center, Atlanta, GA, May 15-16, 2012.

C.A. Nettleman III, A. Abd-Elrahman, D.C. Adams, G. Barnes, T. Ruppert, B. Dewitt, and T. Fik, "Modeling Policy Solutions to coastal climate change in Florida." International

Federation of Surveyors Working Week – Territory, environment, and cultural heritage. Rome, Italy, May 6-10, 2012.

Abt, K.L. and R.C. Abt. "Timber supply: too much or too little?" Departmental Seminar, Department of Forestry, College of Natural Resources, NCSU, April 23, 2012.

Abt, R.C. and K.L. Abt. "Forest Markets, Spatial Scale, and Carbon Accounting." CENREP Seminar, Center for Environmental Resource Economic Policy, NCSU, April 27, 2012.

Kreye, M.M., D.C. Adams, T. Borisova, and F. Escobedo, "Willingness to Pay to Protect Well-Conserved Aquatic Systems: A Meta-Analysis." University of Florida Water Institute Symposium, Gainesville, FL, February 15-16, 2012.

Adams, D.C., "Economic Values of Environmental Services: Water in Florida." University of Florida Water Institute Symposium, Gainesville, FL, February 15-16, 2012.

→ Provide a short narrative describing any workshops, courses, and/or trainings conducted.

→ Provide a short narrative describing experiments or surveys conducted and/or analyzed.

D.C. Adams (co-PI), M.M. Kreye (PhD student), and Justin Soto (undergraduate PINEMAP intern) conducted pilot tests of our survey on willingness to pay for forest-based water quality improvement, which will inform the bioeconomic modeling non-market ecosystem services.

D.C. Adams (co-PI) and Jose Soto (PhD student) have finished the second and final wave of surveys to estimate non-industrial private forest landowners' willingness to accept carbon offset payments. The results of this survey will inform landowner adoption of mitigation and adaptation strategies, and our assessment of policies and programs that affect C mitigation in planted pine forests.

Milestones and Work Plan Progress

Provide a short narrative describing progress and accomplishments on the year 2 milestones and work plan tasks listed below. Please also describe any changes to the Aim 4 milestones and/or work plan.

Year 2 Milestones

- Assess policies & programs that may affect C mitigation in planted pine forests (December 2012).

We have completed a draft summary of market-based programs and policies that are likely to impact C mitigation, and have started work summarizing federal and state programs and policies. We have also identified and mapped forest carbon storage

hotspots (areas of high carbon storage) and other forest areas with low carbon storage (i.e. coldspots) in the State of Florida and the biophysical and forest management characteristics that are driving these hot/coldspots.

- Regional market impacts based on business-as-usual assumptions (November 2012).

We have assessed the effect of bioenergy demands and supply response on markets, carbon and land use in a three-state region. BAU and biomass demand scenarios were evaluated for AL, FL, and GA. The findings were published in *Forest Science*.

- NPV analysis & regional market impacts of adaptation strategies (July 2012).

We have developed the potential future productivity scenarios in light of climate change. In addition, we have defined some mitigation strategies to reduce the negatives effects of disturbances and climate variations (if applicable) on forest productivity. Such strategies could be incorporated into forest management practices.

- Document landowner adoption of mitigation and adaptation strategies (December 2012).

We have completed a first wave of surveys to estimate willingness to accept carbon offset payments by non-industrial private forest landowners in the southeast.

- NPV & regional market impacts of altered disturbance risks (November 2012).

We have completed the first draft of a paper entitled "Economics of climate change in optimal forest management in the United States South". We have assessed the economics of forestry in loblolly pine (*Pinus taeda*) stands under the risk of climate change. Specifically we have explored the following research topics: i) the effect of potential changes in forest productivity coupled with increased disturbances due to climate change on the expected economic returns and optimal rotation age for southern NIPF landowners, ii) the impact of silvicultural strategies such as managing tree density to ameliorate the impact of disturbances on optimal forest management, and iii) the effect of disturbance-resistant tree species on optimal forest management, and iv) the impact of climate change in the supply of C stored in commercial timber. This paper is under collegial review before being sent for publication.

Year 2 Work Plan Tasks

- Literature review and summary of ecosystem functions, goods and services (March-May 2012).

Significant progress has been made by D.C. Adams, and we have working papers that summarize ecosystem functions, good and services related to habitat, water quality, carbon sequestration, and recreation. We also finalized literature review on the effects of forest management and ecological disturbance on understory diversity of Florida pine flatwoods. Literature was compiled into a database and model.

- Complete hurricane risk modeling (May 2012).

We have submitted the manuscript entitled “The impact of hurricane risk on optimal forest management in southern U.S. pine plantations: Application of a generalized Reed model” to Canadian Journal of Forest Research.

- Develop and validate herbaceous richness model (June-August 2012).

We developed a model to predict forest understory herbaceous richness using the existing literature and available USDA Forest Service Forest Inventory and Analysis Data. The model has been validated using an independent data set from pine flatwood sites in Georgia and Florida. Validation statistic such as mean prediction error, percentage error, and mean absolute difference have been used to assess model predictions. The manuscript describing this model will be submitted for review.

- Complete the assessment of implications of carbon sequestration on economic rents for southern forestland owners (July 2012).

We have completed the first draft of a manuscript in which we developed an economic model that incorporate the effect of fluctuating carbon prices, conversion factors to forest products, and proportion of wood that permanently sequester carbon on optimal harvest decision of southern pines.

- Conduct trade-off analysis and optimization (September-November 2012).

Florida FIA data from different measurement periods has been matched at the plot and individual trees level. FIA plot data has also been matched with 2000 US Census data. Matched database can be used to determine plot-level tree carbon sequestration and other socioeconomic covariates. We are also reviewing literature to identify methods for optimization modeling and developing genetic algorithm to analyze interactions among ecosystem services (i.e. species richness, carbon storage and timber (in forested ecosystems of Florida’s coastal plain. Currently, we are analyzing literature on ecosystem service tradeoffs between carbon, timber and herbaceous richness under different management and disturbance regimes, forest types, and geographic regions

- Complete modeling regional market impacts and carbon accounting under the business-as-usual scenario (November 2012).

We will expand from the detailed analysis of three states, to a south-wide analysis that incorporates refined land use change assumptions. The data have been updated to the most recent available (FIA 2011); the model has been updated to allow measurement of welfare impacts from interventions; and the representation of wood product demands is being improved.

- Complete SPB infestation modeling (November 2012).

We have compiled SPB infestation data from the National Forests in the South. Modeling work is underway.

- Update summary of policies and programs affecting carbon mitigation; review of SE state programs and markets (December 2012).

This is in progress.

- Complete survey instrument (December 2012).
  We have completed the design phase of two of the survey instruments (Monroe and Adams; Adams and Soto), and are in the process of completing two others (Grebner et al.; Kreye et al.) to inform assessment of policy alternatives and landowner adoption of adaptation and mitigation tools.

- Complete wildfire data in the South for modeling (December 2012-February 2013).
  All available wildfire occurrence and extent data for all counties in all southern states has been obtained from Fire Program Analysis at NIFC. Socioeconomic data has been obtained from the Bureau of the Census, Bureau of Economic Analysis, and Bureau of Labor Statistics. Weather and climate data developed for the 2010 USDA Forest Service RPA Assessment (historical data downscaled to the county level) have been obtained. Initial econometric models that will be used to forecast wildfire occurrence and extent have been estimated. Forecast socioeconomic and weather and climate data from the 2010 RPA will be used to develop the forecasts.

- Assess the economic impact of SPB outbreaks using the SRTS model (December 2012-February 2013).
  This is in progress.

- Analyze and refine optimization (December 2012-February 2013).
  This is in progress.

- Literature review of modeling multiple ecosystem services under climate change phenomena (November 2012-May 2013).
  This in progress

Broad Impacts & External Collaborations

Provide a short narrative describing broad impacts (i.e., far-reaching and possibly unanticipated outcomes resulting from Aim work, including contacts/collaborations with entities outside of PINEMAP).

The work on the EPA Bio-genic Carbon Science Advisory Board allowed Bob Abt to interact with a national group of experts and point out the importance of regional variation in markets and growth rates on the carbon consequences of using wood for energy. Active southern markets and fast plantation growth give the South a significant carbon advantage when bioenergy demand affects prices.

As forest ecosystems are being managed for multiple uses there is a need to assess trade-offs or interactions between different ecosystem services and the influence of management regimes. Although most forest inventory data provide various tree-level parameters, they often do not provide information on understory characteristics. Biodiversity conservation, forest management, wildlife habitat analyses, and invasive species management require that we provide information on understory characteristics using existing spatial and biometric data. Our species richness model can provide a tool for managers and landowners to estimate

understory herbaceous richness using available forest inventory data and can be used to analyze trade-offs among ecosystem services provided by forests.

The development of the wildfire forecast models is a result of collaborations with climate modelers at the University of North Carolina, Chapel Hill; analysts with the Fire Program Analysis Division at the National Interagency Fire Center; and analysts with the USDA Forest Service RPA Assessment. The market analyses of carbon outcomes is a result of collaborations with the Nicholas Institute at Duke University and the Southern Forest Assessment Cooperative at NCSU.

Training

Please list undergraduate and graduate students, postdocs, and technical personnel trained under this project and include a description of their research focus and/or role in the project.

- Ernest Dixon, M.S. student, North Carolina State University. Ernest has split responsibilities between Aim 3 (genetics) and Aim 4; he is involved in discussions on market and valuation issues in estimating the benefits of genetic gain or reduction in variability. In 2012 Ernest completed a significant portion of his coursework and is currently developing a real options approach to value the flexibility inherent in genetics geared toward reducing risk from climate change.
- Puneet Dwivedi, Postdoc, Yale University. Dr. Dwivedi is working with Dr. Gan to assess impacts of climate change on southern pine beetle infestation and exploring life cycle impacts of different wood products produced using southern pines.
- Puskar Khanal, Ph.D. student, Mississippi State University. Puskar's primary research focus is evaluating forest management practices that enhance carbon sequestration in stands and developing a survey instrument to determine small forest landowner's willingness to implement these practices and identify potential incentives that increase carbon sequestration at the stand level.
- Melissa Kreye, Ph.D. student, University of Florida. Melissa completed a literature review on the economic value of forest-based changes in water quality; conducted a meta-analysis of forest-based water quality values; and specified an econometric model that predicts willingness to pay for forest-based water quality. Using a benefit transfer method, she has applied the model to two representative sites.
- Jose Soto, Ph.D. student, University of Florida. Jose is assessing and summarizing competing programs and policies that incentivize carbon sequestration at the local, state, national, and international level. He has also developed, pre-tested, and implemented a survey of non-industrial private forest landowners to determine their willingness to accept payments for carbon offsets based on offset program characteristics. Results of this work will be used to predict participation rates in programs that incentivize changes in land use that increase carbon sequestration and will be integrated in a bioeconomic model of non-market ecosystem services produced under competing approaches for climate change adaptation and mitigation.
- Andres Susaeta, Postdoctoral Associate, University of Florida. Dr. Susaeta has primarily been involved in developing a forest stand-level model to assess expected economic rents for forest landowners under hurricane risks associated with future climate change conditions. He has also played a key role in developing an economic model to analyze

carbon sequestration in loblolly pine plantations under various carbon subsidies and tax rates in the context of climate change. He will also be exploring different aspect climate change and their effect on ecosystems services provided by forestlands in the U.S. South.

- Nilesh Timilsina, Postdoctoral Associate, University of Florida. Dr. Timilsina is working on assessing the interactions between different ecosystem services in pine flatwoods and optimizing modeling to maximize a particular ecosystem service and asses the tradeoff of the others.
- Justin Soto, Undergraduate Intern, University of Florida. Justin is assisting with assessment of the economic value of forest-based ecosystem services under alternative management and policy regimes.
- Joanna Tucker, Postdoctoral OPS, University of Florida. Joanna is assisting with analysis and manuscript preparation for a project involving the use of available USDA Forest Service FIA forest inventory data to estimate understory species richness (i.e. biodiversity).

Collaborations and "integrated" knowledge developed

Provide a short narrative describing new ideas, research questions, or insights that have arisen through work and discussions with colleagues, stakeholders, and others. In addition, explain the extent to which you intend to incorporate this into PINEMAP milestones and/or your Aim work plan.

EPA SAB work has focused more attention on the role of markets and regional scale in carbon accounting. Further work on this topic is planned that will highlight the role of forest plantations in the carbon impact.

A student funded by a separate project (Stewardship Ecosystem Services Study) has developed a framework for assessing and mapping the potential loss of ecosystem services from hurricanes. The framework identifies forest-hurricane damage risk zones and estimates the potential loss of aboveground carbon storage and timber volume. The framework is based on landcover data, hurricane wind risk maps, available plot-level forest inventory data, the Integrated Valuation of Ecosystem Services and Tradeoff (InVEST) model, and a decision-tree-based framework. Biophysical factors identified in previous studies as being influential in forest damage were used for the decision tree. The framework can be used for identifying timber salvage areas, planning ecosystem service provision scenarios, and implementing pre- and post-hurricane management activities. Manuscript has been submitted to the Journal of Environmental Management.

We are collaborating with Dr. Salvador Gezan, Quantitative Biometrician, University of Florida in developing optimization modeling techniques to analyze the influence of FIA data variables on timber, carbon, and understory herbaceous richness.

Needs from/linkages to other Aim groups

- Provide a bulleted list outlining research results, data, products, or assistance that your Aim group needs from another Aim group.
    - Changes in forest productivity in different geographical zones in the U.S South in light of elevated levels of carbon dioxide and temperatures and altered precipitation patterns.

- Provide a bulleted list outlining research results, data, or products that your Aim group has compiled that have value or relevance to another Aim group (and note which Aim group).
    - Estimates of landowner preferences for C sequestration program features (Aim 6)
    - Extension perceptions of global warming/climate change, and factors driving these perceptions (Aim 6)

- List any additional potential linkages to other Aim groups.
  None to report at this time.

Leveraged funding/additional resources

Describe how PINEMAP funds were leveraged as well as any additional resources obtained. Please list amounts and sources.

$39,200 from Florida Forest Service for survey and modeling work related to ecosystem services production and valuation (F. Escobedo, D. Adams, et al.)