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Trail Traffic Counters

Update

Trail Traffic counters

Update

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9E92A46—Revised Guide on Trail Traffic Counters

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About the Author…

Dave Gasvoda holds a bachelor's degree in electrical engineering from Montana State University. He joined the Missoula Technology and Development Center in 1969 and has worked on a wide variety of projects since then. He has designed electronic devices that have saved Forest Service employees backbreaking labor. Dave has been awarded a patent and has another pending.

Introduction

This is an updated reprint of the 1994 report Trail Traffic Counters for Forest Service Trail Monitoring (9423-2823-MTDC). Some manufacturers have introduced new products or revised their products since 1994. This report contains current information as provided by the manufacturers. No traffic counters have been tested since the previous report was published. Some of the previously tested counter models are no longer available. However, the test is still relevant because it illustrates the typical accuracy, installation considerations, and costs of the general types of counters.

In 1992, the Missoula Technology and Development Center (MTDC) began to reinvestigate the use of trail-monitoring devices in the Forest Service. The center's first involvement with trail counters was in 1968. MTDC engineers used current state-of-the-art technology and developed an infrared trail traffic counter, which was commercially manufactured in 1972. With the renewed emphasis on obtaining accurate recreation-use data, along with rapid advances in the electronics industry, the center was directed to reinvestigate the use of trail traffic counters and ensure that the latest technology meets field needs.

MTDC surveyed the field to determine requirements for trail traffic counters, investigated commercial trail-counting equipment, and tested available equipment. Through this process, the center discovered several newly developed counters that promised to eliminate many of the problems field employees have been experiencing with inaccurate data and high maintenance costs. These new units are also significantly smaller and lighter than their predecessors.

The center evaluated three general types of trail counters: active infrared, passive infrared, and seismic.

The evaluation explored inherent advantages and disadvantages of each type and detailed the unique properties of the eight models tested.

Trail Traffic-Counter Evaluation

The first step of the evaluation process was to survey field employees to determine their requirements. The center distributed a brief questionnaire to forest-level recreation staff. Respondents indicated that they were looking for a traffic counter that was accurate, required low maintenance, was vandal resistant, and was housed in a weather-resistant, rugged case. Because funding for trail monitoring is usually low, respondents indicated that an affordable no-frills unit was more desirable than expensive units with options such as time-date stamps or external cameras.

Keeping the respondents' criteria in mind, a market search revealed several new products. MTDC evaluated eight trail-monitoring systems, including the current version of the MTDC counter. The counters were tested and evaluated for the following qualities: ease of installation, accuracy, construction, and resistance to vandalism.

Analysis of Questionnaire Responses

In 1992, MTDC distributed a Trail Traffic Counter Questionnaire throughout the Forest Service. The questionnaire asked general questions regarding current trail traffic-counter use and solicited ideas and suggestions for improvements.

Use of Trail Counters

Of the 61 respondents, 39 were currently using trail traffic counters, and 22 were not. Six of the 22 who were not currently using them have had experience with them.

Types of Trail Counters Used

Infrared (IR) counters were the most widely used for monitoring traffic, closely followed by seismic counters:

- Infrared, 38%
- Seismic, 33%
- Inductive loop, 18%
- Pneumatic, 13%
- Other, 2%.

The only brands of counters on the responses were Compu-Tech (seismic and passive infrared), Diamond Traffic Products (active infrared), and Scientific Dimensions.

General Problems

MTDC identified five general problem areas:

- Accuracy, 33%
- Installation and sensitivity adjustments, 21%
- Maintenance and battery life, 21%
- Vandalism, 15%
- Poor workmanship, weatherization, and equipment malfunction, 11%.

Other less-significant responses included:

- Too expensive to purchase or operate
- Couldn't classify use, or distinguish human use from animals
- Interpreting data was difficult.

Classification by Type of Use

Twenty-nine respondents attempted to classify the type of use for their counters. The types of uses included:

- Field observation, 52%
- Trailhead registration or wilderness permits, 28%
- Trail monitoring equipment, 21%
- Monitoring use by season or type of trail, 14%.

Classification of use by trail-monitoring equipment was accomplished by using different types of equipment for different uses. For instance, an 8-foot (2.5-meter)-high, active infrared counter might be used to count equestrian traffic and a waist-high counter might be used to count all traffic. Pedestrian traffic was obtained by subtraction.

Accessory Equipment

Only four responses indicated any use of accessory equipment. In all cases, cameras were the accessory equipment.

Improvements Needed

The following general areas of improvement were indicated:

- Improved battery life, 23%
- Increased accuracy, 18%
- Lower cost for purchase and maintenance, 15%
- Better quality construction and ruggedness, 8%.

Other improvements noted:

- Time-date stamps and printouts
- Classification of data.

Summary of Questionnaire Responses and Conclusions

Generally, field employees are looking for inexpensive, accurate, lightweight equipment. The equipment must be capable of maintaining battery power and withstanding adverse weather for long periods. The responses also indicated that complex systems with cameras and time-date stamps are not in demand. The field requires simple, low-cost systems that are accurate.

Test Procedures and Analysis

Procedures—MTDC evaluated the trail counters at a test site at Fort Missoula. The testing was to evaluate the installation of each system and to determine the relative accuracy of each system. The results are shown in table 1.

Each system was installed according to the manufacturer's instructions and was subjectively rated according to the time and effort required to install it. Table 2 shows these ratings, as well as other comparative information.

The relative accuracy was judged by simulating situations likely to provide false or missed counts. Each type of counter is subject to errors in different situations. The situation tested error reference initials, and the types of counters likely to produce error included:

- Closely spaced groups, GRP, (all types)
- Heavier hiker than average, BIG, (seismic)
- Lighter hiker than average, SML, (seismic)
- Light, reflective clothing, LIT, (active IR)
- Dark, matte clothing, DRK, (passive IR).

For the GRP test, two hikers spaced 24 inches (0.6 meters) apart walked through the sensing areas of the installed counters. For the BIG test, a 197-pound (89-kilogram) hiker walked through the sensing area of the installed counters. For the SML test, a 112-pound (51-kilogram) hiker walked through the sensing area of the installed counters. For the LIT test, the hiker was dressed in white, shiny clothing when walking through the sensing area of the installed counters. For the DRK test, the hiker was dressed in dark, matte clothing. On all tests, the hiker maintained a consistent walking speed and consistent foot falls. Ten passes were made through the sensing area for each test.

Analysis—Of all models tested, only the Trail Traffic Counter (Ivan Technologies) tested perfectly. Its accuracy was closely matched by the other active infrared system, the RS501, and the TCS-120, which undercounted in the GRP test and the LIT test.

The passive infrared models as well as the seismic counters overcounted and undercounted throughout all types of tests, which indicates general counting inconsistencies. The trail traffic counters were rated on the following scale and are indicated in table 2:

% Errors	Rating	% Errors	Rating
0	Very good	13 to 18	Poor
1 to 6	Good	19 to 24	Very poor
7 to 12	Average		

Table 1—Test results of the accuracy of the different counters.

Model	GRP*		BIG*		SML*		LIT*		DARK*		Total Percent	
	under	over	under	over	under	over	under	over	under	over	under	over
Cuesta Systems RS 501	1	0	0	0	0	0	2	0	0	0	6	0
Ivan Technologies Trail Traffic Counter	0	0	0	0	0	0	0	0	0	0	0	0
Diamond Traffic TCS-120	2	0	0	0	0	0	3	0	0	0	10	0
Compu-Tech TR-41 Counter, PIR-70 Sensor	2	1	1	0	1	0	0	0	3	0	14	2
Diamond Traffic TT-3 Counter, TT3-IR Sensor	4	0	1	0	2	1	0	0	4	0	22	2
Compu-Tech TR-41 Counter, PR-40 Sensor	0	3	0	3	0	0	1	0	1	0	4	12
Compu-Tech TR-41 Counter, TSS-32 Sensor	1	2	0	2	0	0	0	0	1	0	4	8
Diamond Traffic TT-3 Counter, TT-SS Sensor	4	2	0	1	2	0	1	0	0	1	14	8

* GRP: Closely spaced groups; BIG: Heavier hiker than average (for seismic counters); SML: Lighter hiker than average (for seismic counters); LIT: Light, reflective clothing (for active infrared counters); DARK: Dark, matte clothing (for passive infrared counters).

Table 2—Evaluation of the trail traffic-counter features.

Model	Cost	Weight pounds (kg)	Size inches (cm)	Battery type and life	Internal data logger	Installation	Accuracy	Vandal resistance
ACTIVE INFRARED								
Cuesta Systems RS-501	$595	7 lb (3.2 kg)	11.5x7x6.5 (28.5x18x16.5)	4 C alkaline or 2 C lithium, 12 to 18 months	None	Average	Good	Average
Cuesta Systems TS-601	$755	7 lb (3.2 kg)	11.5x7x6.5 (28.5x18x16.5)	4 C alkaline or 2 C lithium, 12 to 18 months	3 options–see text	Average	Good	Average
Diamond Traffic TTC-442	$420	8 lb (3.6 kg)	10x3x7 (25.5x7.5x18)	4 C alkaline, 12 to 15 months	512 selectable time intervals	Not evaluated	Not evaluated	Not evaluated
Ivan Technologies Trail Traffic Counter	$995 ($1195 with data logger)	6.7 lb (3.0 kg) for receiver and transmitter	6.25x6.25x4 (16x16x10) for receiver and transmitter	8 D alkaline, 180 days 2 N alkaline, 4 years or lithium, 270 days and 10 years	Optional time-and-date stamp	Average	Very good	Good
TrailMaster TM1000	$205	1 lb (0.45 kg) receiver 0.63 lb (0.28 kg) transmitter	7.5x3.5x2.1 (19x9x5) receiver 4.75x3.25 x1.8 (12x8x4.5) transmitter	8 C alkaline, 30 to 90 days	Date and time stamp of 1,000 events; 4,000 or 8,000 events optional	Not evaluated	Not evaluated	Not evaluated
TrailMaster TM1500	$260	1 lb (0.45 kg) receiver 0.63 lb (0.28 kg) transmitter	7.5x3.5x2.1 (19x9x5) receiver 4.75x3.25x1.8 (12x8x4.5) transmitter	8 C alkaline, 30 to 90 days	Date and time stamp of 1,000 events; 4,000 or 8,000 events optional	Not evaluated	Not evaluated	Not evaluated
PASSIVE INFRARED								
Compu-Tech TR-41 Counter PIR-70 Sensor	$347 $189	4.5 lb (2.0 kg) 1.1 lb (0.5 kg)	12x4 dia. (30.5x10 dia.) 3x3x6 (7.5x7.5x15)	4 D alkaline, 1 year 3 AA alkaline, 2 years	None	Easy	Poor	Good
Diamond Traffic TT-3 Counter TT-3-IR Sensor	$210 $179	2 lb (0.9 kg) 1.6 lb (0.7 kg)	3x3.5x5.375 (7.6x8.9x14) 6x1.75 dia. (15x4.5 dia.)	3 C alkaline or 2 3.5-volt lithium 2 3.5-volt lithium, 5 years	None	Easy	Very poor	Good
TrailMaster TM300	$130	0.75 lb (0.34 kg)	4.75x3.25x3.25 (12x8.25x8.25)	4 C alkaline, 1 year	Date and time stamp of 1,000 events; 4,000 or 8,000 events optional	Not evaluated	Not evaluated	Not evaluated
TrailMaster TM550	$180	0.75 lb (0.34 kg)	4.75x3.25x3.25 (12x8.25x8.25)	4 C alkaline, 1 year	Date and time stamp of 1,000 events; 4,000 or 8,000 events optional	Not evaluated	Not evaluated	Not evaluated
SEISMIC								
Compu-Tech TR-41 Counter TSS-32 Sensor	$347 $72	4.5 lb (2.0 kg)	12x4 dia. (30.5x10 dia.) 48x32 (122x81)	4 D alkaline, 1 year	None	Difficult	Average	Very good
Compu-Tech TR-41 Counter PR-40 Sensor	$347 $73	4.5 lb (2.0 kg)	12x4 dia. (30.5x10 dia.) 48 long (122 long)	4 D alkaline, 1 year	None	Average	Poor	Very good
Diamond Traffic TT-3 Counter TT-3-SS Sensor	$210 $109	2 lb (0.9 kg) 1.0 lb (0.45 kg)	3x3.5x5.375 (7.6x8.9x14) 3x1.5x5 (7.5x3.8x12.7)	3 C alkaline or 2 3.5-volt lithium	None	Easy	Very poor	Very good
INDUCTIVE LOOP, BICYCLE								
Diamond Traffic TT-7	$298	8 lb (3.6 kg)	8.5x8.5x4 (21x21x10)	6 D alkaline, 16 months	None	Not evaluated	Not evaluated	Not evaluated

Results

The MTDC evaluation determined the inherent disadvantages of each type of counter and detailed the specific advantages and disadvantages of each unit.

Active Infrared Counters

MTDC evaluated three active infrared systems. Two of these systems, the Diamond Traffic Products TCS-120 and the Cuesta RS-501, are retroreflective systems. The third counter, manufactured by Ivan Technologies, is a through-beam system. Another through-beam counter (not evaluated) is the TrailMaster TM1000/TM1500.

In the retroreflective systems, the scanner emits an invisible infrared beam of light across the trail to the reflector. The reflector returns the light beam back to the receiver. The receiver is housed in a single case with the emitter. If the beam is broken, presumably by a trail user, a count is registered. The size of the beam, which must be interrupted to register a count, is roughly the diameter of the reflector.

In the through-beam system, the emitter and receiver are housed in separate units. The emitter sends an infrared beam directly across the trail to the receiver unit. Again, if the beam is broken, a count is registered. This configuration provides several advantages over the retroreflective type. The beam travels only half the distance, allowing for the beam to travel over longer ranges or for the unit to use less power for a given distance. Also, highly reflective subjects passing close to the retroreflective scanner/receiver can return enough of the beam that the beam is not broken, so they are not counted. While this is not a significant problem in a proper installation of a retroreflective counter, it cannot occur in a through-beam system. The through-beam system does not require a shiny reflector, so it allows the installation to be less conspicuous.

To conserve power and eliminate the influence of ambient light, the infrared beam is pulsed. The pulses are of brief duration compared to the time between pulses.

Incorporated into the counters' circuitry are two timing mechanisms for avoiding false counts. To eliminate false counts from falling leaves, snowflakes, or birds, the beam must be blocked for a minimum length of time before the system registers a count. The second mechanism to eliminate double counting is a time-delay feature. This feature disables the counter for a short time after a count is recorded. The timing functions are usually implemented digitally based on:

- The number of pulses that must be blocked before a count is registered
- The number of pulses that must be seen before the system looks for another count.

Timing is usually set by the manufacturer and is not adjustable in the field. These mechanisms, in combination with the well-defined, narrow detection zone, make active infrared systems the most accurate of the three counter types.

Active infrared counters are mounted above the ground, although their range allows them to be placed well off the trail. The aboveground installation puts counters at risk of vandalism, especially the retroreflective units with highly visible reflectors. If the counter is used in areas where vandalism is a problem, special care must be taken to hide the counter. The scanner can be covered with camouflage netting that has twigs and sticks inserted. Semitransparent filters can be used to eliminate the glare of the reflectors.

Careful site selection and installation are essential to obtaining accurate counts. The counter must be mounted on a rigid support that is not going to move and change the alignment of the beam. Alignment must be checked a week or so after installation to ensure that nothing has moved. Remove branches that wind, snow, or rain could move into the path of the beam.

Active infrared counters will detect any large object passing through the beam. They can be used for monitoring pedestrians, equestrians, off-highway vehicles, bicyclists, skiers, and snowmobilers.

Cuesta Systems Corporation

RS 501 Portable Traffic Counter—The RS 501 (figure 1) is a retroreflective active infrared counter that uses a six-digit LCD to display the total number of counts since the last time the counter was reset. The counter operates 12 to 18 months on four C alkaline or two C lithium batteries. The counter and batteries are contained in a cast-aluminum case painted with camouflage paint. The case is sealed with O-rings. An optional special mount and vandal-resistant steel enclosure are available for installations where the counter cannot be hidden. The counter and its reflector can be installed up to 125 feet (38 meters) apart. The RS 501 can be upgraded to store counts for retrieval at a later date as can the TS601 (described next).

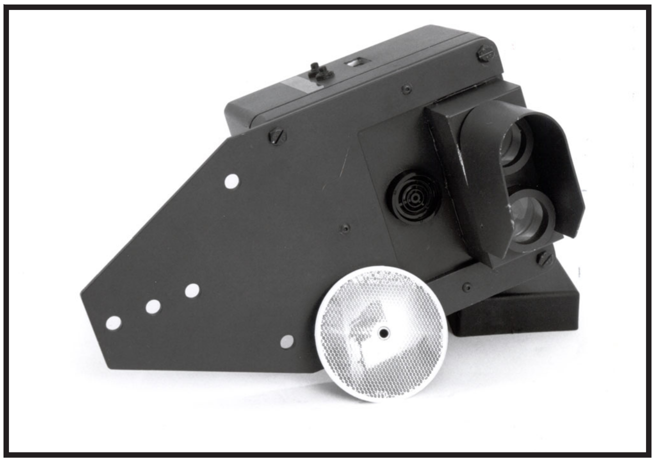


Figure 1—RS 501 portable traffic counter.

TS 601 Traffic Sentry Portable Traffic Counter—The TS 601 counter is basically the same as the RS 501 except that a microprocessor-based data logger is added to store counts within preset time intervals. Three versions offer different date-time programs for surveillance or counting requirements.

The TS 601S statistical version provides total counts by day for a year, and summary information as to total counts, total counts for each weekday, total counts for six sequential 4-hour increments, total counts a.m. and p.m., and total counts day and night.

The TS 601M 1-minute event version groups counts into 160 1-minute intervals with up to 99 counts per group. Each group is tagged with the date and time. The total count is also provided. If no counts are registered in a 1-minute group, that count does not use up one of the 160 intervals.

The TS 601H 1-hour event version groups counts into 160 1-hour intervals with up to 9,999 counts per group. The total count is also provided. If no counts are registered in a 1-hour group, that count does not use up one of the 160 intervals.

A TS 625 interrogator plugs into a TS 601 to access the stored data. The interrogator has a 16-character by 2-line LCD for accessing the data and status information, setting the clock, and resetting the data logger. One interrogator can service multiple counters.

Diamond Traffic Products

TTC-442 Trail Traffic Counter—The TTC-442 (figure 2) is a redesign of Diamond's old retroreflective TCS-90/TCS-120 trail traffic counter. The new design retains the original cast-aluminum housing, but has all new low-power electronics and will operate 12 to 15 months on four D-size alkaline batteries contained in a lockable compartment. The old external battery box has been eliminated. The housing is finished in dull camouflage. Count is recorded in selectable intervals of minutes; 1, 6, or 12 hours; and 1, 2, 3, 4, 5, 6, 14, or 30 days, for a total of 512 possible intervals. The count is displayed on a six-digit LCD (liquid crystal display). The scanner and reflector can be separated by up to 110 feet (33.5 m). The old TCS-90/TCS-120 counters can be upgraded with the new electronics for less than half the cost of a new unit.

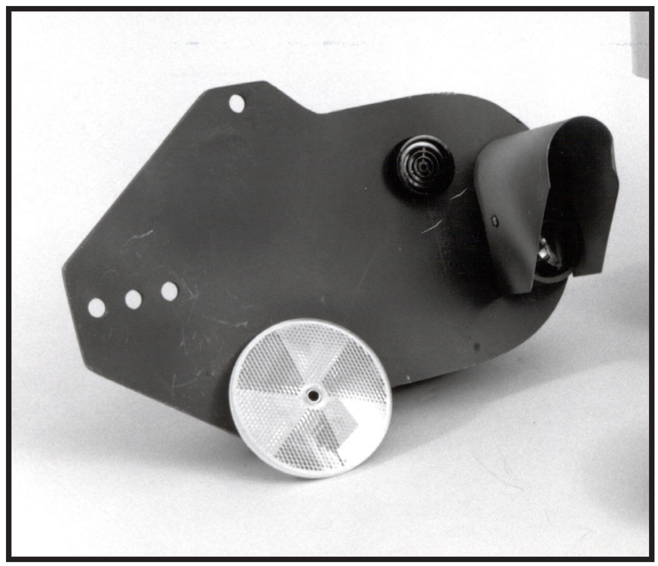


Figure 2—TTC-442 trail traffic counter.

Ivan Technologies

Trail Traffic Counter—The Ivan Technologies trail traffic counter (figure 3) is a through-beam active infrared counter. The transmitter unit emits a beam of infrared light that is focused to a diameter of 6 feet (2 meters) at a distance of 300 yards (274 meters). The receiver unit's lens focuses the beam on an internal detector. This results in an effective beam diameter of 0.5 inches (13 mm) that must be interrupted

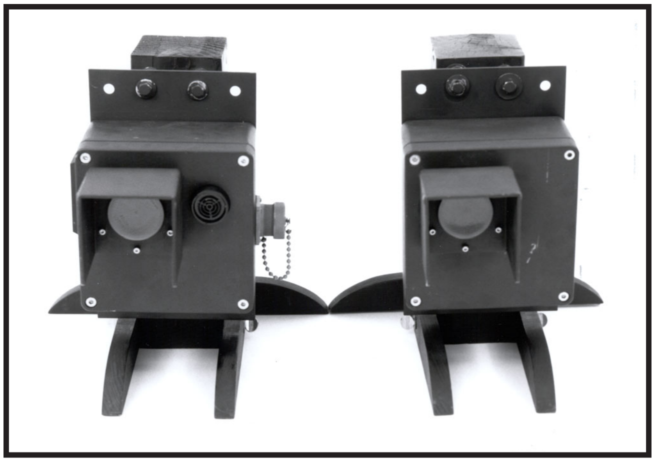


Figure 3—Ivan Technologies trail traffic counter.

to register a count. The units and their batteries are enclosed in weatherproof aluminum housings that can be separated by up to 300 feet (91 meters). Each unit uses four D alkaline batteries that will power the unit for 180 days at 70° F. For cold-weather operation, two D lithium batteries are recommended for each unit. Lithium batteries will power the unit for 270 days. Two N cells power the counter unit for 4 years (alkaline batteries) or 10 years (lithium batteries). Counts are displayed on a six-digit LCD. An optional time-date recorder can store the time and date of each count. The data can be downloaded directly to a personal computer or can be collected with a pocket-sized data collector.

TrailMaster

TM1000 Trail Monitor System—The TM1000 trail traffic counter (figure 4) is a through-beam active infrared counter. The sending and receiving units and their batteries are enclosed in weatherproof housings that can be separated by up to 90 feet (30 meters). Each unit has four C batteries that will power the unit for 30 to 90 days. The infrared energy is transmitted as a wide beam from the transmitter and is received in a $^{3}/_{8}$-inch (9.5-mm)-diameter window on the receiver. The only part of the transmitted beam sensitive to being broken is the narrow beam received by the receiver. The time the beam must be interrupted to register a count can be set to avoid counting small, fast-moving objects. Each count is recorded by date and time to the minute. Models are available that store 1,000-, 4,000-, or 8,000-count events. A built-in LCD provides simple data retrieval.

TM1500 Trail Monitor System—The TM1500 is the same as the TM1000, except that it has optional accessories. The accessories include a TM Data Collector, TM StatPack for data analysis, TM Portable Printer, and TM35-1 (35-mm) camera kit.

The TM Data Collector holds 16,000 events by date and time. Data from different counters are stored by unit numbers. The Data Collector transfers data to any computer through an RS-232 serial interface.

The TM StatPack data-analysis package creates a hard-copy print of the data and can produce a two-dimensional or three-dimensional bar graph of time and date information. It is also possible to graph the information in 15-, 30-, or 60-minute time intervals. The software is available in DOS with Windows 95, 98, or NT.

The TM 24 Portable Printer prints on paper like that used for adding machines. It is powered by an external 12-volt battery.

The TM35-1 35-mm Camera Kit is weatherproof and features a data back, auto-focus, auto-wind, and auto-flash. It is furnished with a tree mount, camera shield, and 25-foot (7.7-meter) cable.

Figure 4—TrailMaster TM1000 trail monitor system.

Passive Infrared Counters

The passive infrared systems operate by detecting a moving object’s infrared signature. Factors that determine the signature include the object’s temperature relative to the background; its infrared reflective and emissive characteristics; and its size, speed of travel, and direction of travel relative to the counter. The infrared energy can originate from the object or can be reflected by the object. Because of the complex interaction of these factors, the detection range varies considerably. Large, fast-moving objects at a temperature much different from the background are detected at the longest range.

Passive infrared systems usually have multiple detection zones through which an object must pass to be counted. By ignoring changes that occur simultaneously in more than one zone, it is possible to reduce false counting when large changes in infrared intensity occur in events such as the sun going behind a cloud. The angular beam width and number of zones are determined by the manufacturer. The size of the zones increases as the distance from the counter increases. At a reasonable installation distance, passive infrared counters cannot distinguish people in a group and will undercount. These counters are also prone to false counting because of changes in the background.

A passive infrared system is best used where knowledge of general numbers or trends is desired. Passive infrared systems are also suitable for use as triggers for external cameras.

Compu-Tech Systems

TR-41 Trail Counter and PIR-70 Sensor—The TR-41 trail traffic counter (figure 5) can be used with passive infrared or seismic sensors. It is housed in a waterproof/weatherproof cylinder and has adjustable sensitivity and time-delay controls. The count is displayed on a six-digit LCD. The four D alkaline batteries will power the unit for a year. An optional interface allows accessories such as data loggers and cameras.

The DL-125 and DL-150 data loggers record time and date for up to 250 events in the Event mode. Alternatively, the data loggers can record counts per time interval in eight selectable intervals from 15 minutes to 24 hours. Data can

Figure 5—TR-41 trail traffic counter by Compu-Tech Systems.

be reviewed on the built-in LCD display. The DL-125 allows data to be downloaded to a computer. The DL-150 is the same as the DL-125 except that data are printed on a handheld thermal printer. These data loggers operate at least 6 months on a single 9-volt battery.

The DL-400 data logger/processor combines the processor unit of the TR-41 counter with the electronics of a DL-125 data logger into a single unit in a weatherproof housing.

The SC-210 35-mm surveillance camera system uses a professional quality 35-mm camera with automatic focus and a 70- to 210-mm zoom lens. Options include a data back to record date and time on the film and timers that will turn the system on and off at specific times, and time-sequenced pictures.

The PIR-70 passive infrared sensor has a range of up to 100 feet. Three AA batteries last up to 2 years. The narrow detection zone is 4 by 2 feet (1.2 by 0.6 meters) even at the edge of the range. When the sensor is activated, there is a time delay of 3 to 4 seconds before it can be reactivated.

TR-41-IR Trail Counter and PIR-70 Sensor—This counter is designed to work exclusively with the PIR-70 passive infrared sensor and costs less than the TR-41. It is shorter than the TR-41 and has no adjustments. It will operate up to 4 years on two N-cell batteries. Other specifications are similar to the TR-41.

Diamond Traffic Products

Traffic Tally 3 (TT-3) Counter and TT-3-IR Sensor—The TT-3 counter (figure 6) can accommodate either a passive infrared or seismic geophone sensor. The counter unit is contained in a waterproof extruded aluminum case and displays the count on a six-digit LCD. The unit is powered by three C alkaline or two 3.5-volt lithium batteries. The count time delay can be adjusted in the field from 1/2 to 10 seconds. The sensitivity is adjustable from 0 to 100 percent. An optional output for accessories is available for triggering external devices.

Figure 6—Traffic Tally 3 (TT-3) counter.

Accessories include camera systems and time-interval recorders.

The PGU-35 is a 35-mm outdoor camera unit that uses a Minolta single-lens reflex camera with an automatic film advance. The number of photos taken per triggering event and the time between photos can be selected.

The Pegasus time-interval counter has programmable recording intervals from 1 minute to 24 hours. It can store 855 days of hourly counts.

The TT-3-IR is a passive infrared sensor with a maximum detection range of 50 feet (15.2 meters). The sensor monitors a 6° field of view, providing a sensed area of 2 feet (0.6 meter) at 15 feet (4.6 meters). The sensed area is 3 feet (1 meter) wide at 45 feet (14 meters). The sensor is housed in an aluminum cylinder 6 inches long by 1 1/3 inches in diameter. The sensor has a mounting bracket with holes for mounting with two lag screws.

TrailMaster

TM300 Trophy Timer—The TM300 is a weatherproof passive infrared counter and recorder (figure 7) that monitors a large area. This area forms a wedge radiating outward in front of the counter. This wedge is 65-feet (20-meters) deep and spreads to a width of 150 degrees. Any object that has an infrared signature higher than the background and moves inside this wedge will register a count. The TM300 can store one event per minute as long as the object is moving inside the wedge area. This information can show how long the object is in the area, but provides very poor count accuracy.

Models are available that store 1,000-, 4,000-, or 8,000-count events. A built-in LCD provides simple data retrieval. Battery life is over a year for four C alkaline batteries.

Figure 7—TM300 Trophy Timer.

TM550 Trail Monitor—The TM550 is the same as the TM300, except that it incorporates an output for connecting to accessories. These accessories are the same as those described above for the TM1500 Active Infrared Counter.

Seismic Systems

Seismic systems consist of a counter unit and a buried vibration sensor or geophone. Often a mat or tube helps carry the vibrations to the sensor. As trail users walk down the trail, their footfalls cause vibrations detected by the sensor and a count is registered.

Seismic systems use the same timing and adjustable sensitivity mechanisms for controlling accuracy as the infrared types. However, because of site variations, the system must be finely tuned for each installation. While the sensing zone of an infrared counter is constant, a large number of variables affect the size of the sensing zone of the seismic sensor.

Different soil types transmit vibrations differently. Heavier footfalls will create a stronger signal, and will be detected sooner than those of a light-footed hiker. To account for these variations, the seismic systems have adjustments for sensitivity and a time delay adjustment. If the sensing zone is too large, you risk double counting an event. If the zone is too small, you risk missing valid counts. The sensitivity adjustment allows you to reduce or increase the size of the sensing zone.

To account for the variations in zone size, the time delay is also adjustable. When the system is optimally tuned, the time delay corresponds to the time required for a trail user to pass through the sensing zone. Reaching a proper compromise between these settings is tricky, especially since the sensing zone varies with each footfall. To compound problems, changing soil conditions from trail compaction or freeze/thaw cycles can drastically change the counter's sensitivity.

The buried seismic system is undetectable and may be well suited for areas where vandalism is a problem.

Spike sensors are geophones with a spike on one end that is poked into the ground. The sensors can detect hikers up to 30 feet (10 meters) from the sensor in compacted soil. The spike sensor is the least accurate seismic unit and should only be used where knowledge of general numbers or trends is desired.

Compu-Tech Systems

TR-41 Trail Counter—The Compu-Tech TR-41 trail counter (figure 8) is also used with the passive infrared sensor and is described earlier in the passive infrared section.

Figure 8—Compu-Tech's TR-41 trail traffic counter (mat not shown).

TSS-32 Trail Sensor—The Compu-Tech TSS-32 standard trail sensor system is a plastic mat 48-inches (1.2-meters) wide by 32-inches (0.81-meters) long with a geophone sensor in the center. It should be used where the trail is not wider than 48 inches (1.2 meters). The mat can be cut with scissors to match the width of the trail. The mat and the sensor are buried about 6 inches (15 centimeters) below the trail tread, requiring a good deal of excavation. For this reason, this system is not well suited for rocky soils.

The trail sensor was designed for use on pedestrian trails. However, if the sensor is installed near a water bar or bump, it can detect off-highway vehicles and mountain bikes.

TR-41 Trail Counter and PR-40 Paved Road/Narrow Dirt Road Trail Sensor—The PR-40 sensor attaches its geophone to a PVC pipe (figure 9) rather than a plastic mat. It is suitable for paths or roads up to 5-feet (1.5-meters) wide. This enables the sensor to be buried in a narrow trench, limiting the amount of excavation required. This sensor is better suited for rocky soils. The sensor's sensitivity is somewhat less than that of the TSS-32 sensor. However, this difference in the sensitivity sensor had little effect on the TR-41 counter's accuracy in our test.

Figure 9—The PR-40 sensor has a geophone attached to a plastic PVC pipe rather than a mat.

TR-41 Trail Counter and SP-20 Spike Sensor—The SP-20 spike sensor is a geophone sensor with a spike on the end to allow it to be pushed into the ground. It is intended for temporary monitoring and is not intended to replace the PR-40 sensor for long-term use.

Diamond Traffic Products

TT-3 Counter and TT-3-SS Spike Sensor—The TT-3 counter (figure 10) is also used with the passive infrared sensor. The TT-3 counter is described above in the passive infrared section.

Figure 10—Diamond Traffic Products' TT-3 traffic counter.

The TT-3-SS spike sensor provides a seismic sensor for quick spot checks on roads and trails. The geophone relies solely on the soil to transmit vibrations to sensors. The sensor spike is buried just below the surface and can be installed in minutes. It is best suited for use in areas where concealment is paramount.

Inductive Loop Bicycle Counters

Diamond Traffic Products

Traffic Tally-7 (TT-7) Bicycle Inductive Loop Counter—The TT-7 bicycle counter (figure 11) is sensitive enough to detect aluminum bicycle wheels passing over loops buried under bike paths. The unit operates on six D cells for over

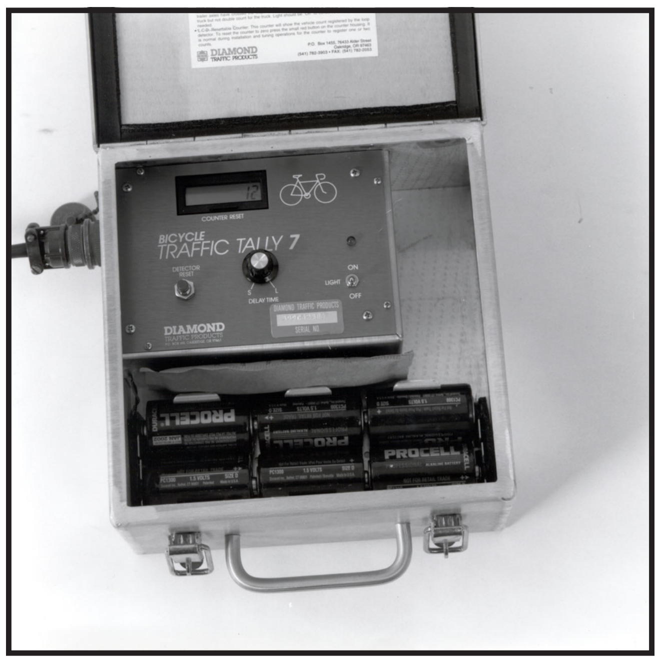


Figure 11—Traffic Tally-7 bicycle counter.

1 year. The count is displayed on an eight-digit LCD that can be reset. The enameled steel case is weather-tight and lockable. The detector is self-tuning and works best with small loops (less than 100 microhenrys).

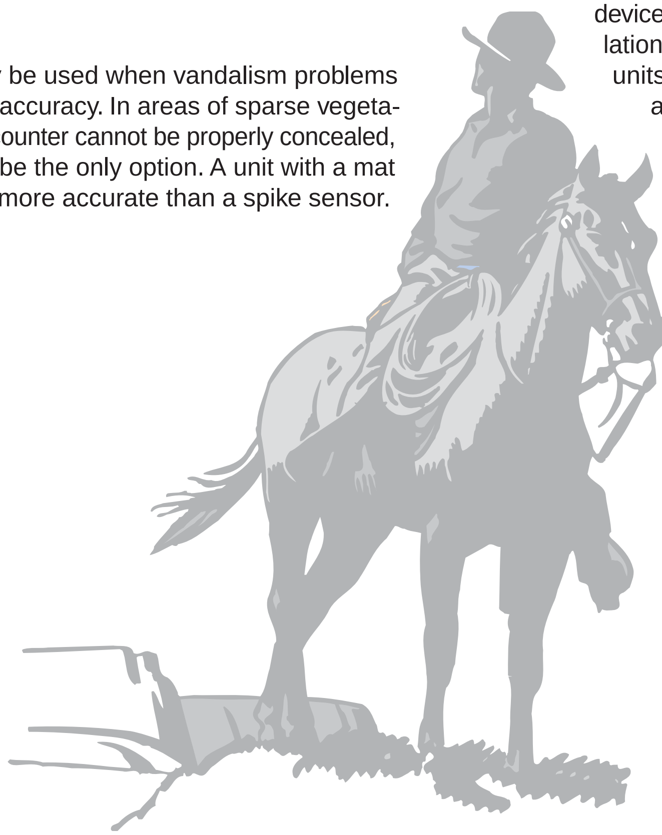
Conclusions and Recommendations

Based on testing and evaluation, MTDC recommends an active infrared system for most trail-monitoring situations. The through-beam counters may provide higher accuracy than the retroreflective designs for marginal installations. They are less likely to be discovered because they do not require the use of a highly visible retro-reflector.

A seismic system may be used when vandalism problems outweigh the need for accuracy. In areas of sparse vegetation where an infrared counter cannot be properly concealed, a seismic sensor may be the only option. A unit with a mat or tube sensor will be more accurate than a spike sensor.

Passive infrared systems should be reserved for situations that require a small, lightweight unit that must be set up quickly. Accuracy will be sacrificed and numbers will only reflect trends.

The primary objective for using trail monitoring devices is obtaining accurate data. Proper installation is crucial with all of the devices. All of the units tested provide excellent documentation and include tips and hints for eliminating false counts. When these guidelines are followed, the accuracy of the units is significantly improved.



Purchasing Information

None of the trail counters evaluated is on the General Services Administration's schedule. The counters can be purchased directly from the manufacturers. Approximate prices are included in Table 2. Contact the manufacturers for current pricing.

Compu-Tech Systems, LLC
P.O. Box 6615
Bend, OR 97708-6615
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Fax: (805) 541-4161
Web site: http://www.cuestasystems.com
E-mail: info@cuestasystems.com

Diamond Traffic Products
P.O. Box 1455, 76433 Alder St.
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E-mail: DiamondTrf@aol.com

Ivan Technologies, Inc.
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Fax: (860) 693-4888
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Library Card

Gasvoda, Dave. 1999. Trail traffic counters update. Tech. Rep. 9923-2835-MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 14 p.

This report updates a 1994 report, *Trail Traffic Counters for Forest Service Trail Monitoring* (9423-2823-MTDC). Three types of trail counters were evaluated: active infrared, passive infrared, and seismic. The report recommends an active infrared system for most trail monitoring situations because these systems provide the most accurate counts. One disadvantage of infrared systems is that they are harder to hide from vandals than seismic systems, particularly the active infrared systems that require bright reflectors to return the beam to the sending unit. Passive infrared systems should be reserved for situations that require a small, lightweight unit that must be set up quickly. Seismic systems may be used when problems with vandalism outweigh the need for accuracy.

Keywords: inductive loops, infrared sensors, monitoring, seismic sensors, sensors, visitor use

Additional single copies of this document may be ordered from:

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