

400

**Fire effects on Cape Sable seaside sparrow demography:
2002 final report.**

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INTRODUCTION

Between 1948 and 1992 the wetland areas of Everglades National Park experienced 752 fires for an average of 17 fires per year (Gunderson and Snyder 1994). Fire is a necessary component of the Everglades. It maintains a habitat mosaic and prevents hardwood shrubs from invading the characteristically open Everglades marshes (Robertson 1953, Egler 1952, Taylor 1983). The Cape Sable seaside sparrow (*Ammodramus miratimus mirabilis*), an endangered subspecies endemic to the southern Everglades, relies on marl prairies that are influenced by fire regimes (Werner 1975). The sparrow lives principally on Federally protected land, most of which lies within Everglades National Park (ENP). Currently ENP manages fires through prescribed burning and strategic control of naturally caused fires. Of central concern to ENP officials is the development of a fire management protocol that promotes USFWS recovery goals for this subspecies. The conception of this fire management plan is profoundly inhibited by the lack of knowledge surrounding the sparrow's response to, and recovery from, fire.

By ENP fire managers allowing a recent fire to burn through a portion of an existing study plot, we had the option of utilizing a study design that can better detect fire effects than previous research. This includes evaluating the possibility that sparrow populations are not noticeably effected by fire (except through the immediate loss of individuals), and evaluating the nature of any lasting demographic effects. In 2002, we proposed a detailed demographic study of individuals subjected to this fire event. This report provides results from the first year of this study.

THE LOPEZ FIRE AND RESULTING STUDY DESIGN

The Lopez Fire

On May 8, 2001 a human-ignited fire began at the eastern boundary of Everglades National Park. Over the course of fifteen days the fire burned 8,427 acres until finally controlled on May 23, 2001. Given the dry conditions at the time, the fire consumed the great majority of vegetation in its path, leaving little in the way of an unburned vegetation mosaic. The path of the fire included the southern portion of population E of the Cape Sable seaside sparrow, including the southern edge of a four-year old study plot (East Camp/Tomato Patch) originally designed to document demographic parameters of this population (Pimm et al. 2002). This event provided us with a serendipitous research opportunity to study the effects of fire on sparrow demography. Such a study was recommended by the Walters report (Walters et al. 2000) as it can provide demographic information surrounding extreme events that can then be used to derive more detailed population viability assessments.

Initial Post-Burn Site Description

During the month of June 2001, we made three weekend trips to the East Camp study plot to map the fire perimeter, resight banded birds, and extend the existing study plot such that it incorporated more burned area. Traveling by helicopter to the site, the path of the fire was immediately obvious (Figure 1). The vegetation surrounding our camp structure was completely burned showing only pinnacle rock (i.e. limestone bedrock). This situation extended to the south and west of the camp structure as far as the eye could

see. To the north and east, the edge of the fire line could be determined in the distance, distinguished by much taller, denser, and contiguous vegetation. A mosaic of pinnacle rock characterizes the East Camp study plot and solution holes whose water level and soil depth determine the type and growth of vegetation. In areas where solution holes were full of water, vegetation did not burn. This produced a mosaic of unburned patches within the western edge of the study plot.

During our late June visits, new growth was apparent across the burned area in the form of growth tips on the dominant grasses and sedges (i.e. *Cladium jamaicense* and *Muhlenbergia filipes*) and newly emergent herbaceous plants (e.g., *Agalinis* sp., *Asclepias lanciolata*, *Ludwigia* sp.). Several hardwood hammocks are located throughout the plot, the majority of which were in the burned area. All woody vegetation was killed in those hammocks located in the burned area.

Designing the New Study Plot

Using Geographic Information System (GIS) maps of the former plot boundaries and knowledge of the fire path, we designed an expanded fire plot. The fire plot was oriented one kilometer north to south and two kilometers east to west. The plot ultimately contained 40% burned and 60% unburned habitat. The former study plot is located in the northern section of the new fire plot (see Figure 2), although we banded individuals and located nests well outside of this boundary from 1998 to 2000 (see Figures 3 and 4). Beginning at the northeast corner of the prior plot we extended the eastern boundary 200 meters (corner marker L10), creating the northeast corner of the new fire plot. From here we used a Global Positioning System (GPS) to grid the new plot (see appendix A for

technical notes), installing 0.5 inch diameter PVC posts with ID tags at every 200 meter interval. Corner markers were marked with 10-foot, 0.5 inch diameter PVC posts and the tops were spray-painted red. The plot was labeled alphabetically from west to east (A to L, with I omitted) and numerically, in multiples of two, from south to north (0 to 10) so that each PVC post was assigned an identification (ID) that represented a combination of corresponding column letter and row number (A0, J4, L8, etc.). This ID was etched on an aluminum tag and secured to a pre-drilled hole in the PVC post using an aluminum clip.

Mapping the Fire Line and Associated Features

Once the plot was completely installed, the fire was mapped by walking the burn line and collecting a GPS line feature. GPS points were embedded into the line feature at 25-meter intervals. In cases where the fire line took a turn, we collected extra GPS points to represent the curvature. At each 25-meter interval we placed a 0.5 inch diameter PVC post and wrote a code on the post in permanent marker (F1 = the first post in the fire line, followed by F2, F3, F4, and so on). We mapped the fire line and numbered it from East to West. Tops of the fire line PVC posts were spray-painted yellow to differentiate them from the plot markers. Once the fire line was complete, all unburned patches were also mapped. We mapped those patches greater than two meters in diameter as a polygon feature by walking their perimeter. We mapped patches less than two meters in diameter as a point feature taken at the estimated center of each. All hammocks in the burned area were also mapped as polygon features by walking their perimeter.

Resulting Study Design

The nature of the 2001 Lopez fire allowed us to utilize a quasi-experimental design, which employs a two-group comparison without randomization (Manly 2001, Stewart-Oaten et al. 1986, Whelan 1995). The manipulation (i.e. fire) is introduced into half of the plot, while the other half is left unaffected. The effect variables of interest (i.e. components of demography, see below) were monitored before and after the fire. In order to account for underlying annual variations in the effect variables, Whelan (1995) suggests monitoring the plots for equal amounts of time before and after the fire is introduced. For vertebrate populations, this typically requires two or more years of information collected before fire is introduced, followed by a further two or more years of post-fire information (Whelan 1995). Accordingly, this represents a summary of the first year's results from a four- to five-year study plan.

The assumption in such designs is that any naturally occurring (i.e. unaccounted for) changes in effect variables will be nearly the same in the control and burned plots. Any extreme changes in effect variables within the burned plot can then be attributed to the fire (Manly 2001). Evidence for an effect of fire on sparrow demography is provided by a statistically significant change in the difference between the control and burned plot before and after the time of burning. On the other hand, if the two plots remain exactly the same before and after fire, then there is no evidence of an effect on sparrow demography.

The following sections detail our results collected during the first full breeding season after the Lopez fire. This time frame includes all research conducted in June 2001, and from March to July 2002. The results are necessarily preliminary, and include very

little statistical validation. However, where possible, we will indicate trends and discuss their biological and management significance. We will detail the methodology and results within each section.

RESULTS FROM 2002 BREEDING SEASON

Density

Taylor (1983) documented an increase in sparrow density just after fire within unburned remnants. In our study, and in accordance with the methods of Taylor (1983) and Curnutt (1998), we established 15 permanent point count locations distributed systematically across the study plot such that five point count stations are completely within the burned area, five are at the edge of the burned area, and five are completely within the unburned area (Figure 5). At least twice each week, an observer who records the number of sparrows seen or heard within a 200m radius over a 7-minute interval visited these locations. The time of day is held constant at between 7:00am and 9:00am. This protocol allows us to estimate relative numbers of sparrows between burned, unburned, and edge sites through time. This protocol also mimics that used by the range-wide sparrow surveys conducted annually by ENP personnel (Pimm et al. 2002) and thus can be directly compared to results gathered covering larger spatial areas and different time frames.

Since there were no point count stations established in 2001, we do not have information immediately post-fire. For the 2002 breeding season (late March to end of July), we collected 121 point count observations with each location receiving eight visits. The average number of sparrows recorded at the point count stations located completely

within the unburned area was 2.75 (standard deviation = 1.38), at the stations located at the edge was also 2.75 (st.dev. = 1.60), and at the stations located within the burned area was 1.05 (st. dev. = 0.99). The few birds that were recorded at the stations within the burned area were located in the western section of the study plot where the fire left a mosaic of unburned patches (see Figure 5). In 2000, two years before the Lopez fire, we conducted point counts at two locations within the former study plot at East camp. We used the same protocol as was used in 2002. The average number of individuals detected at these locations in 2000 was 3.54 (st.dev. = 1.50, $n = 23$). This preliminary evidence indicates that sparrow density was substantially reduced within habitat that was burned during the Lopez fire, and that density is somewhat decreased even within the unburned sections of the study plot. It is unclear if the drop in density within the unburned portion of the study plot (as compared to point counts made in 2000) is due to the effects of the fire or is simply a reflection of annual variations in numbers of sparrows.

Unlike past analyses (e.g., Taylor 1983, Curnutt et al. 1998, and Pimm et al. 2002), we were also able to collect detailed information on the manner in which sparrows utilized available space relative to the fire line. We routinely identified all sparrows that were banded in the study plot by their color bands and we marked their physical location at the time of identification using GPS. We thus were able to collect an average of 14 GPS locations per territorial male (min 2, max 28), with no two points coming from the same day of observation (i.e. the points are independent of each other). We built rough territory maps based on these locations by simply connecting the points representing the outermost perimeter, and these are depicted in Figure 6. These territory boundaries are liberal in the sense that they include locations that may have only been visited

occasionally by each marked sparrow. Nevertheless, Figure 6 illustrates three important points.

First, Cape Sable seaside sparrows typically do not explore a great deal of area during the breeding season as most of these territories are well within a 200m radius area (although clearly irregularly shaped). Second, despite the fact that we recorded sparrows at some of the point count stations within the burn, we failed to record any individuals visiting or using the burned areas. Thus, we did not witness sparrows feeding, singing, recovering nesting material, or in any other way utilizing the burned area. The two individuals that crossed the main fire line did so only to access two relatively large unburned patches. The individuals that were recorded in the point count estimates of density were likely those that held territories at the boundary of the burn, or were visiting unburned sites within the burn itself. Third, there does not seem to be an edge effect whereby relatively many individuals establish territories at the boundary of the burned area. Instead, sparrows claimed habitat as territory right up to the fire boundary, and there is no clear pattern whereby territory size decreases closer to the edge of the burn. This observation is confirmed by the point count information as the average number of sparrows recorded at the stations classified as 'edge' matches that for stations classified as 'unburned'.

Return Rates and Larger Scale Movements

We have been marking individual sparrows, mapping breeding territories, and banding nestlings at this site since 1998; three years pre-fire (Pimm et al. 2002). We searched for these banded birds from June 25 to 30, 2001, approximately one month post-burn and the

following information comes from these efforts. No birds were seen utilizing the burned area at any point during our six days spent on site, although four birds were found in the burn mosaic area of the southwest corner of the plot. In the unburned area, eight unbanded birds were resighted (4 males, 2 females, 2 juveniles), six birds banded in previous years were resighted (5 males, 1 female), and fourteen other singing males were heard but not resighted.

We continued to resight birds during the 2002 breeding season, and this information represents a better estimate of the return rate of birds banded on this study plot prior to the 2001 Lopez fire. In total, we resighted 11 of the 73 sparrows banded between 1998 and 2001. None of the 35 individuals banded in 1998 were resighted. We resighted one of the 17 sparrows banded in 1999, six of the 17 banded in 2002, and all four of the sparrows banded in 2001 just before the fire occurred. None of these resighted sparrows previously held territories within the burned area. Thus, all of these returning sparrows previously held territories in the area that did not burn, and returned to within 200m of those territories. We have not resighted any of the banded individuals that occupied habitat within the burned area.

We resighted a juvenile within our plot that was banded nearly 4 kilometers away at the Ingraham South study plot within population B (see Pimm et al. 2002 for study site descriptions). This individual (USFWS band number 1521-75517 and color banded WH/BK; YL/AL) was banded as a nestling on 28 April, 2002 by David Okines. This is the longest movement recorded for a juvenile of this subspecies and confirms the results of Dean and Morrison (2001) that sparrows occasionally make long-range movements that includes crossing into other populations.

We banded 56 sparrows in the 2002 field season. Twenty-seven of these were males, five were females, 20 were nestlings, and three were juveniles (i.e. recent fledglings). These individuals will be monitored in future years so as to document their annual movements and rate of survival.

Nest Placement and Fecundity

We found 25 sparrow nests in the 2002 field season. All of these were located in the unburned area (Figure 7). The first nest was found 10 March, and the last on 16 July 2002. Sixteen of these nests had hatch dates before June 1st and nine had hatch dates after June 1st. Observing such a relatively high proportion (36%) of nests that were active after June 1st indicates that the study population was successful in fledging second broods. This date also marks the typical onset of the summer rains, and in past analyses we have documented a marked increase in nest predation rates when these rains produce localized flooding (Pimm et al. 2002). In the 2002 season, the summer rains came a few weeks early on 19 May 2002. Accordingly, most nests that were still active after the onset of these rains failed due to predation (Table 1). Six nests failed during incubation, and nine during brooding. The remainder (nine nests) were successful. This produced a somewhat lower daily probability of nest success (i.e. Mayfield score) for this field season as compared to earlier years. However, this decline is due to the substantially lower daily probability of nest survival for ‘late’ nests (i.e. those with hatch dates after June 1st) in 2002. Nests active in 2002 after June 1st fared much worse than those that we have followed in years past (Table 1). We have no evidence to suggest this is due to the

effects of fire. Instead, this low nest success rate for late nests seems to be a product of higher water flows than normal starting in late May.

Vegetation Recovery

Because we know details about the vegetation components sparrows must have to nest (e.g., percent ground cover, presence and height of perching substrate, presence and cover of bunchgrasses; see Pimm et al. 2002 for analyses of sparrow habitat), we can evaluate whether a lack of vegetation recovery post-fire is in part responsible for the failure of sparrows to utilize the burned area. Here we compare vegetation changes between the burned and unburned sites right after the fire, and one year post-fire.

In June 2001, the ENP fire effects crew (lead by Gina Hernandez) established two vegetation transects across our study plot. Each transect ran the length (east-west) of the plot along the 0 and 8 lines. The fire effects crew systematically placed two 1m² quadrats every 200m along these lines and thus collected 22 vegetation samples along each east-west transect. The variables measured included percentage cover of each live plant species, as well as the percentage cover of all dead vegetation (not separated by species) and bare ground. Structural variables included the height of the tallest grass, the height and number of sawgrass seedheads, and the effective height of ground cover. See appendix B for details on transect design, sample placement, and measurement protocols. All vegetation variables have been collected and analyzed prior to this study and found to be important elements of sparrow habitat (Pimm et al. 2002). In June of 2002, Hernandez and her crew re-visited these transects and collected data on the same variables. The

following analyses are thus based on these two surveys and represent a comparison of vegetation characteristics one-month post fire to one-year post fire.

Using the multivariate software Primer-E®, we initially calculated the full Bray-Curtis species similarity matrix for all samples to all others regardless of time since fire. We then used this matrix as the basis for constructing a compositional similarity graph using non-metric multidimensional scaling (NMDS). NMDS is an iterative procedure that constructs a plot of various sample sites by successively refining the positions of those sites (points) in this plot until they satisfy, as closely as possible, the similarity relationships between sites calculated using Bray-Curtis (Clarke and Warwick 2001). Thus, the resulting plot can be naturally interpreted as showing the relative (or rank) similarity of each site to each other, and can be portrayed in as many dimensions as deemed necessary (usually two dimensions; Clarke and Warwick 2001). In this case, the sample sites are the species compositions of each transect (burned or unburned) divided into two time since fire categories; one-month post fire and one-year post fire. Thus, in producing an NMDS plot, we are evaluating how the composition of the burned and unburned transects have changed since the time of the Lopez fire. The positions of the points in the NMDS space can illustrate the extent to which the vegetation composition of the burned transect has recovered as measured by its similarity to the unburned transect. In addition, because the unburned transect has been measured across two successive years, we gain an understanding of how much vegetation species composition naturally varies from year to year within sparrow habitat.

Clarke and Warwick (2001) present a Monte Carlo procedure for evaluating whether or not groups of sites are statistically different in respect to their relative

similarities. This test, called analysis of similarity (ANOSIM), mimics the procedures for a standard univariate ANOVA. In the context of this report, ANOSIM calculates the average of all rank similarities among samples taken across each transect (burned versus unburned) (r_w), and the average of rank similarities arising from all samples between the two time since fire categories (r_b). A test statistic, R , is then calculated as, $R = (r_b - r_w)/(1/2M)$, where $M = n(n-1)/2$ and n is the total number of samples, which in this case is 44 (Clarke and Warwick 2001). The test statistic R will thus vary between +1 and -1, and will take the value of +1 when all the samples within a burn transect (burned, unburned) are more similar to each other than any of the samples from different transects. R will equal zero if the null hypothesis that there are no differences in community composition between transects that burned versus those that did not.

If the null hypothesis is true, there will be little effect on the average R -value if the labels identifying sample compositions belonging to burn transects are arbitrarily rearranged. Thus, the significance level of the observed R -value can be judged by conducting a large number of such permutations, re-calculating R for each result, and then comparing the observed R -value to the resulting distribution of simulated R -values (Clarke and Warwick 2001). We conducted 10000 random permutations to produce a distribution of R -values for comparison to the overall, or global, observed R -value.

The resulting NMDS graph is given in Figure 8. Vegetation composition is influenced by fire, but shows some sign of recovering one-year post-burn. The global R -value is 0.226, which indicates that there is very little separation of sample quadrats according to time since fire or burn transect. Nevertheless, none of the random

permutations of the data yielded an *R*-value larger than the observed thus indicating that the sites show statistically different compositions.

Pairwise comparisons between transects at one-month and one-year since fire illustrate where this difference arises (Table 2). Sample quadrats within the unburned transect are indistinguishable regardless of time since fire ($R = 0.103$, $p = 0.40$) thus indicating that absent the effects of fire, sparrow habitat composition is not particularly dynamic. Higher *R*-values (i.e. more compositional differences) are associated with comparisons between the burned transect sampled one-month post fire and the unburned transect regardless of sampling time (Table 2). There is some evidence of compositional recovery as the difference in compositions between transects declines through time. The lowest recorded *R*-value for comparisons between transects occurs when transects are compared one-year post burn ($R = 0.182$). This *R*-value nears that obtained for comparisons across years but within transects (e.g., unburned one-month post fire versus unburned one-year post fire, see above).

The results of Pimm et al. (2002), along with previous research (Werner 1975, Taylor 1983), illustrate that vegetation composition only influences a sparrow's choice of breeding territory in so much as it produces important vegetative structures. Vegetation that includes a number of sawgrass seedheads provides perching substrate for sparrows, allowing them to defend their territory and nest. Sufficient ground cover, and accumulation of dead material, allows them to build and conceal their nest (Pimm et al. 2002). Thus, changes in vegetation structure that may accompany compositional shifts could be the more important aspects of vegetation recovery after fire.

To test this, and in recognition of the fact that several of the measured structural variables are inter-correlated, we conducted a Principal Components Analysis. Sample quadrats were again grouped by transect (burned, unburned) and further divided by time since fire (one-month, one-year). The first two Principal Components were retained as they accounted for the majority of the observed variance between sample quadrats (72%). According to the resulting eigenvalue loadings, the first Principal Component (PCI) represents a measure of overall cover and the second Principal Component (PCII) represents a measure of sawgrass seedhead density and the ratio of live to dead biomass (Table 3).

Figure 9 illustrates that the fire substantially decreased overall vegetation cover, removed all sawgrass seedheads, and shifted the live to dead biomass ratio toward a dominance of live matter. However, by one-year post fire, the distribution of seedheads and the relative ratio of live to dead biomass was virtually indistinguishable from the unburned transect (regardless of year measured). Overall cover also greatly increased, however no samples within the burned transect one year post-fire were as high as those observed in the unburned transect (regardless of year measured).

Together these results indicate that at least part of the reason sparrows did not return to the burned area one year post fire is because the vegetation structure had not recovered to a suitable state. In particular, there appeared to be a lack of cover available. This lack of cover was not due to a failure for species composition to recover within the burned area. Instead, the composition appears to have substantially recovered and is beginning to resemble the unburned area. However, unlike species composition, vegetation structure suitable for sparrow occupancy may take more than one year to

return. We will continue to collect vegetation information across these two transects in the future, and therefore will be able to produce more powerful tests for this pattern.

CONCLUSION

Our preliminary conclusion is that Cape Sable seaside sparrows respond strongly, and negatively, to fire for at least one year post-burn. We did not observe any use of the burned area immediately after the fire in 2001, or during the 2002 breeding season. In addition, none of the banded sparrows that had territories within the burned area prior to the fire have been seen again since the fire. The fate of these missing individuals is unknown.

The reasons for the failure of sparrows to use the burned area one-year post fire remain unclear, but could be due to a lack of sufficient vegetation recovery. Plant species composition appears have recovered relatively quickly. However, overall vegetation cover has not returned in the burned transect to a level equivalent to the unburned transect. Because elements of cover are documented to play a role in nest placement and breeding success, this in part explains the failure of sparrows to use the burned area thus far (Pimm et al. 2002).

There are alternative reasons why sparrows have not returned to the burned area one year post-burn. For example, there may be a difference in prey base between the two areas that we cannot document. Similarly, there may be a difference in the probability of predation between the two sites that we are unable to document. We will be able test for some effects of these variables on demography in the coming years. For example, in order to document demographic changes related to the availability of food we can

measure body condition of adults, fledging weight of young, and types of food brought to nestlings when sparrows begin to use the burned area for nesting. Similarly, we will be able to document any differences in fecundity between the unburned and burned areas by documenting differences in nest predation rates, and types of nest predators.

No matter the mechanism, the absence of sparrows in the burned area one year post-burn is consistent with previous results obtained by Pimm et al. (2002), but somewhat contrary to those of Werner (1975). [Werner documented use of a burned site by Cape Sable seaside sparrows one year post-burn.] In terms of promoting the recovery of sparrow population numbers, our preliminary results suggest that fire will decrease the affected population in direct proportion to the amount of area burned. There are no apparent edge effects, and there is little evidence to suggest that unburned areas directly adjacent to burned sites are either positively or negatively affected by the fire. This reduction in adult sparrow numbers will decrease the population fecundity level by default as there will be fewer breeding adults to produce young of the year. Fecundity may be further reduced if, by natural chance, the year after the fire breeding conditions are below optimal as we observed in 2002. Combined, these factors suggest careful management of fire with Everglades National Park such that sparrow habitat does not burn too often, or burn over very wide expanses, as a large or ill-timed fire could cause the population to drop to low numbers that will persist for at least one breeding season after the fire has passed.

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Table 1. Daily probability of nest success (i.e. Mayfield scores) for nests found with the East Camp/Tomato Patch study plot between 1998 and 2002 divided according to whether they were 'early' or 'late' nests (i.e. hatch date before or after June 1st). The 2002 season represents nests found in the unburned section of the study plot one-year post fire.

Time Frame	Hatch Rate	Probability of Surviving Incubation	Probability of Surviving as a Nestling	Overall Daily Probability of Success	No. of Nests (Sample Size, <i>n</i>)
1998–2000 early	0.846	0.619	0.699	0.366	29
1998–2000 late	1.00	1.00	0.664	0.664	6
2002 early	0.80	0.577	0.715	0.33	16
2002 late	1.00	0.254	0.489	0.125	9

Table 2. Pairwise Analysis of Similarity (ANOSIM) results for vegetation species composition (live only) between burned (B) and unburned (U) transects, one-month (1) and one-year (2) post fire.

Comparison	Observed R-value	No. Random R-values $\geq$ observed	Significance Level
B1, U1	0.311	0	0.001
B1, B2	0.170	0	0.001
B1, U2	0.273	0	0.001
U1, B2	0.314	0	0.001
U1, U2	0.103	44	0.40
B2, U2	0.182	0	0.001

Table 3. Eigenvalues of the six vegetation structure variables included in the Principal Components Analysis.

Variable	Principal Component I	Principal Component II
Maximum Height (cm)	-0.452	-0.064
Density Sawgrass Seedheads	-0.330	-0.229
Effective Height (cm)	-0.376	-0.542
Ratio of Live to Dead Biomass	0.357	-0.750
Percent Dead Cover	-0.459	0.212
Percent Bare Ground	0.456	0.073

APPENDIX A. GPS NOTES ON PLOT CONSTRUCTION

In previous years much time and effort was spent trying to align the study plots to exact cardinal directions. Different methods were used such as taking a compass bearing and running measuring tape, but because of the size of plots and difficulty of terrain a substantial level of error was introduced causing the plot to be misaligned. In an effort to alleviate this issue, we employed a GPS technique that enabled us to align our plot with sub-meter accuracy using a Trimble Pro XRS receiver and a Trimble TDC1 datalogger. Beginning at the northeast corner of the original plot, we collected a GPS point. At the same location we collected a second GPS point but assigned an offset value of 200 meters at a bearing of 90 degrees (East). After the point was collected, we used the navigation feature of the GPS to navigate to the offset point. Once we reached the point we then installed the PVC post and took our next GPS point, this time assigning a new offset based on the desired direction of plot construction (360 degrees for North, 270 degrees for West, 180 degrees for South). Because the GPS receiver is enabled with real-time differential correction, our points are collected with sub-meter accuracy. Because the topography at our study site is constant, elevation differences are virtually non-existent and do not affect the accuracy of the data. In areas where topography is more diverse, a topographical map should be used to calculate elevation for each offset point.

APPENDIX B. VEGETATION SAMPLING PROTOCOL

Sampling Location

Sampling is done along transects 0 and 8 on the East Sparrow Camp grid. Along the 0 transect (burned), the first grid post, marked by a PVC pole, is A0 with coordinates $-80.697276143, 25.503652685$ (WGS84). The transect runs due east with the grid posts spaced every 200 meters and labeled by the next letter of the alphabet (excluding I). The last grid post is L0 at coordinates $-80.677378261, 25.503656060$. There are 11 posts on each east-west transect. Transect 8 (unburned) lies 800 meters to the north and also runs from A8 ($-80.697268332, 25.510863208$) to L8 ($-80.677377514, 25.510875174$).

From each grid post, the 1m^2 frame is placed 20 meters due north and 20 meters due south and would be labeled by the grid post number and cardinal direction, i.e. A-8-N and A-8-S respectively. The only exception is at grid post F-0 where there is a small tree island directly north. From this post, the frames were placed 20 meters out on azimuths 135° and 225° . These are not permanent plots. Each placement will vary somewhat. There should be 22 frames sampled on each east-to-west transect.

Data Collection

- Place a 1m^2 frame on the ground and straighten any vegetation bent over by the frame so that it is clearly in or out. We have been using a frame with 1'6" legs so that the frame stands up and doesn't damage the vegetation as much.
- Identify all LIVE vegetation and record its percent cover using the following classes: 0-5% (1), 5-10% (2), 10-25% (3), 25-50% (4), 50-75% (5), over 75% (6). Cover for

any individual species cannot exceed 100%, but total cover of all live vegetation can easily surpass 100%.

- Record the percent cover of dead vegetation AS A GROUP.
- Record the percent cover of all open space or bare ground, i.e. percent of frame not covered by anything.
- Record the ratio of live to dead vegetation within the sampling frame. Any scale will work (i.e. 1:4, 1:3, 4:5...). The first number is live vegetation, and the second is dead.
- Record the maximum height of the vegetation that falls within the sampling frame. This is the tallest piece of vegetation when all vegetation is straightened or lengthened out.
- Record whether or not (yes/no) that tallest piece of vegetation was a Cladium seedhead.
- Record the minimum and maximum heights of Cladium seedheads within the frame.
- Record the density or number of Cladium seedheads occurring within the frame.
- Record the effective height of the vegetation. This can be done by placing a graduated pole or stick (a bicycle whip works well) within the densest clump of grass within the sampling frame. Then your scribe leans down to about eye level with the grass, and estimates the height at which they can actually read the numbers on the stick. This is about the same height as the maximum height at which 10% or less of the meter stick is visible.
- Take 4 or 5 quick measurements of soil depth around the frame and record the minimum and maximum depths.



Figure 1. Photo taken days after Lopez fire. Burned areas are red-gray and unburned areas are green-gray. Tree islands are dark green (unburned) or brown (burned). This photo shows a burn mosaic typical of the western edge of our East Camp/Tomato Patch study plot.

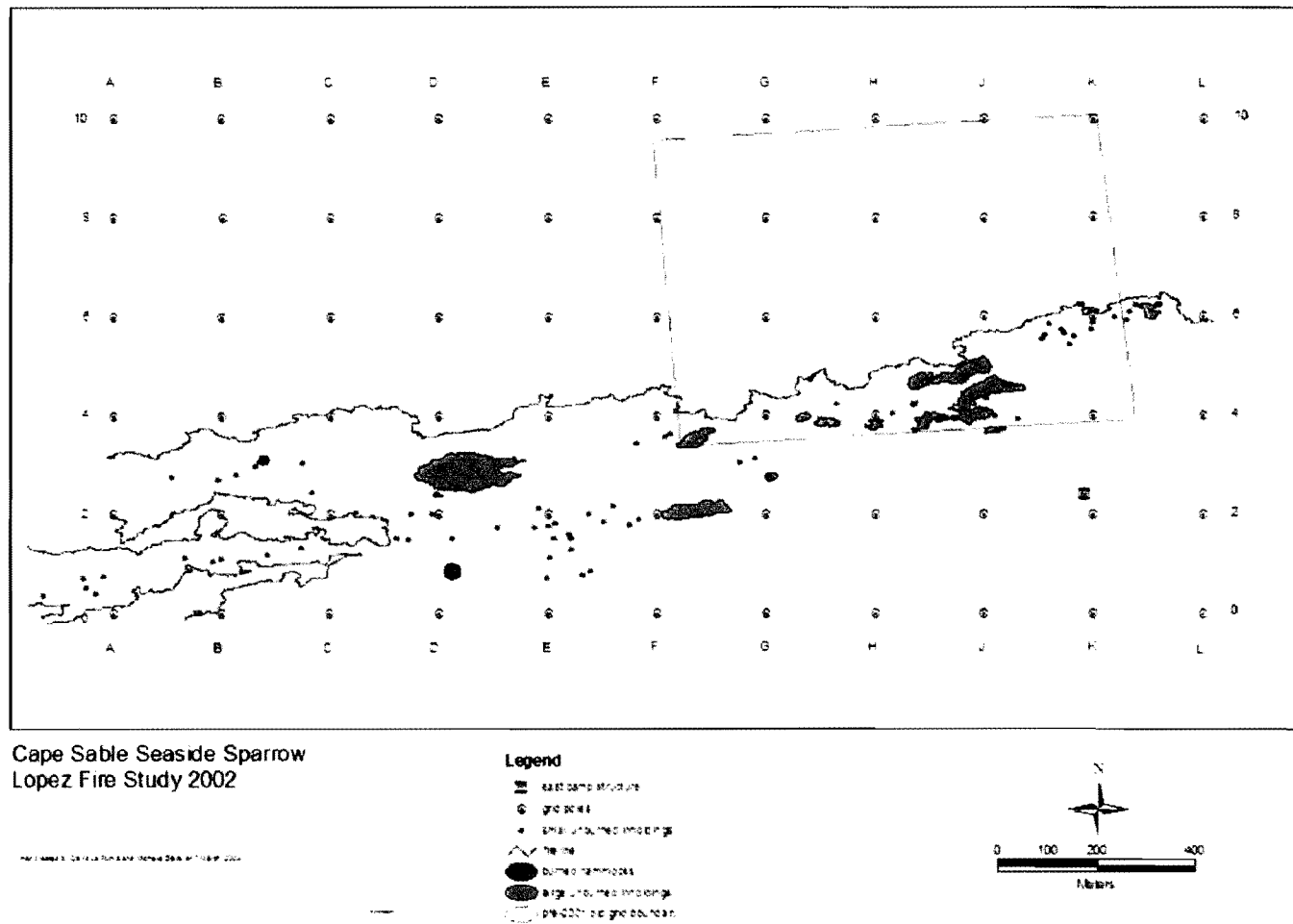


Figure 2. Map of East Camp/Tomato Patch study plot showing plot grid, former plot boundary, the Lopez fire line, and unburned inholdings present within the burned area.

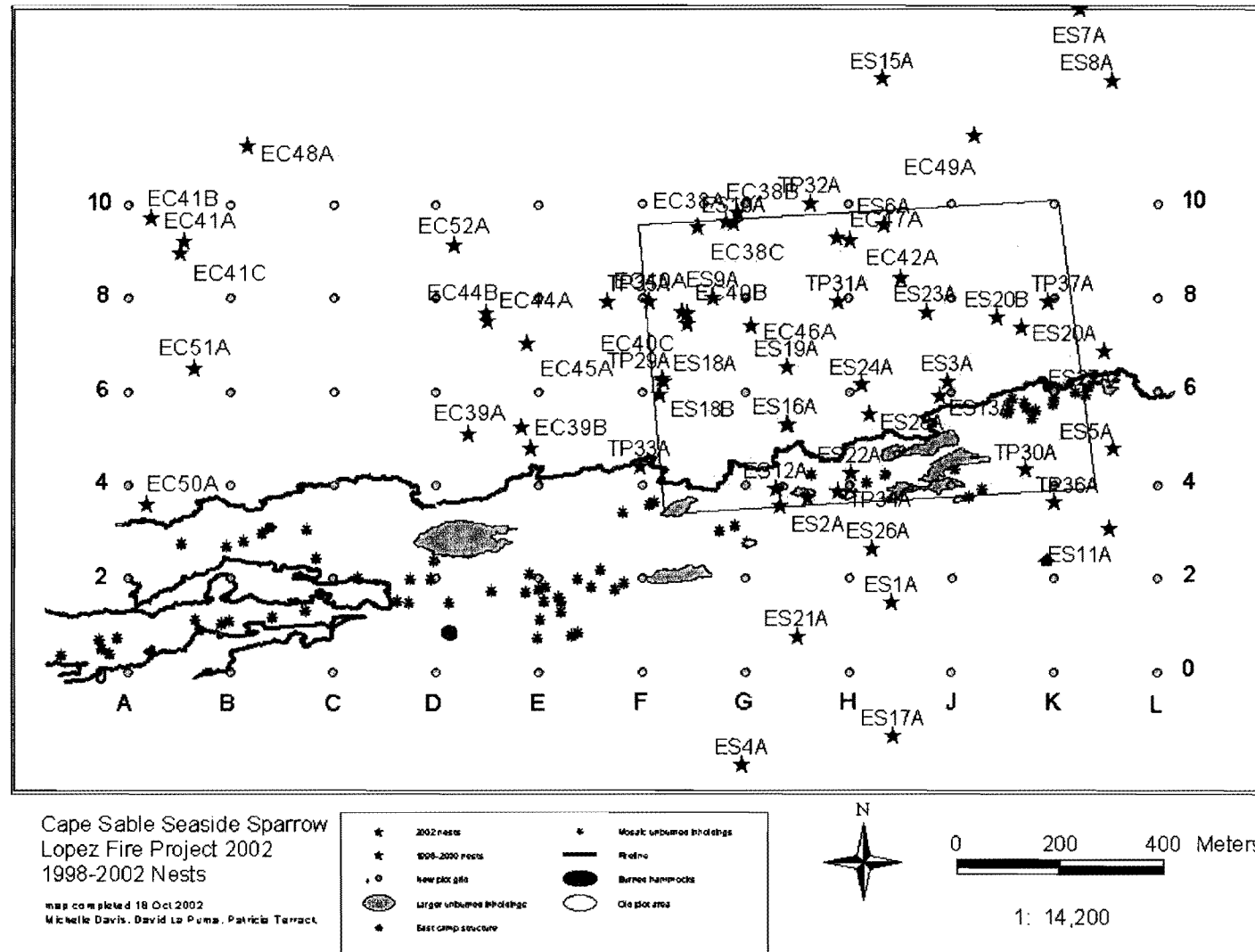


Figure 3. Location of all Cape Sable seaside sparrow nests monitored between 1998 and 2000 at the East Camp/Tomato Patch study plot, shown relative to the Lopez fire line.

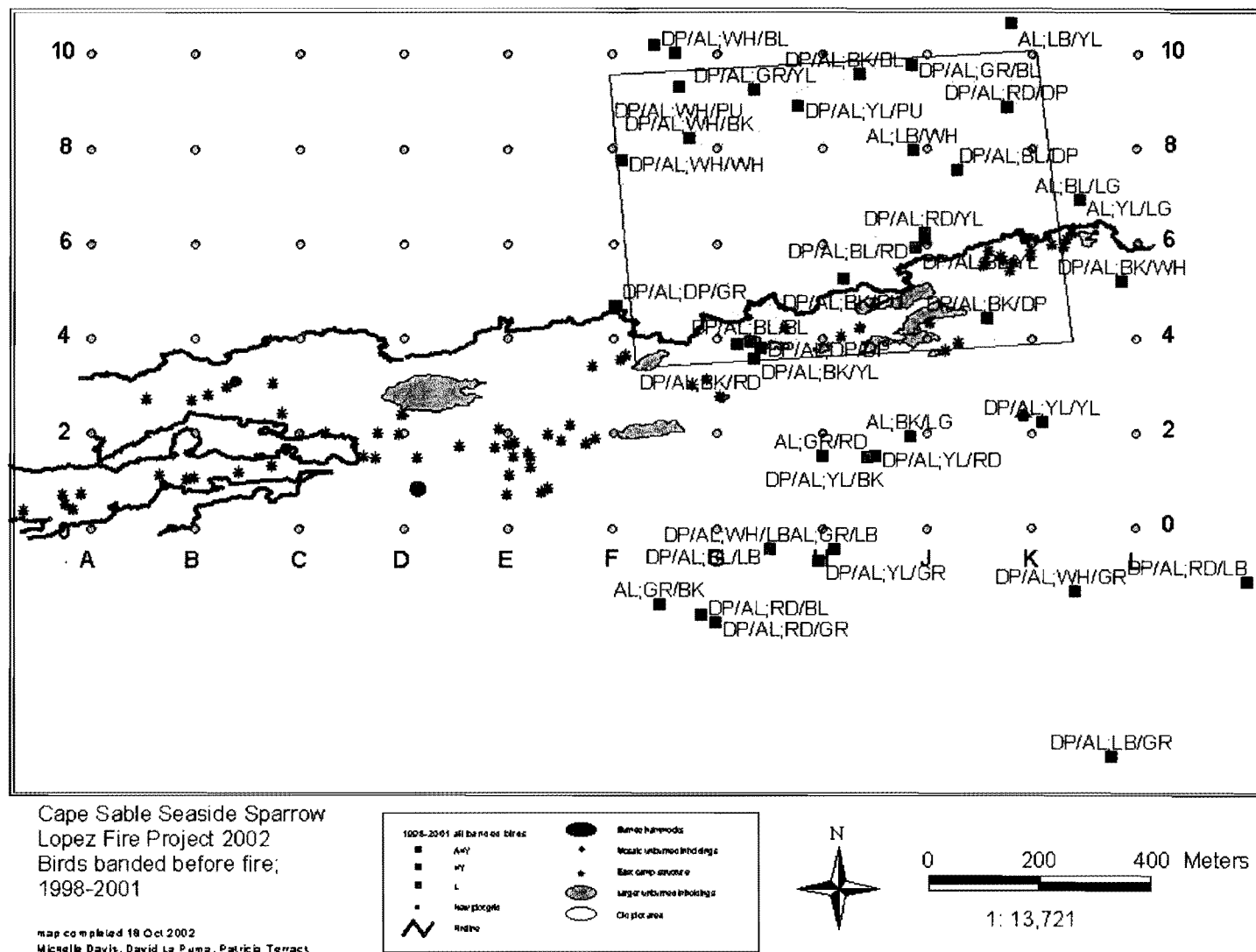


Figure 4. Locations of all sparrows banded within the East Camp/Tomato Patch study plot from 1998 to 2000, shown relative to the Lopez fire line.

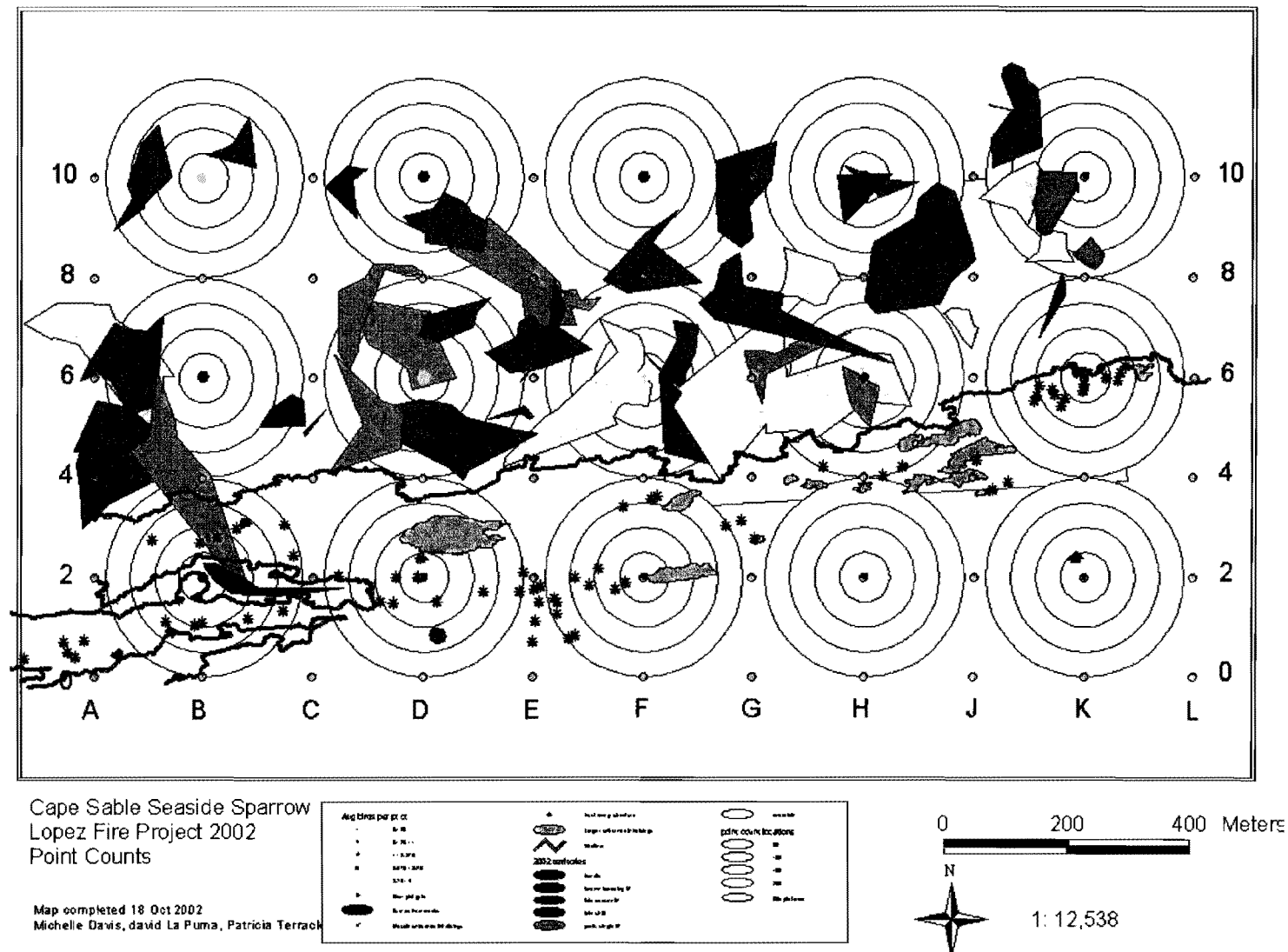


Figure 5. Point count locations and average number of sparrows counted within the East Camp/Tomato Patch study plot in 2002.

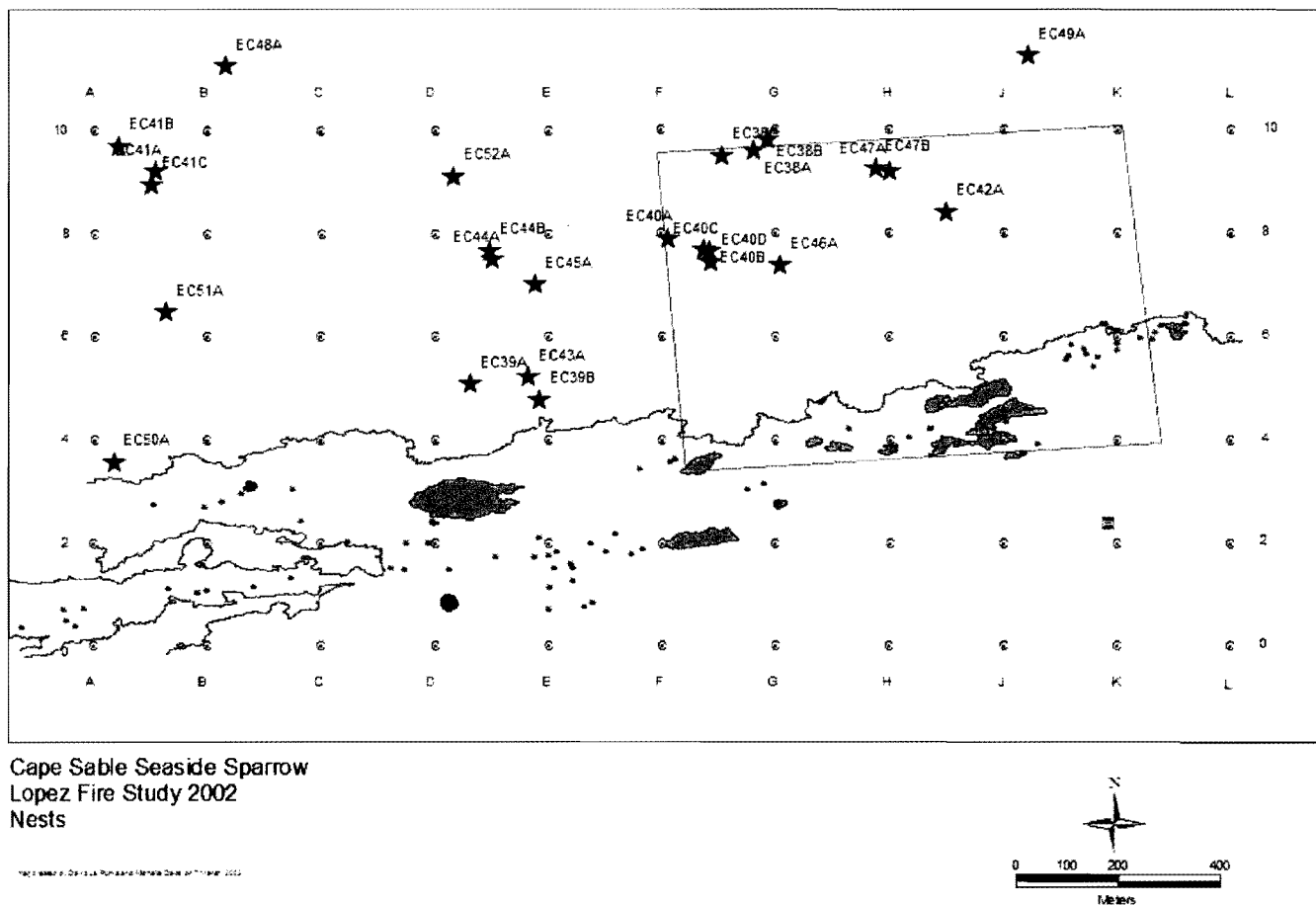


Figure 7. Location of all sparrow nests found within the East Camp/Tomato Patch study plot in 2002.

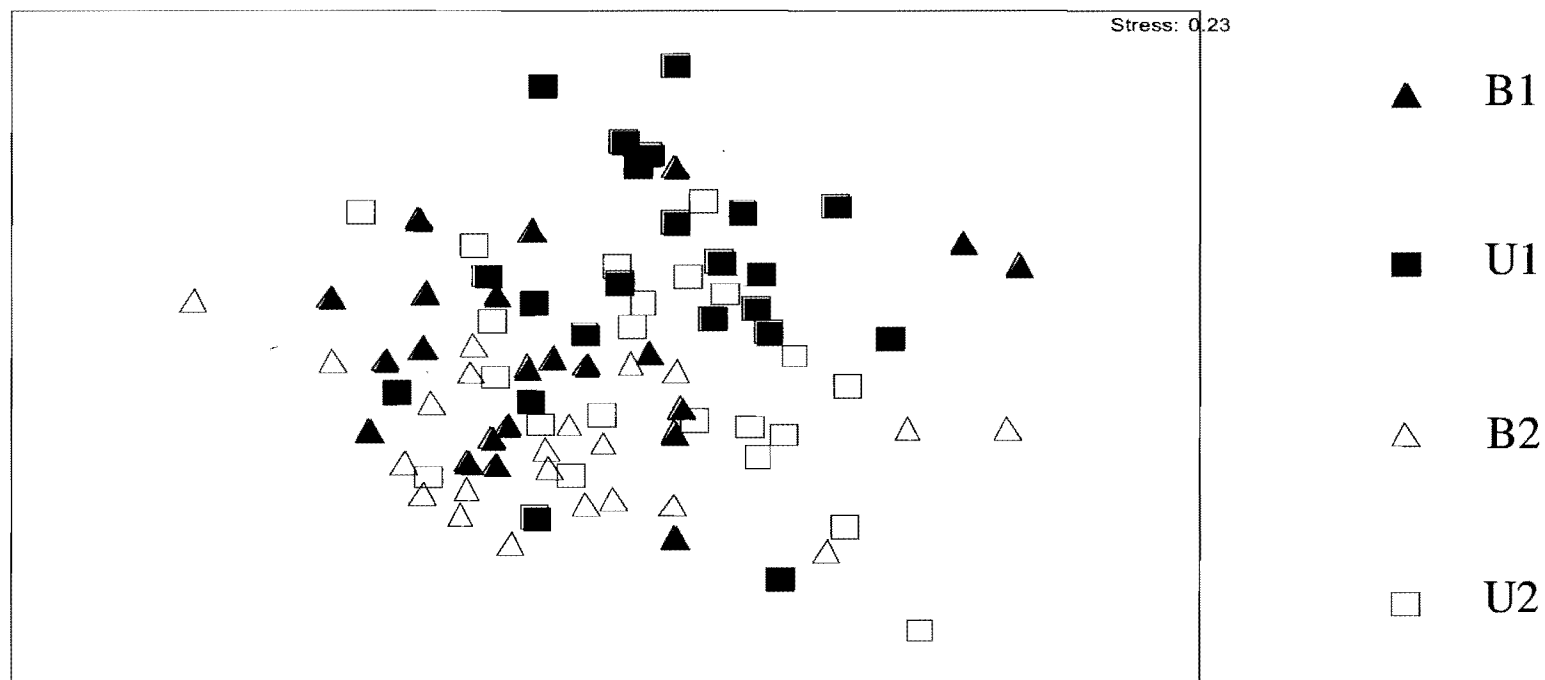


Figure 8. Non-metric multidimensional scaling (NMDS) graph showing the plant composition similarity of the burned and unburned transects one-month and one-year post burn. B = burned transect, U = unburned transect, 1 = one-month post burn, 2 = one-year post burn.

