

**REPORT ON 2001 PERENNIAL VEGETATION CONDITIONS IN
BAIRS GEORGES WELLFIELD PARCEL MANZANAR 37:
EVIDENCE THAT VEGETATION IS STILL SUBJECT TO THE
DROUGHT RECOVERY POLICY**

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September 6, 2001

INTRODUCTION

Line point transect data collected in Bairs Georges wellfield parcel MAN037 in 2000 showed average perennial cover to be approximately equal to the DWP baseline perennial cover (Manning 2001a; 2001b). Baseline perennial cover in the parcel was 42.0%, and the perennial cover measured in 2000 was 43.7%. Prior to 2000, during the 1990s, perennial cover in the parcel had consistently been below 30% (Figure 1). Because of the apparent doubling of perennial cover between 1999 and 2000, I suspected that the 2000 line point transects had not adequately assessed conditions throughout MAN037. For this reason, the parcel was classified as in need of further study with regard to its Drought Recovery Policy status (Manning 2001a). In my report, I recommended that in 2001 the parcel be inventoried both the usual way and using the 1999 transect points and bearings which were scattered more evenly throughout the parcel (Manning 2001a).

Evidence available prior to the 2001 field season supported the hypothesis that 2000 line point transects had not adequately assessed conditions throughout MAN037. For example, data from the permanent transect located in MAN037, BG2, dropped from 24% perennial cover in 1999 to 17% in 2000, rather than increasing. Upon reviewing the random locations of the 2000 transects on the aerial photograph, digital orthophoto quarter quad (DOQQs), and in the field, I observed that about half of the 25 transects had been situated in drainage channels within the parcel. Drainage channels running from west to east across the parcel cover approximately 20% of the parcel's total area, and because water is occasionally run through the channels in spring (see Appendix A), cover in these areas tends to

be higher than in other areas within the parcel. Because about 50% of the 2000 transects were located in these features, I hypothesized that the drainage channels were over-sampled, thereby biasing the 2000 measured cover upward.

In this brief report, I use data collected in 2001 to test the hypothesis that the 2000 data did not adequately assess 2000 perennial cover conditions throughout the MAN037 parcel.

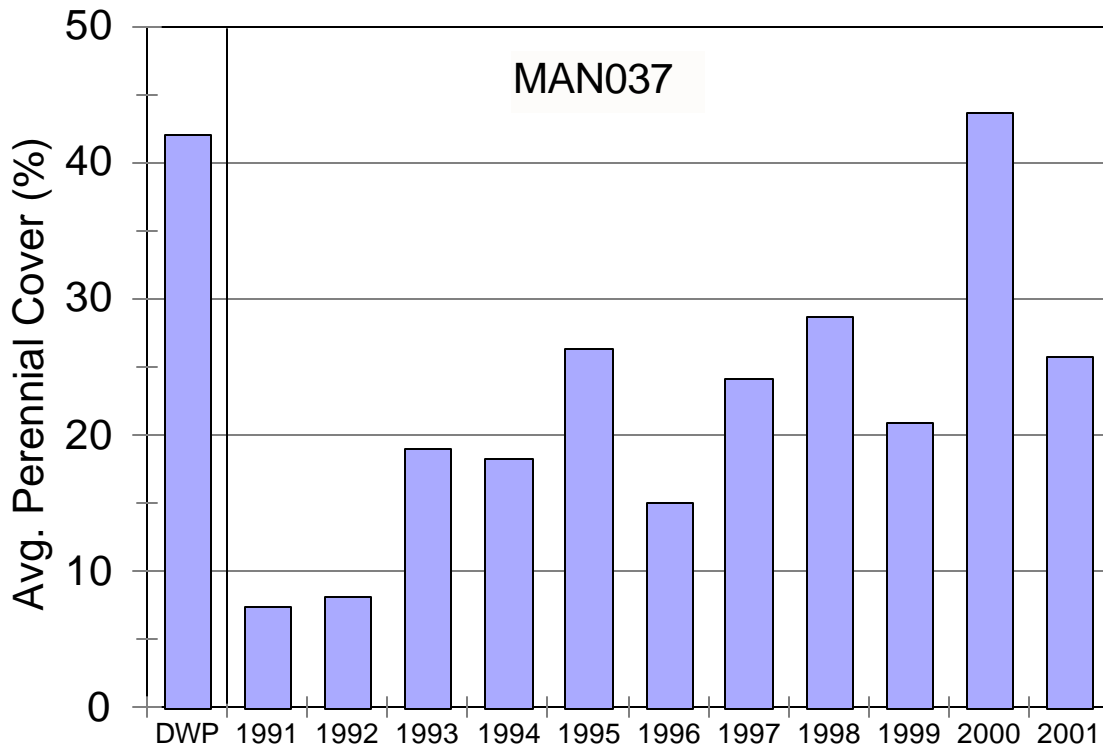


Figure 1. Average perennial cover calculated from transects run in MAN037 during the DWP baseline period (1985) and 1991-2001. Data for 2001 are the average of the 25 new-for-2001 transects.

OBJECTIVES

At least one of four conditions should have been met in 2001 if perennial cover had actually recovered to baseline levels in MAN037 in 2000. Because there was more precipitation during the 2001 water year (ICWD data on file) than in the 2000 water year and because the water table beneath the parcel had not been lowered due to pumping during 2000-01, it could be assumed that moisture

conditions in the parcel would be similar from 2000 to 2001. Therefore, one would not expect a large change in vegetation conditions from 2000 to 2001; that is, perennial cover conditions in 2000 should have persisted into 2001 relatively unchanged.

Thus, if the cover in 2000 had returned to baseline levels, one would expect one or more of the following to have occurred:

- (1) cover as measured along the permanent transect would have been higher in 2000 than in 1999 and it would have stayed high in 2001;
- (2) cover in 2001, as measured with new randomly-located line point transects, would be similar to cover measured in 2000;
- (3) cover measured in approximately the same locations where 1999 transects had been run would show cover at or near baseline conditions in 2001;
- (4) cover in 2001 as measured in approximately the same locations where 2000 transects had been run would be approximately the same as cover measured in 2000, and cover in 2001 at the 2000 transect locations would not be distinguishable from cover measured at the newly-generated 2001 transects in 2001 nor would it be different from cover measured in 2001 at the 1999 transect locations.

METHODS

Field Data

Vegetation cover along the permanent transect in MAN037, BG2, has been measured with the point frame each year in June from 1989 - 2001.

On June 14 and 15, and August 21, 2001, Inyo County Water Department (ICWD) Research Assistants ran line point transects in MAN037. In June, one team ran 25 random transects using new-for-2001 starting points generated the usual way, and the other team used the 1999 transect starting points as waypoints, found the same general location, then ran each transect using the 1999 bearing. In August, one team used the 2000 transect starting points as waypoints, and ran transects in the same general locations as in 2000. In all, a total of 75 transects were run in MAN037 during 2001; in three groups of 25, they were the 2000/01 transects, the 1999/01 transects, and the 2000/01 transects.

Data Analysis

Permanent monitoring site data for BG2 was tallied according to percent cover by species.

The 2001 transect starting locations recorded using GPS were reviewed in ArcView. It's impossible to run exactly the same transect, but using the GPS to re-locate former transect starting points, we found that the 2001 locations were very close to the previous years' start points with most

2001 GPS'ed points within 5m of the original locations. Therefore, all the 1999/01 and 2000/01 field data were used in analysis. Two 2001/01 transects were run near the southern edge of MAN037. I judged these two transects (numbers 7 and 8) to be outside the actual MAN037 boundaries, so these points were excluded from analysis and the 2001/01 sample size was reduced to 23. (Results of all transects are presented in Appendix B, including the 2001/01 data without transects 7 and 8 removed.)

All line point transect data were tallied and the average perennial cover within each group (2001/01, 1999/01, and 2000/01) was calculated. Average perennial cover measured in the different groups and over time were compared. Two-tailed t-tests for independent samples (STATISTICA) were performed to test for statistically significant differences between various data sets.

RESULTS

Cover by species as measured at the permanent transect located in MAN037, BG2, is presented in Figure 2. Total cover was recorded as 24.0%, 17.4%, and 20.4% in 1999, 2000, and 2001, respectively. In summary, cover along the transect decreased from 1999 to 2000, then increased from 2000 to 2001, but cover in 2001 was less than cover measured in 1999.

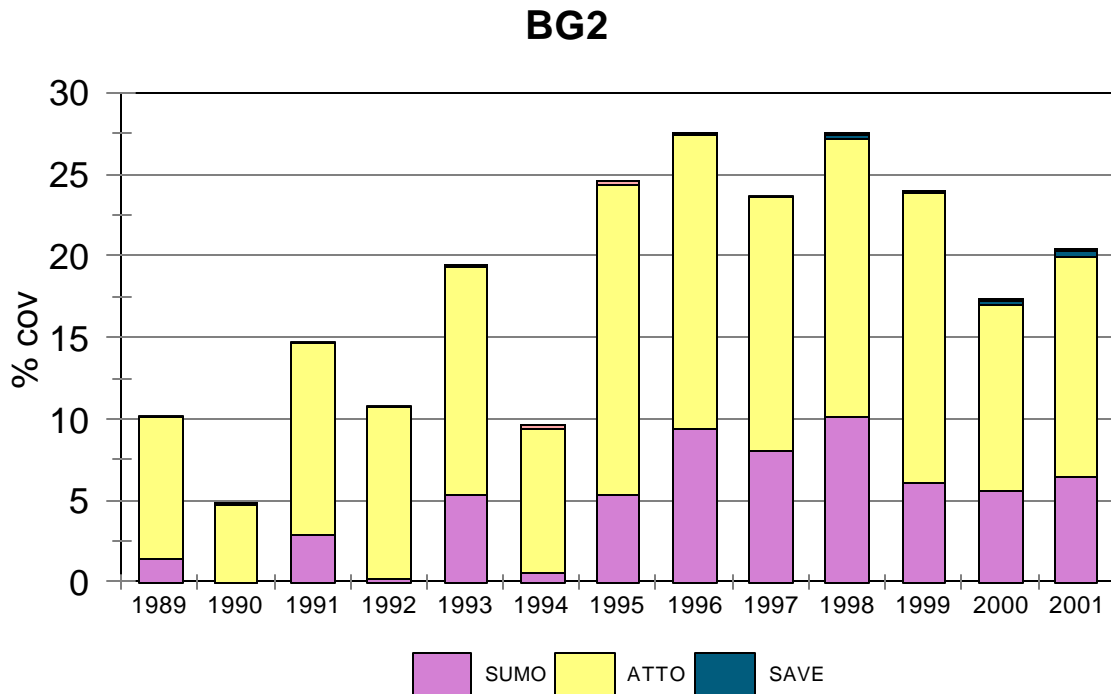


Figure 2. Cover by species as measured 1989-2001 at permanent monitoring site BG2, located in the northern part of MAN037. Only three shrub species have been recorded along this transect: *Suaeda moquinii* (SUMO), *Atriplex torreyi* (ATTO), and *Sarcobatus vermiculatus* (SAVE).

Results of the 2001/01 (that is, the new-for-2001) transects averaged 25.43% perennial cover (Figure 1) (Details of line point transect results are presented in spreadsheets in Appendix B.) This is 16.6% less than the baseline perennial cover (42.0%) and 18.3% less than the perennial cover measured in 2000 (43.68%) (Table 1). Although 2001 perennial cover averaged below baseline, it was not statistically significantly different from baseline ($p = 0.14$). Perennial cover among the 23 transects ranged from 0 - 59%.

Results of the 1999/01 transects averaged 22.96% perennial cover. This value was 19% less than baseline and 20.7% less than cover measured in 2000 (Table 1). Perennial cover measured in 2001 at the 1999 transect locations was significantly different from baseline ($p = 0.04$) and significant different from data collected in 2000 (2000/00) ($p = 0.00$). Perennial cover among the 1999/01 transects ranged from 0 - 52%.

Table 1. Comparison of differences in perennial cover for transect sets run in different years as shown. The first year shows the transect set (year the transects were originally run) and the number after the slash shows the year the set was run. Perennial cover as measured is shown in parentheses. Asterisks denote a statistically significant difference at $p \leq 0.05$, and p values are shown in italics, below the absolute cover differences.

| set/year run | 2000/00 (43.68%) | 2000/01 (38.48%) | 2001/01 (25.43%) | 1999/01 (22.96%) |
|--|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| 2000/01 (38.48%) | +5.2 <i>0.28</i> | 0 | | |
| 2001/01 (25.43%) | +18.3* <i>0.00</i> | +13.1* <i>0.01</i> | 0 | |
| 1999/01 (22.96%) | +20.7* <i>0.00</i> | +15.5* <i>0.00</i> | +2.5 <i>0.60</i> | 0 |
| DWP baseline (42.00%) | +1.7 <i>0.88</i> | -3.5 <i>0.72</i> | -16.6 <i>0.14</i> | -19.0* <i>0.04</i> |

Results of the 2000/01 transects averaged 38.48% cover. This value was 3.5% less than baseline and 5.2% less than cover measured in 2000 at approximately the same locations (Table 1). Perennial cover measured by the 2000/01 transects was not significantly different from either baseline

($p = 0.72$) or from 2000 ($p = 0.28$). Perennial cover among the 2000/01 transects ranged from 2 - 68%.

Perennial cover measured by the 2000/01 transects was 38.48%, a value 13.1% higher than cover measured by the 2001/01 transects (25.43%) (Table 1). This difference was statistically significant ($p = 0.01$). Although both sets of transects were run in the parcel in 2001, the 2000 set continued to measure higher cover while the 2001 set measured cover within the range of cover values measured in the late 1990s (Figure 1). Comparison of the 2000/01 transects with the 1999/01 transects showed a similar result: Cover measured by the 2000/01 transects was 15.5% higher than and statistically significantly ($p = 0.00$) different from the 1999/01 transect results.

DISCUSSION

None of these results provided evidence corroborating the results of the 2000 line point transect data which had shown that perennial cover in MAN037 had returned to baseline levels. None of the four conditions listed in the Objectives were met.

(1) Cover measured along permanent transect BG2 (in MAN037) declined from 1999 to 2000 (Figure 2). If the 2000 line point results had adequately represented vegetation conditions throughout the parcel and parcel cover had increased nearly two-fold from 1999 to 2000, it would be expected that cover along the permanent transect would have increased at least somewhat from 1999 to 2000. However, cover in both 2000 and 2001 was lower than in 1999. In both recent years it was also lower than the cover measured during the entire time period from 1995 through 1999. BG2 showed no evidence of an increase in cover from 1999 to 2000. It is possible that this one transect could have declined in cover while vegetation in other parts of the parcel had substantially increased, but this is not likely. Localized phenomena, such as herbivory, could account for a decline along BG2; however, such impacts were not noted at the site by field researchers. Nevertheless, results from BG2 should be viewed in conjunction with other evidence on vegetation conditions throughout the parcel, discussed below.

(2) Cover in 2001, as measured with new randomly-located line point transects, was not similar to cover measured in 2000. The 2001/01 transects averaged 25.4% cover, thus substantially less than both baseline and perennial cover that had been measured by the 2000/00 transects (Figure 1). It would be expected that had cover throughout MAN037 returned to baseline in 2000 that 2001 cover would also have been near baseline conditions. This was not the case. It is possible that the 2001 transect points were located in places that biased the cover toward low cover conditions. Reviewing the 2001 transect locations on the air photo and DOQQ, however, showed that about 20% of the transects were run in the drainage channels, indicating that sampling was distributed proportionately between the channels and the remaining areas. Thus, from the visible distribution of transects within the parcel, the 2001 transects should have adequately assessed vegetation conditions throughout the parcel. Data from the 2001/01 transects do not corroborate the results of the 2000 data that perennial

cover had recovered to baseline levels.

(3) Because the randomly-located 2001 transects could have been biased away from the high cover areas (although this was not likely as discussed above), in 2001 ICWD researchers ran transects in approximately the same locations as the 1999 transects. This exercise was performed based on the assumption that had perennial cover returned to baseline levels between 1999 and 2000 throughout MAN037, then this cover should have been sustained into summer 2001. Therefore, measuring the cover in approximately the same locations as 1999 should show substantially higher cover in 2001 than in 1999. This was not the case. In 1999, average cover was 20.9% (Figure 1 and Appendix B); in 2001, at approximately the same locations, it was 23% (Table 1 and Appendix B). This slight difference in cover (2.1%) could be explained by the higher precipitation that occurred prior to the 2001 growing season relative to 1999 and/or by random error inherent in re-locating and accurately reading transects. Regardless, it is only a slight difference. This result is not evidence supporting the idea that perennial cover had returned to baseline conditions throughout MAN037 in 2000.

(4) It was expected that by approximately re-locating and re-running the 2000 transects, cover along these transects as measured in 2001 would be similar to cover recorded in 2000. This result was expected because precipitation and water table conditions did not change dramatically from 2000 to 2001; thus it would be expected that vegetation would not change significantly. As expected, cover measured with the 2000/01 transects was similar to cover measured in approximately these same locations in 2000. In 2001, perennial cover was 5.2% lower than cover measured in 2000, but both cover values were near the baseline average of 42%. Re-running (approximately) the 2000 transects in 2001 also served as a means to compare a potentially biased sampling distribution (50% of the transects located in 20% of the parcel area where there were drainage channels) with more evenly distributed sampling distribution (both the 1999 and 2001 transect locations had about 20% of their transects in the drainage channels; thus they were proportionally distributed). As expected, perennial cover measured by the 2000/01 transects was 13.1% higher and statistically significantly greater than perennial cover measured by the new-for-2001 transects (Table 1).

Regarding use of the t-test to analyze the data, it was performed to assist in analyzing the results, but the outcome of this statistical analysis is not the only determinant of perennial cover differences. While the t-test is an appropriate parametric test for determining the difference between two means, the test assumes the data are sufficient to be tested in this manner. The MAN037 data must, however, be interpreted with the following caveats. In instances where a significant difference was measured, it is highly likely that the difference in means was significant, because the chance of a Type I error was low. (A Type I error would occur here when there is no actual difference, but the data and statistics indicate that there is.) Due to the weak power of the test, especially when comparing ICWD data to DWP baseline data, the chance for a Type II error is much greater. A Type II error occurs when there is an actual difference, but the statistical test is not powerful enough to detect it. Small sample sizes, specifically, the fact that there were only three DWP baseline transects and 23 - 24 ICWD transects, weakens the power of the t-test. Therefore, when a difference in means is large, but

the statistical test shows no significance (at $p = 0.05$), a Type II error has probably occurred. The lack of significant difference between baseline and 2001/01 data, where the difference between the means was 16.6% (Table 1), is probably a Type II error. In contrast, the difference between the 2000/01 and the 2001/01 mean cover, 13.1%, was statistically significant (Table 1) even though smaller in magnitude. Here, the power of the test was greater because of the larger the sample sizes.

Calculating the power of a t-test is difficult and somewhat imprecise, and it is not routinely calculated for t-tests using the STATISTICA software. One alternative to calculating power is to alter the probability level at which a measured difference will be declared significant. Note that the p-value calculated for the difference between baseline and 2001/01 was 0.14 (Table 1). If the significance level was set at $p = 0.15$, meaning that there was a 15%, as opposed to a 5%, chance that the differences between means was due to chance alone, then the outcome of the test would be significant. Furthermore, the DWP baseline data could be used to estimate the sample size (number of transects) expected to be needed to show a difference at a p-level of 0.05. According to the following calculation (from Eckblad 1991),

$$\text{sample size} \sim = \frac{(\text{t value})^2 (\text{sample variance})}{(\text{accuracy} * \text{sample mean})^2}$$

where accuracy is set at the desired p-level, 1,146 transects would probably need to be run to assure that a difference could be detected at $p = 0.05$. The large and impractical number is the result of DWP's small sample size, thus large t-value, and relatively large variance. It does not mean that unless 1,146 transects are run, a significant difference will not be found; rather, it is a calculation performed for planning purposes. Using only the 25 1999/01 transects, a significant difference from baseline was detected at $p = 0.04$ (Table 1), so if variance is low and the number of samples is relatively high in the subsequent sampling, significant differences could be detected. An appropriate p-level for comparing ICWD line point transect results with DWP baseline has never been decided by the Technical Group, but this issue and other concerns with baseline and subsequent monitoring data warrant further discussion.

Based on these results, it appears that the 2000/00 line point transects run in MAN037 did not adequately assess perennial cover conditions throughout this parcel. The apparent reason was because, although randomly generated, the transect locations in 2000 were concentrated in drainage channels with higher vegetation cover. The drainage channels comprise approximately 20% of MAN037 by area, but about 50% of the 2000 parcels were located within these areas; thus the channels were over-sampled. Results from 2001 provided no evidence of a "substantial" recovery toward baseline for perennial vegetation in MAN037; in fact, 2001 results show perennial cover to be only about 60% of baseline.

Manning (2000a) had classified MAN037 as in need of further study. The results presented in this report supply the further studies and the evidence that, were the 2000 data and results to be re-

visited, this parcel should be classified as still subject to the Drought Recovery Policy (DRP) in 2000. Obviously, from the data presented, MAN037 would still be classified as DRP based on 2001 data as well (report in preparation). To meet the goals of the water agreement, the water table beneath this parcel should be managed to promote vegetation recovery; that is, LADWP pumping should be managed in the Bairs Georges wellfield to allow the water table to rise. Allowing 2001-02 pumping amounts that result in lowering the water table beneath this parcel is likely to adversely and perhaps permanently affect the vegetation.

ACKNOWLEDGMENTS

Jerry Zatorski, Alison Gillespie, Derik Olson, and Irene Yamashita collected the line point transect data at the 75 locations in MAN037 in summer 2001.

REFERENCES CITED

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- Manning, Sara J. 2001b. Vegetation conditions in monitored Owens Valley parcels in 2000. Inyo/LA Technical Group Report, August 23, 2001.

APPENDIX A

PHOTOCOPY OF 6/26/01 LETTER FROM S. MANNING TO G. COUFAL
REGARDING WATER SPREADING IN MAN037, SPRING 2001

AND

PHOTOCOPY OF COUFAL RESPONSE, 8/23/01

APPENDIX B

MAN037 LINE POINT TRANSECT DATA SPREADSHEETS:

Original DWP Baseline Data
Original 1999 Data (1999/99)
Original 2000 Data (2000/00)
New-for-2001 Data (2001/01 Used in Report)
New-for-2001 Data (2001/01)
Repeat of 1999 Transects in 2001 (1999/01)
Repeat of 2000 Transects in 2001 (2001/01)