Field Data Collection Equipment Guide

United States
Department of
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Forest Service

**Technology &
Development
Program**

7700—Transportation System
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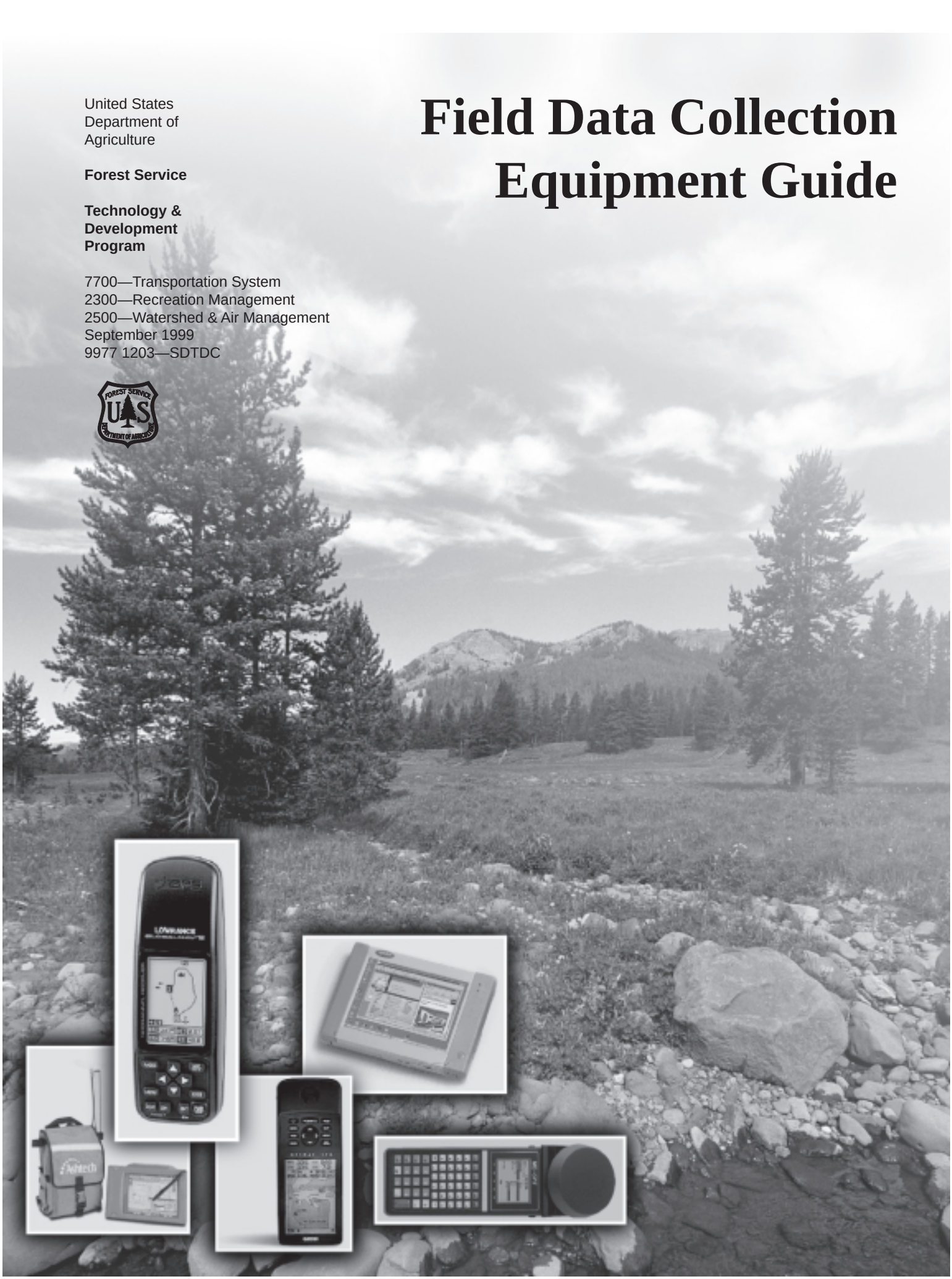

Field Data Collection Equipment Guide

Frank Sutton
Civil Engineer

Ralph Gonzales
Mechanical Engineer

San Dimas Technology and Development Center
San Dimas, California

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GUIDE OBJECTIVES

¥ Provide field personnel with basic information on the range of systems or components that are available for GIS data collection and mapping, where products can be purchased and what they cost.

¥ Facilitate advanced planning and procurement of systems.

¥ Provide information on available state of the art technology and new products that will assist .. personnel in automating data collection tasks in the field.

¥ Introduce the GIS field data collection equipment evaluation.

¥ Provide resources for obtaining additional information on new products.

Scope of this Guide

The Field Data Collection Equipment Guide is a catalog of products available to the Forest Service organized into equipment categories. The guide contains various product features, photos, where appropriate, company contact information including phone number and Internet World Wide Web (WWW or Web) address where personnel can go to obtain additional or more current information.

The equipment tables are preceded by a brief description of the equipment category, including an explanation of nomenclature, equipment uses, and other background information. Users of this guide are asked to contact the equipment vendors for the most recent pricing or other additional information that is required.

As most of the vendors provide product specifications that are viewable by accessing their Internet Web sites, the information contained in this guide was derived mainly from this source.

Contents

THE GIS FIELD DATA COLLECTION PROJECT

Much support from field personnel and by national Technology and Development (T&D) steering committees has resulted in a project being assigned to SDTDC to re-evaluate the current methods used in capturing field data for Forest Service Geographic Information Systems (GIS). New hardware and software systems are being explored that will increase field data collection speed, quality and efficiency.

The main goal of the project was to develop a fully integrated, user friendly and real time system to record and store field information directly into an on-board computer for vehicles or a portable computer for information gathering on foot. The project will investigate a real time data capture methodology that will potentially provide the following benefits:

¥ Improved data quality and provide more complete data.

¥ Improved efficiency and minimized site revisits.

¥ Improved interface to the Forest Service GIS.

¥ Will facilitate the collection of more data more quickly and thus increasing the usefulness of the GIS.

¥ Easier to use user interface that requires less training.

A project advisory committee met in August 1998 to guide the project and help outline a test plan for the evaluation of several real-time data capture software packages. The evaluations will result in feasibility and cost/benefit data, comparing the collection of GIS data in real-time utilizing pen-based computer hardware and mapping/data capture software with conventional methods that use field data recorders (FDR s) and post processed GPS receivers. Testing will qualitatively evaluate six software packages for integration, feasibility, power, and ease of use. The project test plan may be viewed or downloaded from the SDTDC Intranet site at *http://fsweb.sdtdc.wo.fs.fed.us/programs/eng/gis/Test_Plan.aw*

Project work will continue throughout the remainder of fiscal year 1999 and into fiscal year 2000 to will possibly customize a selected mapping/data capture application to best suit field needs. These will be based on the results of field evaluations and the recommendations made by the project advisory committee.

GPS RECEIVERS

Much has been published on GPS technology in the Forest Service. Several such documents produced by Missoula Technology and Development Center (MTDC) can be accessed from the MTDC FSWeb site at *http://fsweb.mtdc.wo.fs.fed.us*

Or they may be ordered by contacting MTDC at:
Phone: (406) 329-3978,
IBM mail: pubs/wo,mtdc

C/A (Civilian Access) Code Receivers

As the Department of Defense intentionally degrades the C/A code transmission in a process called selective availability (SA); receivers of this type require differential correction to bring the accuracy into an acceptable range. This is traditionally done by post processing the data by comparing it to position the data derived from a base station. All brands of C/A code receivers are equally affected by SA, and without differential correction, will only be accurate to within 100 meters 95 percent of the time. The current policy approved by President Clinton in March 1996 provides for the phase out of SA over a ten-year period, but it is expected that this will occur sooner.

C/A Code GPS Receivers					
Manufacturer	Eagle / Lowrance 800-324-1356 *http://www.lowrance.com*				
Model	GlobalNav 12	GlobalMap 12	GlobalMap 100	GlobalNav 200	GlobalNav 212 / Eagle Explorer II
Picture					
Estimated Price	$185	$600	$425	$200	$255
# of Channels	12	12	12	12	12
Waypoint Storage	250	250	750	250	1000
Trip Odometer	yes	yes	yes	~	yes
NMEA Interface	0180, 0183	0180, 0183	0180, 0183	0183	0180, 0183
Receiver Size (mm)	171 x 57 x 41	199 x 86 x 46	171 x 57 x 41	171 x 57 x 41	171 x 57 x 41
Weight (kg)	0.34	0.43	0.43	0.34	0.34
Backlighting	yes	yes	yes	yes	yes
Display Size (mm)	36 x 53		36 x 53	36 x 53	36 x 53
Battery	6 AA, NiMH opt.		4 AA	4 AA	4 AA
Antenna Type	patch	patch	patch	patch	patch

C/A Code GPS Receivers					
Manufacturer	Garmin Corporation *http://www.garmin.com*				
Model	GPS 12 / 12 XL	GPS 12CX	GPS II / GPS II Plus	GPS III / GPS III Plus	GPS 38
Picture					
Estimated Price	$150 - $239	$260	$239	$295 / $370	$232
# of Channels	12	12	12	12	8
Waypoint Storage	500	1000	500	500	250
Trip Odometer	yes	yes	yes	yes	yes
NMEA Interface	0180, 0182, 0183	0180, 0183	0180, 0182, 0183	0183	0180, 0182, 0183
Receiver Size (mm)	150 x 53 x 31	150 x 53 x 31	50 x 232 x 16	58 x 210 x 12	156 x 51 x 31
Weight (kg)	0.27	0.27	0.27	0.27	0.26
Backlighting	yes	yes	yes	yes	yes
Display Size (mm)	56 x 38	56 x 38	38 x 56	56 x 38	56 x 38
Battery	4 AA	4 AA	4 AA	4 AA	4 AA
Antenna Type	patch	patch	quadhelix detachable	quadrifilar	patch

C/A Code GPS Receivers					
Manufacturer	Magellan Systems Corporation 800-669-4477 *http://www.ashtech.com*				
Model	GPS Blazer12	GPS 300	2000XL	4000XL	GPS Trakker
Picture					
Estimated Price	$120	$ 100	$ 160	$200	$230
# of Channels	12	12	12	12	12
Waypoint Storage	100	100	200	200	500
Trip Odometer	yes		yes	yes	yes
NMEA Interface	none	none	0183	0183	0183
Receiver Size (mm)	152 x 51 x 33	152 x 51 x 33	168 x 58 x 33	168 x 58 x 33	175 x 64 x 28
Weight (kg)	0.20	0.20	0.28	0.28	0.34
Backlighting	yes	yes	yes	yes	yes
Display Size (g)	36 x 56	36 x 56	36 x 46	36 x 46	70 x 38
Battery	2 AA	2 AA	4 AA	4 AA	4 AA
Antenna	patch	patch	patch	patch	patch

C/A Code GPS Receivers		
Manufacturer	Magellan Systems Corporation 800-669-4477 *http://www.ashtech.com*	
Model	GPS ColorTrak	NAV 6000 GPS
Picture		
Est. Cost	$280	$720
# of Channels	12	12
Waypoint Storage	500	500
Trip Odometer	yes	yes
NMEA Interface	0183	0183
Receiver Size (mm)	171 x 57 x 41	190 x 81 x 43
Weight (kg)	0.34	0.53
Backlighting	yes	yes
Display Size (mm)	70 x 38	70 x 38
Battery	4 AA	6 AA
Antenna	patch	patch

C/A Code GPS Receivers				
Manufacturer	Topcon 800-223-1130 *http://www.topcon.com*			
Model	GPS 48	TURBO-G1	GPSMAP 175	GPS 45/45XL
Picture				
Estimated Price	$255	Under $4,500 with marine beacon receiver	$560	$270
# of Channels	12	8	12	8
Waypoint Storage	500	10,000	250	250
Trip Odometer	yes		yes	yes
NMEA Interface	0183		0180, 0182, 0183	0180, 0182, 0183
Receiver Size (mm)	156 x 51 x 12	190 x 56 x 38	193 x 74 x 53	156 x 51 x 31
Weight (kg)	0.27	0.48	0.64	0.26
Backlighting	yes	yes	yes	yes
Display Size (mm)	56 x 38	40 x 74	104 diagonal	56 x 38
Battery	4 AA	internal, rechargeable 5.2 volt	6 AA	4 AA
Antenna	external quadhelix	detachable	patch	external quadrifilar

Integrated Data Collection Systems				
Model	CMT MARCH-II-E	HP-GPS-L4	MC-GPS	PC5L-GPS
Picture				
Manufacturer	Corvallis MicroTechnology, Inc. 541-752-5456 *http://www.cmtinc.com*			
Estimated Price	$2,800	$9,900	$4,000	$6,000
Type	Handheld	Backpack	Handheld	Handheld
Accuracy	1-5 meter C/A Code 2 cm+2 ppm opt. Carrier Phase	Carrier Phase Differential: 5cm C/A Code Differential: 30-60cm RTCM-104 Differential: 30-60cm	1-3 meter C/A Code 2 cm+2 ppm opt. Carrier Phase	1- 3 meter C/A Code 2 cm+2 ppm opt. Carrier Phase
Weight (kg)	0.9		1.4	1.4
Data Recorder	Integrated GPS/data recorder	CMT handheld	Integrated GPS/data recorder	Integrated GPS/data recorder
GPS Channels	8	12	6	6, optional 8
DGPS / Post Processing	USCG Beacon, Post-process & optional carrier phase	USCG Beacon, Post-process & optional carrier phase	USCG Beacon, Post-process & optional carrier phase	USCG Beacon, Post-process & optional carrier phase
Data Output	ESRI Shapefiles, ArcInfo AutoCAD DXF	ESRI Shapefiles, ArcInfo AutoCAD DXF ASCII	ESRI Shapefiles, ArcInfo AutoCAD DXF ASCII	ESRI Shapefiles, ArcInfo AutoCAD DXF ASCII

Integrated Data Collection Systems				
Model		Reliance PenMap (SCA GPS Sensor)	Reliance Precision	Reliance Submeter
Picture				
Manufacturer	Leica http://www.leica.com	Magellan Corp/Ashtech 408-614-5100 *http://www.ashtech.com*		
Estimated Price	$9,500	$13,000	$11,500 - $14,200	$8,400 - $11,000
Type	Backpack	Backpack	Backpack	Backpack
Accuracy	2	< 1	75 cm instantaneous 1.5 cm > 30 min occupation time	75 cm 2-sec RTCM latency
Weight (kg)	1.4	3.1	1.8	1.8
Data Recorder	Leica MX 8600PC/MX 8610PC	PenMap software on pen-based computer	Philips Mobile Psion or Husky FS/2	Philips Mobile Psion or Husky FS/2
GPS Channels	6 channel	12	12	12
DGPS / Post Processing	USCG Beacon	USCG Beacon, commercial subscription RINEX, Reliance Reference Station, or post processing	USCG Beacon, commercial subscription, Reliance Reference Station, or post processing	USCG Beacon, commercial subscription, Reliance Reference Station, or post processing
Data Output	ArcView, ARC/INFO, Intergraph, and, and AutoCAD.	ArcView, ARC/INFO, Intergraph, Microstation, MOSS and AutoCAD.	ArcView, ARC/INFO, Intergraph, and AutoCAD.	ArcView, ARC/INFO, Intergraph, and AutoCAD.

Integrated Data Collection Systems					
Model	Outrider-DL	R.A.M.	GIR1000	Pathfinder Pro XR/ Pro XRS	GeoExplorer II
Picture					
Manufacturer	NovAtel (sold by Nikon) 888-645-6647 *http://www.nikonusa.com*	Satloc 602-348-9919 *http://www.satloc.com*	Sokkia Corporation 800-476-5542 *http://www.sokkia.com*	Trimble 800-426-3904 *http://www.trimble.com*	
Estimated Price		$4,500	$8,300 - $8,700	$ 10,000 (XR) $ 10,920 (XRS)	$3,000
Type	Backpack	Backpack	Backpack	Backpack	Handheld
Accuracy (m)	< 1	< 1	< 1	2-5	< 1
Weight (kg)		4.5	1.8	0.4	1.6
Data Recorder		User provided	Husky FS/2, Psion HP200 or HP1000cx	Integrated data recorder	Trimble s Asset Survey or data logger or a customer-supplied pen-based notebook
GPS Receiver		12 channel	12 channel	6	12 channel
DGPS / Post Processing	12 channel	Integrated L-Band Differential Receiver	USCG Beacon, Post-process & optional carrier phase	Post-process	USCG Beacon (XR)
Data Output		ArcView, ARC/INFO, Intergraph, and AutoCAD.	ArcView, ARC/INFO, Intergraph, and AutoCAD.	ARC/INFO, AutoCAD, Intergraph, MGE, ERDAS & GRASS	AutoCAD DXF, ESRI Shapefile, TIFF and BMP map image support

DGPS Receivers

Differential GPS or DGPS refers to differentially correcting data while they are received. C/A code GPS receivers can be combined with radio beacon or satellite receivers that collect correction data via radio broadcasts. The US Coast Guard (USCG) has set up network of radio beacons throughout the country that continuously broadcast correction signals; this service is free of charge to the general population. Radio beacon coverage is constantly being upgraded and the USCG provide up to date status of its beacon sites on their Internet site at *http://www.navcen.uscg.mil/ADO/DgpsSelectStatus.asp.*

Several companies also provide correction services either by radio beacon or satellite. Private radio beacon correction services have a limited coverage that tends to concentrate around large urban areas, where the service providers have the most customers. Satellite correction services generally offer coverage throughout the United States. A wider coverage is obtained because radio signals containing correction data are broadcast from ground base stations up to a series of geosynchronous satellites that rebroadcast the signals back down to earth.

Most DGPS receivers contain both the radio and GPS receivers in the same box, which is either carried in a backpack or mounted in a vehicle. Several products act only as a radio beacon receiver and must be used in conjunction with an existing GPS receiver.

DGPS Receivers					
Manufacturer	Ashtech 408-524-1400 *http://www.ashtech.com*	Communication Systems International Inc. (CSI) 403-259-8311 *http://www.csi-dgps.com*			
Photo					
Model	Z-Surveyor	ABX	MBX	GBX	LGBX
Correction Type	beacon	beacon	beacon	beacon	beacon/satellite
Correction Service	USCG	CSI	CSI	CSI	CSI/Omnistar
GPS Engine	Ashtech Z-12	none	none	Ashtech G-L12	Ashtech G-12L
GPS Channels	12	N/A	N/A	8-12	12
Size (mm)	76 x 185 x 210	150 x 125 x 51	150 x 125 x 51	150 x 125 x 51	242 x 125 x 51
Weight (kg)	1.7	0.54		0.64	1.1
Receiver Price				$1,620-$3,060	
Service Price	$0				
Accuracy	<1 m	N/A	N/A	2-5m	1-3m
Power Req.	10 - 28 VDC				9-16 VDC

DGPS Receivers				
Manufacturer	Cue Co. (Accqpoint) 800 858-8828 *http://www.accqpoint.com/equipment.htm*	Differential Corrections Inc. (DCI) 800-446-0015 *http://www.dgps.com/products.htm*		Leica *http://www.leica.com*
Photo				
Model	DataReceiver	RDS-1000	RDS-3000	MX8600
Correction Type	beacon	beacon	beacon	beacon
Correction Service	Accqpoint	DCI	DCI	Leica
GPS Engine	none	none	none	
GPS Channels	N/A	N/A	N/A	12
Receiver Size (mm)	121 x 61 x 21	104 x 63 x 22		
Weight (kg)	0.20	0.16		
Receiver Price	$405	$375	$375	
Service Price	$810	$250 (5m service)	$250 (5m service)	
Accuracy	N/A	N/A	N/A	<1m
Power Req.	6 - 32 VDC	1.5 VDC	9-32 VDC	

DGPS Receivers						
Manufacturer	OmniSTAR, Inc. 8200 Westglen, Houston, TX 77063 1-888-OMNISTAR *http://www.omnistar.com*				Racal 3624 Westchase Drive, Houston, TX 77042 - 713-784-4482 *http://www.racal-landstar.com*	
Photo			Same as 3000LR	Same as 3000LR		Same as Navigator
Model	7000L	3000LR	3000LR-8	3000LR-12	Landstar Navigator	Landstar Surveyor
Correction Type	satellite	satellite	satellite	satellite	satellite	satellite
Correction Service	Omnistar	Omnistar	Omnistar	Omnistar	Racal	Racal
GPS Engine	Trimble SK8	none	Trimble SK8	Ashtech G-12L	Trimble SK8	Ashtech G-12L
GPS Channels	8	N/A	8	12	8	12
Receiver Size (mm)	191dia. x 114 ht.	227 x 162 x 62			185 x 105 x 60	185 x 105 x 60
Weight (kg)	0.97	1.5			0.75	0.75
Receiver Price	$3,420*	$3,060*	$3,420*	$5,212*	$5,045*	$5,980*
Service Price	$800	$800	$800	$800	$800	$800
Accuracy	1-3m	N/A			<2m	<1m
Power Req.	8-16 VDC				9-36 VDC	9-36 VDC

*Includes one year subscription

DGPS Receivers					
Manufacturer	Satloc, Inc. 602-348-9919 *http://www.satloc.com*		Starlink 800-460-2167 *http://www.starlinkdgps.com*		
Photo		Same as SL2000			
Model	SL2000	SL3000	Invicta 210A	DNAV212G	MRB2-A
Correction Type	satellite	satellite	beacon	beacon/satellite	beacon
Correction Service	Satloc	Satloc	USCG	USCG/Omnistar	USCG
GPS Engine			Ashtech	Ashtech	none
GPS Channels	8	10	10	12	N/A
Receiver Size (mm)	290 x 231 x 46	290 x 231 x 46	170 x 130 x 44	211 x 145 x 53	53.3 x 144.8 x 210.8
Weight (kg)	2.3	2.3	0.57	1.4	0.59
Receiver Price				$8,000	$2,495
Service Price	$800	$800			
Accuracy	<3m	<1m	<1m	<1m	N/A
Power Req.	9.8 - 35 VDC	9.8 - 35 VDC	11-32 VDC	11 to 32 VDC	11-32 VDC

DGPS Receivers		
Manufacturer	Trimble *http://www.trimble.com*	
Photo		
Model	AgGPS 132	AgGPS 122
Correction Type	beacon/satellite	beacon
Correction Service	USCG/Racal,Omnistar	USCG
GPS Engine	Trimble Scorpion	Trimble Maxwell
GPS Channels	12	8
Receiver Size (mm)	145 x 51 x 195	145 x 51 x 195
Weight (kg)	0.76	0.76
Receiver Price	$3,995	$2,995
Service Price	$0/$800	$0
Accuracy	<1m	<1m
Power Req.	10 to 32 VDC	10 to 32 VDC

P (Precision) Code Receivers

Inexpensive and compact P coded GPS receivers are available for use by the Forest Service and other government agencies. These units will remove the effects of SA, but units must be re-keyed annually by MTDC to decrypt the P code broadcast made by DOD navigation satellites. The latest receivers have been shown to be effective under forest canopy conditions, and now produce real-time accuracy s adequate for the majority of USDA Forest Service resource mapping needs. For additional information, contact Bill Kilroy at MTDC (406-329-3925).

PPS-P Code GPS Receivers		
Manufacturer	Rockwell Collins 800-321-2223 *http://www.collins.rockwell.com*	Trimble Navigation, Ltd. 800-874-6253 *http://www.trimble.com*
Picture		
Model	PLGR+96	Centurion
Price	$2,125	$5,450
GPS Channels	5	6
Size (mm)	240 x 133 x 66	211 x 187 x 63
Weight (kg)		1.5
Accuracy	< 8 m with WAGE	< 5 m
Power Req.	9 - 32 VDC	9 - 32 VDC

Hand-held Computers (H/PC's)

Hand-held computers, or H/PC s are rapidly gaining popularity for mobile computing tasks. There are two types covered by this guide, palmtop tablet-style, and clamshell style. Both types are very light weight, and batteries (usually readily available AA or AAA) last an entire day rather than several hours on their larger pen-based counterparts. The devices with monochrome screens are easily visible in sunlight, and most contain backlighting for viewing under poorly lit conditions.

Windows CE, a 32-bit scaled down version of the Windows operating system found on desktop PC s runs on many of the hand-held computers on the market. Applications running under the Windows CE operating system may be rapidly developed to take advantage of its modern GUI (Graphical User Interface) features. Several data collection applications designed specifically for H/PC s are listed in the table.

The pocket-sized palm computers, sometimes referred to as Personal Digital Assistants (PDA s) rely on a stylus or pen (see pen-based computers) for user input, and do not contain a physical keyboard, although most contain an on-screen keyboard. Hand writing recognition software interprets characters entered into text, and makes up for the lack of a keyboard.

Clamshell style computers contain a display and a small keyboard that fold together in a style similar to a notebook computer. Some contain screen digitizers similar to those found on palm computers.

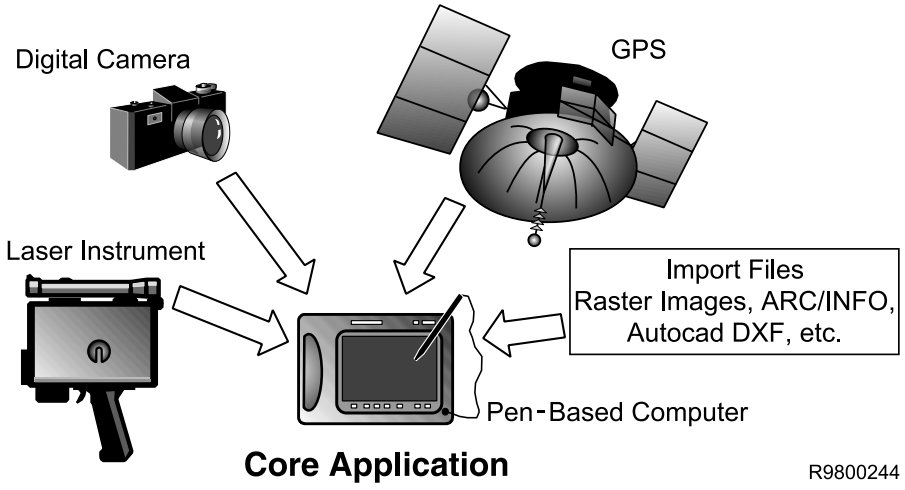
Although originally designed for consumer applications, most H/PC s offer the versatility, power, and memory to allow them to act as reliable field data recorders. Harsh environment cases that are now available for some models help overcome their vulnerability to moisture damage. Photos for this group begin on page 18.

Ruggedized Data Recorders

Ruggedized data recorders have been around for years. MS-DOS is the primary operating system on most of these devices, although some contain a proprietary operating system. Photos for this group begin on page 26.

Pen-Based Computers

Computer hardware has gone through remarkable changes in recent years. Smaller size, increased processor power, increased storage capacity and decreased cost are some of the technological changes that have taken place. Computer history tells us that the trends will continue, with more manufacturers producing low cost, ruggedized computers capable of meeting the demands of Forest Service field personnel. Recently, new models of pen-based computers are appearing that offer features that make mobile computing in harsh field conditions possible, while maintaining the functionality of desktop computers. Field ruggedness, compactness, low power consumption and user-friendliness have become the focus of many of the manufacturers.



Components of a real-time pen-based data collection system

A pen computer (or pen-based computer) consists of a flat display containing a digitizer that records the traces of a pen (stylus) in contact with the display surface. The pen is the input device that replaces the traditional mouse and keyboard found on desktop computer systems. The majority of the pen computers on the market use a monochrome liquid crystal display (LCD) and an Intel compatible processor. Processors manufactured by Advanced Micro Devices have become a popular choice by makers of pen computers because of low heat output and decreased power requirements, but these processors do not offer the CPU speed of newer desktops computers. The latest models of pen computers offer Intel Pentium CPUs. Batteries are generally nickel metal hydride or lithium ion, and typically last a maximum of four hours, so it is essential that a sufficient number of batteries be taken along for fieldwork. Photos for this group begin on page 31.

Ruggedized Notebook/Vehicle Mounted Computers

These machines offer features similar to conventional notebook computers with increased shock and vibration protection, resistance to moisture and extreme operating temperatures. Some offer screen digitizers and cradles for vehicle applications. Photos for this group begin on page 39.

Hand-held Computers					
Model		Palm III, IBM Workpad	Newton 2100	Newton 130	Cassiopeia A-20
Picture					
Contact Information		3Com 800-881-7256 *http://www.palmpilot.com/*	Apple Computer Inc. 800-538-9696 *www.newton.apple.com*		Casio 888-204-7765 *http://www.casio.com/*
Est. Price		$299	$1,200	$700	$499
Physical Characteristics	Dimensions (mm)	122 x 81 x 18	210 x 119 x 28	203 x 101 x 30	184 x 94 x 25
	Weight (kg)	0.15	0.64	0.45	0.43
	Screen Size (mm)		150	120	170
	Pixels	240 x 320	480 x 320	320 x 240	640 x 240
	Color / Mono	mono	mono/ 16 Grays	mono	Mono / 4 shades grays
	Backlighting	yes	yes	yes	yes
Performance Characteristics	O/S	Windows CE	Newton	Newton	Windows CE
	CPU	NEC VR4102	StrongARM	ARM RISC	Hitachi SH-3
	Clock Speed (MHz)	54, 66	162	20	80
	STD. RAM (MB)	4,8,16	4	2.5	8
	PCMCIA slots	0	2	1	1
	I/O Ports	serial, IrDA	serial	serial	serial, IrDA

Hand-held Computers					
Model		Cassiopeia E-10/11	Cassiopeia A-10/11	IT-2000	PA-2400
Picture					
Contact Information		Casio 888-204-7765 *http://www.casio.com/*			
Est. Price		$399	$399		$600
Physical Characteristics	Dimensions (mm)	124 x 83 x 19	175 x 92 x 27	85 x 196 x 30	21 x 179 x 107
	Weight (kg)	0.19	0.38	0.43	0.37
	Screen Size (mm)	99	155		
	Pixels	240 x 320	480 x 240	192 x 384	480 x 240
	Color / Mono	Mono / 16 shades gray	4 shades grays	Mono	Mono (4 greyscale)
	Backlighting	yes	yes	yes	yes
Performance Characteristics	O/S	Windows CE	Windows CE	MS-DOS 6.22 / Windows 3.1	Windows CE
	CPU	NEC VR4111	Hitachi SH-3	80486GX	RISC Hitachi SH-3
	Clock Speed (MHz)	66	80		80
	STD. RAM (MB)	4	2/4	4	8
	PCMCIA	1	1	1	1
	I/O Ports	serial, IrDA	serial, IrDA	serial, IrDA	serial, IrDA

Hand-held Computers					
Model		C-Series 2015c	Freestyle Executive A-10/20	Geofox-One Professional	ShirtPocket GeoLink
Picture					
Contact Information		Compaq 800-345-1518 *http://www.compaq.com/*	Everex 877-472-5672 *http:// www.freestyle.everex.com/*	Geofox 888-443-6369 *http://www.geofox.com/*	GeoResearch 406-248-6771 *http://www.georesearch.com*
Est. Price		$649	$499	$799	$2,650 (with GeoLink Software)
Physicall Characteristics	Dimensions (mm)	186 x 100 x 41	122 x 81 x 18	188 x 119 x 19	191 x 178 x 69
	Weight (kg)	0.43	0.15	0.39	0.50
	Screen Size (mm)	165	102	81 x 155	190
	Pixels	640 x 240	240 x 320	640 x 320	640 x 200
	Color / Mono	4 grays - 256 color	Mono / 4 shades gray	Mono / 16 shades gray	mono
	Backlighting	yes	yes	no	yes
Performance Characteristics	O/S	Windows CE	Windows CE	Windows CE	MS-DOS 5.0
	CPU	MIPS-based RISC	NEC VR4111	ARM-7 CL-PS7110	386-SXLV
	Clock Speed (MHz)	75	66	18	25
	STD. RAM (MB)	20	8	16	4
	PCMCIA slots	1	0	0	2
	I/O Ports	serial, IrDA	serial, IrDA	serial, IrDA	serial, parallel

Hand-held Computers					
Model		360LX	620/660LX	Jornada 820	200 LX
Picture					
Contact Information		Hewlett Packard 800-443-1254 *http://www.hp.com*			
Est. Price		$549	$699/$799	$ 950	$499- $599
Physical Characteristics	Dimensions (mm)	178 x 91 x 25	198 x 104 x 33	246 x 178 x 33	160 x 86 x 25
	Weight (kg)	0.44	0.59	1.1	0.31
	Screen Size (mm)	170	170	210	
	Pixels	640 x 240	640 x 240	640 x 480	640 x 200
	Color / Mono	Mono / 16 shades gray	256 color	256 colors	mono
	Backlighting	yes	yes	yes	yes
Performance Characteristics	O/S	Windows CE	Windows CE	Windows CE	MS DOS 5.0
	CPU	RISC Hitachi SH3	RISC Hitachi SH3	32-bit StrongARM RISC	Intel 80 C186
	Clock Speed (MHz)	60	75	190	7.91
	STD. RAM (MB)	8	16/32	16 - 32	2- 4
	PCMCIA slots	1	1	1	0
	I/O Ports	IrDA	serial, IrDA	serial , IrDA, USB	serial

Hand-held Computers						
Model		HPW 200EC	Pen Key 6100 / 6110	Pen Key 6300	T5200	Phenom Express
Picture						
Contact Information		Hitachi America, Ltd. 800-225-1741 *http://www.hitachi-hpc.com*	Intermec Corp. 425-348-2600 *http://www.intermec.com*		Itronix Corporation 509-742-1237 *http://www.itronix.com*	LG Electronics Inc. 800-243-0000 *http://www.lgphenom.com*
Est. Price		$470				$549
Physical Characteristics	Dimensions (mm)	253 x 131 x 32	112 x 206 x 58	127 x 227 x 38		236 x 150 x 25
	Weight (kg)	0.43	0.62/0.80	1.1		0.82
	Screen Size (mm)	206	121 / 126		185	206
	Pixels	640 x 240	240 x 320	320 x 480	640 x 240	640 x 240
	Color / Mono	256 Colors	Mono	16 gray	Mono	256 color
	Backlighting	yes	yes	yes	yes	yes
Performance Characteristics	O/S	Windows CE	Windows with Pen Extensions	Windows with Pen Extensions	Windows CE	Windows CE
	CPU	RISC Hitachi SH-3	AMD 386 /AMD 486	386SL, 486SL, or 486SL	MIPS	Hitachi 32-bit Super HTM RISC
	Clock Speed (MHz)	100	33 or 100	25 - 50	75	100
	STD. RAM (MB)	16 - 32	2 - 16	2	16	32
	PCMCIA slots	1	2	2	2	1
	I/O Ports	serial, IrDA	IrDA , serial, LAN	IrDA , serial, LAN	serial, IrDA	serial, IrDA

Hand-held Computers				
Model		Phenom Ultra	Mobile Pro 770	Novatel Wireless
Picture				
Contact Information		LG Electronics Inc. 800-243-0000 *http://www.lgphenom.com*	NEC 508-264-8000 *http://www.necnow.com*	Novatel Wireless 602-609-1616 *http://www.novatelwireless.com*
Est. Price		$899	$749	
Physical Characteristics	Dimensions (mm)	254 x 127 x 30	244 x 132 x 28	197 x 127 x 32
	Weight (kg)	0.85	0.77	0.62
	Screen Size (mm)	206	206	183
	Pixels	640 x 240	640 x 240	640 x 240
	Color / Mono	256 color	64K color	Mono
	Backlighting	yes	yes	yes
Performance Characteristics	O/S	Windows CE	Windows CE	Windows CE
	CPU	32 Bit RISC Hitachi SH3	NEC VR4121 MIPS	Hitachi SH3
	Clock Speed (MHz)	100	131	80
	STD. RAM (MB)	16	32	8
	PCMCIA slots	1	2	1
	I/O Ports	serial, IrDA	serial, IrDA	serial, IrDA, VGA

Hand-held Computers					
Model		Velo 500	Nino 312	Series 5	Mobilon HC-4100
Picture					
Contact Information		Philips Electronics 888-367-8356 *http://www.nino.philips.com*		Psion 800-997-7466 *http://www.psion.com*	Sharp Electronics Corp. 800-237-4277 *http://www.sharp-usa.com*
Est. Price		$599	$459	$519	$499
Physical Characteristics	Dimensions (mm)	96 x 173 x 25	88 x 170 x 23		185 x 94 x 25
	Weight (kg)	0.43	0.36	0.22	0.40
	Screen Size (mm)	160	142	183	165
	Pixels	640 x 240	640 x 240	240 x 320	640 x 240
	Color / Mono	mono / 16 shades gray	mono	mono	mono / 16 shades gray
	Backlighting	yes	yes	yes	yes
Performance Characteristics	O/S	Windows CE	Psion EPOC32	Windows CE	Windows CE
	CPU	Philips PR31700	RISC ARM 7100	Philips R3910-32 bit	MIPS RISC
	Clock Speed (MHz)	75	28		75
	STD. RAM (MB)	16	8	8MB	12
	PCMCIA slots	0	0	0	1
	I/O Ports	serial, IrDA	serial, IrDA	serial, IrDA	serial, IrDA

Hand-held Computers						
Model		Mobilon HC-4500/4600	PPT 4100	C2000 Series	PC100/100A	FeX21
Picture						
Contact Information		Sharp Electronics Corp. 800-237-4277 *http://www.sharp-usa.com*	Symbol Technologies	Trogon Computer Corp. 888-487-6466 *http://palmpower.trogoncomputer.com/*	Uniden 888-686-4336 *http://www.uniden.com*	WPI Husky America 727-536-9906 *http://www.huskyinc.com*
Est. Price		$649			$285-$350	$1,899
Physical Characteristics	Dimensions (mm)	210 x 102 x 34	185 x 94 x 30	199 x 81 x 18		191 x 155 x 38
	Weight (kg)	0.47	0.40	0.17		0.74
	Screen Size (mm)	140 x 74	165	104		165
	Pixels	640 x 200	640 x 240	160 x 160	240x320	640 x 240
	Color / Mono	mono	256 color	mono	mono	mono
	Backlighting	Optional	yes	yes	yes	yes
Performance Characteristics	O/S	DOS 5.0	Windows CE	Palm OS	Windows CE	Windows CE
	CPU	F8680A	MIPS RISC	Motorola DragonBall 68328	Philips PR31700	MIPS
	Clock Speed (MHz)	14	75		75	75
	STD. RAM (MB)	1	16	2	4-8	16
	PCMCIA slots	2	1	0	0	2
	I/O Ports	serial	serial, IrDA	serial	serial, IrDA	serial, IrDA

Ruggedized Data Recorders			
Model		MC Series	PC5-L
Picture			
Contact Information		Corvallis MicroTechnology, Inc. 541-752-5456 *http://www.cmtinc.com*	
Est. Price		$1,150 - $1,650	$2,200
Physical Characteristics	Dimensions (mm)	240 x 103 x 50	240 x 103 x 50
	Weight (kg)	0.80	0.82
	Screen Size (mm)		
	Pixels	8 lines x 21 characters	16 lines x 25 characters
	Color / Mono	mono	mono
	Backlighting	yes	yes
Performance Characteristics	O/S	CMT ROSII or CMT-DOS	DOS 5.0
	CPU	CMOS 80C88	
	Clock Speed (MHz)	5 - 10	5 - 10
	STD. RAM (MB)	1- 8	4 - 8
	PCMCIA slots	~	1
	I/O Ports	serial	serial

Ruggedized Data Recorders				
Model		PC9200	PC9400/9500	PC9800
Picture				
Contact Information		DAP Technologies *http://www.dapdech.com*		
Est. Price				
Physical Characteristics	Dimensions (mm)			
	Weight (kg)			
	Screen Size (mm)			
	Pixels	240 x 160	200 x 200	200 x 200
	Color / Mono	mono	mono	mono
	Backlighting	Yes	Yes	Yes
Performance Characteristics	O/S	MS-DOS	MS-DOS/Windows	MS-DOS / Windows
	CPU		386	386
	Clock Speed (MHz)			
	STD. RAM (MB)			
	PCMCIA slots	0	1 (PC9500)	1
	I/O Ports	serial, IrDA	serial, IrDA	serial, IrDA

Ruggedized Data Recorders				
Model		Pen Key 6210		Workabout MX
Picture				
Contact Information		Intermec Corp. *http://www.intermec.com*	Juniper Systems, Inc. 435-753-1714 *http://www.junipersys.com/*	Psion 800-997-7466 *http://www.psion.com*
Estimated Price		~ $,2500		$695 - $895
Physical Characteristics	Dimensions (mm)	24.13 x 8.38 x 7.11	273 x 109 x 48	189 x 92 x 35
	Weight (kg)	0.85	1.1	0.33
	Screen Size (mm)			37 x 66
	Pixels	160 x 200	192 x 128	240 x 100
	Color / Mono	mono / 16 shades gray	mono	mono
	Backlighting		yes	yes
Performance Characteristics	O/S	MS-DOS 5.0	DOS 6.0	EPOC/16
	CPU	80386	80C286	16 bit NEC V30MX
	Clock Speed (MHz)	25	16	27.684
	STD. RAM (MB)	4	1	2
	PCMCIA slots	2	1	0
	I/O Ports	serial, LAN	serial, optional parallel	serial

Ruggedized Data Recorders				
Model		PDT 3200	PDT 3400	Husky FS/MP2500
Picture				
Contact Information		Symbol Technologies, Inc. 1-800-722-6234 *http://www.symbol.com*		WPI Husky America 727-536-9906 *http://www.huskyinc.com*
Est. Price				$1,998
Physical Characteristics	Dimensions (mm)	208 x 38 x 89	58 x 86 x 259	242 x 132 x 44, 74 at handgrip
	Weight (kg)	0.47	0.59	0.70
	Screen Size (mm)			
	Pixels	128 x 64	8-line x 20 char.	240 x 64
	Color / Mono	mono	mono	mono
	Backlighting	yes	yes	yes
Performance Characteristics	O/S	DOS 6.22	DOS 6.22	MS-DOS v6.22
	CPU	AMD Am386	80186	Intel 386EX
	Clock Speed (MHz)	25	16	8
	STD. RAM (MB)	3	0.5	2
	PCMCIA slots	1	2	0
	I/O Ports	serial	serial, IrDA	serial

Ruggedized Data Recorders				
Model		Husky FS/2	Husky FS/3	Husky FS/GS
Picture				
Contact Information		WPI Husky America 727-536-9906 *http://www.huskyinc.com*		
Est. Price		~ $3,200	~ $4,800	~ $3,000
Physical Characteristics	Dimensions (mm)	236 x 128 x 43, 71 at handgrip	236 x128 x 43, 71 at handgrip	236 x128 x 43, 71 at handgrip
	Weight (kg)	0.75	0.85	0.70
	Screen Size (mm)			
	Pixels	240 x 64	240 x 64	240 x 64
	Color / Mono	mono	mono	mono
	Backlighting	yes	yes	yes
Performance Characteristics	O/S	MS-DOS v 3.3	MS-DOS v6.22	MS-DOS v3.3
	CPU	NEC V25+	Intel 386EX	NEC V25+
	Clock Speed (MHz)	8	8	8
	STD. RAM (MB)	1	2	1
	PCMCIA slots	0	1	0
	I/O Ports	serial	serial, parallel, IrDA	serial

Pen-Based Computers				
Model		Orasis	Point 510	Stylistic 1200
Picture				
Contact Information		Dauphin Technology, Inc. 847-358-4406 *http://www.dauphintech.com*	Fujitsu 800-831-3183 *http://www.fpsi.fujitsu.com*	
Estimated Price		$2,900	$3,700 (wireless LAN)	$3,400 $5,500 (color)
Physical Characteristics	Dimensions (mm)	267 x 175 x 41	297 x 221 x 36	283 x 188 x 41
	Weight (kg)	1.4	1.7	1.8
	Screen Size	188	264	197 - 200
	Pixels	640x480	800 x 600	640 x 480
	Color / Mono	Color	256 Colors	TFT Color
	Backlighting	yes	yes	yes
Performance Characteristics	O/S	Windows 95 or NT	Windows 95	Windows 95 or NT
	CPU	Pentium MMX	5x86	Pentium
	Clock Speed (MHz)	133, 150, 166, 200 or 233	100	120
	STD. RAM (MB)	16 - 80	8 - 32	16 - 48
	PCMCIA slots	2	0	optional
	I/O Ports	serial, parallel	LAN	serial, parallel, IrDA

Pen-Based Computers				
Model		Point 510	Stylistic 2300	Point 1600
Picture				
Contact Information		Fujitsu (800) 831-3183 *http://www.fpsi.fujitsu.com*		
Estimated Price		$2,900	$4,485	$3,375
Physical Characteristics	Dimensions (mm)	296 x 222 x 36	283 x 188 x 41	296 x 222 x 36
	Weight (kg)	1.7	1.8	1.8
	Screen Size	264	213	264
	Pixels	800 x 600	800 x 600	800 x 600
	Color / Mono	256 colors	4 k color	65 k color
	Backlighting	Yes	Transreflective	N/A
Performance Characteristics	O/S	Windows 95/98	Windows 95/98 or NT	Windows 95/98
	CPU	5x86	Pentium MMX	Pentium MMX
	Clock Speed (MHz)	100	233	166
	STD. RAM (MB)	8 - 56	32 - 96	32 - 96
	PCMCIA slots	1	2	1
	I/O Ports	IrDA, serial, parallel	IrDA, serial, parallel	IrDA, serial

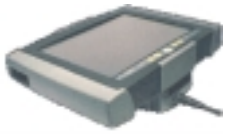
Pen-Based Computers				
Model		Pen Key 6600	Pen Key 6620	Pen Key 6632
Picture				
Contact Information		Intermec Corp. 425-348-2600 *http://www.intermec.com*		
Estimated Price			$5,005	$3,635
Physical Characteristics	Dimensions (mm)	254 x 216 x 53	277 x 267 x 108	263 x 179 x 39
	Weight (kg)		2.3	
	Screen Size		213	213
	Pixels	640 x 480	640 x 480	640 x 480
	Color / Mono	Mono	Both	Active Matrix Color
	Backlighting	yes	yes	N/A
Performance Characteristics	O/S	Windows 95	Windows 95	Windows 95
	CPU	486DX2	AMD 5X86	Pentium
	Clock Speed (MHz)	50	133	120
	STD. RAM (MB)	2	16 - 32	16 - 48
	PCMCIA slots	2	2 - 3	2
	I/O Ports	serial, IrDA (opt) & LAN	serial, parallel, IrDA	serial, parallel, IrDA

Pen-Based Computers					
Model		Trakker Adara 2070 / 2075	500P/ 500V	Condor	Condor
Picture					
Contact Information		Intermec Corp. 425-348-2600 *http://www.intermec.com*	Microslate 450-444-3680 *http://www.microslate.com*	Phoenix Group, Inc. 516-951-2700 *http://ivpgi.com/*	
Estimated Price		$2,296 - $2,812	$3,497	$5,995	$18,500
Physical Characteristics	Dimensions (mm)	246 x 165 x 46	320 x 254 x 66	267 x 203 x 86	81 x 292 x 229 (CPU) 43 x 292 x 229 D (display)
	Weight (kg)		2.7	3.2	9.1
	Screen Size (mm)	190	239	216	264
	Pixels	640 x 480	640 x 480	640 x 480	800 x 600
	Color / Mono	Transreflective mono	TFT Color	16M color	16M color
	Backlighting	yes	yes		
Performance Characteristics	O/S	Windows 95	Windows 95 / 98	Windows 95	Windows 95
	CPU	486-DX4	Pentium	AMD 5x86	Dual Pentium Pro s
	Clock Speed (MHz)	100	133 - 233	133	200
	STD. RAM (MB)	8 - 24	8 - 32	16	
	PCMCIA	2	2	4	4
	I/O Ports	serial, parallel, IrDA	serial	serial, parallel, IrDA	USB, SCSI, serial, parallel

Pen-Based Computers					
Model		Excaliber	PPT 4300	PPT 4500	PPT 4600
Picture					
Contact Information		Satloc 602-348-9919 *http://www.satloc.com*	Symbol Technologies, Inc. 1-800-722-6234 *http://www.symbol.com*		
Estimated Price		$4,450			
Physical Characteristics	Dimensions (mm)	279 x 203 x 38	272 x 206 x 64	210 x 150 x 35	137 x 244 x 90 / 224 x 244 x 90
	Weight (kg)	1.8	1.3	0.85	0.85 / 1.0
	Screen Size (mm)	239	182	182	142 / 198
	Pixels		640 x 480	640 x 480	320 x 480 / 640 x 480
	Color / Mono	Transreflective mono	256 color	256 color	16 grey
	Backlighting	yes			yes
Performance Characteristics	O/S	Windows 95	DOS, Windows	Windows 95	DOS, Windows for Pen Computing
	CPU	Cyrix 5x86	AMD Elan SC300	486DX4	486
	Clock Speed (MHz)	100	33	100	25 or 50
	STD. RAM (MB)	16 - 32	16	16	2
	PCMCIA slots		2	2	2
	I/O Ports	serial, parallel	IrDA, serial	IrDA, radio	IrDA, serial, radio

Pen-Based Computers					
Model		PPT 4631	PTC-1194	PTC 1124	PTC-1134
Picture					
Contact Information		Symbol Technologies, Inc. 1-800-722-6234 *http://www.symbol.com*	Telxon Corp 800-800-8008 *http://www.telxon.com*	Telxon Corp 800-800-8008 *http://www.telxon.com*	
Estimated Price			~$ 7,000		
Physical Characteristics	Dimensions (mm)	137 x 244 x 90 / 224 x 244 x 90	314 x 221 x 39	193 x 114 x 48	213 x 137 x 56
	Weight (kg)	0.85 / 1.0	2.3	0.70	1.0
	Screen Size (mm)	142 / 198	264	119	152
	Pixels	320 x 480 / 640 x 480	800 x 600	320 x 240	640 x 480
	Color / Mono	16 grey	mono / 64 gray	Mono / 64 gray	Mono / 64 gray
	Backlighting	yes	yes	yes	yes
Performance Characteristics	O/S	DOS	Windows 95, Sun Java PC	Java	Windows 95/98
	CPU	486 SLC	Pentium	RISC	486SLC
	Clock Speed (MHz)	20	133		50
	STD. RAM (MB)	2	16 - 80		4 - 12
	PCMCIA	1	2	1	1
	I/O Ports	IrDA, serial, radio	serial, IrDA , RJ-11, USB		serial, IrDA , RJ-11

Pen-Based Computers					
Model		PTC-1144	PTC-1184 / 1184DX	Hammerhead P133	Hammerhead P233
Picture					
Contact Information		Telxon Corp 800-800-8008 *http://www.telxon.com*		WalkAbout Computers, Inc. 614-882-0015 *http://www.walkaboutcomp.com*	
Estimated Price					
Physical Characteristics	Dimensions (mm)	220 x 150 x 38	311 x 241 x 51	279 x 197 x 38	279 x 197 x 38
	Weight (kg)	1.5	2.3		2.0
	Screen Size (mm)	178	241		241
	Pixels	640 x 480	640 x 480		640 x 480
	Color / BW	Mono / 64 gray	Mono / 64 gray	Transflective LCD Mono	Transflective LCD Mono
	Backlighting	yes	yes	yes	yes
Performance Characteristics	O/S	Windows 95/98	Windows 95/98	Windows 95	Windows 95
	CPU	486SLC		Pentium	Pentium
	Clock Speed (MHz)	50		133	233, 266
	STD. RAM (MB)	4 - 12	8 - 32	8 - 32	32
	PCMCIA slots	1	2		2
	I/O Ports	serial, IrDA , RJ-11	serial, IrDA , RJ-11		serial, IrDA

Pen-Based Computers				
Model		FC-486 / FC-486P	FC-PX5	GeneSys 133
Picture				
Contact Information		WPI Husky 727-530-4141 *http://www.huskyinc.com*		Xplore Technologies 512-491-0544 *http://www.xploretech.com*
Estimated Price			$7,506	
Physical Characteristics	Dimensions (mm)	280 x 214 x43	280 x 214 x 43	305 x 229 x 38
	Weight (kg)	2.0	2.2	2.6
	Screen Size (mm)			264
	Pixels	640 x 480	640 x 480	800 x 600 (color) 640 x 480 (mono)
	Color / Mono	Mono	Mono / 64 gray	color / mono
	Backlighting	yes	yes	yes
Performance Characteristics	O/S	Windows for pen computing	Windows 3.1,95	Windows 95
	CPU	80486SLC	AMD Am5x86	Pentium
	Clock Speed (MHz)	25	133	133
	STD. RAM (MB)	2	8	8
	PCMCIA slots	1	4	Optional 2
	I/O Ports	serial, parallel	serial	serial, parallel, USB

Ruggedized Notebook/Vehicle Mounted Computers			
Model		Rocky II	Rocky
Picture			
Contact Information		Amrel Systems, Inc. 626-303-6688 *http://www.amrel.com*	
Est. Price		$ 4,100	$ 4,800
Physical Characteristics	Dimensions (mm)	312 x 246 x 62.5	297 x 244 x 65
	Weight (kg)	4.6	
	Screen Size (mm)	307 or 338	264
	Pixels	800 x 600 or 1024 x 768	800 x 600
	Color / Mono	active color	active color
	Backlighting	yes	yes
Performance Characteristics	O/S	Windows 95/98/NT	Windows 95/98/NT
	CPU	Pentium MMX	Pentium
	Clock Speed (MHz)	200 or 233	200
	STD. RAM (MB)	16 - 128	8 - 32
	PCMCIA slots	2	2
	I/O Ports	serial, parallel	serial, parallel

Ruggedized Notebook/Vehicle Mounted Computers					
Model		5000 Series II	7000 Series	Scout	MSL 3000
Picture					
Contact Information		Fieldworks 800-343-5396 *http://www.field-works.com*		Melard Technologies 914-273-4488 *http://www.melard.com*	Microslate 450-444-3680 *http://www.microslate.com*
Est. Price		$5,995	$6,995		
Physical Characteristics	Dimensions (mm)	123 x 129 x 37	384 x 95	71 x 165 x 233	300 x 226 x 74
	Weight (kg)	6.7	6.7	2.5	3.0
	Screen Size (mm)	264	264		239
	Pixels	800 x 600	800 x 600	640 x 480	640 x 480
	Color / Mono	16M color	16M color	color/mono	Mono/64 shades gray
	Backlighting			yes	yes
Performance Characteristics	O/S	Windows 95	Windows 95	Windows 95	Windows 95/98/NT
	CPU	Pentium	AMD K5, Pentium	Intel 486DX4/AMD x5	Pentium MMX
	Clock Speed (MHz)	133, 166, 200	100, 120, 133, 166, 200, 233	100/133	233
	STD. RAM (MB)	16	16	16	16 - 64
	PCMCIA slots	1	1	2	2
	I/O Ports	serial, parallel	serial, parallel	serial, parallel, IrDA	serial, parallel

Ruggedized Notebook/Vehicle Mounted Computers				
		Roadrunner	Argonaut R300	Triton T6
Picture				
Contact Information		Phoenix Group, Inc. 516-951-2700 *http://ivpgi.com/*	Real World Computer Co. 508-394-9581 *http://www.realworld.ccm*	Satloc 602-348-9919 *http://www.satloc.com*
Est. Price		$7,500	$4,150	$5, 575
Physical Characteristics	Dimensions (mm)	301 x 221 x 104	297 x 244 x 65	292 x 211 x 46
	Weight (kg)	3.6		3.2
	Screen Size (mm)	267	264 or 239	239
	Pixels	640 x 480	800 x 600	
	Color / Mono	16M color	active color or mono	active matrix mono
	Backlighting		Transreflective	yes
Performance Characteristics	O/S	Windows 95	Windows 95/98/NT	Windows 95
	CPU	AMD 5x86	Pentium MMX	Cyrix 5x86
	Clock Speed (MHz)	133	166 / 200	135
	STD. RAM (MB)	16	16 - 64	32
	PCMCIA slots	4	2	1
	I/O Ports	serial, parallel,	serial, parallel	serial, parallel

Data Collection/Mapping Software

Most pen-based applications run under a multi-tasking environment such as Microsoft Windows (pen-based computers) or Windows CE (hand-held computers). Some also offer a version for MS-DOS that will run on DOS-based data recorders or hand-held computers.

Most applications offer a visual map display with either manual or automatic panning and zooming that shows data as it is collected. Loading background images onto the map screen such as digital orthographic quadrangles (DOQ) or scanned topographic maps is also possible with several of the applications. Many also offer interfaces to an array of input devices other than just GPS receivers such as laser range finders, total stations, digital cameras and bar-code readers. (See Figure 1 on page 16).

Most software listed in the table on page 43 offers the user the ability to customize it to their particular data collection application. Data dictionaries or database forms can be constructed with GUI (Graphical User Interface) features such as pull down lists and option or radio buttons that allow users to rapidly select attributes using a pen or stylus on a touch-sensitive screen (see section on pen-based computers on page 31).

Real-time mapping and data capture software is currently under field evaluation by SDTDC. Not all features of this type of software have been determined at the time of printing this guide pending results of the field evaluation. Those interested are asked to check the SDTDC FSWeb site for the most current information and test results.

Field Mapping / Data Collection Software					
Product & Company	Price	Platforms	Input Devices	File Import/Export Formats	Other Features
***Aspen** Trimble Navigation, Ltd. 800-874-6253 *http://www.trimble.com*	$2,495	Windows 3.1/95/98 (16-bit) Windows for Pen Computing (16-bit)	GPS, LRF, camera, other external sensors	Trimble SSF, ESRI Shapefile and dBase with use of Pathfinder Office software, raster background maps	Data dictionary editor included. Only supports Trimble GPS hardware
Composer Amadeus Consulting Group 303-494-2695 *http://www.composerdc.com*		Windows CE	GPS, LRF, bar code scanner		
***Conic Capture** Conic Systems, Inc. 210-832-0100 *http://www.conic.com*	$2,100	Windows 95/98/NT (32-bit)	GPS, LRF	ESRI Shape	Visual Basic API included, form generator available
DynaMo-GIS GeoFocus 800-388-4724 *http://www.gfocus.com*		Windows 95/98/NT (32-bit)	GPS (Trimble only)	ESRI Shape	
***FieldSmart** MapFrame Corporation 214-741-2264 *http://www.mapframe.com*	$1,800	Windows 95/98/NT (32-bit)			Input commands via pen gestures. Red lining capability.
***FieldTools** Penmetrics, Inc. (Tripod Data Systems) 503-827-3848 *http://www.penmetrics.com*	$1,990	Windows 3.1/95/98 (16-bit) Windows 95/98/NT (32-bit)	GPS, LRF, camera	AutoCAD DXF, DWG, MapInfo, ESRI Shapefile, dBase, ASCII text. MapInfo, ODBC, FoxPro, Paradox, Oracle, Informix, Sybase and raster background maps	Input commands via pen gestures and customizable toolbar buttons. Include handwriting recognition. Visual Basic or C/C++ API development kit available
FieldWorker Data FieldWorker Products, Ltd. 416-483-3485 *http://www.fieldworker.com*	$699	Apple Newton Windows CE Java	GPS	ASCII	Includes ArcView macros to import data.
Geo'corder GeoSurv, Inc. 613-820-4545 *http://www.geosurv.com*	*$2,382	Runs on Psion handheld data recorder only (16-bit)	GPS		Database form designer included *Price includes Psion Workabout handheld computer with integrated GPS reciever

*Currently under field evaluation by SDTDC

Field Mapping / Data Collection Software					
Product & Company	Price	Platforms	Input Devices	File Import/Export Formats	Other Features
***GeoLink Powermap** GeoResearch 406-248-6771 *http://www.georesearch.com*	$995	MS-DOS Windows 95/98/NT (32-bit)	GPS, LRF, camera, video, other external sensors	AutoCAD DXF, ESRI Shapefile, Dbase, ODBC and raster background maps	Owns a patent on the technology. Rockwell PLGR GPS Interface Available
GPS-Map Integrated GPS Technologies 800-780-8090 *http://www.gpsgis.com*	$500	ArcView	GPS, Windows DDE		Operates within ArcView.
GPS-Pro Map MPN Components 888-477-7761 *http://www.gpspro.com*		32-bit	GPS	ESRI Shape, AutoCAD DWG and DXF, and MapInfo, ASCII	GPS Receiver Interface, Raster Images
GPS-Map Integrated GPS Technologies 800-780-8090 *http://www.gpsgis.com*	$500				
LTI Map Laser Technology, Inc. 303-649-1000 *http://www.lasertech.com*	$795	MS-DOS (16-bit)	GPS, LRF		Uses office-based mapping software for post-processing data for GIS.
***Penmap** Condor Earth Technologies 209-532-0361 *http://www.condorearth.com*	$1,495	Windows 3.1/95/98 (16-bit)	GPS, LRF, total station, camera, bar code scanner	ESRI Shapefile, AutoCAD DXF, dBase, ASCII text, raster background maps	Digital Terrain Modeling (DTM) and volume calculations included Rockwell PLGR GPS interface available
Solo Tripod Data Systems 800-426-8026 *http://www.tdsway.com*	$1,000	MS-DOS (16-bit) Windows CE	GPS, LRF	ESRI Shape, AutoCAD DXF, MapInfo	Uses office-based mapping software for post-processing data for GIS.
VoCarta Datria Systems, Inc. 303-645-9300 *http://www.datria.com*		ArcView	GPS, LRF		Offers impressive interface for data capture using voice recognition technology.

Georeferenced Raster Maps

Georeferenced Raster Maps				
Company and Product	Scales	Type	Media	Price
Maptech 800-627-7236 *http://www.maptech.com*	1:24,000 1:100,000	DRG	CD-ROM	$295-$975
QuadsUSA, Inc. 888-288-7823 *http://www.quadsusa.com*	1:24,000 1:100,000 1:250,000	DRG	CD-ROM	
Sure!Maps RASTER Horizons Technology 800-828-3808 *http://www.horizons.com/suremaps*	1:24,000 1:100,000 1:250,000	DRG	CD-ROM Internet	$250 per county $15 per quad (Internet)
Sylvan Ascent, Inc. TopoDepot 800-362-8971 *http://www.sylvanmaps.com/*	1:24,000	DRG	CD-ROM Internet	$695 per state $149 per county
U.S. Geologic Survey (USGS) 888-275-8747 *http://www.usgs.gov*	1:12,000 (DOQ) 1:24,000 (DRG)	DRG DOQ	CD-ROM CD-R Internet	$1/ per file + $45 (CD-ROM) $1/ per file + $30 (Internet) $32+10/add. CD-R (DOQ)

DRG Digital Raster Graphic
DOQ Digital Orthographic Quadrangle

Laser Range Finders (LRF)

Although there have been dramatic improvements in GPS under dense canopy or in deep canyons common to Forest Service field environments, laser range finders, sometimes called laser instruments or laser guns, offer an alternative by rapidly obtaining measurements of features without physically occupying them.

Laser range finders are useful for mapping signs, utility poles, trees, topography, or other remote features. Features are mapped in a matter of seconds by simply aiming and triggering the instrument from a known point. Raw measurements from the instrument s sensors (distance, inclination, and azimuth) may be reduced to three-dimensional coordinates by a computer connected to the instrument via an RS-232 interface.

Laser mapping instruments have different features and capabilities, and as such, will influence factors such as accuracy, minimum and maximum range, durability, and utility. They are typically hand-held devices, with an aiming scope, that record distance by measuring the time it takes laser light to travel to a target and reflect to a receiving diode in the instrument. A series of measurements is taken and statistically averaged to obtain the reading. Higher-priced models may include additional sensors that measure tilt (inclination) and an electronic compass for measuring azimuth, the angle referenced from magnetic north. This gives laser instruments qualities similar to total stations, and gives them the ability to provide the three-dimensional coordinates of a feature based on a known point.

Laser Range Finders						
Manufacturer	Laser Atlanta Optics *http://www.laseratlanta.com*	Laser Technology Inc. (LTI) 303-649-1000 *http://www.lasertech.com*			Leica, Inc. 800-367-9453 *http://www.leica.com*	Riegl 407-294-2799 *http://www.riegl.co.at*
Photo			Compass Module for Impulse 200			
Model	Advantage	Impulse 200	Mapstar CM	Criterion 300	Vector 1500	Laser Scout 1000
Range (m)	2-600 (reflectorless) 2-9800 (w/ reflector)	575m (reflectorless)	N/A	3-500 (reflectorless) 3-6000 (w/prism)	5-2500 (reflectorless)	5-2500 (reflectorless) 5-3500 (w/prism)
Range Accuracy	+/- 15.3 cm	+/- 3 cm*	N/A	+/- 2 cm*	+/- 2 m	+/- 20 cm
Azimuth Accuracy	+/- 0.5¡	N/A	+/- 0.3¡	+/- 0.3¡	+/- 0.6¡	
Tilt Range	+/- 50.0¡	+/- 90¡	N/A	+/- 60¡	– 35¡	+/- 60¡
Tilt Accuracy	+/- 0.2¡	+/- 0.1¡	N/A	0.1¡	+/- 0.2¡	+/-0.1¡
Display	Heads-Up	Backlit LCD	LCD Display	LCD Display	Heads-Up	LED Display
Size (mm)	254 x 84 x 279	152 x 64 x 127	310 x 50 x 30	200 x 100 x 150	205 x 178 x 82	126 x 195 x 76
Weight (kg)	2.0	1.0	0.57	2.7	1.7	2.0
Price						
Battery	NiCd	2 AA batteries		NiCd	6 V lithium	NiCd

*Measured to a white target

Dead Reckoning

Dead Reckoning is a recent technology designed to increase the accuracy of GPS while on foot or in a vehicle. Dead reckoning systems continue logging accurate locations where GPS signals are blocked due to steep canyons walls or dense forest canopy. It works by a computer determining position by obtaining input from sensors for heading and distance traveled, and calculating coordinates based on the previously determined position.

Dead Reckoning Systems		
Manufacturer	Point Research Corp. 714-557-6180 *http://www.pointresearch.com*	Trimble *http://www.trimble.com*
Photo		
Price	$1,995	
Model	Pointman Dead Reckoning Module	Placer 455DR
Notes	Module is used to supplement GPS receivers for navigation on foot. Contains compass, pedometer and altimeter sensors that calculate position relative to an initialization point.	Module supplements GPS in vehicle applications only. Unit uses vehicle odometer as input for distance and a Piezoelectric gyro for heading. There is no sensor for vertical position (elevation).

Appendices

Related Forest Service T&D Publication				
Pub. No.	Title	Author(s)	Unit	Date
9871 2324	*Resource Applications of GPS Technology*	Kilroy, Bill	MTDC	1998
9824-1307	*Range Finder Comparison*	Sicking, Lois P.	SDTDC	1998
9823-1209	*Field Automation Using Pen Computing and Laser Range Finder Technologies*	Sutton, Frank	SDTDC	1998
9771-2305	*GPS Traverse Methods*	Jasumback, Tony Chamberlain, Ken	MTDC	1997
9771-2327	*Wide Area GPS Enhancement (WAGE) Evaluation*	Jasumback, Tony Luepke, Douglas McCullough, Rich Weigel, Dale	MTDC	1997
9771-2321	*GPS Walk Method of Determining Area*	Jasumback, Tony Luepke, Douglas McCullough, Rich Weigel, Dale	MTDC	1997
9677-1203	*Voice Data Logger*	Bassel, James	SDTDC	1996
9671-2341	*GPS Evaluation: West Coast Test Site*	Jasumback, Tony	MTDC	1996
9671-2335	*Real Time Global Positioning System (GPS) Evaluation*	Jasumback, Tony Luepke, Douglas	MTDC	1996
9624-2352	*Field Evaluation of the Impulse 200 Laser Instrument for Surveying and Timber Cruising*	Lowman, Ben Trent, Andy	MTDC	1996
9634 2324	*Differential GPS Aircraft Navigation, Resource Inventory, and Positioning Demonstration*	Thistle, Harold	MTDC	1996
9571 2853	*GPS Training in Indonesia: Trip Report*	Jasumback, Tony	MTDC	1995
9571 2852	*Philippine GPS Training: Trip Report*	Jasumback, Tony	MTDC	1995
9571 2853	*Indonesian GPS Training: Trip Report*	Jasumback, Tony	MTDC	1995
9571 2334	*Military PLGR GPS Receiver*	Jasumback, Tony	MTDC	1995
9571 2317	*Trimble CENTURION GPS Receivers*	Jasumback, Tony Kilroy, Bill	MTDC	1995
9424 2824	*GPS — Forest Use Survey Results*	Jasumback, Tony	MTDC	1994
9471 2808	*GPS Training in Indonesia: Trip Report*			1994
9451 2337	*GPS Use in Wildland Fire Management*	Mangan, Dick	MTDC	1994
9324-2319	*Evaluating GPS Under a Dense Tree Canopy*	Jasumback, Tony	MTDC	1993
9324-2321	*Trimble Ensign GPS Receiver Evaluation*		MTDC	1993
9324-2848	*Indonesian GPS Training Trip Report*		MTDC	1993
9377-1202	*Low Volume Roads Survey Laser*	Moll, Jeffry	SDTDC	1993

Company Index

3Com
5400 Bayfront Plaza,
Santa Clara, CA 95052-8145
800-881-7256
http://www.palmpilot.com/

Amadeus Consulting Group, Inc.
1079 Yale Circle
Boulder, Colorado 80303-6406
303-494-2695
http://www.wolfgang.com

Amrel Systems, Inc.
11801 Goldring Road
Arcadia CA 91006
626-303-6688
http://www.amrel.com

Apple Computer Inc.
800-538-9696
www.newton.apple.com

Ashtech
1170 Kifer Road
Sunnyvale, CA 94086
408-524-1400
http://www.ashtech.com

Casio
570 Mt. Pleasant Ave.
Dover, NJ 07801
888-204-7765
http://www.casio.com/

Communication Systems International (CSI)
1200 - 58th Avenue S.E.
Calgary, Alberta
Canada T2H 2C9 403-259.3311
http://www.csi-dgps.com

Compaq
800-345-1518
http://www.compaq.com/

Condor Earth Technologies, Inc.
21663 Brian Lane
Sonora, CA 95370
209-532-0361
http://www.condorearth.com

Conic Systems, Inc.
1919 Oakwell Farms Pkwy
Suite 240, San Antonio, TX 78218
210-832-0100
http://www.conic.com

Cue Co. (Accqpoint)
5 Corporate Park
Irvine, CA 92606
800-858-8828
http://www.accqpoint.com/equipment.htm

DAP Technologies
14502 N. Dale Mabry Suite 227
Tampa, FL 33618-2072
800-229-2822
http://www.daptech.com

Datria Systems, Inc.
7211 South Peoria Street
Suite 260
Englewood, CO 80112
303-645-9300
http://www.datria.com

Dauphin Technology, Inc.
800 East Northwest Highway
Suite 950
Palatine. IL 60067
847-358-4406
http://www.dauphintech.com

Differential Corrections Inc. (DCI)
1735 North First Street, #301A
San Jose, CA 95112
800-446-0015
http://www.dgps.com/products.htm

FieldWorker Products, Ltd.
1425 Bayview Avenue Suite 105
Toronto, Ontario, Canada, M4G 3A9
416-483-3485
http://www.fieldworker.com

FieldWorks
7631 Anagram Drive
Eden Prairie, MN 55344
800-343-5396
http://www.field-works.com

Fujitsu Personal Systems, Inc.
5200 Patrick Henry Drive
Santa Clara, CA 95054
800-831-3183
http://www.fpsi.fujitsu.com

GeoFocus
1155 N.W. 13 Street
Gainesville, FL. 32601 USA
800-388-4724
http://www.gfocus.com/

GeoResearch, Inc.
115 N. Broadway
Billings, MT 59101
406-248-6771
http://www.georesearch.com

GeoSurv, Inc.
89 Auriga Drive
Nepean, Ontario, Canada, K2E 7Z2
613-820-4545
http://www.geosurv.com

Hewlett Packard
3000 Hanover Street
Palo Alto, CA 94304-1185
800-443-1254
http://www.hp.com/handheld

Horizons Technology
400 Virginia Ave. SW Suite 140
Washington, DC 22024
800-828-3808
http://www.horizons.com/

Integrated GPS Technologies
4173 Bluebonnet Drive
Stafford, TX 77477
800-780-8090
http://www.gpsgis.com

Intermec Technologies Corp.
6001 36th Avenue West
P.O. Box 4280
Everett, WA 98203-9280
425-348-2600
http://www.intermec.com

Itronics Corporation
801 South Stevens St.
Spokane, WA 99204
1-800-441-1309
http://www.itronics.com

Juniper Systems
1740 N. Research Park Way
Logan, UT 84341-1941
435-753-1714
http://www.junipersys.com

Laser Atlanta Optics
2827 Peterson Place
Norcross, GA 30071
http://www.laseratlanta.com

Laser Technology Inc. (LTI)
7070 S. Tucson Way
Englewood, Colorado 80112
303-649-1000
http://www.lasertech.com

Leica, Inc.
3155 Medlock Bridge Rd.
Norcross, GA 30071
800-367-9453
http://www.leica.com

LG Electronics Inc.
235 Superior Blvd.
Mississauga, Ontario,
Canada L5T-206
800-243-0000
http://www.lgphenom.com

MapFrame Corporation
100 N. Central Expressway,
Suite 1008
Dallas, TX 75201
214-741-2264
http://www.mapframe.com

Maptech, Inc.
1 Riverside Drive
Andover, MA 01810-1122
800-627-7236
http://www.maptech.com

Melard Technologies
28 Kaysal Court
Armonk, NY 10504
914-273-4488
http://www.melard.com

Microslate
3615-A Isabelle, Brossard
Quebec, Canada, J4Y-2R2
450-444-3680
http://www.microslate.com

Motorola
http://www.mot.com

MPN Components
50 Brookside Ave
Suite A3, Exeter, NH 03833
603-778-7957
http://www.mpn.com

NEC
339 North Bernardo Avenue
Mountain View, CA 94043
800-446-8632
http://www.necnow.com

Nikon Inc.
1300 Walt Whitman Rd.
Melville, NY 11747
888-645-6647
http://www.nikonusa.com

Novatel Wireless
San Diego, CA
602-609-1616
http://www.novatelwireless.com

OmniSTAR, Inc.
8200 Westglen
Houston, TX 77063
1-888-OMNISTAR
http://www.omnistar.com

Penmetrics, Inc.
P.O. Box 947
Corvallis, OR 97339
503-827-3848
http://www.penmetrics.com

Philips Electronics
888-367-8356
http://www.nino.philips.com

Phoenix Group, Inc.
123 Marcus Blvd.
Hauppauge, NY 11788
516-951-2700
http://ivpgi.com/

Point Research Corp.
2740 S. Harbor Blvd. Suite B
Santa Ana, CA 92704
714-557-6180
http://www.pointresearch.com

Psion
1 Red Place,
London, W1Y 3RE
United Kingdom
800-997-7466
http://www.psion.com

QuadsUSA, Inc.
2330 West Mission Lane Ste.1
Phoenix, AZ 85021
888-288-7823
http://www.quadsusa.com

Racal
3624 Westchase Drive
Houston, TX 77042
713-784-4482
http://www.racal-landstar.com

Real World Computer Co.
670 Commercial Street
Manchester, NH 03101
508-394-9581
http://www.realworld.com

Riegl Laser Measurement Systems
8516 Old Winter Garden Road
Suite 101
Orlando, FL 32835
407-294-2799
http://www.riegl.co.at

Rockwell Collins
Dept. 120-130
350 Collins Road N.E.
Cedar Rapids, IA 52498-0120
800-321-2223
http://www.collins.rockwell.com

Satloc, Inc.
15990 Greenway Hayden Loop
Scottsdale, AZ 85260
602-348-9919
http://www.satloc.com

Sharp Electronics Corp.
Sharp Plaza
Mahwah, NJ 07430-2135
800-237-4277
http://www.sharp-usa.com

Starlink
6400 Highway 290 East
Suite 202
Austin, Texas, 78723
800-460-2167
http://www.starlinkdgps.com

Sylvan Ascent, Inc
P.O. Box 4792
Santa Fe, NM 87502
800-362-8971
http://www.sylvanmaps.com/

Symbol Technologies, Inc.
One Symbol Plaza
Holtsville, NY 11742-1300
800-722-6234
http://www.symbol.com

Telxon Corp.
8665 New Trails Drive Suite 150
The Woodlands, TX 77381-4254
800-800-8008
http://www.telxon.com

Toshiba America
Computer Systems Division
9740 Irvine Boulevard
P.O. Box 19724
Irvine, CA 92713-9724
800-457-7777
http://www.computers.toshiba.com

Trimble Navigation, Ltd.
485 Potrero Avenue
Sunnyvale, CA 94086
800-426-3904
http://www.trimble.com

Tripod Data Systems
1853 SW Airport Rd.
Corvallis, OR 97333
800-426-8026
http://www.tdsway.com

Trogon Computer Corporation
16624 Edwards Road
Cerritos CA 90703-2438
888-487-6466
http://www.trogoncomputer.com

Uniden
4700 Amon Carter Blvd.
Fort Worth, Texas 76155
888-686-4336
http://www.uniden.com

WalkAbout Computers, Inc.
8018 Chesham Drive
Rowlet, TX 75088
614-882-0015
http://www.walkaboutcomp.com

WPI Husky Computers
18167 US 19 North Suite 285
Clearwater, FL 33764
727-530-4141
http://www.huskyinc.com

Xplore Technologies Corp.
11801 Stonehollow Drive
Suite 500
Austin, TX 78758
512-491-0544
http://www.xploretech.com

WEB RESOURCES

Professional Organizations

American Congress on Surveying & Mapping (ACSM)
Professional society for the spatial data information industry.
http://www.survmap.com/

American Public Works Association
http://www.pubworks.org

American Society for Photogrammetry & Remote Sensing (ASPRS)
Imaging & Geospacial Information Society
http://www.asprs.org

Association of American Geographers
http://www.aag.org

Forest Resources Systems Institute
Society that promotes the use of computers in forestry.
http://www.forsonline.org/

Geospacial Information & Technology Association (GITA)
(Formerly AM/FM International)
http://www.amfmintl.com

I**nstitute of Navigation**
http://www.ion.inter.net/welcome.html

Urban and Regional Information Systems Association (URISA)
Organization for the use and integration of spatial information technology.
http://www.urisa.org/

Forest Service GPS/GIS Resources

Geometronics Service Center (GSC)
Provides GPS users a convenient source of Trimble Community Base Station GPS reference data as well as receiver performance reports, and links to GPS related information.
http://fsweb.gsc.wo.fs.fed.us/

Forest Service Global Positioning System Homepage
The Center provides base geographic information products and related technical services to Forest Service managers and resource specialists responsible for carrying out the Forest Service mission.
http://www.fs.fed.us/database/gps/

Region 3 GIS World home page
http://fsweb.r3.fs.fed.us/gis/

Region 4 GIS Center of Excellence
http://fsweb.r4.fs.fed.us/

Rocky Mountain Research Station GIS/GPS Remote Sensing Page
http://fsweb.rmrs.fs.fed.us/gis.html

Other Government Agencies

Aerospace Corporation
Introduction to GPS equipment and applications.
http://www.aero.org/publications/GPSPRIMER/index.html

National Park Service GIS Homepage
http://www.nps.gov/gis/

NGS / NOAA GPS Site
The U.S. Department of Transportation s Civil GPS Service has designated NOAA to be the federal agency responsible for providing accurate and timely Global Positioning System (GPS) satellite ephemerides (orbits) to the general public.
http://ngs.noaa.gov/GPS/GPS.html

Satellite Predictor
Naval Air Warfare Center W eapons Division, China Lake, CA
This utility shows what satellites are visible from a given location at a specified time
http://sirius.chinalake.navy.mil/satpred/

Tycho - U.S. Naval Observatory
Computes GPS/GLONASS Satellite Position based on local latitude and longitude.
http://tycho.usno.navy.mil/gps-altaz.html

U.S. Army - Construction Engineering Research Laboratory (CERL)
The home of the GRASS public domain GIS, the Open-GIS (OGIS) foundation, also spatial modeling information.
http://www.cecer.army.mil/

U.S. Bureau Land Management
Includes a GIS page with data and information relevant to land management.
http://www.blm.gov/

U.S. Bureau of the Census
General information and access TIGER census data and much other statistical information for the U.S.A.
http://www.census.gov/

U.S. Coast Guard (official GPS site)
Provides DGPS and GPS status and almanac information.
http://www.navcen.uscg.mil/
http://www.nis-mirror.com (mirror site)

U.S. Department of the Interior
Provides a gateway to all of the U.S. government agencies responsible for conservation and natural resource management.
http://info.er.usgs/doi/doi.html/

U.S. Environmental Protection Agency
Includes information on projects using GIS such as their National Estuary Program. Also some information on software and data.
http://www.epa.gov/

U.S. Federal Geographic Data Committee
This agency is responsible for coordinating the survey, mapping and spatial data activities of various federal agencies. Promotes the Spatial Data Transfer Standard (SDTS). Includes links to all the U.S. National Spatial Data Infrastructure (NSDI) sites.
ftp://fgdc.er.usgs.gov/gdc/html/fgdc.htm

U.S. Fish and Wildlife Service
Inventory that provides access to GIS data. Supports the U.S. National Wetlands a relating to US Wetlands in a number of different formats.
http://www.fws.gov/data/gps.html

U.S. Geological Survey
Provides an overview of GIS technology.
http://info.er.usgs.gov/research/gis/title.html

USGS Geographic Names Information System
The Geographic Names Information System (GNIS), developed by the USGS in cooperation with the U.S. Board on Geographic Names (BGN), contains information about almost 2 million physical and cultural geographic features in the United States.
http://www-nmd.usgs.gov/www/gnis/gnisform.html
ftp://www-nmd.usgs.gov/pub/gnis (FTP format)

Magazines/Journals

Geo Info Systems Magazine
http://www.geoinfosystems.com

GeoPlace
GEOWorld Magazine (Formerly GIS World)
http://www.gw.geoplace.com

GPS World Magazine
http://www.gpsworld.com

Pen Computing Magazine
http://pencomputing.com

Professional Surveyor Magazine
http://www.profsurv.com

Utilities it Magazine
http://www.itforutilities.com

Other GPS/GIS Links

GIS Internet Resources List
An extensive, annotated list of pointers, broken down into subject areas. Also has information on GIS education, research and facilities at UC Berkeley.
http://www.lib.berkeley.edu/UCBGIS/

GIS WWW Resource List
This site, maintained by the University of Edinburgh, provides links to other GIS related sites such as university, government, and manufacturers sites all around the world. The links are listed in alphabetical order.
http://www.geo.ed.ac.uk/home/giswww.html

GISLinx
GISLinx is an Internet site devoted to listing any/all GIS related web sites. GISLinx contains links to GIS related software and hardware vendors, GeoMatics, GIS Events, GIS Data.
http://www.gislinx.com/

Global Positioning System (GPS) Resources - Iowa State University
General site with general information on GPS and GIS and links to manufacturer and government sites.
http://www.cnde.iastate.edu/gps.html

SatNav Predictor
Visibility analysis of GPS & GLONASS at selected location (Number of satellites visible and DOPs).
http://satnav.atc.ll.mit.edu/java/Predictor/Predictor.html

Usenet GPS/GIS and Mobile Computing Related Newsgroups

comp.infosystems.gis

comp.sys.handhelds

comp.sys.palmtops

comp.sys.pen

sci.engr.surveying