Tahoe Yellow Cress (*Rorippa subumbellata*)
Final 2003 Annual Report
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Prepared for:
Technical Advisory Group
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EXECUTIVE SUMMARY

Tahoe yellow cress (*Rorippa subumbellata* Roll.) is a rare plant 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 listed as critically endangered in Nevada (Nevada Revised Statutes 527.260 *et seq.*). The U.S. Fish and Wildlife Service identified Tahoe yellow cress as a candidate species for listing in 1999 under the Endangered Species Act of 1973, as amended, indicating sufficient information on biological vulnerability and threats are available to support a listing proposal (64 FR 57533). The Tahoe Regional Planning Agency also protects this species under its Code of Ordinances.

Because of the imperiled status of the Tahoe yellow cress, conservation efforts have been undertaken to recover the species and ensure its long-term survival. A conservation strategy was completed in 2003 that identifies goals and objectives to meet the recovery needs of the species. These goals and objectives, the research agenda, and other associated activities identified in the conservation strategy, together with an effective adaptive management process, assists land and resource managers in making informed, practical decisions by filling in data gaps and providing an ever increasing knowledge base.

A relatively long survey record has been compiled for this species, beginning in 1978 through the present. Annual surveys are conducted as part of the conservation strategy to determine population numbers, site occupancy, and general disturbance regime. During the 2003 annual survey period, the lake level was approximately 6,224 feet (ft; 1,897 meters [m]). This was the third consecutive year of low water. The survey located Tahoe yellow cress at 45 of the 69 sites surveyed (65 percent occupied), up from 19 percent of sites occupied in 2000 when the lake level was high at 6,228 ft (1,898 m). Approximately 25,200 stems were counted or estimated in 2003, whereas during the 2000 annual survey, the estimated number of stems was 4,590. Surveyors dedicated more than 170 person hours on the search effort, more than double what has been expended in previous years. Over the past 3 years, the survey effort has increased considerably, largely due to the conservation priority of the species being elevated.

Data analyses performed for the strategy established site rankings for the purposes of identifying conservation, restoration, and management priorities. Based on a calculated index of viability, sites were categorized as core, high, medium, and low priority. Pursuant to the strategy, site rankings were revised to incorporate data collected through 2003, which now encompasses two complete cycles of high and low lake elevations. Five sites were promoted in rank, 2 were demoted, and 13 remained unranked either because they were considered new or they do not meet the minimum data requirement to apply the index of viability calculation.

Conservation activities that were implemented in 2003 as part of the conservation strategy included, but were not limited to, seed collection, greenhouse propagation, and an expanded genetics analysis, all of which were in support of the pilot experimental outplanting project that will inform future research specific to restoration and/or augmentation of Tahoe yellow cress sites. Preliminary results of these efforts show that outplanting may be a feasible and practical approach to facilitate long-term survival of the species in the face of imminent threats from various land uses. Activities anticipated for 2004 would be commensurate with those conducted in 2003 including annual surveys, an

expanded scientifically designed outplanting study, and further development and implementation of the stewardship program designed to engage private landowners willing to participate in the conservation of Tahoe yellow cress.

The data obtained each year through annual surveys and other conservation actions are used to guide regulatory and land management agencies in their conservation and management efforts regarding Tahoe yellow cress and its habitat. Continued commitments from stakeholders and successful implementation of the conservation strategy should preclude the need for the U.S. Fish and Wildlife Service to list the Tahoe yellow cress under the Endangered Species Act and potentially remove the species from the candidate list.

1. INTRODUCTION

Tahoe yellow cress (*Rorippa subumbellata* Roll.) is a rare plant species endemic to the shores of Lake Tahoe in California and Nevada. This low-growing, perennial species evolved in the dynamic lakeshore environment, and its presence and absence in any given year correlate directly with fluctuating lake levels (Pavlik *et al.* 2002a). The long-term, continued existence of Tahoe yellow cress is threatened by increasing human activities within the shorezone, especially when coupled with artificially manipulated lake levels.

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).

A relatively long survey record has been compiled for this species, beginning in 1978 through the present. In 1993, a low-water year when lake elevation averaged 6,223 feet (ft; 1,896 meters [m]), plants numbering in the thousands were documented at 35 general locations, the largest number of occurrences ever documented in one year (California State Lands Commission [CSLC] 1998). The latter part of the 1990s saw higher lake levels and the number of occupied sites declined, apparently due to habitat inundation and other factors. Information indicates that high lake levels result in increased, concentrated recreational use in the higher elevation habitats that negatively affects plant populations through soil disturbance and trampling of individuals. In 1995, only 8 of the 35 generalized locations known from 1993 were occupied. While lake-wide surveys were not conducted in 1996, surveys of the 15 sites most likely to support plants revealed the presence of only 5 occupied sites (CSLC 1998).

In 1997, CSLC took the initiative to coordinate multi-agency lake-wide surveys to be conducted annually. Results of surveys conducted between 1997 and 2000 followed similar patterns of low occupancy for years with high lake levels; an average of 38 sites were surveyed each year during this time period, and only 8 to 14 sites supported the species (Pavlik *et al.* 2002a). Lake levels began to recede in 1999, and by the 2001 growing season, the lake elevation was near the natural rim, exposing hundreds of acres of habitat. During the 2001 surveys, of 58 sites visited, 30 sites had been colonized (CSLC 2002). In 2002, which saw the lowest recorded lake levels since 1994, survey efforts were intensified and of the 71 sites surveyed, 48 supported Tahoe yellow cress (CSLC 2003). These data demonstrate the natural fluctuations of Tahoe yellow cress occurrences are a function, in part, of lake elevation and available habitat (Pavlik *et al.* 2002a). It should also be noted that as the conservation priority for this species has increased over the years, so too has the survey effort. Thus, data from the early years of the record may not accurately reflect the distribution of the species around the lake because of less intensive search efforts.

Evidence suggests that while this species is well adapted to a dynamic environment, the combined effects of sustained high lake levels and increased human use of shorezone habitats can result in

precipitous declines in the number of sites occupied by Tahoe yellow cress. Because of the magnitude of threats facing the species, the 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). Implementation of the CS is currently underway, and management and conservation direction will be assessed each year subsequent to the annual surveys. This annual report is being submitted as a requirement of the CS and MOU/CA.

2. 2003 FIELD SURVEYS

2.1 METHODS

Various surveys and studies of Tahoe yellow cress have been conducted on the beaches around Lake Tahoe since 1978. Many historic locations of Tahoe yellow cress have been well documented, providing long-term presence/absence data for the region (CSLC 2003, 2002, 1999, 1998; Ferreira 1988, 1987; Reed 1982; Knapp 1980, 1979; Baad 1979, 1978). However, inconsistencies in survey methods over the years (i.e., non-consecutive survey years, incomplete surveys, and variable sampling methodology) have made direct comparisons of data difficult. Also, the naming convention for the sites has been at issue over the years; therefore, an effort was made prior to the 2003 survey to reconcile site names with previous year's data. As a result, some sites were combined and some were separated based on the presence of enclosures.

As part of the CS, a protocol was developed and implemented that includes a census of known populations and systematic searches of areas supporting unoccupied, potentially suitable habitat (Pavlik *et al.* 2002a). Beginning in 2001, the annual survey was designed to expand on previous efforts through the collection of data on habitat variables that will assist in elucidating the distribution patterns and abundance of Tahoe yellow cress. The program initially included the use of archival and annual survey sheets. The archival survey sheet was designed to record important biotic and abiotic environmental data that are unlikely to vary significantly over time. The annual survey sheet was used to collect information on population census and other dynamic habitat variables. After the 2001 and 2002 field seasons, the TAG determined that much of the information was redundant between the two data sheets; therefore, in 2003, integrating pertinent fields into the annual data sheet eliminated the need for the archival data sheet. Data requirements were subsequently condensed into a two-page field survey form with an attached map (Appendix A). The survey protocol has also been refined each year since its inception in 2001 and is described in its current form in Appendix B of this document. (See Appendix N of the CS for a description of the initial protocol and original data sheets.)

The 2003 lake-wide survey for Tahoe yellow cress was conducted on September 2 through September 5, 2003. Participants included: Mike Vollmer (Tahoe Regional Planning Agency [TRPA]); Jody Fraser (USFWS); Gail Durham, Shana Gross, Beth Brenneman, and Amanda Hardman (U.S. Forest Service [USFS]); Jay Howard and Cheryl Surface (Nevada Division of State Parks [NDSP]); John Copeland (Nevada Division of Forestry [NDF]); Jennifer Newmark (NNHP); Daniel Burmester, Harry Spanglet, and Susan Levitsky (California Department of Fish and Game [CDFG]); Tamara Sasaki, Scott Scheibner, Nancy Lozano, and Gemma Von Knopka (California

Department of Parks and Recreation [CDPR]); Eric Gillies and Maurya Falkner (CSLC); Curtis Hagen (California Department of Water Resources); and Jan Brisco (Tahoe Lakefront Owners' Association [TLOA]). Alison Stanton (BMP Ecosciences) led the seed collection effort, and Valerie Hipkins and Jennifer DeWoody (National Forest Genetic Electrophoresis Laboratory [NFGEL]) collected vegetative material for genetic analysis. (See 2003 Conservation Activities below for seed collection and genetics activities.) This high level of participation is similar to that contributed in the previous 2 years.

Participants were divided into five teams. The teams surveyed 69 known, historical, and potential habitat sites (based on the 2003 naming convention) by covering 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. Site boundaries were delineated using Global Positioning System (GPS) technology. Site boundaries, in general, are defined either by natural (i.e., river mouth or substrate change) or artificial features that restrict the surveyor's lateral movement across the shorezone (i.e., changes in ownership, jetties, fences).

For sites supporting Tahoe yellow cress surveyors estimated general habitat parameters across the entire site, with GPS data obtained for each Tahoe yellow cress "cluster" within the site boundaries. To better characterize the occupied habitat, the TAG determined that physical and biological attributes should be recorded for each individual cluster. A cluster is defined as a group of plants that occur within 21 ft (6.5 m) diameter of each other. This distance equates to the resolution capability for point data using handheld GPS units. Information specific to each cluster was also collected including the actual or estimated number plants, actual or estimated of plants in each phenological stage, and minimum and maximum rosette diameter. Additional physical and biological attributes were recorded for each cluster including slope, distance to lake, substrate/soil composition, and percent cover of associated plant species. Data for each cluster were collected using GPS and a map was drawn showing cluster locations in relation to beach profile. All annual survey forms, including GPS data, were provided to NNHP for addition to the statewide GIS database and are available upon request.

2.2 RESULTS

The lake level was approximately 6,224 ft (1,897 m) during the survey period. This was the third consecutive year of low water. The goal of the 2003 survey effort was to add to the existing record in a comprehensive manner by covering as much of the shorezone as possible, as opposed to limiting the survey to a subset of the known and potentially suitable sites, a method recommended in the CS and the previous annual report (CSLC 2003). Obtaining a consistent level of survey data for multiple years of low lake elevation will assist land managers in identifying and prioritizing conservation actions in future years. All but five sites were surveyed; four of these were on private lands for which access was not granted: Elk Point, Skyland, Logan Shoals Vista, and Logan Shoals. The Tallac Lake site was not surveyed because it is thought to either be an erroneous record or extirpated.

Figure 1 provides a comprehensive map of the shorezone coverage, site boundaries, and presence or absence of Tahoe yellow cress during 2003. Table 1 shows the person minutes dedicated to the

surveys for the past 3 years. In 2003, surveyors spent more than 10,000 person minutes during the surveys (Table 1 and 3), which amounts to over 173 person hours, more than double what has been expended in previous years. In general, more time is spent per core site because these sites typically support the highest number of plants and cover the largest areas (1,865 person minutes for 6 sites). Considerable time was also spent surveying unranked sites and potentially suitable habitat to determine if the species had expanded in distribution. Over the past 3 years, the survey effort has increased considerably, largely due to the conservation priority of the species being elevated.

Table 1. Summary of Person Minutes for 2001, 2002, and 2003 for Tahoe Yellow Cress Sites Surveyed

Survey Person Minutes			
Ranked Sites/Year	**2001**	**2002**	**2003**
Core	1,590	1,570	1,865
High	320	540	860*
Medium	615	937*	2,275
Low	255	180*	756
Unranked/New	845	1,770*	4,169*
Miscellaneous	-	20	205
Total	**3,625**	**5,017**	**10,130**

* Some sites were surveyed but survey time was not recorded on the data sheets.

The intensive 2003 annual survey located Tahoe yellow cress at 45 of the 69 sites surveyed (65 percent occupied), up from 19 percent of sites occupied in 2000 when the lake level was high at 6,228 ft (1,898 m) (Appendix C). This year's effort included surveys of three newly named sites, one of which supported Tahoe yellow cress. Sites occupied by Tahoe yellow cress fall under various management and ownership as identified in Table 2.

Table 2. Summary of Land Management and Ownership of Tahoe Yellow Cress Sites Surveyed in 2003

Management / Ownership	# of Sites Surveyed	# of Sites Occupied	% Occupied	# of Sites Not Surveyed
Private	19	16	84	4
USFS	16	13	81	0
CDPR	9	5	56	0
CTC	3	3	100	0
NDSP	4	3	75	0
City of South Lake Tahoe	1	0	0	0
Incline Village General Improvement District	1	0	0	0
Shared/Public*	11	5	50	0
Unknown	0	NA	NA	1
Total	**64**	**45**	**65**	**5**

*Land management/ownership is either multiple entities or unknown.

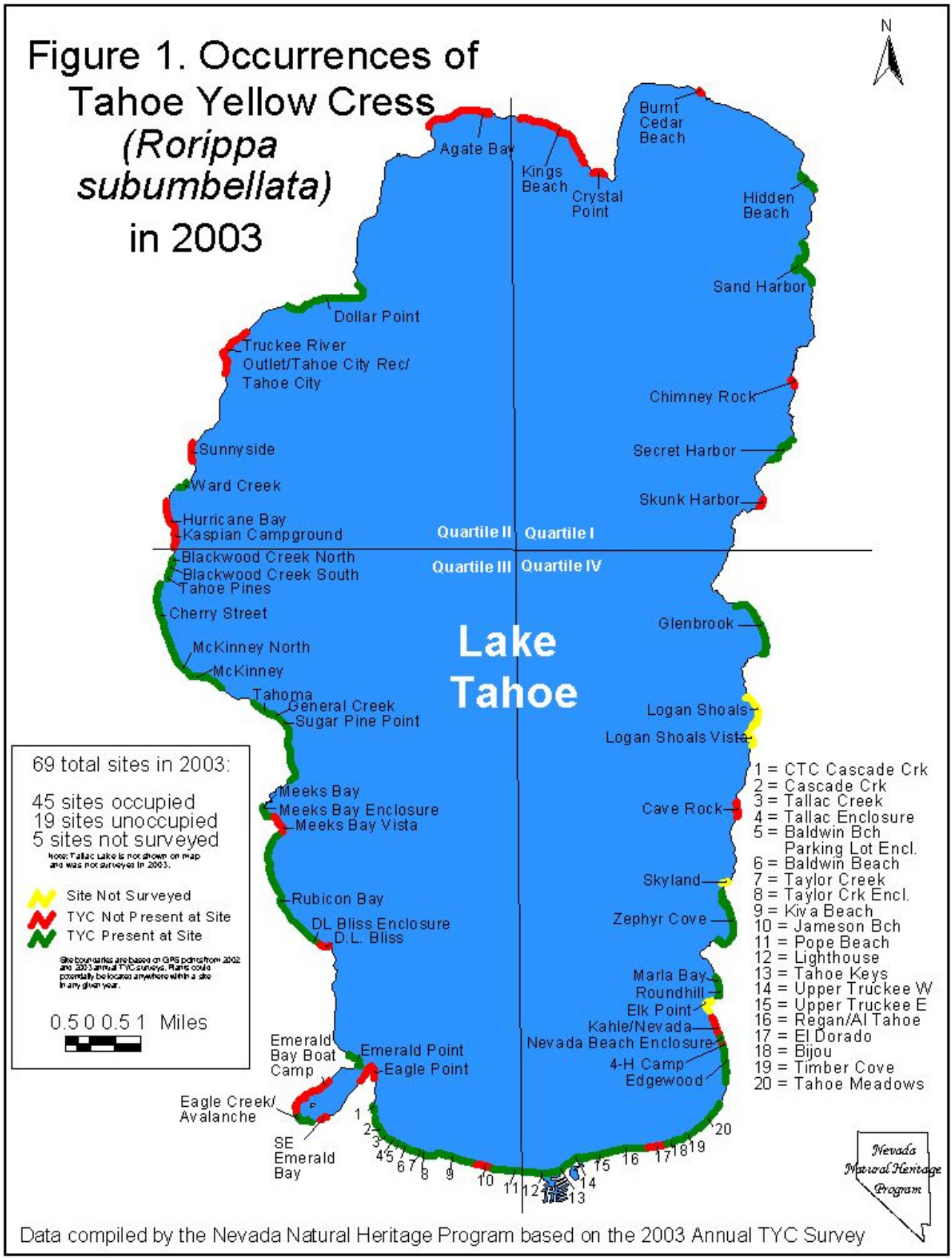
Figure 1. Occurrences of Tahoe Yellow Cress (Rorippa subumbellata) in 2003
N
Lake Tahoe
Quartile II
Quartile I
Quartile III
Quartile IV
Agate Bay
Kings Beach
Crystal Point
Burnt Cedar Beach
Hidden Beach
Sand Harbor
Dollar Point
Truckee River Outlet/Tahoe City Rec/ Tahoe City
Chimney Rock
Secret Harbor
Skunk Harbor
Sunnyside
Ward Creek
Hurricane Bay
Kaspian Campground
Blackwood Creek North
Blackwood Creek South
Tahoe Pines
Cherry Street
McKinney North
McKinney
Tahoma
General Creek
Sugar Pine Point
Glenbrook
Logan Shoals
Logan Shoals Vista
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
Nevada Beach Enclosure
4-H Camp
Edgewood
Emerald Bay Boat Camp
Emerald Point
Eagle Point
Eagle Creek/ Avalanche
SE Emerald Bay
69 total sites in 2003:
45 sites occupied
19 sites unoccupied
5 sites not surveyed
Note: Tallac Lake is not shown on map and was not surveyed in 2003.
Site Not Surveyed
TYC Not Present at Site
TYC Present at Site
Site boundaries are based on GPS points from 2002 and 2003 annual TYC surveys. Plants could potentially be located anywhere within a site in any given year.
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 2003 Annual TYC Survey

In the past, the species has mostly been found at the south end of the lake, with the greatest concentration in the southwest quartile (Figure 1, quartile III); however, over the past 2 years, historic and new sites in the northern portion of the lake have supported plants. The distribution of Tahoe yellow cress by lake quartiles was still highest for the southwest and southeast quartiles, with all but five occupied sites represented in these two sections. Two sites were located in the northwest quartile and three were identified in the northeast quartile. Plants had not been recorded in the northeast quartile since 1992 (Secret Harbor) and 1994 (Crystal Point). Ten of the sites occurred in Nevada, an increase of six from 2001. The remaining 35 occupied sites were located in California. Approximately 60 percent of the Tahoe yellow cress sites (29) occur on lands managed by public agencies, such as the USFS, State, County, or City governments. The remaining populations (16) occur on private lands.

Approximately 25,200 stems were counted or estimated in 2003 at core, high, medium, and low priority sites and unranked, new, and miscellaneous sites (Appendix D; see page 53 of the CS for discussion and definitions of site ranking). During the 2000 annual survey, which was conducted during high lake levels, the estimated number of stems was 4,590. Current stem counts per site ranged from a low of one (McKinney Creek, Timber Cove, and Nevada Beach Enclosure) to a high of 13,660 (Upper Truckee East). This results in a calculated mean of 497 stems per site. Upper Truckee East typically supports more stems than any other Tahoe yellow cress site by orders of magnitude. Therefore, when Upper Truckee East is excluded, the calculated mean decreases to 210 stems per site, which reflects a more realistic view of the numbers of stems typically observed at other sites. Over 1,370 plants were found at unranked and new or expanded sites, which is nearly 8 times the number of plants observed during the 2001 survey (146 plants) for the same category (CSLC 2002). This increase may be a function of lower lake levels and the increased search effort (Table 1).

Tahoe yellow cress was observed in a variety of substrates such as cobbles and rock during the 2003 survey. Generally, suitable habitat is considered to be composed of at least 30 percent sand; however, based on the 2001-2003 survey results, it is apparent the species is adapted to a broader range of habitat conditions than previously thought. Based on 2003 field survey data where Tahoe yellow cress was observed, composition of sandy surface substrate ranged from 5 percent to 100 percent. Over 60 percent of the sites occupied by Tahoe yellow cress were greater than 50 percent sandy surface substrate and about 10 percent had less than 30 percent sandy surface substrate. While the surface substrate may be comprised of variable components, such as cobble and rock, the underlying material is typically sand.

A variety of substrate disturbances were also recorded at each Tahoe yellow cress site. The dominant type of disturbance is associated with recreational beach use. Footprint disturbances were recorded at nearly all of the sites. Nonnative plant species were also common within these sites.

2.3 DISCUSSION

The 2003 annual survey for Tahoe yellow cress was the 21st survey that has been conducted over a 24-year period. The 2001, 2002, and 2003 surveys have been the most comprehensive to date, with 58, 71, and 69 sites visited, respectively, and the largest number of participants. Following the 2001 annual surveys, an analysis of data collected between 1979 and 2001 was performed to determine if

there is a relationship between how many sites are surveyed and the number of sites where Tahoe yellow cress is observed, as well as provide a comparison between low and high lake elevation years (CSLC 2002). This analysis was also applied to the 2002 survey data (CSLC 2003). The analysis of showed that as the number of sites surveyed increased, particularly in low lake elevation years, the probability of observing Tahoe yellow cress at more sites was greater. Results of this analysis were statistically significant ($P < 0.01$) and strongly support this hypothesis. The results also demonstrated that there is a statistically significant negative relationship between high lake elevations and the presence of Tahoe yellow cress during the survey period, which is consistent with the findings in the CS (Figure 2, includes 2003 data). (For a detailed discussion of these analyses and the methods used, refer to Appendix B in CSLC 2003, 2002.)

Data analyses performed for the CS established site rankings for the purposes of identifying conservation, restoration, and management priorities. An index of viability was calculated for each site based on persistence of the species at the site and its abundance relative to the rest of the population. Sites that support relatively large, invariant, and persistent populations have a high, positive index value; while those supporting small, variant, and ephemeral populations have a low, possibly negative value. Sites with low quality presence/absence data or that lack stem count data could not be ranked. 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.)

Appendix D provides Tahoe yellow cress presence/absence by site ranking in 2003. Nearly all of the core, high, and medium priority sites supported Tahoe yellow cress during both high and low lake elevations. The exceptions were the Emerald Bay sites, which are generally present during low lake elevation years but not during high lake elevation years; thus, these sites are referred to as low lake elevation sites (CSLC 2003). In general, sites ranked as low priority, miscellaneous, and new/expanded sites occur where Tahoe yellow cress persists only during periods with low lake elevations.

Pursuant to the CS, site rankings were revised to incorporate data collected through 2003, which now encompasses two complete cycles of high and low lake elevations. Appendix E briefly describes the methods used and shows the resultant rankings based on the index of viability calculations, as well as the initial site rankings. Five sites were promoted in rank (Lighthouse, Upper Truckee West, Tahoe Meadows, Zephyr Cove, and Secret Harbor), 2 were demoted (Glenbrook and Tahoma), and 13 remained unranked either because they were considered new or they do not meet the minimum data requirement to apply the index of viability calculation.

The TAG recommends that the rankings calculated in Appendix E be adopted because they reflect the metapopulation dynamics of the species through complete high and low water cycles. The index of viability would be calculated each year for all sites for which adequate data are available; however, this annual exercise does not imply that the resulting site ranks must be adopted. Running the calculation on an annual basis would simply allow the TAG to track each site over time.

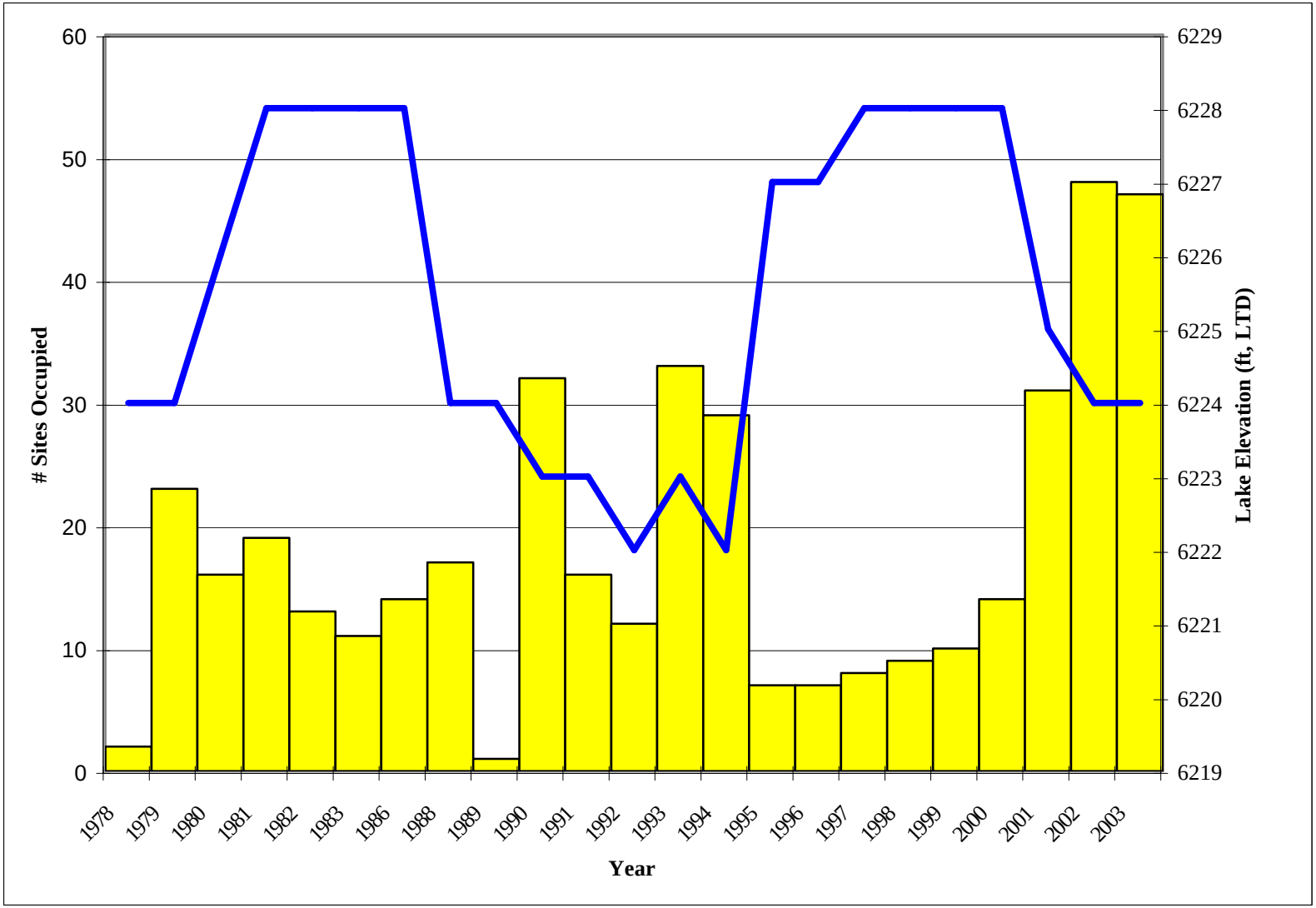

Figure 2. Lake Level and Number of Tahoe Yellow Cress Sites Occupied by Survey Year (Solid Blue Line = Lake Level LTD)

These site rankings should be maintained into the future until the following occur:

- Another complete high/low water cycle is experienced;
- Impacts or threats to the species at a given location warrant adoption of a site ranking and/or modifications to site management;
- Minimum data requirements are met for unranked sites, which would allow the index of viability to be calculated and the sites to be ranked.

The TAG would recommend any changes in management or land use based on site ranking to the Executive Committee for review and approval.

Based on data collected through 2003, lake elevations between 6,222 ft to 6,224 ft (1,896 m to 1,897 m) appear to be optimal for Tahoe yellow cress persistence. The 2001-2002 analyses demonstrated that a significant positive relationship between the number of sites surveyed, particularly in low lake elevation years, and the probability of observing Tahoe yellow cress exists. In addition, as described in the 2001-2002 analyses, this is likely a result of an increase in habitat exposure and a corresponding increase in survey effort (CSLC 2003, 2002). Data collected and observations in 2003 are consistent with these results.

2.4 CONCLUSION

As observed in 2002 and 2003, the low lake elevation (6,224 ft; 1897 m) and intensive survey effort in 2003 resulted in the greatest number of person hours dedicated (173) and the highest individual plant count (25,250) since surveys have been conducted for this species. Based on the annual survey results, Tahoe yellow cress status is at level 1 of the Imminent Extinction Contingency Plan (page 89 of CS). There are four levels defined in the CS. Level 1 is indicative of a stable population trend while level 4 indicates critically low site occupation (Pavlik *et al.* 2002a):

- Level 1: 6 core populations and at least 15 (inclusive of the core populations) total populations (each with greater than 30 reproductive stems) or more than 60 percent of the habitat is occupied

- Level 2: 6 core populations and less than 15 (inclusive of the core populations) total populations (each with greater than 30 reproductive stems) or 6 core populations and less than 60 percent presence

- Level 3: 5 or fewer core populations or less than 10 (inclusive of the core populations) total populations (each with greater than 30 reproductive stems) or less than 50 percent presence

- Level 4: 3 or fewer core populations or less than 7 (inclusive of the core populations) total populations (each with greater than 30 reproductive stems) or less than 40 percent presence

The results of the 2003 survey met all of the level 1 criteria. Plants were observed at all 6 of the core populations identified in the CS, 33 of the 45 occupied sites each supported more than 30 reproductive stems, and 65 percent of the habitat was occupied. Based on 21 years of data for Tahoe yellow cress, the imminent extinction levels according to the CS have been as follows: Level 1

during 8 years; level 2 for 8 years; level 3 for 2 years; and level 4 for 3 years. Table 3 summarizes the historic levels from previous survey years.

Table 3. Summarized Annual Survey Data (1979 to 2003)

Year	Lake Level (ft)	# of Sites Surveyed	# of Sites Occupied	% Occupied	Imminent Extinction Level
1979	6,224	36	25	69	3
1980	6,226	28	16	57	2
1981	6,228	33	19	58	2
1982	6,228	26	13	50	2*
1983	6,228	23	11	48	2*
1986	6,228	24	14	58	2
1988	6,224	22	17	77	1
1990	6,223	41	33	80	1
1991	6,223	24	21	88	1*
1992	6,222	17	15	88	1*
1993	6,223	44	35	80	1
1994	6,222	44	29	66	1
1995	6,227	37	7	19	4
1996	6,227	39	7	18	4
1997	6,228	37	8	22	4
1998	6,228	44	9	20	3
1999	6,228	31	10	32	2
2000	6,228	42	14	33	2
Post Conservation Strategy Survey Results					
2001	6,225	58	31	53	2
2002	6,224	71	48	68	1
2003	6,224	69	45	65	1

(Data source: Pavlik *et al.* 2002a; CSLC 2003, 2002)

*Assumes the core sites (e.g., Upper Truckee East, Blackwood) not surveyed that year were occupied.

3. 2003 CONSERVATION ACTIVITIES

The CS relies on expanding the existing knowledge base through monitoring and research and integrating new information into the conservation and management framework for Tahoe yellow cress. Five key management questions (KMQ) were developed to organize existing and future research related to Tahoe yellow cress (Pavlik and O'Leary 2002). These questions were intended to guide implementation of the CS by focusing research on the restoration of metapopulation dynamics in the context of ongoing stresses to the population from fluctuating lake level and human impacts. The questions address the issues that affect the success of restoration: Potential habitat, ecosystem factors that influence plant performance, the self-sustaining dynamics of the species, genetic factors, and protection from disturbance.

The KMQs are as follows:

1) Can Tahoe yellow cress populations occupy any site around the lake margin that has sandy beach habitat?

2) Are there ecosystem factors that can affect Tahoe yellow cress performance within an occupied site or microhabitat?

3) Can Tahoe yellow cress populations be created or enlarged in order to restore the self-sustaining dynamics of the species?

4) Can any Tahoe yellow cress genotype or gene pool perform equally well at any appropriate site?

5) Can Tahoe yellow cress microhabitats/sites be found or created that are less likely to be adversely disturbed despite high visitor use or intense shorezone activity?

The following conservation activities have been implemented in support of the research agenda and to begin answering KMQs 3 and 4.

3.1 SEED COLLECTION

Similar to 2001 and 2002, seed collection was conducted at several sites during the 2003 survey period. Seeds for the 2003 pilot outplanting project were collected in September 2001, at nine core and priority restoration sites: Blackwood North, Blackwood South, Cascade, Tallac Creek, Taylor Creek, Lighthouse, Upper Truckee East, Tahoe Meadows, and Edgewood. Seeds were obtained from a total of 177 individual plants across these 9 sites (see Table 1 in Pavlik *et al.* 2002b). The entire 2001 seed lot was hand-sorted into three equal lots and stored in manila envelopes at room temperature and humidity. Three nurseries each received one-third of the seed collected from each of the 177 individuals. A small portion of seed was retained for laboratory germination tests. (Refer to Pavlik *et al.* 2002b for a detailed discussion.)

Additional seed crops were collected from 11 sites in September 2002 and from 5 sites in September 2003. As part of the ongoing propagule production necessary for an age-structured reintroduction effort, the 2002 seeds were planted in July and August of 2003 (see below). The 2003 seeds are currently stored at room temperature and humidity in dry manila envelopes and will be sorted and planted in the spring of 2004.

3.2 PLANT PROPAGATION

3.2.1 2002 NURSERY PROPAGATION

Three nurseries received contracts through the USFS to propagate Tahoe yellow cress for the 2003 pilot outplanting project: The USFS facility in Camino, California (in the Sierra Nevada foothills, just east of Placerville at an elevation of 3,200 ft [976 m]); the NDF facility in Washoe Valley, Nevada (at 5,000 ft [1,525 m] elevation); and privately-owned Sierra Valley Farms (in Sierra Valley,

at an elevation of 5,000 ft [1,525 m]) in Beckwourth, California. Only the NDF facility at Washoe had previously propagated Tahoe yellow cress for restoration efforts. The TAG chose to put the plants at three separate facilities to reduce the risk of an unsuccessful propagation. Propagation protocols were developed in cooperation with the three nursery facilities to raise hardy, rather than productive, founders that would survive transplanting (Pavlik *et al.* 2002b).

The nurseries were directed to utilize all seed lots and plant a minimum of 1,400 plants in plastic supercells. Each seed lot represented a specific seed source (site-based genotype) and individual plant. Detailed information associated with the propagules (e.g., seed lot, maternal parent identification) was tracked in order to estimate fitness components (e.g., seed output/ plant size correlations) and evaluate the performance of different reintroduced populations (Pavlik *et al.* 2002b).

3.2.2 2003 Nursery Propagation

The USFS renewed contracts with two of the nurseries to propagate Tahoe yellow cress for the anticipated 2004 reintroduction: the NDF facility in Washoe Valley, Nevada, and Sierra Valley Farms in Beckwourth, California. Propagation efforts for over 4,000 Tahoe yellow cress individuals began in July and early August of 2003. Established plants will be cold hardened in the late winter and spring of 2004 before they are used for the 2004 experimental reintroduction efforts.

3.3 2003 Pilot Outplanting Project

The pilot outplanting project was designed to inform subsequent reintroduction experiments for Tahoe yellow cress. Implementation of the pilot project assisted the researchers in identifying and resolving logistical issues associated with propagating, transporting, and reintroducing a rare plant to its historical habitat. The information garnered from the pilot project is critical to ensure effective design of future outplanting efforts. (Refer to Pavlik and Stanton 2004 for a detailed discussion of the pilot outplanting project.)

3.3.1 Methods

3.3.1.1 Site Selection

Beginning in early 2003 the TAG worked to identify four sites around Lake Tahoe that would be suitable for the pilot outplanting project. The sites selected were: Taylor Creek (USFS), along the southwest shore at Baldwin Beach; Eagle Creek/Avalanche (CDPR), located southeast of Eagle Creek in Emerald Bay State Park; Zephyr Spit (USFS), situated just north of Zephyr Cove, Nevada, on the east shore; and Sand Harbor (NDSP) in the northeast quartile.

Site selection was based on a combination of the following factors:

- The sites subjectively resemble "typical" Tahoe yellow cress microhabitats, possessing the ecological characteristics described in the CS (pages 20-26).
- The agency or landowner could provide an in-kind contribution of staff time for outplanting and monitoring.

- At high use sites, the agency could install fencing to protect the founder plants from human disturbance. The installation of plants and the fencing component would be in compliance with the California Environmental Quality Act as well as the National Environmental Protection Act, and the fence location would be compatible with the recreational patterns on the beach.
- The four selected sites encompass the west-east (mesic to xeric) microclimate gradients described in the CS (page 20).

3.3.1.2 Design

Plant installations at the different sites consisted of outplanting container-grown plants in "transect" configurations perpendicular to the shore that extended from the waterline into beach, dune, or meadow microhabitats. Transects were placed 3.28 ft (1 m) apart and plants within a single transect were planted at 1.6 ft (0.5 m) intervals. Within a site, a stratified random planting scheme was employed to distribute the different seed lots across the microtopographic gradients as evenly as possible. Plants were marked with a color-coded wire flag signifying the seed lot and a colored rubber band signifying the initial vigor.

Overall, the outplanting design was site-specific, lacking replication, and meant to address pilot project objectives rather than the KMQs identified in Pavlik and O'Leary (2002). The specific outplanting design for each site is discussed below.

3.3.2 Pilot Outplanting Sites

3.3.2.1 Taylor Creek

Taylor Creek is designated a core restoration site under the CS, with the highest viability index of any known Tahoe yellow cress site (I = 97). A total of 541 plants were installed in enclosures on May 19, 2003. This site had the most complex array of microhabitats and included moist shoreline, beach trough, dune, dune trough, and meadow (high beach was not planted). The outplanting was divided into five plots, each representing at least one microhabitat. In an effort to discern the effects of human trampling, an additional 40 plants were planted outside of the low beach enclosure. Ten plants each were planted within 32 ft (10 m) of the fence on all four sides of the enclosure, including the footpath. Each plant was carefully mapped but not marked with a flag.

3.3.2.2 Eagle Creek/Avalanche

The Avalanche site is the small patch of readily inundated beach surrounded by logs swept down by the rock avalanche of 1956 at Emerald Bay. Avalanche beach itself is not ranked in the CS due to insufficient data; however, nearby Eagle Creek is ranked as a high priority restoration site, with a moderate viability index (I = 35). Upper portions of Avalanche were still covered with snow in mid-May, so planting was delayed two weeks to allow soils to dry. A total of 300 plants were installed on June 3, 2003. Plants were arranged in two plots. No fences were installed at this site because of its relatively remote location and the protection provided by the avalanche debris. Plain signposts at the water's edge and on the western side of the plots indicated that the beach was closed for restoration.

3.3.2.3 Zephyr Spit

Zephyr Spit is considered part of Zephyr Cove, which is designated a medium priority restoration site in the CS, with a low viability index (I = 5). The USFS installed permanent fencing on the upper reaches of the beach and a temporary fence near the shoreline. In order to further minimize recreational impacts, a footpath was available between the two enclosures. Outplanting of 286 plants took place on May 22, 2003. The same interpretative signage used at Taylor Creek was installed on the fences.

3.3.2.4 Sand Harbor

Sand Harbor is designated a low priority restoration site in the CS, with a very low viability index (I = -38). Naturally occurring plants have not been seen at this site since 1979. However, plants were located here in 2003 away from the outplanting site. The NDSP installed a snow style fence that extended from the lakeshore up to the stabilized upland zone, leaving access open from the lake, but no access corridor to the far north end of the beach. A total of 297 plants were installed on May 20, 2003. This site was very rocky, so it was necessary to work around boulders and divide the plants into three plots. Signage posted along the fence and at the waterline identified Tahoe yellow cress but did not contain interpretative language.

3.3.3 MONITORING

Demographic, physiological, and disturbance monitoring techniques were designed to document responses of Tahoe yellow cress to microhabitat, genetic, hydrological, and recreational factors. A standard data sheet was developed to record the fate of every outplanted individual, allowing subsequent calculations of mortality rates, survivorship to reproduction, and estimate reproductive output using models previously developed (Pavlik *et al*. 2002b). Plants were evaluated at two weeks and four weeks after planting and thereafter on a monthly basis through October. The water relations monitoring component (Pavlik 2001, 1987), 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 twice during the 2003 growing season; once in early June, and again in late September during peak reproduction.

3.3.4 RESULTS

3.3.4.1 Founder Propagation

Two of the three nurseries successfully propagated Tahoe yellow cress under greenhouse conditions. Propagation at the USFS nursery in Camino did not produce any viable transplants, possibly due to heat stress from very high summer temperatures, coupled with over-watering. In April 2003, a combined total of 1,665 plants were available for outplanting (805 plants from Sierra Valley Farms and 850 plants from Washoe Nursery). This number was barely sufficient for the pilot outplanting project and far short of the nearly 4,000 plants required to fully implement the experimental design.

3.3.4.2 Comparison Among Outplanting Sites

A total of 1,424 founders were installed across the four sites in May 2003. By September 2003, 815 founders were still alive. Among the sites, survivorship varied from a low of 27 percent at Sand Harbor, 58 percent at Taylor Creek and Zephyr Spit to a high of 85 percent at Avalanche. Of the survivors, 58 percent were reproductive in September, producing an estimated 220,000 seeds (reproductive output was not calculated for Sand Harbor). The mean survivorship of all sites (57 percent) is slightly lower than that achieved in previous transplanting efforts in 1988 (66 percent). Low lake levels persisted during 1988 and 2003, but it is unlikely that plants were installed in the inundation zone in the previous projects. If the shorezone habitat that became inundated during this pilot project is excluded then mean survivorship for the 2003 pilot project rises to 65 percent.

Table 4. Survivorship and Reproduction of Transplanted Tahoe Yellow Cress Plants, September 2003

Site	# of Transplants	Survivorship (%)	Reproduction (%)	# Seed Produced
Avalanche	300	85.5	56.3	44,794
Taylor	541	63.1	68.4	119,136
Zephyr Spit	286	58.4	63.5	56,218
Sand Harbor	297	27.3	43	NA

Figures for reproduction (%) give the proportion of surviving individuals that produced fruit. The number of seed produced is an estimate based on the equation $y=3.609x - 109.542$ ($r = 0.81$), where y is the number of seeds and x is canopy size (Figure 4 in Pavlik *et al.* 2002b).

In the 2003 pilot project, initial founder vigor appeared to have a strong influence on survivorship at all sites, with the exception of Avalanche (only 9 percent of the transplants at Avalanche were low vigor and this may have slightly boosted survivorship). Mean survivorship of high vigor individuals was two and a half times greater than that of low vigor individuals (65 percent compared to 26 percent), highlighting the importance of high quality founders.

The patterns of survivorship and reproduction among the four sites in 2003 are not easily explained by any single factor. Contributing factors include environmental variables such as microtopography (and depth to water table), recreational impacts, the influences of initial founder vigor, and the genetic source of the founders. Some of these factors were controlled, but the lack of replication in the pilot design precluded efforts to determine the validity of observed trends and make strict comparisons for some variables.

3.3.4.3 Fencing

Fencing effectively reduced the impact of variations in recreation intensity among the sites. There were no reports of intrusion into any enclosure that resulted in plant mortality, and no plant mortality was attributed to human caused disturbance. Maintaining fencing throughout subsequent experimental plantings will be important for detecting other site-specific or genotype-related causes of differential founder survival.

3.3.4.4 Water Relations

Differences in water availability among the sites, specifically the depth to the water table, could not be directly measured, but plant xylem water potentials offered an excellent surrogate measure. Average water potentials in June 2003 showed a significant hydrologic gradient running from the moist shoreline up into high beach or dune habitats at all sites. Water potentials of plants in shoreline were significantly higher (and therefore the plants were less water stressed) than plants in dune habitats. Low beach and high beach had intermediate levels that were also significantly different, indicating that water availability decreases as distance from the lake increases. However, these differences disappeared by September 2003 when there was no detectable gradient.

When comparing the sites, the mean water potential of founders at Avalanche in September 2003, the site with the greatest survivorship, were significantly higher than Zephyr Spit and Taylor Creek, and therefore the plants experienced less water stress. It was anomalous, however, that Avalanche values were not as high as those at Sand Harbor, the site with the lowest survivorship. Mortality of plants that did not become inundated at Sand Harbor cannot be discerned based on the data collected; therefore, further studies are warranted.

3.3.4.5 Genetics Within and Among Outplanting Sites

The different seed sources showed differential survivorship within and among sites, but without replication it is impossible to demonstrate any significance to the observed performances. Differences in initial vigor between some seed sources appeared to explain some of the variation, but no clear patterns emerged that indicated any differential survival based on genetic factors.

As stated previously, the patterns of survivorship and reproduction among the four sites in 2003 are not easily explained by any single factor. Contributing factors are varied and often difficult to control, such as environmental conditions, human related impacts, and the influences of founder vigor and their genetic contribution. The lack of replication in the pilot design also precluded efforts to determine the validity of observed trends and make strict comparisons for some variables.

3.5 2003 GENETIC STUDY

The 2003 genetic study is an extension of previous work conducted by NFGEL to assess the genetic variation of Tahoe yellow cress. The 2003 study was designed to screen 25 sites for variation at the same 23 isozyme loci analyzed in the previous assessment (Saich and Hipkins 2000). Vegetative material was collected from the 25 sites over a period of 2 years (2002-2003) (Table 5). In order to determine if genetic variation is present but undetected by isozymes, additional analyses were conducted using two DNA-based markers on a subset of samples (DeWoody and Hipkins 2004).

The isozyme analysis revealed low levels of genetic diversity within and among Tahoe yellow cress populations, supporting the previous results (Saich and Hipkins 2000). Of the 25 sampled sites, only 4 contained variation, each at a single locus. Populations from Sugar Pine State Park and Tallac Creek contained alternate alleles at one of the loci previously reported as containing variation by Saich and Hipkins (2000), and Eagle Creek and Tahoe Keys contained alternate alleles at two new loci.

DeWoody and Hipkins (2004) also reported that some rare alleles present in the 2000 study were not observed in the 2003 study. The unique alleles detected at Tahoe Meadows were only present at a single locus that was not resolved in 2003 because of technical problems. The Taylor Creek Enclosure contained variation at two loci in 2000, but only plants outside of the enclosure were sampled in 2003 and these did not contain the rare alleles. The only documented loss occurred at Upper Truckee East, where the allele detected in 2000 was absent in the samples from 2003. In this case, the rare allele was likely lost through genetic drift (a random loss) (DeWoody and Hipkins 2004).

Table 5. Site Name, Collection Date, Number Collected, and Number Analyzed (in Parentheses, if Different from the Number Collected) for Genetic Variation of Tahoe Yellow Cress. Names or Dates in Bold Indicate Collections that Displayed Isozyme Variation.

Site Name	Collection Date	# Collected (Analyzed)	Site Name	Collection Date	# Collected (Analyzed)
Blackwood North	9-2-2003	24	**Taylor Creek Enclosure**	**8-15-1999**	10
Blackwood South	9-1-1999	27	Taylor Creek (three clusters)	9-3-2002	53
	9-4-2002	28 (5)	Pope Beach	9-4-2002	7 (0)
	9-2-2003	30		9-2-2003	9 (4)
Sugar Pine	**9-4-2002**	30	Lighthouse	9-1-1999	11
Meeks Bay	9-4-2002	12 (5)		9-1-1999	7
	9-2-2003	7		9-4-2002	31 (10)
Rubicon	9-4-2002	30		9-2-2003	35
Emerald Point	9-4-2002	11(7)	**Tahoe Keys**	9-4-2002	31 (0)
	9-3-2003	30		**9-2-2003**	30
Emerald Bay Avalanche, Native	9-4-2002	21 (1)	Upper Truckee West	8-15-1999	2
	9-3-2003	60		9-3-2002	30
Emerald Bay Avalanche, Planted	9-3-2003	15	Upper Truckee East	8-15-1999	33
Eagle Creek	9-4-2002	4 (0)		9-3-2002	30
	9-3-2003	15	Regan/Al Tahoe	9-3-2002	18
Cascade	9-3-2002	4 (0)	**Tahoe Meadows**	**9-1-1999**	8
	9-2-2003	8		9-4-2002	20 (0)
Tallac Creek	**9-3-2002**	11		9-9-2003	12
Tallac Enclosure	8-15-1999	13	Edgewood	8-15-1999	18
	9-3-2002	10	Kahle/Nevada	9-1-1999	7
Baldwin Beach	8-15-1999	4	4H	9-4-2002	21 (0)
	9-3-2002	3(2)		9-9-2003	30
	9-2-2003	3	Zephyr Spit	9-4-2002	8

1999 collections are part of the previous isozyme study conducted under Service Agreement 14-48-0001-95813; 2002 and 2003 collections are part of the current study, Service Agreement 14320-2-H401.

The genetic findings of the two NFGEL studies, along with the life history described in the CS, have enhanced our understanding of the genetic structure of Tahoe yellow cress. Clonal reproduction, a

mating system characterized by high rates of selfing, and genetic bottlenecks and drift associated with the frequent turnover of populations, have all contributed to a decrease in heterozygosity in the species (DeWoody and Hipkins 2004). Over the years, the recurring extinction and colonization events at the sites that comprise the metapopulation have maintained the low levels of variation currently observed. Although metapopulation dynamics may play an important role in the structure of the species, these studies indicate that gene flow among established populations is rare. In addition, rare alleles have only been observed in a few populations in any given year and no evidence suggests that these rare alleles readily move to new populations.

These studies concluded that restoration outplantings are not likely to significantly alter the genetic structure of the metapopulation, especially if the restoration efforts utilize plants possessing the common genotype, which was observed in 97.6 percent of the individuals sampled in 2003. It is necessary, however, to conserve the small amount of observed variation in order to preserve the species' evolutionary potential (DeWoody and Hipkins 2004).

3.6 2003 HABITAT SOIL STUDY

The USFS received funding to conduct a study of the soil characteristics of Tahoe yellow cress habitat. Soil samples were collected at five sites: Taylor Creek, Baldwin Beach, Cascade, Meeks Bay, and Kahle/Nevada. The research design called for sampling in occupied and unoccupied habitat and each soil pit was sampled at three depths (0-3 inches [in] [0-7.6 centimeters (cm)]; 3-13 in [7.6-33.0 cm], and 13-23 in [33-58.4 cm]). A total of 48 samples were collected, 22 near existing Tahoe yellow cress plants and 26 in unoccupied habitat. Samples were analyzed for total nitrogen, organic carbon, nitrate, ammonium, and phosphorous. No highly significant differences were detected in chemical composition between occupied and unoccupied sites. Sites without Tahoe yellow cress had twice the phosphorous concentration of occupied sites (17.6 compared to 8.3 lbs/acre [8 to 3.8 kilograms/hectare]) but the difference was only mildly significant (P=0.08). Amounts of ammonium and nitrate significantly declined with depth, but this was not related to presence or absence of Tahoe yellow cress.

4. 2003 ACTIVITIES BY AGENCY

As required by the CS, the following is a brief summary of agency staff time spent and agency expeditures on conservation and management activities specific to Tahoe yellow cress during 2003. Activities anticipated for 2004 are also included. Table 6 provides agency hour breakdown for years 2001, 2002, and 2003.

4.1 TAHOE REGIONAL PLANNING AGENCY

Staff from TRPA spent approximately 150 hours on Tahoe yellow cress management and conservation activities during 2003. Activities included, but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings; assisting in the development and implementation of annual survey and monitoring program; assisting in the development and implementation of outreach/education programs; and assisting in the development of research priorities and associated contract administration. Finally, between January 2002 and December

2003, the TRPA Board permitted 41 shorezone projects at Lake Tahoe. No specific information regarding affected habitat was available.

Table 6. Summary of Agency Hours Spent on Tahoe Yellow Cress Related Activities During 2001, 2002, and 2003

Agency/Year	2001	2002	2003
TRPA	No report	No report	150
USFWS	700	500	400
USFS	658	1,250	1,168
NDSP	No report	No report	132
NDF	No report	No report	304
NNHP	130	98	160
CDFG	240	232	272
CDPR	160	155	403
CTC	1,580	1,634	1,024
CSLC	575	565	400
TLOA	No report	No report	100
Total	**4,043**	**4,434**	**4,109**

Staff from TRPA will continue to participate in the implementation of the CS. Activities for 2004 include elements identified in the CS, such as, attending Tahoe yellow cress Executive and TAG coordination meetings, participating in the annual survey, and coordinating permitting needs for research and stewardship efforts.

4.2 U.S. FISH AND WILDLIFE SERVICE

Staff from USFWS spent approximately 400 hours and approximately $20,000 on Tahoe yellow cress management and conservation activities during 2003. Activities included, but were not limited to: Attending and facilitating Tahoe yellow cress Executive and TAG coordination meetings; organizing and participating in the annual survey and monitoring effort for 2003; assisting in development and implementation of outreach/education programs for the stewardship committee of the TAG, including attending the annual TLOA member meeting; assisting in development of research priorities; and preparing the annual report.

Staff from USFWS will continue to participate in the implementation of the CS. Activities for 2004 will be commensurate with those conducted in 2003, such as, organizing and attending Tahoe yellow cress Executive and TAG coordination meetings, participating on the stewardship committee of the TAG, and participating in the annual surveys. The USFWS will also continue attending Tahoe yellow cress Executive and TAG meetings to ensure appropriate levels of implementation of the CS are being met.

4.3 U.S. FOREST SERVICE

Staff from USFS spent approximately 1,168 hours and approximately $35,000 on Tahoe yellow cress management and conservation activities during 2003. Activities included, but were not limited

to: Attending Tahoe yellow cress Executive and TAG coordination meetings; participating in the annual survey and monitoring effort for 2003; assisting in development of research priorities; and implementing research projects on USFS managed lands. Some associated activities included completing environmental compliance documents for the pilot outplanting project and protective fence construction at Zephyr Cove (north of the Dreyfus Estate) and Taylor Creek, maintenance of existing fences, and installation of temporary fencing at Kahle/Nevada Beach. Archeological surveys were also conducted in support of these efforts. Monthly disturbance and demographic monitoring was also performed subsequent to the outplanting project.

Staff from USFS will continue to participate in the implementation of the CS. Activities for 2004 will be commensurate with those conducted in 2003, such as attending Tahoe yellow cress Executive and TAG coordination meetings, participating in the annual survey, coordinating and implementing research efforts on USFS managed lands, and administering a contract to expand upon past genetics studies. The USFS anticipates expenditures of approximately $94,000 on Tahoe yellow cress management and conservation in 2004.

4.4 NEVADA DIVISION OF STATE PARKS

Staff from NDSP spent approximately 132 hours and approximately $3,300 on Tahoe yellow cress management and conservation activities during 2003. Activities included, but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings; participating in the annual survey and monitoring effort for 2003; assisting in development of research priorities; and implementing research projects within the boundaries of Lake Tahoe Nevada State Park at Cave Rock, Sand Harbor, and Hidden Beach management units. Some associated activities included purchasing fence materials for the pilot outplanting project and installing protective fence at Sand Harbor. Monthly disturbance and demographic monitoring and reporting were also performed subsequent to the outplanting project. Temporary regulatory/warning signs were also installed this year at Sand Harbor and Hidden Beach.

Staff from NDSP will continue to participate in the implementation of the CS. Activities for 2004 will be commensurate with those conducted in 2003, such as attending Tahoe yellow cress Executive and TAG coordination meetings, participating in the annual survey, and coordinating and implementing research efforts on NDSP managed lands. Planning efforts are also underway to incorporate an interpretive display specific to Tahoe yellow cress at the new Sand Harbor Visitors Center. Construction of this facility is progressing with an anticipated opening in 2005. Funding for this and other Tahoe yellow cress related activities was secured under the Tahoe License Plate grant for the re-introduction of Tahoe yellow cress on Nevada State Lands. The grant award of $60,000 was secured in April 2003 and will support Nevada's commitment to the basin-wide effort over the next 3 years.

4.5 NEVADA DIVISION OF FORESTRY

Staff from NDF spent approximately 300 hours and $5,000 on Tahoe yellow cress conservation activities during 2003. Activities included, but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings; participating in the stewardship committee of the TAG; assisting in development of research priorities; sowing seeds at the NDF East Lake Nursery for

experimental outplanting; and assisting with the outplanting activities. Staff from NDF will continue to participate in the implementation of the CS, and activities for 2004 will be commensurate with those conducted in 2003.

4.6 NEVADA NATURAL HERITAGE PROGRAM

Staff from NNHP staff spent approximately 160 hours and approximately $5,600 on data management and conservation activities during 2003. Activities included, but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings and updating range-wide Tahoe yellow cress databases with new survey and monitoring data as received and ensuring these data are available to all interested entities. Staff from NNHP anticipates that 2004 activities will be commensurate with those conducted in 2003.

4.7 CALIFORNIA DEPARTMENT OF FISH AND GAME

Staff from CDFG spent approximately 272 hours and approximately $17,000 on Tahoe yellow cress management and conservation activities during 2003. Activities included, but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings; participating in the annual survey and monitoring effort for 2003; assisting in development of research priorities; drafting grant proposals to support implementation of CS; and administering collection permit for germination, propagation, and outplanting experiments. Staff from CDFG have also played the lead role in developing and implementing the Tahoe yellow cress stewardship program (see Friends of Tahoe Yellow Cress section below), which has required close coordination with TLOA, drafting a public participation strategy, and presenting ideas and encouraging input from TLOA members at annual meetings.

Staff from CDFG will continue to participate in the implementation of the CS. Activities for 2004 will be commensurate with those conducted in 2003, such as attending Tahoe yellow cress Executive and TAG coordination meetings, participating in the annual survey, and coordinating and implementing the Tahoe yellow cress stewardship program.

4.8 CALIFORNIA DEPARTMENT OF PARKS AND RECREATION

Staff from CDPR spent 403 hours and approximately $14,000 on Tahoe yellow cress management and conservation activities during 2003. Activities included, but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings and taking meeting minutes; participating in the annual survey; maintaining the existing enclosure at D.L. Bliss State Park; educating seasonal and permanent staff about Tahoe yellow cress; assisting in development of research priorities; and implementing research projects within the boundaries of California State Parks lands. Some associated activities included identifying appropriate outplanting sites and assisting in outplanting activities. Monthly disturbance and demographic monitoring and reporting were also performed subsequent to the outplanting project.

Staff from CDPR will continue to participate in the implementation of the CS. Activities will be commensurate with those conducted in 2003, such as attending Tahoe yellow cress Executive and TAG coordination meetings, maintaining the enclosure at D.L. Bliss State Park, participating in the

annual surveys, and participating in the experimental outplanting projects located on California State Parks lands, including constructing enclosures, outplanting, and monitoring. The CDPR anticipates expenditures of approximately $17,000 on Tahoe yellow cress management and conservation in 2004.

4.9 CALIFORNIA TAHOE CONSERVANCY

Staff from CTC spent 1,024 hours and approximately $38,000 on Tahoe yellow cress management and conservation activities during 2003. Activities included, but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings; assisting in development of research priorities; and maintaining protective fences around Upper Truckee East. The CTC continued conservation efforts at Upper Truckee East and West by providing a land steward at these sites and holding community meetings to inform the public about sensitive resources in the shorezone, including Tahoe yellow cress.

Staff from CTC will continue to participate in the implementation of the CS. Activities will be commensurate with those conducted in 2003, such as attending Tahoe yellow cress Executive and TAG coordination meetings, maintaining the enclosure at Upper Truckee East, and participating in the experimental outplanting projects located on CTC lands, including constructing enclosures, outplanting, and monitoring. The CDPR anticipates expenditures of approximately $23,000 on Tahoe yellow cress management and conservation in 2004.

4.10 CALIFORNIA STATE LANDS COMMISSION

Staff from CSLC spent 400 hours and approximately $38,000 on Tahoe yellow cress management and conservation activities during 2003. Activities included but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings; participating in the annual survey; reviewing environmental documentation for projects permitted by CSLC; educating CLSC staff on Tahoe yellow cress issues; and revising and implementing construction and access guidelines to provide more protection to Tahoe yellow cress sites on lands under CSLC purview. Staff from CSLC has also been integral in the development and implementation of the Tahoe yellow cress stewardship program. The agency's project review process, which will require more site-specific surveys for Tahoe yellow cress on properties within the shorezone in California and help streamline the project approval process, continues to be assessed to ensure effectiveness and efficiency.

Staff from CSLC will continue to participate in the implementation of the CS. Activities will be commensurate with those conducted in 2003, such as attending Tahoe yellow cress Executive and TAG coordination meetings, continuing project/lease reviews that may affect Tahoe yellow cress or its habitat, participating in the annual surveys, and coordinating and implementing the Tahoe yellow cress stewardship program.

4.11 TAHOE LAKEFRONT OWNERS' ASSOCIATION

Staff from TLOA spent 100 hours on Tahoe yellow cress management and conservation activities during 2003. Activities included but were not limited to: Attending Tahoe yellow cress Executive and TAG coordination meetings; participating in the annual survey; and providing information

regarding Tahoe yellow cress to lakefront owners, nurseries, and landscape companies through newsletters and meetings. Staff from TLOA have been integral in the development and implementation of the Tahoe yellow cress stewardship program. The TLOA also sponsored the Shorezone Symposium that highlighted critical issues in the shorezone, including Tahoe yellow cress. Members from the TAG participated in the symposium by presenting the goals of the stewardship program and being available to answer questions.

Staff from TLOA will continue to participate in the implementation of the CS. Activities will be commensurate with those conducted in 2003, such as attending Tahoe yellow cress Executive and TAG coordination meetings, coordinating and implementing the Tahoe yellow cress stewardship program, and providing funding in support of the CS.

5. RECOMMENDED CONSERVATION ACTIVITIES FOR 2004

5.1 IMPLEMENT EXPERIMENTAL REINTRODUCTIONS: PHASE I

The pilot outplanting project proved to be a cost-effective way of inform future reintroduction efforts; however, the lack of replication in the pilot design precluded efforts to determine the validity of observed trends and make robust comparisons for some variables. A scientific program of experimental reintroductions is necessary in 2004 to elucidate the habitat conditions and best management practices required to optimize the chances for successful restoration of Tahoe yellow cress.

Phase I of the experimental reintroduction is part of an 8-year program designed to meet Conservation Goals 2 and 4 of the CS. Goal 2 calls for improvement of the size and persistence of Tahoe yellow cress populations at core and priority restoration sites. The ability to successfully meet that goal is dependent upon efforts to meet Goal 4, which is to conduct research that directly supports management and restoration of the species. The first four years of the program emphasize research, focusing on testable, management-oriented hypotheses that will inform subsequent restoration activities. A gradual transition towards a restoration component begins during year 3 and is fully operative in years 5 through 8. Expansion of either the research or restoration components may be necessary to meet the rigorous criteria set forth in the CS (e.g., core populations with 1200 stems minimum for 6 years out of 10).

5.1.1 KEY MANAGEMENT QUESTIONS

As previously discussed, KMQs were developed to organize existing and future research related to Tahoe yellow cress (Pavlik and O'Leary 2002). The experimental reintroduction project will utilize a hypothesis-driven, replicated experimental design to answer questions in the KMQ framework. A replicated demographic monitoring component will assist in determining those factors that limit population growth and population persistence. Specifically, the project will provide statistically robust data on demographic performance in different microhabitats and the performance of selected genotypes.

5.1.2 PROPOSED OUTPLANTING SITES AND EXPERIMENTAL DESIGN

The most desirable site for Phase 1 is Upper Truckee East, the second highest ranked core site in the CS, which is managed by CTC. Complex gradients at this site support the most diverse assemblage of microhabitats types found anywhere around the lake including low beach, beach trough, high beach, dune, and meadow. The site provides sufficient area to install replicated blocks in each of these microhabitats as well as a precision seeding experiment. The experiment will consist of installing 1,250 plants at Upper Truckee East, which will inform KMQs 2, 3, and 4 with a high degree of certainty.

In addition to the new information that be obtained through experimentation at Upper Truckee East, repeating the pilot outplanting project at two of the 2003 sites (Taylor Creek and Sand Harbor) would make it possible to test the idea of founder cost averaging. This economically based principle evaluates the temporal component of conducting restoration activities by evaluating whether there is a benefit to outplanting all plants in one year or spreading the outplantings over time. The project design also builds in age-structure to the experimental population and enables comparison of different cohorts of founders.

Installation of replicated experiments at two simple gradient sites will take place in 2004: Kahle/Nevada (USFS) and Emerald Point (CDPR). Kahle/Nevada supports two microhabitats and could accommodate 400 plants and Emerald Point could support 200 plants in a single microhabitat. Altogether over 3,000 plants may be installed in support of the Tahoe yellow cress research agenda during the 2004 season.

5.1.3 FENCING/SITE PROTECTION

The 2003 pilot outplanting project demonstrated that fencing was an effective way to minimize disturbance inside the plots. For the most part, people respected the fencing and the plots were not vandalized. Protecting the plants from unnatural, disturbance-induced mortality is an important factor in being able to detect microhabitat or genetic factors that influences differential survival. The 2004 experimental plots will be protected by temporary fencing, which will remain in place through 2006. The lake level would be monitored to ensure that all low water fences would be removed prior to becoming submerged should a rapid increase in lake level occur. This action would remove any potential safety hazards.

5.2 FUNDING

Phase 1, if implemented in 2004, is expected to cost approximately $120,000, excluding fencing, propagation, and agency staff time. Phase II, planned to be implemented in 2005, would be the most expensive year of the program, and is estimated to cost $150,000, due to the intensive nature of the monitoring program. Subsequent to these initial phases, the project costs decrease as the focus shifts toward a restoration component. A 3-year projection estimates the total cost to be $260,000, excluding fencing, propagation, staff time, and propagation, which are expected to cost approximately $100,000 in 2006 and $80,000 thereafter for 2 years (Table 7).

Table 7. Tahoe Yellow Cress 5-year Research Budget Projection

Task*/Year	2004	2005	2006	2007	2008
Task 1	$10,000	$10,000	$10,000	$5,000	$5,000
Task 2	$10,000	$15,000	$5,000	$5,000	$5,000
Task 3	$10,000	$15,000	$10,000	$10,000	$10,000
Task 4	$30,000	$40,000	$25,000	$15,000	$15,000
Task 5	$5,000	$5,000	$5,000	$5,000	$5,000
Task 6	$20,000	$25,000	$20,000	$15,000	$15,000
Task 7	$15,000	$20,000	$15,000	$15,000	$15,000
Labor	$100,000	$130,000	$90,000	$70,000	$70,000
Expenses	$15,000	$15,000	$8,000	$8,000	$8,000
Supplies	$5,000	$5,000	$2,000	$2,000	$2,000
Total	**$120,000**	**$150,000**	**$100,000**	**$80,000**	**$80,000**

*Excludes fencing, propagation, and agency staff time.

The tasks identified in Table 7 are as follows:

- Task 1: Administration -- Includes securing necessary permits and agreements, landowner meetings, organization, TAG participation
- Task 2: Site Layout -- Includes microtopographic characterization of various microhabitats (i.e., low beach, beach trough, high beach, dune, dune trough, and meadow)
- Task 3: Outplanting -- Installation of plants at chosen sites
- Task 4: Monitoring -- Bi-weekly monitoring of demography and physiology (water relations)
- Task 5: Seed Collection -- Collection of seed from 5-10 Tahoe yellow cress populations for future nursery propagation
- Task 6: Data Analysis -- Statistical evaluation of Tahoe yellow cress performance in different microhabitats, including genetic and physiological components
- Task 7: Report -- Full report linking current year activities with previous year efforts, KMQs, and the CS

5.3 FRIENDS OF TAHOE YELLOW CRESS PROGRAM

A critical component of the CS is the establishment of a stewardship committee, a subgroup of the TAG, to oversee implementation of a stewardship program. The program should "encourage landowners and non-governmental entities to manage for the conservation of Tahoe yellow cress…." Spearheaded by CDFG and CSLC, efforts to develop a feasible program have been greatly enhanced by the participation of TLOA. In addition, the director of a statewide public relations firm presented an interactive seminar to the stewardship committee on creating a communications plan of action.

A Draft Public Participation Strategy for Tahoe Yellow Cress Conservation has been prepared, which identifies the following pertinent issues:

- Articulating the motivating reasons behind public desire to voluntarily protect Tahoe yellow cress
- Identifying management actions within the CS that would be more successful through public participation
- Identifying the appropriate audiences to approach, as well as the messages and activities to encourage participation
- Creating options for public/corporate sponsorship of activities
- Developing initial ideas to launch a "Friends of Tahoe Yellow Cress" group

In August 2003, the stewardship committee gave a presentation about the Tahoe yellow cress conservation efforts to approximately 200 members of TLOA as part of an annual forum held to discuss issues around the lake that affect private landowners. Greenhouse-grown Tahoe yellow cress individuals along with a close relative that also occurs at Lake Tahoe (*Rorippa curvisiliqua*) were on hand to show landowners the differences between the two species. Members were asked to allow the TAG access to their beaches during the Tahoe yellow cress annual survey. Several landowners granted access for the surveys and even met with members of the TAG during the surveys to view the plants on their property. The meeting was overall a success and several landowners expressed interest in becoming "Friends of Tahoe Yellow Cress". The stewardship committee will continue to work closely with TLOA and interested landowners as the Friends group is developed in the coming year.

6. REFERENCES

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.

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.

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.

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. 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 under contract to Tahoe Regional Planning Agency. Stateline, NV.

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 under contract to Tahoe Regional Planning Agency. Zephyr Cove, NV.

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. 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.

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.

Appendix A: Field Survey Form Developed for 2003

Appendix B: Revised Survey Protocols for 2003 and Clarifications for 2004

Data sheets:
Information included on the Archival Data Sheet has been integrated into the Annual Data Sheet and the data requirements have been condensed. The Archival sheet has been eliminated and a one page Field Survey Form will now be used.

Please be diligent in filling out all of the data fields as thoroughly as possible while you are on the ground doing the survey. This will ensure that all elements of the survey are captured on the data sheet and details are not omitted or forgotten.

If you have any questions about a data field, please ask.

GPS data:
NNHP has delineated site boundaries based on information provided in 2001 on USGS quads and GPS data from CSLC.

Because most of the site boundaries have been established, surveyors are only responsible for GPSing TYC clusters/individuals unless otherwise noted on the data sheet/map.

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 6.5m in diameter, simply take a central point. For one cluster with a diameter larger than 6.5m, endpoint or corner coordinates can be taken. If two clusters are separated by less than 13m, 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 13m, they should be treated as 2 separate clusters and GPS coordinates should be obtained for each cluster (either endpoints 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 kind 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/or outlying individuals within a site, document what data you have taken and how it should be interpreted by NNHP.

REMEMBER, MORE INFORMATION IS BETTER THAN LESS, SO BE SPECIFIC AND BE DETAILED!!

Clarification for 2004 Annual Surveys (pending TAG approval)

When possible each survey team should have a team leader who has been part of previous survey years, or who has been working closely with the TAG. This will help to synchronize the quality of the data. Surveys shall be conducted following established protocols. Each section of the field survey form is footnoted with a reference number that corresponds with the protocol form. All known population sites will be surveyed annually between June 15 and September 30, additional potential habitat will be surveyed when time and funding allow. Surveys will include all beach and associated backshore segments along the entire length of a given site. Each site length is based on previously defined geographic boundaries. In general, site boundaries are dictated by either natural, (creek mouths, substrate change [sandy beach to boulder]) or human-constructed features (private property fences, rock jetties, etc.), which ultimately restrict the surveyor's lateral movement along the lakeshore. For example, the Blackwood Creek South site extends from the mouth of Blackwood Creek, south to the boat launch at the end of Grand Avenue. The southern border is dictated by private property, which restricts lateral access to adjacent potential Tahoe yellow cress habitat. The boundaries of each site have been delineated using high-resolution GPS technology and are established in the NNHP database.

The surveyor should walk the complete length of the beach, making several passes when needed in order to thoroughly cover the entire potential habitat. In general, a surveyor can cover approximately a 15 ft-wide (4.5 m) section of beach on each pass. Upon completing the end of a lower beach site, the surveyor should then focus on the backshore section of the site. Special attention should be paid to backshore depressions that are likely to have increased soil moisture, and ecotonal boundaries between vegetation and beach substrate. Additionally, on open sandy beaches, microtopographic differences should be investigated closely. Small rises and associated depressions, leeward sides of prominent natural or human-created debris, and litter lines created through wave action provide potentially suitable habitat along any given lakeshore segment and should be investigated carefully.

All information is recorded on Tahoe yellow cress Plant Survey Forms and provided to NNHP and CNDDB. At each site, provide a brief sketch of beach profile noting where TYC clusters are located and estimate and record the level of disturbance (light, moderate, heavy), type of disturbance (raking, foot traffic, recreation, vegetation removal, trash, etc.) and area disturbed. A cluster is based on GPS error. Most GPS units used during the annual survey are only accurate to within 3 to 9 meters and NNHP has a biotic error of within 6.5 meters as acceptable. Therefore TYC plants that are separated by a distance of greater than 13 meters can be considered a new cluster. GPS coordinates should be recorded for each cluster (either end points or central points). Clusters will be considered subsets of the overall population at each site.

If Tahoe yellow cress is present, the number of individuals within each cluster at a site will be counted or estimated. An individual is defined as all stems that are within 6" of each other. For each individual cluster the follow data should be recorded: Estimated percent or actual number of juvenile, reproductive (flowering and fruiting) and senescent individuals; vascular plant species percent coverage at the cluster; and estimate percent substrate type based on USDA's *Comparison of size particle* classes (e.g. sand, fine gravel, boulders, etc.).

Appendix C: Presence (X) and Absence (0) of Tahoe Yellow Cress (1978-2003)

Appendix D: 2003 Annual Survey Data by Ranking Priority
Survey dates: September 2-5, 2003; Lake level: approx. 6,224 ft

Site Name	Ranking	# Stems	Effort (min)
Blackwood North	Core	27	150
Blackwood South	Core	168	150
Tallac Creek	Core	13	225
Taylor Creek Enclosure	Core	910	180
Upper Truckee East	Core	~13660	960
Edgewood	Core	335	200
TOTAL CORE SITES		**~15,113**	**1,865**
Ward Creek	High	52	150
Meeks Bay	High	17	165
Meeks Bay Enclosure	High	25	95
Eagle Creek/Avalanche	High	265	200
Tallac Creek Enclosure	High	33	70
Kahle/Nevada	High	0	180
Glenbrook	High	983	?
TOTAL HIGH SITES		**1,375**	**860**
Tahoma	Medium	8	45
Rubicon Bay	Medium	617	630
Emerald Point	Medium	70	80
Eagle Point	Medium	0	120
Baldwin Beach	Medium	62	90
Lighthouse	Medium	432	165
Tahoe Keys	Medium	~4660	270
Upper Truckee West	Medium	~610	270
Timber Cove	Medium	1	60
Tahoe Meadows	Medium	60	135
4-H Camp/City Pump House	Medium	77	100
Zephyr Cove	Medium	66	310
Logan Shoals	Medium	NS	0
TOTAL MEDIUM SITES		**~6,663**	**2,275**
Pope Beach	Low	16	240
Regan/Al Tahoe	Low	~600	80
El Dorado Beach	Low	0	40
Secret Harbor	Low	92	128
Sand Harbor	Low	98	268
TOTAL LOW SITES		**~806**	**756**

Site Name	Ranking	# Stems	Effort (min)
Sunnyside	Unranked	0	80
Hurricane Bay	Unranked	0	150
Kaspian Camp	Unranked	0	160
Tahoe Pines (Fleur Du Lac)	Unranked	43	80
Cherry Street/Tahoe Swiss Village	Unranked	109	120
McKinney North/Shores	Unranked	50	120
McKinney Creek	Unranked	1	25
General Creek	Unranked	5	60
Sugar Pine Point State Park	Unranked	~99	180
Meeks Bay Vista	Unranked	0	90
DL Bliss Enclosure	Unranked	2	60
DL Bliss State Park	Unranked	0	24
Emerald Bay Boat Camp	Unranked	0	70
SE Emerald Bay	Unranked	0	42
CTC Cascade Creek	Unranked	31	30
Cascade	Unranked	75	469
Baldwin Beach Enclosure	Unranked	25	105
Taylor Creek	Unranked	614	1200
Jameson	Unranked	0	45
Bijou (Timber Cove Lodge)	Unranked	18	60
Nevada Beach Enclosure	Unranked	1	45
Elk Point	Unranked	NS	0
Marla Bay	Unranked	15	50
Skyland	Unranked	NS	0
Cave Rock	Unranked	0	80
Skunk Harbor	Unranked	0	74
Hidden Beach	Unranked	19	140
Burnt Cedar Beach	Unranked	0	75
Crystal Point	Unranked	0	75
Kings Beach	Unranked	0	90
Agate Bay	Unranked	0	?
Dollar Point	Unranked	83	120
Tahoe City/Truckee River	Unranked	0	250
TOTAL UNRANKED SITES		**~1,190**	**4,169**
Kiva Beach/Valhalla	Misc	60	45
Roundhill	Misc	~45	60
Logan Shoals Vista	Misc	NS	0
Chimney Rock	Misc	0	100
Tallac Lake	Misc	NS	0
TOTAL MISCELLANEOUS SITES		**~105**	**205**
TOTAL 2003 SURVEY		**~25,252**	**10,130**

Appendix E: Methods and Proposed Site Ranking for 2004 Based on Long-term Data Set

Data analyses performed for the CS established site rankings for the purposes of conservation, restoration, and management priority. An index of viability was calculated for 29 sites, ranging from 97 (Taylor Creek) to -77 (Regan/Al Tahoe). Not all sites were ranked, only a sub-set of "high quality" records were evaluated. A "long-term, high quality" record was defined as having fewer than four "not surveyed" (NS) events during the period from 1979 to 2000. All of these sites were ranked. A "short-term, high quality" record was surveyed at least seven consecutive years and had 2 or less NS events during that period. At the time the CS was drafted, there were 40 sites fitting these definitions.

Of the 40 sites with high quality records, only 29 had stem counts that could be used to calculate a mean stem count over the period from 1979 to 2000; therefore, only these sites received a ranking. The additional criteria used to whittle it down to 29 was that a record had to span an entire decade and have a Pr > 25%. See pages A11-A13 of the CS for a detailed discussion.

The proposed site ranking revisions for all previously ranked sites are based on new data obtained between 2001 and 2003, and are considered biologically and scientifically valid. Of the previously ranked sites, two were demoted in rank (Tahoma and Glenbrook) and five were promoted rank (Lighthouse, Upper Truckee West, Tahoe Meadows, Zephyr Cove, and Secret Harbor).

The following unranked sites fit the ranking criteria and could therefore be ranked:
Cherry St/Tahoe Swiss Village -- surveyed 10 consecutive years, ranked LOW
DL Bliss Enclosure -- < 4 NS from 1979-2003, almost all presence/ absence data and no actual stem counts, ranked MEDIUM
Emerald Bay Boat Camp -- < 4 NS from 1979-2003, ranked MEDIUM
Cave Rock -- surveyed 11 consecutive years, ranked MEDIUM

Two other sites were surveyed in 9 consecutive years, Kiva/Valhalla and Mc Kinney Creek. Both of these ranked as LOW. We can officially rank both next year when they have 10 consecutive yrs.

Results of the 2003 mathematical calculations for ranking sites demonstrate the importance of an adaptive management process. Four new sites were ranked and existing ranks for eight sites were revised. It is important to note that these rankings are based on biological information obtained for the species and while the ranking of a site has management implications, a decision making process has been put into place to address these issues. As we all recognize, Tahoe yellow cress exists in a dynamic environment and, therefore, change is expected.

The following table shows the results of the index of viability calculations based on data through 2003.

Appendix F: Qualitative Description of Known Tahoe Yellow Cress Sites (1998-2003)

The following includes a brief qualitative description of select Tahoe yellow cress sites around Lake Tahoe and are based on surveys conducted since 1998.

Kaspian Camp: No plants were observed at this site during the 1998, 1999, and 2000 surveys. In 2001, one 7.5-in diameter plant was located approximately 80 ft from the lake (6,225 ft). The plant appeared very healthy and was flowering and fruiting. Although this is a public beach managed by the USFS, very little use was noted, possibly due to the cobble and small boulder substrate. Tahoe yellow cress was not observed here during the 2002 or 2003 surveys and cover by nonnative plant species had increased since 2001, most notably Spanish-clover (*Lotus purshianus*). This may have affected the presence of Tahoe yellow cress at this site.

Blackwood Creek North: No plants were observed during the 1998 and 1999 surveys. In 2000, 25 to 30 plants were found approximately 65 ft north of the stream mouth. Plants were found primarily in medium to large cobble, underlain by fine sand. In 2001, 100 plants were counted ranging in size from 0.4 to 14 in diameter. In 2002, 60 plants were counted and habitat conditions appear to be unchanged. In 2003, the number of plants (27) decreased by more than 50 percent from 2002. The reasons for the decline are unknown. The landowner has expressed an interest in participating in the "Friends of Tahoe Yellow Cress" program. Follow-up is necessary.

Blackwood Creek South: This site is greatly affected by seasonal creek flow and channel alteration. The majority of the plants are located in the backshore area adjacent to private property, though it is common to find plants along the "bathtub ring" around the lake as it recedes over the course of the year. Substrate in this area is composed of black, very fine-grained sands and silt. Soil in the backshore area is generally very dry. The number of rosettes observed since 1998 have remained fairly constant at about 200 to 300 stems. Small plants (0.4 to 3 in diameter) are most common at this site and are frequently observed in the flowering and/or fruiting stages. Plants in general appear stressed - small, yellow, wilted - compared to other sites around the lake. In 2003, 168 stems were counted at this site.

Meeks Bay Enclosure: According to historical records, the USFS planted 500 individuals of Tahoe yellow cress within this enclosure in 1988. By 1990, the number of plants had decreased to 215 and was described as small and chlorotic. No other records are known for this site between 1991 and 1997. Since 1998, the number of plants observed within the enclosure has ranged between 1 and 6. Depending on when the survey is conducted the number of individuals varies. Early in the growing season, the stems are far enough apart to suggest multiple plants; however, later in the growing season, these stems mature and resemble one perhaps two plants. Due to the apparent dryness at this site, the plants flower and set fruit relatively early compared to other sites located on the south and west side of the lake. This enclosure was expanded in 2002 (?) to include plants growing adjacent to the marina. Twenty-five stems were counted within the enclosure during the 2003 surveys.

Rubicon Bay: The Greene property is located approximately 550 ft north of D.L. Bliss State Park, west of a channelized creek. Plants are found in the backshore, under the shade of several large pine trees and with *Salix* sp. adjacent to a manmade slough wall. Numbers at this site have ranged from about 30 stems in 1999 to 4 plants in 2001. The 2002 survey found 39 plants at this location with

several scattered clusters located north of the Greene property. Other areas within Rubicon Bay supported over 600 plants in 2003.

D.L. Bliss State Park: According to historic records, CDPR constructed an enclosure north of the park and outplanted 1,168 individuals in 1989. A survey conducted in 1999 documented 832 plants, but by 2001, only 7 plants were observed and those were found within the litter-layer at the northern most portion of the enclosure. Due to the dryness of this site (located over 40 ft from the water's edge, and at higher elevation), the plants appear moderately stressed and seem to have an accelerated growing season. The 2002 survey identified only four plants within the enclosure, and in 2003, two plants were counted.

Tallac Enclosure: This site is referred to as "Cascade (Tallac) Creek" in historical records. Records indicate that in 1988, 500 plants were outplanted by USFS alongside 68 naturally occurring plants within an enclosure. By 1990, the number of outplanted individuals had dropped to 64, due in part to the lowering of the lake level and encroachment by other plant species. In 1998, over 100 plants were identified in the enclosure. In 1999, the enclosure was found to be in a state of disrepair and believed to be interfering with natural sand movement across the beach because of the fence design. Subsequently, encroachment into Tahoe yellow cress habitat by other plant species appeared to inhibit Tahoe yellow cress growth. The enclosure was rebuilt using 4-strand wire fence, allowing more natural sand movement across the beach profile. In 2001, approximately 182 plants were observed within the enclosure. During 2002, however, the population had decreased to 49 plants, and in 2003, only 33 plants were counted.

During 2001, a small population of eight plants was observed west of the enclosure on private land and is referred to as Cascade West. The population was observed again in 2002, and two more plants were found closer to the lake (Cascade West 2). This area was inundated during the 2001 survey. In 2002 and 2003, plants were again observed here, and the site name has been revised to capture adjacent public and private lands. The site is currently referred to simply as "Cascade".

Tallac Creek (outside of enclosure): Plants were identified at this site in 1998 along the margins of the backshore wetland. Historic records indicate plants were observed in this area in 1981, prior to the lake level rising. Four plants were noted in 1990 in the same general location. In 1998, approximately 50 plants were identified along the margins of the creek, in the open sand near the abandoned barbed wire fence, and near the manhole cover. By 2001, over 200 plants were counted at this site. Many of the larger plants were found growing along the margins of the meadow with grasses and grass-like plants. The plants previously identified near the manhole cover were absent in 2001, likely due to the heavy recreational disturbance evident in the area. During the 2002 survey, 40 plants were observed, and in 2003, only 13 plants were counted.

Baldwin Beach: In 1998, two plants were identified outside the Taylor Creek enclosure. In 2000, when the Taylor Creek enclosure was reconstructed, these plants were included within the fenced area. In 2001, four plants were identified along the margin of the Baldwin lagoon, and in 2002, eight plants were observed.

Taylor Creek Enclosure: This site has expanded considerably since 1998, when approximately 50 plants were observed. During the 2001 survey, surveyors counted nearly 900 plants within the

enclosure. Plants were generally large and vigorous. Prior to 2000, before the enclosure was reconstructed, plants were primarily found near the margins of the enclosure and in a very small backshore depression. Since reconstruction of the enclosure, the plants appear to be expanding throughout the enclosure. In 2002, 1,152 plants were observed at this site, and in 2003, 910 plants were counted.

Taylor Creek: Tahoe yellow cress was observed outside of the Taylor Creek enclosure during 2001, and these areas were identified as Taylor Creek West and Taylor Creek East. Taylor Creek West is located west of the creek and south of the enclosure. In 2001, 44 plants were observed and had expanded to 351 plants in 2002. Taylor Creek East is located on the eastern bank of the creek where eight plants were observed during 2001 and 2002 surveys. A new site was also documented at the mouth, Taylor Creek Mouth, where 71 plants were observed in 2002. This area is considered a low elevation site since it was inundated during the 2001 survey when lake elevations were a foot higher than 2002. In 2003, these sites were combined and are referred to simply as Taylor Creek. Over 600 plants were counted here during the 2003 surveys.

Pope Beach: In 2001, 4 plants were identified on the eastern edge of this beach, approximately 10 ft from the water's edge. During 2002 survey, 14 plants were observed. From 1998 through 2000, this area was completely inundated. Plants were large (up to 6 in diameter) and appeared very healthy. Historic records show 25 plants immediately south of where the current plants are located. The 2001 and 2002 surveys relocated the plants near the water, and in 2003, 16 plants were found throughout the historic site.

Lighthouse: Nearly 500 plants were located at this site in 2001, which comprises 2 clusters. One cluster is located along the western edge of the beach, in an isolated backshore depression that contains water throughout much of the growing season. The second cluster is extends along almost the entire length of the beach, adjacent to the manicured lawns and rock gardens. These high elevation plants may be utilizing water used for landscaping and lawn maintenance. The plants are generally large and appear healthy. During the 2002 survey, approximately 400 plants were observed. Some of the beaches that are obviously raked support few, if any, Tahoe yellow cress. In 2003, both clusters were extant and supported a total of 432 plants.

Upper Truckee West: Plants have been identified periodically at this site since 1979. During the 1999 survey, no plants were identified. In 2000, eight plants were found at the mouth of the river, growing among various herbaceous species. By 2001, as lake levels receded, over 450 plants were observed at the site, primarily in the backshore areas that had been inundated in 2000. In 2002, 253 plants were observed during the survey, and in 2003, over 610 plants were counted.

Upper Truckee East: This site has historically and continues to support the largest, most persistent occurrence of Tahoe yellow cress. It is an important stronghold for the species where plants are able to colonize exposed sand bars because of the relative absence of disturbance. Many healthy plants have been noted at this site dating back to 1980. Numbers have ranged from a low of 50 plants in 1979 to over 6,500 plants in 1990. In 2001, 3,171 plants were recorded and during the 2002 survey an estimated 14,434 plants were documented. In 2003, over 13,000 plants were estimated.

Tahoe Meadows: Plants are located along the drainage ditch/unnamed creek at the northern edge of the property (adjacent to the marina). Plants are relatively healthy and large and have been observed in the same general area since 1979. During the 2002 survey, another cluster of plants was discovered south of this site. Both clusters were extant in 2003 when about 60 plants were counted.

Edgewood: Plants are primarily located at the northern portion of this site, in a backshore depression that holds water during much of the year. Plants are very healthy and large. Several additional clusters of Tahoe yellow cress have been identified along the beach, often found in the bathtub ring where litter accumulates or within depressions formed by creek drainages. In 2003, over 330 plants were counted at this site.

Cave Rock: In 2000, 18 plants were observed at this site. Plants were primarily found among the riprap boulders of the jetty at the south end of the site. However, a few plants were located in the grass, adjacent to the jetty path. In 2001, only six plants were found. In 2002, 2 plants were observed, however, another cluster located south of the original site supported 10 plants (Cave Rock South). Similar to Cascade West 2 and Taylor Creek Mouth, Cave Rock South is considered a low elevation site since it was inundated during the 2001 survey when lake elevations were a foot higher. In 2003, the naming convention was revised and both clusters constitute the Cave Rock site. No plants were found here during the 2003 surveys.

Sand Harbor: In 2003, two clusters of Tahoe yellow cress were observed along the main beach at Sand Harbor. The cluster found at the southeast end (within a rocky area) supported two plants, and one plant was found at the northwest end of the beach. The only previously known observation of Tahoe yellow cress at Sand Harbor was a single plant in 1979.