Special Technology Development Program
Progress Report

PROJECT NUMBER: R10-2000-01

PROJECT TITLE: Developing new image analysis technology to manage cedar decline.

PROJECT STATUS: Continuing

EXPECTED PROJECT DURATION: Two years total with one year remaining

EXPECTED COMPLETION DATE OF THE PROJECT: FY2001

SUBJECT: image analysis, resource classification, forest decline, cedar decline

STATUS OF SUBJECT SPECIES: native

PROJECT OBJECTIVES:

1. Develop repeatable techniques through image analysis to spatially locate and quantify dead and dying yellow-cedar (cedar decline);
2. Apply the newly developed technique to create a resolute GIS delineation of the cedar decline resource on a pilot project study area, and collect ground truthing data to verify results;
3. Develop a GIS/image analysis classification method useful in forest planning, linked to previously developed information on snag age, condition and size.

BRIEF DESCRIPTION OF THE PROJECT:
There is increasing interest in quantifying cedar decline information as dead yellow-cedar is becoming more important as a timber sale resource. Test sales of dead yellow-cedar have been profitable even using helicopter-yarding methods. The wood's numerous desirable characteristics are retained in the decay resistant heartwood long after death. There is a need to determine the amount of resource available beyond current sketch-map capabilities. Addressing this need is twofold; first we need to develop a mechanism to more precisely locate the existing decline resource; second, the resource needs to be attributed with stand-condition, density / volume information. Several ways of obtaining this information will be explored, using image analysis at several scales and GIS analysis. The test results will be checked using the existing GIS cedar decline sketchmapped layer, existing inventory or plot data, and ground truth plots. The developed techniques will be feasibility rated based on scale and potential scope of application. The benefit of this project is to shift timber harvesting from old-growth spruce-hemlock stands to underutilized dead yellow-cedar stands. Other benefits not quantified include preservation of wildlife habitat, less impact on anadromous streams, and fewer conservation assessments. This project will strengthen research/S&PF information delivery.

Primary activities and accomplishments:

The first year of funding this project was FY2000. This first year was dedicated to collection and procurement of remotely sensed data, beginning in June of 2000. During the winter of 2000/2001 we will classify and manipulate the imagery data, followed by ground data collection in the summer of 2001.

The initial step in this project was site selection coupled with acquisition of remotely sensed data. We targeted study sites where a full range of the cedar decline characteristics would be represented along with a representation of other stand types. The site selection process began in June with recon flights over potential study areas. The following two sites were selected:

1) Peril Strait – This area represents LAND with some of the most extensive and concentrated decline. Large-scale Infra-Red films exist for much of the area. This is a location where substantial work has occurred and will continue to occur in the study of cedar decline. The area has good beach access.
2) Kake Area – This area represents a wide variety of decline types including the "Bog / Scrub" type and live healthy stands. Ferry service is available and there is good forest service road access. Resulting classification will possibly be used by PRD if done in an active management area.

Following final site selection we began the process of acquiring and processing remotely sensed data.

We are taking a two-stage classification approach. The first stage of classification is only attempting to delineate the presence or absence of cedar decline. For this first level of classification, it was determined adequate to utilize large scale digital color Infrared (DCIR) imagery for the training and verification data. A photo mission over each study area was conducted using FHTET's Kodak CIR DCS420. The acquired imagery was then post processed and indexed via hot linking in an Arc View Project. These images are ready to be geo-referenced and delineated. Training and verification data will then be delineated with heads-up digitizing.

One of the primary purposes of this project is to develop a multi-stage sampling approach to characterize four different concentration classes and determine the effectiveness of various scales and types of imagery. The second step in this project has been to investigate, collect and preprocess the various forms of remotely sensed data that will be used for this project. Several image types have been identified for analysis and classification. The following imagery has been acquired or is in the process of being acquired and preprocessed.

The largest scale of evaluation imagery we will use is High Altitude (1:60000) **CIR photography**, recently acquired over the study areas in 1996 and 1998. Film positives and scanned files of 34 photos which cover the study sites have been ordered. The scanned photos were scanned at 17.5 microns, producing approximately 500mb files. The large file size has been difficult and time consuming to work with although we felt this degree of resolution was necessary until more is learned. We are in the process of orthorectifying and georeferencing these files using recently obtained DOQs of the area. The completion of this step is necessary before the training DCIR imagery can be geo-referenced and delineated.

The second type of evaluation imagery is **satellite** data of which we have narrowed our evaluation to IKONOS, SPOT and possibly TM data. Archive TM data is available, however we will not procure any TM Imagery until we can gauge the effectiveness of the SPOT Imagery. Some TM data is already available through the region should we feel there is potential information that can be acquired from this imagery.

SPOT imagery will provide the best intermediate resolution between TM and IKONOS; SPOT imagery is 15 meter multispectral and 10 meter panchromatic. Overlapping archive imagery from both spectral modes has been ordered but hasn't been delivered.

We have ordered **IKONOS** imagery at the four-meter multispectral and one-meter panchromatic resolution. Archive data was not available and the satellite will be tasked to our study site. Originally we had hopes of being supplied with (free) IKONOS Imagery from RSAC, however this opportunity did not materialize. Due to the cost of IKONOS data we chose to purchase this imagery only for the Peril Strait study site.

Following image acquisition and preparation we will begin the first round classification. We will perform decline presence/absence image classification using various supervised and unsupervised techniques on all project imagery. The Image classification software will be ERDAS Imagine 8.4. The classification process will investigate the utilization of additional image transforms, such as NDVI, tassel-cap transforms, and texture bands in addition to terrain data for slope, aspect, and elevation. A comparison utilizing image histograms, separability measures, and contingency matrixes will be made to affirm the best delineation technique.

From the presence/absence classification, a sub classification will be generated, in which we hope to classify a range of characteristics of cedar decline stands. The sub classification will be linked to ground sampling of stocking levels, tree diameters, forest composition and concentration of the 5 cedar snag classes.

We will identify and establish a plot design for accuracy assessment. The number of plots will be determined by the variability within the 4 resource classifications. The accuracy assessment will be utilized to determine the effectiveness of the initial cedar decline classification and to evaluate the effectiveness of various imagery. Subsequent processing may be needed to adjust the classification.

Candid description or what has worked and what hasn't worked in the project:

Although the extent of our progress on this project has been limited to mainly image-data acquisition and preprocessing, we have still learned a few things. We have learned remote image-data acquisition takes time. Time lines and budgets should factor in hardware and software glitches, learning curves and procurement delays.

From initial evaluations of the low altitude DCIR imagery, acquired for training and verification data, we discovered that the low elevation (3000ft AGL) and inherent small foot print was too small to easily delineate decline boundaries. We conducted two DCIR missions, each with different lighting conditions. From the resulting imagery, we have observed the mission conducted under overcast illumination resulted in a better product to that of the mission conducted in full sunlight. With observations to this point and for our purposes, we have not detected any apparent advantage in using the DCIR imagery as opposed to true color. The use of low altitude digital images will serve as a cost effective means of ground truthing depending on desired detail.

The high altitude CIR photography has proven to be a challenge to orthorectify and georeference at a high enough degree of accuracy to be useful. With the hardware and software glitches we've experienced, we are still in the process of working out a satisfactory geo-referencing method. It may have been more cost effective to contract out this step.

CHANGES TO ORIGINAL PROJECT SCOPE OR OBJECTIVES: None

ADDITIONS TO ORIGINAL PROJECT SCOPE OR OBJECTIVES: None

FHP LEAD CONTACT (FHP person submitting proposal)**:**

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
Dustin Wittwer	Alaska Region, S&PF, FHP	(907) 586-7971 dwittwer@fs.fed.us (907) 586-7848

PRINCIPAL INVESTIGATOR(S) (add lines as necessary)**:**

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
Dustin Wittwer	Alaska Region, S&PF, FHP Biological technician	(907) 586-7971 dwittwer@fs.fed.us (907) 586-7848
Everett Hinkley	Alaska Region, E&AM EAM Remote sensing specialist	(909) 586-8759 ehinkley@fs.fed.us (909) 586-7555
Paul Hennon	Alaska Region, PMW/S&PF, FHP Forest Pathologist	(907) 586-8769 phennon@fs.fed.us (907) 586-7848

COOPERATORS (contributing to, but not leading, the project)**:**

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
Mark Schultz	USFS R10, S&PF, FHP, Juneau, AK Entomologist	(907) 586-8883 mschultz01@fs.fed.us (907) 586-7848
Gary Fisher	USFS R10, IRM, Regional GIS coordinator, Juneau, AK	(907) 586-8883 gfisher@fs.fed.us (907) 586-7848
Jim Ellenwood	USFS, FHTET Remote sensing & image analysis Program Manager	(970) 295-5842 jellenwood@fs.fed.us (970) 295-5815
Rich Jennings	USFS R10, Petersburg Ranger District, Forester	(907) 772-5960 rjennings@fs.fed.us (907) 772-5995
Frances Biles	PNW Research (JFSL) GIS specialist	(907) 586-8811 ext245 fbiles@fs.fed.us (907) 586-7848

John Coauette	PNW Research (JFSL) Statistician	(907) 586-8811 ext234 jcoauette@fs.fed.us (907) 586-7848

COOPERATOR INVOLVEMENT:

Name	Role	Time Commitment
Dustin Wittwer	Principal investigator, project coordination, image analysis, fieldwork, report writing	6 payperiods
Everett Hinkley	Principal investigator, remote sensing project support, Image analysis	3 payperiods
Paul Hennon	Cedar Decline Resource advisor, data analysis, field work	2 payperiods
Mark Schultz	Project support, field work	1 payperiod
Gary Fisher	GIS Support	1 payperiod
Rich Jennings	Forester, field data collection	As required
Jim Ellenwood	Remote sensing and image analysis advisor	As required
Frances Biles	GIS, ERDAS Imagine workstation support	As required
John Coauette	Statistical advice	As required

PRODUCTS AND DUE DATES (from original application form)**:**
PRODUCTS: Expected after the completion of the project FY2002
New methods and techniques using remotely sensed data and plot data to spatially quantify cedar decline and other forest declines with a similar signature.
New methods to classify decline leading to new ways to manage cedar decline.

PUBLICATION: Expected after the completion of the project FY2002
Publications will most likely result in a USDA Forest Service technical paper or a PNW research note.

ACCOMPLISHMENTS TO DATE:

Products: **Image acquisition and preprocessing**

Arc View project CDs indexing DCIR imagery for project areas.

Publications:

Technology Transfer:

FIRST FISCAL YEAR FUNDED: FY2000

FUNDS OBLIGATED FROM BEGINNING OF PROJECT THROUGH CURRENT FISCAL YEAR (extend table as needed)(Ignore this section if not requesting funds)**:**

	Item	Requested Funding	Expended Funding	Unused Funding
FIRST YEAR				
Administration	Salary	7920	7020	
	Overhead			
	Travel	15000	1000	
Procurements	Contracting	1000	2000	
	Equipment/Supplies		3900	

	Imagery		10,000	
Year Totals		23,920	23,920	0
CURRENT YEAR FY2001 request amount for this year		**Requested FHP STDP Funding**	**Other Source Funding**	**Source**
Administration	Salary	7920	26,312 11,878	R10 / NFS PNW
	Overhead		11,538 1,923	S&PF / NFS PNW
	Field Travel	13,400		
Procurements	Contracting			
	Equipment		18,000	PNW / R10
	Supplies	1600		
	Publication	1000		
Totals		23,920	69,651	
PROJECT TOTALS		47,840		

EXPECTED BUDGET FOR NEXT (Current) FISCAL YEAR (FY2001)**:**

	Item	**Requested FHP STDP Funding**	**Other-Source Funding**	**Source**
Administration	Salary	7920	26,312 11,878	R10 / NFS PNW
	Overhead		11,538 1,923	S&PF / NFS PNW
	Field Travel	13,400		
Procurements	Contracting			
	Equipment		18,000	PNW / R10
	Supplies	1600		
	Publication	1000		
Totals		23,920	69,651	

DIFFERENCE BETWEEN ORIGINAL AND AMENDED REQUESTS AND JUSTIFICATION (the difference between originally requested funds and funds needed based on changes in the budget or scope of the project)**:**

While the amount of the original request for funds has not changed, the accounting of how the awarded funds were spent and will be spent has changed. Some of the target evaluation imagery changed and was not available from the region and needed to be purchased. Most of FY2000 funds were used for equipment and imagery procurement rather than travel and field work. FY2001 will be spent mostly on travel, seasonal salary and field work.

STDP FUNDING NEEDED:

Total estimated additional future funding needed beyond the current fiscal year: None

Estimated STDP funding needed in remaining year(s) of the project by fiscal year. Show separately the funding to be requested/provided from other sources (extend the table as necessary).

Fiscal Year	**STDP Funding**	**Other-Source Funding**	**Source**
Current year FY2001	23,920	69,651	R10 / NFS, PNW