Implementation of the Conservation Strategy for Tahoe Yellow Cress (*Rorippa subumbellata*)

2005 Annual Report
April 2006

Prepared by:
Alison E. Stanton and Bruce M. Pavlik
BMP Ecosciences
156 South Park
San Francisco, CA 94107

Prepared for:
The Tahoe Yellow Cress Adaptive Management Working Group and Executive Committee

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **IV**

1.0 INTRODUCTION **1**

2.0 2005 FIELD SURVEYS **2**

2.1 METHODS **2**
2.1.1 SITE NAMES 2
2.1.2 SITE RANKING 3
2.1.3 DATA COLLECTION 3
2.2 RESULTS **4**
2.3 DISCUSSION **11**
2.4 RECOMMENDATIONS FOR 2006 ..... **12**

3.0 RESTORATION AND EXPERIMENTAL OUTPLANTINGS **13**

3.1 METHODS **13**
3.1.1 SEED COLLECTION 13
3.1.2 PLANT PROPAGATION 14
3.1.3 PLANT INSTALLATION 14
3.1.4 MONITORING 18
3.1.5 TRANSLOCATION 19
3.2 RESULTS **19**
3.2.1 EFFECTS OF INITIAL FOUNDER VIGOR 20
3.2.2 EFFECTS OF LAKE ELEVATION 21
3.2.3 PERFORMANCE IN DIFFERENT MICROHABITATS 22
3.2.4 PLANT WATER STATUS 24
3.2.5 EFFECTS OF FOUNDER POPULATION SOURCE 25
3.2.6 PERSISTENCE THROUGH TIME 26
3.2.7 EFFECTS OF DISTURBANCE 27
3.2.8 OVERALL SITE SUITABILITY 28
3.2.9 TRANSLOCATION 29
3.3 DISCUSSION AND CONCLUSIONS **29**
3.3. 1 KEY MANAGEMENT QUESTIONS 29
3.3 RECOMMENDATIONS FOR 2006 ..... **31**

4.0 GERMINATION ECOLOGY STUDY 31

4.1 METHODS 31
4.2 RESULTS 32
4.3 IMPLICATIONS FOR CONSERVATION 33

5.0 NFGEL GENETIC MONITORING STUDY 33

5.1 METHODS 34
5.2 RESULTS AND DISCUSSION 35

6.0 FRIENDS OF TAHOE YELLOW CRESS STEWARDSHIP PROGRAM 37

7.0 2005 AGENCY ACTIVITY REPORTS 37

7.1 FORMATION OF THE AMWG 38
7.2 SITE-SPECIFIC INFORMATION SHEETS 39

8.0 FIVE YEAR MANAGEMENT PLAN 39

9.0 LITERATURE CITED 41

10.0 APPENDICES 44

APPENDIX A: 2005 ANNUAL FIELD SURVEY FORM FOR RANKED SITES
APPENDIX B: 2005 SURVEY PROTOCOLS FOR TAHOE YELLOW CRESS ANNUAL SURVEYS
APPENDIX C: PRESENCE OF TAHOE YELLOW CRESS (1978-2005)
APPENDIX D: FIVE YEAR MANAGEMENT PLAN (2004-2008)
APPENDIX E: TAHOE YELLOW CRESS SITE-SPECIFIC INFORMATION TEMPLATE
APPENDIX F: SITE-SPECIFIC INFORMATION SHEET ASSIGNMENTS FOR 2005
APPENDIX G: AGENCY MANAGEMENT ACTIVITY REPORTS

List of Figures

Figure 1. Lake level and number of Tahoe yellow cress sites occupied by survey year.

Figure 2. Map of Tahoe yellow cress occurrences in 2005.

Figure 3. The number of Tahoe yellow cress sites in 8 stem count abundance categories for 2004-2005.

Figure 4. Ownership and stem counts for all 62 Tahoe yellow cress sites in 2005.

Figure 5. Graph of the elevation of Lake Tahoe for the 2004-2005 growing season.

Figure 6. The effect of initial vigor on survivorship and reproduction in the 2005 cohort at four sites in September, 2005.

Figure 7. A comparison of mean seed output per plant in the 2004 cohort at three sites in September of 2004 and 2005.

Figure 8. Total survivorship in three microhabitats of the 2005 cohort in September, 2005.

Figure 9. Mean reproduction (the proportion of survivors) in one year-old and two year-old founders at Nevada Beach, September 2005.

Figure 10. Mean water potentials at pre-dawn (AM) and mid-day (PM) of Tahoe yellow cress in July and September of 2004-2005.

Figure 11. Mean survivorship and reproduction of three population sources at Nevada Beach, September, 2005.

Figure 12. Overall rates of survivorship of the 2003 cohort at four sites in September, 2003-2005.

Figure 13. Overall rates of survivorship of the 2004 cohort at four sites in September, 2004-2005.

List of Tables

Table 1. Stem counts and survey effort for 62 Tahoe yellow cress sites in September 2005.

Table 2. Stem count and survey effort in the 2005 annual survey by ranking category.

Table 3. The number of founders installed at nine sites at Lake Tahoe from 2003-2005.

Table 4. Shorezone elevations and plot locations of seven Tahoe yellow cress microhabitats for six outplanting sites.

Table 5. Summary of Tahoe yellow cress populations analyzed by NFGEL.

Table 6. Location and description of variation observed in the 2005 collections analyzed by NFGEL**.**

Table 7. Summary of agency hours spent on Tahoe yellow cress related activities during from 2002-2005.

Table 8. Membership of the Tahoe yellow cress Adaptive Management Working Group (AMWG) in 2005.

Table 9. Budget for implementation of the TYC Conservation Strategy for the years 2004-2007, as presented in the AMWG 2005 Five Year Management Plan.

EXECUTIVE SUMMARY

Tahoe yellow cress (*Rorippa subumbellata* Roll.) is a rare plant species endemic to the shores of Lake Tahoe in California and Nevada. Ongoing threats to the species lead to development of the Conservation Strategy (CS) for Tahoe yellow cress (Pavlik *et al*. 2002a) that was finalized in 2003 through a memorandum of understanding / conservation agreement (MOU/CA) with 13 signatories. The CS identifies goals and objectives to meet the recovery needs of the species. Along with the research agenda and other associated activities identified in the conservation strategy, implementation within an effective adaptive management process will assist land and resource managers in making informed, practical decisions by filling in data gaps and providing an ever increasing and more reliable knowledge base.

The overall intent of the CS is to preclude the need to list Tahoe yellow cress under the Endangered Species Act (ESA) through restoration of a self-sustaining metapopulation dynamic. Such a dynamic should allow the species to persist in sandy beach habitat around Lake Tahoe despite periodic high water levels and human-related impacts (Pavlik *et al*. 2002a). A metapopulation dynamic refers to a population structure where some subpopulations persist over long periods of time while others come and go through the processes of local colonization and extirpation. Achieving a positive dynamic (e.g. colonization events outnumber extirpation) requires understanding the species through surveys and research that directly supports management and restoration activities. Tahoe yellow cress presence is cyclical and mostly related to fluctuations in lake elevation. Low lake elevations (< 6,225 ft Lake Tahoe Datum (LTD)) expose large quantities of suitable habitat and can, therefore, support a greater number of occupied sites than high lake elevations. In addition, recreation is more dispersed at low lake elevations and potential impacts to the species are reduced.

The status of the population has been monitored in annual field surveys that date back to 1978. In 2005, the lake level rose two feet from the previous year to approximately 6,225 feet LTD, which is considered a transitional elevation between low and high water. Despite this rise, Tahoe yellow cress was again located at 47 of the 62 named sites, the same occupancy as 2003 and 2004, when the lake was very low. This occupancy level is the greatest number in the entire survey history, although total survey effort (person-hours) has been increasing in recent years. Nevertheless, for the fourth consecutive year, Tahoe yellow cress is at Level 1 of the Imminent Extinction Contingency Plan as defined in the CS (Pavlik *et al*. 2002a). Level 1 is indicative of a stable or increasing population trend.

Achieving the goals of the CS requires research that directly supports management and restoration activities. Preliminary and final research results were available this year that focused on three areas: germination ecology, population genetic structure, and experimental reintroduction and restoration outplanting.

Lab and greenhouse experiments conducted at UC Davis in the summer of 2005 focused on several unknown parameters of seed biology including how germination of TYC seed was effected by light regime, storage time, seed floatation, temperature, stratification, collection source, and planting month (Ingolia 2006). The resulting characterization of the germination ecology of Tahoe yellow

cress will aid the reintroduction effort and provide a more complete understanding of constraints that affect the metapopulation dynamic.

Researchers at the National Forest Genetic Electrophoresis Laboratory received funding through Round 5 of the Sierra Nevada Public Lands Management Act (SNPLMA) to conduct a third study of the genetic structure of Tahoe yellow cress using isozyme analysis techniques. As in previous studies, extremely low levels of genetic variation were observed in the 2005 collections. The study concluded that the pattern of limited genetic variation is similar among occupied locations around the lake and that greenhouse propagation and outplanting efforts are capturing the genetic variation observed in native populations.

Experimental reintroduction and restoration outplanting was initiated in 2002. These outplanting trials and experiments have included the greenhouse propagation of Tahoe yellow cress and the installation of over 6,200 container-grown plants at 9 sites around the lake. These efforts are designed to address Key Management Questions (KMQs) and generate data with immediate value to decision-making (Pavlik and O'Leary 2002). Unfortunately, the initial quality of plants obtained from the propagation greenhouses in 2005 was very poor. Founders were obviously stressed from lack of care and did not transplant well. Consequently, overall survivorship and reproduction was lower than expected at all sites within the 2005 cohort. While this compromised the ability to draw conclusions, data from the 2003 and 2004 cohorts demonstrated that, in general, survivorship varied among sites and within microhabitats. Favorable survival and reproduction of these two and three year-old plants, regardless of fluctuations in lake level also indicated that these created or enhanced subpopulations had high potential for persistence (sensu Pavlik *et al. 2002a*). Furthermore, overall site suitability in terms of demographic performance supported the assigned rankings of the outplanting sites as suggested in the CS. Finally, although the pilot investigation of translocation as a potential mitigation measure was compromised by vandalism, the limited data indicate that it is possible to move established plants within a site and that pursuing translocation as a potential mitigation strategy is warranted. Future efforts will need to more effectively protect experimental plots and to ensure the highest possible quality of founding plants.

Three important milestones in agency conservation activities and management were achieved during 2005. The first milestone was achieved at the end of the year when the Executive Committee approved the formation of the Adaptive Management Working Group (AMWG) as specified in the CS. All members of the current Technical Advisory Group (TAG) transitioned to become members of the AMWG and the TAG is now a Subcommittee of members of the AMWG with interest and expertise in technical topics. The second milestone was achieved when the AMWG initiated development of Site-specific Information Sheets for all 62 known and potential sites. The purpose of the information sheets is to provide a comprehensive repository of information pertaining to Tahoe yellow cress for all named locations for use in project review on both public and private lands in the shorezone. Public agencies are using the Information Sheets to develop Site-Specific Management Plans by expanding the recommendations section. Finally, the AMWG modified the format and content of Table 14 from the CS to produce a five-year management plan to guide all activities related to Tahoe yellow cress conservation. Continued commitments from stakeholders and successful implementation of the CS should preclude the need for the U.S. Fish and Wildlife Service to list the Tahoe yellow cress under the ESA and potentially remove the species from the candidate list.

1.0 INTRODUCTION

Tahoe yellow cress (*Rorippa subumbellata* Roll.) is a low-growing, perennial species endemic to the shores of Lake Tahoe in California and Nevada. The species was listed as endangered by the State of California in 1982 (California Fish and Game Code 2050 *et seq.*) and is considered endangered throughout its range by the California Native Plant Society (CNPS 2001). Tahoe yellow cress is state-listed as critically endangered in Nevada (Nevada Revised Statutes [NRS] 527.260 *et seq.*), and is considered threatened by the Nevada Native Plant Society (Nevada Natural Heritage Program [NNHP] 2001). In 1999, the U.S. Fish and Wildlife Service (USFWS) identified Tahoe yellow cress as a candidate species for listing under the Endangered Species Act of 1973, as amended (ESA), indicating sufficient information on biological vulnerability and threats are available to support a listing proposal (64 FR 57533).

Field surveys have been conducted for Tahoe yellow cress since 1978, making the dataset one of the most comprehensive for any endangered plant in the U.S. and possibly the world. In response to low numbers of occupied sites between 1995 and 1999, a Technical Advisory Group (TAG) was formed to develop and implement a conservation strategy (CS) and memorandum of understanding / conservation agreement (MOU/CA) for Tahoe yellow cress (Pavlik *et al*. 2002a). The CS determined that the number of Tahoe yellow cress occurrences around the lake correlates directly with fluctuating lake levels. Wide expanses of beach are available for colonization and the number of occupied sites is generally high when the lake is low (with an elevation between 6,220 -6,224 feet Lake Tahoe Datum [LTD]). During high water periods (greater than 6,226 ft LTD), less habitat is available and the number of occupied sites declines. As less habitat becomes available, pressure from recreation intensifies in the remaining habitat and this combination poses a threat to the long-term, continued persistence of Tahoe yellow cress. The overall intent of the CS is to preclude the need to list Tahoe yellow cress under the ESA through restoration of a self-sustaining metapopulation dynamic that allows the species to persist in sandy beach habitat around Lake Tahoe despite high water levels and human-related impacts.

One goal of the CS is that all signatories will implement an interagency adaptive management framework. A specific objective under that goal is to produce at least 6 years of annual reports that document all conservation activities and provide all necessary data for decision-making within the adaptive management framework. This is the fifth annual report completed since 2001. Section 2 of this report presents results from the annual lake-wide survey. One of the key tools for making management decisions is a spreadsheet which contains presence/absence data dating back to 1978 called Appendix C (named to maintain continuity with past annual reports). In 2005, consolidation and reconciling of Appendix C reduced the number of site names to 62. Further consolidation and review will occur in 2006, with a special emphasis on how to best track enclosures, development of an efficient sub-sampling scheme for the annual survey, and the dataset for USFS sites.

Achieving the goals of the CS requires research that directly supports management and restoration activities. The next three sections in this report address those ongoing research efforts. Section 3 presents results from the experimental reintroduction and restoration outplanting research that was initiated in 2002. These outplanting trials and experiments have included the greenhouse propagation of Tahoe yellow cress and the installation of over 6,200 container-grown plants at 9 sites around the lake. This series is designed to address Key Management Questions (KMQs) and generate data with

immediate value to decision-making. Section 4 presents results from lab and greenhouse experiments that were conducted at UC Davis in the summer of 2005 to characterize the germination ecology of TYC in order to aid the reintroduction effort. Finally, Section 5 summarizes work completed by researchers at the National Forest Genetic Electrophoresis Laboratory who received funding through Round 5 of the Sierra Nevada Public Lands Management Act (SNPLMA) to conduct a third study of the genetic structure of Tahoe yellow cress on the shores of Lake Tahoe.

Sections 6-8 of this report present three important milestones in agency conservation activities and management. The first milestone was achieved when the Executive Committee approved the formation of the Adaptive Management Working Group (AMWG) as specified in the CS. All members of the current Technical Advisory Group (TAG) transitioned to become members of the AMWG and the TAG is now a Subcommittee of AMWG members with interest and expertise in technical topics. The second milestone was achieved when the AMWG initiated development of Site-specific Information Sheets that will contain comprehensive information on all 62 known and potential sites. Finally, the AMWG modified the format and content of Table 14 from the CS to produce a five-year management plan to guide all activities related to Tahoe yellow cress conservation.

2.0 2005 FIELD SURVEYS

2.1 METHODS

2.1.1 SITE NAMES

Data on the number and location of occupied TYC sites around Lake Tahoe has been critical for making management decisions for the species. Appendices D and E of the CS presented occurrence and stem count data for a total of 51 known, historical, and potential native Tahoe yellow cress habitat sites for the years 1978-2000 (Pavlik *et al*. 2002a). These tables were subsequently combined into one comprehensive spreadsheet that has been called Appendix C (located in this report). Subsequent to completion of the CS in 2000, intensified annual survey efforts resulted in an expanded number of site locations. The number of named sites rose to a high of 72 in 2002, but many of the new sites were simply adjacent to previously described sites. In 2004, Appendix C was consolidated to 64 site names, reflecting some modifications of the 51 original site names and additional new sites. In 2005, further consolidation and reconciling of Appendix C reduced the number of site names to 62.

Despite the importance of Appendix C in making management decisions, the criteria by which sites are identified have fluctuated since 2000. The Nevada Natural Heritage Program (NNHP) tracks Tahoe yellow cress by Element Occurrence (EO) which is defined for all rare plant species as a distinct population separated by one kilometer or more. While the NNHP has only 38 EOs for Tahoe yellow cress, the program keeps data on all 62 sites, with sites listed as sub-occurrences of the 38 EOs in the database. Further consolidation and review will occur in 2006, with a special emphasis on how to best track enclosures, development of an efficient sub-sampling scheme for the annual survey, and the dataset for USFS sites.

.

2.1.2 Site Ranking

The CS established site rankings for the purposes of identifying conservation, restoration, and management priorities. Based on the index of viability scores, sites were ranked as Core, High, Medium, and Low priority sites. (For a detailed discussion on site ranking methods and results, refer to page 53 of the CS.) In 2003, the TAG revised the site rankings in Table 13 of the CS to incorporate additional data collected since 2000. The 1979- 2000 dataset was skewed toward high lake elevation and the additional data from 2001-2003 normalized the dataset. The revised rankings of 2003 better reflect the metapopulation dynamics of the species through two complete high and low water cycles. Consequently, the TAG will maintain the 2003 site rankings into the future until another complete high/low water cycle occurs. Unranked sites will be ranked as minimum data analysis requirements are met. A total of 39 sites are ranked: 10 Core, 6 High, 13 Medium, and 9 Low. No additional sites met the minimum ranking criteria in 2005. It is expected that modifications of Appendix C in 2006 may alter the rankings of some sites.

2.1.3 Data collection

The 2005 lake-wide survey for Tahoe yellow cress was conducted on September 6-9, 2005. Participants included: Steve Caicco (USFWS); Shana Gross, Beth Brenneman, Stu Osbrack (U.S. Forest Service [USFS]); Jay Howard (Nevada Division of State Parks [NDSP]); Roland Shaw (Nevada Division of Forestry [NDF]); Leslie Allen (Lake Tahoe Environmental Education Coalition [LTEEC] University of Nevada Cooperative Extension; Jacqui Grandfield (California Tahoe Conservancy [CTC]); Daniel Burmester, Curtis Hagen, and Susan Levitsky (California Department of Fish and Game [CDFG]); Tamara Sasaki, Scott Scheibner, Curtis Gray, Nancy Lozano, and Silver Fahey (California Department of Parks and Recreation [CDPR]); Eric Gillies (CSLC); Harry Spanglet (California Department of Water Resources); and Meri McEneny (private). Alison Stanton (BMP Ecosciences) collected seeds for the 2006 propagation and outplanting effort. This high level of participation (20 people) is similar to that contributed in the previous 4 years.

Participants were divided into 5 teams and allocated a portion of the 62 sites and a set of annual field survey forms developed by NNHP. Datasheets for a site were pre-filled in with the site name, ownership, legal access, and previous plant occurrence information, and each was accompanied by a map delineating the site boundaries. At each site, team members covered the entire width of the beach, from waters edge to the backshore. Land use (type and disturbance) and search effort were recorded at both occupied and unoccupied sites. Search effort is defined as the amount of person minutes spent actively searching for and/or collecting data on Tahoe yellow cress. Any modifications to existing site boundaries were delineated using Global Positioning System (GPS) technology.

The data collection protocol beyond general site land use and impacts was modified to separately address ranked and unranked sites. For ranked sites, the protocol was simplified to focus on the presence and abundance of Tahoe yellow cress and additional information necessary for completing the Site-Specific Information Sheet (see section 7.2). Stems were counted only if there were fewer than 250 stems apparent, otherwise one of 6 abundance categories was assigned for the site: 0-250; 250-500; 500-1,000; 1,000-5,000; 5,000-10,000; and greater than 10,000 stems. Estimates of aboveground stems were used rather than counts of individuals because the clonal reproduction of

Tahoe yellow cress makes it difficult to identify an individual. For ranked sites, data collection on the physical and biological attributes of the site was eliminated (see revised field survey form in Appendix A).

For unranked sites, data collection protocols established in 2004 were followed (Appendix B). At occupied sites surveyors estimated general habitat parameters across the entire site and recorded GPS data for each Tahoe yellow cress "cluster" within the site boundaries. A cluster is defined as a group of plants that occur within 21 ft diameter of each other. This distance equates to the resolution capability for point data using handheld GPS units. Clusters of plants separated by more than 22 ft (two times the resolution capacity) are considered separate clusters. To better characterize the occupied habitat, the TAG determined that physical and biological attributes should be recorded for each individual cluster. Biological attribute data included the actual or estimated number plants, actual or estimated number of plants in each phenological stage, and minimum and maximum rosette diameter. Physical attributes were recorded for each cluster including distance to lake, substrate/soil composition, and percent cover of associated plant species. All annual survey forms, including GPS data, were provided to NNHP for addition to the statewide sensitive species and GIS database and are available upon request.

The rationale for making a distinction between ranked and unranked sites in the annual survey data collection was based on the TAG's desire to make the time investment in the annual survey more efficient. Site information for the ranked sites goes back many years in most instances and the meta-population dynamic and relationship between Tahoe yellow cress presence and abundance and lake elevation has been well-established based on the long term dataset for these sites. In addition, the utility of the data on the physical and biological attributes of ranked sites has not been evaluated to determine if it has quantitative value from a statistic standpoint. It is quite likely that large variations in the data from observer bias will obscure significant findings to the extent that the data is little more than a qualitative description. However, pending further analysis of the quality of the physical and biological attribute data, the TAG determined that historical data collection protocols should continue for unranked sites under the premise that the data could be useful in site evaluation and eventual ranking.

2.2 RESULTS

A total of 56 sites were surveyed during the first week of September 2005 and Tahoe yellow cress was documented at 47 sites. Only six of the named sites were not surveyed because of limited access or permission to access was not granted. The lake level during the survey period increased nearly two feet from the previous season from 6223.3 ft (1,896.8 m) to 6,224.8 ft (1,897.3 m) (LTD). A peak lake elevation of 6225.6 ft was recorded in July that was sustained for most of the month before it began a slow decline in August. This was considered a transitional year after three consecutive years of low water in 2002-2004. The last year with a transitional lake elevation was 2001 when the lake was also at 6225 ft and only 29 sites were occupied. Figure 1 shows the cyclic relationship between the number of occupied sites and lake elevation.

The map in Figure 2, developed by NNHP, shows the locations of all 62 named sites and Tahoe yellow cress presence or absence for each site. Tahoe yellow cress is concentrated at the south end of the lake, with only six occupied sites located in the northern two quartiles. Although the number of

occupied sites was the same as 2003 and 2004, the occupancy of several sites shifted. Two sites occupied in 2004 did not have plants in 2005 (Logan Shoals and Meeks Bay Enclosure), while four sites without any detected plants in 2004 had plants in 2005 (Meeks Bay, D L Bliss State Park, Cave Rock, and Tallac Creek). The causes of these specific shifts are not clear. In some instances it may be due to inaccuracies in data collection from the current or previous year or surveying a new stretch of beach and in others it may be due to inundation or the inherent variability in the numbers of stems at the site over time. Alternatively, these appearances could represent emergence from a quiescent seedbank or even colonization events of the metapopulation dynamic. Material from these subpopulations will be collected in 2006 and subjected to microsatellite DNA analysis to help resolve these alternative explanations.

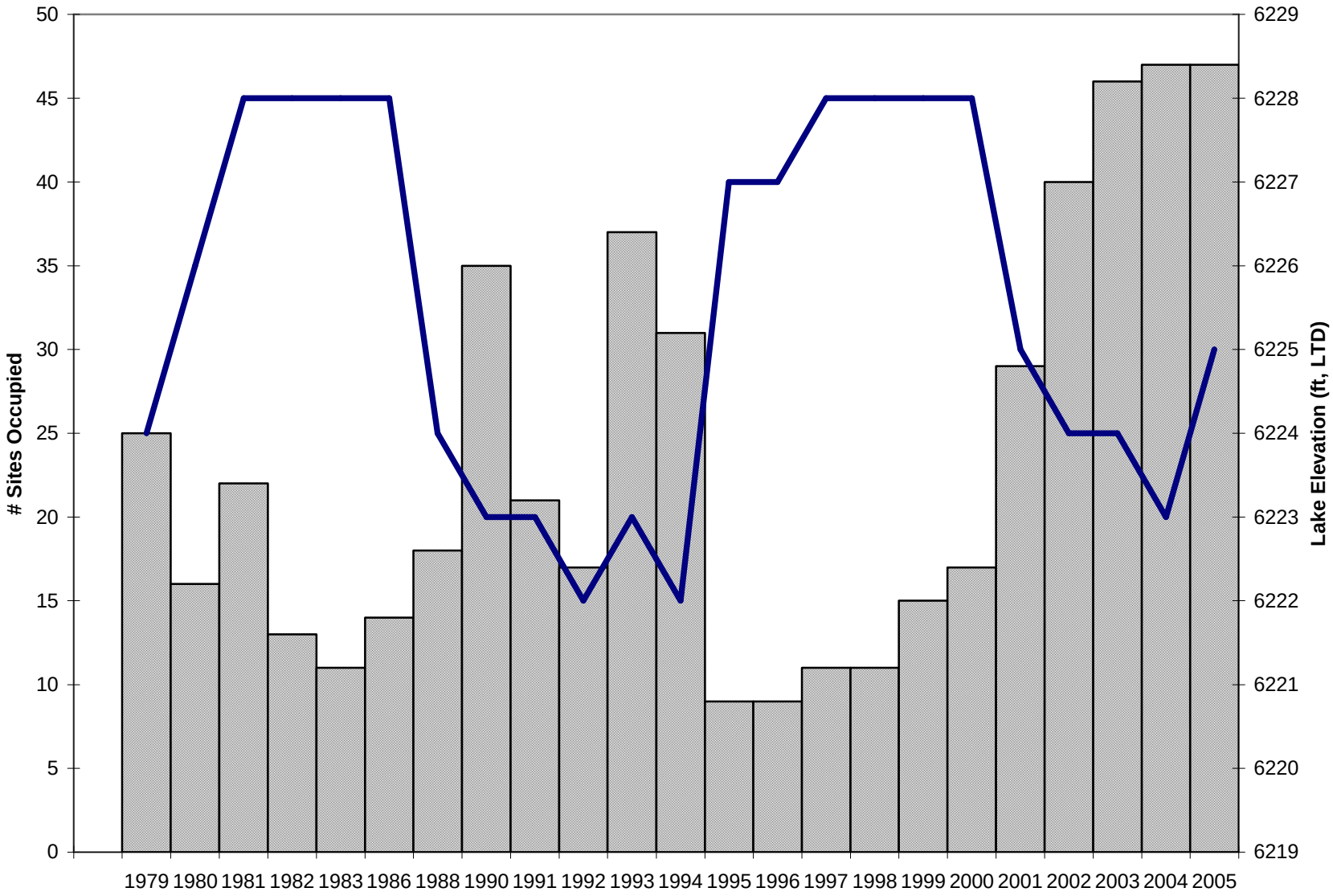

Figure 1. Lake level and number of Tahoe yellow cress sites occupied by survey year (solid blue line = lake level LTD)

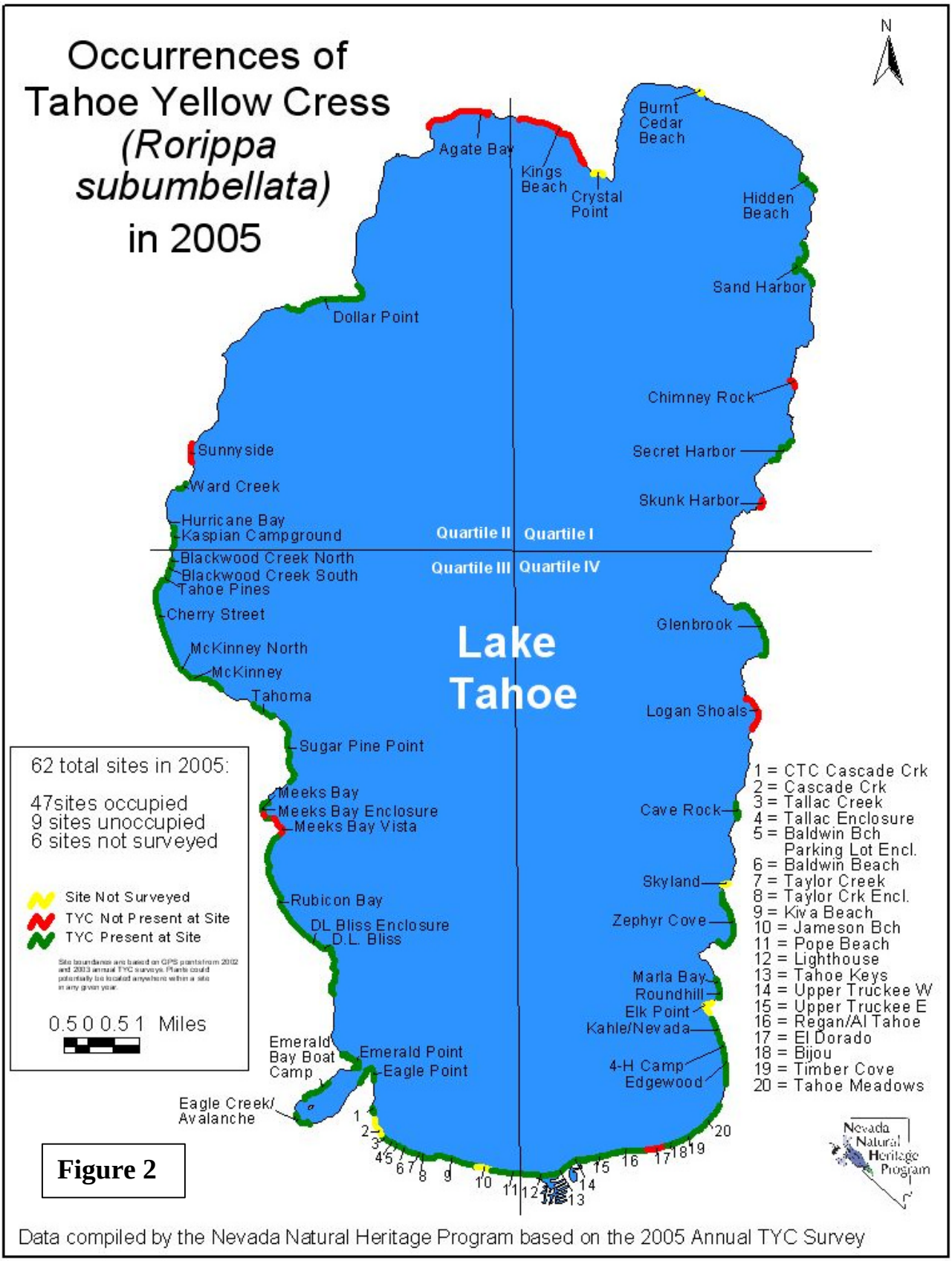
Occurrences of
Tahoe Yellow Cress
(Rorippa subumbellata)
in 2005
N
Lake Tahoe
Quartile II
Quartile I
Quartile III
Quartile IV
Agate Bay
Kings Beach
Crystal Point
Burnt Cedar Beach
Hidden Beach
Sand Harbor
Dollar Point
Chimney Rock
Secret Harbor
Skunk Harbor
Sunnyside
Ward Creek
Hurricane Bay
Kaspian Campground
Blackwood Creek North
Blackwood Creek South
Tahoe Pines
Cherry Street
McKinney North
McKinney
Tahoma
Glenbrook
Logan Shoals
Sugar Pine Point
Meeks Bay
Meeks Bay Enclosure
Meeks Bay Vista
Cave Rock
Skyland
Rubicon Bay
DL Bliss Enclosure
D.L. Bliss
Zephyr Cove
Marla Bay
Roundhill
Elk Point
Kahle/Nevada
4-H Camp
Edgewood
Emerald Bay Boat Camp
Emerald Point
Eagle Point
Eagle Creek/ Avalanche
62 total sites in 2005:
47sites occupied
9 sites unoccupied
6 sites not surveyed
Site Not Surveyed
TYC Not Present at Site
TYC Present at Site
0.5 0 0.5 1 Miles
1 = CTC Cascade Crk
2 = Cascade Crk
3 = Tallac Creek
4 = Tallac Enclosure
5 = Baldwin Bch Parking Lot Encl.
6 = Baldwin Beach
7 = Taylor Creek
8 = Taylor Crk Encl.
9 = Kiva Beach
10 = Jameson Bch
11 = Pope Beach
12 = Lighthouse
13 = Tahoe Keys
14 = Upper Truckee W
15 = Upper Truckee E
16 = Regan/Al Tahoe
17 = El Dorado
18 = Bijou
19 = Timber Cove
20 = Tahoe Meadows
Nevada Natural Heritage Program
Data compiled by the Nevada Natural Heritage Program based on the 2005 Annual TYC Survey

Figure 2

For the first year since the CS, survey effort, in terms of person minutes, decreased (Table 1). Surveyors spent 6,831 minutes (140 hours) compared to over 14,000 minutes (234 hours) in 2004. Approximately 25,384 stems were counted or estimated among the sites in 2005.

Table 1. Stem counts and survey effort for 62 Tahoe yellow cress sites in September 2005 (NA = not available, NS = not surveyed, X= not surveyed, but plants known to be present).

SITE NAME	Rank	# Stems	Survey minutes
Sunnyside	UNRANKED	0	NA
Ward Creek	HIGH	127	60
Kaspian Campground	UNRANKED	4	180
Blackwood North	CORE	416	NA
Blackwood South	CORE	18	NA
Tahoe Pines (Fleur Du Lac)	UNRANKED	91	40
Cherry Street/Tahoe Swiss Village	LOW	25	NA
McKinney North/Shores	UNRANKED	159	NA
McKinney Creek	LOW	5000	270
Tahoma	LOW	500	200
Sugar Pine Point State Park	UNRANKED	908	360
Meeks Bay	HIGH	25	180
Meeks Bay Enclosure (+ 1 new encl)	UNRANKED	0	30
Meeks Bay Vista	UNRANKED	0	15
Rubicon Bay	MEDIUM	5000	540
DL Bliss Enclosure	MEDIUM	1	5
DL Bliss State Park	UNRANKED	302	60
Emerald Point	MEDIUM	244	180
Emerald Bay Boat Camp	MEDIUM	77	15
Eagle Creek/Avalanche	HIGH	601	220
Eagle Point	MEDIUM	12	90
CTC Cascade Creek	UNRANKED	54	60
Cascade Creek	HIGH	NS	NS
Tallac Enclosure	CORE	28	30
Tallac Creek (outside Enclosure)	CORE	31	96
Baldwin Beach	MEDIUM	54	120
Baldwin Bch Parking Lot Encl (+ 1 new encl)	UNRANKED	11	45
Taylor Creek Enclosure	CORE	540	90
Taylor Creek	UNRANKED	509	465
Kiva Beach/Valhalla	LOW	136	165
Jameson	UNRANKED	NS	NS
Pope Beach	LOW	4	135
Lighthouse	CORE	185	240
Tahoe Keys	MEDIUM	1723	180
Upper Truckee West	CORE	425	180
Upper Truckee East	CORE	5000	360
Regan/Al Tahoe	LOW	139	NA
El Dorado Beach	LOW	0	NA
Bijou (Timber Cove Lodge)	UNRANKED	20	NA
Timber Cove	MEDIUM	26	60

SITE NAME	Rank	# Stems	Survey minutes
Tahoe Meadows	CORE	1070	240
Edgewood	CORE	346	480
4-H Camp/City Pump House	MEDIUM	28	40
Kahle/Nevada	HIGH	78	40
Elk Point	UNRANKED	NS	NS
Roundhill	UNRANKED	19	90
Marla Bay	UNRANKED	1	30
Zephyr Cove	HIGH	X	NS
Skyland	UNRANKED	NS	NS
Cave Rock	MEDIUM	3	30
Logan Shoals/Vista	MEDIUM	0	30
Glenbrook	MEDIUM	292	160
Skunk Harbor	UNRANKED	0	60
Secret Harbor	MEDIUM	33	180
Chimney Rock	UNRANKED	0	60
Sand Harbor	LOW	112	360
Hidden Beach	UNRANKED	7	NA
Burnt Cedar Beach	UNRANKED	NS	NS
Crystal Point	UNRANKED	NS	NS
Kings Beach	UNRANKED	0	NA
Agate Bay	UNRANKED	0	120
Dollar Point	LOW	1000	240
Total		**25,384**	**6,831**

Despite the modification of the survey protocol to reduce data collection at ranked sites, the majority of the survey time (76%) was spent at ranked sites (Table 2). However, ranked sites accounted for 92% of the total estimated stem count; only 2,085 stems were tallied on unranked sites. Core sites supported 32 percent of all stems, while Low and Medium priority sites each supported around 29 percent of the total stem count.

Table 2. Stem count and survey effort in the 2005 annual survey by ranking category.

ranking	N	# stems	# survey minutes
CORE	10	8059	1716
HIGH	6	831	500
MEDIUM	13	7493	1630
LOW	9	6916	1370
UNRANKED	24	2085	1615

The number of stems counted at each site was classified into 8 abundance categories (Figure 3). Although the annual survey utilized only 6 abundance categories, these were too coarse to give an accurate idea of the abundance distribution among sites. In addition, sites with less than 250 stems were fully counted, so the more narrow abundance categories presented here reflect that accuracy. In 2005, just 9 sites of the surveyed sites were unoccupied. While the majority of sites (18) had fewer than 50 stems, a total of 10 sites supported over 500 stems each. Compared to 2004, the median number of stems rose from 18 to 54 stems. In both years, five sites had stem counts that exceeded

the Minimum Viable Population (MVP) size of 1,200 stems. According to the CS, that number of stems yields a 90% probability that the population will persist over the next 20 years.

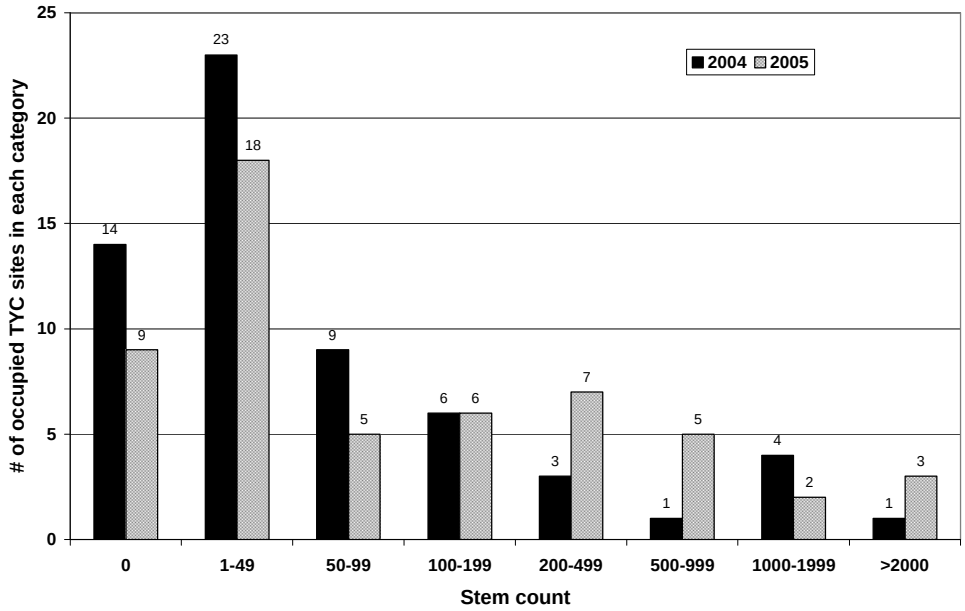

Figure 3. The number of Tahoe yellow cress sites in 8 stem count abundance categories in 2004 (blue bars) and 2005 (yellow bars).

As in previous years, Tahoe yellow cress was observed in a variety of substrates during the survey. Based on the comprehensive shorezone assessment conducted by TRPA in 1993 and 1994, suitable habitat is considered to be composed of at least 30 percent sand. However, the site physical attribute data collected in the field during the annual survey has never been analyzed to assess if it offers a statistically significant method for describing optimal Tahoe yellow cress habitat. The TAG has plans in 2006 to evaluate if the data fields quantifying the relative cover of specific soil particle size classes are useful part of the site description that might be correlated to measures of abundance. Observations suggest the species is adapted to a broad range of soils on the shores of Lake Tahoe including those dominated by pure sand, gravel, cobble, and large boulders. It was observed growing from a crack in a large boulder and from a crack in a concrete weir. Plants were frequently found in and among wood and pine needle debris in the beach wrack deposited at the high water line.

The majority of occupied Tahoe yellow cress sites occurred on lands managed by public agencies (31 sites compared to 22 private and 9 with mixed public/private or disputed ownership) (Figure 4). Although the USFS manages the majority of sites, the number of stems on those sites is relatively low. Conversely, the CTC owns only 3 sites, but the agency is responsible for more stems than any other agency. Approximately 35 percent of sites (22) are privately-owned and are home to nearly 16,000 stems, or more than 62% of the estimated stems in 2005. Five private or mixed ownership sites and Burnt Cedar Beach (IVGID) were not surveyed.

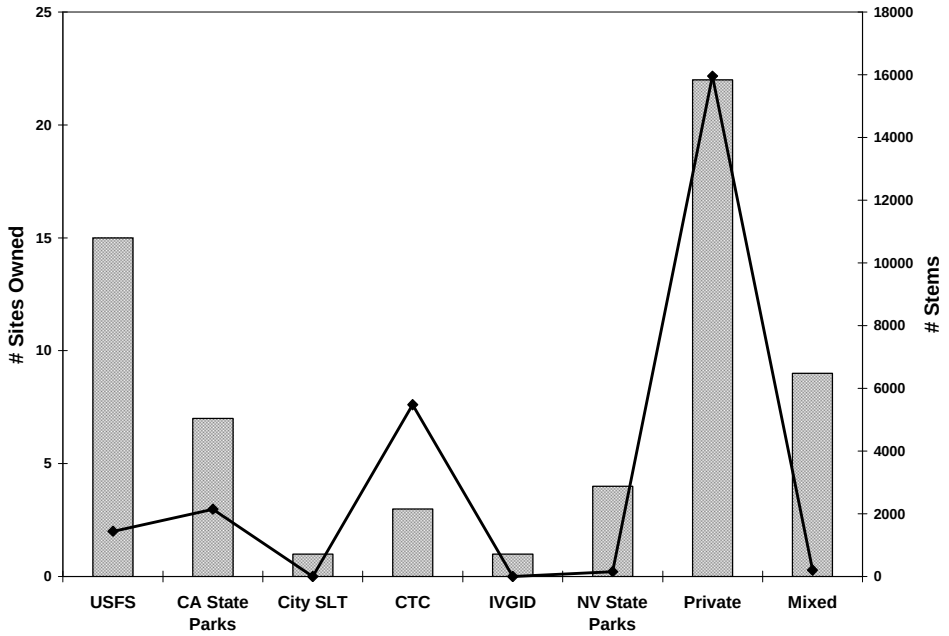

Figure 4. Site ownership (bars) and stem counts (line) for all 62 Tahoe yellow cress sites in 2005.

Land use and disturbance were recorded at all sites, regardless of Tahoe yellow cress presence. The most common recorded disturbances -- footprints, trash, boat dragging, beach raking -- were associated with recreational beach use. Footprint disturbances (among plants) were recorded at nearly all of the sites. Non-native plant species were common within some sites, with mullein (*Verbascum thapsus*) recorded at nearly 50 % of the occupied sites. Despite local restrictions at most public beaches around the lake, dogs or evidence of dogs were noted at many sites. Canada geese have been observed grazing and trampling Tahoe yellow cress alongside other vegetation.

2.3 DISCUSSION

The 2005 annual survey for Tahoe yellow cress was the 23rd survey that has been conducted since 1978. The two foot rise in lake elevation to 6,225 ft is considered transitional and a reduction in the number of occupied sites would have been expected. However, there were still 47 occupied sites, the same number as in 2003 and 2004. Despite modest fluctuations in lake level during the past three years, site occupancy (= presence) has been the highest recorded in the survey history.

The abundance of Tahoe yellow cress, as measured by estimated total stem counts, has also remained fairly constant over the past three years at around 25,000 stems. The 2004 stem count of 13,600 stems was underreported due to the adopted “6 inch rule” and the TAG agreed that the stem count for Upper Truckee East that year was closer to 15,000 stems than the reported 5,000 stems, bringing the total count to 23,600 for the year. The “6 inch rule”, which considered stems less than 6 inches apart as one individual, was not employed in 2005 because of the obvious underestimation it caused.

The high occupancy (presence) in a transitional year is likely a function of many different factors. It may be that the elevational range of 6223-6225ft represents the range of variability for optimal Tahoe yellow cress occupancy. It may also be that there is a threshold, beyond which the number of occupied Tahoe yellow cress declines, and this threshold was not reached in 2005. Search effort and method could be another factor. Past analysis has demonstrated that the probability of observing Tahoe yellow cress increased as the number of sites surveyed increased, particularly in low lake elevation years (CSLC 2003). Although the 2003-2005 surveys were comprehensive, with large numbers of participants, the number of sites surveyed has remained relatively constant over the past 5 years. Since 1993 there have been over 40 sites surveyed every year but one (1999). A final contributing factor could be that the conservation efforts employed since 2000 are in fact improving Tahoe yellow cress persistence and abundance. However, the true test of the efforts of the CS will come in the next extended period of high lake levels.

The presence of 10 Core sites and 76% occupancy rate puts Tahoe yellow cress at Level 1 of the Imminent defined in the CS (Pavlik *et al*. 2002a). Both the number of occupied Core sites and the total number of occupied sites are used to determine one of four Imminent Extinction Levels. Level 1 is indicative of a stable or increasing population trend while Level 4 indicates critically low site occupation. The criteria for each level are based on the presence of a minimum of six Core sites, which was chosen as the low threshold for the species because the lowest number of sites ever occupied in one year was only 7during 1995 to 1996. However, with the re-organization of site names the lowest threshold is now 9 sites and the ranking evaluation in 2003 increased the number of assigned Core sites to 10. Therefore the status of Tahoe yellow cress is more likely to remain at Level 1 in the future. Further consolidation of site names in 2006 could affect the Imminent Extinction Contingency Plan framework.

2.4 RECOMMENDATIONS FOR 2006

The rationale for making a distinction between ranked and unranked sites in the annual survey data collection was based on the TAG's desire to make the time investment in the annual survey more efficient and so data on the physical and biological attributes of ranked sites will no longer be collected. However, these data have never been analyzed or used to make management decisions. One worthwhile analysis would be to see if Tahoe yellow cress presence and/or abundance could be correlated with soil particle size differences among sites. This would further refine the definition of essential habitat of the species and be of use in site management and restoration.

Appendix C is an important tool for characterizing the status of subpopulations and for making site-specific management decisions. However, the criteria by which sites are identified have varied since 2000. In 2005, consolidation and reconciling of Appendix C reduced the number of site names to 62. Further consolidation and review will occur during 2006, with a special emphasis on how to best track subpopulations within enclosures. Discrepancies and inconsistencies in stem count data within and among sites indicate a clear need for the TAG to develop an adequate and reliable measure of abundance for sites that support Tahoe yellow cress. This is particularly important as the CS specifies a minimal viable population (MVP) target of 1,200 stems for Core sites. While the majority of sites have never supported this number of stems, the MVP may be a useful restoration target at

some sites, and it will be necessary to differentiate overall population size between years and among ranked sites.

Although the majority of occupied Tahoe yellow cress sites occurred on lands managed by public agencies, the majority of the estimated stems in 2005 occurred on private property, highlighting the importance of the participation of the Tahoe Lakefront Owners' Association (TLOA) in the implementation of the CS and MOU/CA. Incorporating public education and private property stewardship into Tahoe yellow cress conservation and restoration efforts is, therefore, a critical component in the success of the CS.

Overall, the population of Tahoe yellow cress appears to be stable under low to transitional lake elevation conditions. This supports the recommendation in the CS to reduce the survey effort to a significant sample size when lake elevation is at or less than 6,226 feet (LTD). The TAG expects to develop an appropriate sub-sampling protocol for the 2006 annual survey.

3.0 RESTORATION AND EXPERIMENTAL OUTPLANTINGS

The overall intent of the CS is to preclude the need to list the Tahoe yellow cress under the ESA through restoration of a self-sustaining metapopulation dynamic that allows the species to persist in sandy beach habitat around Lake Tahoe despite high water levels and human-related impacts (Pavlik *et al*. 2002a). Achieving this requires research that directly supports management and restoration activities.

Research began in 2002 with seed collection and greenhouse propagation of Tahoe yellow cress for the 2003 pilot project. The pilot project included outplanting and monitoring of container-grown plants and the installation of protective fences at four sites: Avalanche/Eagle Creek in Emerald Bay (CDPR), Taylor Creek at Baldwin Beach (USFS), Zephyr Cove (USFS), and Sand Harbor (NDSP) (Pavlik and O'Leary 2002, Pavlik and Stanton 2004). Year one of the experimental reintroduction was installed at Upper Truckee East (CTC) and Nevada Beach (USFS) in 2004 (Pavlik and Stanton 2005). In 2005, the experimental design was repeated at the same two sites and three additional sites were outplanted in order to test restoration prescriptions: Ebright and Pope Beach (USFS), and Hidden Beach (NDSP) (Stanton and Pavlik 2006). This section presents results from all outplanting efforts.

3.1 Methods

3.1.1 SEED COLLECTION

Seeds for the 2003 pilot outplanting project were collected in September, 2001 at 9 priority and core restoration sites: Blackwood North and South, Cascade, Edgewood, Lighthouse, Tallac Creek, Taylor Creek, Tahoe Meadows, and Upper Truckee East. Seed for the 2004 pilot replication and experimental reintroduction were collected in September 2002 at the same sites, except that Regan Al Tahoe was substituted for Edgewood. Seed for the 2005 experimental reintroduction and restoration plantings were collected in September 2003 at three sites: Edgewood, Taylor Creek, and

Upper Truckee East. Each year, seed lots were cleaned and hand-sorted into two equal lots and stored in manila envelopes at room temperature and humidity. Seed were delivered to two nurseries in the fall of the collection year.

As part of the ongoing propagule production necessary for an age-structured reintroduction, additional seed were collected in September 2005 for the 2006 outplanting efforts.

3.1.2 Plant Propagation

Two nurseries have conducted the propagation of Tahoe yellow cress for the past three years: The Nevada Division of Forestry (NDF) facility at an elevation of 5,000 ft in Washoe Valley, Nevada; and privately-owned Sierra Valley Farms at an elevation of 5,000 ft in Beckwourth, California. Both followed the same propagation protocol of top sowing-seed in plastic supercells with standard greenhouse soil-less potting mix. One to two inches of Lake Tahoe beach sand were sprinkled on the supercell surface to keep the seeds in place. For further details see Pavlik and Stanton 2003. Sierra Valley Farm delivered about 1,000 plants to the Washoe Valley nursery three weeks prior to the June planting. These were placed in a lathe house along with 1,000 plants from the Washoe greenhouse. At that time, the plants looked healthy and robust, however they were left un-watered for much of the next three weeks and the plants looked very dry and so were senescent just prior to outplanting. All plants were sorted according to seed lot and then assigned a vigor code (low, medium, or high). The vigor code was subjective measure of apparent plant health that largely partially reflected variability from different planting dates, but also the uneven effects of neglect.

3.1.3 Plant Installation

Plant installations consisted of outplanting container-grown plants in “transect” configurations perpendicular to the shore that extended from the waterline into different microhabitats. Transects were placed 3.28 ft (1 m) apart and plants within a single transect were outplanted at 1.6 ft (0.5 m) intervals. Individual plants were marked with wooden stakes. For plots planted with individuals from different seed lots, the stakes were color coded. Within a plot, a stratified random planting scheme was employed to distribute the different seed lots as evenly as possible. An individual plant is referred to as a “founder” (of a new population) within the reintroduction design.

Four sites were outplanted during the 2003 pilot project: Avalanche/Eagle Creek in Emerald Bay (CDPR), Taylor Creek at Baldwin Beach (USFS), Zephyr Cove (USFS), and Sand Harbor (NDSP). In 2004, the pilot project was replicated at two sites: Taylor Creek and Sand Harbor. A new cohort of founders was installed in and among the 2003 plots on the 0.5m interval of the transects running perpendicular to the lake, effectively doubling the size of the outplanting at each site. Avalanche and Zephyr Cove were not re-planted.

Two new sites were selected in 2004 for installation of experimental plots: Upper Truckee East (CTC) and Nevada Beach (USFS). Similar site selection criteria as the 2003 pilot project were employed with the additional criteria that the sites needed to be large enough to accommodate a replicated experimental design. The experimental design was repeated at these sites in 2005.

To begin the transition from an experimental phase to restoration, three additional sites were outplanted in 2005: Ebright and Pope Beach (USFS), both on the south shore, and Hidden Beach (NDSP), located in the northeast corner of the lake. Replicated experimental designs were not possible in the limited space at these sites, however, they are part of the experimental program that is designed to answer KMQs and eventually lead to effective restoration prescriptions for establishing or enhancing self-sustaining populations. For discussion purposes, the 3 sites without a replicated experimental design are referred to as "restoration" sites in order to distinguish them from the two replicated sites where the design allowed for more rigorous statistics. Table 3 presents the number of founders installed at all sites during 2003 to 2005.

In 2004, year 1 of the experimental planting, the first outplanting was conducted in late May with a lake elevation of 6,224.2 ft LTD (Figure 5). The highest level of the season, 6,224.3 ft, was recorded on June 3rd, 10 days after planting. The lake had dropped to 6,223.9 ft at the time of the second outplanting at Upper Truckee East on July 29th.

Table 3. The number of founders installed at nine sites at Lake Tahoe from 2003 to 2005.

	# Founders Installed		
Site Name	**2003 cohort**	**2004 cohort**	**2005 cohort**
Avalanche	300		
Zephyr Cove	286		
Taylor Creek	541	546	
Sand Harbor	297	281	
Upper Truckee East		1,045	650
Nevada Beach		582	534
Ebright Beach			418
Pope Beach			250
Hidden Beach			180
Total	**1,423**	**2,454**	**2,032**

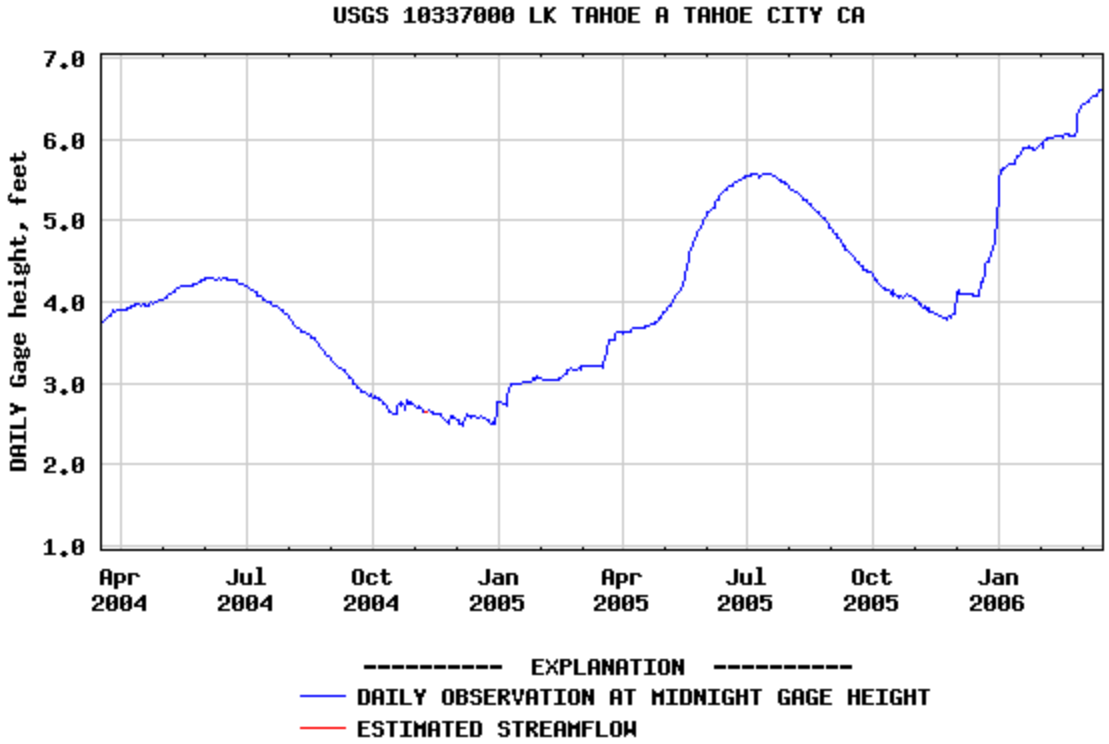

Figure 5. Elevation of Lake Tahoe for the 2004-2005 growing season (add 6,220 ft LTD to gage height on the y axis). Graph from the USGS Tahoe City station.

In 2005, year 2 of the experiment, the first outplanting was conducted during the week of June 7-10, with a lake elevation of 6,225.1ft LTD. The last day of snowfall for the season was on June 8th and the highest lake level of the season, 6,225.6ft, was recorded later in July. Total survival of the 2005 cohort at UTE at 4 weeks was only 36% and, therefore, surviving plants were removed, discarded, and replaced with new founders on July 13th. These new plants came from a late propagation at Sierra Valley Farms with 100 additional plants from Washoe nursery that had been sown in March and April.

The microhabitats identified during the 2003 pilot project were revised for the 2004 installation to correlate site microhabitats with elevation and microtopography. The assumption behind this methodology is that the water table is at the elevation of Lake Tahoe and, therefore, the microtopographic height of a plot above the lake is equivalent to depth to the water table. At each site, a laser level was used to determine the precise elevation of each plot in relation to the lake. A total of six microhabitats were described by elevation: moist shoreline, berm, low beach, dune trough, high beach, and meadow (Table 4).

In 2004, moist shoreline habitat occurred from 6,224.6 to 6,225.7 ft LTD in plots adjacent to the lake, generally in rows 1 through 5. This was an arbitrary habitat location, based entirely on the lake elevation on the day of planting that year in May. This elevation band was completed inundated in 2005. However, the first five rows of the restoration plantings at Ebright and Hidden Beach were characterized by the same saturated soil conditions and wave inundations that occurred in 2004, so

they were designated moist shoreline for analysis purposes. At, Nevada Beach, founders were again installed along the banks of Burke Creek to mimic moist shoreline habitat.

Low beach occurred between the moist shoreline and high beach in the range from 6225.8 – 6228 feet. The maximum lake elevation is approximately 6228 ft so the low beach habitat is susceptible to inundation. High beach habitat (6228-6230.6 ft) is never inundated and provides a refuge in times of high lake levels. The berm habitat that formed in 2004 at Upper Truckee East (UTE) was inundated in 2005.

Finally, two other microhabitats, including dune trough and meadow, were only present at Taylor Creek. In the back beach, dune trough habitat occurred in the moist sand between 6,224.5 and 6,227.5 ft on either side of a persistent lagoon that supports water lilies (*Nuphar* sp.) and other aquatic vegetation. In 2005, founders from the 2003 and 2004 cohorts were translocated from one of the plots in this habitat. Beyond the dune trough, plants have not been able to persist in the meadow habitat amongst the stabilized vegetation at 6,230 ft.

At the experimental sites, the outplanting design incorporated replicated blocks within the available microhabitats. At Nevada Beach, plants were installed in blocks containing 48 founders each. Each habitat had 3-6 replicated blocks for a total of 150-234 founders per microhabitat. Founders at UTE were installed in blocks of 50 and replicated four times for a total of 200 plants per microhabitat.

At the restoration sites, plants were installed in a single plot within temporary fencing at Cascade, and Hidden Beaches in moist shoreline, low, and high beach microhabitats. The installation at Pope was divided into two plots, not directly adjacent to the shoreline. The lower plot was low beach and the upper plot was high beach.

Table 4. Shorezone elevations and plot locations of seven Tahoe yellow cress microhabitats for nine outplanting sites.

MICROHABITAT	Elevation FT (LTD)	PLOT LOCATION
Moist shoreline	6,224.6 to 6,225.7	Inundated in 2003 and 2004 at all sites but Nevada. in rows 1-5 adjacent to Burke Creek. In 2005, found in plots adjacent to the lake at Cascade and Hidden Beach in rows 1-5.
Berm 1 (formed in May 2004)	6,225.3	Upper Truckee East, blocks 1-5, inundated in 2005
Berm 2 (formed in July 2004)	6,224.7	Upper Truckee East, blocks 1-6, inundated in 2005
Low beach	6,225.8 to 6,227.9	Upper Truckee East, blocks 1-5
		Nevada Beach, blocks 1-3 and rows 6-8 in blocks 4-9
		Avalanche, all

MICROHABITAT	Elevation FT (LTD)	PLOT LOCATION
		Ebright Beach, rows 6-14
		Taylor Creek, Plot 2
		Pope Beach Plot 1
		Zephyr Cove, plot 1 (planted in2003)
		Sand Harbor, rows 15 and less
		Hidden Beach, rows 6-16
Dune trough (i.e., back beach depression)	6,224.6 to 6,226	Taylor Creek, in back beach plot 3, rows 1-12 and all of plot 4
High beach	6,228 to 6,230.6	Upper Truckee East, blocks 1-5 planted in May, 2004,blocks 1-6 planted in July, 2004, and blocks 1-4 planted in July, 2005
		Nevada Beach, blocks 10-12
		Ebright Beach, rows 15-19
		Taylor Creek, plot 2A and plot 3, rows 13 and above
		Pope, Plot 2
		Zephyr Cove, plot 2 (planted in2003)
		Sand Harbor, plot 1 rows 16-20
Meadow	6230	Taylor Creek, plot 5

3.1.4 MONITORING

Demographic, physiological, and disturbance monitoring techniques developed for the 2003 pilot project were employed in the present study. Detailed protocols are available in Pavlik and Stanton (2003). A datasheet was developed to record the fate of every outplanted individual, allowing subsequent calculations of mortality rates, survivorship to reproduction, and estimates of reproductive output using models previously developed (Pavlik *et al*. 2002b). Three of the land management agencies (USFS, CTC, and NDSP) committed personnel for outplanting and ongoing monitoring efforts throughout the 2005 growing season. Founders were evaluated at two weeks and four weeks after planting and thereafter on a monthly basis through September. Data collection parameters included: Plant position, seed source**,** phenology**,** vigor**,** initial and final plant size**,** and

current status. Reproductive output was estimated based on an equation that links canopy size to seed output (y=3.609x-109.542, r = 0.81) (see Figure 4 in Pavlik *et al.* 2002b).

The water relations monitoring component measured physiological stress levels (i.e., xylem water potentials) of plants established at different hydrotopographic positions with respect to lake level. Water relations monitoring was conducted three times during the growing season.

Disturbance monitoring was conducted in conjunction with the demographic monitoring. Additional disturbance monitoring was conducted on July 5th in an attempt to document any impacts from high recreational use the 4th of July weekend. During the demographic monitoring, the crews made notes about the following possible disturbances in the plots: Footprints/body impressions, animal prints (especially dogs and Canada geese), trash, and any acts of vandalism, especially those affecting Tahoe yellow cress plants or the fence/signs. Photographs were taken of any significant disturbances.

3.1.5 TRANSLOCATION

Translocation involves moving established plants in the field from one location at a site to another. A total of 56 individuals from the 2003 and 2004 cohorts in Plot 3 at Taylor Creek were carefully dug up and moved within the existing enclosure on June 24, 2005. Each individual was extracted using a sharp shooter shovel and placed in a pot with a variable amount of soil still attached to the roots. Care was taken to cut around the perceived rootmass to minimize damage, but it was not always possible to get all roots due to the extensiveness of some individuals.

Translocation plots were established in 4 replicated blocks around the perimeter of the back beach dune trough within 300 ft (100m) of Plot 3 to the east. Each replicated block consisted of two treatments: amended with soil-less potting mix, and no potting mix. Each block contained 7 individuals for a total of 28 individuals per treatment. Each planting area was pre-watered to allow digging of a hole approximately one foot deep in order to accommodate the rootmass without bending. For the amendment treatment, approximately 1 gallon of potting mix was mixed in the hole with the sandy substrate before planting. Each plant was carefully planted and secured in the ground before more water was applied. The seven individuals in a block were laid out in a clumped design and each plant marked with a wire flag. Plots were monitored at two, four, and eight weeks after planting.

3.2 RESULTS

The hypothesis-driven replicated design with “cause and effect” monitoring provided statistical power to evaluate factors central to Key Management Questions (KMQs) (Pavlik and O’Leary 2002) including the effects of founder initial vigor, microhabitat, founder water status, and founder seed source on demographic performance, and the effects of lake level and disturbance on persistence through time. In this section, results for the experimental sites at UTE and Nevada Beach are presented first with any supporting statistical analysis. Second year results from the experimental sites are presented when relevant along with second and third year results form the 2003 pilot outplanting sites (Avalanche, Taylor Creek, Zephyr Cove, and Sand Harbor). Next, the first year

results form the restoration sites at Pope, Ebright, and Hidden Beaches are presented. Statistical evaluation at these sites was limited to measurements on individual plants for reproductive output.

3.2.1 Effects of Initial Founder Vigor

At UTE, the poor quality of founders severely compromised the experimental outplanting. After four weeks, only 36% of the total had survived. In contrast, mean survivorship in 2004 at four weeks ranged from 75-95% among all microhabitats. Therefore, the entire June planting was removed and discarded and re-planted with founders that were only 3-4 months old. This cohort was not graded for initial vigor because they were small, vegetative, and fairly uniform in appearance. The cohort was derived from only one seed source, so the effects of genetics could not be tested for a second year.

A majority (52%) of the founders at Nevada Beach was classified as low vigor. Although survivorship after four weeks was only 54% (compared to almost 90% at the same time in 2004), the site was not replanted. Overall survivorship at the end of the season in September was 46%, far less than the 75% observed in 2004.

Among the three restoration sites (Ebright, Hidden and Pope), initial founder plant quality and vigor were very low and consequently, overall survivorship and reproduction were lower than expected. Between 40% -64% of the founders at each of the 2005 sites were classified with low initial vigor (Figure 6).

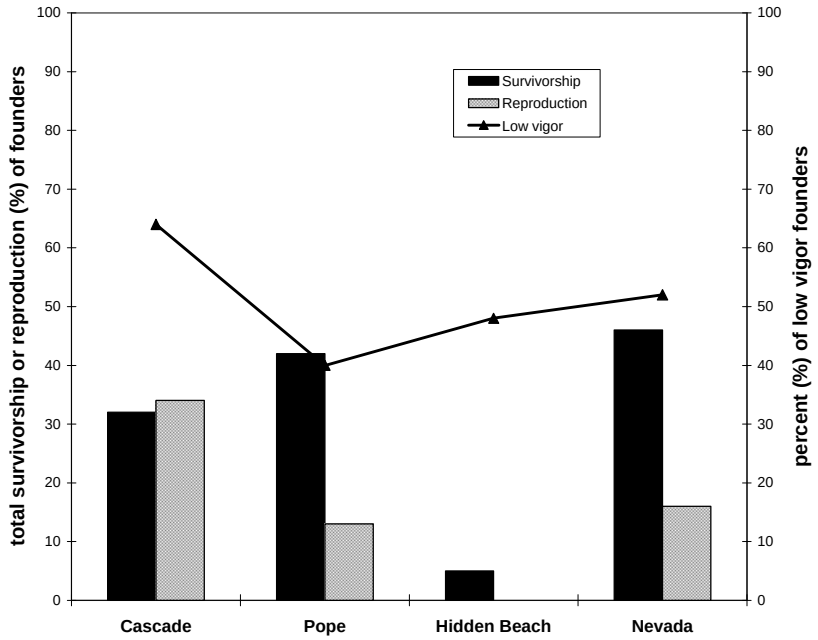

Figure 6. The effect of initial vigor on survivorship and reproduction in the 2005 cohort at four sites in September, 2005. Error bars The cohort at UTE was not evaluated for initial vigor so it is not included here.

At Ebright Beach, only 24% of the outplanting had survived four weeks, so an additional outplanting of 209 founders was installed in July. However, the original 50, low vigor individuals were not removed to observe if any that appeared dead would re-sprout. By September, some of the June cohort did re-sprout and survivorship rose to 32%. Survivorship of the July cohort was only marginally better at 42%, and reproductive proportions were low (34% and 10% in the June and July cohorts, respectively). Figure 6 and subsequent analysis is based upon combined data for the two plantings at Ebright Beach. The June planting at Pope Beach also had low survivorship (42%) and negligible reproduction (10%). At Hidden Beach, only 9 individuals (5%) of the original planting of 180 founders survived to September, precluding any further analysis at this site.

3.2.2 Effects of Lake elevation

Lake elevation reached a high of 6,225.6 feet (LTD) on July 1, 2005. The previous year, the high lake elevation of 6,224.3 feet occurred at the beginning of June (see Figure 5). The increase in lake elevation of over one foot would have several expected outcomes: 1) inundation of the moist shoreline microhabitat, defined in 2004 as occurring between 6,224.6 to 6,225.7 feet, 2) improved water status of outplanted founders in remaining habitats (as measured by xylem water potentials), and 3) increased performance of founders in more xeric habitats (high beach) due to increased water availability.

The higher lake elevation in 2005 did inundate the moist shoreline, eliminating nearly all of the 2003 and 2004 founders in that microhabitat. What had been an optimal habitat in 2004, with survivorship at most sites exceeding 80%, became uninhabitable in 2005 with no survivorship or reproduction. Between 42-54% of the 2004 cohorts at UTE, Taylor Creek, and Sand Harbor were in moist shoreline or other inundated habitats. Therefore, it can be assumed that approximately half of the decline in survivorship among the 2004 cohort in 2005 was due to inundation. However, only 24% of the planting at Nevada Beach was in the moist shoreline habitat along Burke Creek, and this was the only site where founders were able to survive inundation. It is not known if the 2003 and 2004 founders will persist underwater and re-appear if the water eventually recedes.

Although many founders were lost in the lowest microhabitats, higher lake levels did improve the water status of founders in the remaining microhabitats. Measured xylem water potentials of the 2004 cohort in 2005 were significantly higher across all microhabitats than in 2004 (see section 3.2.4). This means there was greater water availability and that plants were experiencing less stress (xylem tension) during 2005.

Increased water availability was expected to improve performance of plants in the high beach during 2005 compared to 2004. However, survivorship and reproduction in the high beach among the 2005 cohort at the experimental sites were not significantly different when compared to the 2004 cohort (see section 3.2.3). At the three restoration sites, survivorship in the high beach was low and reproduction had failed completely. We attribute this outcome to the low initial vigor of the founders. Such a large proportion of the 2005 outplanting died so soon after planting that the low quality of the plants overwhelmed any potential benefits from greater water availability.

Although the performance of the 2005 cohort was compromised, survivors from the 2004 cohort experienced large and significant increases in mean seed output per plant in all microhabitats (Figure

7). The increased water availability and longer establishment period may have allowed two year-old founders to expend more energy on both vegetative growth and seed production.

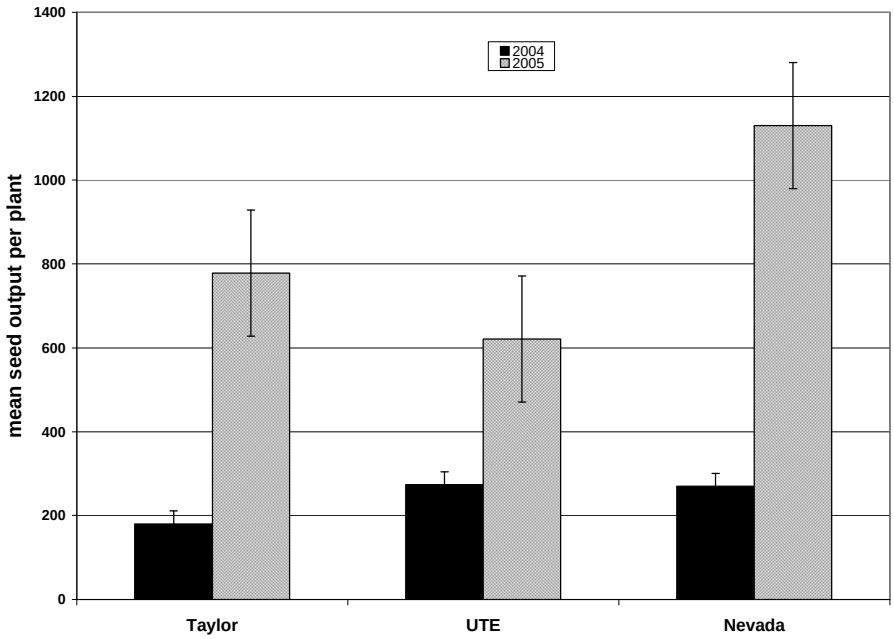

Figure 7. A comparison of mean seed output per plant in the 2004 cohort at three sites in September of 2004 and 2005. Bars indicate ± 1 SD. (Sand Harbor was not evaluated for reproductive output in 2005).

3.2.3 Performance in Different microhabitats

Differences in founder performance among microhabitats varied at different sites in the 2005 cohort (Figure 8). At experimental sites, mean survivorship was significantly reduced in the high beach compared to the low beach or the intermediate microhabitat at UTE, but there was no significant difference among the microhabitats at Nevada. Among the three restoration sites, no clear pattern that emerged. For instance, founders at Pope Beach had optimal performance in the high beach while those at Ebright Beach in the high beach had minimal survivorship. The inconsistency was likely due to the overall low initial quality of the founders and subsequent low performance.

Data from 2003 and 2004 demonstrated that, in general, survivorship varied with microhabitat. Survivorship was maximal in the mesic microhabitats (moist shoreline, berm, and low beach) and reduced in the high beach. However, the patterns of survivorship and reproduction shifted in 2005. Reproduction at Nevada was optimal in the moist shoreline in both 2004 and 2005; however, reproduction did not occur in the high beach in 2005 as it had in 2004(Figure 9). As previously mentioned, the increase in lake elevation was expected to increase founder performance in previously xeric habitats. Lack of reproduction in the high beach was likely due to the low initial vigor of the entire cohort. In contrast, founders from the 2004 cohort experienced a large increase in reproductive capacity and output in the high beach in their second year. This pattern was also evident at UTE, with no reproduction in the high beach among the 2005 cohort and increased

reproduction in both the low and high beach among two year-old founders. These observed increases in reproductive output in two year-old founders in 2005 are likely attributable to a combination of improved water status and improved growth after a second season.

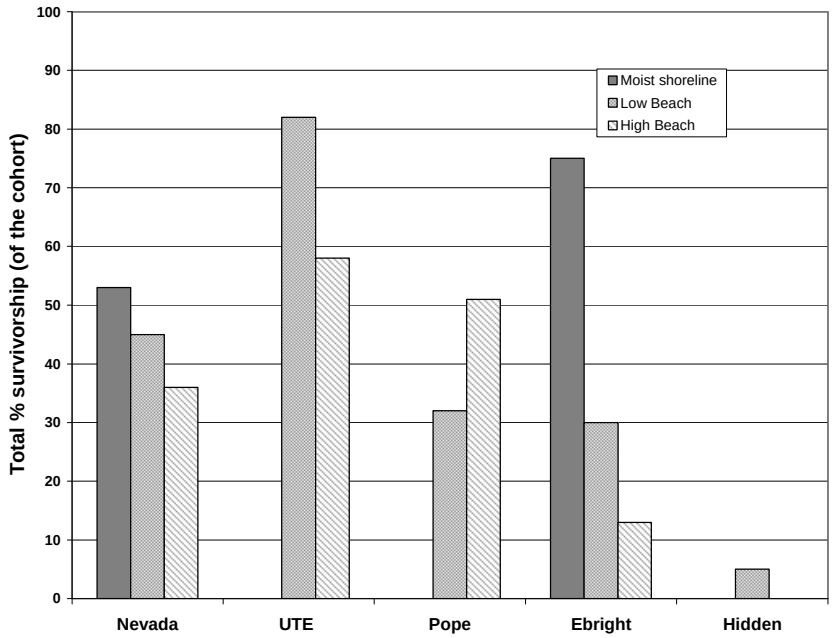

Figure 8. Total survivorship in three microhabitats of the 2005 cohort in September, 2005 (the moist shoreline was not available for planting at UTE or Pope Beach)**.**

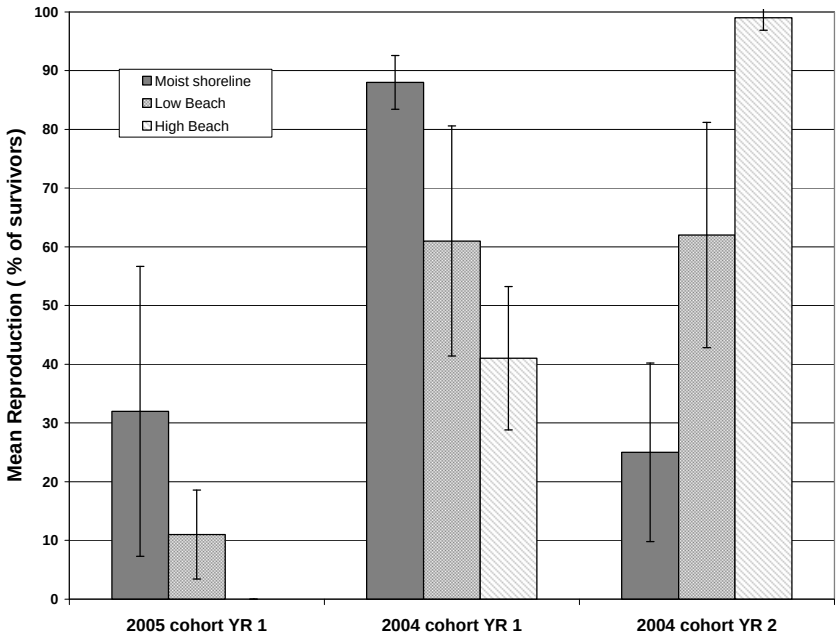

Figure 9. Mean reproduction (the proportion of survivors that reproduced) in one year-old and two year-old founders at Nevada Beach, September 2005. Bars indicate ± 1 SD.

3.2.4 PLANT WATER STATUS

The xylem water potential of vascular plants integrates soil water availability and atmospheric moisture conditions in a single, plant-based measurement of water status (using a pressure bomb). Well-hydrated plants have higher water potentials (less negative and closer to 0 bars) because water is moving through the plant under low tension (negative hydrostatic pressure). As water becomes less available in the soil to replace transpiration losses to the atmosphere, xylem water potentials decrease (i.e., become more negative) and the plant experiences greater stress (e.g., possible loss of cellular turgor pressure and other physiological perturbations). Xylem water potentials of forbs in mesic habitats generally range from at or near 0 bars for a fully hydrated plant to a lower threshold of –15.0 bars for a stressed plant that is at or near the point of wilting.

Pre-dawn water potentials taken before the sun appears in the sky (generally before 6am), provide an indication of available soil moisture because stomata have been closed overnight and the water potential of the plants has equilibrated with the water potential of the soil. For the data pooled across all sites and microhabitats, pre-dawn water potentials (the least stressful in a 24 hr cycle) were significantly higher in 2005 than 2004 from July to September (Figure 10).

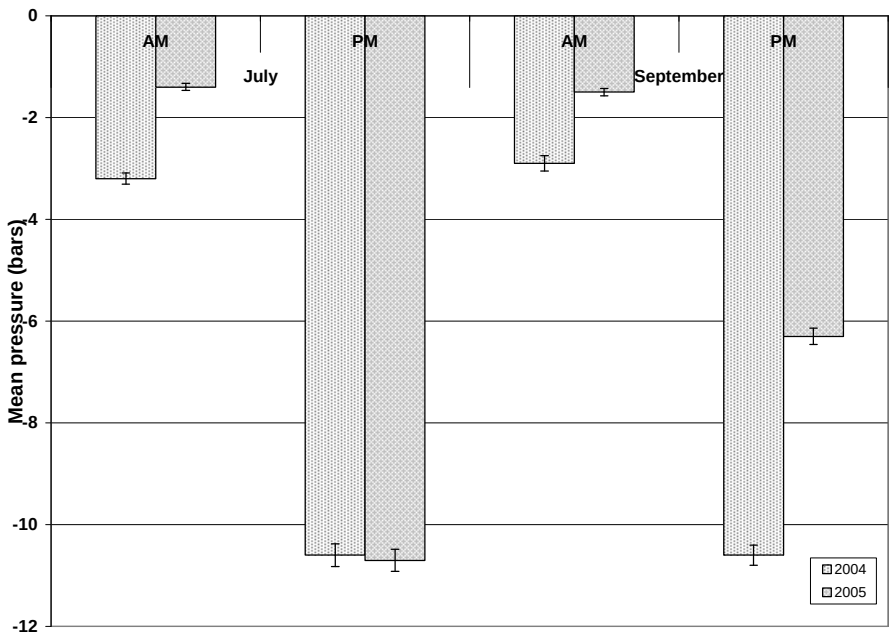

Figure 10. Mean water potentials at pre-dawn (AM) and mid-day (PM) of Tahoe yellow cress in July and September of 2004-2005. Data pooled from all sites. Bars indicate ± 1 SE.

This also held true in separate microhabitats (data not shown), and air temperature were comparable between the years (around 50°F in July and 40°F in September),indicating that founders in 2005 experienced significantly less baseline water stress than those in 2004. It is likely that the increase in lake elevation was responsible for the improved water status of founders in 2005. Mid-day water potentials (when plants are most likely to experience water stress) were significantly different between the years only in September, when plants were experiencing greater water stress due to

lower soil moisture associated with a lower water table. Some of the observed differences in late season water potential could be attributable to differences in the ambient conditions when measurements were made, (air temperatures in September were between 72-76° F in 2004 and 69-70°F in 2005.)

3.2.5 Effects of founder population source

In 2005, it was only possible to evaluate the effects of founder population source on survival and reproduction at Nevada Beach. Founders installed at UTE in the re-planting during July were from a single seed source population.

At Nevada Beach, founders from UTE seed had significantly greater survivorship in September than those from Taylor Creek or Edgewood, but rates of reproduction were similar among the seed sources (Figure 11). However, founders from UTE were four times more likely to be high vigor and significantly less likely to be low vigor. Only 29% of founders from UTE were low vigor compared to 76% from Edgewood, and the resulting superior performance of UTE founders is likely due to this discrepancy. Still, it is not possible to strictly rule out the influence of environmental or genetic factors because of the overall low survivorship and compromised nature of the experiment. Population source was not found to have a significant effect on survivorship or reproduction in 2004 when the quality of the cohort and the data was robust, but it will be necessary to repeat the 2005 experimental design to verify these findings. Until more evidence is gathered, in order to retain any unique alleles that may be present in some source populations (see DeWoody and Hipkins 2004), it would be ideal to mix seed from many locations for restoration purposes.

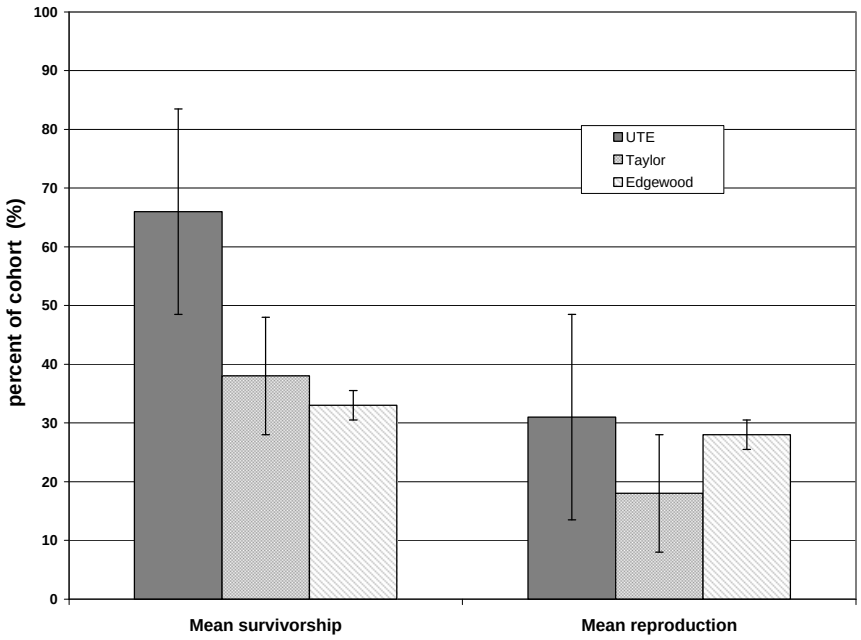

Figure 11. Mean survivorship and reproduction of three population sources at Nevada Beach, September, 2005. Bars indicate ± 1 SD.

3.2.6 PERSISTENCE THROUGH TIME

Total survivorship for the 2003 founding cohort has declined over the past two years (Figure 12). Original survivorship in 2003 ranged from 86% at Avalanche to 27% at Sand Harbor. In 2005, approximately 45% of the original plantings remained at Avalanche and Zephyr Cove, while only 20% of the plantings persisted at Taylor Creek and Sand Harbor, for a mean decline of 42% across the sites. At the end of the 2005 field season, there were 386 founders from the 2003 cohort alive at all sites (not including the 58 plants that were translocated at Taylor), down from 750 in 2004. Of these survivors, 309 (80%) were fruiting in September. Of the initial investment of 1,424 founders, almost 22% survived to reproduce in the third year. Together these individuals have produced an estimated 500,000 seed (not including the missing estimates from Sand Harbor for 2003 and 2005).

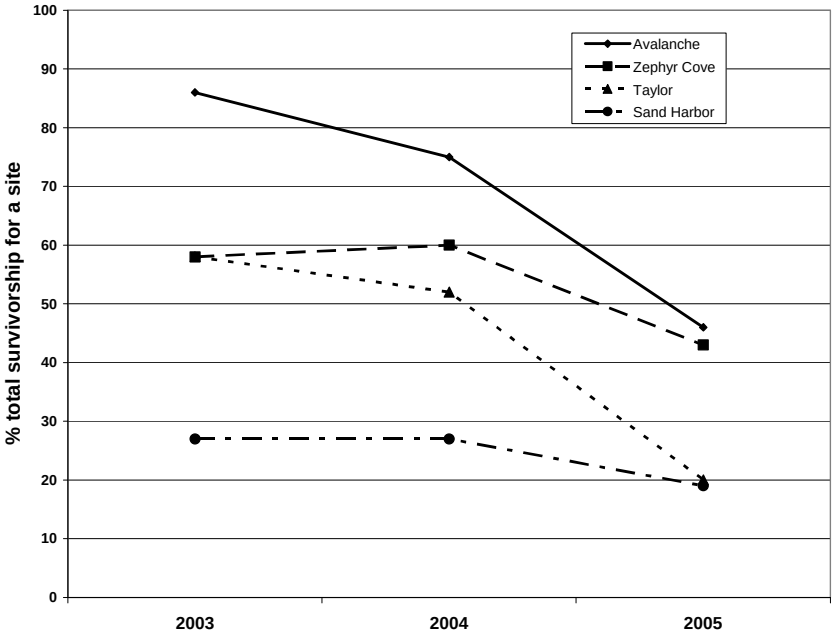

Figure 12. Overall survivorship of the 2003 cohort at four sites in September, 2003-2005.

The ongoing rise in lake level caused sharper declines in the 2004 cohort. Total first year survivorship was approximately 75% at each site except Sand Harbor (43%). In 2005, the average decline in survivorship among the sites was close to 60%. While 47% of the founders survived at Nevada, less than 25% of founders persisted at the other three sites (Figure 13). The higher persistence at Nevada is attributable to less inundation. Only 24% of the 2004 cohort at Nevada Beach was inundated in 2005, compared to 50% at UTE, 54% at Taylor Creek, and 42% at Sand Harbor. Of the initial investment of 2,814 founders, a total of 1000 (43%) were inundated in 2005 and 636 (23%) survived to the end of year two. Of these, a total of 496 were reproductive in September, for an overall survivorship to reproduction of 18%, only slightly lower than third year reproduction in the 2003 cohort.

The fact that approximately 20% of the 2003 and 2004 cohorts survived to reproduce despite fluctuating lake levels indicates that these outplantings are able to persist. An additional indicator of persistence is mean seed production per plant. Among the 2004 cohort, mean seed production increased significantly during 2005 (see Figure 7). As discussed in section 3.2.4, the increase in lake elevation increased soil water availability to founders (as measured by higher xylem water potentials). With more moisture the two-year old surviving founders were probably able to produce and allocate more resources to growth and seed production. Likewise, the three-year old founders also experienced a slight increase in mean seed production after having experienced a decline during 2004.

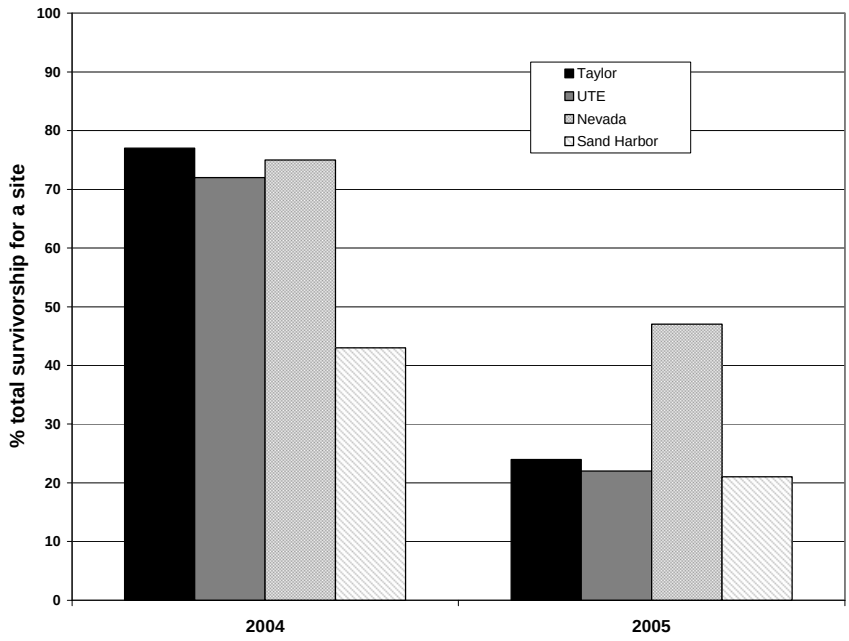

Figure 13. Overall survivorship of the 2004 cohort at four sites in September, 2004-2005.

3.2.7 EFFECTS OF DISTURBANCE

In 2005, all sites were partially or fully enclosed with fences except for Avalanche (the site was not fenced due to its somewhat isolated location). Fencing helped to reduce impacts from recreational activities among the sites, but several of the enclosures were vandalized during the season or damaged by storms.

At Taylor Creek, the wire flags that marked translocated plants within the permanent fence were removed some time in July. Although the flags were replaced by biologists they were removed again in August. It was difficult to positively identify and re-mark the individuals because of the recruitment of natural seedlings after the translocation. The resulting uncertainty compromised our ability to interpret the data with any confidence. Wooden stakes marking low beach habitat in the temporary fencing were also removed and strewn about the beach and some plants were intentionally pulled up. This plot had not been fully enclosed along the shoreline because of the fluctuating lake level, so it was easy to enter. The regular pattern of this plot made it easy to replace the stakes, but it

was not possible to determine the exact number of plants that were pulled. The estimated number was less than 10.

The most severe effects of disturbance were at Hidden Beach. A storm in July damaged the temporary fencing as the lake inundated about one third of the plot. Large amounts of woody debris and trash were deposited by stormwaves. The fence was soon repaired, but many of the plants had been washed away or covered completely with beach wrack. Survivorship at that site was only 5%, the lowest of any outplanting this year.

At UTE, the permanent plastic-wrapped wire and wood post fencing along the eastern and southern perimeter of the enclosure remained intact throughout the season; however, the signage on the enclosure had badly deteriorated and most signs were ripped and illegible. Although signs of dogs and footprints were evident in the enclosure during every monitoring period, no wooden stakes were intentionally removed, and it appeared unlikely that any plant deaths could be attributed to any humans. The disturbance from the rising lake eliminated the berm habitat that formed during 2004 and completely inundated the entire moist shoreline habitat.

Newly installed fences at Pope Beach and Ebright Beach were not vandalized or damaged and the re-constructed temporary fencing at Nevada Beach was also intact throughout the season. Temporary fencing constructed in the low beach at Zephyr Cove and at Taylor was not enclosed along the lake because of the higher lake elevation and sporadic inundation. Surviving individuals in these plots were subject to some trampling, primarily from dogs.

Fluctuating lake levels make for challenging conditions in designing appropriate and effective fencing, however maintaining fencing throughout subsequent experimental and restoration plantings will be important for maintaining confidence in the data collected.

3.2.8 OVERALL SITE SUITABILITY

Overall site suitability must be inferred from performance of the 2003 and 2004 cohorts since the low quality of the 2005 founders compromised results for this year. Overall survivorship of the 2003 cohort was optimal in all years at Avalanche and Zephyr Cove (Figure 12). Both sites are mesic compared to Taylor Creek and Sand Harbor. Zephyr Cove is fully inundated in high water years, as is Avalanche, despite the fact that it had designated high water beach habitat (see long-term presence record in Appendix C).

Among the 2004 cohort, Sand Harbor was the least suitable site. Total survivorship was nearly equivalent at Taylor, UTE, and Nevada Beach (see Figure 13). Founders at Sand Harbor had significantly greater lower dawn water potentials than the other sites in July, indicating drier baseline soil moisture conditions. In 2005 mean seed output per plant was greatest at Nevada Beach (1,130 mean seeds per plant) and similar between UTE and Taylor Creek (621 and 728 mean seeds per plant, respectively). Seed output was not estimated at Sand Harbor. The greater reproduction at Nevada could be due to a lack of competition from any competing vegetation. The low beach habitat at UTE had very high lupine cover and the dune trough habitat at Taylor Creek had relatively high cover of a variety of different species.

3.2.9 TRANSLOCATION

The translocation tests were compromised when the wire flags marking the translocated individuals were removed by vandals for a second time in August. It was difficult to positively identify and re-mark the individuals because of the recruitment of natural seedlings subsequent to the installation. Three of the blocks were eliminated from analysis, leaving only 5 replicate blocks. Uncertainty remained over the identification of specific plants in the remaining five blocks so these individuals were also eliminated from analysis, lowering the total number of translocations from the original 56 to only 32. Consequently, it was not possible to evaluate the treatment of amending the soil with potting mix prior to planting, and only limited summary results are presented.

A total of 77% of the transplants were surviving on July 11, two weeks after translocation. By the time of the four week monitoring, the flags had been removed but it was still possible to relocate them. Total survivorship had risen to 87.5%, although some of the increase could be attributed to natural seedling recruitment. By the end of August, the flags had been removed again and total survivorship was calculated at 84%, or 27 of the identifiable 32 translocations.

Two months after the translocation it was difficult to visually determine which plots had received the soil amendment, and even with the compromise of the experiment, the treatment had no apparent effect. This treatment will not be pursued in 2006 in favor of other factors that likely have a greater effect on survivorship such as timing, watering regime, habitat, and site differences.

Despite the limited dataset, the high survivorship indicates that it is possible to move plants within a site and that pursuing translocation as a potential mitigation strategy is warranted. Future efforts will need to more effectively protect experimental plots and develop a method for permanent marking.

3.3 DISCUSSION AND CONCLUSIONS

3.3. 1 KEY MANAGEMENT QUESTIONS

The Key Management Questions (KMQs) outlined in the CS guide the conservation and restoration research on Tahoe yellow cress. This means that generated data has immediate value to decision-making within an adaptive management framework (Pavlik and O'Leary 2002). Each of the sections in the results addresses aspects of the five KMQs, with the exception of the effects of lake elevation. Although lake elevation is perhaps the most critical determinant of the abundance and persistence of Tahoe yellow cress (Pavlik *et al* 2002a), it is not directly addressed in the KMQs because it is not a factor subject to direct management. Nevertheless, integration of the effects of lake elevation with other important factors can directly inform how to best manage Tahoe yellow cress in different (high and low water) years.

During 2005 the increase in lake elevation of nearly two feet improved the water status of founders in habitats that were not inundated, meaning that there was more water available and the plants were experiencing less stress than they had in 2004. The increased water availability apparently allowed

two year-old founders (including those in the high beach) to produce and allocate more resources to both growth and seed production.

Unfortunately, the initial quality and vigor of founding plants was very low in the 2005 cohort and overall survivorship and reproduction were lower than expected based on results from previous years. Overall site suitability, microhabitat suitability, and the effects of other factors must largely be inferred from performance of the 2003 and 2004 cohorts since the low quality of the 2005 founders resulted in anomalous poor performance.

KMQ 1 and 2 address differences in overall habitat suitability among sites and the suitability of microhabitats within a given site, respectively. Data from the 2003 and 2004 cohort demonstrated that, in general, survivorship varied among sites and within microhabitats. Among three year-old founders, performance was optimal at Avalanche and Zephyr Cove, moderate at Taylor, and poor at Sand Harbor. Among two-year old founders, only those at Sand Harbor performed poorly in all years. Across sites and within sites, survivorship and reproduction were optimal in the mesic microhabitats (moist shoreline, berm, and low beach) and much lower in the high beach.

Overall site suitability, as indicated by demographic performance, supported the priority site rankings presented in the CS. Sand Harbor is the only "Low Priority" site that had been outplanted and it had consistently poor performance during all years. Both Taylor and UTE (as well as Nevada Beach, originally) were ranked as "Core" sites in the CS and these sites had correspondingly high survivorship and reproductive output. Zephyr Cove was ranked "Medium Priority" in the CS which was subsequently revised to "High" in the 2004 ranking evaluation. Even though half of this site was inundated by the rising lake in 2005, it still supported vigorous, reproductive plants. The restoration sites represented different ranks (Ebright Beach - Unranked, Pope Beach-Low, and Hidden Beach-Unranked) but as discussed, the low initial quality of the founders prevented an assessment of differences in demographic performance.

KMQ 3 addresses those factors that might influence the success of outplanting and, therefore, determines the feasibility of creating or enhancing populations as a restoration tool. The fact that approximately 20% of the 2003 and 2004 cohorts survived to reproduce despite fluctuating lake levels indicates that outplantings are able to persist. Large and significant increases in reproductive output by two- and three year-olds across all sites indicate that age-structured enhancements have a high potential for self-sustainability. In addition, three successive years of outplantings at the same sites have yielded markedly different levels of demographic performance, giving support to the concept of spreading the risk of founder investment across years using "founder cost-averaging". Finally, although results from the translocation experiment were limited, the data indicate that it is possible to successfully move plants within a site and that pursuing translocation as a potential mitigation tool is warranted.

KMQ 4 addresses the importance of using multiple seed lots in restoration efforts. Although the amount of data was limited, there was some evidence of superior performance of one seed lot among the 2005 cohort at one site. Population source was not found to have a significant effect on survivorship or reproduction during 2004 when the quality of the founding cohort and the data were robust. Still, it is not possible to strictly rule out the influence of genetic factors and it will be necessary to repeat the 2005 experimental design. Until more evidence is gathered, it would be

appropriate to mix seed from many locations for restoration purposes in order to retain any unique alleles that may be present in some source populations.

Finally, KMQ 5 focuses on disturbance from visitor use and intense shoreline activity and whether we can mitigate adverse impacts from recreational use. Fencing helped to reduce impacts from recreational activities among the sites, but several of the enclosures were vandalized during the season or damaged by storms. Future efforts will need to more effectively protect experimental plots and develop a method for permanent marking that is less susceptible to vandalism.

3.3 RECOMMENDATIONS FOR 2006

The most important factor for ensuring the success of the restoration and experimental outplanting will be to ensure the high quality of propagated plants in the greenhouse. This will require close oversight and coordination with nursery personnel on a regular basis. A second important factor that compromised portions of the research effort was vandalism. Installing additional signage on the exterior of enclosures and directly within or next to experimental plots that explicitly informs the public that there is an experiment underway and asks them to refrain from removing any stakes or tags may help to decrease vandalism. If signage fails to deter people from entering the plots it may be necessary to develop patrol and enforcement actions. In conjunction with adequate signage, public outreach efforts should be implemented to educate the public on the benefits of the project. A media event at the time of outplanting, with coverage in local papers and television spots, could help raise the profile of the project and foster support.

In addition to continuing the outplanting research, the translocation experiment should be pursued in 2006 with a design that investigates the effects of factors that likely have a great effect on survivorship such as timing, watering regime, habitat, and site differences. These plots should be especially well protected with adequate signage.

Finally, the AMWG could pursue other research opportunities in areas that would inform TYC management such as seed bank dynamics and rootstock longevity. A potential collaboration developed in 2005 with the University of Nevada at Reno to develop microsatellite DNA analysis techniques. This avenue of research could yield valuable insight into the dispersal patterns of Tahoe yellow cress.

4.0 GERMINATION ECOLOGY STUDY

4.1 METHODS

Lab and greenhouse experiments were conducted at UC Davis in the summer of 2005 to investigate the germination ecology of TYC. The specific objectives of this study involved characterizing TYC germination ecology in order to aid the reintroduction effort. Mia Ingolia, a Master of Science candidate in the Horticulture and Agronomy Graduate Group conducted greenhouse and lab experiments focused on several unknown parameters of seed biology including how germination of TYC seed was effected by light regime, storage time, seed floatation, temperature, stratification, collection source, and planting month (please see Ingolia 2006 for specific details). She developed

her research program with initial consultation with the TAG. Below is a brief summary of significant results.

4.2 RESULTS

Light regime

The results indicate that Tahoe yellow cress requires light for germination. Averaged across collection sources, seed in full light had 22% germination, seed in shade (50% light reduction) had 6% germination, and seed in the dark did not germinate at all. Seedlings grown in the shade were thin and etiolated, providing further evidence to support field observations that TYC does poorly in highly competitive situations. This dependence on full exposure for germination gives the species an advantage in colonizing newly exposed beach habitat but could impart a disadvantage during successive years of low lake elevation as more competitive species like lupine occupy greater expanses of beach habitat.

Flotation

The floatation experiment tested the adaptive ability of seed to germinate while floating on water and to survive (long-term) water dispersal. Hydrochory (water dispersal) is an important method of seed dispersal among wetland habitat species. In the 2005 experiment, floatation at 17°C (63°F) had a negative effect on germination. Overall, 11% of seed floated for one week germinated (some while floating and others after they were sown in pots), but only 5% of seed floated for one month germinated. This apparent inhibition has been found among other species with hydrochory and the mechanism could be an adaptation to prevent too many seed from germinating in open water where chances of the seedling surviving until it reached beach habitat is low. However, for species like TYC with a metapopulation dynamic, the small proportion of seed that could germinate after floating great distances would impart an advantage in colonizing suitable habitat.

Temperature

Temperature regime had a profound effect on germination. Optimal germination of 71% occurred in a 12 hour 24/10°C (75/50°F) day/night regime, compared to 18% in the 18/4°C (64/39°F) regime and only 7% in the 13/-1°C (55/30°F) regime. The dramatic reduction in germination at cool temperatures indicates that TYC has a conditional dormancy that is broken at high temperatures. Seeds in the warm temperature regime also germinated 50% faster than the lower temperatures. The 24/10°C temperature regime corresponds to air temperatures in the Lake Tahoe Basin in mid June to July. Sand surface temperatures may reach higher temperatures earlier in the growing season which could allow TYC to germinate earlier than other potentially competitive species, however early germination would be subject to late frosts and possible inundation if late snow melt caused a rise in lake elevation.

Storage time

Seed collected in 2001 germinated at a far higher rate (40%) than seed collected in 2003 (9%) or 2004 (8%). Older seed were more likely to germinate than younger seed in the cooler temperature regimes, and at the lowest temperature regime older seed had the highest germination percentages, indicating that seed may lose viability/dormancy requirements with age. The ability of old seed to retain germinability and the sensitivity of TYC to an adequate light regime indicate that the species

may have the ability to support a seed bank. Further investigation of seed bank dynamics may prove important for the conservation effort.

Stratification

Cold stratification is the storage of moist seed at low temperature (usually between 0-10℃). Seeds that were cold stratified for varying intervals showed a negative response to any period of stratification, across all temperature regimes. When averaged across all other treatment variables, 31% of non-stratified seeds germinated and only 19% of stratified seeds germinated. In addition, germination percentage decreased as stratification time increased.

Seed Source

Seed source data was averaged across the light regime and floatation trials to analyze the effect of collection source on germination. In the greenhouse, seed from Tallac Creek had the greatest germination percentages, averaging 15%, while UTE averaged 7%, and Blackwood averaged 4%. While this result in the greenhouse trials was statistically significant, the lab germination trials examining the effects of temperature, storage time, and stratification did not show any significant differences in germination between seed sources used (average germination was 34% and 28% for Baldwin Beach and UTE, respectively). Field experiments in 2003-05 have shown no significant difference in survival or reproduction of transplanted TYC related to seed source so it is difficult to determine the origin of the inconsistent outcome of these trials. The greater germination of the Tallac Creek seed lot could be due to genetic factors, environmental factors, or to differences in seed maturity at the time of collection.

4.3 IMPLICATIONS FOR CONSERVATION

Many of the results of these experiments further confirm and explain some of the results from the experimental reintroductions. For instance, confirmation of a light requirement explains the poor performance of founders in the low beach at UTE in 2004 where surviving seedlings were etiolated and unlikely to reproduce. Low beach generally has little to no vegetative cover and was optimal habitat at other sites. However, lupine cover was greater than 60% in that habitat at UTE and the results of the germination trials indicate that founders may have performed poorly because they lacked sufficient light. Therefore, outplanting in open habitats with a low competition from other species may increase survivorship.

With respect to the nursery production of seedlings for outplanting, propagation efforts should take into consideration that TYC does not require stratification and that it germinates best with top sowing seed in full sun conditions at temperatures of at least 24°C. Warm temperatures will promote higher germination percentages and faster germination.

5.0 NFGEL GENETIC MONITORING STUDY

Researchers at the National Forest Genetic Electrophoresis Laboratory received funding through Round 5 of the Sierra Nevada Public Lands Management Act (SNPLMA) to conduct a third study of the genetic structure of Tahoe yellow cress using isozyme analysis. The following summary is excerpted from DeWoody and Hipkins, 2006.

5.1 METHODS

A total of 430 samples were collected from 21 populations of Tahoe yellow cress in 2005 (Table 5). For large populations, up to thirty plants were sampled, and when less than thirty plants were present, the population was sampled completely. Samples were collected, stored, and prepared for isozyme analyses following DeWoody and Hipkins (2004). Starch gel electrophoresis took place following NFGEL Standard Operating Procedures (USDA Forest Service 2003). A total of 22 isozyme loci were assayed in three buffer systems.

Table 5. Summary of *Rorippa subumbellata* populations analyzed by NFGEL. The number of samples analyzed each year (1999, 2002, 2003, and 2005) is listed for each population. Numbers in bold indicate that variation was observed at that site.

Population Name	1999	2002	2003	2005
4H			30	
Baldwin	4	2	3	
Blackwood North			24	
Blackwood South	27	5	30	
Cascade West			8	
Eagle Creek			**15**	24
Edgewood	18			
Emerald Bay Avalanche, Natural		1	60	
Emerald Bay Avalanche, Outplanted			15	30
Emerald Point		7	30	
Glenbrook Bay				31
Hidden Beach, Natural				1
Hidden Beach, Outplanted				**10**
Kahle/Nevada	7			
Lighthouse	18	10	35	
Marla Bay				2
Meeks Bay		5	7	
Pope Beach			4	
Regan/Al Tahoe		18		
Round Hill				**14**
Rubicon		30		
Sand Harbor Outplanted				**30**
Sand Harbor Natural				6
Skyland				11
Sugar Pine		**30**		**22**
Tahoe Keys			**30**	**26**
Tahoe Meadows	**8**		12	**40**
Tallac Creek		**11**		**3**
Tallac Enclosure	13	10		
Taylor Creek East		12		

Population Name	1999	2002	2003	2005
Taylor Creek Enclosure	**10**			
Taylor Creek Enclosure 1 Natural				13
Taylor Creek Enclosure 2 Outplanted				**30**
Taylor Creek Mouth		10		
Taylor Creek Outplanted				30
Taylor Creek West		31		
Upper Truckee East	**33**	30		30
Upper Truckee East Outplanted				30
Upper Truckee West	2	30		
Zephyr Cove				17
Zephyr Cove Outplanted				30
Zephyr Spit		8		

5.2 RESULTS AND DISCUSSION

As in previous studies, extremely low levels of genetic variation were observed in the 2005 collections. Alternate alleles were observed at only two loci, compared with three loci in 1999 (Table 6).

Table 6. Location and description of variation observed in the 2005 collections. "Number of Plants" indicates the number of samples having the indicated genotype. The common allele at each locus is designated as "1" and the alternate allele as "2."

		Locus	
Population	**Number of Plants**	**DIA1**	**UGPP1**
Hidden Beach Enclosure	1	11	12
Round Hill	2	12	11
Sand Harbor Enclosure	1	11	12
	1	11	22
Sugar Pine	1	12	11
Tahoe Keys	2	11	22
Tahoe Meadows	1	12	12
Tallac Creek	1	11	22
Taylor Creek Enclosure 2	2	12	11

The study focused on populations located on the east short of Lake Tahoe, as well as the persistence of variation in previously sampled sites. Specifically, the project was designed to address the following four questions:

1) What is the genetic structure of Tahoe yellow cress populations on the northeastern shore of Lake Tahoe?

Ten sites were inspected for Tahoe yellow cress on the east shore of Lake Tahoe in Nevada. Seven of the sites contained Tahoe yellow cress plants, and a total of 152 plants were sampled for genetic analyses. Five plants in three populations contained genetic variation: Round Hill, Sand Harbor Enclosure, and Hidden Beach Enclosure. However, both Sand Harbor and Hidden Beach enclosures were outplanted with individuals derived from seed from the south and west shores. Therefore, the pattern of genetic variation observed in populations on the northeast shore is similar to that observed in populations on the south and west shores (see question 3 below)

2) Do sampled populations contain the same variation as was observed in the 1999/2002/2003 studies?

   Seven populations that contained alternate alleles in at least one previous study were re-sampled in 2005. Five of these seven populations contained variation. One of the populations lacking variation (Eagle Creek) was sampled completely, and has likely lost the alternate allele through genetic drift. The other population (UTE) is the largest population, and may contain variation in the individuals not sampled in this study.

   Two of the five alternate alleles observed in previous studies were observed in the 2005 collections. Two of the three alleles not observed in this study have likely been lost to drift since those populations in which they were first reported were sampled completely (Eagle Creek and Tahoe Keys). The third allele may be present but un-sampled in the relatively large population where it was first reported (Taylor Creek Enclosure 2 Outplanted). Four of the populations sampled in 2005 contained different alternate alleles than reported at these sites in earlier studies. This finding is likely due to regeneration of plants from dormant rootstock, the recruitment of plants from a seed bank, or the migration of seed among populations.

3) Are seed collection and outplanting efforts capturing any genetic variation observed in native populations?

   Ex situ propagation efforts are capturing the genetic variation observed in native populations. Seven populations containing outplanted individuals were sampled, and three of those populations contained alternate alleles (Hidden Beach Enclosure, Sand Harbor Enclosure, and Taylor Creek Enclosure 2). A greater proportion of all sampled outplanted populations contain variation (43%) than sampled natural populations (23%) reflecting the genetic variation in the seed source populations, but the location of the outplanted sites results in an even distribution of genetic variation geographically around Lake Tahoe. Based on outplanting records, the sources of the genetic variation observed in outplantings on the northeast shore are populations located on the south shore. Thus, outplanting efforts are successfully managing the limited genetic variation observed in this species.

4) What is the mating system of *Tahoe yellow cress*?

   This objective was not addressed in 2005 due to a lack of coordination with the contractor overseeing the *ex situ* propagation and the lack of extra *Tahoe yellow cress* plants from the 2005 outplantings. NFGEL is able and willing to perform this work in 2006, if desired.

6.0 FRIENDS OF TAHOE YELLOW CRESS STEWARDSHIP PROGRAM

TAG members again attended the TLOA annual education meeting to distribute handouts, including a small poster to post in rental homes that has photos of TYC with identification information, and a brochure on invasive species to remove from TYC habitat areas. Several site visits were held at lakefront landowner's properties to show them TYC and discuss conservation options. In addition, several landowners were contacted by the Tahoe Lakefront Owner's Association to gain access for the annual survey.

Leslie Allen of the Lake Tahoe Environmental Education Coalition (LTEC) and the University of Nevada Cooperative Extension has joined the Stewardship Subcommittee and will be available in 2006 to conduct stewardship meetings and create materials to give landowners and interested businesses about conservation of TYC. Funding is being pursued for her participation in Stewardship subcommittee on these and other activities.

Discussions continued with TRPA on how to best implement the "Friends of TYC" stewardship program. Central issues included the types of proposed fencing and signage that are allowed under current regulations and whether new regulations would need to be added to the updated Shorezone Regulations.

7.0 2005 AGENCY ACTIVITY REPORTS

In collaboration with the TAG, the CTC developed an Agency Activity Report form in 2004 to assist management agencies in describing the following activities: Site-specific conservation activities for each Tahoe yellow cress location undertaken during the previous growing season; general Tahoe yellow cress conservation activities (i.e., public outreach, consultation, TAG participation, etc.); significant disturbances to the species or its habitat and subsequent response; planned Tahoe yellow cress conservation activities anticipated for the upcoming year; and all shorezone projects undertaken within potentially suitable Tahoe yellow cress habitat. Agency Activity Report forms submitted in the year 2005 are supplied in Appendix G.

The CS requires a brief summary of annual agency staff time and expenditures on conservation and management activities specific to Tahoe yellow cress. Table 7 provides the hourly breakdown of staff time for each agency for 2002-2005. Although the number of staff hours increased by about 600 hours over the last year to 3,047, staff time for the annual survey was significantly reduced from 563 hours in 2004 to 357 hours in 2005. The reduction can largely be attributed to the modification of the annual survey protocol to reduce time in the field. The total cost contributed by each agency for all staff time amounted to $135,954, similar to expenditures in 2004 of $136,769. In most instances, these costs do not include funding for programs or equipment and materials costs. However, the USFS did include some material costs but the reporting among agencies should be standardized in 2006.

Table 7. Summary of agency hours spent on Tahoe yellow cress related activities during from 2002-2005.

Agency/Year	2002	2003	2004	2005
TRPA	No report	150	326.5	200
USFWS	500	400	390	70
USFS	1,250	1,168	516.5	980
NDSP	No report	132	189	No report
NDF	No report	304	144	89
NNHP	98	160	95	175
CDFG	232	272	325	334
CDPR	155	403	218	358
CTC	1,634	1,024	140	606
CSLC	565	400	224	235
TLOA	No report	100	48	No report
Total	**4,434**	**4,109**	**2,616**	**3,047**

7.1 FORMATION OF THE AMWG

At the November 15, 2005 TYC Executive meeting, the Executives approved the formation of the Adaptive Management Working Group (AMWG) as specified in the CS. All members of the current Technical Advisory Group (TAG) transitioned to become members of the AMWG. The TAG is now a Subcommittee of the AMWG and consists of AMWG members with interest and expertise in technical topics. The AMWG will review TAG recommendations to integrate them into a program of basin-wide priority actions and expenditures, in turn making recommendations to the Executives as part of basin-wide resource planning activities. The current AMWG members are in Table 8 (TAG affiliation is noted with an *). The Executive Committee is comprised of the head representative of all signatories on the Conservation Strategy MOU.

Table 8. Membership of the Tahoe yellow cress Adaptive Management Working Group (AMWG) in 2005.

Agency or Entity	**AMWG Representative** (*denotes TAG rep)
TRPA	Eileen Carey, Vegetation Program Manager*
USFWS	Steve Caicco, Botanist
USFS LTBMU	Jody Fraser, Forest Botanist* and Shana Gross, Sensitive Plant Coordinator*
NDSP	Jay Howard, Park Supervisor
NDF	Roland Shaw, Forester
NNHP	Jennifer Newmark, Program Biologist*
CDFG	Susan Levitsky, Environmental Scientist
CDPR	Tamara Sasaki, Resource Ecologist
CTC	Peter Maholland, Wildlife Program Coordinator
CSLC	Eric Gillies, Environmental Specialist*
TLOA	Jan Brisco, Executive Director
BMP ECOSCIENCES	Bruce Pavlik, PhD and Alison Stanton, Research Botanist*
LTEEC/UNCE	Leslie Allen, Environmental Education Coordinator

7.2 SITE-SPECIFIC INFORMATION SHEETS

The CSLC, in consultation with the AMWG, developed a Site-Specific Information Sheet in 2005 (see the template in Appendix F). General information in the Information Sheet includes the site location, ownership, viability index, priority rank, and whether the site is a TRPA threshold site. The form also includes important information for management: site description, survey history, population and ecological characteristics, potential threats/concerns. Finally, the forms include descriptions of past and current activities and include recommendations for future management. The purpose of the Information Sheets is to provide a comprehensive repository of information pertaining to Tahoe yellow cress for all named locations. This format fulfills the intent of Appendix J in the CS, Proposed Actions for Core and High Priority Sites, and expands the number of sites to include private lands. The information will be useful for project review on both public and private lands in the shorezone. The public agencies are using the Information Sheets to develop Site-Specific Management Plans by expanding the recommendation section. Information Sheets for private lands could be used to develop a management plan in the future if mitigation or other circumstances required.

All 62 named sites have been assigned to AMWG members to complete the site- specific information sheets prior to review by the group. Final approved forms are submitted to Eric Gillies, CSLC, for inclusion in a comprehensive file that will be periodically updated. The CSLC is assigned 17 sites and is taking primary responsibility for completing Information Sheets for private lands. Each agency is completing Information Sheets for all sites on their property as follows: USFS (15); CDPR (9); CTC (7); NDSP (5). The TRPA, a non-land owning agency, will complete 4 Information Sheets. The Site-Specific Information Sheet assignments are in Appendix F.

8.0 FIVE YEAR MANAGEMENT PLAN

The signatories of the CS MOU developed a list of initial management and monitoring responsibilities (Table 14 in the CS). In 2005, the AMWG modified the format and content of Table 14 to produce a 5 Year Management Plan to guide all activities related to Tahoe yellow cress conservation. The plan is partitioned into six sections: Budget; Management; Regulation; Research; Restoration; Stewardship. Each section specifies actions and the entities responsible for a 5 year period. Each year's plan will always include the previous year for reference, the plan for the current year, and projected actions for the subsequent three years. Therefore, the 2005 plan contains actions from 2004-2008; a brief summary is below. The complete plan is in Appendix D.

The AMWG will develop details of the plan at quarterly meetings and the plan will be implemented within the adaptive management framework specified in the CS. The budget for implementation of the CS in presented in Table 9. A total amount of $105,000 was allocated for outplanting and restoration research in 2004 and total funds of $285,000 was allocated for outplanting and restoration research, genetic research at the NFGEL, and USFS staff time in 2005. In 2006, funding of $484,000 will be allocated over at least two years to support outplanting, restoration mitigation research, development of the Stewardship Program, USFS staff time, and other products specified in the SNPLMA Round 6 proposal.

Table 9. Budget for implementation of the TYC Conservation Strategy for the years 2004-2007, as presented in the AMWG 2005 Five Year Management Plan.

Action	Entity	2004	2005	2006	2007
Budget					
Implement Conservation Strategy					
	USFWS			$100,000 Congressional earmark	continued
	BOR-administered by TRPA	$80,000	$150,000	Application expected	
	NDSP	$20,000 Lake Tahoe License Plate Funds	$20,000 Lake Tahoe License Plate Funds	$10,000 Lake Tahoe License Plate Funds	
	CTC	$5,000	$15,000	Cap outlay available	
	USFS		$100,000 Round 5 SNPLMA	$350,000 Round 6 SNPLMA	$350,000 Round 6 SNPLMA cont; $150 request Round 7
	CDFG			$24,000 Section 6 funds	$24,000 Section 6 funds

The AMWG will participate in most management activities specified in the plan while the TAG will be primarily responsible for implementing research and restoration, data management, and making technical recommendations to the AMWG. Actions in the plan that pertain to regulations will seek to integrate TYC conservation activities into basin-wide planning efforts such as the Pathway 2007 Regional Plan Update, the TRPA Shorezone EIS, and interagency shorezone project review. Finally, the Stewardship elements will address educational and outreach needs for the public and agency staff.

9.0 LITERATURE CITED

Baad, M. 1979. Rare Plant Status Report for *Rorippa subumbellata*. Report prepared for California Native Plant Society, CA.

Baad, M. 1978. Endangered Plant Species of El Dorado National Forest: A Report to the Forest Supervisor's Office. Placerville, CA.

California Native Plant Society. 2001. Inventory of Rare and Endangered Plants of California (sixth edition). Rare Plant Scientific Advisory Committee, David P. Tibor, Convening Editor. California Native Plant Society. Sacramento, CA. 388 pp.

California State Lands Commission. 2003. Tahoe Yellow Cress (*Rorippa subumbellata*) 2002 Annual Survey Report. Sacramento, CA.

California State Lands Commission. 2002. Tahoe Yellow Cress (*Rorippa subumbellata*) 2001 Annual Survey Report. Sacramento, CA.

California State Lands Commission. 1999. Synopsis of 1999 Tahoe Yellow Cress Annual Surveys. Sacramento, CA.

California State Lands Commission. 1998. Tahoe Yellow Cress Draft Biological Assessment. Sacramento, CA. 45 pp. plus appendices.

DeWoody, J. and V.D. Hipkins. 2004. Expanded evaluation of genetic diversity in Tahoe yellow cress (*Rorippa subumbellata*). USDA, Forest Service, National Forest Genetic Electrophoresis Laboratory. Placerville, CA.

DeWoody, J. and V.D. Hipkins. 2006. Genetic Monitoring of *Rorippa subumbellata* (Tahoe yellow cress): Analyzing Northeast Populations and Monitoring South Shore Populations. USDA, Forest Service, National Forest Genetic Electrophoresis Laboratory Project #194. Placerville, CA.

Ferreira, J.E. 1988. The Potential Effects of Pier Removal and Construction on *Rorippa subumbellata* Roll. at Ward Creek, Placer County, CA. Tahoe Regional Planning Agency, Zephyr Cove, NV. 35pp.

Ferreira, J.E. 1987. The Population Status and Phenological Characteristics of *Rorippa Subumbellata* Roll. at Lake Tahoe, California and Nevada, M.A. Thesis. California State University, Sacramento. Sacramento, CA.

Ingolia, M. 2006. Germination Ecology of an Endangered Endemic Plant in the Lake Tahoe Basin, *Rorippa subumbellata* Roll. (Tahoe Yellow Cress). M.S. Thesis. University of California, Davis.

Knapp, C.M. 1980. *Rorippa subumbellata* Roll. Status in the Lake Tahoe Basin. USDA, Forest Service, Lake Tahoe Basin Management Unit. South Lake Tahoe, CA.

Knapp, C.M. 1979. *Rorippa subumbellata* Roll.: Its Status on Historical and Potentially New Sites. USDA, Forest Service, Lake Tahoe Basin Management Unit. South Lake Tahoe, CA.

Nevada Natural Heritage Program. 2001. *Rorippa subumbellata* (Tahoe yellowcress): Site occurrences in the Lake Tahoe basin. Carson City, NV.

Pavlik, B.M. 1987. Autecological monitoring of endangered Plants. (In T. Elias, ed.) Rare and Endangered Plants: A California Conference. Proceedings of the Symposium. California Native Plant Society Special Publication 8:385-390. Sacramento, CA.

Pavlik, B.M. 2001. Developing an ecosystem perspective from experimental monitoring programs II. Physiological responses of a rare geothermal grass to soil water. Environmental Management 28:243-253.

Pavlik, B.M. and A.N. O'Leary. 2002. Implementation of the Conservation Strategy for Tahoe Yellow Cress (*Rorippa subumbellata*). II. Key Management Questions as a Framework for Research. Prepared for the Tahoe Yellow Cress Technical Advisory Group and the Tahoe Regional Planning Agency.

Pavlik, B., D. Murphy, and Tahoe Yellow Cress Technical Advisory Group. 2002a. Conservation Strategy for Tahoe Yellow Cress (*Rorippa subumbellata*). Tahoe Regional Planning Agency. Zephyr Cove, NV.

Pavlik, B., A. Stanton, and J. Childs. 2002b. Implementation of the Conservation Strategy for Tahoe Yellow Cress (*Rorippa subumbellata*): I. Seed Collection, Assessment of Reproductive Output, and Propagation for Reintroduction. Prepared for the Tahoe Yellow Cress Technical Advisory Group and the Tahoe Regional Planning Agency. Zephyr Cove, NV.

Pavlik, B., and A. Stanton. 2004. Implementation of the Conservation Strategy for Tahoe Yellow Cress (*Rorippa subumbellata*): III. Pilot Project to Support Reintroduction Experiments. Prepared for the Tahoe Yellow Cress Technical Advisory Group and the Tahoe Regional Planning Agency. Stateline, NV.

Pavlik, B., and A. Stanton. 2005. Implementation of the Conservation Strategy for Tahoe Yellow Cress (*Rorippa subumbellata*): IV. Experimental Reintroductions: Year One. Prepared for the Tahoe Yellow Cress Technical Advisory Group and the Tahoe Regional Planning Agency. Stateline, NV.

Reed, S. 1982. Sensitive Plant Interim Management Prescription for *Rorippa Subumbellata*, Roll. USDA, Forest Service, Lake Tahoe Basin Management Unit. South Lake Tahoe, CA.

Saich R.C. and V.D. Hipkins. 2000. Evaluation of genetic diversity in Tahoe yellow cress (*Rorippa subumbellata*). USDA, Forest Service, National Forest Genetic Electrophoresis Laboratory. Camino, CA.

Stanton, A., and B. Pavlik. 2006. Implementation of the Conservation Strategy for Tahoe Yellow Cress (*Rorippa subumbellata*): V. Experimental Reintroductions: Year Two. Prepared for the Tahoe Yellow Cress Technical Advisory Group and the Tahoe Regional Planning Agency. Stateline, NV.

USDA Forest Service. 2003. National Forest Genetic Electrophoresis Laboratory Standard Operating Procedures. Placerville, California.

10.0 APPENDICES

Appendix A: 2005 Annual Field Survey Form for ranked sites

TAHOE YELLOW CRESS *(Rorippa subumbellata)* FIELD SURVEY FORM FOR RANKED SITES

Survey date: _____

Surveyor: _____ Affiliation: _____

Email: _____ Telephone: _____

LOCATION (attach copy of quad map showing boundaries and pictures taken)

Site name: _____

USGS quad: S. Lake Tahoe Emerald Bay Meeks Bay Homewood Tahoe City Kings Beach Marlette Lake Glenbrook

County: El Dorado Placer Washoe Carson Douglas **Site ownership:** Private State Federal City/Local

Legal access: _____

TYC Present? Yes No Actual Number of Plants: _____ or Abundance Category: _____

1) 0 to 250 (conduct actual count)
2) 250 to 500
3) 500 to 1,000
4) 1,000 to 5,000
5) 5,000 to 10,000
6) 10,000 and above

Number of plants within cluster_____ Actual Number or Estimated Percentage in each phenological stage (circle one)

Juvenile: _____ Senescent: _____ Flowering: _____ Fruiting (may also be flowering): _____

Amount of person minutes spent in search? _____

Previous plant occurrence? Yes No Date plant last observed: _____

SITE BOUNDARY OR CLUSTER (individual clusters are equal to TYC that is within 13 m radius): (record additional clusters on back or on additional data sheets)

GPS Coordinates taken: (UTM NAD 27, Zone 11) – be specific about where the coordinates are from (centroid, endpoints, cluster, etc.)

Easting: _____ Northing: _____ Location: _____

Easting: _____ Northing: _____ Location: _____

Easting: _____ Northing: _____ Location: _____

Easting: _____ Northing: _____ Location: _____

LAND USES, IMPACTS, AND MANAGEMENT RECOMMENDATIONS

Cover of footprints within patch: <5% 5-25% 26-50% 51-75% >75%

Note vegetation removal, trash, recreational impacts, vandalism and/or other impacts:

_____

Enclosure effectiveness: good fair poor Comment: _____

Possible management actions and other notes:

Appendix B: 2005 Survey Protocols for Tahoe Yellow Cress Annual Surveys

For following protocol refers to the data sheet for unranked sites. For ranked sites, use the field form for ranked sites. Stems may be estimated at ranked sites and assigned an abundance category.

1-Survey Date: Date of on the ground survey work

2-Surveyor/E-mail/Affiliation/Telephone: At least list survey leader with their contact information (normally person who has conducted surveys in past); ideally list all participants and contact info. Contact information is very important to include in case questions arise about the survey data.

3-Location: This information will be filled out prior to survey for all known sites. When a new site is found fill out the information for Site name, Site ownership and Legal access.

4-TYC Present: Circle appropriate response after surveying site.

5-Actual number of stems, or estimated stems: After surveying the site this should be a total (or estimate when there are too many plants to count) of all the clusters found at each site.

6-Amount of person minutes spent in search: Total the time spent on each site, by each individual.

7-Previous plant occurrence: On site with a previous occurrence this will be filled out prior to the survey using the information from past surveys that is stored at NV natural heritage.

8-Date plant last observed: On site with a previous occurrence this will be filled out prior to the survey using the information from past surveys that is stored at NV natural heritage program (NNHP).

9-Cluster: If two clusters are separated by less than 13 m, consider them one cluster. For TYC clusters separated by a distance greater than 13 m, they should be treated as two separate clusters. Use exact measurement, if you can pace it off this is okay just be sure you and your team members are correct in pacing. Refer to 10-GPS coordinates below for additional information about working with and about the logic behind the cluster definition. Page one has space for the first cluster only. Space for clusters two and three can be found on page two, any additional clusters can be found on the additional cluster page; please fill in the cluster number in the blank after cluster.

10-GPS Coordinates: The preferred reading should be in Nad 27, zone 11, if you do not take a reading in this zone or datum make sure you indicate where it was taken. Because the site boundaries have been established, surveyors are only responsible for GPSing TYC clusters/individuals. Most of the GPS units we will be using are only accurate to within 3 to 9 meters (m) and for NNHP Biotics an error within about 6.5 m is acceptable. Therefore, for example, if you find a cluster that is less than 6.5 m in diameter, simply take a central point. For one cluster with a diameter larger than 6.5 m, endpoint or corner coordinates can be taken. If two clusters are separated by less than 13 m, consider them one cluster and either take one point on each of the outer edges or one central point. For TYC clusters separated by a distance greater than 13 m, they should be treated as two separate clusters, and GPS coordinates should be obtained for each cluster (either end points or central points). NNHP will keep track of these clusters, but they will be subsets of the overall population at that site. **It is critical to indicate what and where particular coordinates are from and if they are central points or endpoints in order to ensure proper data interpretation!** Drawing pictures is helpful as well. Additionally, if you take multiple points for clusters and outlying individuals within a site, document what data you have taken and how it should be interpreted by NNHP.

11- Number of plants in cluster__ Actual Number or Estimated Percentage in each phenological stage (circle one). Juvenile: _____ Senescent: _____ Flowering: _____ Fruiting (may also be flowering): _____ Min. Rosette Diameter (cm): _____ Max. Rosette Diameter (cm):

Record the actual or estimated number of plants within the cluster then circle actual number if you count each individual plant within the cluster or estimated percent if you estimate the phenology of the cluster. Then recorded the number/percent in each of the phenological stages.The last thing in the box is the min. and max. rosette size within the cluster.

12-Elevation/Lake Level: This information will be filled in by NNHP after the survey. If you know the information you can fill it in.

13-Distance to lake water line (meters): Measure meters to Lake Tahoe for each cluster. If there is another body of water closer note this also.

14-Sketch beach profile: Sketch the beach profile and any dominate markers that help to identify the site. Either draw in space provided or use back site of map. If have time, it is nice to also include a map of the locations of each cluster.

15-Substrate/soils: The size for each type of substrate is based on USDA's *Comparison of size particle classes* from the Field Book for Describing Sampling Soils version 2.0. Give a percentage to each category of substrate (make sure this adds up to 100%) for the area within the cluster to 0.3 meters outside of it. If you are unsure use a ruler to measure the substrate until you get a feel for it. It is also a good idea to do the first percentage estimate with the group to try to calibrate everyone into the percentage estimates.

16-Total Vegetation % cover: This is a measurement of how much % cover of vegetation is within each cluster to 0.3 m away from cluster.

17-Associated vegetation: Include any vegetation found within the cluster, include species when possible. Then include the percent cover of each of the species within the cluster; this should add up to 100%. Don't forget to include TYC.

18-Non-native species: Circle yes or no if there are any non-native species found within the cluster. Identify the non-native species with an * next to their names.

19-Land use and impacts: This data is for the whole site, not individual clusters.

20-Cover of footprints/Impacts to site: Record everything that you see within the site, especially if found within actual clusters.

21-Management actions/other notes: Use this for any suggestions or notes about abnormalities, for example, if a cluster of TYC is growing on a 50% slope recorded that information here.

Appendix C: Presence (X) and Absence (0) of Tahoe Yellow Cress (1978-2005)

(see separate file Appendix C.xls)

Appendix D: Five Year Management Plan (2004-2008)

Action	Entity	2004	2005	2006	2007	2008
Budget						
Implement Conservation Strategy						
	USFWS			$100,000	continued	
	BOR	$80,000	150,000	Applic expected		
	NDSP	$20,000 Lake Tahoe License Plate Funds	$20,000 Lake Tahoe License Plate Funds	$10,000 Lake Tahoe License Plate Funds		
	CTC	$5,000	$15,000 for 2004 annual report	Cap outlay available		
	USFS		$100,000 Round 5 SNPLMA	$350,000 Round 6 SNPLMA	$350,000 Round 6 SNPLMA cont; $150 request yr 2	
	CDFG			$24,000 section 6 mitigation research	$24,000 section 6 mitigation research	
Management						
AMWG meetings	AMWG	x	x	x	x	x
Establish adaptive management coordination process	AMWG			x		
Annual Executive meeting	Executive Committee	x	x	x	x	x
Annual survey	AMWG and partners	x	x	x	x	x
standardize data collection protocol	AMWG	x	x			
Develop survey protocols that detect meta-pop dynamic	AMWG			x		
standardize datasheets	NNHP, TAG	x	x			

Action	Entity	2004	2005	2006	2007	2008
TYC database and data dictionary	NNHP, TAG	x?	x	x	x	x
incorporate TYC database into TIMMS real-time database (site specific info?)	TRPA		x?	x	x	x
Add emergency fencing for high water protection (per imminent extinction plan) to all agency MOUs with TRPA	TRPA; USFS; CDPR; NDSP; CTC			x		
Annual report	BMP Ecosciences	x	x	x	x	x
Secure access to private lands for surveys and possible restoration	AMWG			x	x	
Appropriately sign all enclosures	USFS, DFR, NDP, CSLC			x		
Develop Site-Specific Information Template to replace Appendix J of the CS	CSLC		x			
Complete Site-Specific Information for private sites	CSLC; Stew subcomm		x	x		
Assist private stakeholders in drafting management plans				x	x	x
Do Site-Specific management plans for public sites	AMWG		x	x		
Update Site Rankings	TAG	x	x	x	x	x
Non-experimental Enclosure maintenance						
Meeks	USFS	x	x	x	x	x
Baldwin	USFS	x	x	x	x	x
Taylor	USFS	x	x	x	x	x
DL Bliss	CDPR	x	x	x	x	x
DL Bliss re-build fence and install TYC for educational purposes	CDPR		x	x		
Upper Truckee East	CTC	x	x	x	x	x
Investigate private land acquisition opportunities	CTC; USFS	x	x	x	x	x

Action	Entity	2004	2005	2006	2007	2008
Regulation						
TRPA Shorezone EIS	TRPA; AMWG review	x	x	x		
Review Environmental docs for public projects (BOR, DWR, TROA, EIS/EIRs)	AMWG	x	x	x	x	x
Review private landowner requirements in project review	AMWG, TLOA, TRPA	x	x	x	x	x
Coordinate w/ Interagency Shorezone Review Committee on project application review	TRPA; CSLC; CDFG; NDSL		x	x	x	x
P7 Environmental Threshold Review	TRPA;BMP Ecosciences; TAG		x	x	x	x
Determine experimental plant status re TRPA code				x		
Assess species' listing status	FWS; CDFG	x	x	x	x	x
Research						
Address KMQ framework in experimental designs	TAG; BMP Ecosciences	x	x			
Greenhouse propagation	USFS;NDF	x	x	x	x	x
Nursery oversight	BMP Ecosciences	x	x	x	x	
Soil analysis report	USFS; BMP Ecosciences			x		
Germination ecology studies	UCD; TAG	x	x			
Mitigation/translocation feasibility pilot year 1 with 03 and 04 cohort	BMP Ecosciences		x			
Mitigation/translocation feasibility experiment year 2 with 03, 04 and 05 cohort	BMP Ecosciences			x	x	

Action	Entity	2004	2005	2006	2007	2008
Experimental Enclosure - plant installation and maintenance						
Taylor (permanent fence)	USFS	x	x	x	x	x
Taylor (temporary fence)	USFS		x			
Nevada (perm)	USFS	x	x	x	x	x
Nevada (temp)	USFS	x	x	x	x	x
Zephyr Cove (perm)	USFS	x	x	x	x	x
Zephyr Cove (temp)	USFS	x	x	x		
Sand Harbor	NDSP	x	x	x		
Pope (temp fence)	USFS		x	x	x	x
Ebright (temp)	USFS		x	x	x	x
Hidden Beach (temp)	NDSP		x	x	x	x
Avalanche (temp)	CDPR	x	x			
Experimental monitoring-demographic and disturbance						
Taylor	USFS; BMP Ecosciences	x	x Yr3	x Yr4		
Upper Truckee East	CTC; BMP Ecosciences	x	x Yr2	x Y3		
Nevada	USFS; BMP Ecosciences	x	x Yr2	x Yr3		
Zephyr Cove	USFS; BMP Ecosciences	x	x Yr3	x Yr4		
Sand Harbor	NDSP; BMP Ecosciences	x	x Yr 3	x Yr4		
Pope	USFS; BMP Ecosciences		x Yr1	x Yr2		
Ebright	USFS; BMP Ecosciences		x Yr1	x Yr2		
Water relations monitoring	BMP Ecosciences	x	x	x	x	
Write Research report	BMP Ecosciences	x	x	x	x	
Develop microsatellite DNA techniques	UNR			x	x	x

Action	Entity	2004	2005	2006	2007	2008
Restoration						
Translate research results into restoration prescriptions					x	x
Test prescriptions at multiple sites					x	x
Large scale propagations for restoration purposes					x	x
Enhance Core populations to meet MVP						x
Enhance High priority populations to meet MVP						x
Implement new survey protocol to detect metapopulation dynamic						x
Stewardship						
Create education materials for public	AMWG w/UNCE			x	x	
TYC identification aids	AMWG			x		
Prep school materials	UNCE				x	x
Prep brochures		x	x	x	x	x
Tri-fold	CSLC					
Tourist Rack Card	CDFG					
Launch "Friends of TYC" group	TLOA & AMWG	x	x	x	x	x
Determine signage & fencing	AMWG & TRPA		x			
Develop "Pledge of Support"	CDFG	x	x	x		
Develop "Thank You"s				x		
Identify partners to sponsor actions	TLOA & AMWG	x		x		
Work with visitor bureaus & motels to distribute info	TLOA & AMWG			x	x	
Conduct education forums for landowners, contractors, etc	UNCE, TLOA & AMWG			x	x	

Action	Entity	2004	2005	2006	2007	2008
Contract with University of Nevada Reno Cooperative Extension to develop educational materials	AMWG			x	x	
Report on successes in conserving TYC	AMWG			x	x	x

Appendix E: Tahoe Yellow Cress Site-Specific Information Sheet Example

Tahoe Yellow Cress Site-Specific Information: Dollar Point (934)

Prepared by: Eric Gillies, California State Lands Commission (CSLC), in collaboration with the Tahoe Yellow Cress Technical Advisory Group (TAG)

Date: May 10, 2005 (rev. _____)

County/State: Placer County, California

Location: Tahoe City Public Utility District (TCPUD) Recreation Area (public access point), Lake Forest, The Northshore, and Dollar Point private residential areas off North Lake Blvd (Highway 28) northeast of Tahoe City

Ownership/Management: Private (approx. 12 individual parcels) and TCPUD

Contact Information: Eric Gillies, CSLC, (916) 574-1897, gilliee@slc.ca.gov

Meets Ranking Criteria: Yes, surveyed 14 consecutive years with 2 NS events (Table 1)

Viability Index and Rank: unranked (2000); -8, Medium Priority Restoration Site (2004)

Lake Elevation Persistence: Low only

TRPA Threshold Site: No. The site should count toward maintaining a minimum number of populated sites (26 sites); however, if conducting a threshold attainment evaluation during a high water year (>6224 ft LTD), the population would not be persistent due to inundation.

Site Description

The Dollar Point site has several scattered Tahoe yellow cress populations located along the approximate 1.6-kilometer shoreline reach. The shoreline reach is from TCPUD Recreation Area on the west to approximately 500 meters west of Dollar Point on the east (see attached map). Because of the great distant between the eastern and western clusters and each having different habitat characteristics, this site may warrant splitting into two. The historic population is the eastern clusters and the western clusters were first observed in 2002.

Survey History

Table 1 provides a summary of the survey history and results for the Dollar Point site. This Tahoe yellow cress site was first observed in 1991 and was observed in 1993 and 1994, which was within a

low water period. Plants were not observed from 1995 to 2001, which, except for 2001, was a high water period. The site was not surveyed in 1992 and 1999. Plants have been observed in 2002, 2003, and 2004. Surveys have occurred over one full high/low lake elevation cycle. Currently, its persistence is at 50% (6 out of 12 years).

Table 1. Tahoe Yellow Cress Annual Survey Summary – Dollar Point

Year	Lake Elev. (ft. LTD)	Survey Data	Stem Count	Comment
1991	6222	X	n/a	1st year of site record
1992	6223	NS	-	
1993	6223	X	191	1993 Shorezone Survey data
1994	6222	X	n/a	
1995	6227	0	-	
1996	6227	0	-	
1997	6228	0	-	6 year high lake elevation period
1998	6228	0	-	
1999	6228	NS	-	
2000	6228	0	-	
2001	6225	0	-	Lake elevation transition year (high to low)
2002	6224	X	10	Western cluster near TCPUD Recreation Area 1st observed
2003	6224	X	83	
2004	6223	X	315	

X = present; 0 = absent; NS = not surveyed

Population and Ecological Characteristics

During the comprehensive 1993 Shorezone Survey, 191 stems were observed. The population in 2002 had only 10 stems, which was a year following a period of high water years, 1995 to 2000, and a transition year, 2001 (Table 1). In 2004, with lake elevation falling below 6223 ft Lake Tahoe Datum (LTD), 315 stems where observed in several clusters. Presently, this site appears to persist when lake elevation is at or below 6224 ft LTD and has greater abundance when lake elevation is 6223 ft LTD and below.

The population on the west end near the TCPUD Recreation Area is typically very small with few plants (<10). The substrate has little sand (<10%) and is mostly fine to medium gravel (>85 %) on a relatively flat shoreline (1-2 % slope). Associated species include *Epilobium* spp., willow (*Salix* spp.), and *Trifolium* spp. with 20-50% total vegetative cover. The cluster's distance to the lake in 2004 (lake elevation 6223 ft LTD) was 25 to 35 meters.

The population clusters at the east end are more extensive and in different habitat. The substrate is mostly sandy and fine gravel (>85%) with larger gravels to large cobbles making up the rest of the beach substrate. Associated species include pigweed (*Chenopodium* spp.), mullein (*Verbascum thapsus*), sweet clover (*Melilotus alba*) and some willow saplings. The beach has overall low vegetation cover (10-15%) in strips paralleling the shoreline. Tahoe yellow cress has been observed within the understory of large mullein and sweet clover plants. The sandy and fine gravel beach begins to narrow and become very limited with cobbles beginning to dominate the substrate with denser weedy species such as clover (*Lotus purshianus*) as the shoreline begins to bend around the

point. The cluster's distance to the lake in 2004 (lake elevation 6223 ft LTD) was typically about 5 meters.

There is approximately 800-meter stretch of shoreline between the west and east clusters, where plants are not observed. This stretch is a steep sloping beach with no vegetation and the substrate consists of 100% fine to medium gravel. Its characteristics are very dissimilar to locations where the plants are observed and described above.

Potential Threats/Concerns (ranked in order of significance)

1. High lake elevation levels (>6224 ft LTD)
2. Recreation (beaching watercrafts and foot traffic/beach use)
3. Shoreline projects (private piers, revetment, and utility projects)

Past Activities

No Tahoe yellow cress conservation actions have occurred in the area.

Present Activities

The area has been surveyed for shorezone projects including shoreline revetment projects. In 2003, TCPUD did some sewer line repair and revetment work adjacent to some of the populations. Plants were found growing against the silt fences during the 2003 survey. Construction activities did not appear to have a detrimental effect since nearly four times the number of plants were observed in the following year. There is a moderate amount of shoreline development that can occur in or around the clusters. Shoreline project approving agencies need to ensure pre-construction surveys for Tahoe yellow cress are conducted, which is required under CSLC lease agreements; however, not all shoreline projects require a lease form CSLC, e.g., revetment projects.

Recreational use is moderate to heavy during the summer months. Temporary fencing of the clusters similarly designed at Sugar Pine Point or signage during low water years and when the plants are present may be a strategy for the area. The TAG Stewardship Subcommittee needs to strategize on how to outreach to the private landowners and have them consider entering into Voluntary Conservation Agreements.

Recommendations:

- Site will continue to be part of the annual surveys, although surveys probably do not need to occur when lake elevation is above 6225 ft LTD. This should be confirmed early into the next high water or transition period.
- Initiate outreaching efforts to the private landowners and have them consider entering into Voluntary Conservation Agreements.
- Although the site is a medium priority for restoration efforts, the site is highly susceptible to high lake levels and there would need to be support from the many private landowners.

Appendix F: Site-Specific Information Sheet assignments for 2005

Agency	# of Sites Assigned
California State Lands Commission (CSLC)	17
United States Forest Service (USFS)	15
California Dept of Parks and Recreation (CDPR)	9
California Tahoe Conservancy (CTC)	7
Nevada Division of State Parks (NDSP)	5
Tahoe Regional Planning Agency (TRPA)	4

SITE NAME	NNHP EO NUMBER	OWNERSHIP/YEAR ELEVATION	SITE-SPECIFIC INFORMATION ASSIGNMENTS
Sunnyside	929	Private/Placer Co	CSLC
Ward Creek	921	Private	CSLC (in prep)
Hurricane Bay		Private	negative data
Kaspian Campground	901	USFS	USFS
Blackwood North		Private	CSLC
Blackwood South	919	Private/Placer Co	CSLC
Tahoe Pines (Fleur Du Lac)		Private	CSLC
Cherry Street/Tahoe Swiss Village	937	Private	CSLC
McKinney North/ Shores		Private	CSLC (in prep)
McKinney Creek	928	Private	CSLC (in prep)
Tahoma	918	Private	CSLC
Sugar Pine Point State Park		CA State Parks	CDPR (in prep)
Meeks Bay	917	USFS	USFS
Meeks Bay Vista	910	Private	CDPR
Rubicon Bay	936	Private	CDPR
DL Bliss State Park & Enclosure	916	CA State Parks	CDPR
Emerald Point	924	CA State Parks	CDPR
Emerald Bay Boat Camp	914	CA State Parks	CDPR
Eagle Creek/Avalanche	915	CA State Parks	CDPR
Eagle Point	927	CA State Parks	CDPR
CTC Cascade Creek		CTC	CTC
Cascade	925	Private	CTC
Tallac Enclosure & Tallac Creek	912	USFS	USFS
Baldwin Beach	931	USFS	USFS
Taylor Creek & Enclosure	911	USFS	USFS
Kiva Beach/Valhalla	913	USFS	USFS
Jameson		Private	negative data
Pope Beach	909	USFS	USFS
Lighthouse	938	Private	CTC
Tahoe Keys	926	Private	CTC
Upper Truckee West	908	CTC	CTC
Upper Truckee East	907	CTC	CTC
Regan/Al Tahoe	905	Private/City SLT	CTC
El Dorado Beach	906	City SLT	CSLC

SITE NAME	NNHP EO	OWNERSHIP/YEAR	SITE-SPECIFIC INFORMATION
Bijou (Timber Cove Lodge)	903	Public	CSLC
Timber Cove	904	Private	CSLC
Tahoe Meadows	902	Private	CSLC
Edgewood	2	Private	USFS
4-H Camp/City Pump House	1	UNR/City	USFS
Kahle/Nevada & Enclosure	8	USFS	USFS
Elk Point	14	Private	TRPA
Roundhill	9	USFS	USFS
Marla Bay		Private	TRPA
Zephyr Cove	11	Private/USFS	USFS
Skyland	5	Private	NDSP
Cave Rock	17	NV State Parks	NDSP
Logan Shoals	10 & 6	Private	TRPA
Glenbrook	4	Private	TRPA
Skunk Harbor	16	USFS	USFS
Secret Harbor	12	NV State Parks	NDSP
Chimney Rock	13	USFS	USFS
Sand Harbor	3	NV State Parks	NDSP
Hidden Beach		NV State Parks	NDSP
Burnt Cedar Beach		IVGID	USFS
Crystal Point	933	Private/Placer Co	CSLC
Kings Beach	932	Private/Public	CSLC
Agate Bay	920	Private	CSLC
Dollar Point	934	Private	CSLC (completed)

Appendix G: Agency Management Activity Report Forms for 2005

US Forest Service (USFS)
US Fish and Wildlife Service (USFWS)
Tahoe Regional Planning Agency (TRPA)
California State Lands Commission (CSLC)
California Department of Fish and Game (CDFG)
California Department of Parks and Recreation (CDPR)
California Tahoe Conservancy (CTC)
Nevada Natural Heritage Program (NNHP)
Nevada Division of Forestry (NDF)

US Forest Service Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **December 31** of each year.

Please complete the following fields. Press the tab key to scroll from field to field:

Enter name of reporting agency:	Lake Tahoe Basin Management Unit
Reporting period:	January 1 through December 31, 2005
Enter date report submitted to TAG:	January 23, 2006

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
Ebrights Ski Beach	Outplanting, Monitoring of outplanted plants, Data Entry	120	7,500
Taylor Creek	Outplanting, Monitoring of outplanted plants, Data Entry	120	7,500
Pope Beach	Outplanting, Monitoring of outplanted plants, Data Entry	120	7,500
Nevada Beach	Outplanting, Monitoring of outplanted plants, Data Entry	120	7,500
Zephyr Cove	Monitoring of outplanted plants, Data Entry	100	6,000
All Forest service beaches (minus Zephyr)	Annual Survey	120	4,500
	Site Specific Conservation Activities Totals	700	40,500

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
TAG participation	100	3,000
Initiation of interagency agreement for genetic work, and review of initial report	30	1000
Initiation of work involved to contract out 2006 money	30	1000
USFS site notebook update to include TYC	20	750
BE to complete outplanting at Ebrights and Pope	100	3,900
General Conservation Activities Totals	280	9650

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)
None			
	Totals		

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year:

Continuation with outplanting study

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:
No projects were implemented during reporting period, however several projects were surveyed for and will be implemented in following reporting period (such as those listed)	New bathrooms on several beaches, GID improvement at Roundhill, Master Plan revision at Zephyr Cove, and renewal of permit at Roundhill (most if not all of these will happen during the 2006 calendar year)

US Fish and Wildlife Service Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **December 31** of each year.

Please complete the following fields. Press the tab key to scroll from field to field:

Enter name of reporting agency:	US Fish and Wildlife Service
Reporting period:	January 1 through December 31, 2005
Enter date report submitted to TAG:	02/13/06

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
N/A			
	Site Specific Conservation Activities Totals		

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
TAG/Exec Meeting Participation	40	$3,000
Annual Field Survey	30	$2,250
General Conservation Activities Totals	70	$5,250

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)
	Totals		

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year:

AMWG, TAG, Annual Survey, Exec Meeting

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:
N/A	

Tahoe Regional Planning Agency Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **December 31** of each year.

Please complete the following fields. Press the tab key to scroll from field to field:

Enter name of reporting agency:	Tahoe Regional Planning Agency
Reporting period:	January 1 through December 31, 2005
Enter date report submitted to TAG:	March 9, 2006

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
N/A	N/A	N/A	N/A
	Site Specific Conservation Activities Totals		

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
Conservation Strategy Participation (Mike Vollmer, Rita Whitney)	90	$3,486
Contract Administration (Mike Vollmer, Rita Whitney)	110	$4,260
General Conservation Activities Totals	200	$7,746

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)
N/A	N/A	N/A	N/A
	Totals		

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year:

Continued participation in the Tahoe Yellow Cress Advisory Group or Adaptive Management Working Group

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:
Projects on parcels with known habitat	
3655 Idlewild	BMP Retrofit; APN 085-190-01
Projects on parcels with potential habitat	
Water's Edge Association	QE for replacement of deck; APN 015-351-01
Lake Tahoe Park Association	QE to repair of wall pilings; APN 083-100-03
John Lovewell	Single family dwelling tear down rebuild; APN 083-162-26
None (Applicant: Tahoe Swiss Village Homeowners)	Beach Recreation. Stabilization or eroding shorezone to minimize erosion of the upland, improve water quality, and provide long term protection from wave action to upland improvements, uses, and features per condition with TRPA staff; APN 085-020-80
Bernice Hogan	QE to repair existing catwalk; ANP 085-030-15
Nancy Wiedemann	Minor rev of residential property; APN 085-202-05
Fleur Du Lac Estates Association	QE for replacement of 4 timber piles with black steel piles; APN 85-400-36
Richard and Lorraine Whitehurst	QE for roof over existing deck at entrance to residence and QE for cover over garage stairs; Relocate walkway coverage for new entry deck – banking 69 sf of Class 6 coverage; APN 092-142-15
Omeah Limited Partnership	Single family dwelling exist major rev; APN 092-200-14
Lakehouse Mall Properties	Plan revision to fire rebuild permit; APN 094-090-10
Steven Merrill	Pier structural repair; APN 094-140-07
US Coast Guard	Plan revision to clean up coverage violations; APN 094-140-15
Gifford Investments Inc.	Minor plan revision to move one wall on lake side back 5 feet and increase size of boiler room within footprint of prior excavation; APN 094-140-20
Fred Toney	QE to replace 9 wooden piles with natural wood colored piles; ANP 094-150-23
Frank Berlogar	Reviewed with permit acknowledgement to file 20030066 for grading due to sewer line replacement; APN 094-273-12
Tahoe Marina Lodge	QE for beach recreation (piers); APN 094-510-02
West Lake Associates	Single family dwelling BMP retrofit; APN 097-164-06
Brown Estate Property	QE for beach recreation (pier repair); APN 097-182-01
KB Foster Civil Engineering	Single family dwelling BMP retrofit; APN 115-020-07
Crystal Shores Village Association	Recreational boating. Dredging and slip replacement; APN 122-060-01
Nancy Binz Trust	Single family dwelling addition expansion; APN 122-181-44
David and Linda Shaheen	Single family dwelling exist rebuild; APN 123-101-08
Van Dyck Pier Repair	QE Pier repair; APN 123-101-09
Otto J. Miller	Residential addition expansion; APN 123-132-01
Johnson Family Revocable Trust	Single family dwelling grading; APN 1318-09-701-002
Granite Bay Holdings	Refacing of existing garage and existing block fence; APN 1418-27-210-012
Cave Rock Sliding Dock Replacement	Rebuild boat launching facilities (pier); APN 1418-27-401-001
Brad Schiller	Single family dwelling addition expansion; APN 1418-34-110-002

California State Lands Commission Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **December 31** of each year.

Please complete the following fields. Press the tab key to scroll from field to field:

Enter name of reporting agency:	California State Lands Commission
Reporting period:	January 1, 2005 through December 31, 2005
Enter date report submitted to TAG:	January 30, 2006

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
	Site Specific Conservation Activities Totals		

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
TYC TAG	77	8,300
TYC Brochure	6	650
Site-Specific Plans	50	5,400
Site Ranking	3	325
Shorezone Project Planning/Review	84	9,070
TYC Executive Meeting	15	1,620
General Conservation Activities Totals	235	20,505

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)
	Totals		

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year (2006):

- Finishing and maintaining Site-Specific Information sheets for all TYC sites
- Continued Participation on TAG, AMWG, and Exec meetings
- Participating in 2006 Annual Survey
- Continue Shorezone Project Review and Agency Coordination

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:

California Department of Fish and Game Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **December 31** of each year.

Please complete the following fields. Press the tab key to scroll from field to field:

Enter name of reporting agency:	California Department of Fish & Game
Reporting period:	January 1 through December 31, 2005
Enter date report submitted to TAG:	Too late (March 7, 2006)

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
N/A			
	Site Specific Conservation Activities Totals		

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
TAG meeting prep & participation	136	$6600
TYC Exec meeting prep & participation	16	$800
Stewardship activities	64	$3000
TYC surveys	70	$2600
Contract coordination	48	$2200
General Conservation Activities Totals	334	$15,200

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)
N/A			
	Totals		

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year:

Continued work with AMWG and others as needed

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:
N/A	

California Department of Parks and Recreation Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, by January 1 of each year, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **November 1** of each year.

Please complete the following fields. Press the tab key to scroll from field to filed:

Enter name of reporting agency:	
Reporting period:	January 1 through December 31, 2005
Enter date report submitted to TAG:	

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
	Site Specific Conservation Activities Totals		

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
General Conservation Activities Totals		

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)

	Totals		

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year:

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:

California Tahoe Conservancy Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **December 31** of each year.

Please complete the following fields. Press the tab key to scroll from field to field:

Enter name of reporting agency:	California Tahoe Conservancy
Reporting period:	January 1 through December 31, 2005
Enter date report submitted to TAG:	January 30, 2006

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
Upper Truckee East	CTC crews planted TYC for outplanting research project.	88	$1,350
Upper Truckee East	CTC crews completed barbed wire fence removal and fence maintenance activities.	26	$400
	Site Specific Conservation Activities Totals	114	$1,750

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
Public Outreach – Upper Truckee Marsh Stewardship	360	$6,000
TAG Participation and meeting preparation	40	$1,600
Annual Reporting	20	$800
Annual Site Surveys	24	$960
Site Specific Forms	40	$1,600
General Conservation Activities Totals	484	$10,960

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)
Upper Truckee East	December 31, 2005 – significant rain-on-snow event resulted in Trout Creek breach of barrier beach in historic location. This event resulted in loss of some of the experimental population located at this site. As this is a natural event, no response was initiated other than monitoring.	8	$320
	Totals	8	$320

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year:

- TYC onsite management activities (includes fence and sign maintenance)
- TYC interpretative signs development and installation
- Participation in TYC TAG activities
- Continued presence of onsite land steward at Upper Truckee East
- Assist with outplanting efforts
- Conducting annual surveys and reporting

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:
None during 2005.	

Nevada Natural Heritage Program Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **December 31** of each year.

Please complete the following fields. Press the tab key to scroll from field to field:

Enter name of reporting agency:	Nevada Natural Heritage Program
Reporting period:	January 1 through December 31, 2005
Enter date report submitted to TAG:	19 January 2006

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
	Site Specific Conservation Activities Totals		

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
Comprehensive update and reconciliation of all TYC sites through 2004	120	3960
Attendance at TAG meetings	10	330
Update, revise, and provide annual TYC survey form	20	660
Provide GIS map for annual report	5	165
Provide summary information and photocopied reports and documents for site specific management plans	20	660
General Conservation Activities Totals	175	5775

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)
	Totals		

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year:

Update the database with 2005 and 2006 data; provide GIS map for annual report; attend TYC TAG meetings when possible; provide 2006 data forms for site specific surveys.

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:

Nevada Division of Forestry Annual Report
Agency Tahoe Yellow Cress Conservation Activities

As agreed to in the Tahoe Yellow Cress (TYC) Conservation Agreement, the TYC Technical Advisory Committee (TAC) shall prepare an annual report describing the status of TYC. A component of the annual report is a reporting by each of the participating agencies on TYC conservation activities undertaken or planned for the future

This form provides a standardize format to assist management agencies in submitting their annual report to the TAG. This report should be completed by each management agency and submitted to the TYC TAG no later than **December 31** of each year.

Please complete the following fields. Press the tab key to scroll from field to field:

Enter name of reporting agency:	Nevada Division of Forestry
Reporting period:	January 1 through December 31, 2005
Enter date report submitted to TAG:	January 30, 2005

Describe in the table below site-specific conservation activities for each TYC site within the agency's jurisdiction undertaken during the previous growing season. Please use site names as listed in the TYC Conservation Strategy:

List TYC site name:	Describe site specific activities:	Staff hours involved	Cost (include staff time and other costs)
Sand Harbor	Outplanting	6	$168
Sand Harbor	Monitoring Outplanting	3	$84
Sand Harbor	Annual Survey	2	$56
Upper Truckee East/West	Annual Survey	4	$112
Hidden Beach	Annual Survey	2	$56
Agate Bay	Annual Survey	2	$56
Kings Beach	Annual Survey	2	$56
	Site Specific Conservation Activities Totals	21	$588

Describe in the field below general TYC conservation activities undertaken by the agency during the reporting period (i.e. public outreach, consultation, TAG participation, etc.):

Describe general conservation activities:	Staff hours involved	Cost (include staff time and other costs)
Nursery	36	$507
TAG Participation	32	$896
General Conservation Activities Totals	68	$1403

Please describe in the field below any significant disturbances to the species or its habitat on land within agencies jurisdiction and subsequent response:

List TYC site name:	Describe disturbance and response:	Staff hours involved	Cost (include staff time and other costs)
	Totals		

Please describe in the field below planned TYC conservation activities anticipated for the upcoming year:

List and describe in the table below all shorezone projects within the agency's jurisdiction undertaken within potentially suitable TYC habitat:

Project Name (list below):	Project Description including location:
Crystal Shores Villas Marina	Maintenance Dredging and Slip/Floating Dock Replacement APN 122-060-01 through 22, Washoe County Authorization issued by NDSL on October 4, 2005
Elk Point Marina	Maintenance Dredging APN 1318-16-801-001, Douglas County Authorization issued by NDSL on June 28, 2005