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May 11, 2009

John Nickerson
Climate Action Reserve
523 W. Sixth Street, Suite 428
Los Angeles, CA 90014

RE: Comments on Updated Forest Project Protocol (April 15, 2009)

Dear Mr. Nickerson:

Thank you for the opportunity to offer comments on the Updated Forest Project Protocol. The Delta Institute is a 501(c)(3), non-profit organization, whose mission is to transform the Great Lakes region into the vital center of an emerging green economy. For more than a decade, we have helped individuals, organizations and communities demonstrate that community economic development and environmental quality go hand in hand through energy efficiency, sustainable development, and carbon trading.

In 2006, Delta received a Forest Stewardship grant from the Michigan Department of Natural Resources to develop a program to register sustainably managed forest projects on the Chicago Climate Exchange. Delta's pilot Managed Forest Carbon Protocol was approved by the CCX as an offset project in August 2007 and then used as a basis for the CCX's *Protocol for Sustainably Managed Forests*, released in December 2007. Delta is highly regarded within the Midwest for our expertise on the development and implementation of the forest carbon offset protocol. Delta staff has presented the forestry protocol at dozens of meetings, workshops and conferences, from Colorado to Maine and Canada to Texas.

While we take great pride in having provided the foundation for the CCX *Protocol for Sustainably Managed Forests*, we are more proud of the fact that we have successfully brought the project to full scale in two years. What began as a demonstration project with 34 landowners and 48,665 acres in Michigan is now a full-fledged program with 122 landowners and 134,000 acres from 9 states, providing over 1.1 million metric tons of offset credits modeled to date from 2007 through 2010. Attachment A to this comment is a map showing the location of these projects. Many of our landowners received management plans and third party certification for the first time as a result of this program, a fact that is perhaps more significant than the program's scalability. We have no doubt that our work has led to improved forest management practices throughout the Great Lakes region – and beyond.

Delta's carbon program demonstrates that an accurate yet pragmatic program, based on an aggregation structure, can provide substantial environmental benefits through the participation of small, family forests. We believe that these smaller parcels are critical to abating carbon emissions.

While we focus our efforts on aggregating the small family forestlands, we have enrolled nearly a dozen landowners with projects in excess of 3,000 acres. However, it is unlikely that any of these larger landowners would have participated in the carbon market if Delta's program were structured like the FPP. Because of the perceived high initial and annual costs, protocol complexity and "consultant heavy" approach, our clients could not justify the effort, despite potential long-term returns. We support performance standards, auditing and the use of aggregation to accumulate small plots into large reductions in CO_2e. Attestation, verification and unannounced field audits are critical to a robust and credible program. We certainly do not oppose the continued improvement in measurement and maintenance of forestry stocks. In general, Delta feels that the Reserve should adopt a more practical approach - at least in the early years.

We have reviewed the FPP from a scalability and implementation perspective. So, our comments are less technical and more practical in nature. To simplify our review, we have split our comments into two categories: program design and project implementation. Our intent is to suggest ways that the Reserve can implement the FPP at scale and with existing resources, while maintaining the Reserve's standards for offset quality.

Comments on Program Design

1. **The FPP should seek to provide maximum environmental integrity without compromising efficient, practical implementation at scale.**

When Delta developed Managed Forest Carbon Protocol in 2006, our greatest challenge was balancing "research" with "real world." We sought to design a program that was accurate and defensible, yet practical to implement. The FPP, however, appears to be defining an extremely precise process that could adversely affect implementation on a national level.

We empathize with the challenge of designing a program that is robust enough to identify and deliver the highest quality credits from forest carbon sequestration, while being simple enough for multiple entities to implement on a national scale. Like others, Delta desires an accurate, defensible program that reflects the carbon sequestration ability of the nation's forestlands. From our experience with landowners and professional foresters, the process outlined by the FPP will likely be perceived as exceedingly onerous and expensive, potentially limiting its effectiveness and contribution to the climate change discussion. The Reserve should thus consider modifying the precision of the protocol to improve functionality and ease of implementation. Furthermore, Delta suggests the Reserve consider implementing more practical measures initially to generate interest and participation. Then, after a few years, more stringent requirements could be phased-in.

2. The FPP poses significant barriers, particularly the 100-year commitment period, that could prevent participation by the vast majority of non-industrial, private forest landowners.

As was noted by many previous commentators, the 100-year commitment period required by the FPP will effectively eliminate most non-industrial, private forest landowners. Delta understands the rationale behind the requirement, but feels that the requirement sets the bar too high for trying to encourage new adopters.

Please consider the following facts and table from a recent U.S. Forest Service report titled, *Family Forest Owners of the United States, 2006* (Gen.Tech. Rep NRS-27):

- An estimated 11 million private forest owners (± 3%) collectively control 56% of the forest land (423 million acres ± 0.4%) in the United States.
- Family forest owners account for 92% of the private forest owners and 62% of the private forest land (35% of all forest land) in the United States.
- 61% of family forest owners in the United States own less than 10 acres of forest land, but 53% of the family forest land is owned by people with 100 or more acres.
- Nationally, the average size of family forest holdings is 25 acres.
- Although 12% of the family forest owners, who own 24% of the family forest land, have heard of sustainable forest certification (e.g., American Tree Farm System, Green Tag, Forest Stewardship Council or Sustainable Forestry Initiative), less than 1% of the family forest owners, who own 4% of the family forest land, are currently enrolled.
- The average (mean) land tenure for family forest owners is 26 years.

Size of forest landholdings	Area		Ownerships	
	Acres	Sampling error	Number	Sampling error
Acres	Thousands	Percent	Thousands	Percent
1-9	19,158	6.4	6,220	4.4
10-49	58,585	3.1	2,831	2.2
50-99	41,562	3.2	644	2.3
100-999	97,667	2.5	508	2.1
1,000+	35,003	5.6	19	8.3

For the Reserve to be effective at maintaining and growing the U.S. forest carbon sink, the FPP should provide reasonable opportunities for participation by landowners in all size levels. This is particularly true for Avoided Conversion guidance, which would be most applicable for forestlands less than 50 acres.

Delta suggests that the Reserve require a 25-year commitment period, which mirrors the mean land tenure for a non-industrial, private forest landowner. A 25-year period is still a significant barrier to entry and will effectively screen those landowners who are not committed to long-term, natural forest management. Such a duration is much more palatable to the private landowner and will eliminate uncertainty in private land management, creating additional carbon benefits.

We admire the Reserve's intent and commitment to developing the most scientifically defensible protocol possible. However, we note that immediate reductions are shown by the science to be the most significant. Furthermore, we are concerned that a 100-year commitment period will create a disincentive for landowners who are currently managing in a sustainable manner. This could become an example of "the perfect being the enemy of the good."

In the end, we fear that the FPP could have little relevance to the private forest landowners most deserving of credit, and even cause unintended consequences, e.g. landowners abandoning natural forest management practices.

3. The Reserve should encourage the use of aggregators, who can bring forth multiple projects in a cost effective and efficient manner.

As noted in the *Family Forest Owners* Report, 95% of the private forest landowners in the U.S. own less than 100 acres of land. With this type of ownership pattern, the most cost efficient and effective means of reaching these landowners is through an aggregator model, similar to what is used by the Chicago Climate Exchange. The use of "pools" of smaller projects provides diversity of risk and, in Delta's program, provides a reserve account for unexpected occurrences. These are simple tools that are easily explained to landowners.

Delta knows from experience that community outreach and education is the most time consuming task associated with protocol implementation. An aggregator model would take some administrative pressure off of the Reserve by allowing aggregators to promote the protocols and educate landowners, freeing up Reserve staff to focus on new protocol development.

Also, Delta suggests the Reserve develop rigorous standards for vetting potential aggregators, ensuring credibility and competency. The standards should focus on fiscal responsibility, data management capabilities, and staff competency.

4. The Reserve's Improved Forest Management guidance has many elements in common with the Managed Forest Carbon Protocol that Delta developed for the Chicago Climate Exchange.

Delta compared over 70 program elements from the Reserve's forestry protocols with Delta's Managed Forest Carbon Program. Not surprisingly, the programs are very much alike. With some modification (of either the Reserve's protocols or Delta's), it is our belief that our clients would meet Reserve standards. To this end, there are two program elements standing in the way of potential integration:

- Baseline establishment methodology; and
- 100-year commitment period

Delta would enjoy working with the Reserve to see how we might integrate our protocols with the Reserve, providing access for high-quality offsets, from sustainably managed forestlands in the Midwest and beyond.

Comments on Program Implementation

1. A "Business as Usual" baseline approach is not well-suited for private landowners.

We would suggest an alternative approach to the "business as usual" test. Business as Usual is unique to individual landowners. For some landowners, BAU is to let nature take it course and perform no management. For other landowners, BAU is intensive management, with annual harvests. Furthermore, a landowner's approach to management changes over time, particularly in response to changing family condition (children, college, etc.) and economic conditions. In most cases, the only thing usual about private land management is uncertainty.

One of the goals of the Reserve should be reducing uncertainty amongst private forest landowners and ensuring that the carbon sink is maintained and improved over time. Your response to Mr. McAbee (Q#154 "…offset credits cannot be given for reductions or sequestration that would have happened 'anyway'…") assumes the proposed baseline scenario is an accurate measure of what would have happened in the absence of a market for offsets. With private landowners, the high level of uncertainty effectively makes it impossible to speculate on what would happen without offset credit.

As a rule, absent of any state or federal regulation, most forest landowners can manage their land as they see fit. Thus, landowners - who participate in the carbon market and agree to manage their land according to certain principles, such as natural forest management - provide an "additional" carbon benefit because they have eliminated the uncertainty surrounding the long-term management of land and ensured a long-term, stable, forest carbon sink. The very act of subjecting forests to the oversight and measurement for sustainable management is "additional." It also demonstrates a landowner's intent to obtain carbon offset credits, a key indicator for "additionality."

To simplify baseline establishment for Improved Forest Management, Delta believes that the project start date should be the baseline and that a modified carbon accounting approach should be implemented.

2. The baseline methodology for Improved Forest Management is too cumbersome and complex to be cost efficient and effective in practice (Section 6.2.1.1).

Delta agrees with comments made by Baldwin, Blomstrom, Wilkinson & Associates, Inc (Q.211 – Summary of Contents and Responses) in the previous public comment period. For the FPP to be scalable, the baseline methodology ought to be easily understood, particularly since private landowners can bring forth projects themselves. Because of the complexity of this baseline approach, it is realistic to think that most private landowners will rely on a third-party project developer (or an aggregator, if approved) to quantify net carbon sequestration. It is also realistic to expect that project developers will collect significant fees for their work. Such a baseline methodology would increase enrollment costs, providing less of an incentive for landowner involvement.

If the intent of the FPP is "to facilitate the positive role that forests can play to address climate change," the Reserve must ensure that project development costs are minimized so the landowner maintains a financial incentive to participate. Delta believes that the best way to minimize project development costs and maintain the financial incentive for landowner participation is to simplify the methodology.

3. It is unclear how a private landowner or project developer would go about establishing the 80% stocking reference (Section 6.2.1.1).

It is not clear how a project developer would "document changes in the project's live tree carbon over the preceding 10 years, or as long as the current owner has had control of the stocks." The requirement implies that the project developer must model existing data backwards or perform some regression analysis to determine changes in carbon stocks over the proceeding 10 years. In most cases, the landowner will only have an inventory developed at the start of this program. Using current data to determine past carbon storage rates is a complicated process that could introduce significant error. The CCX Forestry Committee discussed this issue, ultimately rejecting the use of regression analysis and "back-modeling" to calculate the rate of past carbon storage. Delta recommends the Reserve clarify this requirement or eliminate it altogether.

4. The determination of the financial and legal reference is difficult to understand (Section 6.2.1.1).

After reviewing this section, the only clear aspect is that the project developer must take current inventory data and model it for a 100-year period, incorporating planned management activities, such as harvests or reforestation. The average amount of carbon sequestration per acre then becomes the financial and legal reference. However, the language implies that the financial and legal reference could be adjusted up or down if certain criteria are met, such as implementing best management practices or maintaining a conservation easement. In the context of an actual project, it is not clear how this would be done.

Calculation of the financial constraints could also use additional explanation. It is not clear how a landowner would "capture the relevant costs and returns for the baseline scenario, taking into consideration all legal, physical and biological constraints, with reference to…actual costs and returns on the subject property or other properties in the assessment area" and incorporate that information into the model run. Additionally, it is unclear how a landowner would incorporate "evidence of activities similar to the proposed activities in the baseline within the past 15 years in the assessment area" into the model run.

Delta understands the purpose behind the financial and legal reference calculation, but feels this particular methodology is too burdensome and expensive to effectively implement on a national level.

One possible solution is for the Reserve to incorporate this information in the eligibility requirements by creating a financial and legal screen. Lands that meet all requirements are fully credited. Lands that partially meet the requirements take a deduction. By simplifying the requirements and placing them early in the process, the administrative burden is lessened with little sacrifice to overall program accuracy.

5. The modeling of live, on-site stocks in proximity to the control is difficult to understand (Section 6.2.1.1 – Step 3).

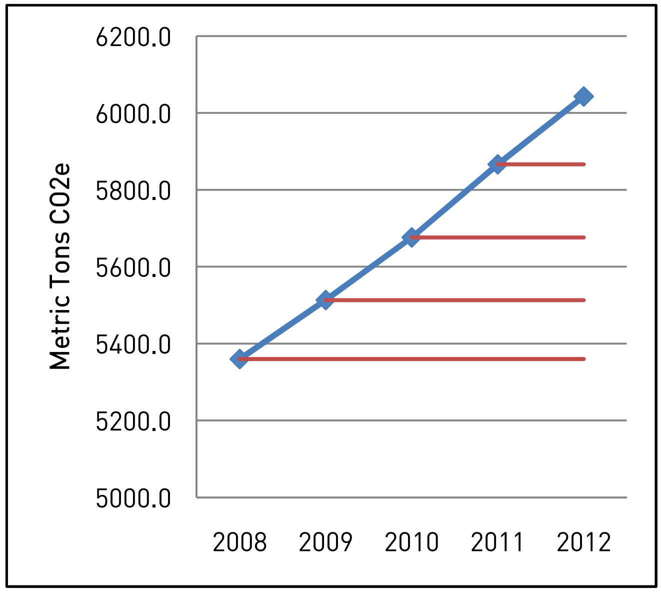
It is not clear what is meant by modeling live, on-site stocks in proximity to the control. The sample figure in Step 3 shows that carbon stocks decline from the initial point to the Common Practice. In the absence of any disturbance, the carbon stock of a forest will increase over time. Only a late successional stage forest would be likely to show a stable or declining carbon stock.

Stand	Acreage	Start	End	Wght C Incrmnt
A	37	39.5	40.6	1.13
2008 Carbon Stocks (mT CO2e)		5359.6	5513.1	153.4
Stand	Acreage	Start	End	Wght C Incrmnt
A	37	40.6	41.8	1.20
2009 Carbon Stocks (mT CO2e)		5513.1	5676.0	162.9
Stand	Acreage	Start	End	Wght C Incrmnt
A	37	41.8	43.2	1.40
2010 Carbon Stocks (mT CO2e)		5676.0	5866.1	190.1
Stand	Acreage	Start	End	Wght C Incrmnt
A	37	43.2	44.5	1.30
2011 Carbon Stocks (mT CO2e)		5866.1	6042.7	176.5
Stand	Acreage	Start	End	Wght C Incrmnt
A	37	44.5	46.1	1.60
2012 Carbon Stocks (mT CO2e)		6042.7	6259.9	217.3

The table on the left is an example from a small, Midwestern, Northern Hardwoods forest. Here, the landowner's initial carbon stock, on December 31, 2007, was 39.5 mT C per acre, for an initial baseline of 5,359.6 mT CO_2e. By December 31, 2008, the standing carbon stock rose to 40.6 mT C per acre, for a total of 5,513.1 mT CO_2e.

The difference between the starting and ending points is the net annual GHG reduction (153.4 mT CO2e for 2008). From here, the amount would be reduced to account for sampling error and the buffer pool. (This data is taken directly from the FVS output reports.)

The net GHG reduction is shown graphically. The red lines indicate the baseline from year to year. A landowner can remove carbon down to the previous year's baseline without any penalty (other than the loss of offset credits for that year). If a harvest or catastrophic event causes a landowner to fall below the previous year's baseline, a reversal has occurred and the landowner forgoes offset credits until the reversal is made up. If the reversal cannot be made up, the landowner must buy an equivalent amount of credits off the market.



From this graph, it is easy to visualize how the Reserve could incorporate a baseline based on FIA data, and perhaps adjust that baseline up or down to account for legal and financial constraints.

Delta suggests that the Reserve rewrite the instructions in Section 6.2.1.1 to be clearer and to include realistic data sets to illustrate the concepts.

6. The Reserve should address the end of life scenario for credits in the buffer pool (Section 7.2.1).

The Reserve requires all projects to annually contribute offsets to a buffer pool, which is determined by rating the project's risk. The offsets remain in the buffer pool as insurance against unintentional reversals. The buffer pool concept is one the Delta understands well and wholeheartedly supports. However, the Reserve does not address the "end of life" scenario for offsets in the buffer pool. What happens to the offsets at the end of 100 years? Are they returned to the landowner for sale on the market or does the landowner simply lose title to the buffer pool offsets? The Reserve must provide a scenario for the treatment of buffer pool offsets at the end of 100 years.

In lieu of a 100-year buffer pool, Delta suggests a 5-year cycle, upon which the project risk rating revised and all remaining offsets in the buffer pool are released to the landowner or project developer for sale on the market. A 5-year cycle, where risk is re-evaluated and offsets are released to the landowner, provides a financial incentive for a landowner to reduce future risk.

7. The FPP should require landowners to enroll all the lands under their name or controlling interest to better guard against internal leakage, rather than allow landowners to define the project boundaries and account for internal leakage after the fact.

As currently written, the FPP appears to allow the landowner or project developer to define the assessment area, essentially allowing the entity to "cherry-pick" the best lands for the inclusion in the program. The Reserve compensates for the user-defined assessment area by requiring project developers to "account for internal leakage by reviewing increases in harvest data for the *entity*." [Emphasis added] Delta does not believe that the extra step of accounting for internal leakage during annual monitoring is necessary, when the question of internal leakage can be resolved by requiring a landowner to enroll all forestlands under their name or controlling interest.

Clearly, the landowner's costs will increase by requiring an inventory for all forestlands. It is possible, however, that the additional inventory expense will be balanced by the generation of additional offset credits. We believe that it is in the best interest of the landowner and the Reserve to require that all lands, under the same titleholder or controlling interest, be subject to baseline establishment, inventory and modeling.

8. Please clarify your response to Question #53 in the Summary of Comments & Responses, where you state that "Carbon rights are not currently recognized as a legal right."

Landowners maintain both explicit and implicit rights associated with property ownership. It is an established rule of law that landowners hold the rights to multiple values on their property, including ecosystem values, unless they give up those rights in some way.

The Reserve must clearly articulate their position on the issue of carbon rights. The most likely participants in the FPP (as currently written) are land conservation organizations that hold conservation easements on private land. It is likely that some land trusts will include language within an easement, claiming the carbon rights to the property, as a way to fund stewardship and long-term monitoring of the property. The Reserve should craft additional guidance for situations where one party is selling the carbon rights on land they do not own.

9. Please clarify which data elements qualified foresters are required to collect during the forest inventory.

The Improved Forest Management guidance suggests that total tree height is necessary to run the growth-and-yield model. However, the Forest Vegetation Simulator (and the Jenkins formula within FVS) can accurately calculate carbon storage by using Site Index (base age 50) as a proxy for height. In fact, FVS does not function without Site Index. By requiring qualified foresters to measure total tree height during sampling, the Reserve is adding more time to the inventory and thus greater costs to the landowner, without any appreciable gain in biomass accuracy.

Similarly, the Reserve should establish approved sampling methodologies, perhaps on a regional basis to account for different forest cover types and industry practices. As written, the inventory guidance suggests that nested, fixed radius plots are the preferred sampling methodology. Delta implements a sampling method that blends variable and fixed radius plots for accurate sampling of overstory and understory vegetation at a low cost. This method works well because it is easily understood and implemented by field foresters.

With several Michigan foresters, we have discussed the practicality of implementing nested, fixed radius plots. The response has been very negative. Field foresters believe that nested, fixed radius plots are too time consuming, even though less sample points would be needed across a property. Several foresters indicated that inventory costs would be two to four times greater than our current sampling methodology.

Delta suggests that the Reserve draft more specific inventory guidance, based on regional operating procedures. For a reference, please see Attachment B – Delta's Forest Inventory Guidance.

10. The 12-year interval between inventories is too long, and should be shortened to 5 years.

The results from modeling are only as good as the data originally inputted. Any error inherent in the data (or its collection) is compounded over time. After 12 years, the results could be wildly inaccurate.

Adopting a 5-year inventory cycle would also correspond with the interval between complete updates to FIA data. If the Reserve plans to use FIA data as the baseline, it only makes sense for the property level inventory to match that interval. While a 5-year inventory interval increases costs to the landowner, the Reserve would be assured fresh, accurate data.

11. The Reserve should require "true-up" inventories after each harvest or catastrophic event.

Delta's protocols currently require qualified foresters to perform "true-up" inventories for any areas impacted by timber harvesting or catastrophic events. The true-up inventory allows Delta to continually update the carbon accounting for the property and ensure accurate estimates of carbon storage. Additionally, the true-up inventories provide a periodic field review of the property, ensuring that the landowner is following their management plan and adhering to the principles of sustainable forest management.

12. Third-party sustainable forest management certification (American Tree Farm System, Forest Stewardship Council, and Sustainable Forestry Initiative) should be a base program requirement, replacing the evaluation criteria of Table 3.1 of the FPP.

Delta agrees with the comments from several respondents (AF&PA, Weyerhaeuser, Jim Cathcart, and NAFO/OFIC/WFPA) that ATFS/FSC/SFI standards should be recognized. Furthermore, Delta believes that compliance with such third-party schemes should be mandatory. Requiring third-party certification is another check on the system, ensuring that participating landowners are committed to long-term, sustainable forest management. Plus, third-party certification systems provide periodic monitoring of the property, providing a proactive view of upcoming management practices and encouraging update to individual management plans. Delta recommends that the Reserve recognize SFI, FSC and ATFS as eligible certification programs. All three programs have been certified by the Programme for the Endorsement of Forestry Certification. A large majority of Delta's current projects belong to ATFS Independently Managed Groups, and Delta proposes that Individual or basic certification should only be recognized where annual monitoring takes place. Delta also suggests that certain state tax programs, such as Wisconsin's Managed Forest Law Program or Indiana's Classified Forest and Wildlands Program, be recognized as an eligible certification program, so long as the state tax program requires annual monitoring.

CONCLUSION

Delta appreciates the Reserve's work and leadership around the concept of forest carbon offsets. With a similar focus on doing innovative and transformative work, Delta shares your concern over the development and implementation of a robust forest carbon offset program.

We look forward to future discussions with the Reserve staff on the forestry protocols.

If you have any further questions or comments, please feel free to contact Todd Parker at 517.482.8810.

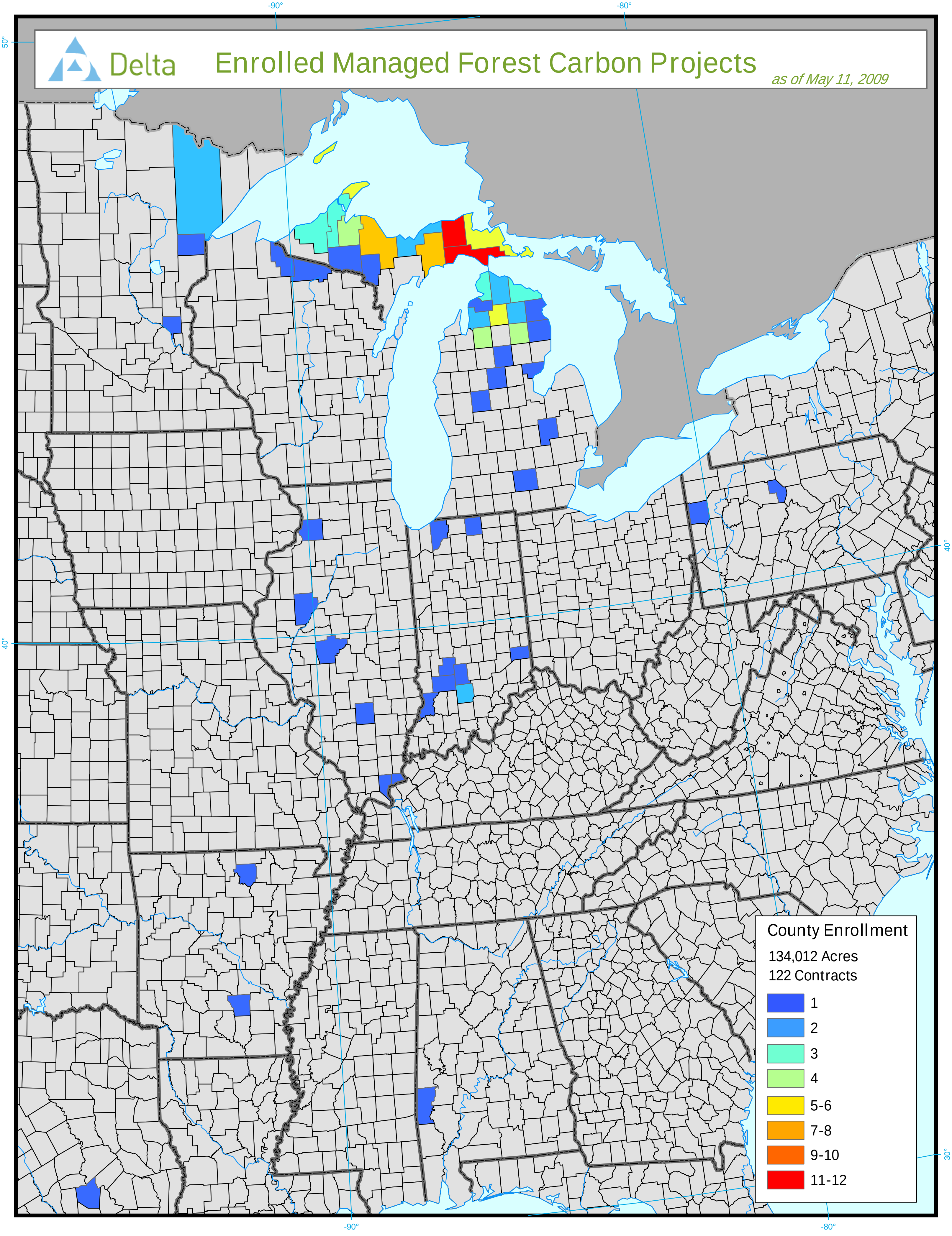
Sincerely,
The Delta Institute

Attachment A – Location of Delta Carbon Offset Projects
Attachment B – Delta Institute Managed Forest Carbon Inventory Guidance

Enrolled Managed Forest Carbon Projects

Delta

as of May 11, 2009



Property Level Carbon Inventory Guidance

1. Introduction

Project Owners must obtain an initial inventory of their forestland to establish the carbon baseline. This carbon inventory is different from a typical timber inventory because the emphasis is on measuring total growth within the stand, not just growth on commercially valuable trees. Thus, the Delta Institute has developed an inventory scheme, combining variable and fixed radius plot samples, as a means of balancing time, cost and statistical accuracy. On its own, variable radius sampling is not effective for a carbon inventory because of bias towards large diameter trees – a tree's probability of being sampled is proportional to its diameter. Thus, the fixed radius plots are necessary to capture the smaller diameter stems within a stand that are storing carbon.

To obtain a property level forest inventory, Project Owners must hire a "qualified" forester. For purposes of this agreement, a "qualified" forester is one who is 1) a Certified Forester through the Society of American Foresters, 2) a State Registered/Certified Forester, 3) a member of the Association of Consulting Foresters, or 4) in certain situations, a Certified Forest Stewardship Plan Writer who holds a Bachelors Degree in Forestry. The forester must perform the carbon inventory during the dormant season.

Landowners can use existing inventories that are not less than 5 years old if it meets or exceeds the requirements listed in this document.

2. Sampling Intensity, Plot Location and Strata Measurements

To measure the carbon stocks within a forestland accurately, a qualified forester must follow the inventory guidance listed below. Failure to follow this guidance may delay the property's acceptance into the enrollment pool and result in additional data collection.

1. Stratify the property into common forest cover types, delineate all strata[1] in a GIS layer, and assign an identification letter (A, B, C, Etc) for each stratum. To better achieve the required level of accuracy, the stratums should be as large as possible. It is not necessary to sub-stratify the forest cover types by stocking level. You should, however, sub-stratify the forest cover types if there a distinct changes in the size class, i.e. sawtimber vs. sapling stands.
    a. <u>Exception</u>: If you know that a certain area will be harvested during the contract period, please stratify that stand separately regardless of its size. By stratifying harvested areas separately whenever possible, it is quicker, easier and less expensive to reestablish the carbon baseline for the stand.
2. Establish sample points on a systematic grid across the property. At each sample point, establish a variable radius plots to measure overstory vegetation and a fixed radius plot to measure understory vegetation.
    a. Establish plots with reference to cruise maps and Global Positioning System (GPS) coordinates, i.e. waypoints. Each cruise map will show the location of the plot, the plot number and property lines. Save the coordinates of each plot for future use during a post-harvest inventory
    b. To locate plot in the field, use a GPS unit to navigate to within 2 to 3 chains of the plot location. Then, use a compass and pace the remaining distance to the plot center based on the bearing and distance provided by the GPS. Do not use the GPS unit to navigate all the way to plot center, since coordinates are only accurate to within approximately 50'.
        i. On property greater than 1,000 acres, always use a GPS unit in conjunction with compass and pacing. On property less than 1,000 acres, the forester has the discretion to use a compass and pace the entire distance between plots if more efficient and cost effective.

[1] The terms "strata", "stratum" and "stand(s)" are used interchangeably in this document. The meaning and intent of the statement is the same, regardless of which word is used.

c. Locate plots precisely where compass and pacing prescribes, with the following exceptions:

   i. Sample points near the property line or off the property. The minimum distance between plot center and the property line is equal to the limiting distance of the largest tree for BAF 20 (or BAF 10, whichever is used for the stratum) in the immediate vicinity of the sample point. For plots that fall too close to a property line, offset an even number of chains perpendicular to, and away from, the property line and establish a new plot. Do not sample any trees outside of the property. Note the plot adjustment for the record.

   ii. Consider paved or county roads and rights-of-way as off the ownership. Do not take any plots on roads or right-of-ways. However, consider interior roads and "two-tracks" as part of the stratum in which they are located. Do not offset any plot that falls on or near an interior woods road.

3. Level of Accuracy - The goal of the stratification and sampling is to produce a carbon inventory with a sampling error of 20% or less at a 90% confidence interval for estimated mean wood volume. While the forester should strive to achieve or exceed this level of accuracy for all stands, there will be strata where it is not possible to reach this level of accuracy. In those stands, place an appropriate number of sample points that adequately captures the inherent variability of the stand.

4. At each sample point, the forester will establish both a variable radius plot and a fixed radius plot (See below for precise details)

   a. Variable Radius Plot – use 10 or 20 BAF prism

   b. Fixed Radius Plot – 1/100th acre plot, which has a radius of 11 feet 8 inch

5. Using the USDA Soil Surveys, list the site index and site index species for each stratum. For the site index species, use the US Forest Service 3-digit species codes listed below. If a single stratum has different site indices due to different soil types, use the site index best suited for that forest cover type. The site index measurement is crucial for accurate modeling of the stands because foresters are not collecting total height of the sample trees. Each stand MUST have a site index and site index species!

6. Indicate the age of each stratum. For uneven aged stands, please give provide an estimate of the overall stand age. It is acceptable to use "greater than" notation, i.e. >90

7. Record the forest cover type name and code, using the list below

8. Use the following format to summarize property stratification:

Stratum	Forest Cover Type	Age	BAF	# of Points	Acres	Site Species	Site Index
A	801 - Sugar Maple	>90	20	42	226	318	64
B	901 - Aspen	10	10	8	82	746	60
C	102 - Red Pine	22	20	11	125	125	55
D	999 - Non-stocked	---		2	6		

9. Submit aerial photos with the property and strata delineated.

10. Always record the dates of the inventory and the name of the qualified forester performing the inventory.

3. Plot Measurements and Data Requirements

To measure the carbon stocks within a forestland accurately, a qualified forester must follow the inventory guidance listed below. Failure to follow this guidance may delay the property's acceptance into the enrollment pool and result in additional data collection.

1. Establish a variable radius plot at every point in the systematic sample. Use either a 10 or a 20 basal area factor prism to measure overstory vegetation. You may use different basal area factors within a property, e.g. a 10 factor prism for one strata, a 20 factor prism for another, but <u>never</u> use different basal area factor prisms within a single stratum.
    a. Record the species, using three-digit USFS codes. For codes less than 100, please include the zero, e.g. 012, 094, 095.
    b. Measure the diameter to the nearest one-inch diameter class for all live trees, live cull trees, and dead trees greater than or equal to the 5-inch diameter class (4.6 to 5.5" dbh). [See chart on page 35 complete listing of diameter classes]
    c. Please note, that total heights are not necessary for this model. The site index measurements provide a suitable substitute. You are welcome to collect and provide total height data, but it is not required to run the model.
    d. Indicate the count for each sample tree
        i. In most cases, the count will be one, unless there are multiple trees of the same species and diameter class in a single plot. For example, if there were four red pine trees in the five-inch diameter class in a single plot, then you could record species and diameter once with a tree count of four, rather than inputting the tree data four times.
    e. Indicate the tree's history
        i. 1 – Live Tree
        ii. 9 – Dead Tree
    f. (Optional) – For live trees, indicate the tree's value
        i. 1 – Desirable
        ii. 2 – Acceptable
        iii. 3 – Live Cull
        iv. 8 – Non-stocked (use this code when there are plots with no overstory or understory vegetation)
    g. (Optional - only necessary for stands with marked timber harvests) Indicate the tree's management prescription the following codes. This information provides details on the any future harvests. When a sample tree is marked for harvest, Delta can remove that tree from the inventory and re-run the model to reestablish the carbon baseline after a harvest.
        i. 1 – Leave Tree
        ii. 2 – Cut Tree
    h. (Optional) – Indicate the diameter increment for a species. By taking diameter cores from 5 trees per species and measuring the growth increment over the last 5 years, you can recalibrate the model to fit the site. This will provide more accurate estimates of growth.
2. If trees are marked for harvest, please include them in the baseline inventory. However, mark the trees as "cut" as directed in above in 3.1.G. By doing so, we add an extra layer of transparency to the inventory process, ensuring an accurate estimate of baseline and future carbon storage.

3. Establish a 1/100th acre plot (fixed radius of 11 feet 8 inches) to measure regeneration and understory trees within each stratum. Tally all seedlings and saplings greater than 12 inches in height, but less than the 5-inch diameter class (4.6" to 5.5" dbh).

    a. Record the species, using three-digit USFS codes. For codes less than 100, please include the zero, e.g. 012, 094, 095. Only tally species that have FIA codes listed in the table below. Do not tally shrubs such as cranberry, spicebush, etc, <u>unless</u> there is an FIA code associated with that species.

    b. Measure the diameter at breast height

        i. For trees greater than 1 foot tall, but less than 4.5 feet tall, record the diameter as 0.1 inches, which is equal to the diameter of the terminal bud.

    c. Count the number of stems for each species

    d. Estimate the height, in one-foot increments, for each stem. For plots with multiple species in the same diameter class, i.e. aspen cuts, provide the average height of the regeneration.

    e. In areas with extreme amounts of regeneration, i.e. recent aspen cuts, count all the stems in the NW quadrant and multiple by four to record the total tree count. Record the average diameter to the nearest one-inch diameter class and the average height to the nearest one-foot increment.

4. Use the following format to record individual tree data. Please note that plot numbers should be consecutive for the entire property (e.g. 1-100). Please do not re-number plots for each strata (e.g. A – 1,2,3,4; B – 1,2,3,4; C – 1,2,3,4).

Strata	Plot #	Count	History	Species	DBH	Height (regen)	Tree Value	Prescription
A	1	1	1	318	8		2	1
A	1	1	1	318	14		1	1
A	1	6	1	318	2	12	2	1
A	1	1	1	316	6		2	1
B	2	1	9	743	12		2	2
B	2	1	1	743	10		2	2
B	2	1	1	743	11		2	2
B	2	1	1	743	13		2	2
B	3	1	1	743	10		2	2
B	3	1	1	743	15		9	2
C	4	1	1	094	12		2	1
C	4	1	1	094	14		2	1
C	4	18	1	071	1	10	2	1
C	4	1	1	095	22		3	1
C	5	32	1	071	1	8	2	1
A	6	1	1	318	14		1	1
A	6	1	1	318	16		1	1
A	6	1	1	318	10		2	1
A	6	1	1	318	9		2	1

Delta P2E2 Center

4. Forest Cover Type Codes and Names

Code	Red / White / Jack Pine	Code	**Western White Pine**	Code	**Oak / Pine**	Code	**Maple/Beech/Birch**
101	Jack pine	241	Western white pine	403	Longleaf pine / oak	801	Sgr maple/beech/yel.birch
102	Red pine		**Fir/Spruce/Mtn Hemlock**	404	Shortleaf pine / oak	802	Black cherry
103	Eastern white pine	261	White fir	405	Virginia pine / southern red oak	805	Hard maple / basswood
104	Eastrn WP/eastrn hemlck	262	Red fir	406	Loblolly pine / hardwood	809	Red maple / upland
105	Eastern hemlock	263	Noble fir	407	Slash pine / hardwood		**Aspen / Birch**
	Spruce / Fir	264	Pacific silver fir	409	Other pine / hardwood	901	Aspen
121	Balsam fir	265	Engelmann spruce		**Oak / Hickory**	902	Paper birch
122	White spruce	266	Englmn sprc/subalpine fir	501	Post oak / blackjack oak	903	Gray birch
123	Red spruce	267	Grand fir	502	Chestnut oak	904	Balsam poplar
124	Red spruce / balsam fir	268	Subalpine fir	503	White oak / red oak / hickory	905	Pin cherry
125	Black spruce	269	Blue spruce	504	White oak		**Alder / Maple**
126	Tamarack	270	Mountain hemlock	505	Northern red oak	911	Red alder
127	Northern white-cedar	271	Alaska-yellow-cedar	506	Yellw-poplar/wht oak/N.red oak	912	Bigleaf maple
128	Fraser fir		**Lodgepole Pine**	507	Sassafras / persimmon		**Western Oak**
129	Red spruce / Fraser fir	281	Lodgepole pine	508	Sweetgum / yellow-poplar	921	Gray pine
	Longleaf/Slash Pine		**Hemlock / Sitka**	509	Bur oak	922	California black oak
141	Longleaf pine	301	Western hemlock	510	Scarlet oak	923	Oregon white oak
142	Slash pine	304	Western redcedar	511	Yellow-poplar	924	Blue oak
	Tropical Softwoods	305	Sitka spruce	512	Black walnut	931	Coast live oak
151	Tropical pines		**Western Larch**	513	Black locust	933	Canyon live oak
	Loblolly/Shortleaf Pine	321	Western larch	514	Southern scrub oak	934	Interior live oak
161	Loblolly pine		**Redwood**	515	Chestnut oak/blk oak/scrlett oak	935	California white oak
162	Shortleaf pine	341	Redwood	516	Cherry/white ash/yellow-poplar		**Tanoak / Laurel**
163	Virginia pine	342	Giant sequoia	517	Elm / ash / black locust	941	Tanoak
164	Sand pine		**Other Western Softwoods**	519	Red maple / oak	942	California laurel
165	Table-mountain pine	361	Knobcone pine	520	Mixed upland hardwoods	943	Giant chinkapin
166	Pond pine	362	Southwestern white pine		**Oak / Gum / Cypress**		**Other Harwoods**
167	Pitch pine	363	Bishop pine	601	Swp chestnut oak/cherrybrk oak	961	Pacific madrone
168	Spruce pine	364	Monterey pine	602	Sweetgum/Nuttall oak/willow oak	962	Other hardwoods
	Other Eastrn Softwoods	365	Foxtail pine/bristlecone pine	605	Overcup oak / water hickory		**Woodland Hardwoods**
171	Eastern redcedar	366	Limber pine	606	Atlantic white-cedar	971	Deciduous oak woodland
172	Florida softwoods	367	Whitebark pine	607	Baldcypress / water tupelo	972	Evergreen oak woodland
	Pinyon / Juniper	368	Misc. western softwoods	608	Sweetbay/swp tupelo/red mple	973	Mesquite woodland
182	Rocky Mountain juniper	369	Western juniper	609	Baldcypress / pondcypress	974	Cercocarpus woodland
184	Juniper woodland		**California Mixed Conifer**		**Elm / Ash / Cottonwood**	975	Intermountain maple wdlnd
185	Pinyon-juniper woodland	371	California mixed conifer	701	Blck ash/American elm/red mple	976	Misc. woodland hardwoods
	Douglas-fir		**Exotic Softwoods**	702	River birch / sycamore		**Tropical Hardwoods**
201	Douglas-fir	381	Scotch pine	703	Cottonwood	982	Mangrove
202	Port-Orford-cedar	383	Austrian Pine	704	Willow	983	Palms
203	Bigcone Douglas-fir	384	Norway spruce	705	Sycamore / pecan / American elm	989	Other tropical hardwoods
	Ponderosa Pine	385	Introduced larch	706	Sgrberry/hackberry/elm/grn ash		**Exotic Hardwoods**
221	Ponderosa pine		**Other Softwoods**	707	Silver maple / American elm	991	Paulownia
222	Incense-cedar	391	Other softwoods	708	Red maple / lowland	992	Melaleuca
224	Sugar pine		**Oak / Pine**	709	Cottonwood / willow	993	Eucalyptus
225	Jeffrey pine	401	Eastn WP/N. red oak/wht ash	722	Oregon ash	995	Other exotic hardwoods
226	Coulter pine	402	Eastern redcedar / hardwood				

Source: U.S. Forest Service, Forest Inventory & Analysis Unit,
National Core Field Guide, Version 4.0, October 2007

5. Species Codes and Names

Code	Common name	Code	Common name	Code	Common name	Code	Common name	Code	Common name	Code	Common name
010	Fir spp.	090	spruce spp.	132	Virginia pine	311	Florida maple	377	Virginia roundleaf birch	503	Brainerd hawthorn
011	Pacific silver fir	091	Norway spruce	133	singleleaf pinyon	312	bigleaf maple	378	northwestern paper birch	504	pear hawthorn
012	balsam fir	092	Brewer spruce	134	border pinyon	313	boxelder	379	gray birch	505	fireberry hawthorn
014	bristlecone fir,	093	Engelmann spruce	135	Arizona pine	314	black maple	381	Chittamwood, gum bumelia	506	broadleaf hawthorn
015	white fir	094	white spruce	136	Austrian pine	315	striped maple	391	Am. hormbeam, musclewood	507	fanleaf hawthorn
016	Fraser fir	095	black spruce	137	Washoe pine	316	red maple	400	hickory spp.	508	oneseed hawthorn
017	grand fir	096	blue spruce	138	four-leaf pine	317	silver maple	401	water hickory	509	scarlet hawthorn
018	corkbark fir	097	red spruce	139	Torrey pine	318	sugar maple	402	bitternut hickory	510	eucalyptus spp.
019	subalpine fir	098	Sitka spruce	140	Mexican pinyon pine	319	mountain maple	403	pignut hickory	511	Tasmanian bluegum
020	California red fir	100	pine spp.	141	papershell pinyon pine	320	Norway maple	404	pecan	512	river redgum
021	Shasta red fir	101	whitebark pine	142	Great Basin bristlecone pine	321	Rocky Mountain maple	405	shellbark hickory	513	grand eucalyptus
022	noble fir	102	Rocky Mtn bristlecone pine	143	Arizona pinyon pine	322	bigtooth maple	406	nutmeg hickory	514	swamp mahogany
040	cedar spp.	103	knobcone pine	144	Carribean pine	323	chalk maple	407	shagbark hickory	520	persimmon spp.
041	Port-Orford-cedar	104	foxtail pine	200	Douglas-fir spp.	330	buckeye, horsechestnut	408	black hickory	521	common persimmon
041	Alaska yellow-cedar	105	jack pine	201	bigcone Douglas-fir	331	Ohio buckeye	409	mockernut hickory	522	Texas persimmon
043	Atlantic white-cedar	106	Common pinyon	202	Douglas-fir	332	yellow buckeye	410	sand hickory	523	Anacua
050	cypress	107	sand pine	211	redwood	333	California buckeye	411	scrub hickory	531	American beech
051	Arizona cypress	108	lodgepole pine	212	giant sequoia	334	Texas buckeye	412	red hickory	540	ash spp.
052	Baker cypress,	109	Coulter pine	220	cypress spp.	336	red buckeye	413	southern shagbark hckry	541	white ash
053	tecate cypress	110	shortleaf pine	221	baldcypress	337	painted buckeye	420	chestnut spp.	542	Oregon ash
054	Monterey cypress	111	slash pine	222	pondcypress	341	ailanthus	421	American chestnut	543	black ash
055	Sargent's cypress	112	Apache pine	223	Montezuma	345	mimosa/silktree	422	Allegheny chinkapin	544	green ash
056	MacNab's cypress	113	limber pine	230	baldcypress yew spp.	350	alder spp.	423	Ozark chinkapin	545	pumpkin ash
057	redcedar, juniper	114	southwestern white pine	231	Pacific yew	351	red alder	424	Chinese chestnut	546	blue ash
058	spp. Pinchot juniper	115	spruce pine	231	Florida yew	352	white alder	431	giant chinkapin	547	velvet ash
059	redberry juniper	116	Jeffrey pine	240	Thuja spp.	353	Arizona alder	450	catalpa spp.	548	Carolina ash
060	drooping juniper	117	sugar pine	241	northern white-cedar	355	European alder	451	southern catalpa	549	Texas ash
061	Ashe juniper	118	Chihuahua pine	242	western redcedar	356	serviceberry spp.	452	northern catalpa	550	locust spp.
062	California juniper	119	western white pine	250	torreya (nutmeg) spp.	357	common serviceberry	460	hackberry spp.	551	waterlocust
063	alligator juniper	120	bishop pine	251	California torreya (nutmeg)	358	roundleaf serviceberry	461	sugarberry	552	honeylocust
064	western juniper	121	longleaf pine	252	Florida torreya (nutmeg)	360	Madrone spp.	462	hackberry	555	loblolly bay
065	Utah juniper	122	ponderosa pine	260	hemlock	361	Pacific madrone	463	netleaf hackberry	561	Ginkgo
066	Rocky Mountain juniper	123	Table Mountain pine	261	eastern hemlock	362	Arizona madrone	471	eastern redbud	571	Kentucky coffeetree
067	southern redcedar	124	Monterey	262	Carolina hemlock	363	Texas madrone	475	curlleaf mtn-mahogany	580	silverbell spp.
068	eastern redcedar	125	red pine	263	western hemlock	367	Pawpaw	481	yellowwood	581	Carolina silverbell
069	oneseed juniper	126	pitch pine	264	mountain hemlock	370	birch spp.	490	dogwood spp.	582	two-wing silverbell
070	larch spp.	127	gray pine, California foothill	299	unknown dead conifer	371	yellow birch	491	flowering dogwood	583	little silverbell
071	tamarack (native)	128	pine pond pine	300	acacia spp.	372	sweet birch	492	Pacific dogwood	591	American holly
072	subalpine larch	129	eastern white pine	303	sweet acacia	373	river birch	500	hawthorn spp.	600	walnut spp.
073	western larch	130	Scotch pine	304	catclaw acacia	374	water birch	501	cockspur hawthorn	601	butternut
081	incense-cedar	131	loblolly pine	310	maple spp.	375	paper birch	502	downy hawthorn	602	black walnut

Delta P2E2 Center

Code	Common name	Code	Common name	Code	Common name	Code	Common name	Code	Common name	Code	Common name
603	N. CA black walnut	740	cottonwood and poplar spp.	811	Engelmann oak	854	gumbo limbo	915	other palms	995	tungoil tree
604	S. CA black walnut	741	balsam poplar	812	southern red oak	855	sheoak spp.	919	western soapberry	996	smoketree
605	Texas walnut	742	eastern cottonwood	813	cherrybark oak	856	gray sheoak	920	willow spp	997	Russian-olive
606	Arizona walnut	743	bigtooth aspen	814	Gambel oak	857	Australian pine	921	peachleaf willow	998	unknown dead hdw
611	sweetgum	744	swamp cottonwood	815	Oregon white oak	858	camphor tree	922	black willow	999	other, unknown live tree
621	yellow-poplar	745	plains cottonwood	816	scrub oak	859	fiddlewood	923	Bebb willow		
631	tanoak	746	quaking aspen	817	shingle oak	860	citrus spp.	924	red willow		
641	Osage-orange	747	black cottonwood	818	California black oak	863	pigeon plum, tietongue	925	coastal plain willow		
650	magnolia spp.	748	Fremont’s cottonwood	819	turkey oak	864	soldierwood	926	balsam willow		
651	cucumbertree	749	narrowleaf cottonwood	820	laurel oak	865	geiger tree	927	white willow		
652	southern magnolia	752	silver poplar	821	California white oak	866	carrotwood	928	Scouler's willow		
653	sweetbay	753	Lombardy poplar	822	overcup oak	867	bluewood	929	weeping willow		
654	bigleaf magnolia	755	mesquite spp.	823	bur oak	868	blackbead ebony	931	sassafras		
655	mountain magnolia	756	honey mesquite	824	blackjack oak	869	great leucaena	934	mountain ash spp.		
657	pyramid magnolia	757	velvet mesquite	825	swamp chestnut oak	870	Texas sophora	935	American mountain ash		
658	umbrella magnolia	758	screwbean mesquite	826	chinkapin oak	873	red stopper	936	European mountain ash		
660	apple spp.	760	cherry and plum spp.	827	water oak	874	Inkwood, butterbough	937	northern mountain ash		
661	Oregon crabapple	761	spp. pin cherry	828	Nuttall oak	876	strangler fig	940	mahogany		
662	southern crabapple	762	black cherry	829	Mexican blue oak	877	shortleaf fig, wild banyantree	950	basswood spp		
663	sweet crabapple	763	common chokecherry	830	pin oak	882	Blolly, beeftree	951	American basswood		
664	prairie crabapple	764	peach	831	willow oak	883	manchineel	952	white basswood		
680	mulberry spp.	765	Canada plum	832	chestnut oak	884	false tamarind	953	Carolina basswood		
681	white mulberry	766	American plum	833	northern red oak	885	mango	970	elm spp.		
682	red mulberry	768	bitter cherry	834	Shumard’s oak	886	poisonwood	971	winged elm		
683	Texas mulberry	769	Allegheny plum	835	post oak	887	fishpoison tree	972	American elm		
684	black mulberry	770	Chickasaw plum	836	Delta post oak	888	schefflera, octopus tree	973	cedar elm		
690	tupelo spp.	771	sweet cherry	837	black oak	890	false mastic	974	Siberian elm		
691	water tupelo	772	sour cherry	838	live oak	891	white bully, willow bustic	975	slippery elm		
692	Ogeechee tupelo	773	European plum	839	interior live oak	895	paradise tree	976	September elm		
693	blackgum	774	Mahaleb plum	840	dwarf post oak	896	Java plum	977	rock elm		
694	swamp tupelo	800	oak – deciduous	841	dwarf live oak	897	tamarind	981	California laurel		
701	eastern hophornbeam	801	spp. California live oak	842	bluejack oak	901	black locust	982	Joshua tree		
711	sourwood	802	white oak	843	silverleaf oak	902	New Mexico locust	986	black mangrove		
712	paulownia, empress-tree	803	Arizona white oak	844	Oglethorpe oak	906	paurotis palm	987	buttonwood mangrove		
720	bay spp.	804	swamp white oak	845	dwarf chinkapin oak	907	silver palm	988	white mangrove		
721	redbay	805	canyon live oak	846	gray oak	908	coconut palm	989	American mangrove		
722	water-elm	806	scarlet oak	847	netleaf oak	909	royal palm spp.	990	desert ironwood		
729	sycamore spp.	807	blue oak	850	oak – evergreen	911	Mexican palmetto	991	saltcedar		
730	California sycamore	808	Durand oak	851	spp. Chisos oak	912	cabbage palmetto	992	melaleuca		
731	American sycamore	809	northern pin oak	852	torchwood	913	key thatch palm	993	chinaberry		
732	Arizona sycamore	810	Emory oak	853	pond apple	914	Florida thatch palm	994	Chinese tallowtree		

6. Diameter Classes

Diameter Range		Diameter Class
0.6	1.5	1
1.6	2.5	2
2.6	3.5	3
3.6	4.5	4
4.6	5.5	5
5.6	6.5	6
6.6	7.5	7
7.6	8.5	8
8.6	9.5	9
9.6	10.5	10
10.6	11.5	11
11.6	12.5	12
12.6	13.5	13
13.6	14.5	14
14.6	15.5	15
15.6	16.5	16
16.6	17.5	17
17.6	18.5	18
18.6	19.5	19
19.6	20.5	20
20.6	21.5	21
21.6	22.5	22
22.6	23.5	23
23.6	24.5	24
24.6	25.5	25
25.6	26.5	26
26.6	27.5	27
27.6	28.5	28
28.6	29.5	29
29.6	30.5	30