ROADSIDE VEGETATION MANAGEMENT EQUIPMENT AND TECHNOLOGY

ANNUAL REPORT FOR FY 2009

ODOT SPR ITEM NUMBER 2156

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Metric Conversion Page

SI (METRIC) CONVERSION FACTORS

Approximate Conversions to SI Units

Symbol	When you know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	25.40	millimeters	mm
ft	feet	0.3048	meters	m
yd	yards	0.9144	meters	m
mi	miles	1.609	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.0929	square meters	m^2
yd^2	square yards	0.8361	square meters	m^2
ac	acres	0.4047	hectacres	ha
mi^2	square miles	2.590	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallon	3.785	liters	L
ft^3	cubic feet	0.0283	cubic meters	m^3
yd^3	cubic yards	0.7645	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.4536	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	degrees Fahrenheit	(°F-32)/1.8	degrees Celsius	°C
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.448	Newtons	N
lbf/in^2	poundforce per square inch	6.895	kilopascals	kPa

Approximate Conversions from SI Units

Symbol	When you know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.0394	inches	in
m	meters	3.281	feet	ft
m	meters	1.094	yards	yds
km	kilometers	0.6214	miles	mi
		AREA		
mm^2	square millimeters	0.00155	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.196	square yards	yd^2
ha	hectacres	2.471	acres	ac
km^2	square kilometers	0.3861	square miles	mi^2
		VOLUME		
mL	milliliters	0.0338	fluid ounces	fl oz
L	liters	0.2642	gallon	gal
m^3	cubic meters	35.315	cubic feet	ft^3
m^3	cubic meters	1.308	cubic yards	yd^3
		MASS		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.1023	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	degrees Fahrenheit	9/5(°C)+32	degrees Celsius	°F
		FORCE and PRESSURE or STRESS		
N	Newtons	0.2248	poundforce	lbf
kPa	kilopascals	0.1450	poundforce per square inch	lbf/in^2

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

As in the past, the focus of this report continues to be the conveyance of information on new or previously underutilized technologies and resources that have application to the Oklahoma Department of Transportation's (ODOT) roadside vegetation management program. ODOT administrators and supervisors deal with many highway maintenance challenges. They have opportunities to use techniques and equipment that can increase efficiency or efficacy of management. As part of ODOT's contract with the Oklahoma State University Roadside Vegetation Management (OSU RVM) program, OSU personnel attend the annual National Roadside Vegetation Management Association (NRVMA) meetings to gather information regarding technology transfer as it applies to vegetation management. Additionally, OSU RVM and its connection to the land-grant university system allow a unique opportunity for recommendations to ODOT regarding new applicable resources generated by other universities.

Identification of weed species can be challenging for many people. Many ODOT field employees are charged with having expertise in diverse areas spanning vegetation management to pavement technology to public relations. Plant or weed identification guides can be an important tool for ODOT employees when fulfilling their vegetation management roll. Over 100 ODOT employees are trained at Joint OSU/ODOT Certified Herbicide Applicator Schools each year. Over 600 ODOT employees receive continuing education in vegetation management from the OSU RVM team each year. Training of ODOT employees at the initial Certification Schools and the Continuing Education Workshops includes but is not limited to identification of desirable as well as problematic weed species and then selecting the appropriate mechanical or chemical (herbicide) control that effectively suppresses the objectionable species.

Proper plant identification and herbicide selection are part of a management program striving to stretch monetary resources. Applying an herbicide that does not control the targeted weed species can waste money invested in the herbicide purchase and this results in an additional waste in the labor used to apply the wrong herbicide. Although plant identification resources are widely available on the internet, their remains tremendous need for a durable, portable, color plate plant identification resource that can travel with vegetation managers into harsh field working environments.

Along with proper plant identification and subsequent herbicide selection for weed control there is a need to accurately record where herbicide treatments are applied. Mapping equipment to automatically log herbicide applications is ever evolving. The spectrum of cost and complexity of older mapping systems ran from the tens of thousands of dollars to the recent, more basic, Global Positioning System (GPS) data collection units that cost in the range of five hundred dollars to one thousand dollars.

The objectives of this report are to i) introduce and recommend a high volume purchase of the new weed identification guide entitled Weeds of the South for ODOT vegetation managers and ii) introduce and recommend the purchase of the Garmin GPSMAP 276C Global Positioning System (GPS) receiver on a limited trial basis.

2.0 WEEDS OF THE SOUTH WEED IDENTIFICATION GUIDE

In fall of 2009 the OSU RVM program team conducted Divisional Herbicide Program meetings across the state of Oklahoma with ODOT vegetation managers. As a part of these meetings and in Question 11 of the Annual ODOT Herbicide Program Survey (Montgomery et al. 2009) ODOT attendees were asked “Please name any specific weed problems that you have along your roadsides that are not being controlled by your current herbicide program?” This question generated much discussion. We found that managers had several weeds of concern and that proper identification and representation of the problematic weed by common name was difficult for ODOT employees. “Regionalized” common names were often being used by ODOT staff. This resulted in several different weed species being called by the same common name. This in turn made it somewhat challenging for OSU RVM personnel to provide assistance to ODOT vegetation managers. Additionally, when descriptions of weeds species are verbally articulated between OSU RVM personnel and ODOT vegetation managers over the phone without the presence of images, perception of the plant in question are open for vast individual interpretation.

One way to circumvent this dilemma is for ODOT to provide their employees that are involved in roadside vegetation management with a high quality, durable plant and weed identification guide. Such a guide could be carried into the field and survive intermediate term, rugged, field-use.

2.1 Recommended Purchase of Weeds of the South

We recommend ODOT purchase copies of Weeds of the South for use by their vegetation management personnel directly involved in weed control on roadside rights of way. The soft bound book entitled Weeds of the South was published in 2009 (Bryson and DeFelice, 2009). The work was published by the University of Georgia Press in cooperation with the Southern Weed Science Society. The full reference and contact information for this publication is provided in the References section of this report. The guide features more than 1,500 full-color photographs and provides essential information on 400 of the most troublesome weedy and invasive plants found in the southern United States.

In Weeds of the South, each species account includes:

- Up to four full-color photographs showing seed, seedling, plant, flower, and other unique plant features.
- Plant geographical distribution maps.
- For grasses, a line drawing of the collar (where the leaf joins the stem), an important identifying characteristic.
- Scientific names, common names, and local synonyms of common names.
- Vegetative characteristics for seedlings and leaves
- Special identifying features, reproductive characteristics, and toxic properties

Although we have not found any single plant identification source that covers 100% of the weeds that are encountered by ODOT personnel, we feel that Weeds of the South provides excellent coverage of weedy species found on ODOT rights of way at this point in time.

2.2 Cost Analysis For Purchase and Implementation of Weeds of the South

We recommend that ODOT purchase enough copies to supply one copy to each ODOT county unit. The price per copy varied from the publisher's list price of $27.97 per copy (http://www.ugapress.uga.edu/index.php/books/weeds_of_south/0/1 at The University of Georgia Press website) to $25.50 per copy from two Ebay.com vendor sources on December 8, 2009. The approximate cost to ODOT to purchase 99 copies, supplying 91 copies to county and interstate units and one copy to each of the 8 Division headquarters would range from approximately $2,524.50 to $2,769.03. Shipping & handling was included with the Ebay sources but not with the University of Georgia Press source. As with all high volume purchases, a volume discount should always be pursued by ODOT; we did not investigate this possibility with the vendors at this preliminary phase. If ODOT would approve funding for and the purchase of 99 copies of this publication by the OSU RVM Team, we could distribute copies of the publication to ODOT staff at the upcoming FY 2010 Herbicide Applicator Continuing Education Workshops being held in February through March of 2010 as a part of ODOT/OSU Joint Project 2156.

3.0 GARMIN GPSMAP 276C GPS RECEIVER

During the course of our interaction with ODOT vegetation managers, there have been incidences of right of way areas inadvertently receiving two applications of an herbicide treatment for the same problem within a short duration of time. This type of mistake occurs when an herbicide spray crew stops at one physical location and either the same crew or another spray crew resumes spraying at a later time at the stopping point where the first application was “perceived” to have ended. The method to physically mark where herbicide application start-stop points are located varies from county unit to county unit. Most often operators use a physical landmark (highway intersections, distance from intersections, buildings, cities limits as well as other physical features) at which spay application was stopped and where spray application is to be resumed.

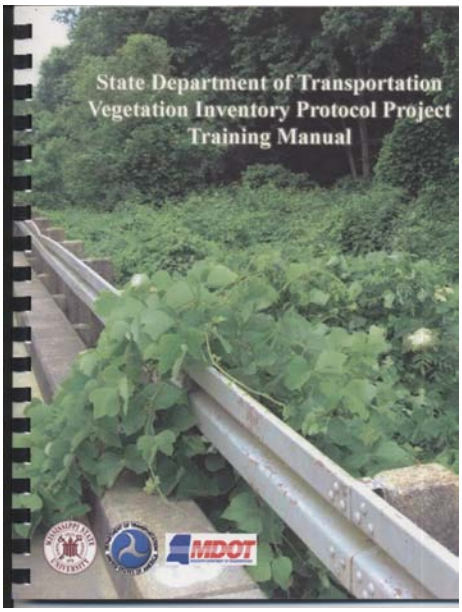

Figure 1. Cover Image of State Department of Transportation Vegetation Inventory Protocol Project Training Manual

While use of a relatively permanent physical landmark can be highly suitable for designation of an herbicide application boundary, a more accurate method would involve use of Global Positioning System (GPS) coordinates.

3.1 Recommended Purchase and Small Scale Trial of the Garmin GPSMAP 276C GPS Receiver

We recommend that ODOT approve funding for the purchase of a single Garmin GPSMAP 276C GPS receiver as well as a supplemental Garmin Auto Navigation Kit containing secondary road detail, a friction dash mount, an auto dash mount and a data card. We recommend that the unit be installed and trialed by a single spray crew in Division 4 during the 2010 herbicide application season. We would request that the spray crew work closely with the OSU RVM program such that the results of the trial could be written up by our OSU RVM team in the FY2010 Equipment Technologies Report being generated as a part of Joint ODOT/OSU Item 2156.

Specific requests for this high accuracy and precision quantitative record keeping method, including utilization of GPS technology and map overlays, originated from consultations in 2008 and 2009 with Mr. Roy Counts, Division 4 Maintenance Engineer.

A recently published report from a Joint Highway Project between the MS Dept. of Transportation and the MS State University (Figure 1) identified the Garmin GPSMAP 276C (Figure 2) as the GPS receiver of choice (Maddox et al. 2009). The subject publication State Department of Transportation Vegetation Inventory Protocol Project Training Manual (Figure 1) was distributed to National Roadside Vegetation Management Association (NRVMA) participants in September of 2009. ODOT funded the travel and expenses for an OSU RVM team member to participate in this meeting.

OSU RVM personnel sought and obtained expert opinion on October 1, 2009 and November 25, 2009 from Mr. Mark Gregory concerning whether the specifications for the Garmin GPSMAP 276C would allow for the unit to fulfill the mapping needs of ODOT vegetation managers. Mr. Mark Gregory is an Assistant Research Professional with the Dept. of Natural Resources, Ecology and Management at OSU, Stillwater. Mr. Gregory's Curriculum Vitae is posted at: http://nrem.okstate.edu/faculty/gregory.html. He has over 15 years experience and expertise in Geographic Information Systems (GIS) and GPS. His contact information is: Phone:405-744-9603 and e-mail mark.gregory@okstate.edu. Mr. Gregory indicated that based on the specifications of the Garmin GPSMAP 276C receiver unit (Table 1), the unit's capabilities would fulfill the mapping needs of ODOT vegetation managers. Additionally, Mr. Gregory's assessment included his opinion that mapping needs for overlays using ODOT Geomedia software and other commonly used software would be compatible.

Figure 2. Garmin GPSMAP 276C GPS receiver

We recommended that a Division 4 spray crew trial the basic Garmin 276C GPS Unit in 2010 for its ability to detect lakes, streams, and rivers of various sizes, principal urban areas, interstate, state and county and municipal level roads as well as mapping overlay capability. Region specific software is custom loaded at the factory in addition to the North American base-map so it will be necessary for Division 4 to provide location information for factory representatives to load the appropriate detailed software at the factory. We would recommend that ODOT try to use the base unit before the inclusion of software from the Auto Navigation supplemental kit, so as to assess the capability of the base unit plus any added value obtained from the added expense/detail of the supplemental software. Additionally, the Auto Navigation

supplemental kit contains a friction mount and dashboard mount to be used in lieu of the marine mount specified with the base unit. It would be beneficial for ODOT Division 4 personnel to attempt mounting with the base marine mount before turning to the supplemental friction or dashboard mount. These experiences by the Division 4 personnel will be valuable in forming an opinion as to the necessity of purchase of the supplemental fixtures in the event ODOT decides to expand use of this or similar units onto their herbicide application vehicles.

3.2 Cost Analysis For Purchase and Limited Scale Trial of the Garmin 276C GPS Receiver

We recommend that ODOT budget $800 to cover the purchase of a single Garmin GPSMAP 276C GPS receiver plus supplemental Auto Nav package and shipping charges. The Garmin GPSMAP 276C GPS receiver (Product code: 010-00331-00) manufacturer's suggested retail price (MSRP) was $499.99 at https://buy.garmin.com/shop/shop.do?pID=233&locale=en_EN#featureTab on December 8, 2009. This price does not include shipping and handling. A search from the vendor site Ebay.com on December 8, 2009 did not yield a lower price than the listed manufacturer price above. It is not clear whether the standard marine mount furnished with the base unit would be most satisfactory for mounting on the dashboard of an ODOT spray vehicle. Therefore it may be necessary to trial an accessory "Friction mount" (Product code: 010-10306-00, MSRP: $35) or semi-permanent "auto mount" (Product code: 010-10485-00, MSRP: $34.99) to find which is most satisfactory by ODOT. Additionally, more detailed street-level software may be found to be necessary based on trialing in Division 4. If this additional level of detail is necessary, it would be most cost effective to purchase an Auto Nav supplemental package (Product code: 010-10510-02, MSRP: $199.99) which not only includes more detailed street and small stream information but also the two supplemental mounts discussed above. Purchase and installation of the Garmin 276C unit by mid January 2010 would allow for the unit to be trialed on a small scale basis during the 2010 herbicide application season beginning in March and extending through summer of 2010. Trial results from use by Division 4 personnel could then be included in the FY2010 Equipment Technology report for further consideration by ODOT.

Table 1. Specifications Concerning the Physical Size, Performance, Mapping and Memory Features of the Garmin GPSMAP 276C Unit[1].

Feature	Specification or Details
Unit dimensions, WxHxD:	5.7" x 3.2" x 1.9" (14.5 x 8.1 x 4.8 cm)
Display size, WxH:	3.0" x 2.2" (7.6 x 5.6 cm)
Display resolution, WxH:	480 x 320 pixels
Display type:	256-color TFT
Weight:	13.6 oz (385 g)
Battery:	rechargeable internal lithium-ion
Battery life:	up to 15 hours
Waterproof:	yes (IPX7)
High-sensitivity receiver:	no
Antenna:	detachable
NMEA input/output:	NMEA 0183
RoHS version available:	yes
Maps & Memory:	
Basemap:	yes
Preloaded street maps:	no
Ability to add maps:	yes
Built-in memory:	none (cannot load maps to internal memory)
Accepts data cards:	Garmin data cards
Waypoints/favorites/locations:	3,000
Routes:	50
Track log:	10,000 points; 20 saved tracks

[1]Specifications for the Garmin GPSMAP 276C, Part Number: 010-00-00331-00. Available on-line at: https://buy.garmin.com/shop/shop.do?pID=233&ra=true#specsTab. (Verified December 8, 2009).

----------**Table 1 Continued On Page 8**----------

Table 1. Specifications Concerning the Physical Size, Performance, Mapping and Memory Features of the Garmin GPSMAP 276C Unit (continued from page 7).

Feature	Specification or Details
Garmin radar compatible:	no
Garmin sonar compatible:	yes
CANet® compatible:	no
Garmin Marine Network™ compatible:	no
Touchscreen:	no
Supports AIS (tracks target ships' position):	no
Supports DSC (displays position data from DSC capable VHF radio):	yes
Audible alarms:	yes
Tide tables:	yes
Hunt/fish calendar:	yes
Sun and moon information:	yes
3-D map view:	no
Auto Guidance:	no
Automatic routing (turn by turn routing on roads):	yes
XM WX Weather & Radio for U.S. & Canada compatible:	no
Voice prompts (e.g. "Turn right in 500 ft."):	no
Speaks street names (e.g. "Turn right ON ELM STREET in 500 ft."):	no
Remote control:	no
Headphone jack/audio line-out:	yes
Audio/video input/output:	no
Portable:	yes
Automotive/motorcycle-friendly:	yes

[1]Specifications for the Garmin GPSMAP 276C, Part Number: 010-00-00331-00. Available on-line at: https://buy.garmin.com/shop/shop.do?pID=233&ra=true#specsTab. (Verified December 8, 2009).

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