

SUWANNEE RIVER WATER MANAGEMENT DISTRICT

INVITATION TO BID

NO. 17/18-011 AO

FORESTRY CONSULTING SERVICES

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Suwannee River Water Management District
9225 CR 49
Live Oak, FL 32060
386.362.1001
386.362.1056 (Fax)
800.226.1066 (Florida only)
www.mysuwanneeriver.com

SECTION 1 - INTRODUCTION

The Suwannee River Water Management District (District) is conducting this Invitation to Bid (ITB) for Forestry Consulting Services. Contractors shall be individuals or firms that provide professional forest management services for tracts of forestland in north central Florida. These forestry services may include forest inventory, timber harvest planning and oversight, timber sale cruising, timber marking, timber sale inspection and security, timber sale boundary marking, seedling survival and stocking counts, forest health analysis, and forest stand mapping. The initial contract shall be for a period of one year with two subsequent one-year renewals based upon the mutual agreement of the District and the Contractor.

The District is divided into four regions as shown on the attached map (Appendix A). Services are required in these areas for regularly scheduled, optional, emergency, and as-needed operations in conformity with the specifications and procedures described in the Scope of Services. Contractor shall provide all labor, materials, equipment, tools, transportation and supplies required to complete the work.

SECTION 2 - PROPOSED SCHEDULE

February 6, 2018	Release of Invitation to Bid.
February 22, 2018	Bids due prior to 10:00 a.m. at District Headquarters in Live Oak. Opening will occur at this time. *
March 13, 2018	Governing Board Approval of Top-Ranked Firms at District Headquarters in Live Oak. *

* Denotes a public meeting. All times denote Eastern Standard Time (EST).

SECTION 3 - INSTRUCTION TO PROPOSERS

Questions: To provide equal opportunity and ensure the same information is provided to all proposers, any questions should be submitted by email to Steve Carpenter at SCC@srwmd.org before February 12, 2018. The questions with answers will be posted on the District website www.mysuwanneeriver.com, on February 16, 2018. Questions cannot be answered via telephone or other verbal communication.

Bid Document: Proposer shall submit a document that illustrates the Firm's understanding of the work requested, which includes the items below.

- **Qualifications:**
 - List at least three (3) projects of a similar nature specified in this Scope of Work over the past five (5) years. List shall include a brief description of the project, name and address of company the services were performed for, and a contact person and phone number of same company.

Delivery of Bids: One original copy of the bid should be sent to:

Pennie Flickinger, Business Resource Specialist III
Suwannee River Water Management District
9225 County Road 49
Live Oak, Florida 32060 Phone: 386.362.1001

Bids are due at the above address by 10:00 a.m. on February 22, 2018 Bids received after this time, for any reason, will be rejected.

Bids must be hard copy. FAX or email submittals will not be accepted.

All Bids shall be submitted in sealed envelopes with the **Bid number (ITB No. 17/18-011AO and Bid opening time and date (February 22, 2018 at 10:00 a.m.) clearly marked in large, bold and/or colored lettering**. Bids delivered in an envelope not properly marked with the Bid number and Bid opening date and time that are inadvertently opened by District personnel will not be considered. The response shall be hand-delivered or mailed.

SECTION 4 – KEY POINTS

Challenge of Solicitation Process: If a potential respondent protests any provisions of this ITB, a notice of intent to protest shall be filed with the District in writing within 72 hours after the posting of the Invitation to Bid on the District’s website. **“Failure to file a protest within the time prescribed in Section 120.57(3) Florida Statutes shall constitute a waiver of proceedings under Chapter 120 of Florida Statutes.”**

Challenge of District’s Intent to Award Contract: If a respondent intends to protest District’s intent to award contract, the notice of intent to protest must be filed in writing within 72 hours after posting of a notice of intent to award contract and the respondent shall file a formal written protest within ten (10) days after filing of notice of intent to protest. Any respondent who files a formal written protest pursuant to Chapter 28-110, Florida Administrative Code, and Section 120.57(3), Florida Statutes shall post with the District at the time of filing the formal written protest, a bond pursuant to Section 287.042(2)(c), Florida Statutes (2017).

Failure to file a notice of intent to protest or failure to file a formal written protest within the time prescribed in Chapter 28-110, Florida Administrative Code and Section 120.57(3), Florida Statutes, or failure to post the bond or other security required by law within the time allowed for filing a bond shall constitute a waiver of proceedings under Chapter 120, Florida Statutes. More specifically, **“Failure to file a protest within the time prescribed in Section 120.57(3) Florida Statutes shall constitute a waiver of proceedings under Chapter 120 of Florida Statutes.”**

Americans With Disabilities Act: The District does not discriminate upon the basis of any individual’s disability status. This nondiscrimination policy involves every aspect of the District’s functions including one’s access to, participation, employment, or treatment in its programs or activities. Anyone requiring reasonable accommodation as provided for in the Americans with Disabilities Act should contact Gwen Lord, Contracts and Procurement Coordinator, at 386.362.1001 or 800.226.1066 (Florida only). The District’s fax number is 386.362.1056.

Minority Business Enterprises: The District recognizes fair and open competition as a basic tenet of public procurement. Respondents doing business with the District are prohibited from discriminating on the basis of race, color, creed, national origin, handicap, age, or sex. The District encourages participation by minority business enterprises. Whenever two or more service providers are ranked equally, a minority business enterprise shall be given preference in the award process.

Veteran’s Preference: In the absence of minority business enterprise, whenever two or more service providers are ranked equally by the Selection Committee, a veteran-owned business enterprise shall be given preference in the award process.

Drug Free Workplace Act: The selected PROPOSER shall certify that it has established a drug free workplace.

Public Entity Crime: Section 287.133(2)(a), Florida Statutes, states “A person or affiliate who has been placed on the convicted vendor list following a conviction for a public entity crime may not submit a bid on a contract to provide any goods or services to a public entity, may not submit a bid on a contract with a public entity for the construction or repair of a public building or public work, may not submit bids on leases of real property to a public entity, may not be awarded or perform work as a contractor, supplier, subcontractor, or consultant under a contract with any public entity, and may not transact business with any public entity in excess of the threshold amount provided in s.287.017 for CATEGORY TWO for a period of 36 months from the date of being placed on the convicted vendor list.”

Insurance Requirements: If awarded, PROPOSER shall represent and guarantee that all employees, agents, servants or representatives of the respondent, and all employees, agents, servants, or representatives of subcontractors are covered by workers' compensation insurance. Prior to entering into contract with the District, respondent agrees to furnish the District certificates of insurance on all insurance, naming District as additional insured for items 2 and 3 below, providing evidence that respondent has in full force and effect the following minimum insurance with insurers authorized to do business in the State of Florida:

- 1) Workers' compensation insurance as required above;
- 2) Motor vehicular liability insurance with limits of not less than \$1,000,000 combined single limit which insurance shall be applicable to any and all vehicles utilized by respondent to provide the services requested by District;
- 3) General liability insurance for all services rendered by respondent for the requested services with a minimum of \$1,000,000 personal and advertising injury and \$1,000,000 general aggregate.

The certificate of insurance shall also provide that District shall be notified in writing by the carrier at least 30 days prior to any cancellation of said insurance.

Rejection of Responses: Pursuant to Rule 40B-1.812, Florida Administrative Code, the District reserves the right to reject any and all bids or other proposals submitted in response to District invitation. District also reserves the right to waive any minor deviations in an otherwise valid Bid.

Renewal of Contract: The initial contract shall be for a period of one year with the potential for two subsequent one-year renewals based upon the same terms and conditions or terms more favorable to the District, and mutual agreement of the District and the Contractor.

SECTION 5 - SCOPE OF WORK

INTRODUCTION

The District is divided into four regions as shown on the attached map. Services are required in these areas for regularly scheduled, optional, emergency, and as-needed operations in conformity with the specifications and procedures described in the Scope of Services. Contractor shall provide all labor, materials, equipment, tools, transportation and supplies required to complete the work.

District requests that all rates listed in the Project Cost Schedule to be populated except for rates associated with forest inventories. Inventories require specific technology that all contractors may not have or use but all other rates should be populated.

SCOPE OF SERVICES

Contractors shall be individuals or firms that provide professional forest management services for tracts of forestland in north central Florida. These forestry services may include forest inventory, timber harvest planning and oversight, timber sale cruising, timber marking, timber sale inspection and security, timber sale boundary marking, seedling survival and stocking counts, forest health analysis, and forest stand mapping.

Contractors are to provide quotes that are not-to-exceed rates. The District will select the three contractors with lowest not to exceed Timber Sale Planning and Oversight and Timber Marking quotes based on the 3-year estimated acreage per region. Those firms will be used to complete requested services in those regions. Once an operation requiring forestry services is determined by the District, the three selected regional contractors will be contacted by email to determine availability and contractor rate for the specific project. The District email will provide project details so the bidding contractor has the information necessary to submit a fair rate for the specific project. This District will choose the contractor with the lowest specific project rate that can complete the project in the desired time period. If rates and availability are equal, the project contractor will be selected at random. The contractor may not submit a rate higher than the not to exceed quote provided in response to this ITB. Contractors that submit a higher rate may be removed from regional list and no other work offered to the contractor.

More than one contractor maybe selected for a complex project. Once a contractor(s) is selected for the project a Work Order will be issued indicating the final project scope of services and the project schedule. If a contractor does not respond to the services or manage the operations in an efficient and effective manner the District reserves the right to remove the contractor from the project and reject the contractor's services for future projects.

SERVICES

Forest Inventory – The District uses a specific process to inventory its forests. The District's current Forest Inventory System is provided in Appendix B. All deliverables from the Contractor must be compatible with F4 Tech's SilvAssist program for ArcGIS and follow the protocol in the Forest Inventory System document. In general, the District's inventories require two separate sampling methods; one for mature stands and another for sub-merchantable stands. Plots are allocated in mature stands (15 years or older) at an approximate rate of 5 acres per plot with a maximum of 40 plots per stand and a minimum of 3 plots. In the mature stands the sampler will be required to use a variable radius point sampling (20 BAF Prism) to gather data on pine species with a diameter at breast height (DBH) greater than 4.5 inches and hardwood species

with a DBH greater than 5.5 inches. Within the variable radius plot two sub-fixed area plots (1/50 acre and 1/300 acre) will be used. The 1/50 acre plot gathers data on pine species with a DBH of 1 inch or greater to 4.5 inches and hardwood species with a DBH of 1 inch and greater to 5.5 inches. The 1/300 acre plot gathers data on pine regeneration. In younger stands a separate 1/50th acre fixed radius sub-merchantable plots are used at an approximate rate of 1 plot per 8 acres to gather data in stands that are between 6-7 years old or to capture pine seedling survival rates on reforested sites.

Plots will be provided by the District as ArcGIS shapefiles and .mdb files. The contractor must deliver to the District .tce, .tcd and .mdb files in a format that can be uploaded to T-cruise and SilvAssist. If the District's Forest Inventory System is updated, all regional contractors will be notified of the changes.

Harvest Planning and Oversight – Contractor will be responsible for planning and overseeing all aspects of timber harvests. This may include clear-cut, first thinning, second thinning, and salvage operations. The contractor will work with the District to create a comprehensive action plan for specific timber stands, implement the approved plan, and manage the operation until its completion. Thinnings are generally focused on reducing or maintaining the timber stand at 30-50 basal area however some thinnings may have different residual basal area requirements. Work may include timber sale cruises, sale boundary delineation, GIS mapping, timber sale security, timber sale oversight, provide site specific terms for sale contracts, coordinate with contracted logging company, recommend improvements to transportation systems, and be available for all necessary meetings.

Timber Sale Cruise – Contractor will be responsible for planning and implementing timber sale cruises. Generally cruises will be at a rate of 1 plot per 2 acres and will be allocated by the contractor. However the District may request to increase or decrease the plots per acre depending on stand conditions. Contractor will submit to the District a preliminary plan and maps to accomplish the cruise. The District must approve the plan prior to implementation. Deliverables may include a cruise report (cruise type, sampling intensity, accuracy, volume, basal area, harvest recommendation, and expected income by product with current market values), spreadsheet summary (total trees, volume, and basal area), timber sale cruise maps with labeled plots, digital T-cruise files, and ArcGIS shapefiles.

Timber Marking – Contractor will be responsible for marking specific timber stands prior to a harvest. District generally requires all trees that are to be retained during a timber harvest to be marked. However trees to be harvested may be marked in certain instances. Marking will occur at a rate designed by the District. Thinnings are generally focused on reducing or maintaining the timber stand at 30-50 basal area. However some thinnings may require different residual basal area requirements.

Timber Sale Inspection and Security - Implement and document timber security compliance and inspection checks during timber operations. Document and deliver timber tracking reports or other suitable documentation no less than each month when a timber operation is underway. Maintain load sheets and revenue reconciliation if required for per unit sales. Deliver inspection forms based on District and Florida Forest Service (FFS) Best Management Practice (BMP) standards no less than each month a timber operation is underway or as requested by District. District Inspection forms and examples of timber tracking reports will be provided by the District.

Timber Sale Boundary Marking – Contractor will be responsible for marking timber sale boundaries with designated boundary line flagging tape. Boundary marking may also require

Special Management Zones (SMZ) flagging following the FFS BMP standards and other District required flagging as needed. Deliverables may include final flagging maps and ArcGIS shapefiles.

Seedling Survival & Stocking Counts – Contractor will be responsible for planning and implementing cruises. Cruises will follow District’s Forest Inventory System for sub-merchantable stands as provided in Appendix B. These cruises will be 1/50th acre fixed radius plots at an approximate rate of 1 plot per 8 acres. The District may increase the number of plots per acre depending on stand conditions. Deliverables may include a cruise report (cruise type, sampling intensity, accuracy, volume, trees per acre, stand health, and stand recommendation), spreadsheet summary (total trees, volume, and basal area), timber sale cruise maps with labeled plots, digital T-cruise files, and ArcGIS shapefiles.

Forest Health Analysis – Contractor will be responsible for planning and implementing a forest health analysis for a specific area. Contractor may be required to inventory the extent of disease, damage, or insect infestation in specific forest stands. Deliverables may include a final report (cruise type, sampling intensity, accuracy, volume, basal area, operational recommendation, and expected income by product with current market values) and maps delineating subject health issue. District may not be able to provide specific details in the initial Work Order due the nature of this type of analysis. District may request follow up field meetings or modify the Work Order to incorporate additional work following the initial analysis.

Forest Stand Mapping - Develop and deliver forest stand maps of designated sites. This may include mapping of stands for future timber sales, natural communities following Florida Natural Areas Inventory (FNAI) criteria, SMZ mapping following FFS BMP standards, and pine beetle infestation mapping. Deliverables may include maps and ArcGIS shapefiles with the District’s stand attributing.

QUALITY ASSURANCE

District staff will randomly check plots, marking, mapping, and security compliance. Based on the results of the checks, District will reserves the right to request the contractor to revise or re-do all or part of a specific area.

PAYMENTS

Payments will be made based on the specific project quoted rate which will be incorporated into the final Work Order. Invoices must be detailed to show date, site, person, activity and rate. Additional work outside the scope of the Harvest Planning & Oversight and Timber Marking in this ITB may be based on per acre, hourly, or per plot rates.

Pursuant to Ch. 119, Florida Statutes, the District is required to comply with public records requests. Trade secrets and/or confidential information are not desired as part of submissions. If any material submitted as part of the response is exempt and/or confidential under Florida’s public records laws, Respondent must submit a redacted copy of their Bid to the District with their primary submission. A cover sheet must reference the redactions and provide a specific statutory citation to support each redaction, any material in your submission is exempt and/or confidential under the laws of the State of Florida, please provide a redacted copy of your submission with these areas redacted. Submissions must be properly redacted and not merely identified. Please be aware that under no circumstances will the District defend a lawsuit challenging redactions. Defense of any claim is the sole responsibility of the Respondent.

This procurement is conducted under the rules, policies, and procedures of the Suwannee River Water Management District and the District's Governing Board. This procurement is not conducted pursuant to Ch. 287, Florida Statutes, except where explicitly provided by law. The District's rules, policies, and procedures are available by contacting the procurement officer.

SECTION 6 - RESPONSE FORM

**FORESTRY CONSULTING SERVICES
REQUEST FOR QUALIFICATIONS FORM
17/18-011AO**

Company Name - Proposer

FEID #: _____

Proposer Representative/ Title

Address

City, State, Zip Code

Telephone Number

Fax Number

Email address

**FORESTRY CONSULTING SERVICES
COST SCHEDULE**

NORTHEAST – REGION 1

The northeast region properties owned by the District are generally along the Withlacoochee River, Alapaha River, and upper Suwannee River (north of the confluence of the Santa Fe River). Please see Appendix A or visit our website at mysuwanneeriver.com for more details about the tract locations in this region. Estimated 2018-20 acreage is for bid comparison only and may not represent actual contracted acreage. Please enter not to exceed rates for all categories.

Harvest Planning & Oversight

Service	Estimated 2018-2020 Acres	Per Unit Rates \$	\$ Bid Comparison
First Thinning (100% marked thinning)	500	/Acre	
First Thinning (logger select w/ marked sample area)	0	/Acre	0
Volume Reduction Thinning (100% marked thinning)	400	/Acre	
Clear-cut	120	/Acre	
Salvage Cut	0	/Acre	0

Timber Marking

Service	Estimated 2018-2020 Acres	Per Unit Rates \$	\$ Bid Comparison
First Thinning (100% marked thinning)	500	/Acre	
Volume Reduction Thinning (100% marked thinning)	400	/Acre	

Bid Comparison Total = \$ _____

Company Name: _____

Signature: _____

Date: _____

**Northeast Region
Other Services**

Services	Per Unit Rates
Forest Inventory	/Plot
Timber Sale Cruise	/Plot
Seedling Survival & Stocking Counts	/Plot
Timber Marking	/Hour
Timber Sale Inspection and Security	/Hour
Timber Sale Boundary Marking	/Hour
Forest Health Analysis	/Hour
Forest Stand Mapping	/Hour

Personnel Rates

Clerical Rate: \$ _____ /hour
 Labor Rate: \$ _____ /hour
 Technician Rate: \$ _____ /hour
 Technician Rate: \$ _____ /hour
 Professional Rate: \$ _____ /hour
 Professional Rate: \$ _____ /hour
 Labor Crew Rate (2 or more individuals): \$ _____ /hour
 Supervisor: \$ _____ /hour

Company Name: _____

Signature: _____

Date: _____

**FORESTRY CONSULTING SERVICES
COST SCHEDULE**

NORTHWEST – REGION 2

The northwest region properties owned by the District are generally along the Aucilla River and Econfina River. Please see Appendix A or visit our website at mysuwanneeriver.com for more details about the tract locations in this region. Estimated 2018-20 acreage is for bid comparison only and may not represent actual contracted acreage. Please enter rates for all categories.

Harvest Planning & Oversight

Service	Estimated 2018-2020 Acres	Per Unit Rates \$	\$ Bid Comparison
First Thinning (100% marked thinning)	200	/Acre	
First Thinning (logger select w/ marked sample area)	1800	/Acre	
Volume Reduction Thinning (100% marked thinning)	0	/Acre	0
Clear-cut	0	/Acre	0
Salvage Cut	0	/Acre	0

Timber Marking

Service	Estimated 2018-2020 Acres	Per Unit Rates \$	\$ Bid Comparison
First Thinning (100% marked thinning)	200	/Acre	
Volume Reduction Thinning (100% marked thinning)	0	/Acre	0

Bid Comparison Total = \$ _____

Company Name: _____

Signature: _____

Date: _____

**Northwest Region
Other Services**

Services	Per Unit Rates
Forest Inventory	/Plot
Timber Sale Cruise	/Plot
Seedling Survival & Stocking Counts	/Plot
Timber Marking	/Hour
Timber Sale Inspection and Security	/Hour
Timber Sale Boundary Marking	/Hour
Forest Health Analysis	/Hour
Forest Stand Mapping	/Hour

Personnel Rates

Clerical Rate: \$ _____ /hour
 Labor Rate: \$ _____ /hour
 Technician Rate: \$ _____ /hour
 Technician Rate: \$ _____ /hour
 Professional Rate: \$ _____ /hour
 Professional Rate: \$ _____ /hour
 Labor Crew Rate (2 or more individuals): \$ _____ /hour
 Supervisor: \$ _____ /hour

Company Name: _____

Signature: _____

Date: _____

**FORESTRY CONSULTING SERVICES
COST SCHEDULE**

SOUTHEAST – REGION 3

The southeast region properties owned by the District are generally along the Santa Fe River, Waccasassa River, and lower Suwannee River (south of the confluence of the Santa Fe River). Please see Appendix A or visit our website at mysuwanneeriver.com for more details about the tract locations in this region. Estimated 2018-20 acreage is for bid comparison only and may not represent actual contracted acreage. Please enter rates for all categories.

Harvest Planning & Oversight

Service	Estimated 2018-2020 Acres	Per Unit Rates \$	\$ Bid Comparison
First Thinning (100% marked thinning)	150	/Acre	
First Thinning (logger select w/ marked sample area)	0	/Acre	0
Volume Reduction Thinning (100% marked thinning)	25	/Acre	
Clear-cut	0	/Acre	0
Salvage Cut	0	/Acre	0

Timber Marking

Service	Estimated 2018-2020 Acres	Per Unit Rates \$	\$ Bid Comparison
First Thinning (100% marked thinning)	150	/Acre	
Volume Reduction Thinning (100% marked thinning)	25	/Acre	

Bid Comparison Total = \$ _____

Company Name: _____

Signature: _____

Date: _____

**Southeast Region
Other Services**

Services	Per Unit Rates
Forest Inventory	/Plot
Timber Sale Cruise	/Plot
Seedling Survival & Stocking Counts	/Plot
Timber Marking	/Hour
Timber Sale Inspection and Security	/Hour
Timber Sale Boundary Marking	/Hour
Forest Health Analysis	/Hour
Forest Stand Mapping	/Hour

Personnel Rates

Clerical Rate: \$ _____ /hour

Labor Rate: \$ _____ /hour

Technician Rate: \$ _____ /hour

Technician Rate: \$ _____ /hour

Professional Rate: \$ _____ /hour

Professional Rate: \$ _____ /hour

Labor Crew Rate (2 or more individuals): \$ _____ /hour

Supervisor: \$ _____ /hour

Company Name: _____

Signature: _____

Date: _____

FORESTRY CONSULTING SERVICES

COST SCHEDULE

SOUTHWEST – REGION 4

The southwest region properties owned by the District are generally along the Steinhatchee River. Please see Appendix A or visit our website at mysuwanneeriver.com for more details about the tract locations in this region. Estimated 2018-20 acreage is for bid comparison only and may not represent actual contracted acreage. Please enter rates for all categories.

Harvest Planning & Oversight

Service	Estimated 2018-2020 Acres	Per Unit Rates \$	\$ Bid Comparison
First Thinning (100% marked thinning)	0	/Acre	0
First Thinning (logger select w/ marked sample area)	750	/Acre	
Volume Reduction Thinning (100% marked thinning)	0	/Acre	0
Clear-cut	0	/Acre	0
Salvage Cut	0	/Acre	0

Timber Marking

Service	Estimated 2018-2020 Acres	Per Unit Rates \$	\$ Bid Comparison
First Thinning (100% marked thinning)	0	/Acre	0
Volume Reduction Thinning (100% marked thinning)	0	/Acre	0

Bid Comparison Total = \$ _____

Company Name: _____

Signature: _____

Date: _____

**Southwest Region
Other Services**

Services	Per Unit Rates
Forest Inventory	/Plot
Timber Sale Cruise	/Plot
Seedling Survival & Stocking Counts	/Plot
Timber Marking	/Hour
Timber Sale Inspection and Security	/Hour
Timber Sale Boundary Marking	/Hour
Forest Health Analysis	/Hour
Forest Stand Mapping	/Hour

Personnel Rates

Clerical Rate: \$ _____ /hour
 Labor Rate: \$ _____ /hour
 Technician Rate: \$ _____ /hour
 Technician Rate: \$ _____ /hour
 Professional Rate: \$ _____ /hour
 Professional Rate: \$ _____ /hour
 Labor Crew Rate (2 or more individuals): \$ _____ /hour
 Supervisor: \$ _____ /hour

Company Name: _____

Signature: _____

Date: _____

SIMILAR PROJECTS

Date: _____
Firm: _____

Please complete the forms below that show completed projects over the past five years that are related to the scopes of services described herein. Include information on the equipment and labor used, the names of personnel assigned to each, name of the agencies/companies for whom the work was performed, and a contact person and telephone number:

COMPLETED PROJECT:

AGENCY/COMPANY: _____

CONTACT: _____ TELEPHONE: _____

NAME OF PROJECT: _____

DESCRIPTION: _____

START DATE: _____ COMPLETION DATE: _____
(month/year) (month/year)

COST OF PROJECT \$ _____

NAMES OF PERSONNEL ASSIGNED TO PROJECT: _____

COMPLETED PROJECT:

AGENCY/COMPANY: _____

CONTACT: _____ TELEPHONE: _____

NAME OF PROJECT: _____

DESCRIPTION: _____

START DATE: _____ COMPLETION DATE: _____
(month/year) (month/year)

COST OF PROJECT \$ _____

NAMES OF PERSONNEL ASSIGNED TO PROJECT: _____

Make copies and attach additional sheets for additional work examples.

REFERENCES

Date: _____
Firm: _____

(Names/address/telephone of three clients who can attest to your experience as it relates to the tasks provided in Scope of Services attached. These references should not include SRWMD.)

FIRM NAME: _____

ADDRESS: _____

CONTACT PERSON: _____

TELEPHONE: _____

FAX: _____

FIRM NAME: _____

ADDRESS: _____

CONTACT PERSON: _____

TELEPHONE: _____

FAX: _____

FIRM NAME: _____

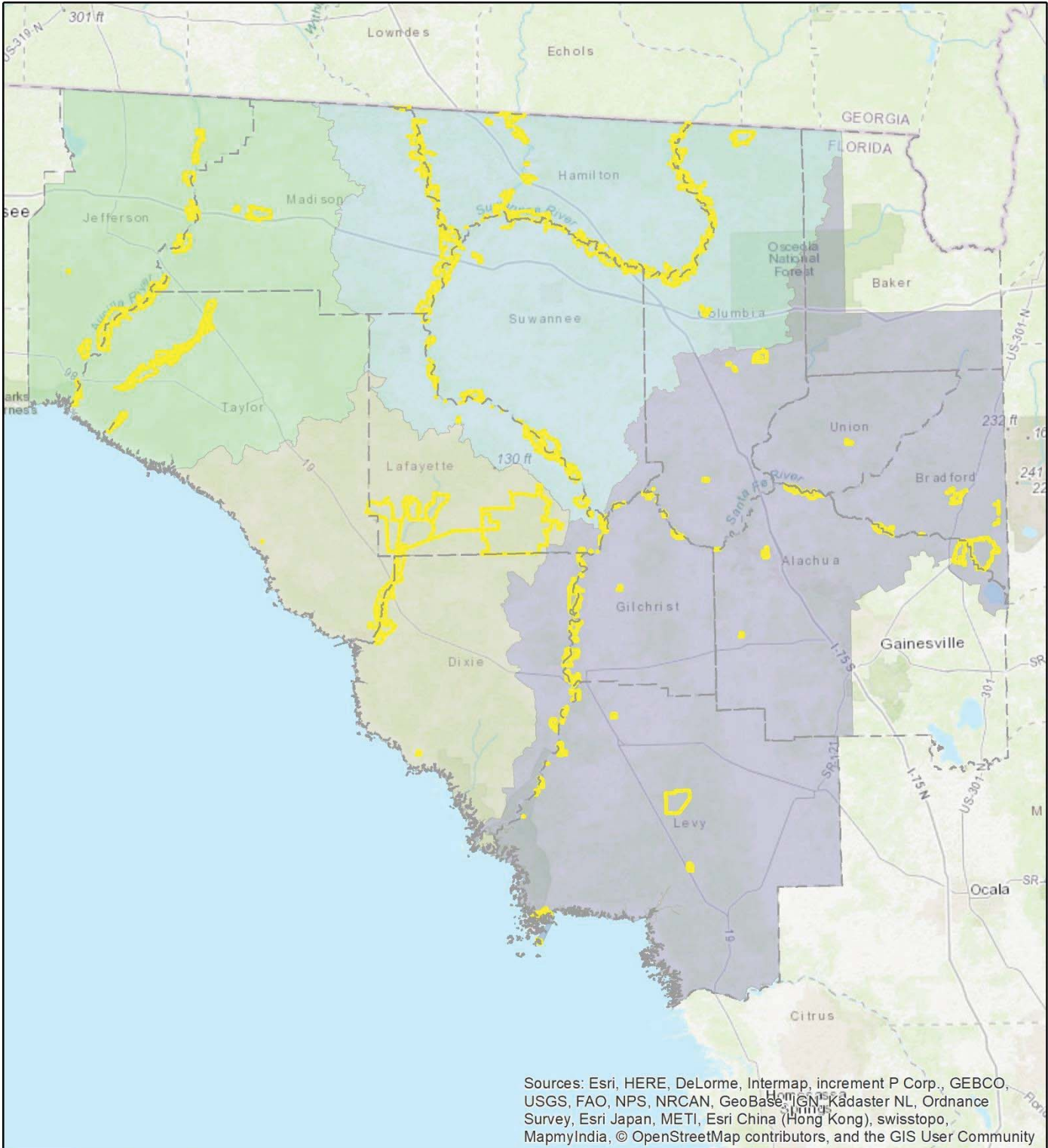
ADDRESS: _____

CONTACT PERSON: _____

TELEPHONE: _____

FAX: _____

Appendix A

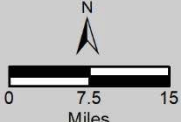


Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

CONTRACT REGIONS

- NORTH EAST
- NORTH WEST
- SOUTH EAST
- SOUTH WEST

Contract Regions



Note: This map was created by the Suwannee River Water Management District (SRWMD) to be used for planning purposes only. SRWMD shall not be held liable for any injury or damage caused by the use of data distributed as a public records request regardless of their use or application. SRWMD does not guarantee the accuracy, or suitability for any use of these data, and no warranty is expressed or implied. For more information please contact the SRWMD at 386-362-1001.
Map Created on 11/11/2017

Appendix B

**Suwannee River Water Management District
Live Oak, FL**



Forest Inventory System Document

Prepared By:

**F4 Tech
Tallahassee, Florida**

February 24, 2011

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Document Purpose

This document provides a forest inventory system framework for addressing Suwannee River Water Management District (SRWMD or the “Client”) management needs. In 2011 certain parts of the new inventory system will be implemented, mainly the baseline inventory. Management objectives to be addressed with this inventory system are:

- Sustainable forestry and SFI compliance
- Reliable access to forest information and data
- Growth and yield
- Determination of harvestable areas

As with any system which is under development, not all objectives will be addressed immediately. This document will provide a general framework for system components to come and sufficient detail to execute the 2011 baseline inventory. The baseline inventory portion of this document can be broken off as a standalone document to help guide this project’s field procedures. The client has identified five types of field sampling necessary to support management objectives:

- Sales Cruise
- Compliance Check
- Stocking Check
- Stratum Verification
- Management Cruise or Rolling Inventory (TBD)

Inventory System

1. Overview and Terms

The inventory system described in this document is in development. It focuses on the Client’s primary management unit: the forested stand. At this point, due to data and time constraints, this is considered the same as a geodatabase polygon. This may change in the future as the working dataset purpose and structure is refined, or polygons are manipulated to be stands leading up to inventory planning. A point, cruise plot, sample point and plot are often synonymously referring to a cruise point.

Stand: a contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit

Plot: A point in space, within a sample target polygon, to be visited in the field for tree sample data collection.

Event: something which takes place at some point in time within a stand

Allocation: The act of laying out grids across target sample areas

Grid: a collection of sample points which are spaced either automatically by fitting a certain number of plots in a stand, or by indicating a grid spacing, usually in chains.

Point Sampling: a type of forest sampling in which the sample is selected with a probability proportional to tree size. Generally utilizes a prism to select trees.

Strata: a group of like features or observations¹ such as stands with the same forest type, origin and age.

Operable: a designation for a stand which states that certain types of forest management operations such as harvests are permitted. Used as an initial qualifier for doing inventory. Operable stands may not be “inventoriable” due to an in progress harvest event, small

size, etc. This is something an organization must decide based on how it conducts operations. Ideally what is operable can be queried from a data set.

2. Measurements for Success

An important part of any project is to have measurable targets to reach. “Metrics” provide quantitative measures such as statistical quality of information or number of units completed. One goal or metric discussed for SRWMD inventories was “determination of per acre *ownership wide* operable volumes at a 90% confidence and 10% target error”. However, an ownership level target may not be rigorous as a stand or strata level one. This and other metrics should be explicitly defined as new data permits in order to clearly support management goals for SFI and growth and yield. The baseline cruise has metrics for field measurements to aid contractors and foresters in meeting project expectations. These metrics are listed as part of audit requirements in Appendix I.

The upcoming baseline cruise was intended to support ownership growth projections by strata for SFI and provide a means for doing analysis for subsequent inventories. To meet the objective of ownership growth, a sample of existing strata (see definition later in document) within planning areas was to be performed. Sampling of strata was predicated on there being too many acres of stands which could be inventoried given the 2011 budget. Through the process of determining areas to inventory in 2011, exclusions from data queries and manual stand selections resulted in there being 31,400 of a potential 59,600 acres of operable areas which could receive sample plots. Given a small pool of available acres to sample within, the following was observed:

- Many strata which occur have no samples
- Some planning areas have as few as 10 samples
- 52 strata have less than 10 samples
- 136 strata planning area combinations have less than 10 samples

The result is that the baseline cruise no longer addresses strata and planning area coverage. This means the resulting inventory data may have limited use in performing ownership wide projections such as volume estimation and growth. Though ownership wide projections can still be performed, it will likely take more time and yield a result with greater uncertainty than if strata coverage were adequate.

3. Re-Measurement

Most inventory systems include rule sets for re-measurement. When an inventory system reaches the point where each yearly inventory is simply maintenance to refresh retired plots or capture data where change has occurred, the approach may be termed a “rolling inventory”. Data validity is not indefinite since stands grow and change and management events can affect what is on the ground. The cycle at which an inventory data should be re-measured consider the following:

- Management need for data by area, e.g. pine or hardwood, if data is for basic landbase information, modeling or for a timber sale
- Margin of error which is acceptable
- Budgets
- Accuracy of growth and yield

For most systems 4 to 6 years is a good rule of thumb for replacement of plots. The baseline management cruise to be conducted by SRWMD should provide more information as to what is a valid re-measurement cycle in years. The update period becomes more critical when inventory

has been caught up such that one is focused on maintaining data and monitoring change due to events.

4. Inventory Resolution

While some organizations maintain stand level inventory data and systems, many will find strata level to be adequate. Unfortunately inventory is quite costly and time intensive for an organization's staff. A good compromise, especially early in an inventory system implementation, is to use some type of stratification. A stratum is a group of like features or observations¹ which will be treated as a sampling unit. Stratification is a variance reduction technique which leverages limited samples to achieve a certain statistical confidence about a population. The stratification system used in the baseline inventory is based on fields in the stand polygon feature class as follows:

SAF Forest Type Code, Stand Origin (natural or planted), Development (tree size), Basal Area Class.

An example stratum is "84 N 4B" which is a Slash pine stand of natural origin with Small to Medium Sawtimber 11.5- 15.5" DBH and a Basal Area between 75 and 94 square feet.

For the baseline inventory, an additional component of planning area was initially added to each stratum in order to insure that all strata within a smaller geography would be represented.

Note, where inventory data was present from 2001 to 2007 (Legacy plots dataset) strata labels were computed using tree data. Where there was no data, the labels were estimated in a previous project using aerial imagery. A strata assignment and update field protocol will be created in an upcoming project to insure that when a stand has no inventory plots that its stratum label has been designated by a structured and defensible means. The updates from this new process will not take place until the inventory is done. *It is important not to change the stratification used in an inventory project after said project is underway or the sample design will be compromised, making reporting and analysis by strata overly complicated.*

5. Current Client Geodatabase

The client geodatabase (GDB) has been added to and modified over several years of work. It contains Level 1 and 2 legacy inventory plots installed from 2001 to 2007 ("Legacy Plots") as well as sample grids for the upcoming baseline inventory (Plots_2011) and some plots deferred to later years (Plots_2012). Due to current organization and completeness of data (ages, stand types, events) used to qualify operable and inventoriable stands, performing future inventory analysis and planning will be time intensive. Implementing some best practices data work combined with training and staff assignment of data updates could simplify planning processes and result in better decision making. Implementing these tools will be a matter of defining high priority forestry business processes and designing software and data models which fit them. A short list of best practices is shown in Table 1. This will be spoken to further in the events section of this paper.

Table 1 - Database Mechanisms and Status

Best Practice	Rationale	Implementation Status
Clearly define target unit for management	Mixed purpose datasets often result in conflicts when conducting analysis or planning.	No, current polygons are not stands, stands are not polygons
Relate other business data to target unit	Much like a customer database has a customer's address and phone number, a single stand should have other tables which list it's plots, trees and events	Partially
Data driven definition of what is operable	Management activities of interest to SFI and growth computations take place primarily in these areas. In order to do inventory which supports computations and planning, the areas should be clearly defined.	Partially, but done as a manual process in this project
Maintenance of an inventory support table	Allows a process to retrace steps for how inventory areas were chosen	Partially
Log planned events and track to completion	See events management section of document	Partially

Ideally the stand dataset should have a clear purpose and rule set for maintenance. A purpose statement for a stand dataset may read:

“the stand layer is for tracking forest operations such as harvests and inventory where each stand is a polygon (one record, one spatial feature) within a tract representing a collection of like stand history, age and species composition.”

Further defining of the dataset may have quantities aspects which follow from on the ground forestry operations:

- Stands should have a target average size of 20 acres
- Stands should rarely be under 5 acres
- Stands should not exceed 150 acres in size
- A non forest feature may be as small as 0.10 acres
- A single stands will not cross tract lines
- When a stand is too large and crosses a state, country road or natural barrier, that stand should be split into two polygons

In a desktop geodatabase, a good practice is to have *minimal* information inside the stand polygon table, especially if that information meets the following criteria:

- It is calculated from another table or dataset
- Is a duplication of other data (e.g. tract number)

Data which is related to stands can be easily reported through relationship keys shared between datasets. This is a flexible way for dealing with computations associated with one to many relationships between data. In general, the stand polygon should represent an area and extent with basic attribute information. A recommended tabular design is shown in Table 2. Note, the old dataset has been saved as StandsOLD102110; this dataset has numerous legacy fields and

data to facilitate a onetime growth simulation. If needed, the old dataset can be related to new data by StandID_LM.

Table 2-Recommended Stand Table Modifications

Existing Stand Table			
Field	Description	Example Value	Recommended action
<i>StandID</i>	Client unique ID, Tract +Stand number	730055	Keep, but refine and document methods. No longer use as a database key to relate data.
<i>FNAI_Code</i>		Wet Flatwoods	Keep
<i>Development</i>		Poles 4.6-11.5" DBH	Keep
<i>BA_Class</i>	New field, replaces density/canopy closure	>=95	Keep
<i>ACRES</i>		0.551285	Keep
<i>TRACT_ID</i>	Domained field. The name is the description, but a number like 55 is held in data field.	JONES MILL CREEK	Could keep or defer to master tract file, lest the two datasets diverge. Must be sure to add new tracts into domain, then calculate new tract number into field to show name
<i>EST_CD</i>	if stand is nat. or planted	Natural	Keep
<i>EST_YR</i>	Year stand was planted		Keep
<i>PL_SPECIES</i>	Dominate spp or spp planted		Keep
<i>INVTYR_YR</i>	Legacy field		Delete, since legacy plots contain dates, this is redundant data which has no update means
<i>Operability</i>	Planing field	Operable	Will move to an inventory support table, related by StandID_LMS
<i>Inventory_status_1</i>	Planing field	Unknown, no age data	Will move to an inventory support table, related by StandID_LMS
<i>StandID_LMS</i>	A unique DB key to relate stand to other business data	5209	This is used in all relates now since standid was not complete or unique. Can be used until system more refined. Must be very cautious of editing this number since it could negate relationships to events tables. Plots and stocking checks can always be overlaid when ID's change, related tables cannot.
<i>Plots</i>	Number of plots so auto grid can be created	<Null>	Will move to an inventory support table, related by StandID_LMS
<i>Plan_Area</i>	Planning area		Will move to an inventory support table, related by StandID_LMS
<i>Stratum_Plan</i>	Strata + Planning area	0 N 3A1	Will move to an inventory support table, related by StandID_LMS
<i>Stratum</i>	SAF Spp + EstCD + Development + BA_Class	84 N 3A	Keep
<i>SAF_Spp</i>	SAF forest type	Loblolly Pine/Hardwood	Keep

Open items related to geodatabase:

- Move forward with a simplified stand table. Keep old one as reference.
- Clearly define purpose of stand dataset and identify structure needed to support that purpose
- Use domains, no nulls and field types to eliminate out of range or blank values
- Migrate existing polygon events over to related tables through stand polygon edits and event table entries
- Shore up incomplete harvest event entries which arose from inventory planning process
- Enter all planned and in progress events in events tables related to stands
- Enter special inventory needs for upcoming inventories in an inventory support table

6. Events management

A stand event can include numerous things such as harvests, site prep or even inventory plots. In this document, an event primarily refers to a harvest such as a clear cut, salvage cut or thinning. Access to events information is a critical component of forest inventory planning. There two schools of thought on maintaining events in a spatial database:

- A. Create a polygon spatial extent separate from the stand polygon and maintain it on its own (such as in Figure 2)

- B. Maintain the stand as reflection of a set of like events. If part of a stand is cut, create a new stand. Event details are kept in a related table on a one to many (1:M) basis, that is one stand can have many events (2001 thin, 2010 clear-cut).

Option B is the recommended option and has been implemented in the current GDB. While option A maybe a goal, it is highly recommended that one start with option B if data maintenance time is to be minimized or data resides in a desktop environment (lacking advanced spatial processing and DBMS support such as in ArcGIS server). If one wishes to keep the spatial extent of past events on stands while using option B, they can archive the data for reference purposes. Some of the benefits of option B are:

- Events for stands are easily selected on map with queries using “relates” between feature classes and tables
- Relates accommodate one to many relationships where a stand may have more than one event
- Provides easier means for summarizing or reporting multiple events on multiple stands
- The complexity of analyzing polygons on polygons is eliminated

Figure 1 shows how SRWMD planting and harvest events tables have been associated with stands through a relate between Stand.StandID_LMS and StandEvents.StandID. The harvest event shown was provided during recent inventory design.

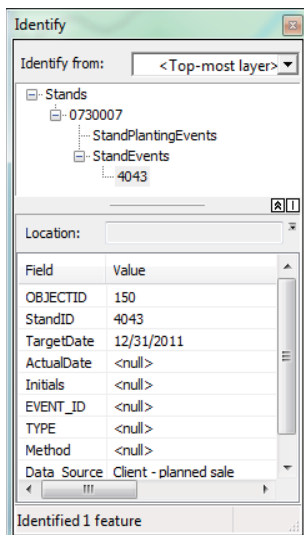


Figure 1-Identify Tool Showing Feature Class to Table Relate for Events

As one can observe in Figure 2, there may be past events which are not reflected in the current stands polygons. Changing stand polygon shape as soon as a harvest is planned (with GPS data, imagery or estimation) or when complete can help avoid the challenges of fixing the data later. *The outstanding event edits which affect inventory planning such as shown in Figure 2 are an open item contingent on finalizing database design and dedicating staff time for data edits.*

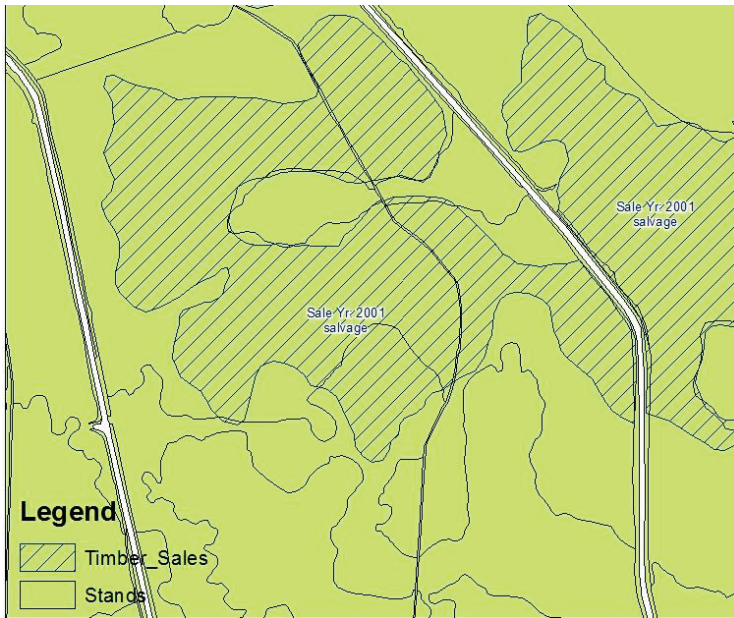


Figure 2 - Polygon Based Event Data

Several database domains are used the harvest and planting events tables. Domains help structure data entry and keep erroneous values out. There are two ways to implement domain codes and descriptions:

- Have the code and description the same so that when values are updated, user can calculated in the description instead of a code, and when a shapefile is exported it will contain the full description
- Have the code be a short code such as an abbreviation. This is effective for use in label construction. Codes are a good practice if one anticipates a description may be changed at some point. An example of this is where canopy closure was changed to basal area classes. The code (part of strata label) remains the same.

Table 3-Harvest Type Domain

Code	Description
CC	Clear Cut
FT	First Thinning
ST	Second Thinning
S	Salvage Cut
SPB	Pine Beetle Salvage Cut
FS	Fire Salvage
FW	Fuelwood (thin, CC?)
PL	Planting

Table 4-Status Domain for Events

Code	Description
Complete	Complete
Planned	Planned
In progress	In progress

7.

8. Inventory Workflow

As SRWMD inventory system develops, a clearer picture of roles and tasks should form. Much of this will become clearer after the 2011 inventory. A draft inventory process workflow diagram² is shown in Table 3. This workflow starts with a trigger (creating a budget) and ends with a result (data delivery and sign off).

Table 5-Draft Inventory Workflow

Draft Inventory Workflow															
Step	Trigger	1	2	3	4	5	6	7	8	9	10	11	12	13	Result
Role															
Client Forester	Budget For Inventory	Define Inventory Metrics	Define Operable Stands	Define Inventoriable Stands	Determine Sample Rates	Allocate Plots	Distribute Data								Sign off as Complete
Contracted Project Forester								Arrange Field Effort	Conduct Field Training		Ongoing Field Audit and Mgt.			Finalize and Report	
Contracted Field Forester										Collect Data			Submit Data		
Notes		Statistics, number of plots, date to complete		Equals operable minus: harvests, wet, data issues, etc.			Plots, stands, plot spec, etc.		With client as well						

A potentially problematic component of the inventory process involves data handoffs. Since GIS data used for inventory is not centrally available, client and contractor should agree on who has the authoritative dataset. The stakeholder who possesses that data will perform changes and edits, while the other will hold off (not edit in parallel). This should be discussed along with roles before project start.

9. Plot Allocation

In addition to goals and objectives, one must decide where to allocate inventory plots. Key considerations in an allocation are the following:

- How many samples will be done (the budget)
- Operational priorities such as recent harvests, high value stands, sensitive areas or upcoming sales
- What the target population is, a stand, strata or tract
- Exclusions and exceptions
- What processes will be supported, e.g. strata averages growth or growth and yield
- The desired target statistical error and confidence level of the resulting data
- Field efficiency (grid arrangement and distribution of plots)
- Sampling rules such as maximums, minimums and special cases

All the aforementioned items were considered for this inventory except for statistical requirements. This is because the previous inventory's suitability for computing statistics was unknown. Below are the basic steps taken to allocate plots in polygons for the 2011 management cruise:

- Choose operable stands: broad selection of stands which require data conduct operations
 - Manual selection
 - By species or forest type
 - By age class
 - Event trigger such as thinning
 - Combinations of above
- Choose stands which are inventoriable (will receive plots)
- Determine each sample type rate of sampling. In this case 1 plot per 5 acres for mature stands and 1 plot per 8 acres for 6 to 7 year old stands.
- Apply a 3 plot minimum for smaller stands and a 40 plot maximum for larger stands.
- Apply exclusions such as harvests, sold areas or areas to defer to future inventories
- Maximize field efficiency and concentration of sample points by a variation on the “probability proportional to size” or PPS³ method by concentrating samples in the largest polygons within each strata and within each planning area (in order to insure coverage of all operable strata so that growth can be conducted with some level of certainty). The rule used was to sample the 5 largest (acres basis) polygons for each strata and planning area combination. *While this was to be used initially, manual exclusions of inventoriable areas were such that there were too few stands to allocate the current plot budget in. This meant that every inventoriable stand (as designed by client) received plots.*
- Create grids with a grid tool using an automatic grid function which reads the required number of plots from a stand field and creates a grid which fits the polygon. Due to irregularity of polygon shapes, a square grid was used. Though a rectangular grid is often preferred in the field, some polygons only have room for one line when using a rectangular grid.
- Quality review process
- Recreate or adjust grid as necessary

2011 Baseline Inventory

This section applies to the 2011 Baseline Inventory which is the first inventory cruise to be implemented on Suwannee River Water Management District (SRWMD) lands by LandMark Systems (LMS) and will provide the foundation for future inventory efforts. The purpose is to build a data repository to support growth and yield modeling, computation of annual allowable harvest, forest management planning and additional inventory design. To accommodate growth and yield requirements a field sampling methodology for younger stands (6-7 years) will also be implemented as part of the management cruise.

Project Organization

SRWMD has engaged LMS to coordinate, oversee, compile data and audit this project. Mike Berzinis is the project manager and Harrison Peterson will be the project forester for LandMark Systems (LMS). LandMark Systems’ project foresters will be conducting all inventory audit procedures. LandMark Systems will work with contractors to oversee field work. All field workers/cruisers will be required to attend a one day training session regarding safety requirements, access and plot measurement and data procedures. Appendix A contains contact information for LMS and Suwannee River Water Management District personnel.

Equipment

The ArcView 9.3 or above, ArcPad RTI and TCruise software (both desktop and handheld versions) are a requirement for all data collection on this project. All forestry tools necessary for the accurate and complete collection of sample plot data are available from LandMark Systems or its sub-contractors for its customary fees.

Point Sample Design and Specifications

10. A. Sampling Units/ Sample Points

Sample units will be stand polygons as determined by stand development stage. These stages will include planted pine stands older than 15 years, planted pine stands 6-7 years old and natural upland pine stands. Samples or plots are in systematic grids, the preferred method for sampling in nearly all forest inventories¹. Grids were created automatically using a 2:1 ratio between lines and points along a line. Systematic grids are preferred for field efficiency and coverage of areas. Random samples often leave large portions of stands un-sampled, resulting in inefficient field travel and cannot be validated as to whether they are truly random or not.

Operable sample stands were determined by SRWMD. Stands were excluded from consideration in the following instances:

- Stands with dominant age less than 6 years
- Stands with dominant age between 8 and 14 years
- Stands actively being harvested
- Stands designated non-forested
- Stands under 10 acres

Sample points will be allocated systematically within stand polygons at a rate determined by stand development stage. Natural and Planted pine stands older than 15 years will be allocated at a rate of 5 acres per plot on a grid with a maximum of 40 plots per stand and a minimum of 3 plots. Stands of 6-7 years in age will be allocated at a rate of 8 acres per plot on a grid. Total plot allocation will be approximately 5,000 plots.

11. B. Merchantable Plantation and Upland Inventory

12. Variable Radius Point Sample: 20 BAF

Within a 20 BAF variable plot radius the following data will be recorded for all “in” trees which meet the minimum product specifications (Appendix E): Species, DBH, Product and presence of forest health issue. Total height will be measured and recorded for the first stem of each merchantable species on the plot. Species code must be designated by the cruiser for each overstory tree tallied. The species list with valid species codes can be found in Appendix B.

Species code and DBH determine the automatically assigned product class within the TCruise Template. TCruise uses an Auto Assign feature for tree products. Tree product will remain on Auto Assign (AA), unless the tree is downgraded to pulpwood (PW) or cull (CL). Trees will be tallied in a clockwise format starting from the first tree north and the first tree will be flagged. Diameter at breast height will be measured to the nearest 0.1 inch. Tree products will be called by the cruiser based on product specifications which are illustrated in Appendix E.

If there are certain discernable conditions on a tree it will be recorded at the tree level. A list of these conditions and coding can be found in Appendix D. If more than one condition is observed in a single tree, the most prominent will be recorded.

Age data will be collected at the rate of 2 ages for all inventoried stands which have no recorded age data (as designated by a layer or label). An increment core will be taken at breast height (4.5 ft. above ground level) to determine tree age at DBH, on pine species only. Six years will be added to Longleaf Pine and three years will be added to all other pine species to get total tree age. Age trees need to be either strong co-dominant or dominant in crown position and representative of the stand. The predominant pine species of the stand will be selected for aging by the cruiser and all ages in that stand will be from the same pine species. Off plot trees may be used if the necessary pine species are not present.

All standing dead trees should be classified as dead hardwood, dead pine. If type is not discernable it should be classified dead tree. These codes can be found in the Species List (Appendix B).

13. Fixed Radius Sub-Plot: 1/50th Acre (16.7 foot radius)

A fixed-radius 1/50 acre plot will be used to capture sub-merchantable trees which are not captured in the variable radius plot. All trees between 1.0" and 4.5" for pine species and 1.0" and 5.5" for cypress and hardwood DBH, will be tallied by 1" species groups with an average height for the group. The presence of invasive or exotic species as per Appendix C will be recorded within this plot on the custom plot info page. For each possibility the default value will be absent and will be changed when present.

14. Fixed Radius Sub-Plot: 1/300th Acre (6.8 foot radius)

A fixed-radius 1/300th acre plot will be used to capture pine regeneration. Pine trees with second generation needles (not directly from seed) and a total height ≥ 1 foot and < 1.0 DBH will be tallied by species and designated regeneration by checking the "r" column in TCruise. This is to record advanced natural regeneration in certain areas.

C. Sub-Merchantable Plantation Inventory

15. Fixed Radius Sub-Plot: 1/50th Acre (16.7 foot radius)

In sub-merchantable stands (planted pine, 6-7 Years), data collection methods are the same as described for 1/50th acres sub-plots in merchantable stands (see above). Custom level plot information to be recorded (on 1/50th acre nested plots and plots in sub-merchantable stands) includes the presence of certain invasive, exotic plants (See Appendix C) at the plot level and presence of specific forest health problems (See Appendix D), recorded at the tree level.

16. D. Plot Monumentation Standard

All plots will have flagging with the sample plot number and the cruiser's initials hung from any branch nearest plot center at eye-level. Flagging will also be inserted into the ground at plot center and hung from the first tallied tree. All audited plots will have an additional flag, of a different color, with auditor's initials.

17. E. Boundary Correction

Correction for boundary overlap of stands or property boundaries will be accomplished by the Walkthrough Method³. This is similar to the Mirage Method, but statistically more correct. It entails doubling the critical distance to a tree near a boundary. If the doubled distance is greater than the distance to the boundary line, the tree is counted twice. Specific instructions and

information regarding this method will be covered in the training session for the cruisers and is illustrated in Appendix G.

18. F. Measurement Procedure

Tree diameters will be measured with either diameter tapes or calipers reading to the nearest 0.1 inch. Limiting distances will be measured with a Haglof DME or measuring tape. Tree heights will be measured as total height with a traditional clinometer, digital clinometer, or laser. All plots will be tallied starting from the first tree to the north and working in a clockwise direction.

19. G. Sample Auditing Specifications & Procedures

An audit of primary data collection accuracy will be conducted on 5% of the sample points visited during all phases of the inventory. Any plots taken in the field, can be audited by Landmark Systems and/or SRWMD staff. Using the same GIS plots from the initial sample the auditor will revisit any plots chosen for audit. During the audit, the plot will be tallied according to the initial specifications. Plot by plot comparisons can then be made at any time after the audit is completed. The LandMark project forester will return any T-Cruise tce files with errors to the crew leader along with a list of the errors to be corrected. Payment for any plots with errors will be withheld until errors have been corrected. A brief summary of auditing requirements is found in Appendix I.

Audited plots that do not meet the required accuracy will be revisited and re-measured by the cruiser, at no cost to the client. Individual field workers whose audited plots are routinely outside the parameters set will be the contractor crew leader's responsibility to correct. If no acceptable improvement is shown in the field worker's plots, those plots will not be recognized as complete and payment will be withheld. The project forester representing LandMark Systems will provide audit feedback reports to the crew leader for each cruiser. The crew leader will disseminate that information to the cruisers and take any corrective actions necessary.

Note: Payment for any plots with critical errors will be withheld until errors have been corrected by cruiser.

20. I. Data Handling and Storage

The raw field data will consist of one file for each cruiser per week, a T-Cruise (.tce) file, and two files for each field crew, a plots shapefile and a dbf cruise support table. File naming schemes for the tce files will use the six digit numeric date followed by the field worker's three initials (ex. 113009JCC). The 2 character number that represents the day in the numeric date will always be the Monday of that week. The plots shapefile will only use the 6 character numeric date format with the day always representing the Monday of that week and preceded by Plots (ex. Plots_081009). This format will be strictly adhered to throughout the project. It is recommended that the field crew perform daily back-ups of the raw data from the handhelds to a PC for each field worker.

References

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3. Borders and Shiver, 1996. *Sampling Techniques for Forest Resource Inventory*. New York: John Wiley & Sons, INC.
4. Ducey, M., Gove, J, and Valentine, H., 2004. *A walkthrough Solution to the boundary overlap problem*. *Forest Science*, 50, pp. 427 – 435.

Appendix A: Contact List

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Appendix B: Species Coding

<u>Species Code</u>	<u>Species</u>	<u>Species Code</u>	<u>Species</u>
SLP	Slash Pine	YP	Yellow Poplar
LBP	Loblolly Pine	SM	Southern Magnolia
SAP	Sand Pine	SBY	Sweetbay
PDP	Pond Pine	LB	Loblolly Bay
SHP	Shortleaf Pine	MH	Mockernut Hickory
SPP	Spruce Pine	WH	Water Hickory
LLP	Longleaf Pine		
LAO	Laurel Oak	PH	Pignut Hickory
SLO	Swamp Laurel Oak	WE	Winged Elm
SPO	Sand Post Oak	AE	American Elm
TO	Turkey Oak	CE	Cedar Elm
PO	Post Oak	WA	White Ash
WO	White Oak	GA	Green Ash
SO	Shumard's Oak	BA	Basswood
SCO	Swamp Chestnut Oak	PE	Pecan
SRO	Southern Red Oak	SB	Sugarberry
BLO	Bluff Oak	HB	Hackberry
CHO	Chapman's Oak	RB	Red Buckeye
BJ	Bluejack Oak	PER	Common Persimmon
OO	Overcup Oak	AB	American Beech
CO	Chinquapin Oak	BB	Bluebeech
WTO	Water Oak		
LO	Live Oak		
BO	Black Oak	RBH	River Birch
SG	Sweetgum	SYC	American Sycamore
RM	Red Maple	CW	Eastern Cottonwood
FM	Florida Maple	BC	Black Cherry
PCY	Pond Cypress	CWL	Carolina Willow
BCY	Bald Cypress	SAS	Sassafras
WTU	Water Tupelo	HY	American Holly
OTU	Ogeechee Tupelo	DOG	Flowering Dogwood
STU	Swamp Tupelo	SDG	Swamp Dogwood
BG	Blackgum	ER	Eastern Redbud
FT	Fringetree	WL	Water Locust
RC	Red Cedar	CP	Cabbage Palm
DCN	Dead Coniferous	DHW	Dead Hardwood
DTR	Dead Tree		

Appendix C: Exotic Plant Species

<u>Scientific Name</u>	<u>Common Name</u>
<i>Albizia julibrissin</i>	Mimosa
<i>Aleurites fordii</i>	Tung Oil Tree
<i>Broussonetia papyrifera</i>	Paper Mulberry
<i>Cinnamomum camphora</i>	Camphor Tree
<i>Dioscorea bulbifera</i>	Air Potato
<i>Imperata cylindrica</i>	Cogongrass
<i>Ligustrum spp.</i>	Privet, Non-native
<i>Lonicera japonica</i>	Japanese Honeysuckle
<i>Lygodium japonicum</i>	Japanese Climbing Fern
<i>Melia azedarach</i>	Chinaberry
<i>Nandina domestica</i>	Nandina
<i>Paulownia tomentosa</i>	Princess Tree
<i>Phyllostachys aurea</i>	Golden Bamboo
<i>Pueraria montana</i>	Kudzu
<i>Rhynchelytrum repens</i>	Natal Grass
<i>Sapium sebiferum/ Triadica sebifera</i>	Chinese Tallow Tree
<i>Solanum viarum</i>	Tropical Soda Apple
<i>Wisteria sinensis</i>	Chinese Wisteria

Appendix D: Forest Health Issues

Code - Description

FR - Fusiform rust (*Cronartium fusiforme*)

FD - Fire Damage

MD - Mechanical Damage (Logging Machine Damage)

BB - Bark Beetles

AD - Animal Damage (Cattle, hog etc)

Appendix E: Product Specifications

PRODUCT	MINIMUM DBH	MINIMUM TOP DIAMETER (INCHES)	MINIMUM MERCHANTABLE HEIGHT (FT)
Pine:			
Pulpwood	4.6"	3.0"	20'
Chip-n-Saw	8.0"	5.0"	29'
Sawtimber	12.6"	9.0"	18'
Hardwood:			
Pulpwood	5.6"	3.0"	20'
Sawtimber	12.6"	8.0"	16'
Cypress:			
Mulch	5.6"	4"	16'
Sawtimber	12.6"	11"	16'

Appendix F: Plot Specifications Table

Criteria	Polygons within operable areas representing ≥ 15 YO planted and natural stands			Polygons representing 6 to 7 YO stands
Plot Desc	Merchantable Plot			Submerch Plot
Plots and subplots	20 BAF Variable Radius	1/50 acre fixed radius	1/300th acre fixed	1/50 acre fixed radius
Measurements				
<i>DBH</i>	10th inch. Pine trees ≥4.6" and hwd trees ≥5.6"	1" classes for all species 1" to <4.6" (1 to 5.6 for cypress)	None entered, or 1" for all counts	1" classes for all species ≥4.6"
<i>Tree count</i>	Individual	Count	Count those ≥1'	Count
<i>Species</i>	Species list	Tree species counts	Pine only	Tree species counts
<i>Height</i>	First of each spp of pine and hardwood	A mean height for each inch DBH class of like species	none	A mean height for each inch DBH class of like species
<i>Age</i>	2 per stand minimum, only pine* On designated stands only.			
<i>Product</i>	Auto assign by DBH, or downgrade to pulp or cull	Auto assign	regeneration	Auto assign
<i>Snags</i>	Count (included in species list)			
<i>Exotic plants/forest health - Presence</i>		List		List

Appendix G: Boundary Correction

Using the Walkthrough Method⁴

The Walkthrough Method is unbiased and easy to implement in the field since it does not actually require the cruiser to cross the boundary. The figure below depicts instances where sample 'in' trees are counted once and locations where they are counted twice. Simple instructions for each 'in' tree near the boundary are presented below:

Procedure:

1. Measure the distance from the point center to the sample 'in' tree.
2. While maintaining the same bearing, double the distance. If the endpoint falls outside the boundary, the sample 'in' tree is counted twice. All other 'in' trees are counted once.

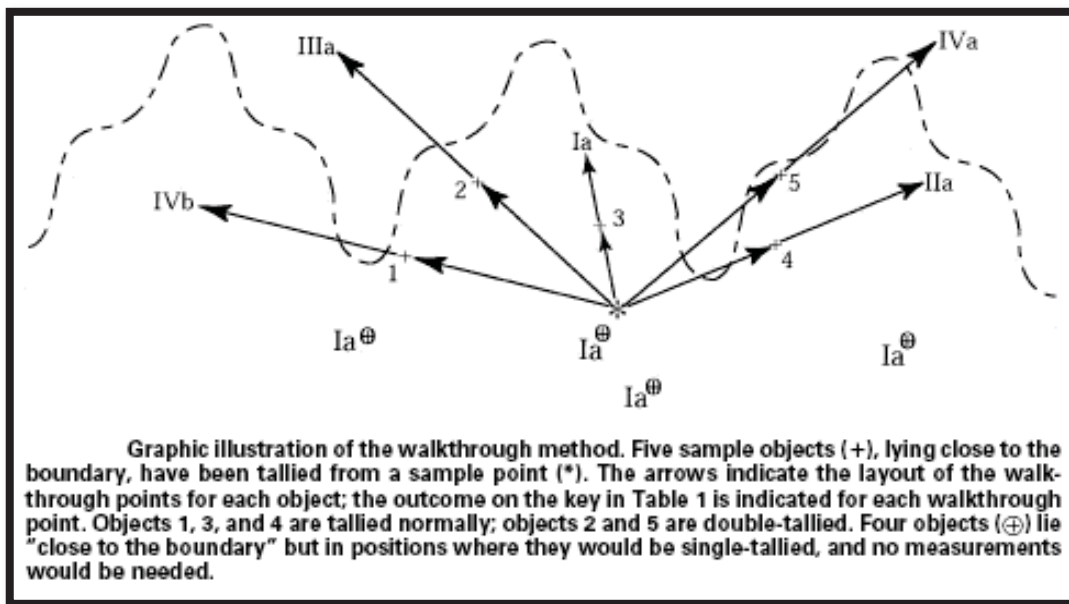


Table 1. A decision key for field implementation of the walkthrough method. The key is entered whenever a tallied object appears close to the boundary.

- I. Is it possible that the tallied object is closer to the boundary, than to the sample point?
 - Ia. NO—No action needed. Tally the object normally.
 - Ib. YES—Proceed to II.
- II. Measure the distance from the sample point to the object—call this distance x . Now measure the distance from the object to the boundary, continuing on the same bearing. Call this distance y . Is y less than x ?
 - IIa. NO—No action needed. Tally the object normally.
 - IIb. YES—Proceed to III.
- III. Does the boundary curve back across the walkthrough line?
 - IIIa. NO—Walkthrough point must be outside the tract. Double-tally the object.
 - IIIb. YES—Proceed to IV.
- IV. Move to the walkthrough point, so that the distance to the object equals the previously measured distance x along the same bearing, or to a point where that location can be clearly identified. Is the walk through point inside the tract?
 - IVa. NO—Double-tally the object.
 - IVb. YES—Tally the object normally.

Appendix H: Cruise on Plot Procedure

- 1) Once on plot center, select Yes when prompted to enter tree data.
- 2) Place orange flagging at plot center and at nearest branch with plot ID and cruiser initials.
- 3) Fill out all DBH's to 0.1" while working from the first tree to the north in a clockwise direction.
- 4) Do not pick product unless it is to be downgraded to Pulpwood.
- 5) Measure critical distances on border line trees with DME.
- 6) Collect species, DBH on a 20-BAF plot.
- 7) Record height for the first of each species of merchantable pine.
- 8) Record sub-plots (1/50 and 1/300) as described above.
- 9) Record the presence of specified invasive exotic plant species and forest insects or diseases.
- 10) Take increment bores where necessary (as indicated by age stands in map).
- 11) Save plot (→ F) to get a blank screen, and then go back to ArcPad to navigate to next plot.

Appendix I: Audit Specifications

Quantitative Variables to be Evaluated:

Plot Location -	Must be within 50 feet of audit location.
Limiting Distance -	$\pm 1\%$ of distance as measured with tape.
DBH (nearest 0.1 in.) -	$\pm 2\%$ of diameter as measured with steel tape.
Plot stem count -	1 pulpwood stem missed for every 25 stems tallied. 1 sawlog stem missed for every 50 trees tallied.
Height (total) -	$\pm 3\%$ from height measured with laser, Vertex 3 or Suunto clinometer.
Product class -	Pulpwood/CNS – 1 error per 50 trees tallied. Sawlog - ± 1 product per 100 trees vs. audit.
Custom plot level -	Presence of exotic plants see Appendix B
For Pine Species-	Tree age at dbh - ± 3 years. Two ages minimum in designated stands. Disease presence – See Appendix D.
Audited Plot Volumes-	$\geq 90\%$ of original total plot volume MUST be within $\pm 5\%$ of the audited plot volume.
All Audited Plots-	Average variation in total volume measured by Standard error MUST be within $\pm 5\%$ of audited plots variation in total volume Standard Error.

Appendix J: Site Index Calculation

Introduction

This document will be used to outline the process of calculating Site Index from the collected plot and tree data. Sections will describe inputs, equations, procedures and outputs. Site index is valuable as a component of long term forest management and as a portion of a growth and yield model. All background information on site indexes as well as equations can be found in the following cited publications:

- Carmen W.H., Hahn J.T., Jacobs R.D. ***Site Index Curves for Forest Tree Species in the Eastern United States***. General Technical Report NC-128. North Central Forest Experiment Station. USDA Forest Service. 1989. 146p.

Certain relevant sections of this publication are also attached to this document as appendices.

Measured Data: Inputs

In natural stand types the cruiser must collect total age, species and total height at each selected site index tree. Care should also be taken to select suitable site trees which are dominant or co-dominant, free-growing and uninjured. In cases where the stand being measured is a natural stand, direct measurement is the only probable way to determine the age of individual trees. The total age is determined by counting growth rings from pith of the tree to the bark and adding a constant number of years determined by species. This constant for Longleaf pine is 6 years and the constant for all other pine species is 3 years.

Total Height from the root collar to the terminal bud of the selected tree is used to calculate Site Index. Height data in this inventory was collected on the first tree of each species on each plot due to the fiscally restrictive nature of measuring total height for each tree on a variable radius plot. When the data is processed in TCruise Desktop a regression is applied to all unmeasured trees to estimate total height based FIA equations and sampled height and dbh measurements. Due to the random sampling of height classes on each plot, including dominant or co-dominant trees, the total height of trees within any height class can be estimated. This regression will be an estimate based on a statistical model (created by TCruise) of the local heights and diameters. As sample size increases the regression will exhibit a higher statistical confidence and a higher R^2 value, indicating a better fit to the graphical regression curve for species with more frequent occurrence in the inventory. Species is determined by the cruiser at the time of measurement.

Planted stands, if clear-cut as part of the site prep, could potentially use the date of planting instead of a measured age. In planted stands, where an age of origin for the stand is recorded, an estimated site index can be determined using only the total height and species. The total height and species is determined in the same manner as on natural stands.

Site Index Equations

The initial equation as expressed in the literature is used to determine height with previously established site index and age. Regression parameters as indicated by b_n can be found in the same literature and are determined by the species and stand structure of the measured tree. These regression parameters for the relevant species can also be found as appendices at the end of this document (Appendix A - F).

$$H = BH + [((b_1S)^{b_2}) * ((1 - e^{-b_3A})^{b_4S})^{b_5}] \quad (1.1)$$

Where:

- S** → Site Index
- BH** → Constant determined by age measurement; If Age is total age then BH = 0, If not BH = 4.5
- A** → Age
- e** → Base of natural logarithm (constant mathematical function)
- b_n** → Regression parameters as determined by species sheets (attached)
- H** → Height

The reorganized equation allows calculation of site index from collected height and age data. The regression parameters (c_n) can be found in the appendices for the species and structure of the tree and stand in question.

$$S = BH + [((c_1H)^{c_2}) * ((1 - e^{-c_3A})^{c_4H})^{c_5}] \quad (1.2)$$

Where:

- S** → Site Index
- BH** → Constant determined by age measurement; If Age is total age then BH = 0, If not BH = 4.5
- A** → Age
- e** → Base of natural logarithm (constant mathematical function)
- c_n** → Regression parameters as determined by species sheets (attached)
- H** → Height

Calculation Procedure

The actual calculation of Site Index will be conducted within Access 2007. It will consist of a series of queries that will use the inputs, outlined above, found within the plot, plots and tree table of the standard LandMark Systems geodatabase format. The values will be programmatically applied to the previously detailed algorithm. These calculations will be used to update the created fields within the tree and plot table called Site Index.

Data: Outputs

The outputs from this procedure will be Site Index Species and Site Index in two locations, the stand table and the tree table. In the tree table an integer value will be entered into the Site Index field in any row that contains all necessary inputs. In the plot table an integer value will be entered into the Site Index field in every stand where inventory data was entered. The dominant stand type will determine which site index results from the tree table will be used at the stand level. Each tree with this dominant species type and a stand index value will be aggregated to produce an average Site Index value for the dominant species of each stand. In this way the user will have information at the stand level for a single species but also at the tree level for any pine species that may be present and inventoried.

Notes:

A straight average by stand will include trees of various crown position whereas site index is often computed using dominant co-dominant trees. While the impact of this is unknown at this point, it may not represent the optimal method for gauging stand productivity or calibrating growth and yield tools such as FVS. Since site indexes will be provided by tree, calculated stand values can be recomputed at a later point using the tallest trees (for example).

Appendix K: Strata Calculation

Introduction

Over time the structure of a forested stand can change due to natural processes or through manipulation by land managers. Due to these changes it can become necessary to periodically update the stratum level information associated with a stand either through field checks or inventory data. This document defines the process that will be used to calculate the stratum values using inventory data.

Method: Stratum Components

The stratum field is populated by a text string (Figure 1) that is composed of four components. These components are calculated separately and then concatenated into a single expression. These components and their calculation methods are described below.

Strata Label	Example Value	Value Definition	Stand Field	Description
82 N 2A	82	Loblolly Pine/Hardwood	SAF_Spp	Observed or calculated SAF species number for stand
	N	Natural	EST_CD	Designated origin type for stand: Planted(P) or natural (N)
	2	Saplings <4.6" DBH	Development	Observed or calculated size of trees in stand
	A	>=95	BA_Class	Observed or calculated basal area of stand

Figure 1. Example of Stratum expression and components.

Broad Stand Type (SAF Type geodatabase field)

Broad Stand Type will be defined by the SAF forest code. From the inventoried data the SAF stand type will be determined during the FVS growth and yield model that will be run as a separate part of the inventory project. It will be displayed as a two or three letter numeric code which can be located in the summary-east table of the FVS output database. From here it will be updated into the SAF_Spp column of the stands layer.

Regeneration Type (EST_CD geodatabase field)

Regeneration Type will be defined by the method trees are regenerated after some management action. The two options would be planted or natural. Planted regeneration represents a single artificially generated cohort of a preferred species or mix of species and can be for stand regeneration or under-planting to increase stocking level. Natural regeneration is from existing seed stock and may represent a range of naturally generated cohorts of onsite species. This data cannot be determined from inventory data and must be determined by the onsite forester. The value can be found in the field of the stands feature called EST_CD.

Development Class

Development Class will be determined by the Quadratic Mean Diameter (QMD) of the tallied trees. The Quadratic Mean Diameter will be converted to a coded value displayed here:

Development Class Coded Value	Definition / Description
1	Seedling (Dbh < 1")
2	Sapling (Dbh >= 1" and Dbh < 4.6")
3	Poles (Dbh >= 4.6" and Dbh < 11.6")
4	Small/Medium Sawtimber (Dbh >= 11.6" and Dbh < 15.6")
5	Medium/Large Sawtimber (Dbh >= 15.6")

The Quadratic Mean Diameter (QMD) is a value that represents the average sized tree in a given stand. It is preferable to the statistical mean for two reasons. The first is that there is a direct relationship between the QMD, the stand basal area, and the number of trees per acre. The second advantage is that it produces a weighted average which takes into account variance across the stand more effectively than a statistical mean. The equation used to calculate QMD is:

$$D_Q = \sqrt{BA / (k * n)}$$

where: D_Q = Quadratic Mean Diameter
 BA = Basal Area per acre
 k = Units Constant (sq. ft. = 0.005454)
 n = Number of Trees per Acre

Basal Area Class

Density Class will be represented by the average basal area of the stand. This measure will be calculated in by multiplying the number of "in" trees on each plot by the Basal Area Factor of the prism being used and calculating the arithmetic mean of the three sample points. This operation is then converted to a coded value displayed below:

Basal Area Class Coded Value	Definition / Description
A	Basal Area < 45 sq. ft.
B	Basal Area <75 and Basal Area >= 45
C	Basal Area < 95 and Basal Area >= 75
D	Basal Area >=95

Appendix L: FVS Growth and Yield

Introduction

Growth and yield models are predictive tools used to keep past stand data relevant and to predict future behavior of a stand using inventory data. For this growth and yield model the USFS Forest Vegetation Simulator will be utilized. It is a widely used distance-independent model which operates on the individual tree level. This means it can be applied to previously collected inventory data with little manipulation. The rest of this document will outline the method used, program parameters and assumptions that will be built into the model.

Outputs

Raw from FVS

The outputs from FVS will be an Access 2000 database containing a stand summary table called "FVS_Summary_East" and a tree table called "FVS_Tree_List". This information is unformatted and contains the raw data as it comes out of the FVS model. The information from these tables will be converted by F4 Tech personnel into a more familiar format.

Formatted Outputs

The primary formatted output will be a modified stand and stock table in which strata can year can be selected. An example of this format can be seen below. The user will select stand ID, and a year and volume information will be displayed by species and product.

Stand & Stock

Stand ID: 100001
Plot Count: 5
Acres: 27.5
Strata **0 N 3 A**
Year **2012**

Row Labels	Trees/Acre	Basal Area	PW Tons/Acre	TW Tons/Acre	SW Tons/Acre	Total Tons/Acre
Laurel Oak						
Pulpwood						
14	3.8	4	3.09	0	0	3.09
Pulpwood Total	3.8	4	3.09	0	0	3.09

Method

The stratum value of inventoried stands will be recalculated as described in the previously submitted "Suwannee Stratum Recalculation Methodology and Sign-off Document 092011". Within ArcMap, stands of common stratum will be dissolved and spatial overlay will be

conducted to assign stratum to plots. F4 Tech's TCruise to FVS converter will be run to format the data from the stands, plot and tree tables for use in the Forest Vegetation Simulator. During formatting and running of the Suppose Interface a number of parameters and assumptions must be made. The parameters and assumptions that are used will be detailed below:

- **Variant** - Southeastern Variant (SN)
- **National Forest** - Osceola National Forest
- **Time Frame** - The model will have a common starting year of 2011 and a common ending year of 2031. This will allow 20 years of growth and yield prediction after the current inventoried year.
- **Cycle length** - Inventory cycles will be one year long. Data will be presented on the stand and tree level for each year from 2011 to 2031.
- **Management Modifiers** - Default management modifiers will be maintained for this model run. This means that all stands will be run as if they are naturally occurring stands in the variant location with no prediction of manipulation. This is a basic run to determine future volumes of growth according to collected inventory data without assumption of mortality outside of natural causes.