BRUNEAU DUNES

TIGER BEETLE INVENTORY

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INTRODUCTION

In the decade of the eighties a tiger beetle now known as The Dunes Tiger Beetle became a species of concern. The range of this species, Cicindela arenicola Rumpp, is restricted to the dune systems associated with the Snake River in Idaho. Collectors and naturalists found the numbers of this species to be greatly reduced in the Bruneau Dunes State Park area. Also, it was no longer found at some localities where it had been previously collected (Anderson 1988). In accordance with the Endangered Species Act, the Dunes Tiger Beetle (Cicindela arenicola Rumpp) has been designated a Category 2 species.

William F. Barr of the University of Idaho first collected the beetle in 1963, and Norman L. Rumpp later described it (Rumpp 1967). Cicindela arenicola is one of sixteen tiger beetles known to occur in Idaho, and is apparently the only species limited to Idaho (Shook 1984). The species' range extends from the general area of the Bruneau Dunes State Park in Owyhee Co. in the west to the St. Anthony dunes complex in Freemont Co. in the east. The eastern populations evidence high numbers and appear to be thriving (Anderson 1989). In contrast, the western populations occur at much lower numbers and are thought to possibly be on the verge of extinction (Anderson 1989).

Cicindela arenicola is reported to have both a spring and fall activity period but is inactive during the hottest summer months. Adults mate and lay eggs in the spring, and first instar larvae hatch in late spring or early summer. Both adults and larvae are predators on other invertebrates (Anderson, 1988). Adults actively run over open dunes in search of prey and mates (Plates 1 & 2). Larvae live in vertical burrows where they wait for passing prey. Larval burrows are more common in the more stable, flat areas where the sand is not actively drifting (Plates 3 - 5). Larvae require two to four years to complete their development during which time the burrow is periodically excavated to a larger size and depth (Bauer 1991). Piles of small balls of excavated material are a great aid in finding these burrows which

otherwise blend very well with the background, especially when the head capsule of the waiting larva fills the burrow opening (Plate 6).

This study had two major objectives:

1. to determine the distribution of Cicindela arenicola at this time within Owyhee County.
2. to estimate the size of the population of C. arenicola at Bruneau Dunes State Park.

OBJECTIVE ONE: DISTRIBUTION OF CICINDELA ARENICOLA IN OWYHEE COUNTY

INTRODUCTION

Previous reports indicated that Cicindela arenicola existed in very low numbers in a very limited area in Owyhee County. The only known sites were within, or bordering Bruneau Dunes State Park (Anderson 1989, 1992). These previously known sites and other prospective areas within the park were checked by foot surveys. All terrain vehicles were not used due to the fragile nature of the habitat and the wary nature of the beetles. Foot surveys were also conducted in other areas of Owyhee County far removed from the park. Areas outside the park were selected for survey using soil maps provided by Jim Klott of the Twin Falls Office of the Bureau of Land Management. Surveys were conducted in areas with sandy soil in hopes that these areas might provide conditions adequate to support populations of the beetle. As a result of these surveys the Dunes Tiger beetle is now known to occur at two sites in Owyhee County: the previously known Bruneau Dunes State Park area and the newly discovered Windmill Site, located about 13 km east of Bruneau Dunes State Park.

DISTRIBUTION AT BRUNEAU DUNES STATE PARK

Surveys conducted within the park established the existence of one large area (Site C below) and several limited areas wherein small subpopulations of the beetle occur. Areas of suitable habitat are generally located in the rather flat transitional zones situated between the barren

sand dunes and the surrounding desert vegetation. Cicindela arenicola had been seen in some of these areas in the past, but generally in quite low numbers. Historically, collectors favored the smaller subpopulations that occurred along the old boundary on the western side of the Park. These sites were designated populations A and B by Anderson in his 1992 report (See Plates 7-10). Collectors indicate that historically these sites had much higher numbers of adults and were, therefore, those sites more often frequented for the collection of adults of this species. (G. A. Shook, personal communication). Site C is situated about 1.5 km southwest of subpopulation A. It is the largest subpopulation at Bruneau Dunes State Park with about 84,250 sq. meters of larval habitat (see Map 1).

The smaller subpopulations are principally distributed along the eastern and southern edge of the major dune system of the Bruneau Dunes State Park. They display a patchy distribution. The scope of this report does not include measurement of these habitat patches or comprehensive surveys for the estimation of the numbers of adults and larvae in each area. Their collective numbers appear lower than those for the single, larger subpopulation at Site C. George Stephens of the Conservation Data Center conducted the surveys which pinpointed many of these smaller communities at Bruneau Dunes State Park. Copies of George Stephens' field notes are included as an appendix of this report. All locations where C. arenicola is known to occur at the Bruneau Dunes State Park are given on the map (see Map 1).

A NEW SITE

Surveys conducted at locations outside of Bruneau Dunes State Park disclosed the presence of a previously unknown population of the Dunes Tiger Beetle. This new locality is about 13 km east of the park and has been named the Windmill Site since a windmill is located nearby (see Plates11-16). The area is accessed from Pot Hole Road south of Hammett in Owyhee County (see Map 2). Surveys conducted for this area disclosed very limited numbers of both adults and larvae.

The Windmill Site represents a distinct biological population well isolated from other known populations in the western portion of this species' range. The inoperative windmill at this site may have served to concentrate cattle activity in past years. Cattle activity has been shown to have a potentially negative impact on larval survival of Cicindela arenicola (Bauer 1991). This beetle population may have been adversely impacted in the past by cattle routinely traversing the larval breeding areas on their way to water.

Time limitations precluded an extensive inventory of the Windmill Site population this year. Three walk-through censuses to assess adult numbers were done. No more than 10 beetles were seen on any one of the surveys. Three adult beetles of C. arenicola were collected as voucher specimens for this site on May 1, 1993. The area in which larval burrows are known to occur is estimated to be about 500 m long by 50 to 75 m wide. This is not a very big area to sustain a population. The area where larval burrows occur runs generally north to south in a depression along the eastern edge of the largest dune complex at this site. Areas of larval habitat have a quite patchy distribution within this general area. The brief survey conducted on May 1 for larval burrows indicated that they were at a lower density here than at site C at Bruneau Dunes State Park. There was evidence of some off-road vehicle use at this site with a few old tire tracks running through the larval habitat area.

A few specimens of a related species, Cicindela tranquebarica, were also collected at this site. Larval habitat for C. tranquebarica is found within this dune system where the wind has exposed an area of saline clay substrate with a high soil moisture level. This was the only other species of tiger beetle collected on the visits to the Windmill Site this year. Photographs of this site are provided in the appendix.

OBJECTIVE TWO: POPULATION SIZE ESTIMATION OF CICINDELA ARENICOLA FOR SITE C AT BRUNEAU DUNES STATE PARK

PART 1 : ADULTS

Introduction

A mark and recapture technique was used to develop a population estimation for adults of C. arenicola in the eastern portion of its range (Anderson 1989). The very low numbers of adults seen in the western populations required the use of a different technique for the estimation of population size. It was deemed better not to stress these few adults by netting, marking, and attempting recaptures.

Materials and Methods

The surveys for adults started at a marker (stamped C1/4, S27,T6SR6E) near the south end of this dune system. Three observers walked north in a line on the open dunes with a distance between them of about 10 m. The observer on the eastern end of the line adjusted to topographical changes so as to remain about 10 m from the edge of the open dune system. The other observers adjusted their line of march to accommodate for changes in direction taken by the observer on the eastern end. The length for this line of march was about 850 m with a width of about 40 m. The area surveyed was 3.4 hectares. Surveys were done in the morning when surface temperatures became optimum for beetle activity (80-110 ° F). Sighted adult beetles were counted only when they were passed or they flew behind the line of walkers so as not to recount the same beetle.

Results

The results of the three surveys are as follows:

DATE	TEMPERATURE		NUMBER OF ADULTS
	Sand Surface	Air	
May 12, 1993	110°F	94°F	9
May 13, 1993	85°F	76°F	8
May 14, 1993	86°F	76°F	11

The total area for each of these surveys was 3.4 hectares. The average number of adults seen during each of these three surveys was 2.7/ hectare.

Discussion

The number or adults seen per hectare at Bruneau Dunes State Park was much lower than the number seen by Anderson (1989) in the eastern portion of the range of this species. We saw an average of 2.7 beetles/hectare. Anderson reported 7.6 beetles/hectare for the smaller, more heavily vegetated dunes and an average of 14.26 beetles/hectare for the larger, more open dunes which represented the better habitat for the Dunes Tiger Beetle. It is of interest to note that his lower values were reported for those dunes which for vegetation and size are more like the dunes seen at Bruneau Dunes State Park.

The highest number of adults seen on any walking survey for 1993 was 11 beetles. Such low numbers could easily contribute to significant errors in population estimation. Although our measures of density did not vary widely over time, we feel little confidence in the reliability of our measures. This is because surface conditions on the dunes can fluctuate widely within very short time periods. The beetles adjust their activities according to the prevailing conditions. Whenever it is too hot or too cold adults will burrow into the sand. At the time of a survey not all adults may be active, due to the topographical differences at the various places where they have burrowed into the sand. In surveys of large populations such variability is less important.

With very small populations, however, the absence of just a few individuals could greatly skew the results. The very wary nature of the adults also made detection difficult. When the wind was blowing, movement of vegetation and drifting debris made detection of flying adults virtually impossible.

The very low number of adults, their very wary nature and cryptic condition, and the rapid fluctuation in conditions which determine their observability suggested that an alternative method should be employed to estimate the size of the beetle population at Bruneau Dunes State Park. Accordingly, a method utilizing the number of late instar larval burrows was developed for population size estimation. Late instar larval burrows are burrows with a diameter of at least 4 mm and which presumably contain only third instar larvae.

PART 2: LARVAE

Introduction

Late instar larval burrows should provide a more reliable basis for deriving an estimation of population size. We decided to use the number of late instar larval burrows (4 mm diameter openings) as the basis for population number assessment for the following reasons:

1. The burrows are regularly available for counting throughout the early spring activity period. The presence of adults, by contrast, is much more dependent on weather conditions. The burrows generally remain open under cool, windy, or cloudy conditions. Such conditions often cause the adults to take refuge beneath the surface where they are unavailable for survey purposes.

2. Only the largest class size (4 mm) was used to derive a population size estimation since the smaller burrows are much more difficult to see and could more easily be overlooked. Use of only the largest size should reduce counting errors.

3. The 4 mm size burrows contain the largest larvae and these are more likely to successfully reach adulthood. This 4 mm cohort is, therefore, the best size class for predicting adult numbers in the next year.

4. The burrows have a fixed position which can be mapped and marked and used for other study purposes if desired.

Larval burrows are available throughout the seasonal activity period of this beetle. They are apparently opened in the spring at very nearly the same time that adults appear. Burrows probably have a permanent location once established but larvae are reported to occasionally abandon a burrow, move, and quickly excavate a new burrow (Pearson 1988). Some burrows were still active on June 4, 1993, when the field work for this study was concluded. No adults were seen after May 19 of this year. An estimation of the population size was done by counting the number of the late instar larval burrows present in systematically placed quadrats and then extrapolating for the total area of larval habitat.

Materials and Methods

Larval habitat occurs in a narrow band between the drifting sand of the dunes and the established desert plant community. This ecotone band is characterized by scattered sandy hummocks with interspersed flat areas of varying size. Sandy hummocks generally support some type of vegetation (cheat grass, rice grass, sand-bur, and Russian thistle) which serves to hold the drifting sand. The intervening flat areas have a covering of small gravel, pebbles, or rocks which helps to stabilize the underlying sand. These flat areas usually lack plants but may support a limited number of the same species of plants that occur on the hummocks. When plants are present in the flat areas, they are smaller and appear to be more stressed than those on the hummocks.

The length of the larval ecotone habitat is approximately 950 m in a north-south direction. The width of the band in an east-west direction is about 100 m, tapering to 50 m in the last 100 m at each end. The band is shaped in a gentle arc (see Map 1). Initial plans envisioned transects at every 40 m, but time constraints required that some be done at every 80 m if the entire area was to be surveyed. Eighteen west-to-east transects were established along the length of the arc. The length of the transect varied with the distance to which larval habitat extended out from the dune system. Three transects on the ends were only 50 m long. All others were 100 m long. Transects A through G are 80 m apart. Transects N9 through S1 are 40 m apart. The distance between transect G and transect N9 is 54 m, and the distance between transect S2 and S1 is 57 m. (see Fig. 1). The larval habitat area that was studied is estimated to occupy 84,250 sq. meters.

Each transect started at the edge of the drifting sand that bordered the west side of the larval habitat. The transects traversed to the east across the ecotone band to terminate in the more established plant community that bordered the east side of the larval habitat. Transects started at a point on the dune that was within a few meters of where the dune stopped and the transition habitat that supported larval burrows commenced. They ended in an area which was beyond the preferred transition habitat where the larvae normally occur (see Plate 17).

Permanent markers (orange-painted digger bars pounded to within a few inches of the surface) were placed at the starting and ending points for each transect. Additional digger bars were placed at every 25 m along each transect. The starting point of each transect was flagged, as were the end points of most transects. Transects were established using a surveyor's Brunton compass and tripod on a sighting of N30W/S30E. A meter tape was affixed to the zero, 50 and 100 m digger bars as a reference line for positioning of quadrats. Every other square meter of habitat along the north side of the transect was inventoried using a quadrat that was 1 m^2. A

coin toss determined whether odd or even numbered quadrats on a given transect were inventoried.

Data was taken for each quadrat by one observer on the south side of the quadrat and another observer on the north side. Estimations of each variable (see below) were made by each observer; when different values were obtained a reevaluation was done to the mutual agreement of the observers (see Plate 18).

The information obtained for each quadrat surveyed is as follows:

1. Number, size, and placement of any larval burrows.

   The diameter of the opening of each larval burrow was measured. There were three classes for the diameter of the larval burrows: 2, 3, and 4 mm. The particular decimeter square of the quadrat in which each burrow was located was also recorded.

2. Percent vegetation cover.

   Vegetation cover was estimated to the nearest 5%.

3. Nature of the composition of the surface layer.

   Surface coverage with sand, gravel, pebble or rock was determined. Sand was material of less than 1 mm diameter, gravel was from 1 to 3 mm diameter, pebble was 3 to 13 mm diameter, and rock was greater than 13 mm diameter. Percent coverage within each quadrat was estimated for each of these four categories.

4. Topography.

   The surface was rated as **level** if it was flat and not inclined, as **even** if it was flat but inclined, or **uneven** if the surface was irregular due to the presence of hummocks.

Great care was taken to minimize the impact of this survey upon the habitat under investigation. Bauer (1991) had previously demonstrated that cattle walking on burrows could collapse the burrow tubes of the larvae of this beetle such that they could not recover. Early in this study experimentation was done with special footwear (sandshoes) that more widely distributed one's weight, but the footwear proved too cumbersome. A simple compaction test was also conducted with normal footwear. One person deliberately stepped twice on the opening of two burrows of the 4 mm diameter category. Although both burrows were successfully reopened by the next day, it is likely that repeated trampling would reduce survival. A larger sample size was not used due to the sensitivity of this species. The amount of compression and general disturbance caused by someone walking on larval burrows could be expected to be greater if the sand was much drier or if the sand was of a much finer nature. It is also likely that smaller diameter burrows, especially the 2 mm size, would be less likely to successfully recover from such disturbance. The period of larval hatching and establishment which occurs in late May and early June would be a time when these very small larvae with rather shallow burrows would be most sensitive to surface disturbance.

As the work progressed it became quite evident that burrows of the beetle larvae occurred nearly exclusively in the flatter, more open areas. We could generally avoid walking on burrow openings by keeping to the elevated hummocks. When forced to traverse the areas of larval habitat we went slowly and stepped only where no burrow openings were seen. Anyone following walked in the footprints of the lead person (see Plates 19 & 20).

Results

Density and Total Population Size of Late Instar Larval Burrows

Twelve late-instar burrows were seen in the 825 quadrats, each 1 m^2, that were carefully inventoried. From these data we can estimate first, that the density of burrows is 0.0145455 burrows/m^2 (+/- 95% CI) and second, that the total number of late-instar larval burrows is

1,225.5 for Site C, with a 95% confidence interval of 521.5 to 1929.5 (Scheaffer, et al., 1979). The coefficient of dispersion (variance to mean ratio) for the number of larvae per quadrat equals 0.987, which gives no evidence of non-random distribution (clumped or uniform) of larvae, at least at the scale of 1 m^2 quadrats.

The design of the larval study was such that all larval habitat was supposed to occur within the transect grid. During the latter part of the project several small outlying areas of larval habitat were found just east of the study area for site C. The collective size of these outlying communities was not deemed large enough to materially affect the study. Our best estimation is that the total square meter area of all of the other larval habitat at the Bruneau Dunes State Park including these outlying areas near site C does not exceed the total square meter area surveyed this year for site C. The total late-instar larval population for Cicindela arenicola at Bruneau Dunes State Park probably does not exceed 2,500 specimens, with a 95% confidence interval of 1,043 to 3,859.

Habitat Preference of Larvae

Larval burrows of all ages occurred in only 23 of the 825 quadrats surveyed. For these 23 quadrats there were only 12 burrows of the 4 mm diameter size. Larvae were most likely to occur in quadrats wherein the mix of surface materials was 30% sand, 40% gravel and 30% pebbles (Figures 2-4).

By using the frequency distributions of the quadrats without larvae as a measure of the available habitat, we can make several conclusions about the habitat preferences of larvae. First, larvae occur more than expected in areas of 30-40% sand, and substantially less than expected where coverage with sand was greater than 50% (Fig. 2). Larvae also were more common than expected in quadrats with gravel comprising 30-50% of the surface, and were less common than expected in areas where gravel was less than 10% of the surface (Fig. 3) . Larvae were

more common than expected in areas with a 20-40% pebble cover, and less common than expected where pebble cover was 10% or less (Fig. 4).

Larvae occurred more commonly than expected in areas with little vegetation cover. Over 90% of the burrows were in areas where the vegetation cover did not exceed 30% and nearly 50% of the larvae were found in areas with zero to 10% vegetation cover (Fig. 5).

Approximately 60% of the larval burrows occurred in areas categorized as uneven while 40% of the burrows occurred in the areas designated as even or level. However, since the uneven habitat is far more common (4.8 times as common), the larvae clearly prefer or survive better in areas that are even or level (Fig. 6).

Examination of how habitat affinities differ among age classes (Figures 7 and 8) should yield some insight into the mechanism that causes the preferences thus far discussed. If habitat preference is expressed by females laying eggs, then the three age classes should have similar frequency distributions. If females lay indiscriminately and habitat preference is caused by higher survival in some habitats than in others, then the age classes should have different frequency distributions, with 2 mm larvae distributed similar to plots with no larvae and 4 mm larvae showing a distinct preference. The actual result is closer to the latter, although low sample sizes make definitive determination impossible. Two mm and four mm larvae both appeared to have higher than expected occurrences at low percent of vegetation, indicating that a preference for non-vegetated areas is exhibited at the egg-laying stage.

Discussion

The density of burrows for the Dunes Tiger Beetle at Site C was quite low compared to that seen for several other species of tiger beetles in this part of Idaho. Larval densities for the populations of this beetle in eastern Idaho have not been reported. It is quite possible that they

are higher than those seen for western populations since the adults are reported to have much higher densities in the eastern populations as discussed previously.

The reliability of estimates made during a single year is questionable. First, the spring of 1992 was exceptionally wet and cold, and a phenological delay of two to three weeks was common for most events. The effect of this on adult beetle activity and density is difficult to estimate. Second, Cicindela arenicola requires two to four years to reach the adult stage (Bauer 1991). Accordingly, populations of adults may naturally have high and low years which are the result of good or bad habitat conditions over the one to three years preceding a count. The number of larval burrows could be affected in a similar fashion. To accurately or meaningfully inventory the population and assess population trends would require five or more years of annual monitoring for a species such as C. arenicola.

Late in the study (May 18 to June 4) after most of the survey work had been completed, high numbers of 2 mm diameter burrows appeared at many places within the area of Site C. The high number of these burrows (which are made by hatching larvae) indicated that a great amount of ovipositional activity had occurred even though the number of adults observed on any day was quite low. This would have occurred if peak adult activity occurred this year at times when no surveys were conducted. Another possible explanation is that multiple year diapause is known for certain stages of some insects so there is also the possibility that eggs of this species may lie inactive in the sand for more than one year before optimal conditions stimulate hatching. This would most logically occur in areas where the surface was stable from year to year such as the flat areas with gravel and pebbles. These areas would provide more protection for eggs than the open, changing dune habitat.

Anderson (1988) noted that the widespread occurrence of new larval burrows at the time of hatching reflected an apparent non-selective ovipositional behavior for females of the eastern

populations. By contrast, the new 2 mm diameter burrows at Bruneau Dunes State Park appeared almost exclusively within the flat areas, very few being found in the very sandy areas (see Plate 21). The analysis of the habitat data provides additional support for selectivity of habitat in choosing oviposition sites since 2 mm larvae tended to occur more than expected in areas with moderate sand and low vegetation cover.

Anderson (1989) indicated that this beetle did not occur on many of the dunes in Power Co. that were overgrown with vegetation. Such dunes were deemed by him to be "unsuitable for C. arenicola." The beetle apparently needs naked dunes in order to exist. We concur with him on this point and suggest that the low numbers of beetles at Bruneau Dunes State Park may primarily be due to vegetational encroachment upon the critical habitat for this species. Two exotic species of plants, Russian thistle and cheat grass, are quite common in much of the habitat where the larvae are found.

Overgrowth of these areas by weedy species could result in lower survival of larvae since they have evolved to live in open areas. The presence of vegetation would hinder burrow maintenance and could make the larvae more vulnerable to predators, parasites, and parasitoids. Vegetation could prevent the larvae from being able to throw out the sand balls, and vegetation situated directly above the burrow opening could complicate prey recognition by the tiger beetle larvae. This could interfer with effective capture of the prey. Shading could also adversely impact laraval success (see Plate 22).

Increased vegetation would also provide more cover and protection for lizards which can be a significant predator of adult tiger beetles (Pearson 1988 and Anderson 1990). It is quite possible that the beetles seek the open dune areas for foraging and mating so as to avoid predation by lizards. Leopard lizards were often spotted taking refuge in the vegetation of the sand hummocks. The female beetles are believed to enter the flats among the hummocks in order

to find ovipositional sites. It is of interest that this species was found most abundantly this year on these ovipositonal sites at the time of the first visitation. This was on April 20 with an air temperature of only 64 ° F. The lizards were not active under these conditions. We suggest that the early activity of this beetle may be an adaptation to avoid the increased risk of predation by lizards that comes with the warmer temperatures later in the spring.

It is the opinion of the writer that the most critical factor in the survival of C. arenicola at this time is the availability of adequate and undisturbed non-vegetated habitat that will support larval development for a two to four year period of time. This habitat needs to be in the close proximity of open dunes where the adults can forage and mate.

MANAGEMENT RECOMMENDATIONS

The several communities of the Dunes Tiger Beetle which occur in Owyhee Co. present a range of challenges if their continued viability is to be ensured. These populations and subpopulations can be formed into three groups for purposes of future monitoring and management.

Group one is a collection of smaller and rather scattered subpopulations within Bruneau Dunes State Park. These disjunct subpopulations occur in a general arc to the east, south and west of the main dunes complex within the park. Populations A and B in the reports written by Dr. Robert Anderson are included in this group.

Group two is the extensive subpopulation that is located along the east side of the low dunes complex located above the bluffs at a higher elevation in the southwest corner of Bruneau Dunes State Park. This area is also referred to as Site C or Population C in earlier reports.

Group three is the newly discovered Windmill Site. The beetles at the Windmill Site certainly qualify as a true biological population. The very isolated nature and very small size of this site

probably precludes regular genetic exchanges from occurring between this population and other populations.

Recommendations for Group One

It is recommended that present management practices continue for these scattered communities. It appears that the habitat available for successful larval reproduction is quite scattered and quite limited throughout the range of this group. It is very difficult to assess the impact of introduced species of plants on the vegetation pattern for these scattered areas; it is unknown if these species are increasing, decreasing, or stable. Such species as Russian olive trees and Russian thistle have certainly impacted the area and have produced changes in the landscape which may have caused the perceived decline in numbers of this species.

Vegetational overgrowth is probably deleterious to larval success. The dunes tiger beetle appears to need rather flat, open habitat for larval reproduction and is apparently adept at locating such areas as they form. This permits the species to colonize new areas to replace those that are no longer adequate due to changes in vegetation and dune topography. It is very probable that historically there have been short-term and long-term fluctuations in the population numbers of this species. Accordingly, it is virtually impossible to determine in one year whether or not current numbers of this species are really depressed due to man's impact or are at a low in a cycle that results from climatic fluctuations and natural biological factors.

It is unknown at this time if cattle or humans have adversely impacted the newly hatched larvae of this species during the hatching period when they are establishing their first larval burrow. This critical period occurred during late May and early June this year. It is generally quite hot by this time in the season and the elevated temperatures tend to reduce park visitations. The more isolated and less attractive areas which serve as breeding areas are rather infrequently used by visitors at this time. It is recommended that the use of these areas during this period,

especially by large groups, be discouraged. Should burrows be trampled by humans during other times of the year there is the possibility that at least the more mature larvae would be able to reopen the burrows. The impact of repeated trampling by humans, however, is unknown.

In the event that serious negative impacts brought about the demise of one or more of these scattered subpopulations there is a very high probability that recruitment from other nearby subpopulations would bring about recolonization. It is even possible that adults move about among several of these nearer areas. Should all of the subpopulations of this group gradually decline and fail, re-establishment would be possible from the larger subpopulation at Site C which is situated on higher ground southwest of the general park area.

It is recommended that the known larval habitat areas for group one be surveyed for the presence of mature larval burrows at least every two years so as to document the occupation of these sites by the dunes tiger beetle. The number of adult beetles seen on each of these surveys should also be recorded. Such survey work would complement that done this year and would provide data for monitoring the general trend in numbers for these scattered communities. These surveys should be conducted when weather conditions are proper for adult activity.

It is further recommended that the surveys be done when the sand lily (Leucocrinum montanum Nutt.) begins to flower (Plate 23). The initiation of activity by the dunes tiger beetle adults appears to coincide closely with the initiation of flowering by the sand lily. The monitoring of this plant would appear to provide a good guage for when the beetle commences surface activities. Calendar dates are less reliable since seasonal variation due to weather conditions can significantly advance or delay biological activity patterns. Adult beetles were seen on dunes at Site A on March 22 this year. No flowers were open on the sand lily although buds were evident.

Recommendations for Group Two

Group two is synonymous with population C of Anderson's report (1992). It is the largest subpopulation known for the Dunes Tiger Beetle in the western reach of its range. It was first discovered on April 28, 1992 at the time of the workshop by Anderson on this species. Plans call for the inclusion of this area within the boundary of the Bruneau Dunes State Park. The construction of a fence along the western and southern boundaries by the end of the 1993 calendar year will provide initial protection for this site. This subpopulation will then be included within the area protected by Bruneau Dunes State Park. The fence should efectively exclude cattle and off- road cyclists.

This dune system did not appear to be highly impacted by human activities during the spring months of this year. During the course of the survey work done from April to June of 1993 no humans were seen to visit this area. A few old wheel tracks from prior years were still visible. It is quite unlikely that hikers would utilize these more remote dunes. The low and rolling nature of these dunes offers little in the way of a recreational challenge for hikers. These dunes are not visible from the more highly developed recreational areas of Bruneau Dunes State Park situated at a lower elevation to the east.

Subpopulation C is well located for continued inventory and assessment studies since it is not generally impacted by human activity. Such studies would provide data so as to establish population trends and elucidate species' dynamics. This area already has an established, extensive transect system for the purpose of estimating the mature larval population. Annual counts of larval burrows should be done for at least the next five years so as to establish the population trend. Counts should also be done for adult beetles at the same time even though they are less reliable for reasons discussed above.

Subpopulation C may well represent a "source site" as discussed by Hubbell and Foster (1986). All other sites in the Bruneau Dunes complex may, at least in the short term, represent "sink sites". The larger, more successful subpopulation C is well-positioned to produce colonizers for the patchy larval habitat found downwind. Subpopulation C may be the stable reproductive base that persists while the other areas may come and go.

All the subpopulations within the Bruneau Dunes State Park should be considered as one biological population since they are probably close enough to permit regular genetic exchange, considering the known flight capabilities and habits of other species of tiger beetles. Adults of normally diurnal Cicindela marutha are known to oviposit at night on dunes up to 1 km away from their diurnal pond edge habitat, and specimens of Cicindela trifasciata have been collected at lights on offshore platforms 160 km from the nearest land (Pearson 1988).

Recommendations for Group Three

The Windmill Site should be carefully inventoried in 1994 in view of its small size and unprotected nature. The area needs to be carefully walked and mapped so as to delineate all the currently active larval habitat areas. Surveys for both adults and mature larvae should be conducted to establish a baseline for the numbers of both categories occurring in this population. At a minimum, three walk-through censuses for adults should be done during the flowering period of the sand lily (Leucocrinum montanum Nutt.). A transect study should be performed so as to estimate the number of mature larvae for this small population. A count of first instar burrows should be done at the time that the first instar larvae hatch and establish their first burrows. Such counts may prove to be valuable in determining the collective ovipositional activity in any year.

The density of the first instar larval burrows may be a very good indicator for the viability of populations of this beetle wherever it occurs. Observations at Site C this year indicated a great overproduction of first instar larvae relative to the number of later instar larvae that survive. There is the possibility, however, that eggs laid in one season may not hatch until the next year if hatching conditions are not proper for this species. Thus, there may be an accumulation of eggs for a few years with extensive hatchings in years of very heavy spring precipitation. Careful studies need be performed to resolve questions such as this.

If studies at the Windmill Site establish that these dunes are subject to human disturbance such as camping, offroad vehicles, or all terrain vehicles, then an exclosure fence should be established to protect the very limited area of habitat that supports larval development.

This population is of considerable biological interest in that it is so small and so isolated. Its small size allows for ready inventory of the total population at relatively little cost. It is not recommended, however, that more extensive ecological studies be done at this site, at least in the near future. Disruption associated with such studies could overtax this site. Any studies involving manipulation of plants, predators, or parasitoids would more appropriately be assigned to the larger Site C area of the Bruneau Dunes State Park.

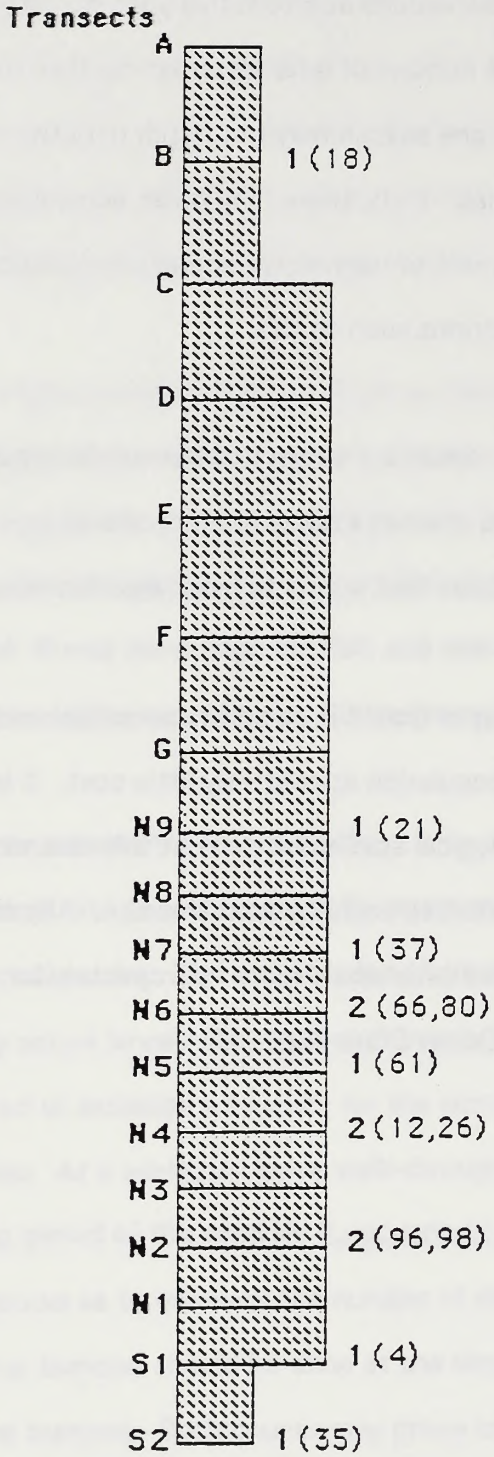


Figure 1
Schematic of area surveyed for larval burrows of Cicindela arenicola Rumpp at Site C. Transects A, B, and S2 are each 50 m long. All other transects are 100 m long. The distance between transects is to scale in this figure.

Bold numbers = number of 4 mm diameter burrows seen in that transect.

Number in parenthesis = number of the quadrat in that transect where the burrow was found.

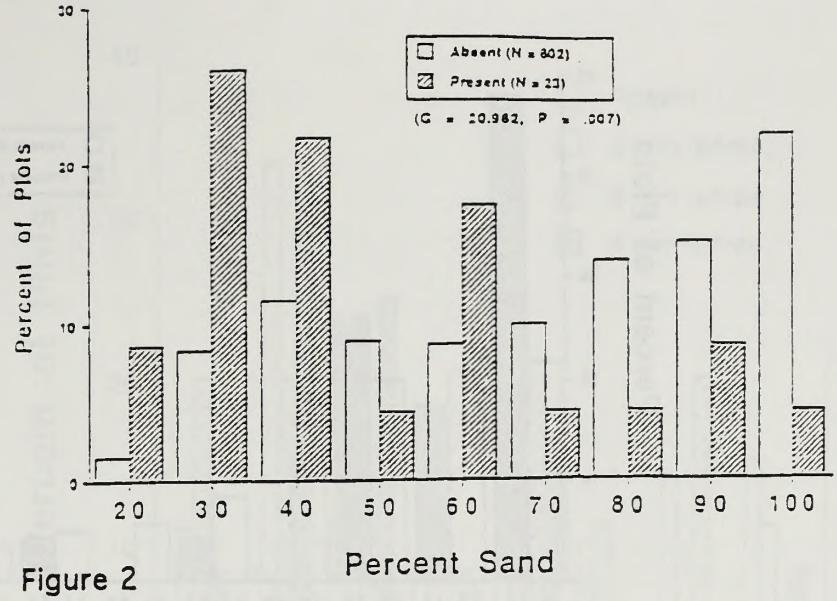


Figure 2

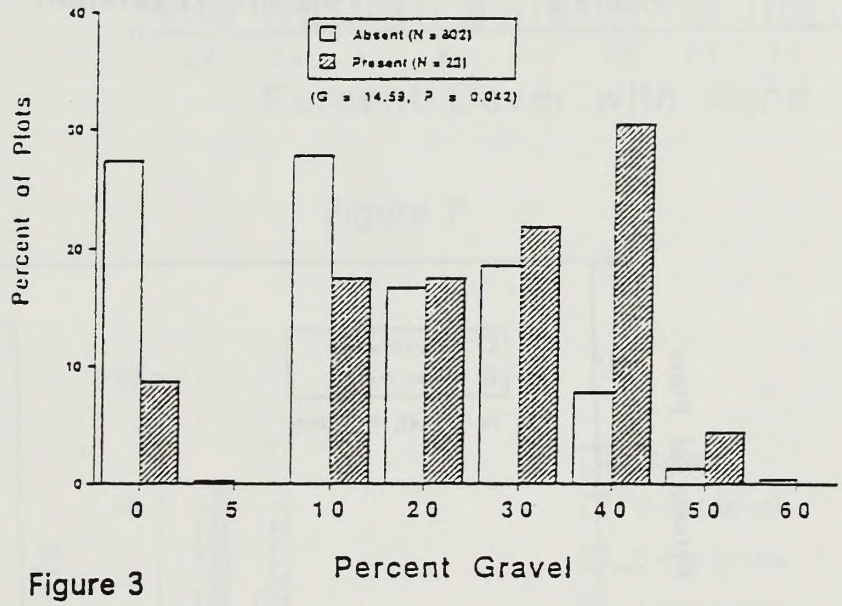


Figure 3

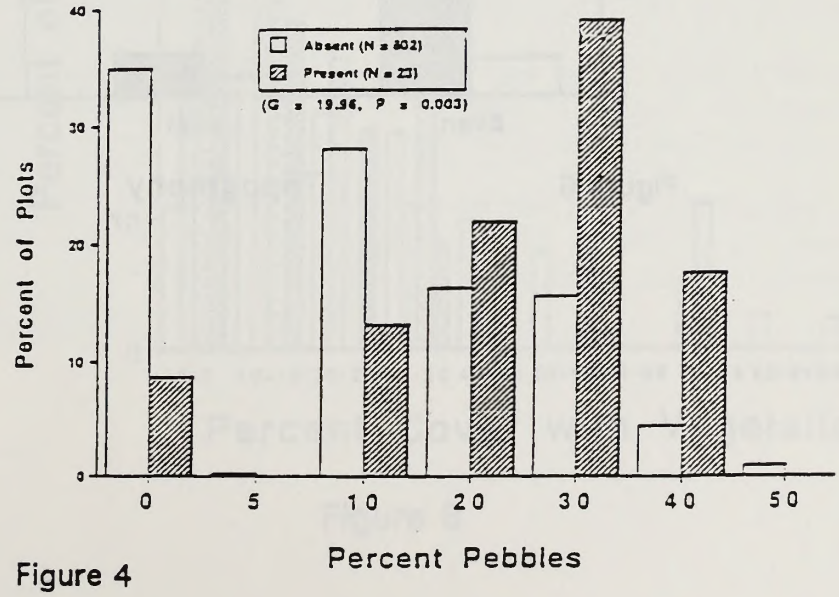


Figure 4

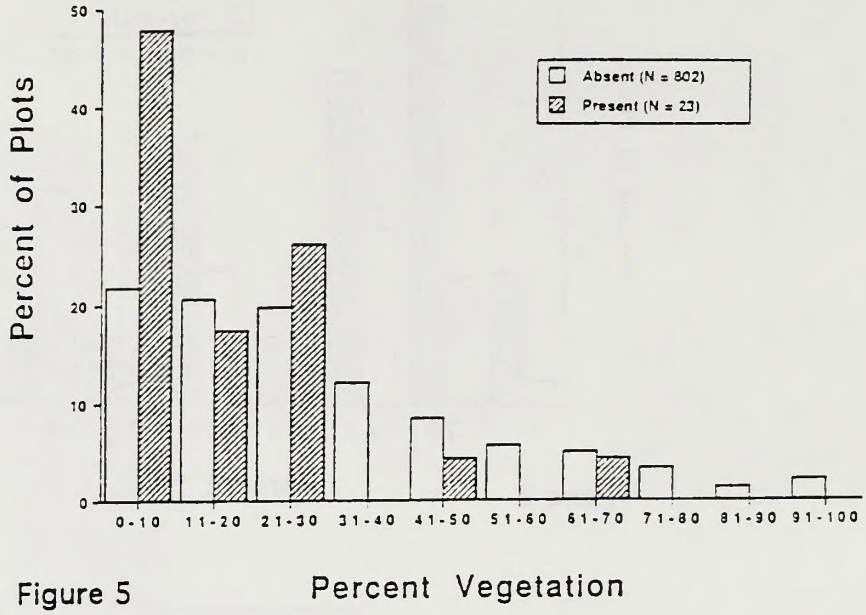


Figure 5

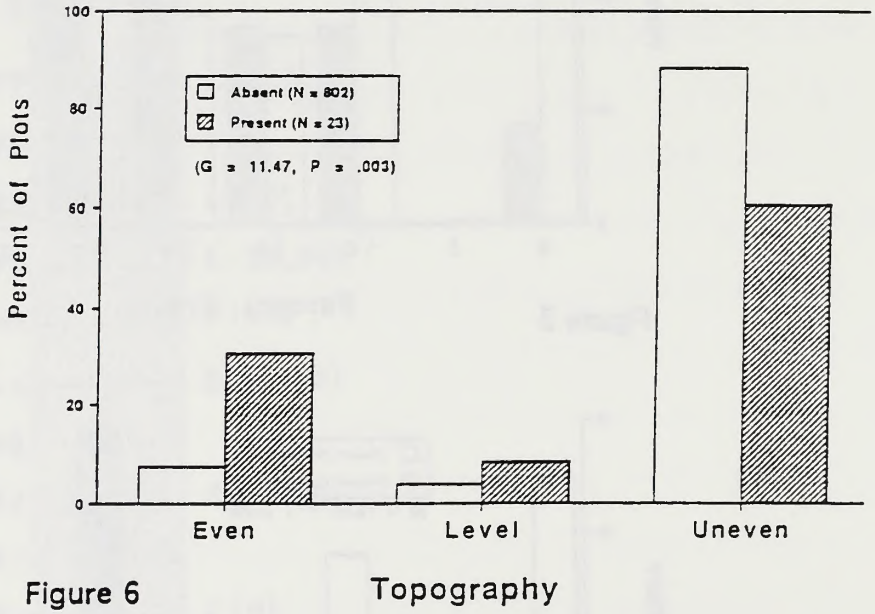


Figure 6

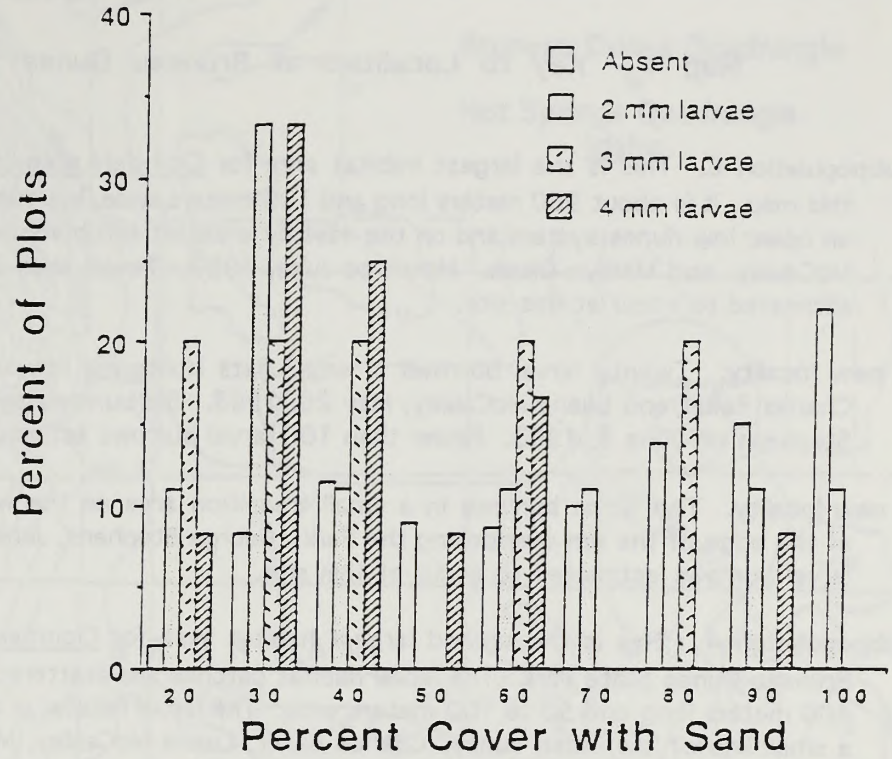


Figure 7

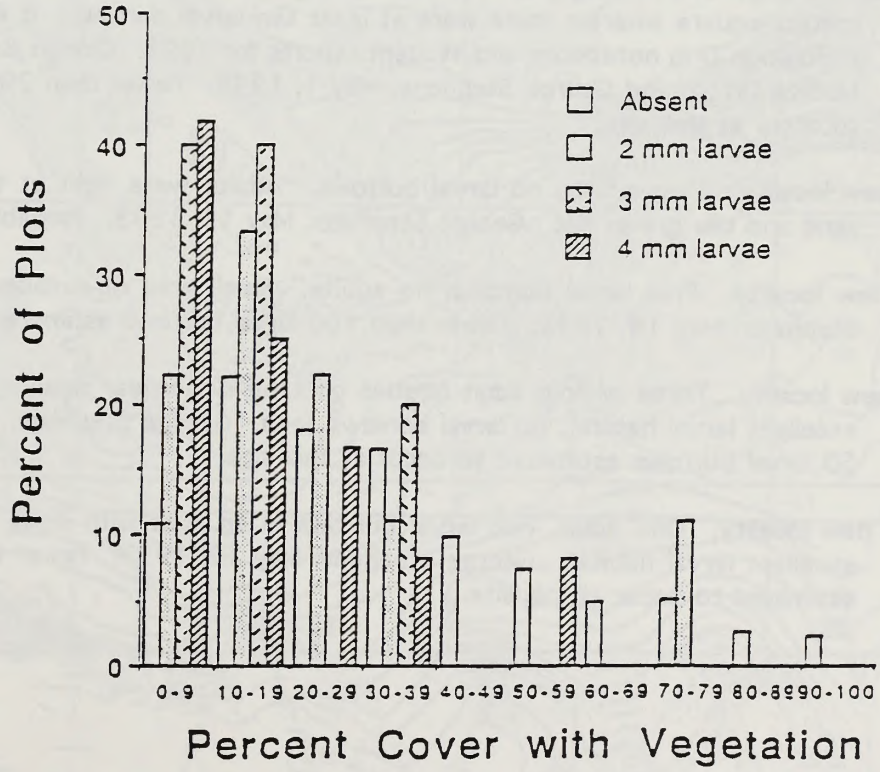


Figure 8

Map 1 - Key to Localities at Bruneau Dunes State Park

1. **Subpopulation C.** This is the largest habitat area for Cicindela arenicola for the area of this map. It is about 950 meters long and 100 meters wide, bounded on the west by an open, low dunes system and on the east by a desert shrub community. Charles Baker, Luana McCauley, and Marilyn Olson. March to June, 1993. Fewer than 2,500 larval burrows are estimated to occur at this site.

2. **A new locality.** Twenty larval burrows in small flats bordering low scattered dunes. Charles Baker and Luana McCauley, May 26, 1993. Six burrows seen here by George Stephens on June 8, 1993. Fewer than 100 larval burrows estimated to occur at this site.

3. **A new locality.** Ten larval burrows in a small transition area on the west flank of the big dune at the edge of the rim overlooking the Park. George Stephens, June 8, 1993. Fewer than 100 larval burrows estimated to occur at this site.

4. **Subpopulation A.** This is the second largest habitat area for Cicindela arenicola in the vicinity of Bruneau Dunes State Park. The larval habitat patches are scattered over an area about 200 to 400 meters long and 50 to 100 meters wide. The larval habitat is located along the east side of a small line of low, open dunes. Charles Baker, Luana McCauley, Marilyn Olson. March to May, 1993. Fewer than 500 larval burrows estimated to occur at this site.

5. **Subpopulation B.** No adults or larvae were seen here in 1993. No larval burrows were seen here in 1992. Mating adults were seen here by Charles Baker in 1992. Cicindela arenicola does not appear to currently occur at this site.

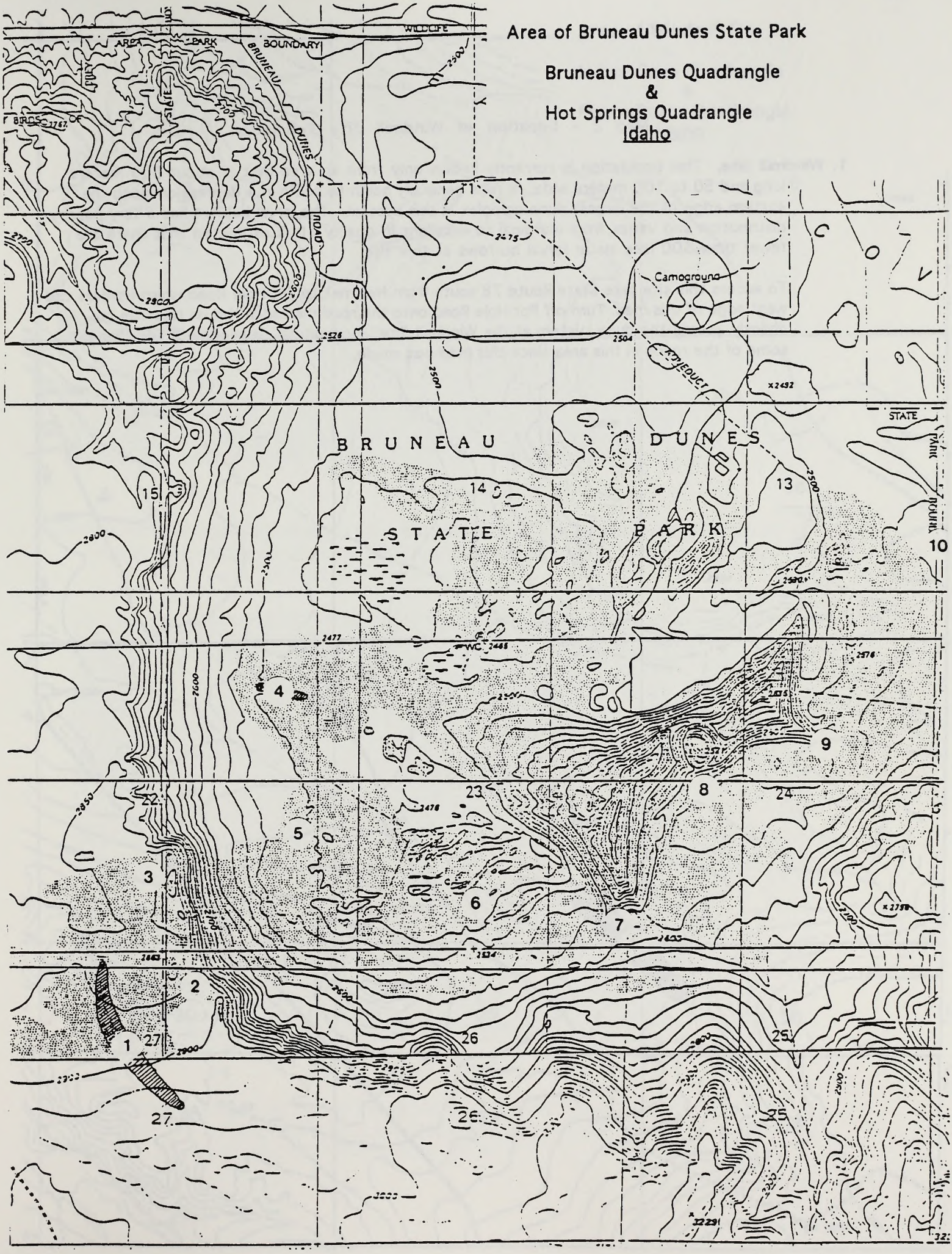
6. **A new locality.** One mating pair of beetles on an open sand slope above a small flat about 10 meters square wherein there were at least ten larval burrows. It was initially designated as Population D in notebooks and student reports for 1993. Charles Baker, Luana McCauley, Marilyn Olson, and George Stephens, May 1, 1993. Fewer than 200 larval burrows estimated to occur at this site.

7. **A new locality.** Two adults, no larval burrows. Adults were right at the interface of the bare sand and the gravel flat. George Stephens, May 19, 1993. Probably no burrows at this site.

8. **A new locality.** Five larval burrows, no adults. Small area of excellent larval habitat. George Stephens, May 19, 1993. Fewer than 100 larval burrows estimated to occur at this site.

9. **A new locality.** Three or four adult beetles on sand slope near small area of what appeared to be excellent larval habitat, no larval burrows seen. George Stephens, May 19, 1993. Fewer than 50 larval burrows estimated to occur at this site.

10. **A new locality.** One adult, two larval burrows in an area with small pockets of marginal to excellent larval habitat. George Stephens, May 19, 1993. Fewer than 100 larval burrows estimated to occur at this site.


Area of Bruneau Dunes State Park
Bruneau Dunes Quadrangle
&
Hot Springs Quadrangle
Idaho
BRUNEAU DUNES STATE PARK
Campground
BOUNDARY
WILDLIFE
BRUNEAU DUNES ROAD
STATE PARK ROAD
PIPELINE
1
2
3
4
5
6
7
8
9
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23
24
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26
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Map 2 - Location of Windmill Site Population

1. Windmill Site. This population is currently known only from an area that is about 500 meters long and 50 to 100 meters wide. It runs generally north to south in a depression along the eastern edge of the largest dune complex in this system. The larval habitat has a very patchy distribution and varies from marginal to excellent in quality. It is estimated that there are fewer than 500 late instar larval burrows at this site.

   To access this site take State Route 78 south from Hammet to Pot Hole Road which borders the west edge of this map. Turn off Pot Hole Road onto the road marked in red on this map to directly access the dune system at the Windmill Site. Agricultural development has changed some of the roads in this area since this map was made.

Area of Windmill Site

Indian Cove Quadrangle
&
Pence Butte Quadrangle
Idaho

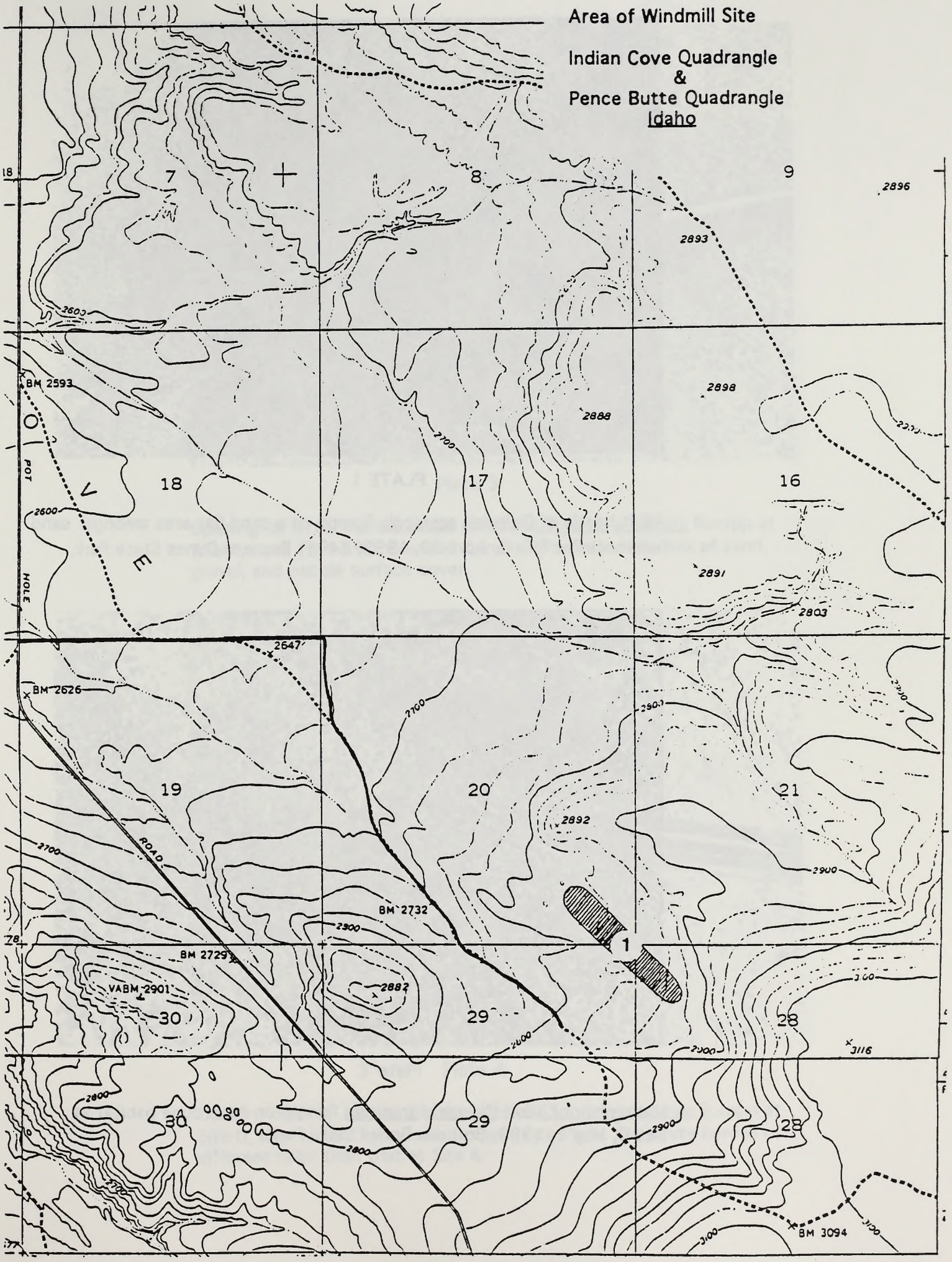

PLATE 1

Adult beetle of Cicindela arenicola Rumpp on a sand flat area amongst sand hummocks at Site C, April 20, 1993, 64° F, Bruneau Dunes State Park.

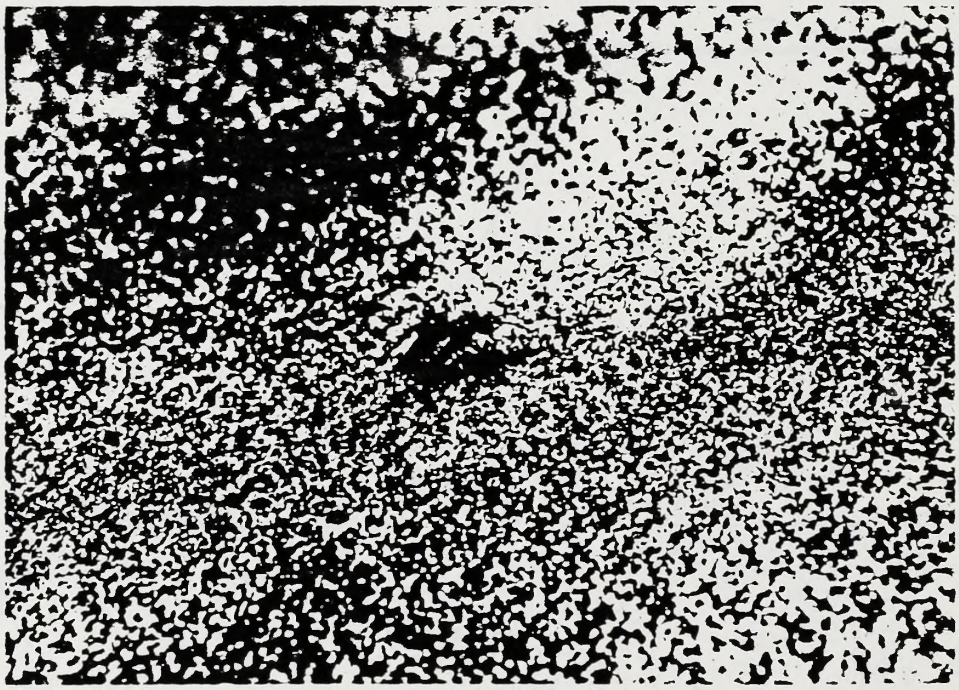

Plate 2

Mating pair of adult Cicindela arenicola Rumpp on open dune habitat at Site D, May 1, 1993, Bruneau Dunes State Park.

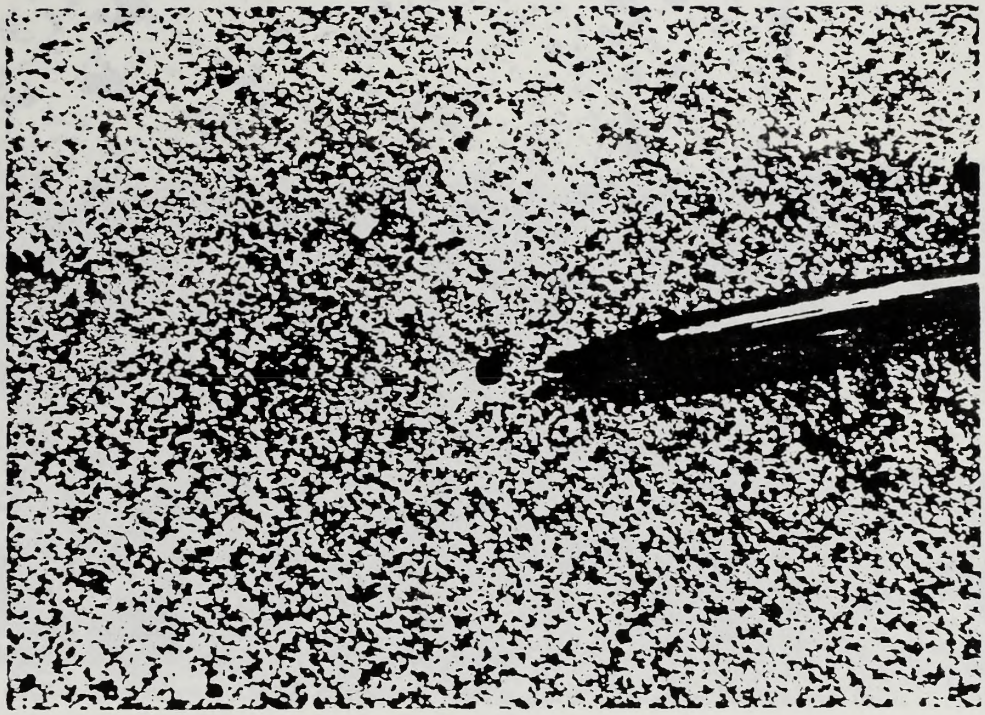

Plate 3

Opening of larval burrow (4mm size) of Cicindela arenicola Rumpp at Site A, April 13, 1993, Bruneau Dunes State Park. Note mix of sand, gravel, and pebble surface cover.

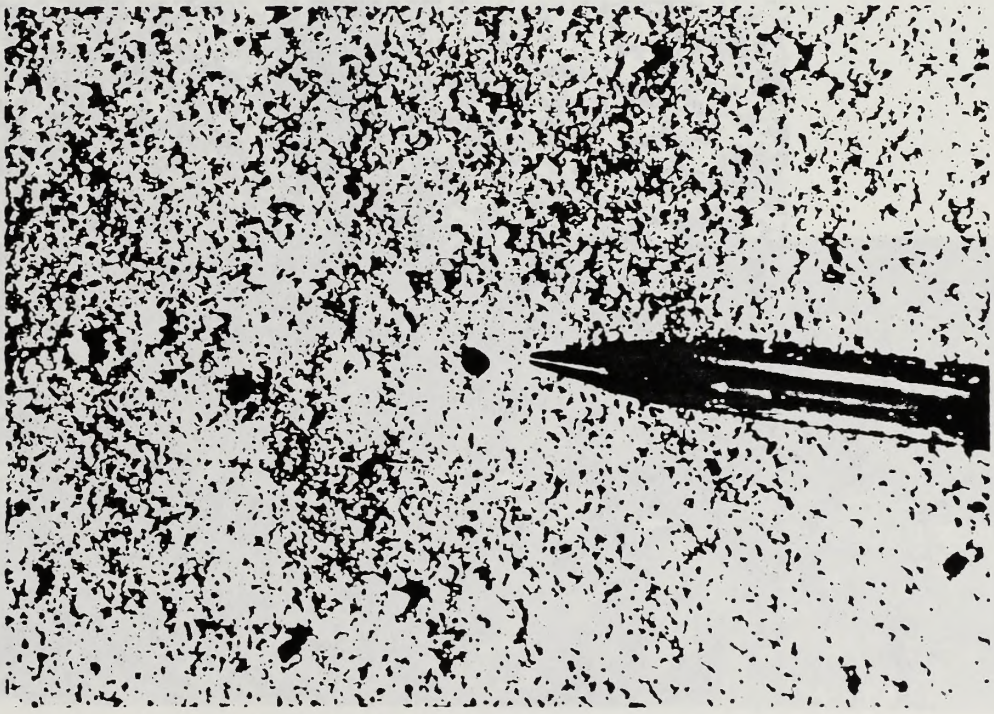

Plate 4

Opening of larval burrow (4 mm size) of Cicindela arenicola Rumpp at Site D, May 1, 1993, Bruneau Dunes State Park. Substrate here is of a different color than that at Site A.

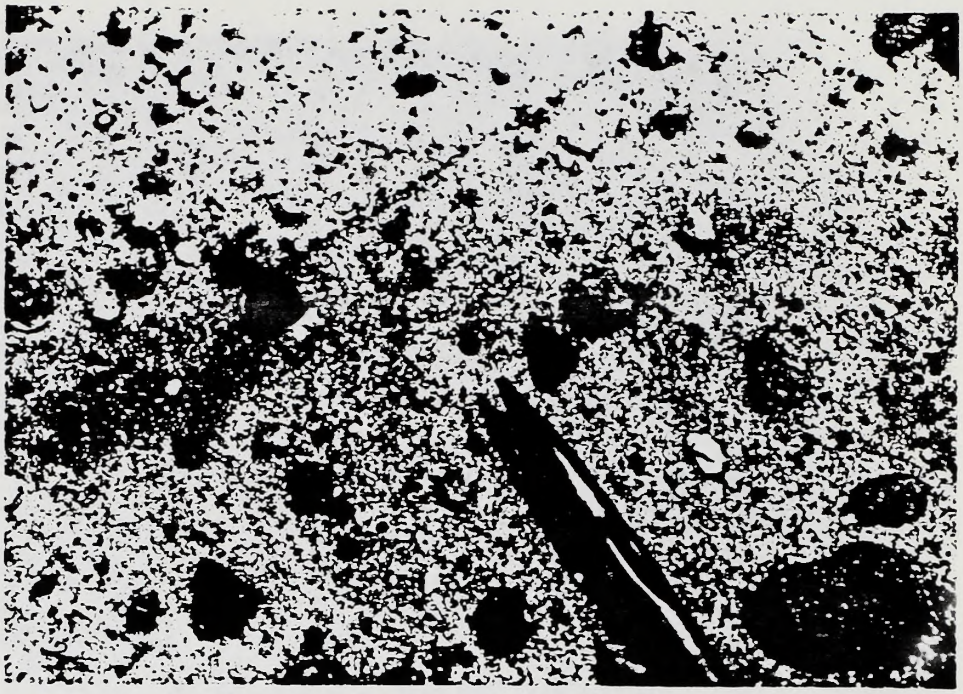

Plate 5

Opening of larval burrow (4 mm size) of Cicindela arenicola Rumpp at Site C, April 20, 1993, Bruneau Dunes State Park. Substrate with pebbles of mixed colors.

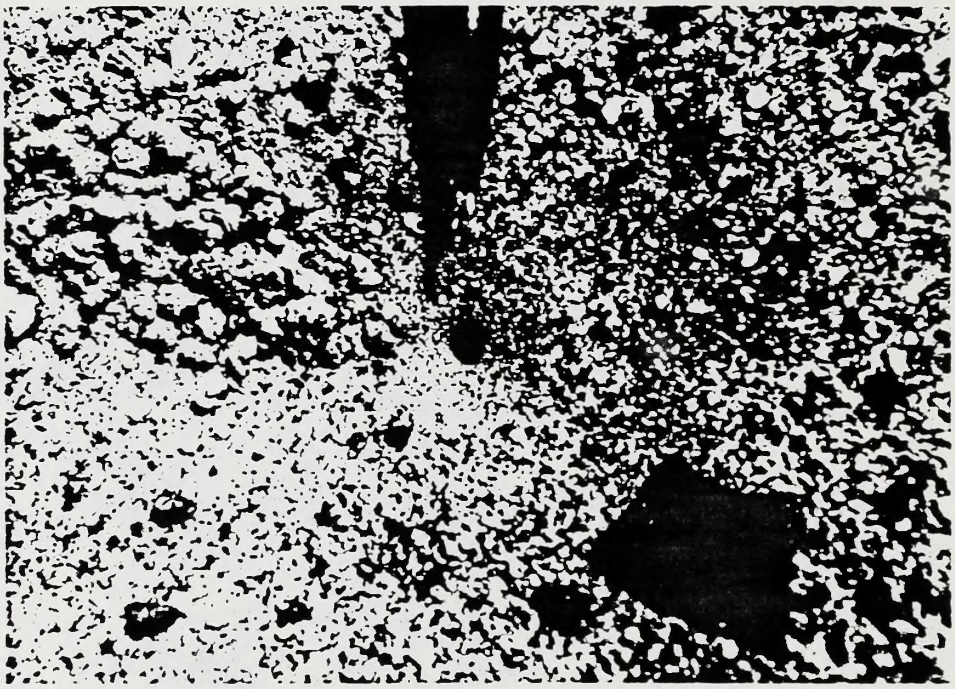

Plate 6

Opening of larval burrow (4 mm size) of Cicindela arenicola Rumpp at Site C, April 20, 1993, Bruneau Dunes State Park. Note pile of sand balls thrown out when larva cleans out or enlarges the burrow.

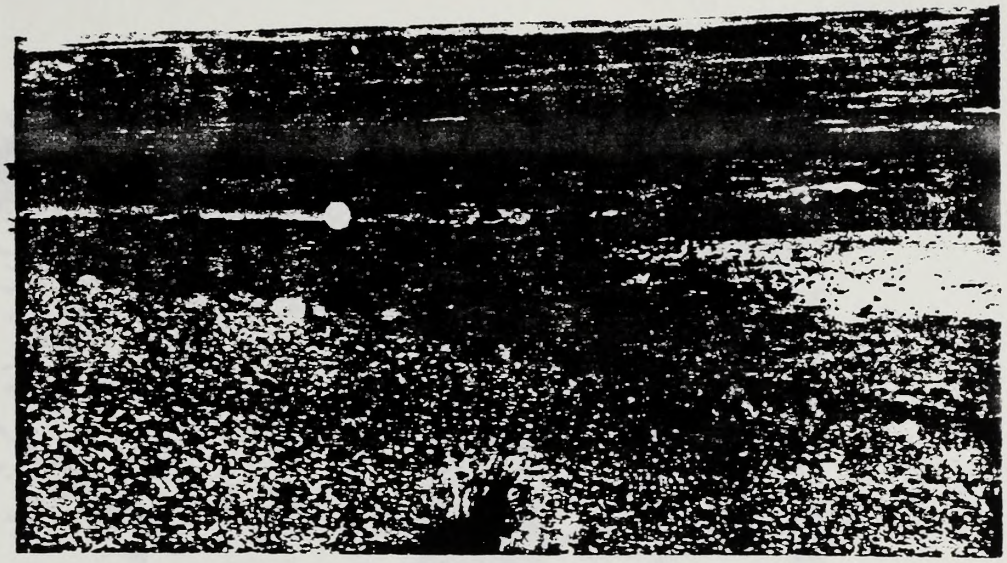

Plate 7

Sites A and B at Bruneau Dunes State Park. Picture taken from edge of rim to southwest that overlooks these sites. Site A indicated by yellow dot. Plate 8 continues to the right. May 26, 1993.

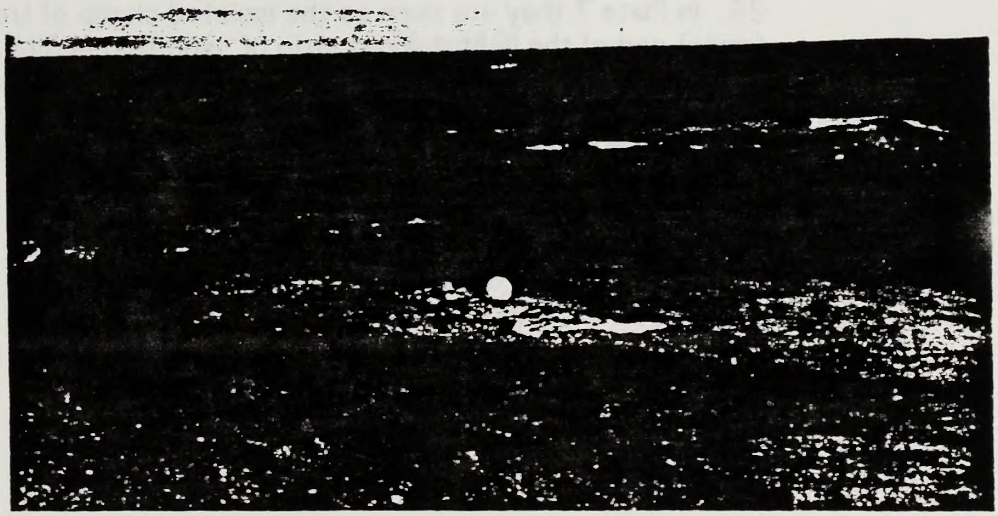

Plate 8

Sites A and B at Bruneau Dunes State Park. Picture taken from edge of rim to southwest that overlooks these sites. Site B indicated by yellow dot. Some of site B can be seen in Plate 7. Trees in center are main campground. May 26, 1993.

Plate 9

Site A at Bruneau Dunes State Park. April 13, 1993. Flag marks burrow in a flat area amongst sand hummocks. The clump of Russian olive trees at the upper left corner can also be seen in Plate 7. These trees were not in leaf on April 13, but are seen in full leaf on May 26. In Plate 7 they are seen as the isolated clump of trees at the east (right) end of the light colored strip of sand that is Site A as marked by the yellow dot. Most of the larval burrows at this site occur at the eastern end of the strip near the clump of Russian olive trees. This site has the second largest area of larval habitat known at this time for Cicindela arenicola at Bruneau Dunes State Park.

Plate 10

Site B at Bruneau Dunes State Park. April 13, 1993. No adults or larvae were seen here in 1993. Wind activity appears to be actively eroding features at this site. The "E.T." column seen in this picture crumbled in this year. Very little vegetation is seen here and there are few, if any, stable areas where larvae could live. The pictures seen in Plates 7 and 8 were taken from the edge of the rim in the center background of this picture. Site C is located about 1 km beyond the rim edge.

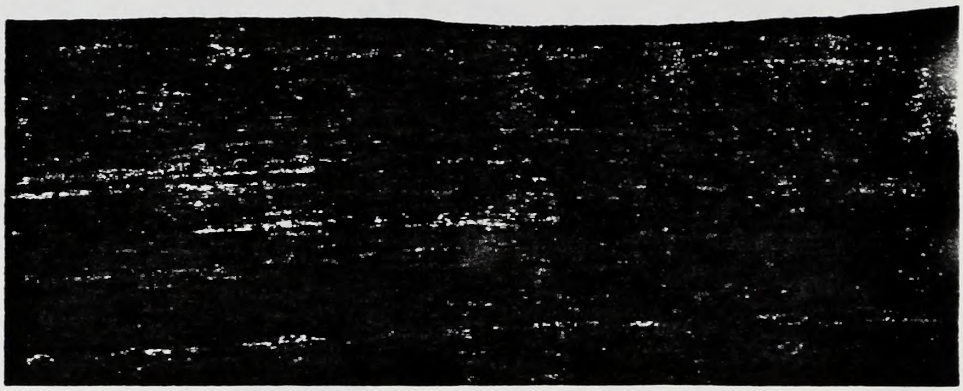

Plate 11

Windmill Site. March 6, 1992. The line of dunes mark the area where adult beetles were collected later in the year. The Windmill is situated to the west of this dune line, behind the photographer.

Plate 12

Windmill Site. March 6, 1993. This site has many areas of dunes that support little vegetation. The sand is of a generally darker brown color as compared to the color of the sand at Bruneau Dunes State Park.

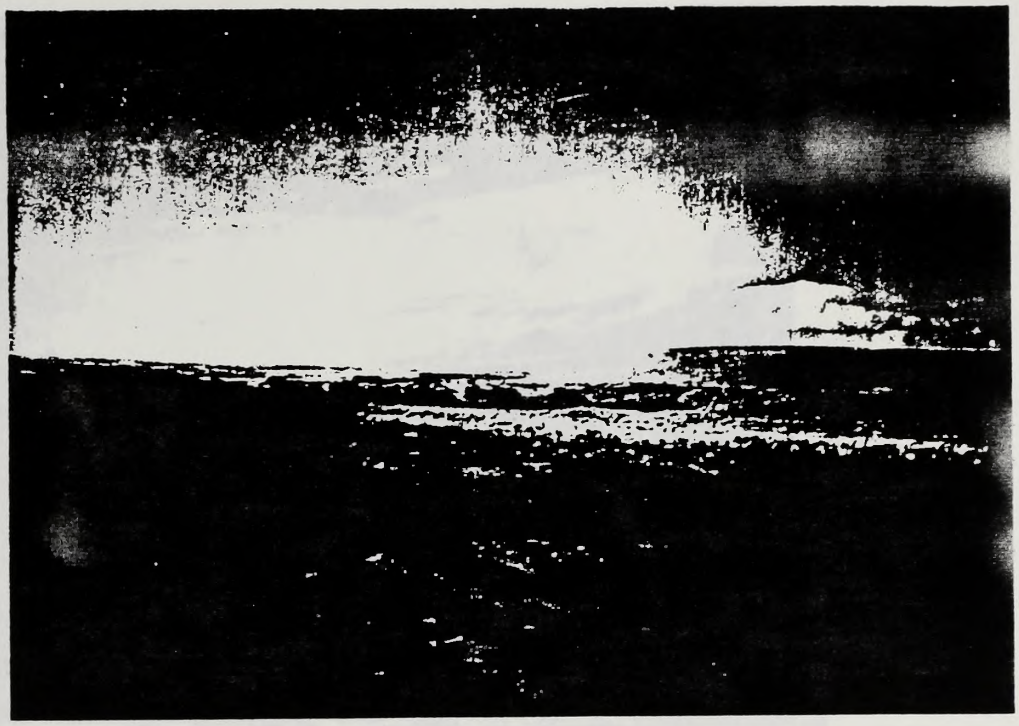

Plate 13

Windmill Site. September 17, 1993. The area in which larvae of Cicindela arenicola Rumpp occur at this site borders, and is interspersed in, the area of light-colored rice grass seen in the center of the photograph. Seen here is the north end of the band of rice grass habitat that continues through Plates 14, 15, and 16.

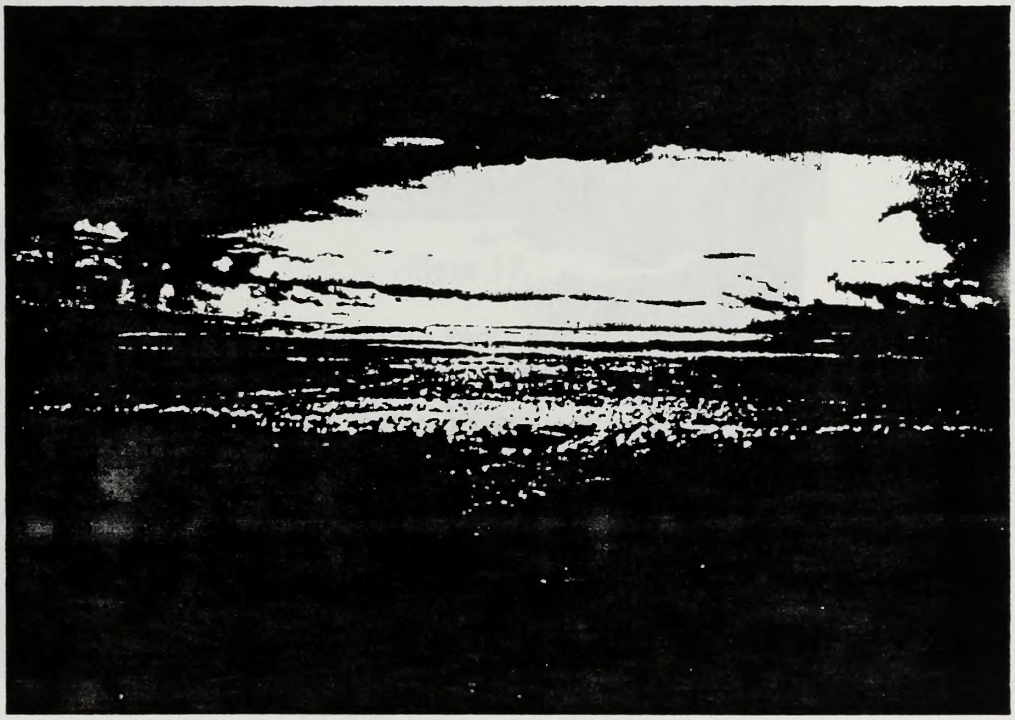

Plate 14

Windmill Site. September 17, 1993. The rice grass habitat that starts in Plate 13 continues in this photograph. Larval burrows of Cicindela arenicola Rumpp are more abundant in the northern half of this band of rice grass habitat.

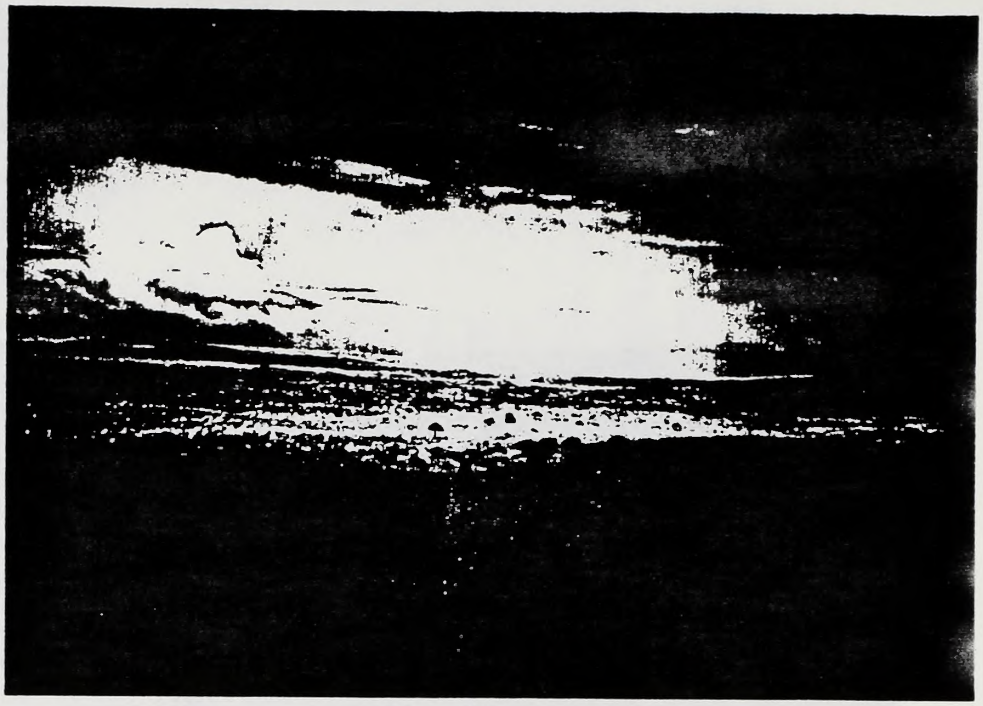

Plate 15

Windmill Site. September 17, 1993. Seen here is the central reach of the rice grass habitat that borders the area of larval habitat of Cicindela arenicola Rumpp at this site. This photograph overlaps the one seen in Plate 16.

Plate 16

Windmill Site. September 17, 1993. The south end of the band of rice grass habitat can be seen to spread over the slope of the hill in the center of this photograph. Very few burrows of Cicindela arenicola were seen in this area. The exposed saline soil at the lower right supports a few burrows of Cicindela tranquebarica.

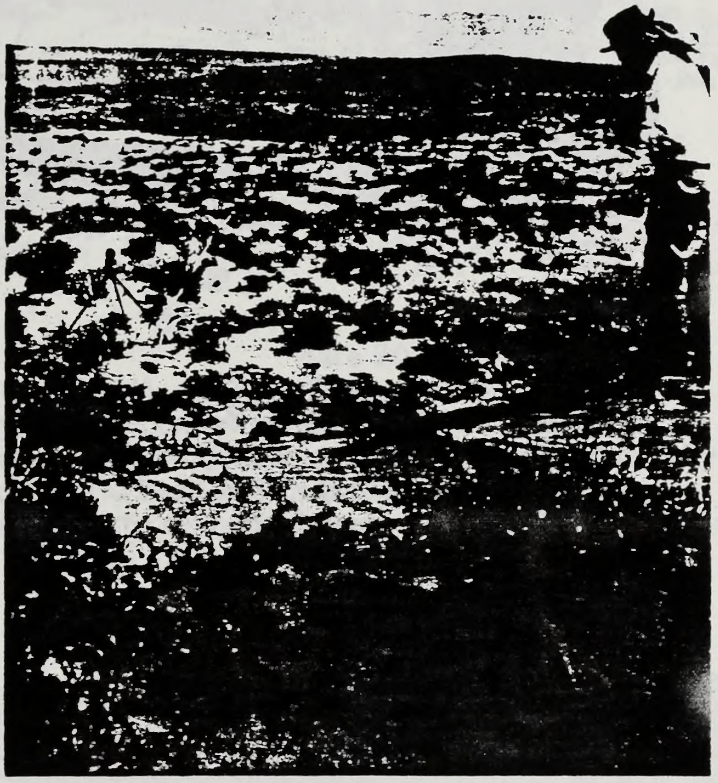

Plate 17

Site C at Bruneau Dunes State Park. May 28, 1993. The open, elevated dune habitat is seen in the foreground and ends near where the survey tripod is located. Vegetation was abundant this year due to the much above normal spring precipitation. The foreground plants are almost exclusively sand bur and Russian thistle.

Plate 18

Site C at Bruneau Dunes State Park. May 13, 1993. Transects started in the very unstable drift sand at the edge of the dune and preceded out to the more densely vegetated area seen beyond the open area traversed by the tape. This band of more open habitat in the middle of the photograph is the area where most larval burrows occur.

Plate 19

Site C at Bruneau Dunes State Park. May 12, 1993. Care was taken to avoid trampling larval burrows in the stable flat areas amongst the sand hummocks. This larval habitat ceased rather abruptly at the base of the open dunes seen in the background.

Plate 20

Site C at Bruneau Dunes State Park. May 12, 1993. A flat area near the north end of the dune system with a very good density of late instar larval burrows (flags). Few burrows were found in the area beyond the scratch line in this photo where cheat grass was abundant.

Plate 21

Site C at Bruneau Dunes State Park. June 4, 1993. The circle of pink flags encloses an area where more than 60 newly established larval burrows (2 mm diameter) were seen. Thirty of these burrows were flagged with green markers for future reference. New burrows were not seen on the elevated, more vegetated sandy hummocks.

Plate 22

Site C at Bruneau Dunes State Park. May 18, 1993. The edge of the dunes seen here is heavily overgrown by plants. Larvae may occur here but their detection is virtually impossible. It is also very improbable that female beetles would oviposit in such an area.

Plate 23

Near Site A at Bruneau Dunes State Park. April 13, 1993. Seen here is the sand lily (Leucocrinum montanum Nutt.) at peak bloom. Adult beetles of Cicindela arenicola Rumpp were seen at site A on March 22 this year, shortly before the start of flowering by the sand lily.

SUMMARY OF UNITS OF ACCOMPLISHMENT

1. One new population of Cicindela arenicola was found in Owyhee County and the locality designated as the Windmill Site.
2. Seven "new" areas of beetle occurrence (either larvae, adults, or both) were documented for Bruneau Dunes State Park.
3. A transect/quadrat study of Site C at Bruneau Dunes State Park indicated a late instar larval population of 1225.5 with an estimated late instar larval population of 1,000 to 4,000 for the entire Bruneau Dunes State Park area.
4. Surveys for adult beetles were done at both the Windmill Site and Bruneau Dunes State Park. No more than 11 adults were seen on any survey in 1993.
5. Surveys of late instar larvae were done at Site C. They showed that the burrows have a non-random distribution. They are found almost exclusively in rather flat areas with a mixed surface of sand, gravel and pebbles.
6. Distribution maps for all sightings for 1993 are included in this report.
7. Management recommendations are given for all known areas where this beetle occurs in Owyhee County.
8. Photographs are included in Luana McCauley's report and in the Final Report for 1993.
9. Copies of the reports done for the Independent Study Projects by Luana McCauley and Marilyn Olson (Boise State University senior students) are provided with the Final Report.

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