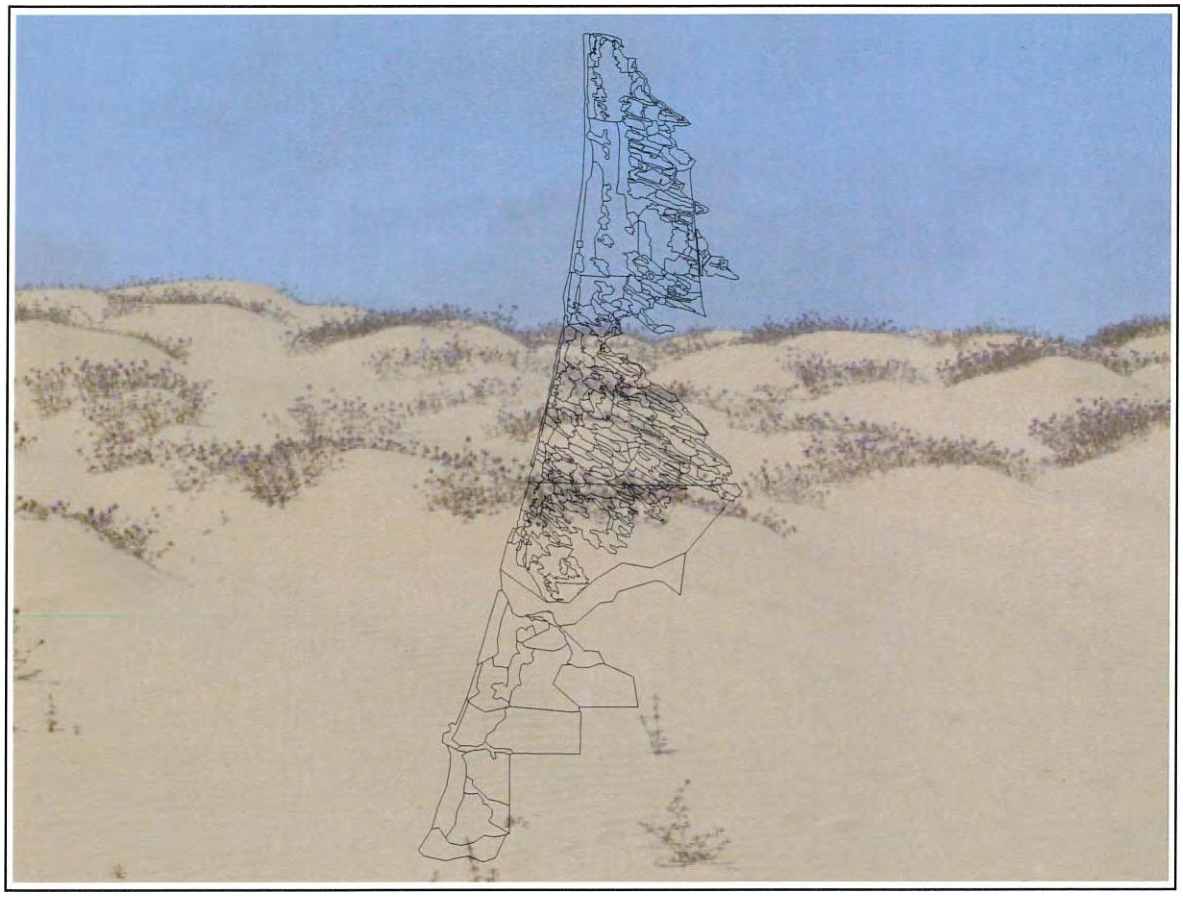
The Dunes GIS Project:
Setting Priorities For Restoration



Prepared by
The Land Conservancy of San Luis Obispo County
for
The Dunes Center
with funding provided by the Restoration Subcommittee,
The California Coastal Conservancy and
The California Department of Fish and Game, Office of Oil Spill Prevention and Response

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Executive Summary

This report documents the completion of work concerned with setting priorities for the restoration of the Guadalupe-Nipomo Dunes, in compliance with a contract between the Dunes Center and the Land Conservancy of San Luis Obispo County. The work involved preparing aerial photographs and creating land management units and a related database. This report also describes the development of committees to handle funding resulting from the Unocal Oil Spill, to be used by multiple land managers of the Guadalupe-Nipomo Dunes for restoration purposes; documenting decisions that were made in the planning of the project, the processes used and the lessons learned throughout these processes. The resulting GIS mapping program and database have proven to be valuable tools in setting priorities as illustrated in Section III, Chapter 3. The final product is a flexible program that can be used to adjust priorities for quarterly review and planning.

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Table of Contents

List of Figures iii

I. Introduction 1

II. Framework 2
1. Land Conservancy's Commitment to Land 2
2. Phase I—Initial Restoration Work 2
3. Beginning Phase II—Background of the Proposal for Unocal Oil Spill Funds 4
3.1 The Fund Committee 4
3.2 The Stewardship Collaborative 4

III. Work Completed Under Interim Contract 5
1. Task 1—Aerial Photography 5
2. Task 2—Consolidating Existing GIS Data 6
3. Task 3—Digitize Land Management Units and Develop Database 8
3.1 GIS Map 8
3.2 The Database 9
3.2.1 Data Sheets 9
3.2.2 Testing Linkage between Database and GIS Map 9
3.2.3 Assigning Priorities 10
4. Task 4—Confirmation of Land Management Units 13
4.1 GPS 13
4.2 Plant Documentation 15
5. Task 5—Final Product/Installation of GIS at the Dunes Center 15

IV. Concluding Comments 17

APPENDICES

A. Detailed Maps of Guadalupe-Nipomo Dunes Land Management Units 18
B. Data Collection 35
C. Priority Rankings for Restoration **41**
D. Database Field Descriptions 48
E. Dune Plant List 52
F. Plant Data Maps 57
G. Personal Note on Fieldwork Experience 63

Figures

Figure

1. Resulting Priorities from Phase I, 1999 3
2. Aerial Photograph 5
3. Nature Conservancy Data Sample 7
4. CCC Data Sample 7
5. GIS Map of Aerial Photographs Overlaid with Land Management Units 8
6. Data Fields 11
7. Database Report 11
8. Long-Term Restoration Priorities for January 2003 12
9. Quarterly Restoration Priorities for January-March 2003 12
10. Waypoint Data 14
11. Dune Photos 16

A-1 Numbering System of Land Management Units 20
A-2 Index to Landscape Unit Maps 21
A-3 Index A: Oceano 22
A-4 Index B: Oceano 23
A-5 Index C: Dune Lakes 24
A-6 Index D: Phillips 66 25
A-7 Index E: Oso Flaco 26
A-8 Index F: Refuge 27
A-9 Index G: Refuge 28
A-10 Index H: Refuge 29
A-11 Index I: Unocal 30
A-12 Index J: Unocal 31
A-13 Index K: Guadalupe 32
A-14 Index L: Guadalupe 33
A-15 Index M: Guadalupe 34

B-1 Field Data Sheet 39
B-2 Example of Completed Field Data Sheet 40

C-1 Key to Restoration Priorities 45
C-2 Long-Term Restoration Priorities for January 2003 46
C-3 Quarterly Restoration Priorities for January-March 2003 47

F-1 Basic Plant Community Structure of the Guadalupe-Nipomo Dunes 58
F-2 Rare Species Magnitude of the Guadalupe-Nipomo Dunes 59
F-3 All Data Waypoints Collected in 2001 and 2002 60
F-4 Dominant Weeds of Heavily Infested Areas in the Guadalupe-Nipomo Dunes ... 61
F-5 Presence of Target Weeds in the Guadalupe-Nipomo Dunes 62

I. Introduction

The Guadalupe-Nipomo Dunes are located along the central coast of California between Oceano and Point Sal. They contain 9,000 acres of unique and valuable resources that create exceptional diversity in a fragile environment; however, these resources are in need of restoration efforts to eradicate the exotic weed species that threaten them. As a result of a legal settlement following the Unocal Oil Spill in the dunes, a series of projects were funded under contracts with the Dunes Center for restoration purposes involving the multiple land managers of the dunes. This report documents the work completed in compliance with one contract between the Dunes Center and the Land Conservancy that resulted in the creation of a GIS (Geographic Information System) map and database for the unified management of the Guadalupe-Nipomo Dunes.

This project is only a part of the Land Conservancy's involvement in the dunes which, in turn, is only one part of a larger effort that consists of working with other land managers in a collaborative long-term planning process. The Land Conservancy's other role in this process involves the physical eradication of exotic weeds, as documented in a separate report. The larger effort is being undertaken through what is known as the Stewardship Collaborative. The "framework" section of this report provides a brief history of the Stewardship Collaborative and the evolution of this GIS project. The section following is a sequential description of the work that was done in compliance with the contract mentioned above and is outlined by task.

II. Framework

1. Land Conservancy's Commitment to Land

The Land Conservancy's mission is to permanently protect and enhance lands with scenic, agricultural, habitat and cultural values. This mission embraces the protection of habitats supporting populations of rare and endangered plants. The dunes have approximately twenty species of rare plants, of which fourteen are endemic to California and seven are restricted in range to San Luis Obispo and Santa Barbara Counties.

The Land Conservancy's interest in the dunes began with the purchase of property in Black Lake Canyon funded by the Coastal Conservancy in 1990, and the acquisition of land surrounding and including Black Lake that was a gift from the Nature Conservancy in 1997. The initial surveys of these newly acquired properties made it apparent that there was an on-going need to remove exotic species threatening known populations of rare plants.

2. Phase I—Initial Restoration Work

The Land Conservancy was awarded a Coastal Resource Grant from San Luis Obispo County in 1998 that involved a two-year contract to remove exotic weed species in the dunes. The Land Conservancy undertook a brief planning process at the start of this contract to establish priorities for where to begin work. This planning process resulted in a slogan, "saving the best of the best," as the guiding principal. The "best of the best" was defined as those areas that had significant populations of rare plants in an otherwise undisturbed area.

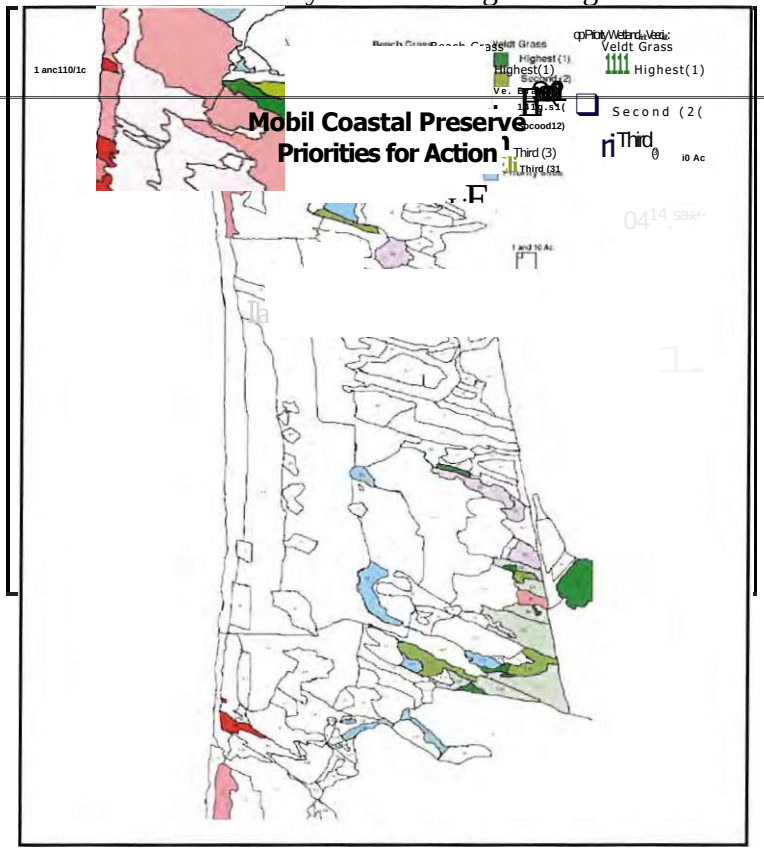
The dunes are made up of a variety of landscapes comprised of unique characteristics in relation to history or geologic structure (e.g. valleys, slopes). Land management units were created as a way of integrating that variety of information and to holistically understand those "special places" in the dunes. Land management units were identified based on homogenous sets of characteristics, using the experience of John Chesnut to delineate the first draft of these units.

John Chesnut, a botanist contracted by the Land Conservancy for his extensive experience studying vegetation in the dunes, prepared a hand drawn map of priorities for restoration based on the level of threat of the weeds (Beach Grass, *Ammophila arenaria* and Veldt Grass, *Ehrharta calycina)* to sensitive units (defined by the presence of rare species of plants). Figure 1 is a map delineating these priorities. This map was used throughout the remainder of the County contract to guide the removal of exotics. A report that documents the work completed under this County contract is on file at the Land Conservancy office and is titled "Final Report of work completed under Coastal Resource Grant with San Luis Obispo County to undertake restoration and enhancement in the Guadalupe-Nipomo Dunes, May 2001".

The Land Conservancy began its fieldwork by undertaking a series of tests using different techniques of weed removal. These tests involved pilot projects used to study the effects of different removal techniques that involved manual labor, chemicals, and cattle. The information that resulted from

Figure 1. Resulting Priorities from Phase 1, 1999

these test plots was inconclusive because they were not large enough in scale. It was not until we



started our full time work did we learn which techniques were useful and which were not. The final result of this County contract was the removal of exotic weeds that had spread over 53 acres of land.

3. Beginning Phase II— Background of the Proposal for Unocal Oil Spill Funds

3.1 The Fund Committee

Our second phase of work in the dunes began as the result of a settlement between the State of California and Unocal. One part of this settlement resulted in $9,000,000 being set aside for restoring lost habitat values. This money was allocated to the California Coastal Conservancy and the Department of Fish and Game, Office of Spill Prevention and Response (OSPR). These two agencies were constituted as the Fund Committee (also known as the Restoration Subcommittee).

The Fund Committee initiated a public planning process that involved the creation of a citizen advisory committee and a public request for work proposals. The Land Conservancy responded with proposals that would allow us to (1) continue exotic removal work and (2) continue the work of setting priorities for restoration initiated in phase **I.** The second proposal would allow us the opportunity to re-visit the work started in phase I and turn it into a tool for long-term holistic restoration planning in the dunes. This second proposal was later approved and became the contract that is the subject of this report.

The Land Conservancy's current restoration project continues the work from Phase **I** and was designed to allow priorities to be changed over time. The project includes four elements: revising priorities, mapping rare plant locations and locations of exotic plant populations, and learning more from other land managers.

The Fund Committee subsequently created the Stewardship Collaborative to review these proposals and obtain suggestions and recommendations from local land managers who had extensive knowledge of the dunes.

3.2 The Stewardship Collaborative

The Stewardship Collaborative consists of representatives from the U.S. Fish and Wildlife Service, California State Parks (Central Coast District and Oceano District), the Center for Natural Lands Management, the Land Conservancy, the Dunes Center, the City of Guadalupe, and the Counties of Santa Barbara and San Luis Obispo. The Stewardship Collaborative was created for the purpose of reviewing all the projects submitted to the Fund Committee and providing the Fund Committee with recommendations on which projects to approve.

The Stewardship Collaborative recommended that two kinds of projects be approved. The first would be short-term projects that could get underway immediately. These were called "interim projects." The second were long-term projects that could take a year or more to define.

The Land Conservancy's proposal to continue the priority planning process was subsequently reviewed by the Stewardship Collaborative and recommended to the Fund Committee. This resulted in a contract administered by the Dunes Center and became known as the "Dunes GIS Project". The remainder of this report documents work undertaken through this contract.

HI. Work **Completed Under Interim Contract**

This section of the report provides a description of what the Land Conservancy has accomplished, the issues encountered and the lessons learned along the way.

The success of this project depended on the cooperation of all organizations and individuals involved directly and indirectly with the Guadalupe-Nipomo Dunes. Working together we were able to resolve several important issues. These included gaining access from multiple landowners (California State Parks, U.S. Fish and Wildlife Service, Unocal, Center for Natural Lands Management, and the private landowners) as well as sharing data.

The work completed under this interim contract responds to five tasks, each of which is described below in greater detail. It is hoped that this report will be helpful to others who are beginning the same type of planning process.

1. Task 1—Aerial Photography

Goal: Obtain up-to-date aerial photographs in a digital and geo-rectified form for use as a base layer in a GIS program and upon which land management units will be digitized.

The first aerial photographs used for initial work by John Chesnut were dated 1994. For management purposes it is necessary to use the best and most current aerial photography available. The Land Conservancy was fortunate that the Nature Conservancy had previously paid for air photos dated 1997 that were 1:1000 scale photographs of the entire dunes and at I :400 scale for selected locations that were very sharp. The option of obtaining new photography in a digital format was considered, but it was more cost efficient to scan and geo-rectify the existing photos. Geo-rectification involves placing the photos into a common geographic projection to facilitate use in overlaying the photos with maps of the area. Figure 2 shows a resulting aerial photograph.

Figure 2. Aerial Photograph

2. Task 2—Consolidating Existing GIS Data

Goal: Gather and incorporate from several sources all existing and current data that is available in a format compatible with Arc View GIS and will contribute to a complete and unified database.

Data was consolidated from the following four organizations/agencies: the Nature Conservancy, California Conservation Corps (CCC), Unocal, and California State Parks.

The Nature Conservancy. The Nature Conservancy had GIS maps providing information on property boundaries, plant communities, roads, etc. that were created during their prior ownership of areas in the Guadalupe-Nipomo Dunes. These maps were referenced in the creation process of a new GIS map. Figure 3 is a sample of some of the maps provided by the Nature Conservancy.

California Conservation Corps. The CCC received a grant from the David and Lucille Packard Foundation in 2001 to assist the Land Conservancy in some preliminary GIS mapping of the dunes. The CCC, using a GPS (Global Positioning System) device and led by Bobby Jo Close, mapped rare plant locations and areas of weed infestation with Land Conservancy employee Mark Skinner (Field Restoration Manager). This data was used to guide the Land Conservancy's fieldwork under another contract specific to exotic weed removal and to develop the methodology of data collection and analysis for this project. Figure 4 is a sample of some of the data collected by the CCC.

Unocal. The Land Conservancy had limited access to the units within the Unocal borders due to large-scale, on-going restoration there. Unocal had been undertaking their own mapping program for several years through the firm LFR Levine-Fricke resulting in a habitat inventory and ecological database. Their GIS maps of rare plant and weed locations were used to complete the Land Conservancy data set. However, their data was not collected in the same manner as the Land Conservancy data and because of access restrictions there is no data for use in setting priorities for restoration as described under Task 3.

California State Parks. The Oceano District State Parks maintains several kinds of data related to their management of Off Road Vehicles (ORV) use on their land. This was not incorporated into this project.

Initially, projection problems were encountered with the existing data, as each agency chose different coordinate systems to characterize their geographic data. Through trial and error and conferring with consultants, the Land Conservancy was able to re-project the data into a common coordinate system. The final data set is projected into the State Plane System for California Zone V. The geographic datum is North American Datum (NAD) for 1983. The map units are in feet. This represents the same projection used by the County of San Luis Obispo.

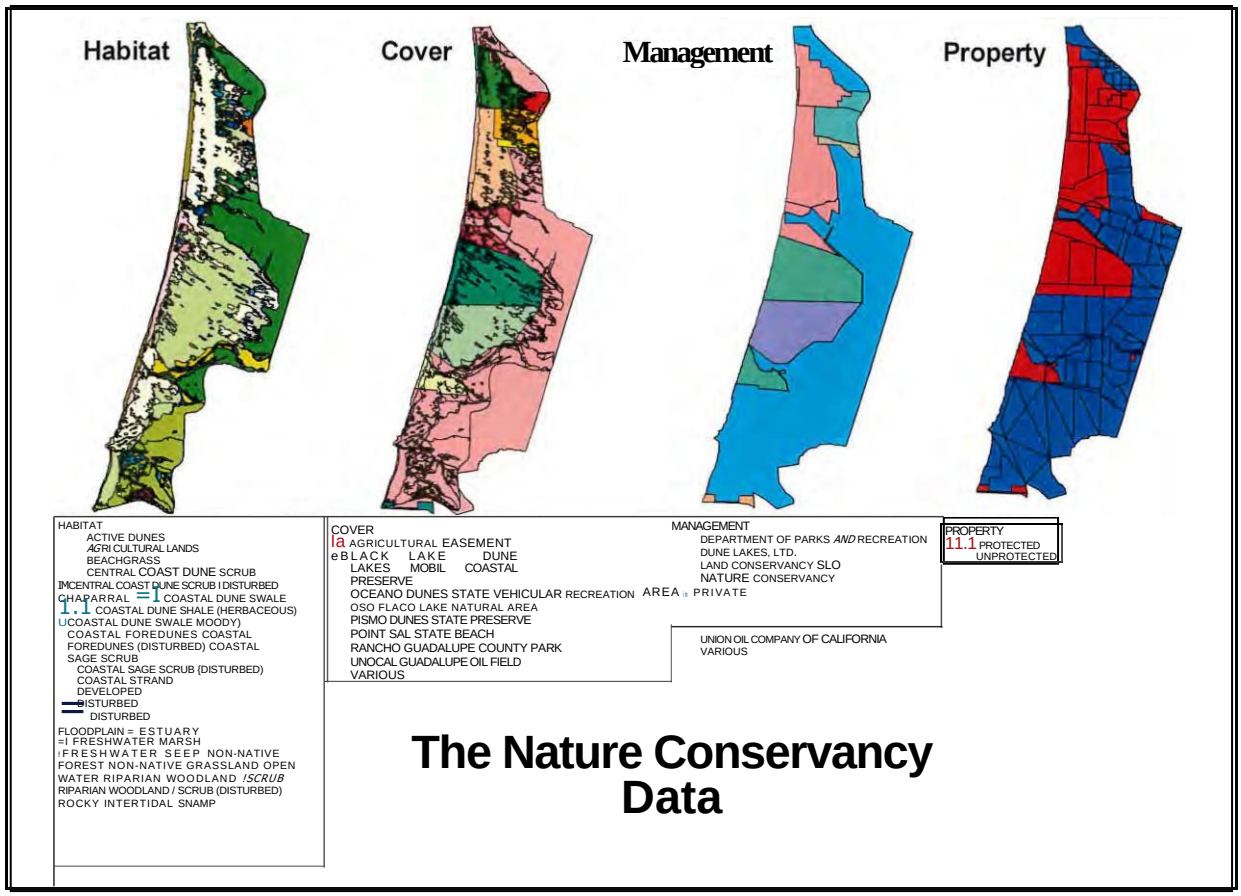


Figure 3. Nature Conservancy Data Sample

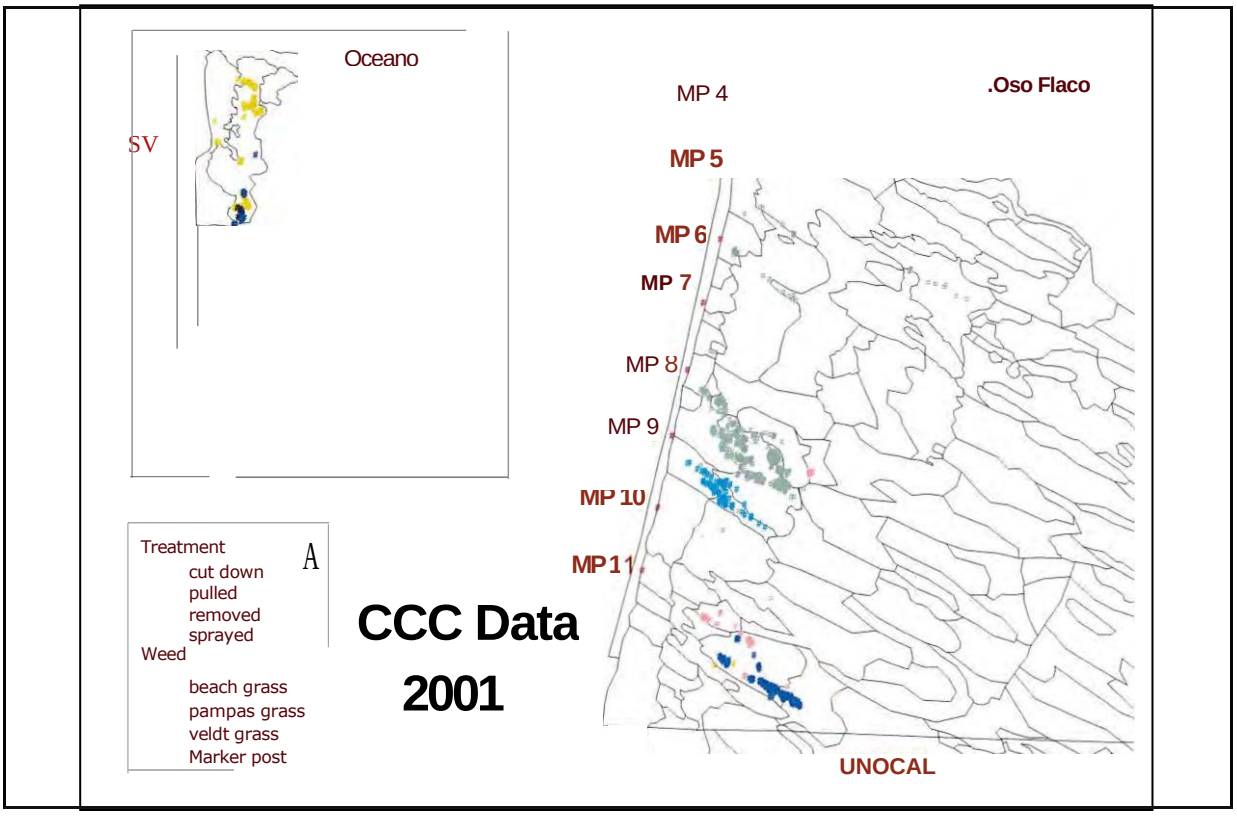


Figure 4. CCC Data Sample

3. Task 3—Digitize Land Management Units and Develop Database

Goal.. Create a GIS map and interrelated database of land management units of the entire Guadalupe-Nipomo Dunes Complex for use in setting criteria for prioritizing restoration activities.

3.1 GIS Map

The Land Conservancy used background information provided by the Nature Conservancy and aerial photographs to recreate those land management units originally delineated by John Chesnut in 1999. This required field visits (under Task 4) to confirm unit boundaries that resulted in the modification, division, combination and creation of new units. Digitizing the boundaries of the units on top of the air photo using ArcView GIS created the final map of Land Management Units.' Figure 5 below is the resulting GIS map of the Guadalupe-Nipomo Dunes. Appendix A includes GIS maps in greater detail with the corresponding land management unit numbers and an explanation of the unit numbering

system.

Figure 5. GIS Map of Aerial Photographs Overlaid with Land Management Units
ArcView GIS 3.2 software for desktop GIS and mapping.

3.2 The Database

The next step in creating a GIS system that could be used to set priorities for restoration was to create a database containing information on the natural resources and other characteristics of each Land Management Unit. The database was started using information provided by Chesnut in a Microsoft Excel spreadsheet and moving this to a database program. The Land Conservancy uses Visual dBASE, a program that communicates information to the ArcView GIS mapping program. This initial database consisted of the following information pertaining to each unit: acreage, morphology, vegetation type, rare plant presence and the dominant weed. Having met and discussed this database with the Restoration Task Force (a subcommittee of the Stewardship Collaborative) it was learned that there were other parameters that needed to be incorporated before we could set priorities. The data structure was expanded and standard data sheets were formatted to collect the necessary data from each unit during field visits. The final data structure is described in Appendix D.

3.2.1 Data Sheets

The goal set by the Land Conservancy was to visit each Land Management Unit twice, preferably with different individuals, and fill out a standardized data sheet for each unit. The procedure of these field visits is described under Task 4. The data sheet included information on rare plants, plant community, weeds, human impact or use of the unit and notes relative to the ease of access into the unit. Land Conservancy biologist Claudia Makeyev and botanist Jasmine Watts recorded the data and entered it at the end of each field day into the database program. Copies of the data sheet used, an example of a completed data sheet, and a detailed definition of the evaluation criteria are included in Appendix B.

3.2.2 Testing Linkage between Database and GIS Map

The next step was to test the database for accuracy. This was done by illustrating the database in colored maps using ArcView. A map that would illustrate the location of a specific rare plant, for example, would be made and then visually checked to make sure the map reflected field recollection.

The first problem encountered was data entry typos, which were fixed by editing and double-checking the information in the database. The second problem involved the unit numbering system. Chesnut's original hand-drawn map had units in two different areas with the same unit numbers. In ArcView, each unit links to one record and thus you cannot have a unit with multiple records. This numbering system issue was resolved by Makeyev's modification of the original unit numbers, resulting in each land management unit being assigned its own unique identification number. It is described in further detail in the first pages of Appendix A.

The final problem dealt with the database structure. Most of the detailed information from the data sheets was recorded in memo fields that can only be expressed in a written report as opposed to looking at it in ArcView. New data fields were created to express this data on the GIS map. This was a time-consuming process, but the maps it generated portrayed valuable information that was species specific to the presence of rare plants and dominant weeds in a unit. Examples of these maps are included in Appendix F.

Figure 6 shows the data fields included in the database for one record. Figure 7 shows a sample of the information contained in each data field. Appendix D contains descriptions of the information entered for each data field in the database. Once the linkage between the database and the land management unit map was tested for accuracy, the Land Conservancy was ready to begin looking at ways to use this data and set priorities for restoration.

3.2.3 Assigning Priorities

There were many factors to consider when developing a system for assigning priorities for restoration. Priority was determined by a combination of variables that included the presence of rare plants, the native biodiversity, and the threat of weed infestation to a unit. The process of assigning priorities is discussed in Appendix C. Below is a brief discussion of the construction of an effective method for determining priorities.

The first effort to devise a method for prioritizing units for restoration involved incorporating several data fields into a computer program that would calculate an order of priorities. These fields included rare plants, biodiversity, weed infestation and vulnerability to invasion. This proved very difficult in that too many variables and combinations of variables were involved. The first program proved to be overly-complex and did not yeild viable priorities.

To simplify the program it was modified to eliminate consideration of vulnerability to weed infestation. This modification is justifiable in light of the fact that present resources are only sufficient to actively work in currently infested areas. The resulting program improved the accuracy of priority assignments when field-confirmed. This program is the first of two steps in assigning priorities for restoration. The first step results in long-term priorities for restoration illustrated in the map in Figure 8 (page 12).

The second step in assigning priorities for restoration involves a subjective review, based on field knowledge and experience, of the first priorities from step one to establish quarterly priorities for restoration. The resulting quarterly priorities establish a plan dictating the order in which restoration work will proceed for that quarter. Figure 9 illustrates these priorities (page 12).

The above process was reviewed by the Restoration Task Force, which validated the need to use value judgments based on field knowledge in setting final priorities. The long term priorities are reviewed annually and quarterly priorities are continously assigned based on the season and work accomplished. Task 3 was completed when the land management units and database were used to produce a map of high priorities for restoration in December 2002.

UNITS A- RARE B 640 CJ NV 0_ VULNERBI F_HUMAN ECU VAL PRIORITY
2030_00 1 ,1 4 1 1. _ i_ i
PRIORITY_2 PtOVER WHY Nil GOAL r4), TECHNIGLIE Fil, COMPLETE
DOK_WEED 90 CE PAM V DATE NOTES DATE _A

SECONONOTE RARE_RICH A m AP BS CDR DO ES OS HK L
PP SA SS. SW SP 5T wt, X_ PROM TY T T2 13- COMMENTS AREA. AC
alb - 1.00_ - 0 0 1 Mixed Lupe
MORPHOLOGY NAME LINIT LOCATION
Dune Scrub REFUGE
UNITS 2
2030

Figure 6. Data Fields ***(expressed in the database for unit 2030)***

Guadalu pc-Wiper:no Dunes Land Management Units

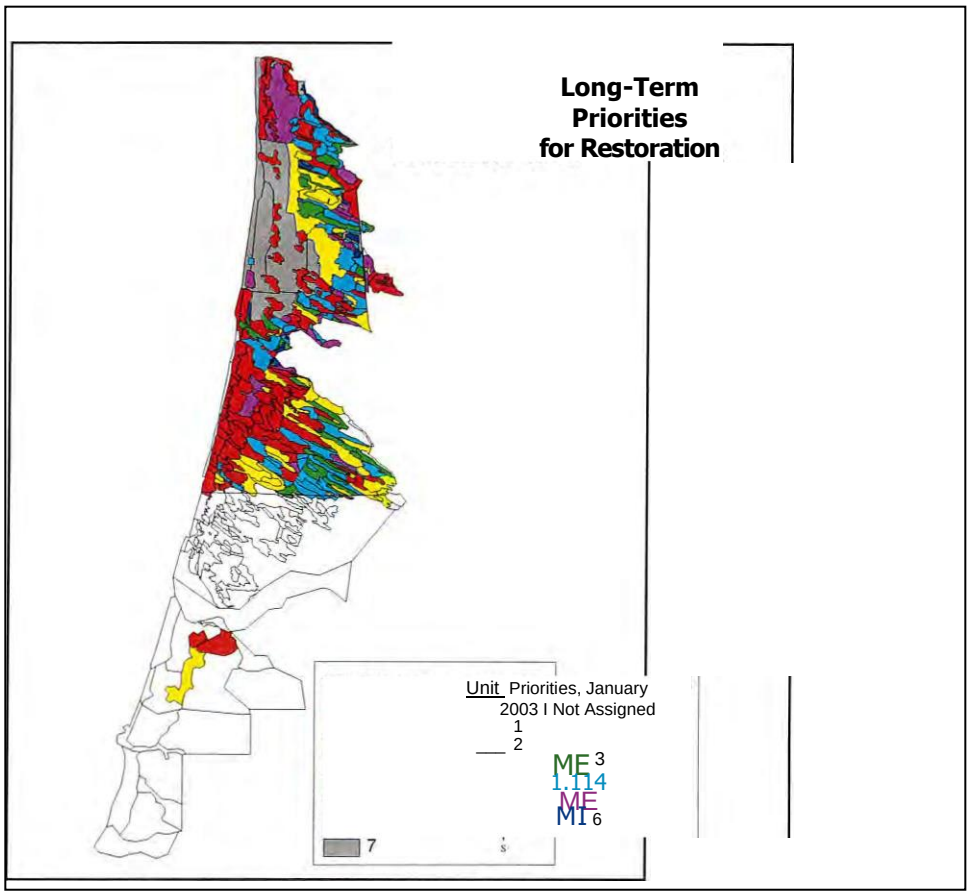
UNITS MORPHOLOGY LOCATION UNIT NAME UPDATED

2,030.00 Dune Scrub REFUGE 1'17/02 to 15112102
1 PRIOPdTV (subjective) Habitat Raniung,s- Rare plant: 1 Biodiversity,› 1 Infestation> 4 Vulnerability; I
NOTES> 03/17(2002 Claudia Makeyev
Dunescrub
Rare5ppCoteopsis (Dont).. delphinium, horkelia
Ass: M H. dudIcya, owls clover. beckwiE:at
Inv; BC3CI Grass
High density of Corcopsis intertwined with HG. great bia.wit half is tompletely coveted in BG iipuind infestation
Very high priority
NOTES> ON 12f02 Jasmine Walls
Mills
Ram Spp: &J MC. SLO, EB,
Dom: SL, 6.114
Asso: AU, POP, CY, PB,. LS. COB, GN, BW. DW, Pl.., PO, PR, AM, DUD, CH, PH
Good variety
Inv: Bri+ with Si and lee
very heavy- weed cover

2,031 00 Thinc Scrub REFUGE 1/ 9/02 to 6/12/0f
I PRIORITY (subjective) Habitat Rankings- Rare plaur,' I Biodiversiry> I Infestation> 3 Vulnerability; I
NOTES> 0110912002
Central dune scrub. S. of mills and moving dune. Spp: M. crispa. A. maritima and umbellata(scattered),slovralthower. coreopsis.. senedo. pndth pliloN, cobweb thistle. end SL, dudleya, primrose, phagelia, and willow.
Good bin.Lcading edge of small veldt creeping in from Mills litige patch of BG to the we. priority.
NOTES> 05/24/2002 CM
Active, sparse, &newt* haw= 2015 and 2033 active dories,
Dom: SL+, MN, willow
Asso: ptintrose, ambrosia, common yarrow, willow.
Relative to habitat type great rare percentage and great bio, Front of BG, threatens adjacent and downwind.. pristine MUM Easy access and low BO ground cover.

06/l2)2 Jasmine Waits
Mills
Ram- Spp SB, MC, BLU/EB, SW
Dom: SL. MM
Asse: CY, FL+, AM, LS, FD, DW, PB. W. CI3, Bull thistle
good to moderate bio
Inv: SL BG, CM - light cOycJ

Figure 7. Database Report. ***A page from a report created to express selected data fields for each record in the database***



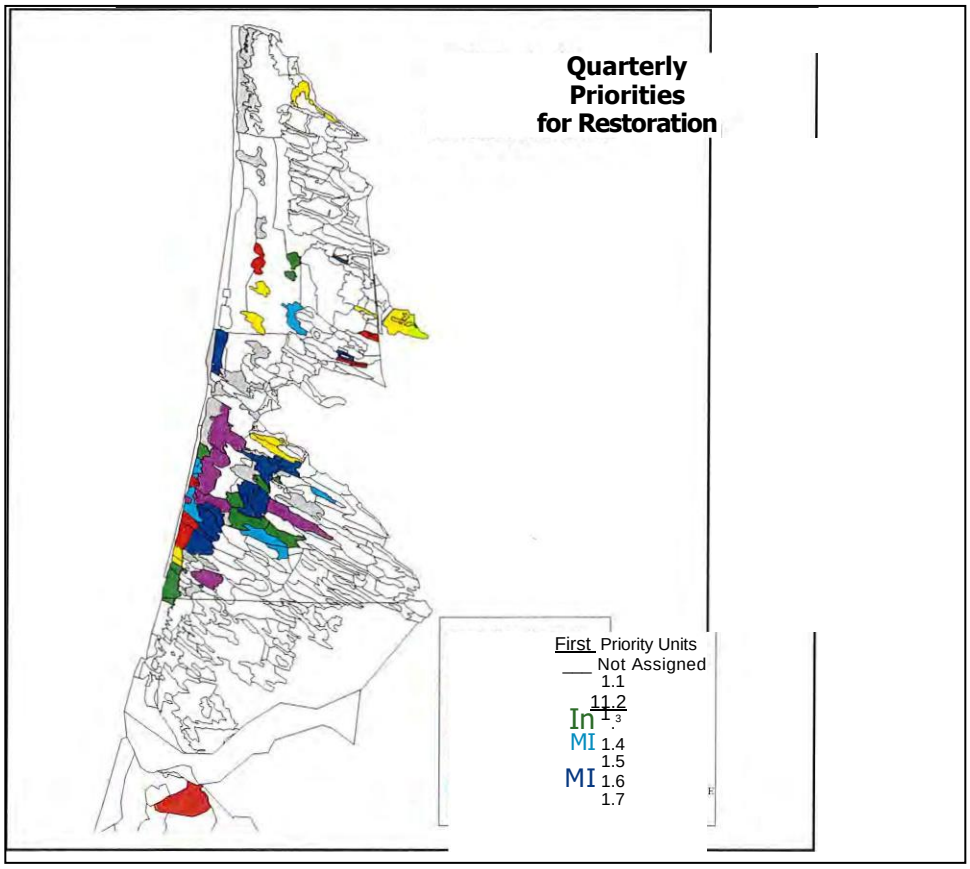


Figure 8. Long-Term Restoration Priorities for January 2003
Figure 9. Quarterly Restoration Priorities for January- March 2003

4. Task 4—Confirmation of Land Management Units

Goal: Verify the locations of the digitized land management unit boundaries in the field using known locations of key benchmarks and a technical review committee.

The Restoration Task Force was formed as a technical review committee to assist the Land Conservancy in verifying the boundaries, data entered into the database, and the criteria for setting priorities. Discussions on what criteria make a unit top priority resulted in recommendations on the criteria to be used. The need for field verification became more and more important as the amount of data to be collected expanded and the database was subjected to increased testing and use in setting priorities. Task 4 became much more involved than originally anticipated and resulted in the expansion and enhancement of the products of Task 3. The following is a description of the lessons learned in an expanded field testing program.

4.1 GPS

The first step taken to make fieldwork easier was to laminate aerial photograph maps with the GIS land management units overlaid. Appendix A has these maps. This made keeping track of each unit visited easier while in the field.

In addition, a GPS unit was purchased for use in verifying location in the field and taking point locations of rare and exotic species populations.' The following paragraphs describe why and how GPS was used. It was learned later that using a low-level GPS, purchased on budget, required a lot of office time to figure out how to make it connect. The waypoints were not as accurate as they could have been with a better GPS unit and accuracy is key in mapping rare plant locations. It is worth spending the money up front for a better GPS unit.

Using GPS. The 9,000 acres of dunes can be an overwhelming area to navigate through. A problem encountered in making field visits was in being able to know for sure which unit one was in when recording data for each unit. From aerial photographs overlaid with the outlines of the land management units, one could assume his or her location, but to verify one's actual location, a GPS device was used. With each visit into the field a GPS was used to periodically take waypoints. Waypoints show the location, with known coordinates extracted from satellites, where one has traversed the dunes. Each waypoint is numbered, and these numbers were recorded for the unit they corresponded to on the data sheet. Upon returning to the office, these waypoints were downloaded and projected into ArcView on top of the aerial photographs so that one could check the waypoint numbers recorded on the data sheets and confirm the assumed locations. Figure 10 on the following page shows an example projection from two different field visits: the highlighted waypoints from the October 1, 2002 field visit, 055-063, were taken in unit 109; if the corresponding data sheet for that field visit has a different set of waypoints recorded for that unit, then a revision of the observations would be necessary.

Once waypoints were projected onto aerial photographs a consistent error became apparent in their positions. This consistent error has been attributed to the degree of accuracy of the geo-rectification of the aerial photography. Some errors in the accuracy are to be expected because the nature of the dune environment made the establishment of a dense ground control network impractical. This

LA Garmm GPS HI Plus unit was used.

positional difference was easily corrected by including this off set in the re-projection calculations. Therefore, the waypoints could be projected with a closer relationship to the aerial photograph.

GPS codes. GPS is also used to take locations of rare plant populations and individuals as well as to take the location of weed infestations and fronts. The plants were identified in the GPS by modifying the waypoint names to include standard plant codes. Thus, waypoint "001" could be modified to read "001ST", which would signify the location of a population or individual of Surf Thistle *(Cirsiurn rhothophilum),* a rare foredune plant. The code "ST" was developed when Makeyev and Watts put together a list of dune plants with their respective GPS codes for use out in the field. Appendix E has the complete list of dune plants with their respective UPS codes.

Waypoints. Waypoints are organized into shape files to be expressed in ArcView. Each waypoint shape file contains data from a dated field visit. Specific rare plant waypoints have been segregated and combined into their own shape file. Thus, all waypoints ending in "ST" can now be displayed as one shape file. This allows for comparison of different ranges and locations of rare plants. A naming convention was developed for shape files to aide their organization: "wpts10-01-02jw-p" would indicate that that shape file consists of waypoints taken on October 1, 2002 by Jasmine Watts and the data has been projected. An "-n" at the end of the file name would indicate that the data is non-projected.

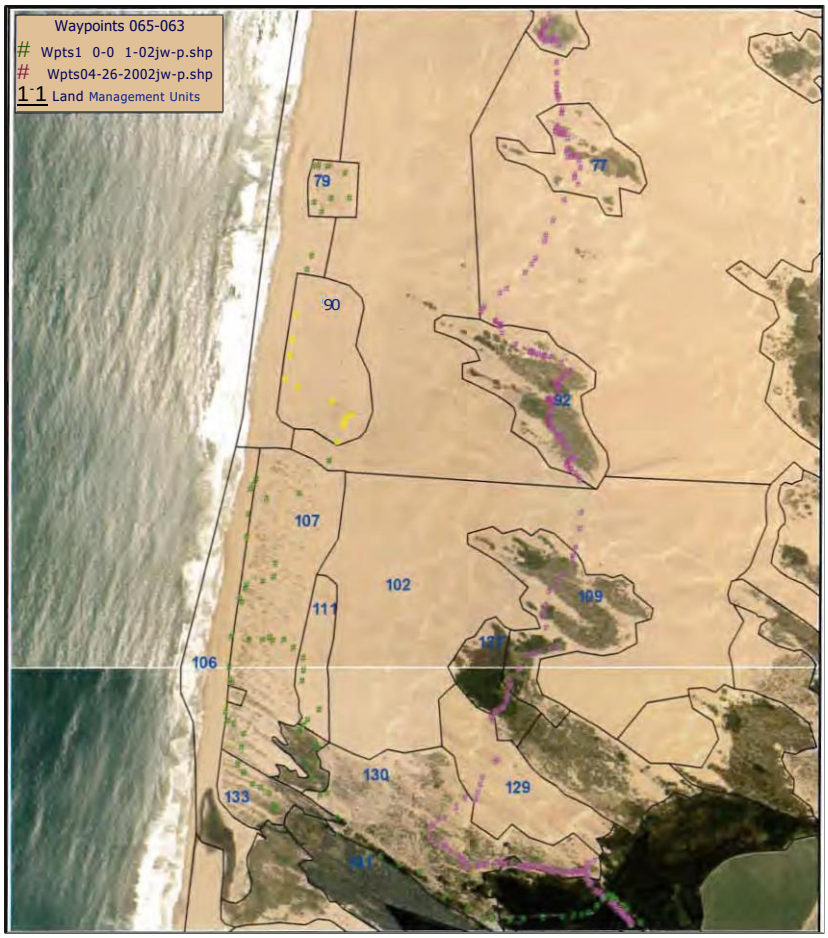


Figure 10. Waypoint Data *(from two field visits on April 26, 2002 and October 1, 2002 by Jasmine Watts)*

4.2 Plant Documentation

While performing Task 4, a wealth of botanical information became accessible that is useful for educational and research purposes. With each field visit to the dunes, the locations of each plant species encountered were documented.

Plant Data. Appendix F includes maps produced in ArcView using the fields in the database to express land management units with their corresponding plant communities, rare plant presence, dominant weeds, and target weed presence. A map of all data waypoints taken by the CCC in 2001 and the Land Conservancy in 2002 is included.

Plant Photos. Digital photos were taken throughout the project of each species encountered in its various growth stages. Photos are in "jpeg" format and are named accordingly: plant code, description of plant stage, e.g. flower, leaf (optional), date, and initials of photographer. For example, a photo labeled "st040102cm" would indicate a photo of Surf Thistle taken April 1, 2002 by Claudia Makeyev. Appendix E includes the initials used for the various photographers at the bottom of the plant list. The photos can be found on file at the office of the Land Conservancy of San Luis Obispo County. Future funding will enable the development of a dune plant guide put together by Jasmine Watts and Claudia Makeyev. Figure 11 shows a few of the photos taken.

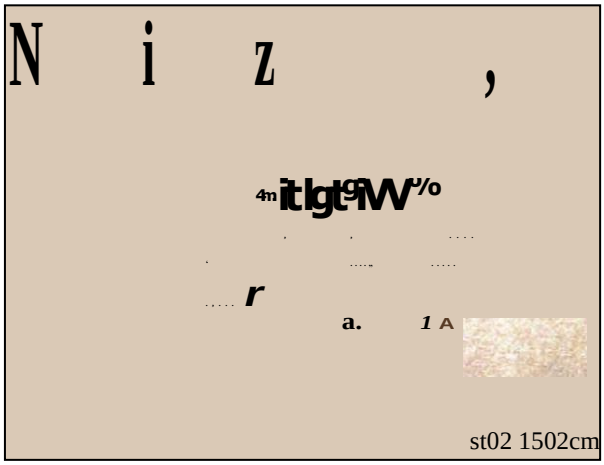
5. Task 5—Final Product/Installation of GIS at the Dunes Center

Goal: Install an operating GIS system at the Dunes Center containing the data collected for this project.

The final product, representing the culmination of the above four tasks, was a computer installation containing all of the information described above at the Dunes Center. This includes the geo-rectified aerial photographs, delineated land management units based on the morphology and property boundaries of the dunes, and a database relating the location of both native and exotic plant species to the respective units. A computer with an operating GIS system was installed at the Dunes Center to make the product described above available to the Stewardship Collaborative for Restoration Management purposes.

Confidentiality—Limits on our Scope of Work. The goal of this project was to develop a data structure and GIS mapping program that would be applicable throughout the Guadalupe-Nipomo Dunes from Oceano to Point Sal. The focus for this process was on the Oceano and Refuge areas studied during the initial restoration work of Phase I. Throughout the implementation of this project an effort was made to incorporate data from other areas. In some cases this meant access to private property (Dune Lakes) with strict limitations on the accessibility of the data collected. Other cases concerned the inability to physically access the property (UNOCAL) or concerned areas that were not previously mapped in detail that was consistent with our structural standards (CNLM). There is also a general concern that locations of rare plants be kept confidential.

It is essential that the Dunes Center strictly restrict access to sensitive data and maintain the agreement between the Dune Lakes Ltd for confidentiality.



Surf Thistle *(Cirsium rhothophiluin)*

Prickly Phlox *(Leptodactylon californicum)*

Dune Mint *(Monardella frutescens)*
Normally with purple flowers, this plant lacks pigmentation

Sand Food *(Pholisma arenaria)*

Beach Evening Primrose
(Camissonia cheiranthifolia)

Behr's Metalmark *(Apodemia virgulti)*

Figure 11. Dune Photos ***(taken by Claudia Makeyev and Jasmine Wafts)***

IV. Concluding Comments

The Land Conservancy would like to thank the Fund Committee: the California Coastal Conservancy and the Department of Fish and Game, Office of Oil Prevention and Response, for funding this "Dunes GIS" project. This project was instrumental in establishing a basis for a long-term plan for the restoration of the Guadalupe-Nipomo Dunes. The fieldwork was very involved and allowed for an intimate understanding of one of the Central Coast's most prized resources. A personal note on the fieldwork experienced during this project is located in the last appendix of this report, Appendix G. Thank you.

Appendix A

Detailed Maps of Guadalupe-Nipomo Dunes Land Management Units

Delineation of Land Management Units

The Guadalupe-Nipomo Dunes were divided into over 400 land management units as a means to set priorities for restoration and track progress in exotic weed eradication. Units were first drawn by hand corresponding to habitat boundaries (including ridgelines, contours, fence-lines and trails), weed infestation, and locality of specific rare plant species with the use of aerial photographs and field notes by botanist John Chesnut in 1999. These units were refined and redrawn using GIS software in 2001 by field biologist Claudia Makeyev. Makeyev visited each unit, making field observations that either divided or combined existing units based on changes in plant populations.

Land management units were assigned identification numbers based on the numbering system developed by Chesnut. The units located in the Oceano dunes, which include the State Vehicular Recreation Area, Dune Lakes, Phillips 66[1] property (formerly Tosco Refinery), and the dunes surrounding and north of Oso Flaco Lake, have unit numbers ranging from 1 to 157. The units south of Oso Flaco Lake are part of the National Wildlife Refuge maintained by the U.S. Fish and Wildlife Service and bordered by private property. These units, ranging from 2000 to 2170, were previously referred to as the Mobil Coastal Preserve (Makeyev modified the numbering of these units by adding 2000 to Chesnut's original unit numbers for ease in entering the information into the new database).

The units located south of the refuge were delineated based on aerial photography due to the limited access of these areas. Units located on Unocal property are in the 3000s (3000-3050) and those located in Guadalupe and maintained by the Center for Natural Lands Management (CNLM) are in the 4000s (4000-4022). It is important to note that these units are awaiting data input into the database developed by the Land Conservancy from separate databases set-up by Unocal and the Dunes Center. Therefore, priorities for the weed removal in these areas are not reflected in this report. Figure A-1 shows the land management units and their numbering divisions. Figures A-2 through A-15 are maps of the units layered onto the aerial photographs.

[1] The Phillips 66 property has since been changed to the name of Conoco Phillips.

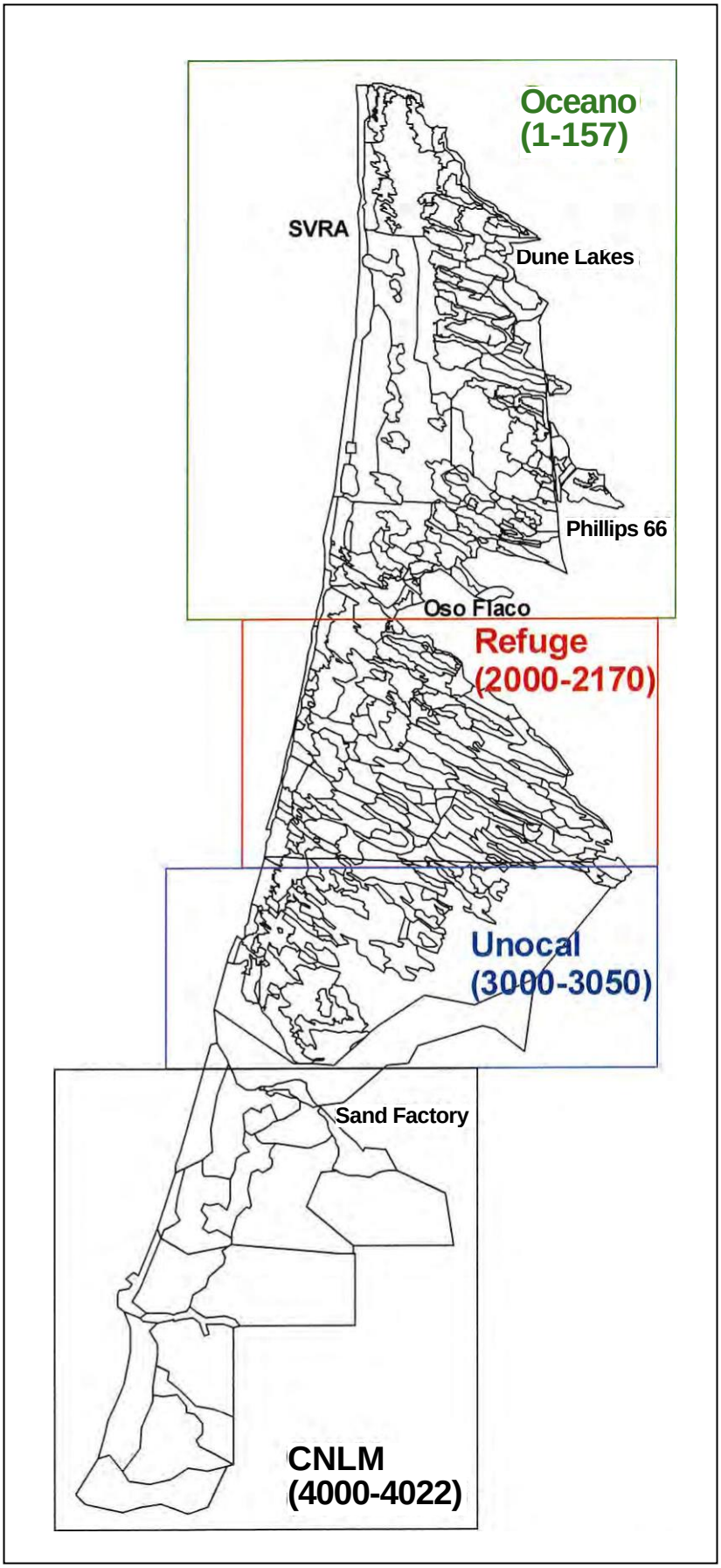


Figure A-1. Numbering System of Land Management Units

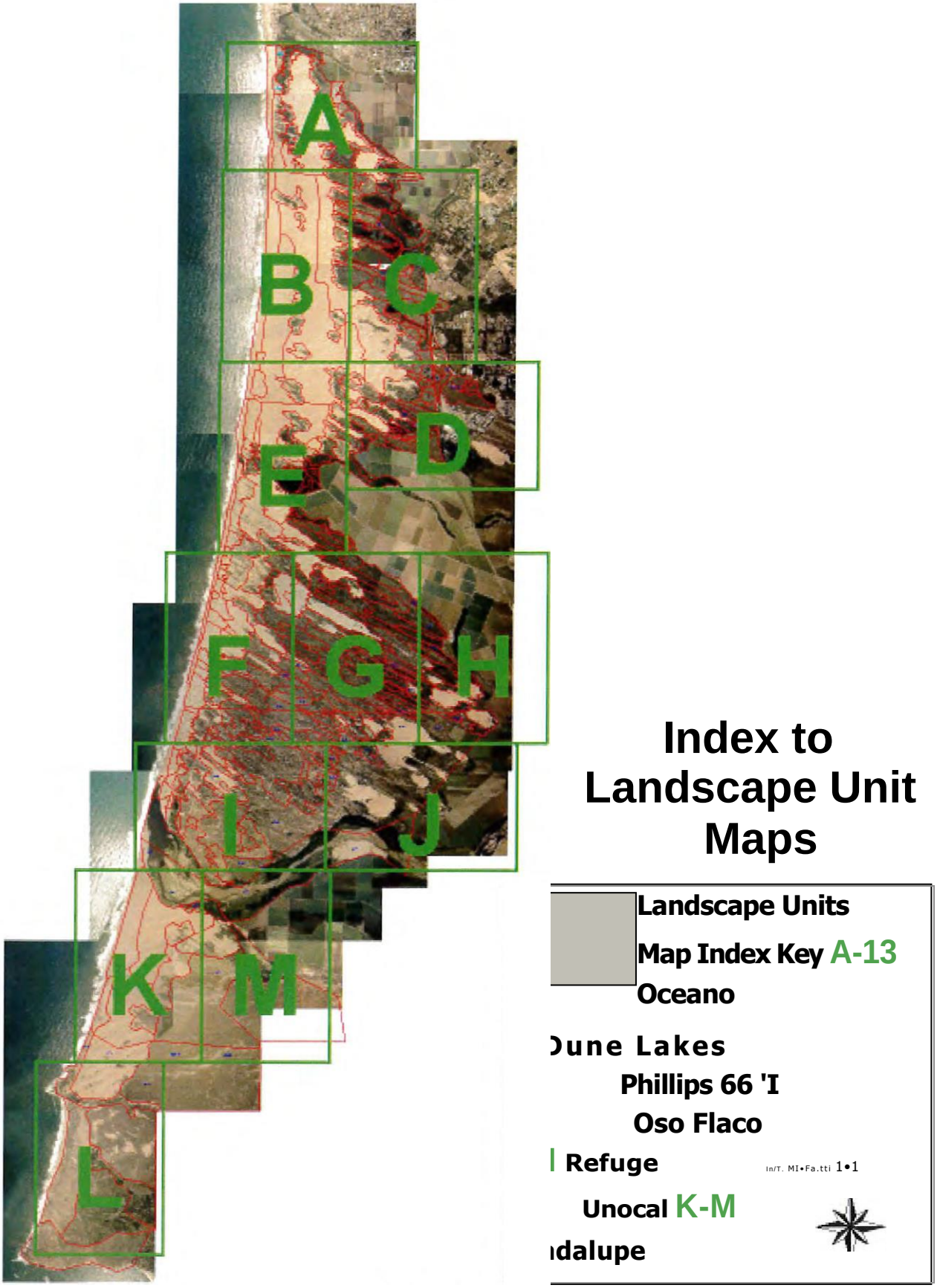

A
B
C
D
E
F
G
H
I
J
K
M
L
Index to Landscape Unit Maps
Landscape Units
Map Index Key A-13
Oceano
Dune Lakes
Phillips 66 'I
Oso Flaco
Refuge
Unocal K-M
dalupe

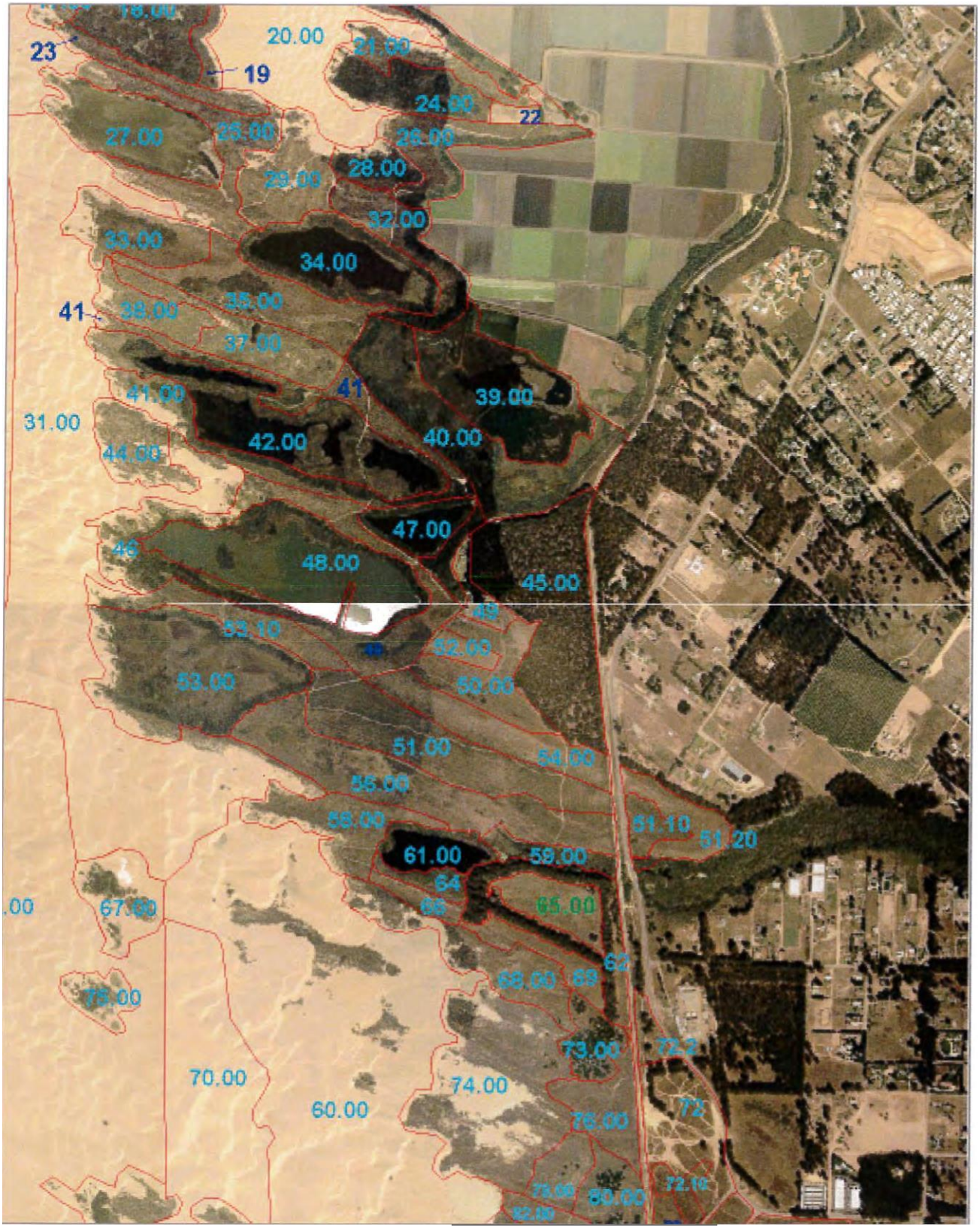
Figure A-2

Index A: Ocean

Figure A-3

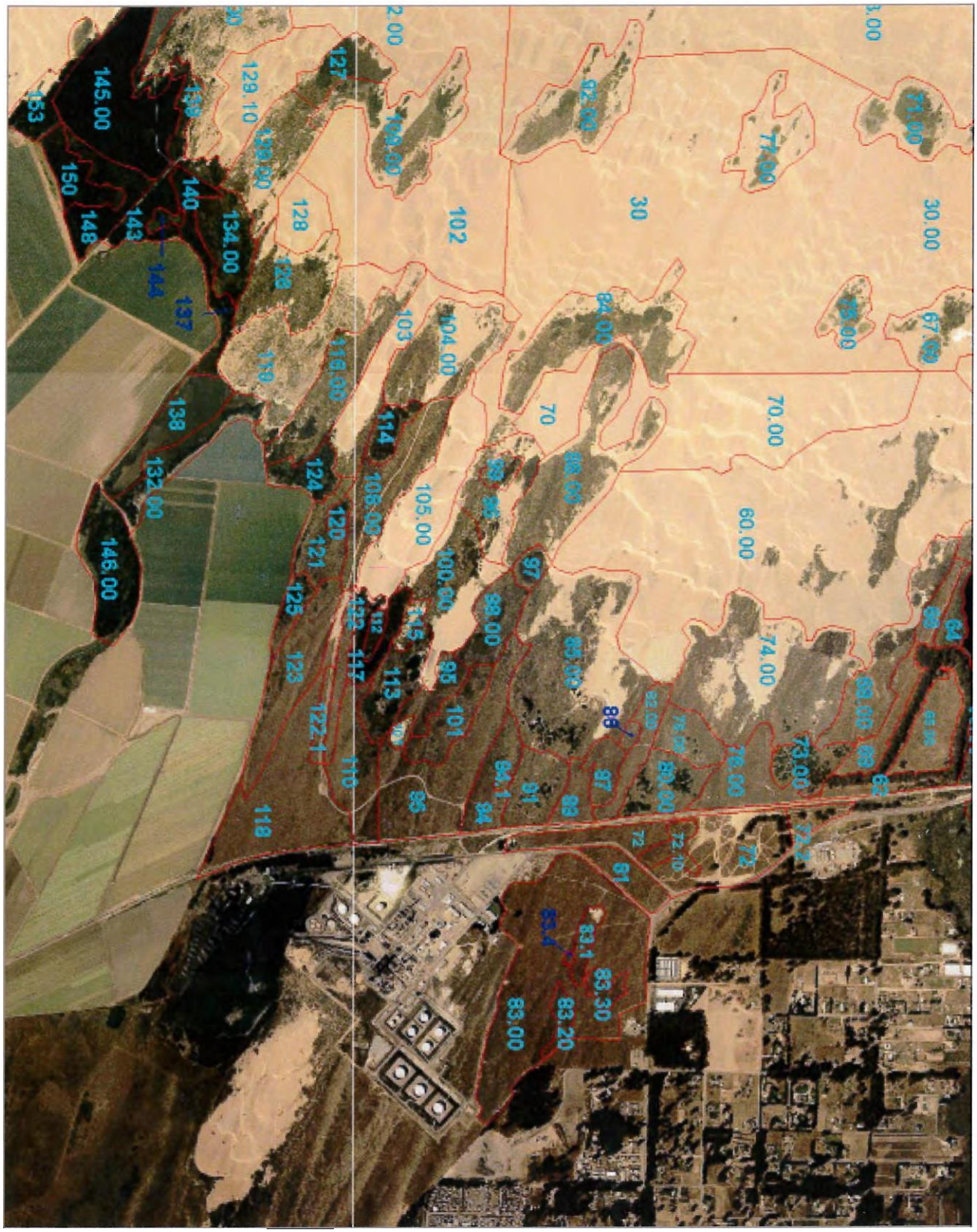
Index B: Oceano

Figure A-4



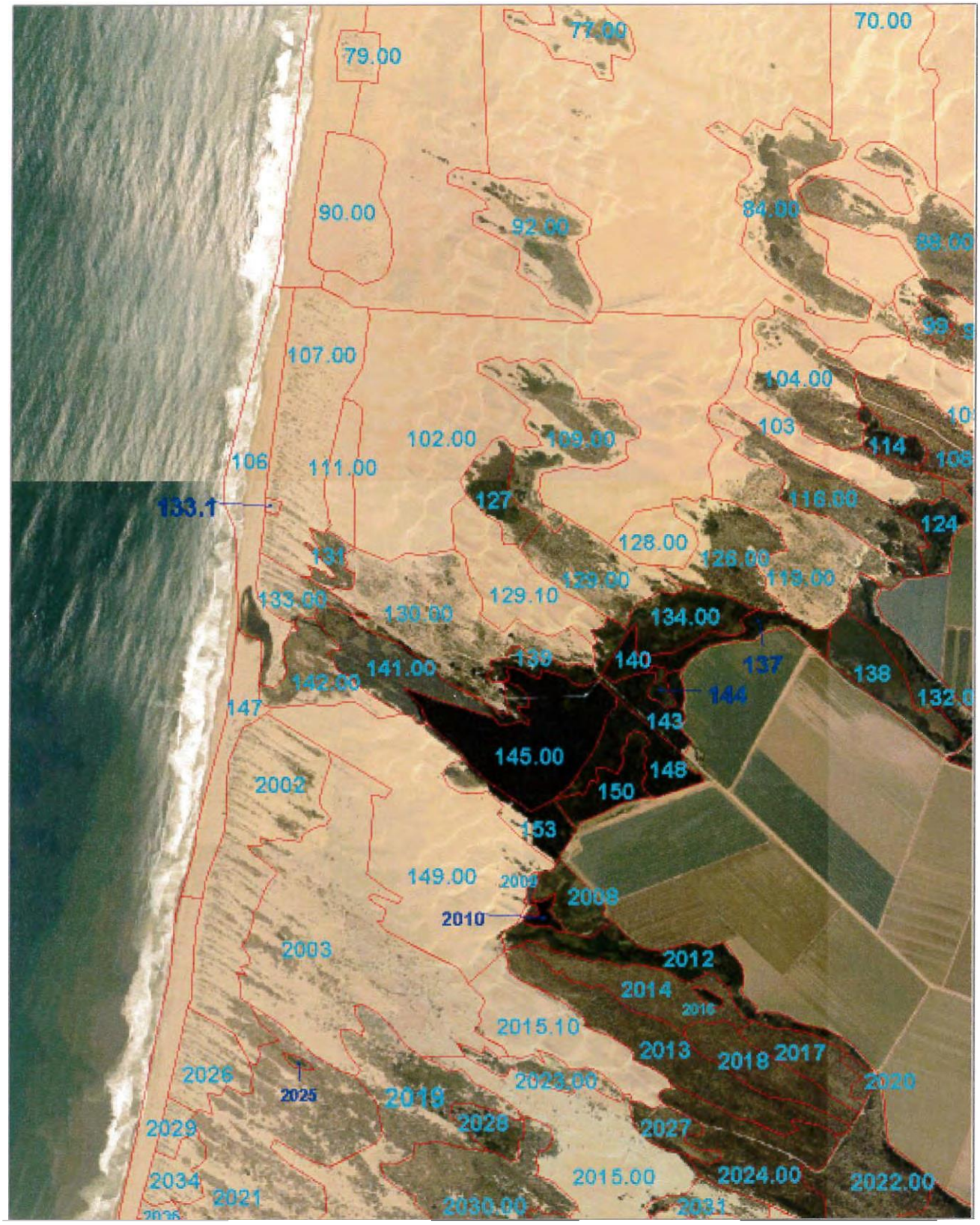
Index C: Dune Lakes

Figure A-5



Index D: Phillips 66

Figure A-6



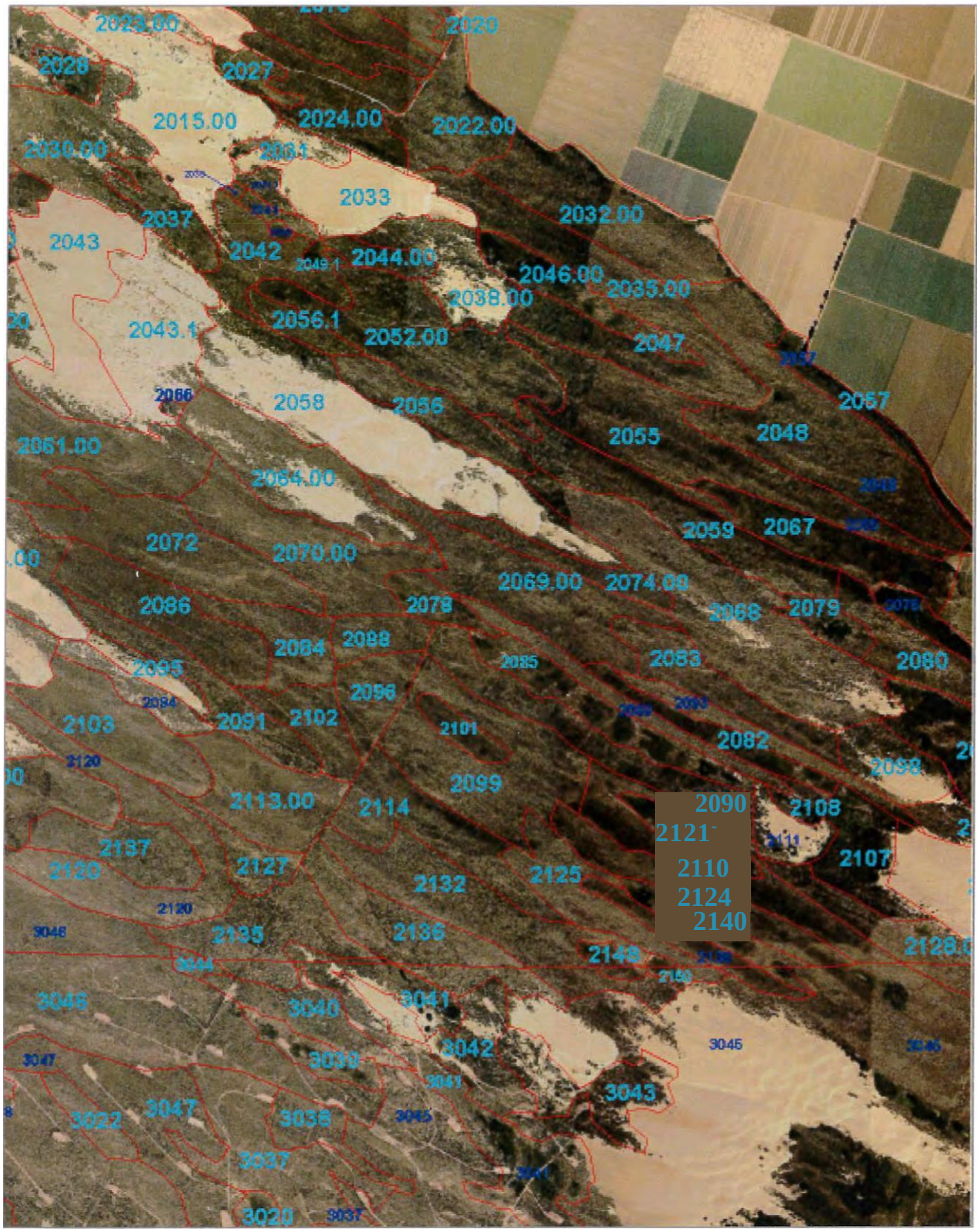
It

Index E: Oso Flaco

Figure A-7

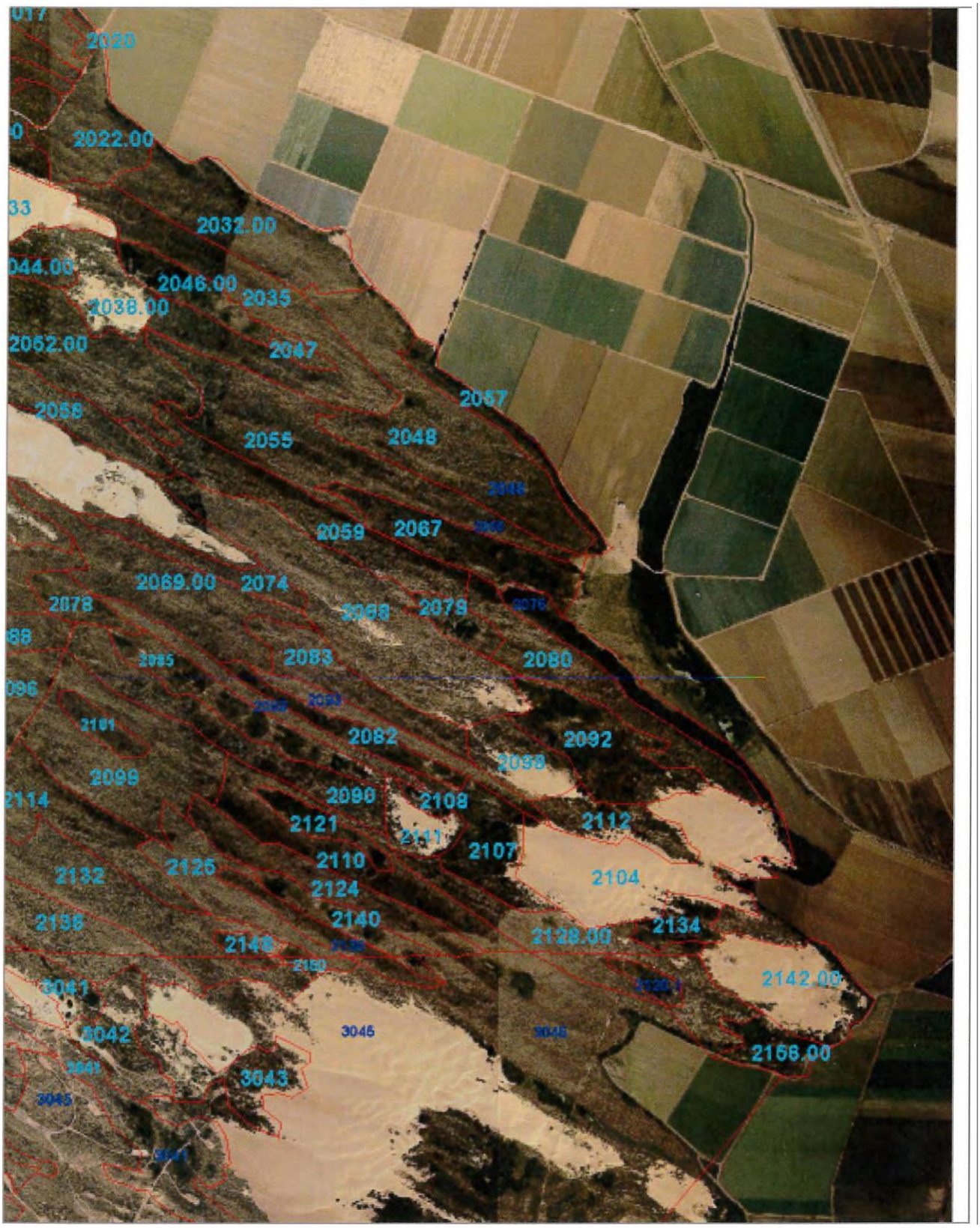
Index F: Refuge

Figure A-8



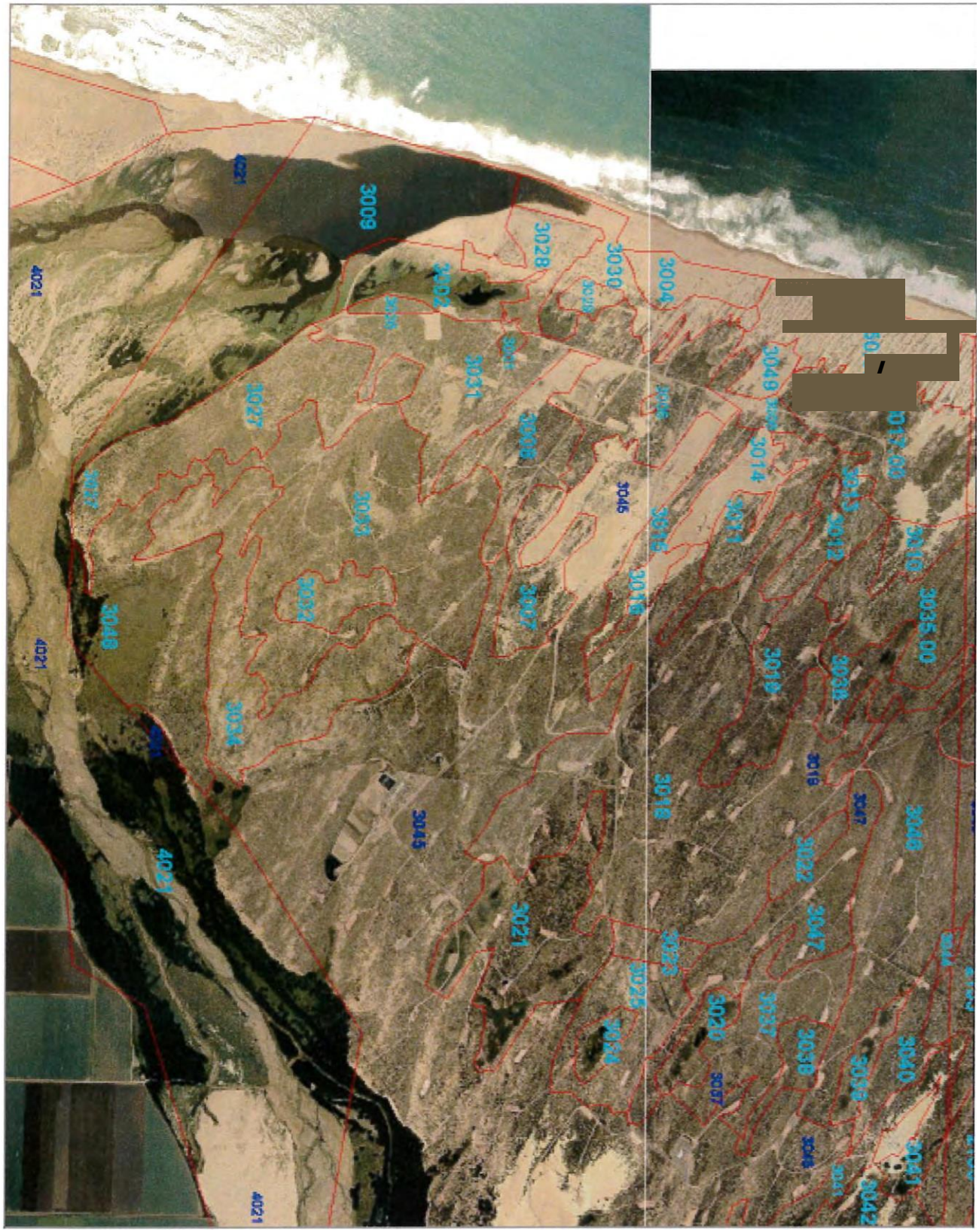
Index G: Refuge

Figure A-9



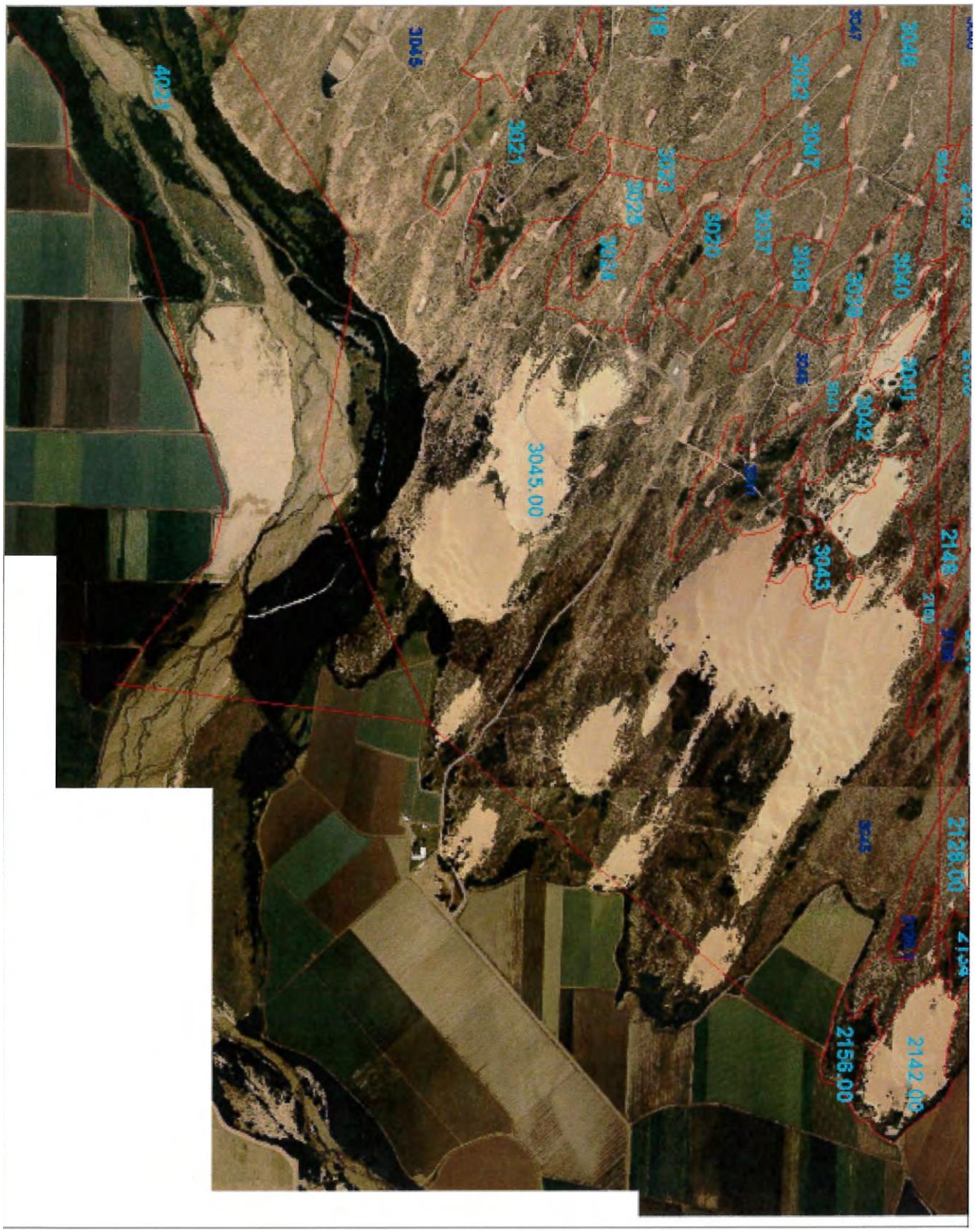
Index H: Refuge

Figure A-10



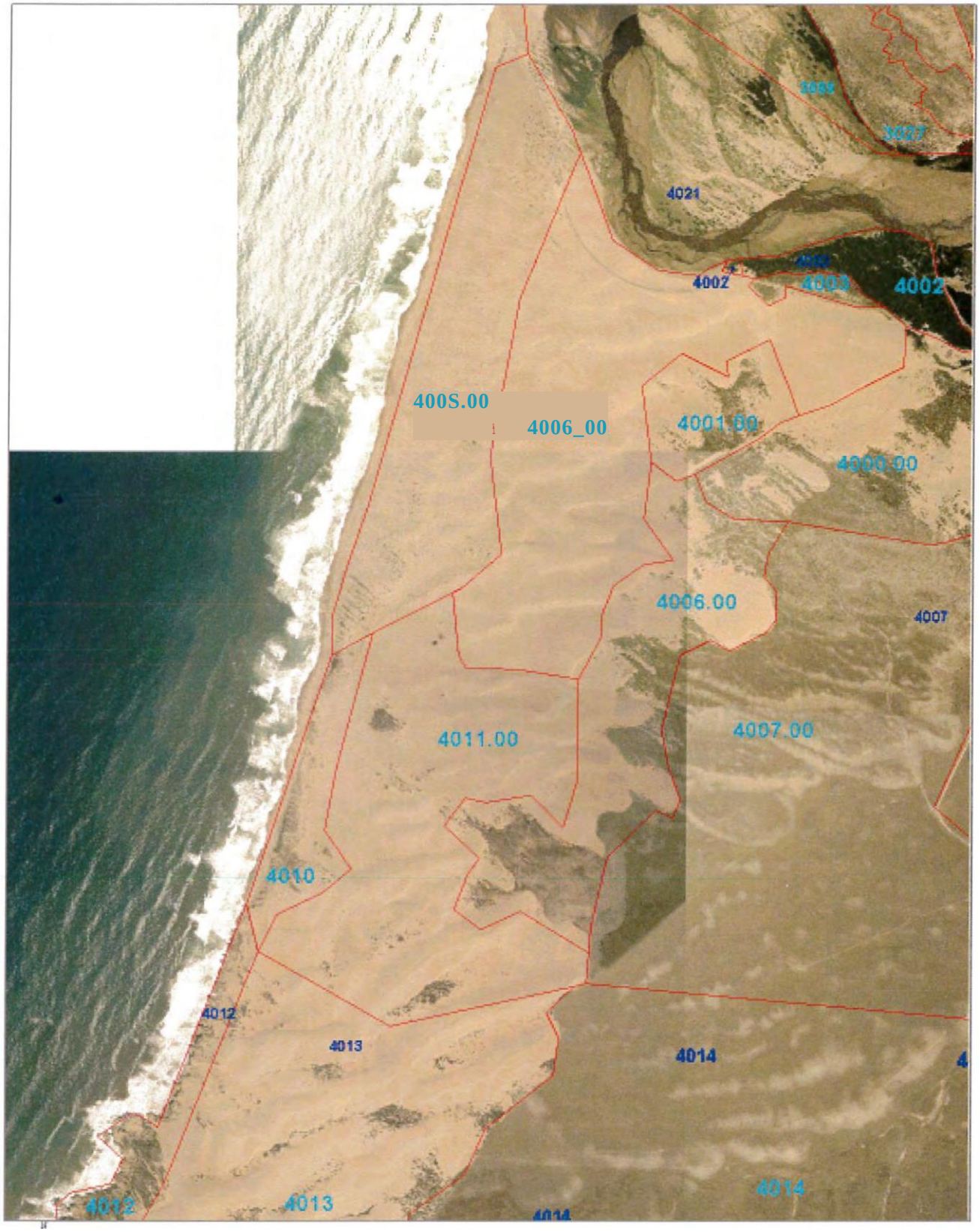
Index I: Unocal

Figure A-11



Index J: Unocal

Figure A-12

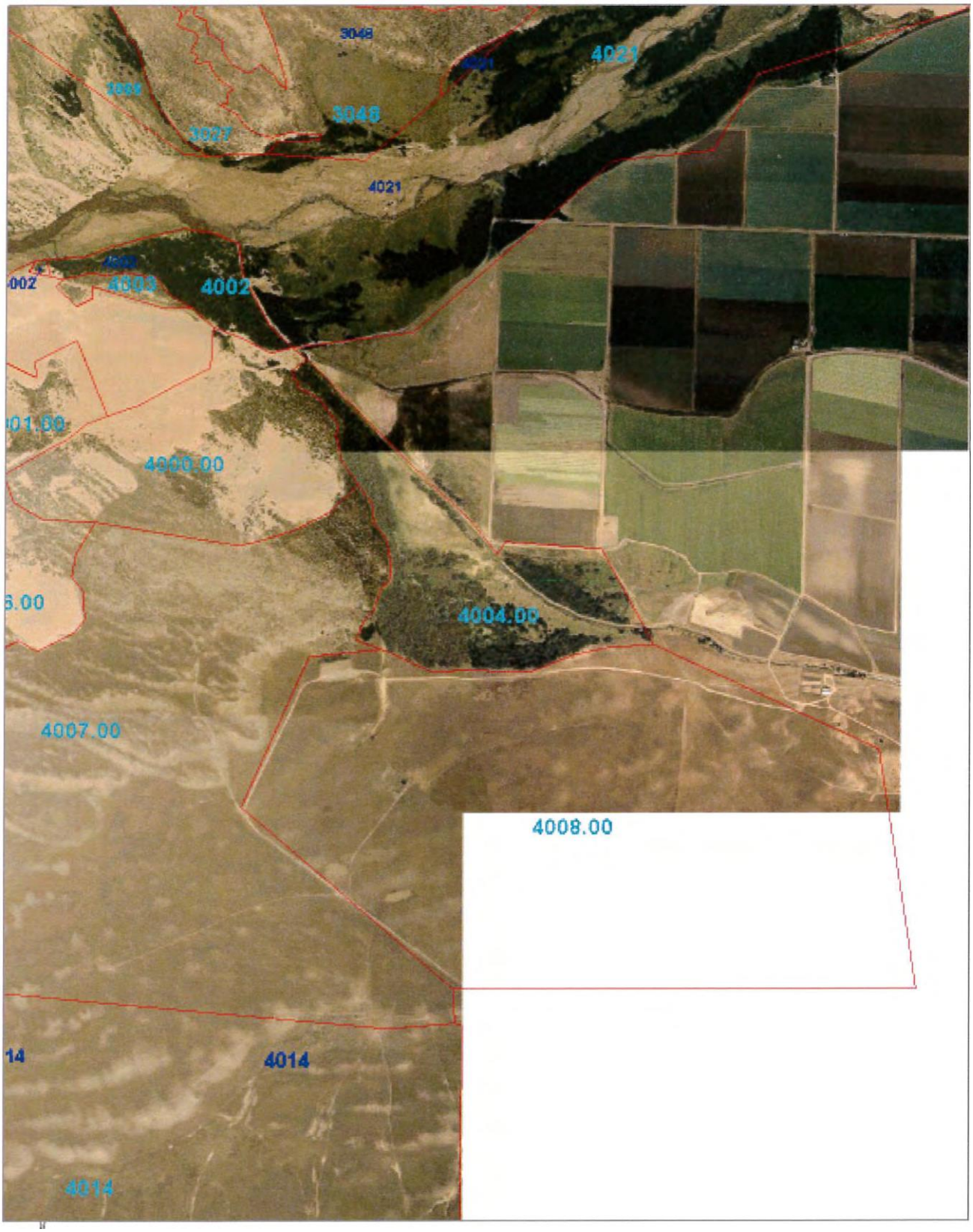


Index K: Guadalupe

Figure A-13

Index L: Guadalupe

Figure A-14



Index M: Guadalupe

Figure A-15

Appendix B

Data Collection

Evaluation Criteria

Four kinds of data were collected for each Land Management Unit to assist in setting priorities for restoration. These include (1) the presence of rare natives, (2) native biodiversity, (3) extent of weed infestation, and (4) the unit's vulnerability to further invasion. Below are the definitions of the different rankings of each habitat quality evaluated on the field data sheet (refer to Figures B-1 and B-2).

Presence of rare natives. Rare natives include those plant species listed by the California Native Plant Society to be rare, threatened, or of local concern and that have been found to grow in the Guadalupe-Nipomo Dunes. A list of these plants is located in Appendix E. A ranking system of 1-5 was assigned to each Land Management Unit as follows.

> Rare = 1. There is a significant presence of several species of rare plants. This may indicate an overwhelmingly healthy biodiversity that is no longer often seen in the dunes.
>
> Rare = 2. There is an abundance of one rare species or there are several species scattered throughout the unit. The difference between rank 1 and 2 can be subjective, but keep in mind the abundance of one species versus the abundance of many.
>
> Rare = 3. There is one rare species represented by a few individuals.
>
> Rare = 4. There is one rare species represented by one individual.
>
> Rare = 5. There are no rare species present.

In judging the status of one species, the overall importance of the rare plant involved becomes an important factor. For example, there are units located on the Phillips 66 property with a small number of Nipomo Lupine *(Lupinus nipomensis)* present and no other rare species. This would normally result in a ranking of a 2 or a 3, but because Nipomo Lupine is one of the most rare and endangered plants in the dunes, the units with the presence of this plant were ranked a 1.

Other important rare plants whose presence ranks the unit a 1 are those with CNPS R-E-D Codes of 3-3-x[1]. These include Beach Spectacle Pod *(Dithyrea maritima)* and Nipomo Lupine. Surf Thistle *(Cirsium rhothophilum),* although its R-E-D Code is not 3-3-x, is also considered a top rank because of its habitat's vulnerability to destruction and because its range is not extensive in the Guadalupe-Nipomo Dunes. There are, however, more plants that have a R-E-D Code of 3-3-x, but are not given special consideration for the following reasons: a few of the species are wetland plants and there is no immediate invasive weed threat to these areas other than Pampas Grass, which already qualifies the unit for top priority; or in the case of *Horkelia cuneata* ssp. *sericea,* there was no discernment between subspecies and therefore the data shows this plant to be widespread.[2]

---

[1] The California Native Plant Society uses a "R-E-D" code to further classify rare plants with a degree of concern. The acronym addresses rarity, endangerment and distribution, represented by a 1, 2 or 3 with 3 having a greater level of concern.

[2] Plants were not identified to subspecies or varieties in the field to expedite the process of collecting data. It is very difficult to identify a subspecies or variety without keying the plant out, and to do this for each and every plant in the 9,000 acres of dunes is not practical.

Native biodiversity. Native biodiversity is an overall evaluation of the quality of habitat and the number of native plant species present in a unit. High biodiversity provides the base for a healthy ecosystem and the foundation for future development of native plant populations. Native plants are those plants native to California including the rare plants. Plant lists in this category may include naturalized or non-invasive species when inventoried but are not included in the measure of native biodiversity. Native biodiversity rankings start at **1** (high biodiversity) and end at 5 (no biodiversity). The difference between rankings is not only subject to numbers of species present but also to the size of the populations and the type of habitat defining the unit (for example, the high biodiversity for a foredune habitat would be a good to moderate biodiversity ranking for a dunescrub habitat); therefore, there is a lot of subjectivity involved with this ranking. An approximate average of number of species specific to each ranking is listed in parentheses after each ranking description below, but keep in mind that the number is not limited to the ranking because of the other factors involved.

Bio =**1.** There are a high number of native plants present. This rank usually indicates a pristine area important to preserve. (>20)

Bio = 2. There is a good variety of species present. This rank describes a good habitat and reflects potential of what other species could be present in that unit. (15)

Bio = 3. There is a moderate diversity of plant species present. This rank describes an average to below average representation of the flora present in the greater dune complex. (10)

Bio = 4. There is low diversity of plant species present. This rank indicates a very poor habitat or a monoculture of one species. This rank often describes a unit containing a severe weed infestation.

Bio = 5. There are no plants present in this unit. This rank is usually reserved for disturbed areas, such as parking lots or agricultural fields, but may also include areas with no colonization of terrestrial plant life such as open beach and bodies of water.

Invasive weed infestation. Invasive weeds include those plant species not native to California that compete with the native plants for habitat and resources. Infestation refers to a weed that begins to inhabit an entire area and will eventually result in a monoculture of that weed. Invasive weed infestation rankings start at 0 (no infestation) and end at 5 (very heavy infestation).

Weed = 0. No weeds present.

Weed = 1. Very light presence, less than 1% weed cover.

Weed = 2. Light presence, 1% to 5% weed cover.

Weed = 3. Moderate presence, 5% to 25% weed cover.

Weed = 4. Heavy presence, 25% to 50% weed cover.

Weed = 5. Very heavy presence, 50% to 100% weed cover.

Vulnerability to invasion. Vulnerability to invasion describes how much a unit is being threatened by invasive weeds. This rating is important because it indicates the future of weed infestations to the unit. For example, if a unit is surrounded by weeds or is downwind from an invasion, there is a need for immediate attention to preserving the pristine area. An infestation that is upwind from a unit is a source of infestation to that unit. Vulnerability to invasion rankings start at 1 (high vulnerability) and end at 3 (low vulnerability).

Threat = 1. There is a high vulnerability to invasion. This rank describes a unit that is surrounded by a weed infestation *and* the infestation is upwind.

Threat = 2. There is a medium vulnerability to invasion. This rank describes a unit that is surrounded by a moderate weed infestation *or* the infestation is upwind.

Threat = 3. There is a low vulnerability to invasion. This rank describes a unit that is neither surrounded nor downwind from a weed infestation.

Figure B-1. Field Data Sheet

SLO Land Conservancy Dune Plant Data

Date Location Polygon # B oned by:

From Waypoint #_____

Habitat type: Shoreline, Foredune. Coastal dune scrub, Central dune scrub, Swale, Active dune, Wetland, Lake, Riparian(forest). Agriculture, Disturbed (houses, parking lot, development etc), Other

A. Presence of Rare?kiativec

Species present:

Several spp. In abundance | **Abundance of I spp. s2..r Emlim¡cattered** | *1 spp_* Few individuals 3 | **Iplant 4** | **NONE 5**

B. Native Biodiversitr

Dominant speciesl.., _r.:4...

Associate spoeies:,,,1

(High number of different species in habitat ranging to include kw species to a monoculture)

High natives	Good variety	moderate	low,	Nopc
I	2	3	4	5

Comments,,:.•• , ra t,r, ... ,,

C,Presence of Invasive=

Dominant species. .....

Assoclieespecies:.. Weed Infestation

C. Invasive Weed Infestation Rating:

C) None

1 iitt. Very Light, **less than 1% weed cover**

2 — Light, 1% to 5% weed cover

3 ,= Moderate,, 5% to 25% weed cover

4 **Heavy, 25% to 50% weed cover**

5 = Very Heavy, 50% to 100% weed cover

D. Vulnerability to invasion:

Unit surrounded and upwind: 1High **Unit** surrounded or upwind: 2Mcd Neither 3 I_ ow

Human Impact/use: 1High 2 Med ..

Easy or Difficult Amen

SLO Land Conservancy Dune Plant Data

Date:6— 1 La-Location: M ,''S Polygon #: C) Recorded by:

From Waypoint # E 3 0 ' to LS[1]" 7

Habitat type: Shoreline, Foredune, oastal dune sera) Central dune scrub, Swale, Active dune, Wetland, Lake, Riparian(forest), Agric , isturbed (houses, parking lot, development etc), Other

A. Presence of Rare Natives: Species present: ..S . „ee[1]... ..... s. E13.1 A Ahl

.....

.....

everal spp. In abundance	Abundance of 1 spp. or several spp. Scattered	lspp. Few individuals	1 plant	NONE
1	2	3	4	5

Comments .....

..... CecKto?r;:- .....

A. Native Biodiversity:

Dominant species:.. M .

Associate pecies:. . t. N

1-3 k iljarAC/`e V a

.....

.....

(High number of different spec bitat ranging to include few species to a monoculture)			
High natives	moderate	low	None
1	3	4	5

Comments.....

.....

C—Presenceofinvasham

Dominant species:.. .....

.....

Associate .....

Weed Infestation Rating/cornments...aiVi- w/lots of Bent Grass .....

.....

C. Invasive Weed Infestation Rating:

0 = None

1 — Very Light, less than 1% weed cover

2 = Light, 1% to 5% weed cover

3 = Moderate, 5% to 25% weed cover

e6Heavy, 25% to *50%* weed cover Very

Heavy, 50% to 100% weed cover D.

Vulnerability to invasion:

Unit surrounded and upwind: 'High **Unit surrounded or upwind:** 2Med **Neither: 3Low**

Human Impact/use: 1Hith 2Med 3Low.....

Easy or **Difficult Access**

Figure B-2. B-2. Example of Completed Field Data Sheet

Appendix C

Priority Rankings for Restoration

Priority Rankings for Restoration

The system for determining a land management unit's priority for restoration is a two-step process. Below the steps are described in detail with step one including a description of each priority ranking.

Step 1—Establishing Long Term Priorities

Long-term priorities for restoration are assigned using a program that establishes ecological importance and a need for restoration work to a unit. Different combinations of habitat quality assessments from the data sheet are used to determine ecological importance. These habitat qualities include biodiversity and the number of individual species or populations of rare plants that are present in a unit. The presence of rare plants is deemed important because the unit in which they are present is habitat that preserves or encourages their existence. The ecological importance of a unit is the foundation from which priority assignments are derived.

To make this program effective for determining need for restoration work, the definition of first priority is restricted to the presence of rare plants, presence of pampas grass, and high levels of weed infestation. Without this restriction, the priority ranking of I could indicate an important area but the area might not need any immediate restoration efforts. If there are no weeds to remove then there is no work to be done by the field crew. Therefore it is determined if a unit is ranked first priority but is rated a I or a 2 for the "Invasive Weed Infestation" category (indicating a very light to light infestation), the unit is lowered to second priority. If the unit was ranked with a high "Invasive Weed Infestation" rating, then the unit remains a first priority.

The presence of the invasive weed Pampas Grass creates a special situation. Pampas Grass is a highly invasive weed that produces a great number of seeds each year that are disseminated through the air and can travel far distances to produce more individuals. Pampas Grass usually is found in the dunes threatening wetlands and receives immediate attention from the field crew. If a unit has Pampas Grass present, it is a first priority.

Defining Priority Rankings. Below are the descriptions for the assigned long-term priority ranks of land management units. Figure C-1 on the following page illustrates the computer program to establish this first set of priorities in the format of a key, similiar in structure to the keys used in plant identification. This key can be used to manually assign priorities.

> Priority =**1.** This ranking indicates important pristine areas defined by the high presence of rare natives or the native biodiversity of a unit and requires the immediate attention from the Dunes Restoration Field Crew. *Subjectively:* This priority ranking also describes a unit with the presence of invasive weed Pampas Grass or the presence of very rare and endangered native plants (indicated by the CNPS R-E-D Code of 3-3-x). This ranking may also describe a unit that consists of a heavy source of weeds that threaten nearby important pristine areas.
>
> Priority = 2. This ranking indicates important pristine areas without a significant presence of rare plants, or indicates units having a significant presence of rare plants but that are not significantly threatened by infestation of invasive weeds. These units require periodic field visits to ensure the continual security of health and the lack of a significant threat.

Priority = 3. This ranking indicates a unit with high native biodiversity but low presence of rare plants or a unit with a good representation of rare and native plants.

Priority = 4. This ranking indicates a unit with a good representation of rare plants moderate native biodiversity, or a unit with a high or good native biodiversity but without a significant, if any, presence of rare plants.

Priority = 5. This ranking indicates a unit with a few individuals of rare plants and a low to no native biodiversity, or a unit with one individual to no rare plants but have a moderate native biodiversity.

Priority = 6. This ranking indicates a unit with one individual to no rare plants and has a low to no native biodiversity.

Priority = 7. This ranking indicates no presence of rare plants and no native biodiversity. This ranking is usually reserved for units having a weed monoculture or other botanically uninhabited units such as open beach, bodies of water, agricultural lands and also include units with disturbed areas such as parking lots.[1]

Priority = 8. This ranking indicates a unit that has been completed in regards to restoration efforts involving the removal of invasive weeds and is no longer a priority at that time.

Step 2—Establishing Quarterly Priorities

Quarterly priorities for restoration are assigned using a subjective review of the first priorities from step one to determine an order in which restoration work will proceed for that quarter. The Restoration Field Manager reviews the first priorities and assigns the quarterly priorities based on the accessibility to the units and the feasibility of weed removal from that unit.

Accessibility is determined by two factors: ease of travel by driving and/or hiking and, more specifically, the Snowy Plover Season affecting the accessibility of the foredunes. Feasibility is determined by the amount of work required in a particular unit, if there is availability of sufficient field crew to complete the work, and whether the unit can be completed in a short amount of time or take a year to complete.

Units that contain significant sources of weed infestations may be included amongst the first priorities and worked on periodically to prevent the spread of a weed into nearby important and/or non-infested units. All first priority units receive a secondary priority ranking reflecting the order in which the units will be treated for that quarter. This priority ranking is expressed as a decimal to the first priority ranking. E.g.: **1.1** through 1.7, the "0.1" and "0.7" derived from the working order determined by the Restoration Field Manager.

The Need for Ongoing Database Management

The above two steps develop a set of priorities on a quarterly basis for restoration. After significant work has been completed, a re-evaluation of the priorities will be necessary to establish a new set of

[1] Botanically uninhabited refers to terrestrial native plants not including emergent plants or commercial crops.

priorities. This process may include return field visits to areas that were previously not infested but vulnerable to future infestation, and to areas where prior work was done to make sure weed removal/ reduction/or containment was successful. Monitoring will play a significant role in the re-evaluation of priorities. All second priorities will be re-evaluated yearly to confirm their level of priority or to change it, most likely to first priority when and if necessary. Priorities are not absolute; they were never intended to be and are appropriately changeable.

Creating Maps to Illustrate Priorities for Restoration

Data in the database can be linked and expressed in the attribute tables (data fields corresponding to graphic features) of ArcView to produce the data in graphic form. Any category can be expressed in ArcView as a Land Management Unit map. Units can be highlighted to depict priority assignments. Figure C-2 shows a map of the long-term priorities set in January 2003 for each unit. Figure C-3 shows a map of the quarterly priorities used to layout the scope of work for the quarter January-March 2003.

Key To Restoration Priorities

Rare = 1; or presence of Pampas Grass

B Inv = 3, 4, or 5;
or presence of Pampas Grass

B' Inv = 1 or 2

Rare = 2, 3, **4,** or 5;
and *no* presence of Pampas Grass
Rare = 2

D Rare = 2, Bio = 1 ...

D' Rare = 2, Bio = 2, 3, 4, or 5 Rare = 2, E Bio = 2 ...

Rare = 2, Bio = 3, 4, or 5 ... Rare = 3, 4, or 5

Rare = 3

19jRare = 3, Bio = 1 ...

U

Rare = 3, Bio = 2, 3, 4, or 5 Rare = 3, Bio = 2 or 3 Rare = 3, Bio = 4 or 5
Rare = 4 or 5 **5**

Rare = 4

pi Rare -= 4, Bio = 3 ...

Rare = 4, Bio = 1, 2, 4, 5

IMRare = 4, Bic = 1 or 2

Rare = 4, Bio = 4 or 5

Rare = 5

Rare = 5, Bio = 5 ...

Rare = 5, Bio = 1, 2, 3, or 4 n Rare = 5, Bio = 4 ...

Fm Rare = 5, Bio = 1, 2, or 3

Rare = 5, Bio = 3 **5**

Rare = 5, Bio = 1 or 2

Figure C-1

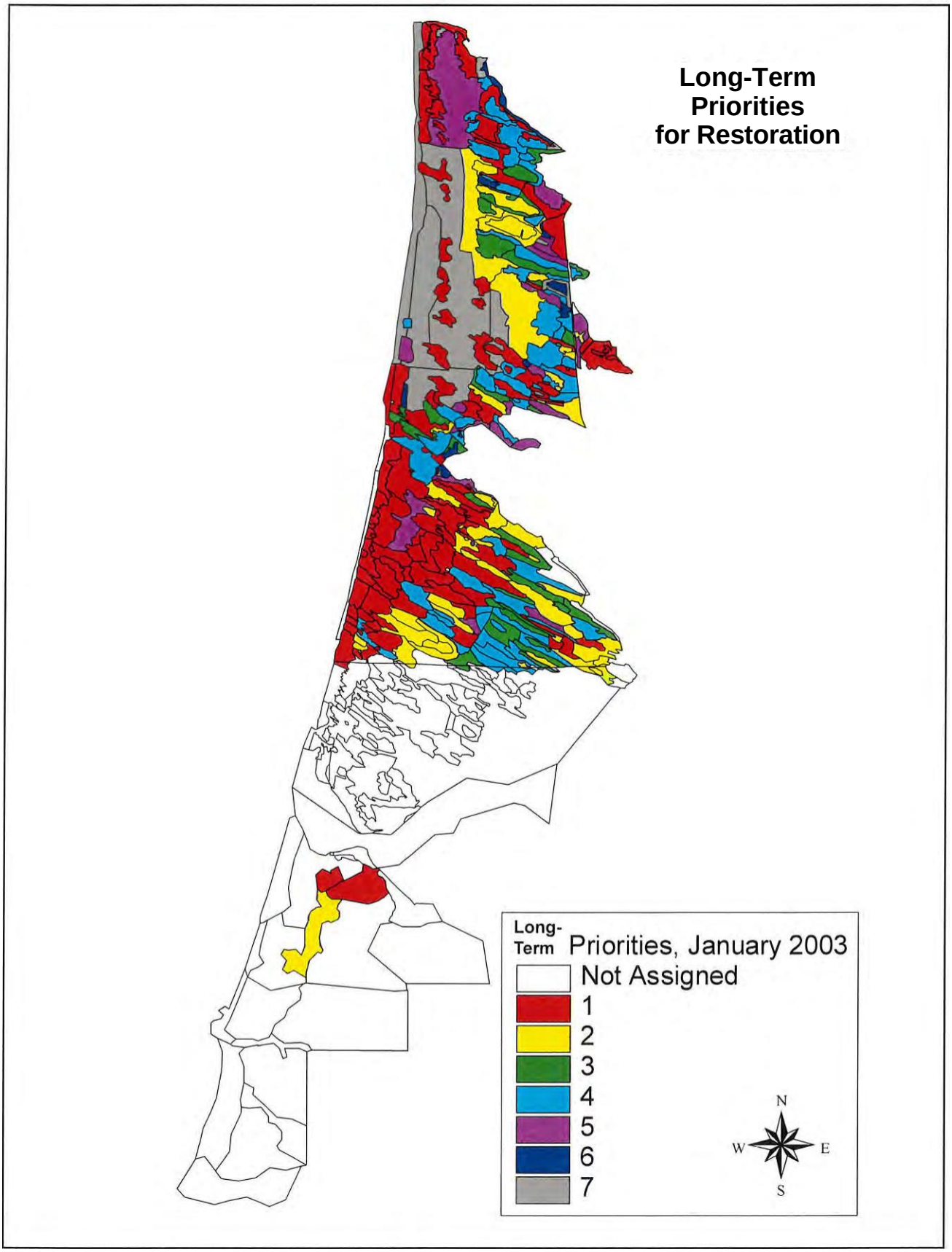


Figure C-2. Long-Term Restoration Priorities for January 2003

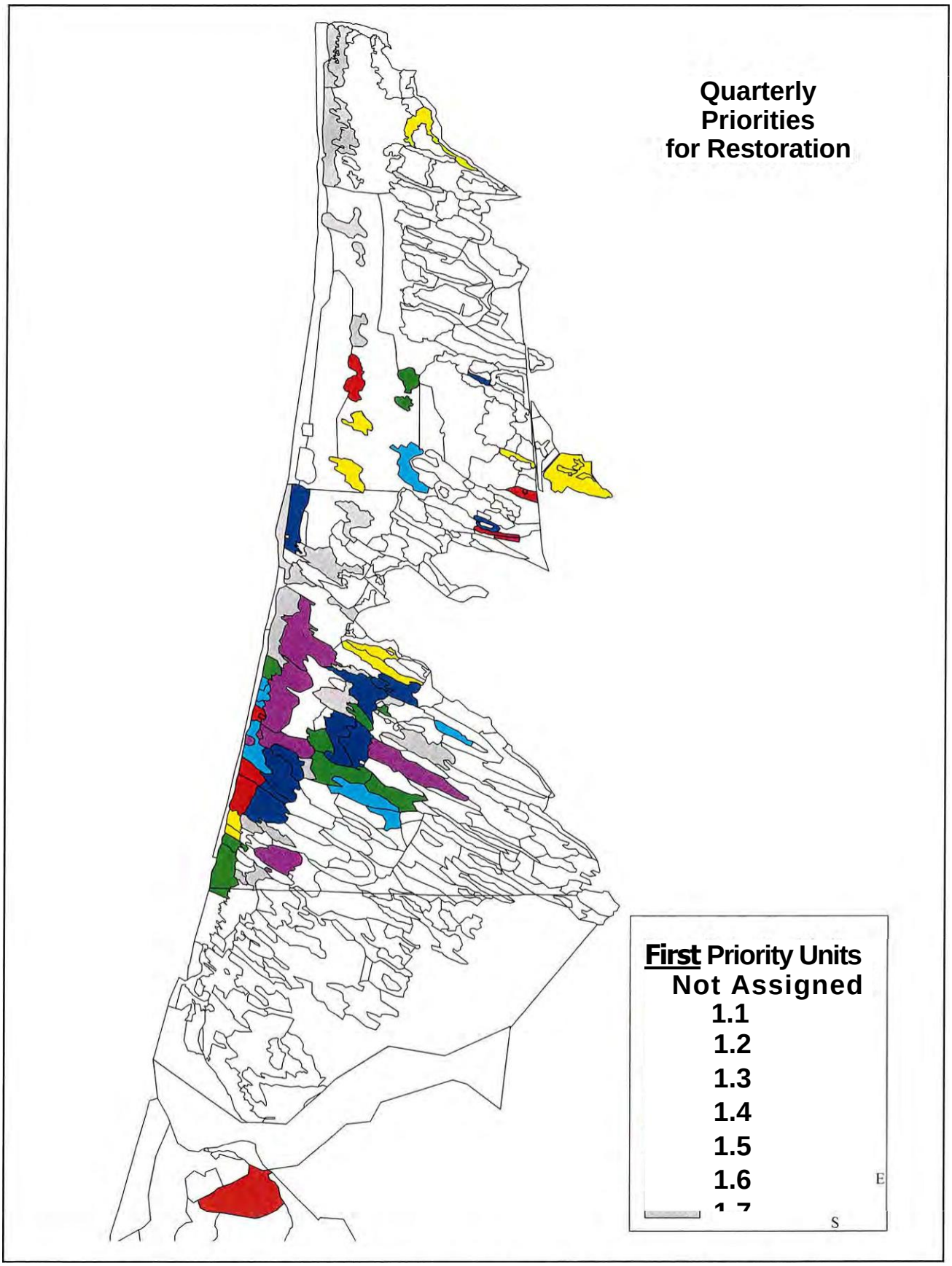


Figure C-3. Quarterly Restoration Priorities for January-March 2003

Appendix D

Database Field Descriptions

The Database

Each land management unit has a corresponding database developed using "Visual dBASE," a program that communicates information to the GIS mapping program used (ArcView) in order to manipulate and display all corresponding information visually onto maps. Over fifty data fields were created to record any and all information available and collected from field visits, data sheets, and previous observations documented by John Chesnut in the earlier report. The database includes over 400 records, each describing a different unit in the dunes. Below each data field is defined and described.

DATA FIELD (type). Description.

UNITS (numeric). The land management unit number assigned by Makeyev.

A_RARE (numeric). The "presence of rare natives" rating recorded from field data sheets.

B BIO (numeric). The "native biodiversity" rating recorded from **field data sheets.**

C INV (numeric). The "presence of invasives" rating recorded from field data sheets.

D VULNERBL (numeric). The "invasive weed infestation" rating recorded from field data sheets.

F HTJMAN (numeric). The "human impact/use" rating recorded from field data sheets.

ECO VAL (numeric). The priorities assigned manually using the "key to priority rankings" based solely on the importance and pristine-ness of a unit, determined by the A_RARE **and B_BIO data field ratings.**

PRIORITY (numeric). The modified priorities using the "key to priority rankings with subjectivity" and further modified by review from the Dunes Restoration Field Manager.

PRIORITY _2 (numeric). This is a secondary priority ranking assigned by the Dunes Restoration Field Manager for the first priority units. This number shows the order in which the units will be treated for that quarter or year. This priority ranking is expressed as a decimal to the PRIOR SUBJ ranking. E.g.: 1.1 through 1.7, the "0.1" and "0.7" derived from the number entered in the E_PRI2 field.

PLOVER (character). This indicates whether the unit is accessible during plover season or not, which affects the E_PRI2 rankings. Most foredune units are closed to public access during the months in which the endangered Snowy Plover nests. "Yes" signifies the units accessible during plover season; "no" signifies the units accessible during the off-plover season and otherwise inaccessible.

WHY (memo). This field gives the reason for the unit's first priority ranking and is used when writing quarterly reports on the scope of work for weed removal.

GOAL (memo). This field provides a goal for the success of weed removal, whether it is removal, reduction, or containment of the weed population in question. This field is also used in the quarterly reports mentioned above.

TECHNIQUE (memo). This field gives the technique being used to remove the weeds in a particular unit, and is also used in the quarterly reports mentioned above.

COMPLETE (numeric). This data field is copied from another database used by the Dunes Restoration Field Manager, listing the percent-completed weed treatment of a unit. This field is used to create the quarterly reports on the status of weed removal in the dunes.

DOM WEED (character). This field indicates the dominant weed, if any, in a unit. In general, only units with an invasive weed infestation rating greater than 2 are given a dominant weed indication. This field is useful for creating a map of the dominant weed locations in the dunes using ArcView.

BG, ICE, PAM, V (character). These four fields indicate the presence of Beach Grass, Ice Plant *(Carpobrotus* sp. indicated by "ice" or *Conicosia* sp. indicated by "si"), Pampas Grass, and Veldt Grass, respectively. These fields are useful in creating presence/absence maps of the weeds in each of the land management units in the dunes using ArcView.

DATE and **DATE — 2** (date). These two fields give the dates of the first and second field visits to the unit, respectively, corresponding to the field notes entered into the next two data fields below.

NOTES and **SECONDNOTE** (memo). These two fields are entered from the data collected on the field data sheets, consisting of the plant inventories and personal observations and comments for each unit.

RARE RICH (numeric). This field contains the number of rare species present, used to create a rare species magnitude map.

AM, AP, BS, COR, DD, EB, GB, Inc, LGT, LK, MC, MY, NL, PP, SA, SB, SLO, SP, ST, WC (character). These twenty fields indicate the presence of a specific rare plant in a unit. These fields are useful in creating presence/absence maps of the rare plants in each of the land management units in the dunes using ArcView. The codes correspond to the GPS codes provided in the plant list in Appendix E.

X PRIORITY (numeric). The priorities assigned mechanically using a program that calculates each unit's priority based on a formula derived from the A_RARE and B_BIO data fields of that unit.

T, T2, T3 (numeric). These three fields were used in the program described above for E PRIORITY as "place-holders" for the calculating of priorities.

COMNIENTS (character). Recorded from Chesnut's data table, this field consists of Chesnut's personal notes for a unit.

AREA AC (numeric). The acreage of a unit, available only for those units recognized in Chesnut's report.

MORPHOLOGY (character). This field lists the habitat/community type of each of the land management units. Data was first entered into this field from Chesnut's report, and was further added to and modified by Makeyev and Watts.

NAME _UNIT (character). This field provides a descriptive name of a unit. For example: "Coreopsis Hill", "Post 7" or "Valley."

LOCATION (character). This field refers to a unit's location, for example: "Oceano", "Refuge", "Unocal" or "CNLM".

UNITS _2 (numeric). This data field is a copy of UNITS but is formatted without decimals and is used for labeling units in ArcView.

Appendix E

Dune Plant List

Dune Plant List

Each dune plant encountered by either botanist was given a two or three letter code that pertained to the first letters of the genus and species of a plant, or to the first letters of the plant's common name, as was the case in the above example using Surf Thistle. Sometimes when developing the code duplicates were encountered and other easily remembered codes were assigned. A few plants have more than one code assigned to them due to overlooked duplicate codes that were later noted and modified. For plants with multiple codes, the first code listed is the code more frequently used. These GPS codes were also used when recording an inventory of species found growing in each unit.

Dune Plant List For Photos & GPS

CODE	LATIN NAME	COMMON NAME	COMMENTS	COMMUN
Endangered/Rare/Special Concern Plants				
am	*Abronia maritima*	beach sand verbena	List 4/Red 1-2-2	fd
ap	*Arenaria paludicola*	marsh sandwort	List 1B/Red 3-3-2	rp
bsp/bs	*Dithyrea maritima*	beach spectacle pod	List 1B/Red 3-3-2	fd
cor/c/coreo	*Coreopsis gigantea*	giant coreopsis	Species of Local Concern	ds
dd	*Malacothrix incana*	dunedelion	List 4/Red 1-1-3	fd/ds
eb/bld	*Erigeron blochmaniae*	blochman's leafy daisy	List 1B/Red 2-2-3	ds/sw
gb	*Ribes divaricatum var. pubiflorum**	straggley gooseberry	Species of Local Concern	rp/sw
hk	*Horkelia cuneata ssp. sericea**	horkelia	List 1B/Red 3-3-3	sw/ds
lgt	*Cirsium loncholepsis*	La Graciosa Thistle	List 1B/Red 3-3-3	sw
lk/dl	*Delphinium parryi var.blochmaniae*	dune larkspur	List 1B/Red 3-2-3	ds
mc	*Monardella crispa*	dune mint	List 1B/Red 2-2-3	ad
mf	*Monardella frutescens*	dune mint	List 1B/Red 2-2-3	ds
nl	*Lupinus nipomensis*	nipomo lupine	List 1B/Red 3-3-3	ds
pp	*Leptodactylon californicum ssp. tomentosum*	prickly phlox	List 4/Red 1-2-3	ds
sa	*Prunus fasciculata var.punctata*	sand almond	List 4/Red 1-1-3	ds
slo	*Erysimum insulare spp. suffrutescens**	slo wallflower	List 4/Red 1-2-3	ds/sw
sb/sn	*Senecio blochmaniae*	blochman's groundsel	List 4/Red 1-2-3	ds/sw/ad
sp/f/spn	*Mucronea californica*	spine flower	List 4/Red 1-2-3	ds
st	*Cirsium rhothophilum*	surf thistle	List 1B/Red 2-2-3	fd
wc	*Rorippa gambelii*	water cress	List 1B/Red 3-3-2	rp
Common Natives				
al	*Abronia latifolia*	beach sand verbena		fd/ds
amb	*Ambrosia chamissonis*	beach bur-sage		fd/ds
ana	*Anagallis arvensis*	scarlet pimpernall	naturalized	ds
au	*Abronia umbellata*	beach sand verbena		ds
bb	*Rubus ursinus*	blackberry		sw/rp/ds
bdi	*Dichelostemma capitatum*	blue dicks		ds
bf	*Pteridium aquilinum*	bracken fern		rp
bicolor	*Lupinus bicolor*	bicolor lupine		ds
bl/ylu	*Lupinus arboreus*	bush lupine	yellow or purple flwrs	ds/sw
bm	*Bromus spp.*	brome	naturalized	ds
bn	*Solanum douglasii*	black nightshade		rp/sw/ds
br	*Sparganium eurycarpum*	bur reed		rp
bs	*Salvia mellifera*	black sage		ds
bul	*Cirsium vulgare*	bull thistle		sw
bw	*Eriogonum parvifolium*	coastal buckwheat		ds
ca	*Carex spp.*	sedge		sw/ds
cb	*Baccharis pilularis*	coyote brush		sw/ds

CODE	LATIN NAME	COMMON NAME	COMMENTS	COMMUN
Common Natives				
cff/cf	*Rhamnus californica*	coffee berry		ds/sw
cgy/cg	*Eriophyllum stachaedifolium*	coastal golden yarrow		fd/ds
ch	*Chenopodium californicum*	goosefoot		ds
china	*Collinsia heterophylla*	chinese houses		ds/sw
cla	*Quercus agrifolia*	coast live oak		rp/ds
cob/cbt	*Cirsium occidentale*	cobweb thistle		ds
cp	*Eschscholzia californica*	california poppy		ds
cr	*Croton californicus*	california croton		ds
cs	*Artemisia californica*	california sagebrush		ds
ct	*Typha latifolia*	cattail		rp/sw
cv	*Meconella linearis*	carnival poppy		ds
cw	*Populus fremontii* and *P.balsamifera*	cottonwood		rp/sw
cy	*Achillea millefolium*	common yarrow		ds/sw
ddf	*Heteranthemis viscidehirta*	different dog fennel	non-native but not invasive	rp
ds	*Distichlis spicata*	salt grass		sw
dud/d	*Dudleya lanceolata*	rock lettuce		ds
dw	*Lotus scoparius* and *L.heermanii*	deerweed		ds/sw
eq	*Equisetum spp.*	horsetail		sw/ad
er	*Erodium sp.*	filaree		sw
fd	*Amsinckia spectablis*	fiddleneck		ds/sw
gf	*Lasthenia sp.*	gold fields		ds
gn/cud/cd	*Gnaphalium californicum* and *G.bicolor*	cudweed/everlasting		ds/sw
h	*Heliotropium curassavicum*	wild heliotrope		rp
he	*Stachys bullata*	hedge nettle		rp
hp	*Oenotheraa elata ssp. hookeri*	Hooker's evening primrose		sw/rp
hy	*Hydrocotyle ranunculoides*	marsh pennywort		rp/sw
hz	*Hazardia squarosa* or *Isocoma sp.*	sawtoothed goldenbrush		sw
ia	*Stephanomaria virgata*	wreath flower		ds
j	*Juncus spp. (J.acutus* and *J.lesuerii)*	rush		sw
ja	*Jaumea carnosa*	jaumea		sw
jg	*Koeleria macrantha*	june grass	inter-mixed with veldt	ds
ls/las/l	*Lessingia filaginifolia*	california aster		ds
lw	*Astragalus nuttalii*	locoweed		sw
mb	*Baccharis douglasii*	marsh baccharris		sw/rp
md	*Madia sativa*	coast tarweed	very sticky - glandular	sw
mg	*Calystegia soldanella*	beach morning glory		fd
mh	*Ericamerica ericoides*	mock heather		ds
mk	*Mimulus aurantiacus*	monkey flower		rp
mp	*Oenanthe sarmentosa*	marsh parsley		rp
mw	*Artemisia douglasiana*	mugwort		sw/rp
n	*Hesperocnide tenella*	western nettle		ds
ns	*Cyperus sp.*	nutsedge		sw/rp
ow/oc/o	*Castilleja exserta*	owls clover		ds
pb	*Castilleja affinis*	indian paint brush		ds
ph	*Phacelia ramosissima* and *P.distans*	phacelia		ds
pl	*Silene laciniata*	indian pink/painted lady		ds
pla	*Plantago subnuda* and *P.major*	plantain		sw
pn	*Solanum xanti*	purple nightshade		ds
po	*Toxicodendron diversilobum*	poison oak		sw/ds/rp
poe/si	*Potentilla anserine*	silverweed		sw
pop	*Cryptantha leiocarpa*	popcorn flower		ds
pr	*Camissonia cheiranthifolia*	beach evening primrose		fd/ad

CODE	LATIN NAME	COMMON NAME	COMMENTS	COMMUN
Common Natives				
rag	*Ambrosia psilostachya*	western ragweed		sw
rd	*Rumex sp.*	dock		sw
rg	*Polypogon monspelensis*	rabbitsfoot grass	naturalized	sw
rye	*Elymus condensatus*	giant wild rye		rp
sand/sdm	*Cardionema ramosissimum*	sandmat		ds
sc	*Scirpus californicus* and *Scirpus spp.*	sedge/bulrush/tule		rp/sw
sca	*Penstemon centranthifolius*	scarlet bugler		ds
sf	*Pholisma arenaria*	sand food		ds
sl	*Lupinus chamissonis*	silver lupine		ds/sw
slt	*Atriplex californica* and *A.leucophylla*	saltbush		fd
sm	*Sambucus mexicanus*	elderberry		rp
sol	*Solidago californica* and *S.confinis*	goldenrod		sw
straw/stw	*Fragaria chiloensis*	strawberry		fd/sw
sz	*Helenium puberulum*	sneezeweed		rp/sw
t	*Heterotheca grandiflora*	telegraph weed		ds/sw
ta	*Artemisia dracunculus*	tarragon		sw
tb	*Lonicera involucrata var. ledebourii*	twinberry		rp
tule	*Scirpus californicus*	Cali Bulrush		rp/sw
ty	*Heteromeles arbutifolia*	toyon/Christmas berry		ds/rp
ud	*Urtica dioica*	stinging nettle		sw/rp
va	*Verbena lasiostachys*	vervain		sw
w	*Salix lasiolepsis*	arroyo willow		sw/rp
wa	*Eriastrum densifolium*	woolly blue star		ds
wm	*Myrica californica*	wax myrtle		ds/rp
z	*Phacelia douglasii*	dunes babyblue eyes		ds
Invasives				
bg	*Ammophila arenaria*	beach grass		fd/ad/ds
bra	*Brassica nigra*	mustard		sw
ci	*Senecio mikanioides*	cape ivy		rp
cm	*Conium maculatum*	poison hemlock		sw/rp
e(u)c	*Eucalyptus spp.*			rp
I	*Carpobrotus spp. (C.edulis* or *C.chilensis)*	ice plant		fd/ds
it	*Carduus pycnocephalus*	italian thistle		sw/rp
mel	*Melilotus alba*	white sweetclover		sw
ox	*Piciris echiodes*	bristly ox-tongue		sw/rp
p/pom/pa	*Cortaderia jubata*	pampas grass		sw
sr	*Cakile maritima*	sea rocket		fd
si	*Conicosia pugioniformis*	slender leafed ice plant		ds/sw
v	*Ehrharta calycina*	veldt		ds
e v	*Ehrharta calycina*	end veldt		ds

Communities				
ad	active dune/ open dune	dominant: pr, mc		
ds	dunescrub	dominant: mh, sl, ls, bw		
fd	foredune	dominant: am, amb		
rp	riparian/ wetland	dominant: w		
sw	swale	dominant: j, ca		
Photographers				
bj	Bobby Jo Close	CCC GIS Program Manager		
cm	Claudia Makeyev	LC Field Biologist		
jw	Jasmine Watts	LC Field Botanist		
ms	Mark Skinner	LC Restoration Field Manager		

***Rare Plants:** Plants were not identified to subspecies or varieties. For example, all 'hk' indicates a presence of *Horkelia cuneata*, of which *Horkelia cuneata* ssp. *sericea* may be included. This was done to expediate the long process of collecting field data and taking gps points (it is very difficult to identify a subspecies or variety without keying the plant out, and to do this for each and every plant in the 9,000 acres of dunes...)

Appendix F

Plant Data Maps

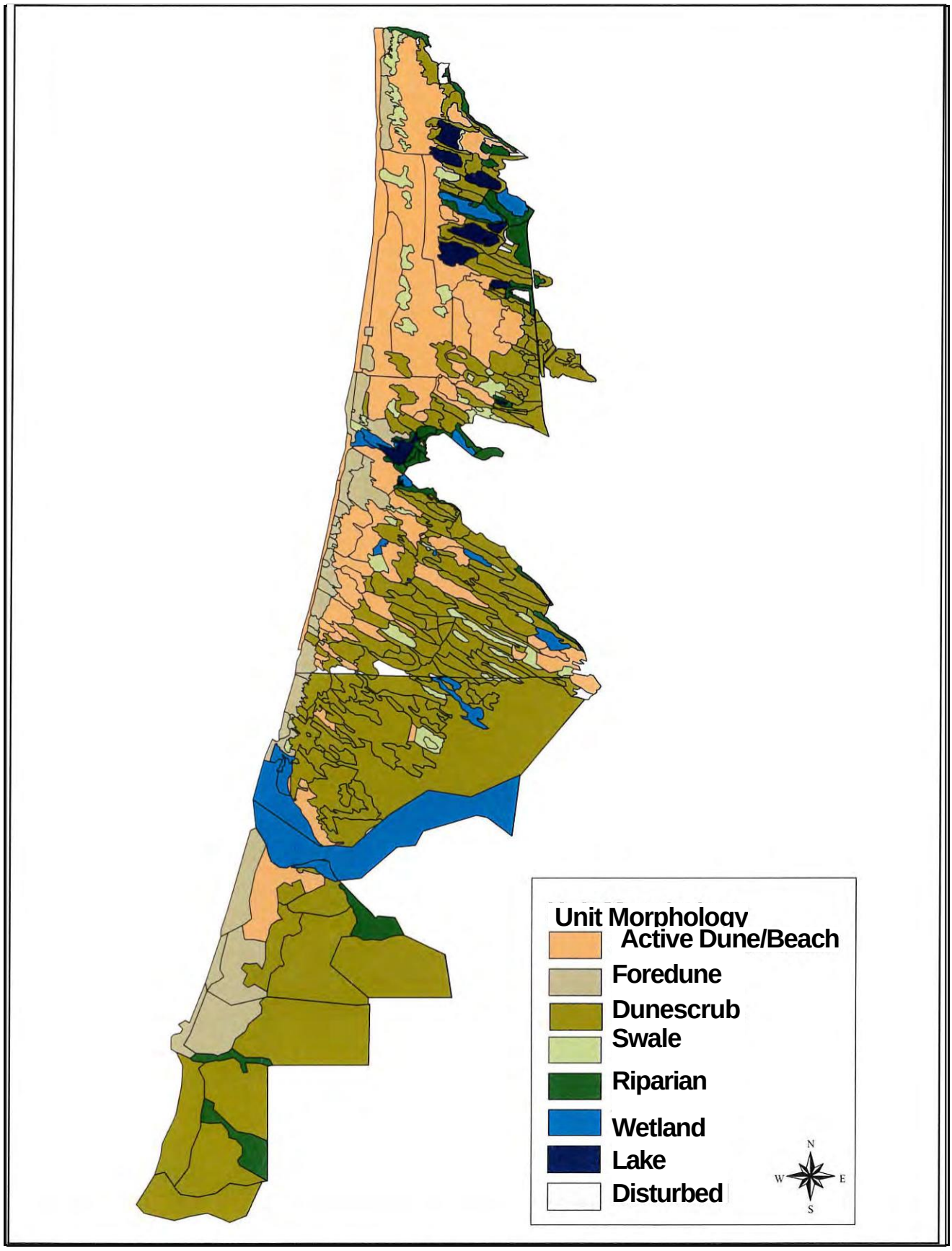


Figure F-1. Basic Plant Community Structure of the Guadalupe-Nipomo Dunes

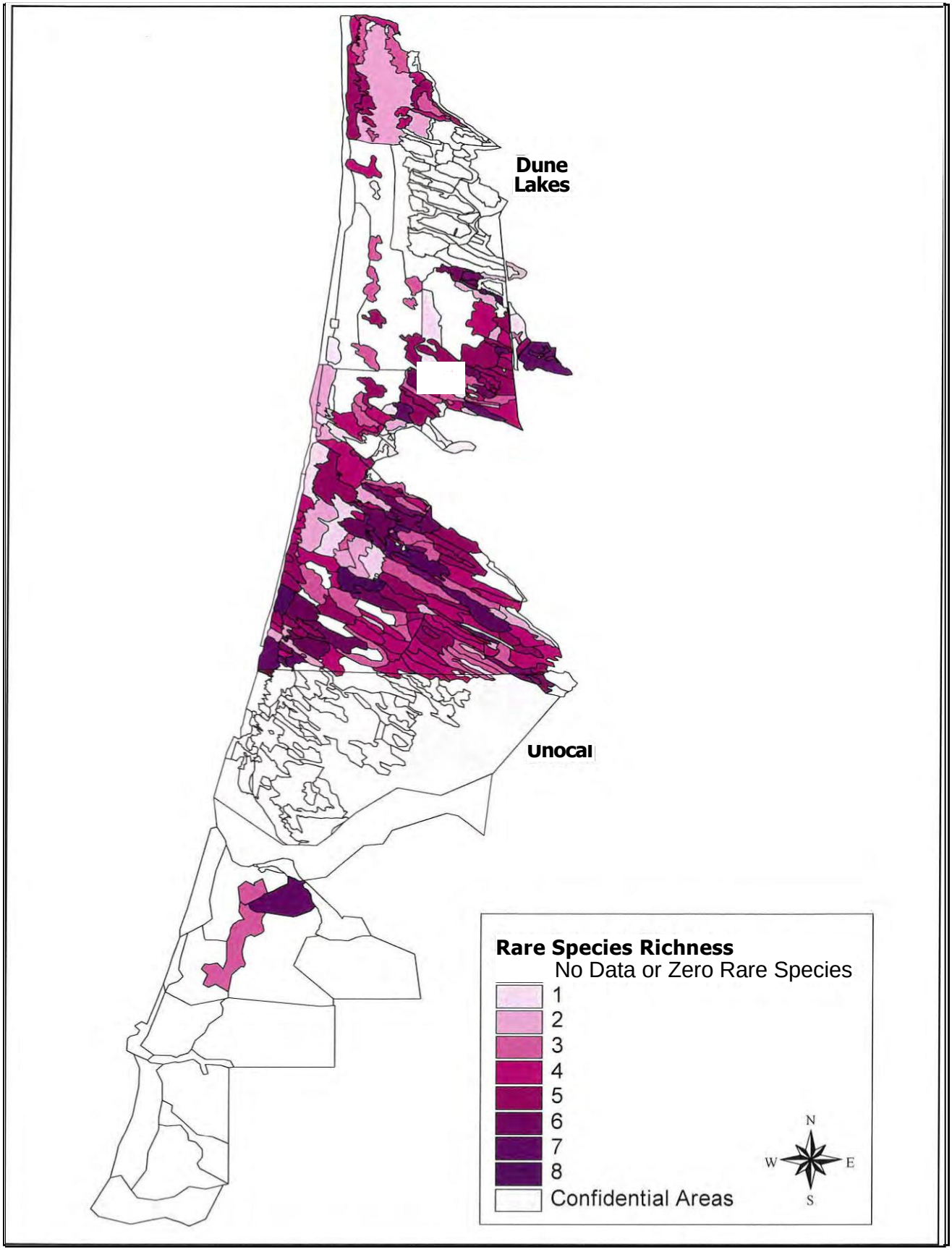


Figure F-2. Rare Species Magnitude of the Guadalupe-Nipomo Dunes

Waypoi

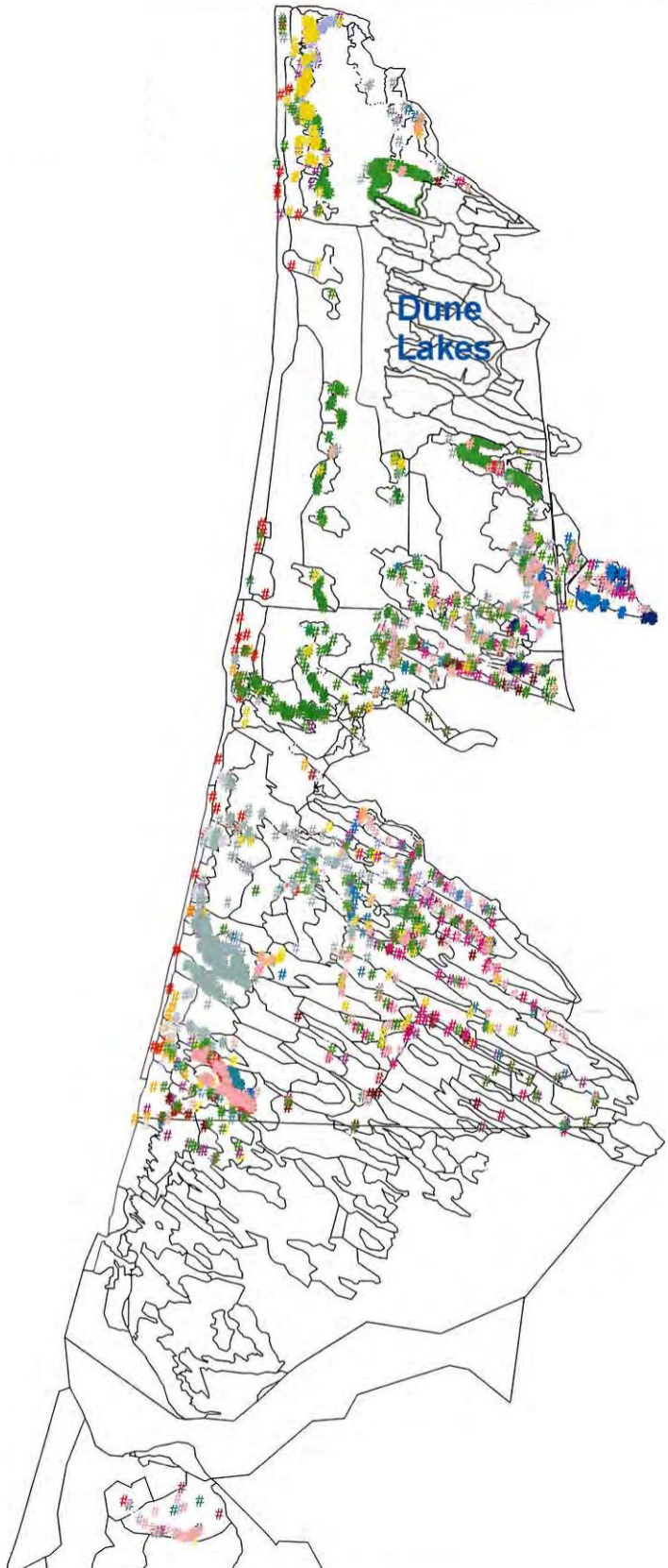


Figure F-3. All Data Waypoints Collected in 2001 and 2002

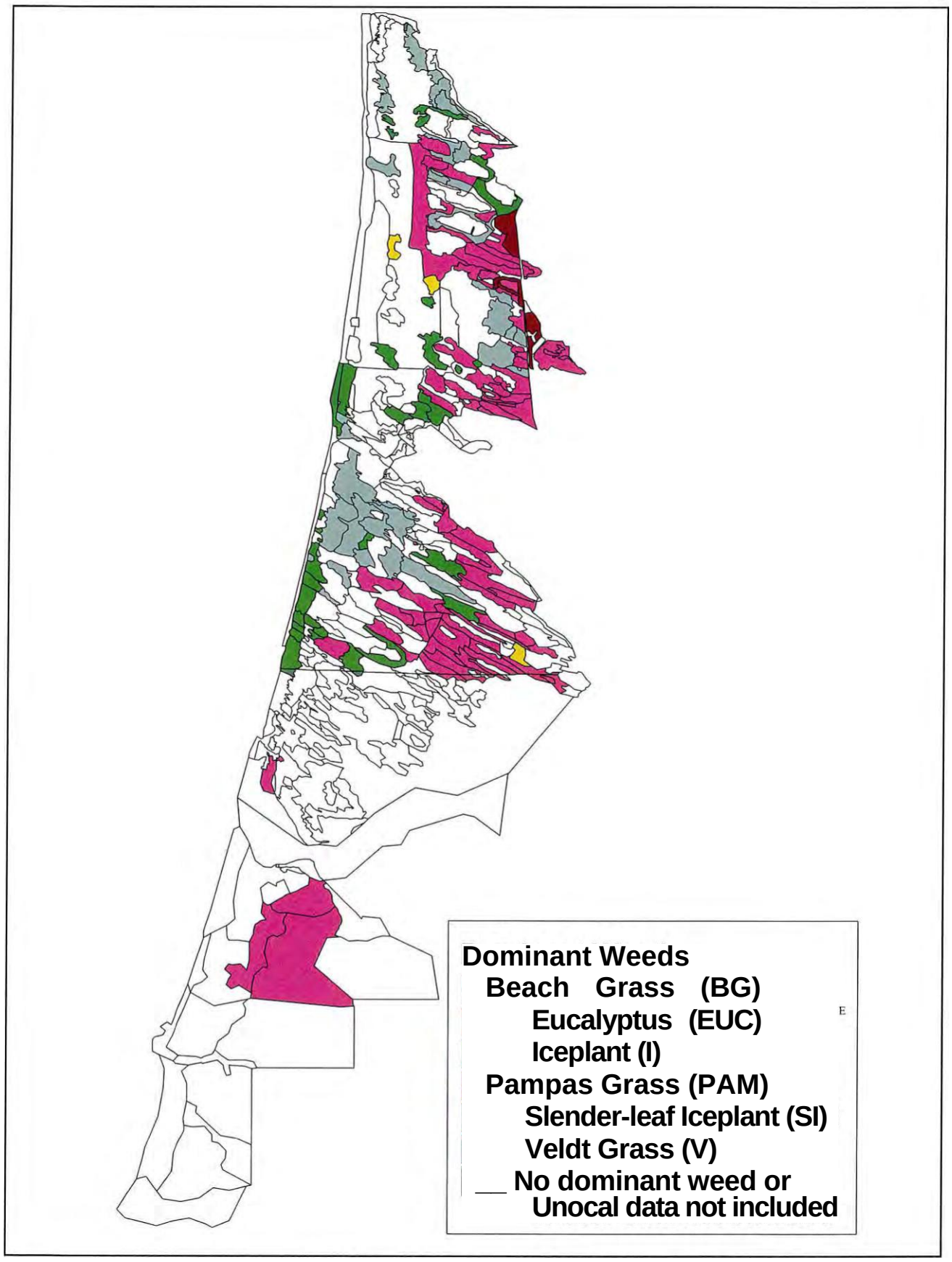


Figure F-4. Dominant Weeds of Heavily Infested Areas in the Guadalupe-Nipomo Dunes

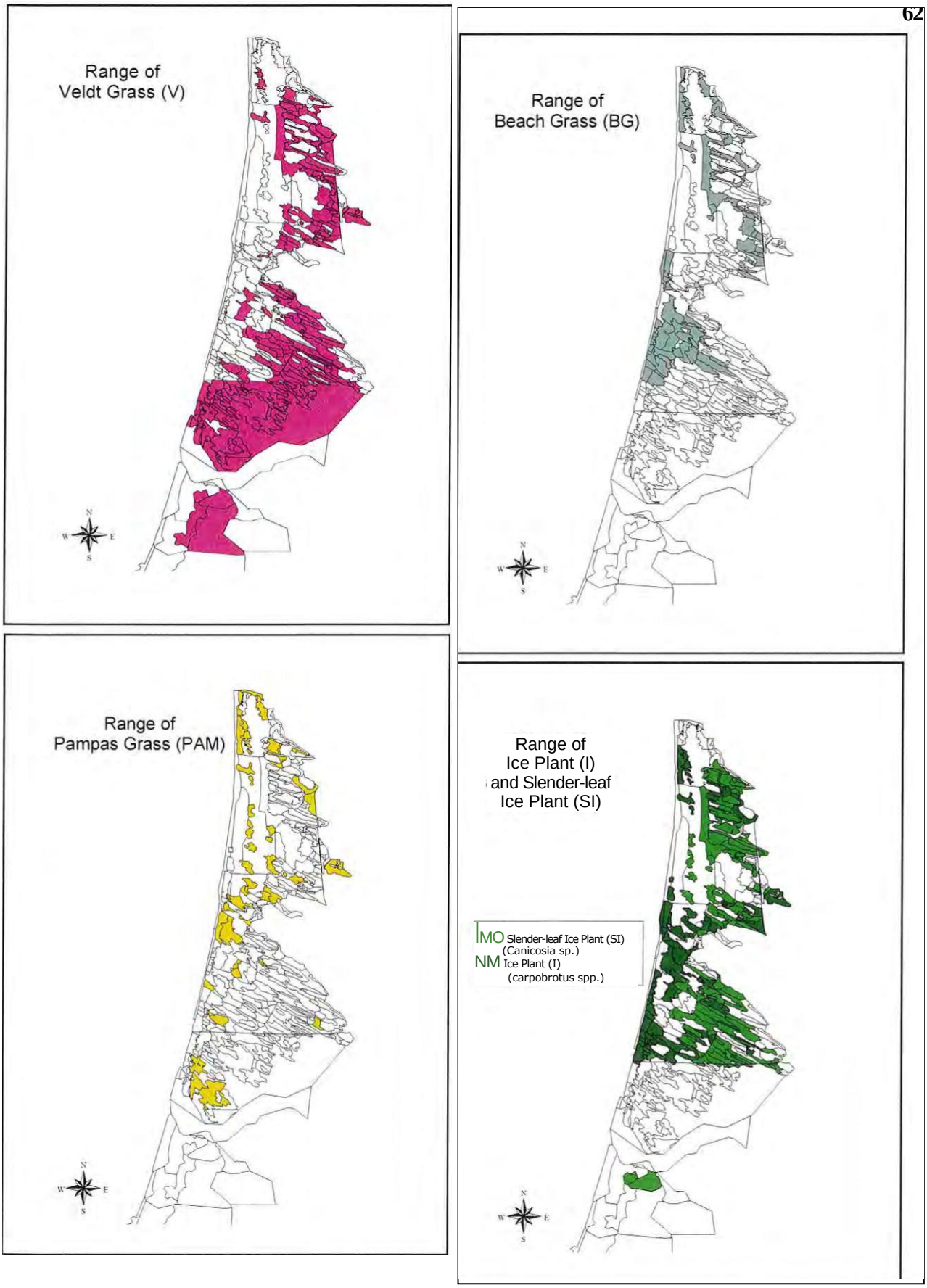


Figure F-5. Presence of Target Weeds in the Guadalupe-Nipomo Dunes
(note that these maps are not complete for the Unocal area)

Appendix G

Personal Note on Fieldwork Experience

In the Field

The "Dunes GIS" project gave Claudia and myself a wonderful opportunity to explore the diverse habitat of the Guadalupe Nipomo Dunes. We hiked up, down, and all around each of the dune communities, documenting every plant species we encountered. Whether hiking alone or together for six hours a day, exploration of the dunes was fascinating work.

Imagine hiking out all day away from the civilized roads and paths into an area some refer to as a desert: full of sand and sometimes sparse vegetation with few if any trees.
Imagine next watching the dunes spring into full bloom, greeting plants that were first introduced to you as scratchy gray-green shrubs but were now showing off their splendor of color and beauty. Wow! Our cameras went crazy in the spring as we attempted to capture each shrub in bloom. We would come back to the office telling the others that they must see our pictures: "wait until you see our Prickly Phlox shot" or "look where *we* were today" or "you wouldn't believe the rare plant we found today!"

We became so familiar and comfortable with the dune environment that we would often talk of the possibilities of living out there one day. To wake up every morning and be able to take long walks where you know "everybody's" name. These "long walks" took a lot of work and perseverance: a grueling 6-hour hike transformed itself into something pleasurable because of the wonderful plants and places we were able to witness. To be a botanist and surrounded by protected plants and habitats... you become familiar with and fall in love with these beautiful plants that you spend your day searching for and observing.

The dune ecosystem is a beautiful place to study and appreciate, especially in those areas still left relatively untouched. Out there you often get the feeling that you are the first person to appreciate the landscape before you, and that is a feeling that is rare and almost impossible in most places today. The excitement of finding new locations of rare plants and the accomplishment felt at the end of one day of surveying out in the field made working on this project the best job either of us has ever had.

Thank you for this wonderful opportunity of becoming intimate with such a prized resource as the Guadalupe-Nipomo Dunes. It is satisfying to know we have contributed to the future restoration and conservation of this area.

Jasmine Watts
Field Botanist