Enclosure 3

Special Technology Development Program
Progress Report

PROJECT NUMBER: R6-1999-02

PROJECT TITLE:

Developing Technologies for Early Detection and Predicting Occurrence and Spread of Yellow Starthistle

PROJECT STATUS:

Continuing (funds are being requested for the next fiscal year to continue the project)

EXPECTED PROJECT DURATION: 4 years

ORIGINAL EXPECTED COMPLETION DATE OF THE PROJECT: fiscal year 2002

EXPECTED COMPLETION DATE OF THE PROJECT: fiscal year 2002

SUBJECT:

Weed prevention (Yellow Starthistle), detection and management of exotic weeds.

STATUS OF SUBJECT SPECIES:

Yellow starthistle is a non-native noxious plant

PROJECT OBJECTIVES:

To evaluate several sampling strategies and technologies designed to locate yellow starthistle (YST). Methods will be evaluated for accuracy and cost effectiveness. The project is also developing a predictive model to aid in finding nascent infestations. A hazard/risk rating process will be imbedded into a final predictive model so that lands with high risk of YST invasion can be identified and closely monitored.

Specific Objectives:

1. Develop methodologies for identifying weed populations by using an integrated approach including ground surveys, remote sensing, GIS, and landscape modeling techniques.
2. Compare the methodologies tested by determining the strengths, weaknesses, and costs of each method.
3. Develop a model for predicting the occurrence and spread of YST.
4. Use the information collected to develop an integrated weed management strategy, and to create alliances with landowners.

BRIEF DESCRIPTION OF THE PROJECT: (Progress to Date – See Previous Progress Reports)

Weed control, including slowing the rate of spread across a landscape, is facilitated if nascent populations are found quickly and treated before the weed establishes and builds a reservoir of propagules in the soil. New infestations are, unfortunately, difficult to find. We have been developing technologies that locate new infestations of yellow starthistle (YST) and predict which areas are at risk. The area that was initially chosen to study was the Applegate Valley of Jackson Co. and Josephine Co., Oregon. These counties were invaded relatively recently; yellow starthistle was first documented in Jackson County (20 miles east of Medford) in 1928 and Josephine County (Cave City) in 1935.

It became obvious when we mapped the locations of YST in the Applegate Valley that the invasion process was ongoing and many sites that could support the plant were still weed free (Figure 1). Because we believed that it was necessary to obtain data from an area that had a longer invasion history, we mapped locations in the Bear Creek Valley south of Ashland to near Gold Hill, Oregon. This area had been exposed to YST longer and infestations were relatively continuous. We also believed that a statewide distributional map would better define the sites at risk. The Oregon Department of Agriculture Weed Division shared their database identifying sections (1 square mile) that have populations of YST (Figure 2). This database is not complete and some sections with infestations, especially those in the west central and northwest portions of the state, have not been logged.

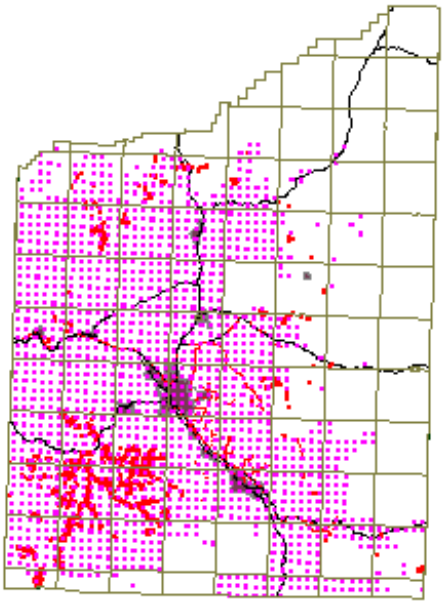

Figure 1. Red dots represent individual locations where yellow starthistle has been mapped for the project in Jackson County, Oregon. Fuchsia points are sections that are listed in the Oregon Department of Agriculture's weed database where yellow starthistle has been reported. Township and county boundaries are in brown, highways are in black and cities are in purple.

Our initial analysis (in the Applegate Valley) indicated that YST was very strongly associated with roads, abandoned roads, and sites where heavy equipment had operated. Random search methods were inadequate to find new infestations, as we had assumed. Detailed maps of YST distribution were produced in cooperation with Ms. Barbara Mumblo (USFS) by 100% cruise of selected areas in the watershed. We examined variety of land types covering the full range available within the watershed. This information was needed because we wanted to know which areas were infested as well as which were weed free. The 100% cruise was technician and time intensive and, therefore, very costly. Because of the roughness of the terrain and limited distance that could be fully observed, an individual can survey only a small area each day. In our survey 2 person days were required to survey 1km^2 in the Applegate region using this technique. Level, open ground was surveyed more rapidly while rough terrain more slowly. Since so much of the Applegate is steep it would be impossible to use the 100% cruise for more than limited areas. This sampling technique was used to judge the effectiveness of other techniques.

Aerial surveys of areas with known infestations were done using both aerial photography (both conventional color and color infrared) and visual observation by a person familiar with yellow starthistle and the area. A professional photo-interpreter could identify only dense stands of YST on 1:4000 scale photographs. Most infestations were not visible in either

conventional color or color infrared photos. The situation was similar for an aerial observer. Only large patches of starthistle were visible, many small diffuse stands were missed. The best season for YST detection was in the early summer when the plants had bolted but not yet flowered. It may be possible to detect scattered plants using hyper-spectral imaging systems, but these units are at present very expensive and were not used in this study. It is our conclusion that aerial photography can identify some densely infested sites but many small or diffuse infestations would be missed.

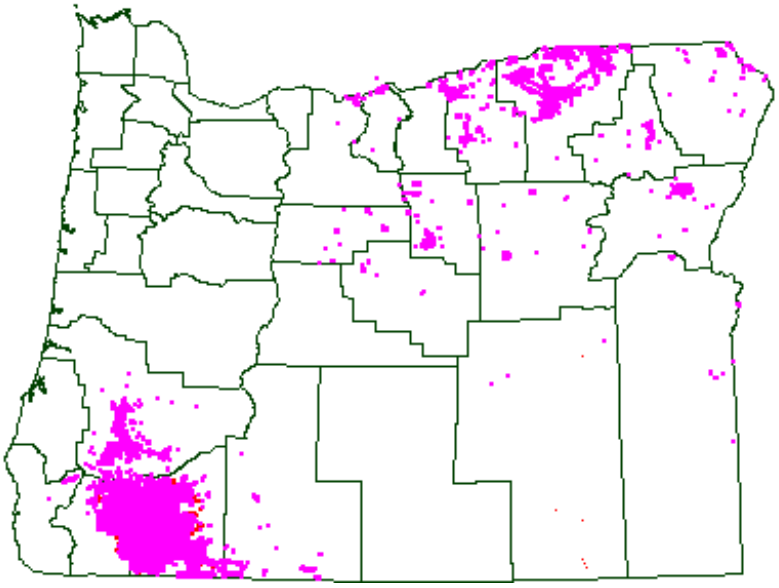

Figure 2. Distribution of Yellow Starthistle in Oregon. Each fuchsia point represents a section of land with at least one yellow starthistle infestation.

Stratified sampling and adaptive sampling improved detection rates. Last year, we acquired GIS data themes for the Applegate watershed including: 1) elevation, 2) highways, 3) roads, 4) streams, 5) lakes, 6) land ownership, 7) vegetation cover type, 8) percent cover, 9) watershed boundary, 10) townships, and 11) quad sheets. From this data we are deriving land slope and aspect and distance from roads for all locations in the test area. In addition to this data, we procured five Landsat 5 scenes and a Landsat 7 scene, which are being analyzed for spectral categories used in the risk assessment model.

GIS data layers were used to stratify the watershed into a series of nine classes, which represented all combinations of three distances from roads classes (0-50m, 50-100m, and >100m) and three over-story cover classes (Dense Forest, Sparse Forest, and Open). Maps were created in ArcInfo and are compatible with existing USFS data. By concentrating our sampling on areas near roads and abandoned roads, we substantially improved the probability of finding new infestations. Roadside surveys generated the most infestations per unit of time spent sampling in the Applegate Valley. It should be remembered that nearly all infestations in the Applegate area are adjacent on at least one side to a road. In the Bear Creek Valley the invasion of yellow starthistle has progressed to the point that it is more uniform across the landscape and locations 4 kilometers or more from a public roadway have dense starthistle stands.

The road survey is the most effective and efficient technique for surveying yellow starthistle in both watersheds that we have used thus far. This technique is superior for a number of reasons. 1) The technique is not nearly as time intensive as the 100% cruise or the stratified random sampling. Using this technique 155 km roads of interest were surveyed by 2 crews of 2 persons each in a period of 8 days. 2) Because the majority of infestations lie along

roadsides, it is more efficient to focus survey efforts along roads. 3) The accuracy obtained from road surveys is very high. Because most infestations were mapped using a GPS in conjunction with USGS topographic quad maps, most infestation positions are mapped to within 2 meters of their true location. In those areas where a GPS position was not available, infestation locations were estimated using USGS topographic quad maps and USGS orthographic photo quad maps, and we feel locations are within 10 meters of their true location. 4) Areas that are not often visited can be carefully examined. As shown by our mail surveys, large infestations that are visible from main thoroughfares are commonly known by many of the individuals living in the Applegate watershed. However, less significant infestations on roads seldom traveled are usually overlooked. It is important to document these smaller infestations, so that they can be controlled before the infestation spreads. The road survey is an excellent method for finding and documenting these hard-to-find infestations. 5) Road surveys detect small infestations that are not detectable with most other methods. Often, nascent infestations may be comprised of fewer than 10 plants that are less than six inches high. It is unlikely that landowners or agency employees will notice infestations like these, and they are not detectable from aerial photography. Because of this, road surveys provide the only reasonable method for documenting these nascent infestations.

A road survey team consists of a driver and an observer who records locations on paper maps and in the DGPS data loggers. Care must be taken when doing road surveys, because the vehicle moves slowly and may pose a traffic hazard. It is not appropriate for heavily traveled highways. We suggest using a vehicle equipped with warning lights on an overhead light bar.

In order to develop a landscape risk model, it is important to have information from infestations across a broad spectrum of environmental conditions. Smaller infestations on high mountain roads are just as important to the model as large infestations in the fields along well-traveled roads. The roads survey is the only effective method for gathering data on this cross section of conditions. For this reason we feel that the road survey has been the most effective survey method we have evaluated thus far.

Landowner Questionnaires/Sighting Reports

Because most methods of starthistle survey were restricted to public lands, we felt it necessary to obtain information regarding starthistle on private lands. Distance from core infestations may be an important variable to include in a landscape risk model. Therefore, it is important to document all core infestations that may exist. In order to gather data on private lands, 100 surveys were sent to landowners in the Applegate watershed in March of 2000. Recipients of the survey were individuals who were known to own some property and reside in the Upper Applegate watershed. Each survey contained a brief letter, a questionnaire, and a series of 9 township maps. The letter requested recipients to fill out the questionnaire and mark infestations of starthistle on the maps provided.

Out of the 100 surveys, 52 responses were received and 5 letters were returned undeliverable. The overall percentage of responses out of the surveys delivered was 55%. Of those surveys returned, 67% of them included at least one map.

The questionnaire consisted of 4 questions and an area for additional comments. The first question addressed the familiarity of the individual with the Applegate area. The second question was designed to ascertain the familiarity of the individual with the plants in the area. The third question asked if the individual could correctly identify yellow starthistle in its various forms. The final question requested the opinion of the individual regarding the seriousness of noxious weed invasion. In addition to recording an individual's responses to the four questions, note was made of those individuals who voluntarily offered to cooperate with efforts to stem the spread of yellow starthistle, as well as any other comments that were made.

Each returned map was digitized into an Arc/Info coverage for comparison with the data from the road survey/100% cruise. Reported infestations were verified on the ground, and the helpfulness and accuracy of each map submitted was evaluated. Overall helpfulness was ranked on a scale of 1 to 4 from misleading to very helpful.

In order to establish the accuracy of the maps, two descriptors were evaluated with respect to each township map submitted. Errors that described infestations where none existed were called errors of inclusion. Errors that failed to describe infestations where they did exist were called errors of exclusion. A third descriptor of the reports evaluated the overall tendency of the reporter with regard to each infestation reported, specifically whether the individual tended to overestimate or underestimate the size of those infestations reported. Finally, the acreage reported on each township map was estimated.

Over 80% of the individuals considered themselves either familiar or very familiar with the Applegate area and its plants, and 98% could usually or always recognize starthistle. 88% considered noxious weeds a very serious problem needing to be addressed. Over half (53%) of the maps returned were considered not very helpful. The most common errors were errors of exclusion, where large areas of starthistle were poorly described or not described at all. Most reports seemed to focus on particular areas respondents were familiar with and no effort was made to survey additional areas.

Overall, we considered the survey to be extremely successful. The high level of response and the extreme level of concern regarding noxious weeds indicate that the issue of yellow starthistle invasion is a very important one to landowners. While most reports of infestations were not particularly helpful or accurate, a few were, and using all reports together, only the remotest of sites were not described. We were somewhat disappointed in that most reports described areas that were easily accessible, whereas we had hoped to gain information about more remote or harder to reach areas. Overall the reports were useful for getting a general description of the weed's distribution; however, if more specific information were needed, such as for the development of our predictive model, a road survey or 100% cruise would still be necessary.

Results from the landowner survey reinforced our belief that a mapping effort involving many observers over a long period of time, all reporting to a central data repository, would be most effective. This is the reason that we have been developing an Internet server with weed maps, weed information, and a weed sighting report form.

Weed Mapper Internet Server

In order to facilitate information exchange among federal, state, and county weed authorities, as well as private citizens, we developed an interactive weed-mapping server (Weed Mapper) that is located at http://www.weedmapper.org/. Weed Mapper uses Intergraph's GeoMedia® WebMap® software to deliver weed infestation information through a series of map interfaces. Currently, our server provides maps of the known distribution of yellow starthistle within Jackson County, Oregon, to anyone with an Internet connection. Using detailed maps generated from TIGER® line files, it allows users to locate any site within ± 100 m of its true location and report weeds via an email message through a text and graphical report post form. Weed Mapper requires users to have a personal computer with a Pentium® or equivalent processor, Windows® 98, 2000 or NT® 4.0, and a video card that supports a minimum of 256 colors. The PC should be equipped with Internet Explorer® version 4.0 or higher or Netscape Navigator® 4.6.1 or higher. The first time a user accesses Weed Mapper he/she needs to download CGI viewer software that is available free on the Internet.

We were asked by the Oregon Department of Agriculture's Plant Division/Weed Control to expand the area covered by Weed Mapper from the test area of the Applegate to a statewide

coverage and expand the number of species covered (Tables 1 and 2). During 2001 we sequentially added maps for all Oregon counties. Each county is divided into townships that are usually 36 sections. The user can zoom in to see a map of several sections or less. Township maps contain cities, highways, roads, rivers, streams, reservoirs, coasts, and section lines (Figure 3). This year we are adding US Forest Service, USDI BLM, and ODA weed distribution data for all the important weeds throughout the state. The Burns District of the BLM (Ms. Lesley Richman and Ms. Pam Keller) has provided data for Weed Mapper and we are compiling data from Federal weed specialists throughout the state.

Table 1. Oregon "A" designated weeds. Weeds of known economic importance which occur in the state in small enough infestations to make eradication/containment possible or which are not known to occur, but their presence in neighboring states makes future occurrence in Oregon seem imminent.

Common Name	**Scientific Name**
African rue	*Peganum harmala*
Purple nutsedge	*Cyperus rotundus*
Barbed goatgrass	*Aegilops triuncialis*
Purple starthistle	*Centaurea calcitrapa*
Bearded creeper (Common Crupina)	*Crupina vulgaris*
Short-fringed knapweed	*Centaurea nigrescens*
Big-headed knapweed	*Centaurea macrocephala*
Silverleaf nightshade	*Solanum elaegnifolium*
Bulbed goatgrass	*Aegilops ventricosa*
Skeletonleaf bursage	*Ambrosia tomentosa*
Camelthorn	*Alhagi pseudalhagi*
Smooth cordgrass	*Spartina alterniflora*
Coltsfoot	*Tussilago farfara*
Smooth distaff thistle	*Carthamus baeticus*
Feather-headed knapweed	*Centaurea trichocephala*
Spartina	*Spartina densiflora*
Giant hogweed	*Heracleum mantegazzianum*
Spartina	*Spartina anglica*
Hydrilla	*Hydrilla verticillata*
Squarrose knapweed	*Centaurea virgata*
Iberian starthistle	*Centaurea iberica*
Syrian bean-caper	*Zygophyllum fabago*
Kudzu	*Pueraria lobata*
Tausch's goatgrass	*Aegilops tauschii*
Lepyrodiclis	*Lepyrodiclis holosteoides*
Texas blueweed	*Helianthus ciliaris*
Matgrass	*Nardus stricta*
Whitestem distaff thistle	*Carthamus leucocaulos*
Ovate goatgrass	*Aegilops ovata*
Wild safflower	*Carthamus oxycantha*
Plumeless thistle	*Carduus alanthoides*
Woolly distaff thistle	*Carthamus lanatus*

Table 2. Oregon "T" designated weeds. Weeds that represent an economic threat to the state of Oregon and are the focus of the weed control program sanctioned by the Oregon State Weed Board.

Gorse	*Ulex europaeus*
Leafy spurge	*Euphorbia esula*
Purple starthistle	*Centaurea calcitrapa*
Spotted knapweed	*Centaurea maculosa*
Tansy ragwort	*Senecio jacobia*
Yellow hawkweed	*Hieracium floribundium*
Iberian starthistle	*Centaurea iberica*
Purple loosestrife	*Lythrum salicaria*
Rush skeletonweed	*Chondrilla juncea*
Squarrose knapweed	*Centaurea triumfetti*
Wooly distaff thistle	*Carthamus lanatus*
Yellow Starthistle	*Centaurea solstitialis*

Weed Mapper operates within Microsoft® Internet Information Server® installed on a Pentium® system running NT 4.0 Server® and is connected to the Internet via OSU wide area network. GeoMedia WebMap® software is an open GIS application that uses no proprietary languages or data formats. It reads MGE, FRAMME, ARC/INFO®, ArcView®, MicroStation®, ORACLE® Spatial Cartridge/Spatial Data Option (SC/SDO), and ACCESS® data directly, without translation.

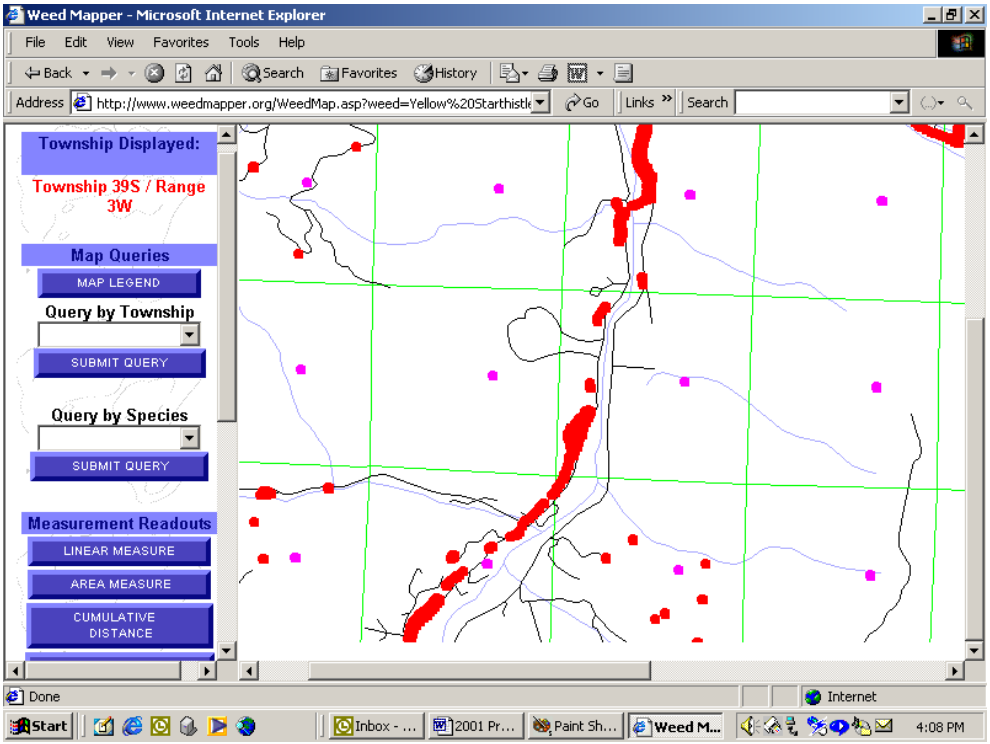

Figure 3. Screen capture of Weed Mapper web page showing the location of yellow starthistle in Township 39S, Range 3W, Jackson County, Oregon. Section lines (mile lines) are green, high-resolution starthistle locations are shown in red and ODA sections with starthistle are marked with a fuchsia dot. Note that at least one section marked as infested by ODA is actually starthistle free.

End-users access GIS weed data through standard Web browsers such as Microsoft® Internet Explorer® and Netscape Navigator® running under Windows® 95, 98 or Windows NT®. Since these tools are already on most desktops, individuals can access GIS formatted weed information. They can also download weed maps to their home machine for printing. Maps can also be magnified, zoomed or annotated by right clicking the mouse while the cursor is on a map. The "redline" feature permits drawing circles, rectangles, lines or compound lines as well as text on the map. Polygons can be drawn on maps using the multi-line feature in the "redline" menu. Users therefore, can annotate a weed map, save it to the clipboard or to a file, and send it via email to the project or to USFS or County Weed Specialists. We have also added buttons that permit the user to measure linear distance, cumulative distance, and measure area.

In addition, Weed Mapper allows users to report infestations though the weed sighting report form on the web page. If the user queries for the coordinates of a location, the coordinates are automatically loaded on the weed sighting report form along with the township, range, and a copy of the map. When a user completes and submits a report (Figure 4) on the net, a line

is added to a file on the server. The line contains information in a comma-delimited format that can be copied to a database. We can therefore print out reports to be verified by weed professionals or botanists in the county. Verified infestations would then be added to the master database. Weed Mapper currently resides on a dedicated net server in the Department of Rangeland Resources. We have expanded Internet bandwidth to supply maps to users quickly and efficiently. In addition to maps, we provide a link to weed publications and videos from the OSU extension service (http://eesc.orst.edu/agcomwebfile/EdMat/agriculture/weeds_1.htm) and taxonomic and distributional data from the NRCS Plants Database (USDA, NRCS. 2001. The PLANTS Database, Version 3.1 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.).

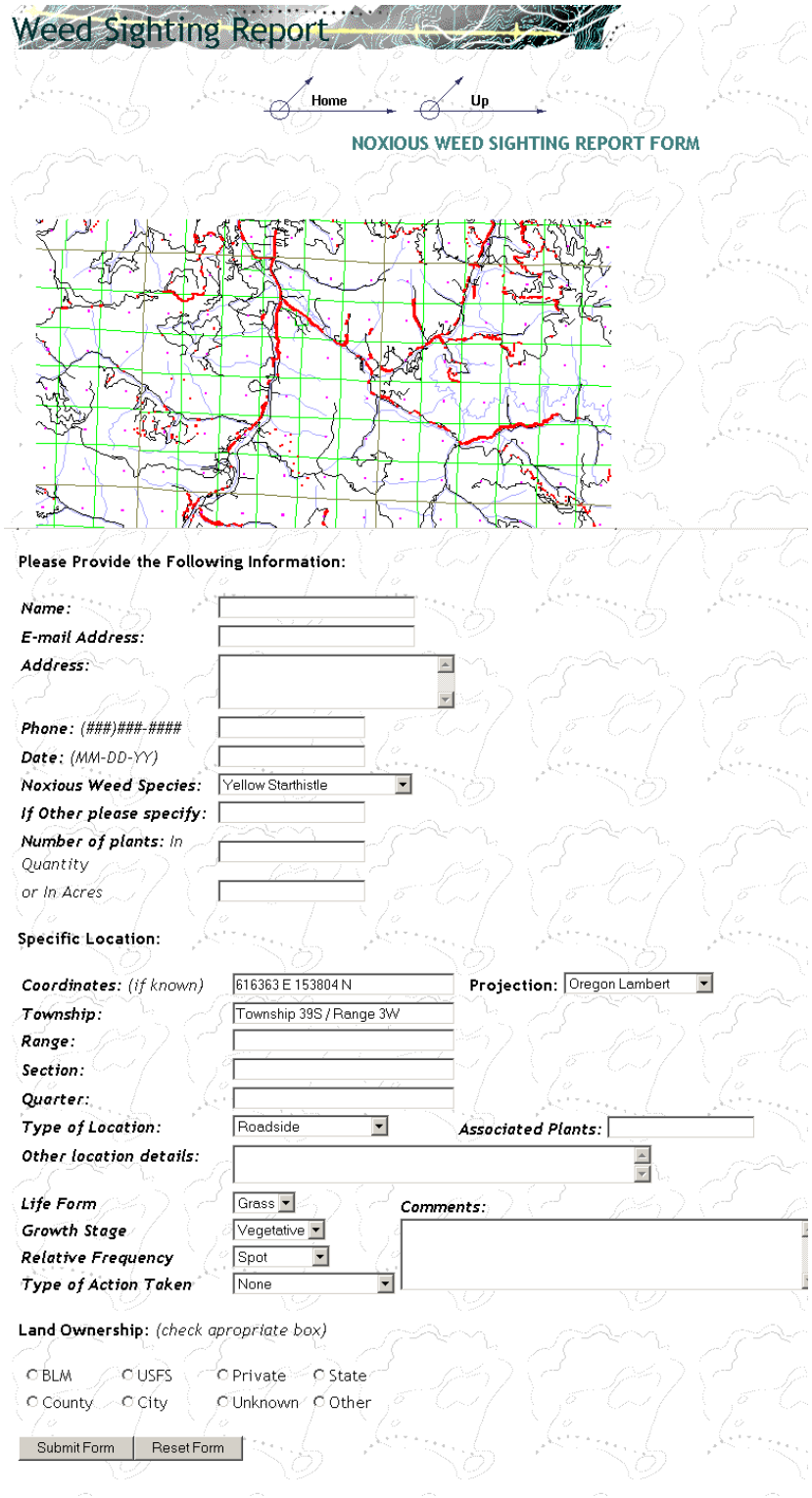

Figure 4. Weed Mapper weed sighting report form. Data from this form, along with the map shown at the top, is automatically loaded on the Weed Mapper server in digital format. A location queried on the mapping screen of Weed Mapper is automatically input on the form in Oregon Lambert projection. This projection was chosen because it covers the entire state.

Landscape Risk Model

Surveys of yellow starthistle infestations can be greatly streamlined if areas of likely infestation are be determined prior to the survey. One way to determine the most effective areas in which to perform searches for weed infestations is to develop a "Landscape Risk Model." Such a model takes into account a number of variables that influence a weed's presence, and then uses those variables across a landscape to determine areas that are prone to invasion by the weed.

In order to begin building such a model for yellow starthistle in the Applegate, a number of GIS layers were obtained. Elevational data were acquired from a USGS Digital Elevation Model (DEM). Using Arc Grid, these elevational data were used to determine slope and aspect for each location in the Applegate watershed.

Because yellow starthistle tends to be spread by vehicular traffic along roadways, it is important to know the distance of a particular location from a core infestation along the road. Knowing that core infestations existed near Ruch, and became less frequent as the road proceeded south, distances were calculated from the north end of upper Applegate road. Arc Grid was used to calculate the distance of each observation along the road from the north.

In order to determine vegetative communities that are associated with starthistle infestations, overall canopy cover density, percent shrub cover, percent barren and percent herbaceous cover were extracted from a data set provided by Applegate Ranger District. The data set had been determined for them by Geographic Resource Solutions® using Landsat TM imagery, Digital Elevation Models, and measured field data. These data had a resolution of 30x30 meters. We do not have an accuracy assessment of this data.

A class variable was also developed from an unsupervised classification of a Landsat 7 TM scene. ERDAS® Imagine® was used to formulate a classification of 20 spectrally distinct classes by combining spectral data from the blue, green, red, near infrared, and 2 middle infrared bands. These data are also at a resolution of 30 meters. There has been no ground verification of these classes, so the specific representations of each class are unknown. If these data prove to be useful in predicting starthistle locations, ground verification will be performed in the coming field seasons.

The final variable to be obtained for the model was the presence or absence of yellow starthistle infestations. Because the data were tied closely to the road we decided to test our first formulation of the model on areas close to the road. To this end Arc/Info® was used to create a buffer of 30 meters on either side of the road. The road segment was extracted from 1:100K Tiger line files of Jackson County. After the buffer was made, the polygon file was rasterized and Arc Grid® was used to update the raster file with infestation information from the road survey along the upper Applegate road. In order to bring all these data together in a format that could be used in a statistical model, ARC GRID® was used to combine each layer on the basis of the infestation data, and the data were output to a text file.

After the data were extracted from the GIS layers, they were imported into SAS, where they were used to predict presence or absence of starthistle by fitting them to the logistic regression model:

$$\text{logit}(p) \equiv \log\left(\frac{p}{1-p}\right) = \alpha + \beta' \chi$$

The full model contained 9 variables, listed in Table 3. Stepwise regression with backward elimination was used to evaluate the usefulness of all 9 variables for determining presence.

Variables were dropped if Pr > Chi Square was greater than 0.05. Elevation and density dropped out, leaving the remaining variables in the final model (Table 4). The fact that elevation and density dropped out is to be expected. Elevation was highly correlated with distance because the road goes consistently uphill from the beginning. Most of the variation in density can be described by a combination of % barren, % herbaceous, and % shrub (R^2 = 0.82).

Table 3. These variables were collected for locations adjacent to upper Applegate road and used to develop a model for predicting the presence of yellow starthistle.

Variable	Type	Description
Density	Continuous	Percentage of overhead canopy cover
%Shrub	Continuous	Percent shrub cover
% Herbaceous	Continuous	Percent herbaceous cover
% Barren	Continuous	Percent barren ground
Aspect	Categorical	Direction of slope divided into 8 45° slices
Slope	Continuous	Inclination of the slope, measured in degrees
Elevation	Continuous	Height above the ellipsoid
Presence	Binary Response	Presence or absence of Yellow Starthistle
Class	Categorical	Grouping based on unsupervised classification of a Landsat 7 scene.
Distance	Continuous	Distance from the beginning of the road

Table 4. Variable used in the final model for predicting presence or absence of yellow starthistle with the probability of being greater than the chi-square distribution.

Effect	DF	Wald Chi-Square	Pr> Chi-Squre
Aspect	8	60.96	<.0001
Classes	17	59.08	<.0001
Distance	1	172.57	<.0001
Slope	1	4.61	.0318
Barren	1	21.46	<.0001
Herbaceous	1	10.20	.0014
Shrub	1	8.11	.0044

In order to test the model, SAS proceeds through each record, fits the model without that record, and uses the resulting model to predict that point. The percentage of correct predictions is then reported. The final model was able to predict infestations correctly 85% of the time. One must keep in mind that if one chose to predict all pixels as having no starthistle, the prediction would be correct 77% of the time, as 77% of the observations are starthistle free. Thus, the model improves this estimation by 8%.

A clearer view of the accuracy of the model is gained by looking at the R^2 value for the model. This model had a Max Rescaled R^2 = 0.43. This Max Rescaled R^2 has been rescaled to account for the fact that for discrete models, such as this one, R^2 has a maximum value of less than 1 (Cox and Snell 1989, Nagelkerke 1991).

At this time there are a number of steps we may take in an effort to improve upon this model. One shortcoming of the data used in this model is that, due to the presence of infestations only along roads, observations are highly correlated with one another and with the presence of the road. In order to address this issue, we have started road surveys in the Bear Creek watershed, along the I-5 corridor where starthistle infestations began earlier and have expanded farther. In this valley YST has, therefore, had more opportunity to establish infestations across the range of available sites, often at considerable distances from well-traveled roads.

Another question to be addressed has to do with the resolution of the data. Infestations were documented on a plant-by-plant basis and often occupied only 1 or two meters directly adjacent to the road. The data extracted described a 30x30 meter plot that could have included many areas that were not representative of areas prone to starthistle invasion. Further, the accuracy of much of the existing GIS data is unknown. We think that it is unwise to rely completely on these data until their accuracy is ascertained.

In order to address the difficulties of data resolution and accuracy, a sample of infestations will be taken and data will be gathered for these locations on the ground. Information regarding elevation, slope, aspect, vegetative community, land use, and soils will be gathered for each location, and used in a model similar to the one here to predict occurrence of yellow starthistle.

CHANGES TO ORIGINAL PROJECT SCOPE OR OBJECTIVES (changes that need to be made to the original proposal and reasons for the changes): None

ADDITIONS TO ORIGINAL PROJECT SCOPE OR OBJECTIVES (describe additional accomplishments expected from the project)**:**

We have extended the geographical area (State of Oregon) and the target list of weeds (Oregon "A" and "T" List) that will be followed with the spatial database. This was done at the request of Oregon Department of Agriculture.

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

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
Don Goheen	SWOIDSC	
K. Marshall	SWOIDSC	

FHP LEAD INVOLVEMENT

	Role	Time Commitment
Don Goheen	SWOIDSC	
K. Marshall	SWOIDSC	

PRINCIPAL INVESTIGATOR(S):

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
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PRINCIPAL INVESTIGATOR(S) INVOLVEMENT (add lines as necessary)**:**

Name	Role	Time Commitment
Douglas E. Johnson	Principal Investigator	0.15

Enclosure 3 continued

COOPERATORS (contributing to, but not leading, the project) (add lines as necessary)**:**

Name	Affiliation (Office or Dept.)	Phone, E-mail, Fax
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Jeanette Brucker (Nee Williams)	Ecologist Rogue River National Forest jbrucker@fs.fed.us	V 541-899-1812 F 541-899-2401
David Thomas	Dept. of Statistics (Emeritus) Oregon State University dave.thomas@orst.edu	V 541-737-1608 F 541-737-0504
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Paul Korbulic	Jackson Co. Native Plant Society	
Lee Bradshaw	Cattlemen's Association of Jackson Co. Oregon	

COOPERATOR INVOLVEMENT (add lines as necessary)**:**

Name	Role	Time Commitment
Randy White	Facilitator/Extension	2 weeks per year
Dennis Isaacson	Liaison with ODA	1 week per year

PRODUCTS AND DUE DATES (from original application form)**:**

The product of this research will be a thorough, documented, examination of several survey methods, the development of a predictive model of where yellow starthistle is likely to invade, and a map of starthistle populations on the target area within the Applegate landscape. This weed map will facilitate information exchange and cooperation. Map coordinates or map overlays on an accurate base map will identify locations of weeds, their relative abundance and other observations.

STATUS OF PRODUCTS/PRESENTATIONS:

We have completed the tasks that were scheduled during the first three years phase of the project (see project timeline in project proposal). The project is on track and proceeding according to plan. FY 2002 funding will permit us to complete the YST modeling effort. Weed sighting and reporting via the Internet will be added to the YST and other "A" and "T" list weed database. We will continue to follow the research plan found in the original project proposal.

ACCOMPLISHMENTS TO DATE:

Products:

1. Yellow starthistle distribution map in the Applegate Watershed
2. www.weedmapper.org An interactive web site that provides maps of weed infestations within the state of Oregon as well as descriptions of noxious weeds and links to OSU Extension publications dealing with weed management and control.

3. Vegetation Measurement Program – a Visual Basic® computer program that is designed to be used with a laptop computer, platform mounted digital camera, and NMEA GPS antenna (National Marine Electronics Association Global Positioning System). This program allows the user to acquire a vertical (straight down) digital image of a weed infestation, determine the latitude/longitude position the image (± 20m), and collect ancillary data (keyboard input) into a structured electronic data format. The image can also be processed in the field to give an estimate of vegetative cover or annotated to identify plants. This system will permit better documentation of weed infestations so that weed expansion can be quantified. Weed control techniques can also be evaluated using this system. The Vegetation Measurement Program is being developed using funds from this project and other projects funded by USDA and the State of Oregon.
4. Preliminary landscape risk model of YST

Publications:

Johnson, D.E., G.M. Casady, M. Laliberte, and J. Utterback. 2001. A weed map server for Oregon. Abstr. of Papers, 54th annual meeting Soc. for Range Manage., Kona, Hawaii, U.S.A.

Johnson, D.E., M. Laliberte, J. Utterback, M. Louhaichi, S. Bulkin, J. Brucker and B. Mumblo. 2001. Weedmapper. 5th Annual Meeting Northeastern Oregon GIS Conference, May 18th, Pendleton, Oregon, U.S.A.

Johnson, D.E., N.R. Harris, M. Louhaichi, G.M. Casady, & M.M. Borman. 2001. Mapping selected noxious weeds using remote sensing and geographic information systems. Abstr. of Papers. Am. Chem. Soc. Proceed., Am. Chem. Soc., San Diego, CA. (Invited Paper)

Casady, G.M. and D.E. Johnson. 2001. Comparison of Methodologies for Yellow Starthistle (*Centauria solstitialis* L.) Detection and Mapping. Abstr. of Papers, International Knapweed Symposium, Western Society of Weed Science. Coeur d'Alene, Idaho.

Technology Transfer:

Johnson, D.E., N.R. Harris, M. Laliberte. 2001. Weed mapping: state of the art. Oregon Vegetation Management Association Annual Meeting. Newport, Oregon.

Johnson, D.E., M. Laliberte, S. Bulkin, J. Brucker and B. Mumblo. 2001. Weedmapper. Presentation to the Applegate Watershed Group. Ruch, Oregon.

Johnson, D.E., M. Laliberte, S. Bulkin, J. Brucker and B. Mumblo. 2001. Weedmapper and Weed Control. Presentation to landowners. September 25, 2001, Medford, Oregon.

FIRST FISCAL YEAR FUNDED: 1999

FUNDS OBLIGATED FROM BEGINNING OF PROJECT THROUGH CURRENT FISCAL YEAR: (include both monetary and in-kind, excluding FHP base funding and salaries) (extend table as needed)**:**

	Item	Requested Funding	Received Funding	Expended Funding
FIRST YEAR FY 1999				There were no unused funds
Administration	Salary	$22,487	$22,487	$22,487
	Overhead	9,516 (OSU)	9,516 (OSU)	9,516 (OSU)
	Travel	1,738	1,738	1,738
Procurements	Contracting	0	0	0
	Equipment	0	0	0
	Supplies	7,800	7,800	7,800
	Other	4,575	4,575	4,575
YEAR TOTALS		$46,116	$46,116	$46,116

	Item	Requested Funding	Received Funding	Expended Funding
SECOND YEAR FY 2000				There were no unused funds
Administration	Salary	$19,225	$19,225	$19,225
	Overhead	6,266 (OSU)	6,266 (OSU)	6,266 (OSU)
	Travel	1,739	1,739	1,739
Procurements	Contracting	0	0	0
	Equipment	0	0	0
	Supplies	3,136	3,136	3,136
YEAR TOTALS		$30,366	$30,366	$30,366

	Item	Requested Funding	Received Funding	Expended Funding
THIRD YEAR FY 2001				There will be no unused funds
Administration	Salary	$30,733	$30,733	$30,733
	Overhead	13,026 (OSU)	13,026 (OSU)	13,026 (OSU)
	Travel	1,739	1,739	1,739
Procurements	Contracting	0	0	0
	Equipment	0	0	0
	Supplies	2,128	2,128	2,128
	Tech./Video	15,500	15,500	15,500
YEAR TOTALS		$50,100	$50,100	$50,100

	Item	Requested Funding	Received Funding	Expended Funding
CURRENT YEAR FY 2002				There will be no unused funds
Administration	Salary	$19,225	$19,225	$19,225
	Overhead	6,226 (OSU)	6,226 (OSU)	6,226 (OSU)
	Travel	2,739	2,739	2,739
Procurements	Contracting	0	0	0
	Equipment	0	0	0
	Supplies	4,136	4,136	4,136
YEAR TOTALS		$26,100	$26,100	$26,100

DIFFERENCE BETWEEN ORIGINAL AND AMENDED REQUESTS AND JUSTIFICATION:

No changes from the original proposal are needed.