

Tahoe Yellow Cress (*Rorippa subumbellata*)

2002 Annual Survey Report

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Prepared for:

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Tahoe Yellow Cress 2002 Annual Survey Report

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Tahoe Yellow Cress 2002 Annual Survey Report

INTRODUCTION

Tahoe yellow cress (TYC) (*Rorippa subumbellata* Roll.) is a rare plant species endemic to the shores of Lake Tahoe in California and Nevada. It was listed as endangered by the State of California in 1982 (California Fish and Game Code 2050 *et seq.*) and is considered endangered (List 1B) throughout its range by the California Native Plant Society (Skinner and Pavlik, eds. 1994). TYC is state-listed as critically endangered in Nevada (Nevada Revised Statutes (NRS) 527.260 *et seq.*), and is considered threatened by the Northern Nevada Native Plant Society (Nevada Natural Heritage Program (NNHP 2001).

In 1980, the U.S. Fish and Wildlife Service (USFWS) identified TYC as a category 1 candidate species for listing under the Endangered Species Act of 1973, as amended (ESA), indicating sufficient information on biological vulnerability and threats were available to support a listing proposal (45 FR 82479). During a 1994-1995 periodic review, the USFWS assessed the need to propose TYC for listing as a threatened or endangered species. During that same period, a regional drought resulted in a significant drop in lake elevations. The lower lake elevations exposed large expanses of contiguous potentially suitable habitat for TYC. The species responded by colonizing many of these areas. As a result of the species' response to low lake elevations, as well as changes to the USFWS' method of categorizing species, TYC was downgraded from category 1 candidate status to a species of concern in 1996 (61 Federal Register 7595).

The drought ended in the mid-1990s and lake elevations began to rise, inundating most established TYC occurrences and its shoreline habitat. Prolonged periods of inundation coupled with increased recreation in the shorezone prompted the USFWS to again review the status of the species. In 1999, TYC was again added to the candidate list (64 FR 57533). Surveys conducted in September 2000 documented 14 occupied sites, down from 35 sites in 1993 and 51 known historic sites. Based on those surveys, it was determined that TYC occupied only 33 percent of the known, historic sites (see Attachment A of Appendix B). Evidence suggests the decline in the number of sites occupied by TYC is due to a variety of causes, including the combined effects of sustained high lake elevations and increased human use of lakeshore habitats. Because of the imminent threats facing the species, a task force (TYC Technical Advisory Group (TAG)) was formed to develop and implement a conservation strategy (CS) and memorandum of understanding (MOU) for TYC (Pavlik et al. 2002). Implementation of the CS is currently underway, and management and conservation direction will be reassessed each year subsequent to the annual surveys.

This report, as required by the CS, describes the status of TYC in 2002. It includes a summary of the number of populations identified and individuals estimated during the annual field survey. It also summarizes conservation activities undertaken by each agency, staff time spent during 2002, and future conservation activities anticipated for 2003. Appendix B offers an overall assessment of the surveys conducted between 1979 and

2002; Appendix C gives a qualitative description of the known TYC sites; and Appendix D provides an overview of seed collection activities and propagation efforts.

2002 FIELD SURVEYS

Methods

Various surveys and studies of TYC have been carried out on the beaches around Lake Tahoe since 1979. Many historic locations of TYC have been well documented, providing long-term presence/absence data for the region (Baad 1978, 1979; Knapp 1979, 1980; Reed 1982; Ferreira 1987, 1988). However, inconsistencies in sampling methods over the years (non-consecutive survey years, incomplete surveys, and differing methodology) have made direct comparisons of data difficult.

As part of the CS, an effective survey/monitoring protocol was developed and implemented in 2001 that includes a census of known populations and systematic searches of unoccupied, potentially suitable habitat areas. The protocol was designed to expand on previous efforts through the collection of data on habitat variables that will assist in explaining the distribution and abundance of TYC. The protocol includes the use of archival and annual survey sheets (Appendix A). The archival data sheet is designed to record important biotic and abiotic environmental components that are unlikely to vary significantly in the future. The annual data sheet is used to collect information on population census and other dynamic habitat variables.

The 2002-lakewide surveys for TYC were mostly conducted from September 3 through September 5, 2002. Surveys at some sites on the east shore were conducted on September 16 and October 2. Participants included: Maurya Falkner, Sarah York, and Eric Gillies of the California State Lands Commission (CSLC); Jerry Dion of the Tahoe Regional Planning Agency (TRPA); Tamara Sasaki and Scott Scheibner of the California Department of Parks and Recreation (CDPR); Jody Fraser of the USFWS; Daniel Burmester of the California Department of Fish and Game (CDFG); Gail Durham, Molly Bernegger, Marchel Munnecke, and Bob Becker of the U.S. Forest Service (USFS); and Alison Stanton of BMP Ecosciences. This was the highest number of staff persons to participate in the annual survey, largely due to the contribution of four additional USFS and CDPR surveyors. CSLC, CDFG, and USFS contributed various hand-held Global Positioning System (GPS) units. GPS data were provided to CSLC for download and map creation. BMP Ecosciences led a second seed collection effort at several occupied sites around the lake. Similar to 2001, seeds were collected for propagation and outplanting research beginning in 2003. Finally, staff from the USFWS and National Forest Genetic Electrophoresis Lab collected vegetative material at various sites for genetic analyses of the species.

Teams ranging from one to five individuals surveyed each site, covering the entire width of the beach, from water's edge to the backshore habitat. Physical (slope, aspect, substrate type, and soil moisture), biological (species composition and cover), and land use (type and percent disturbance) attributes were collected at each site. Search effort was also recorded for most of the sites, which is defined as the number of person minutes spent

actively searching for and/or collecting data on TYC. Data were recorded on the archival and annual survey sheets. Additional species-specific information including, but not limited to, life stage, rosette diameter, and distance to water was collected at sites supporting TYC. GPS data were obtained for new and expanded sites.

Results and Discussion

Lake elevations ranged between 6,224.04 and 6,223.95 feet (ft) during the survey period (USGS 10337000 Tahoe City gauging station). This is the lowest recorded lake elevation since 1994. As a result of this and increased survey effort, all but six of the historic sites identified in the CS were searched in 2002. Four of the six sites not surveyed are located on private property where access was denied.

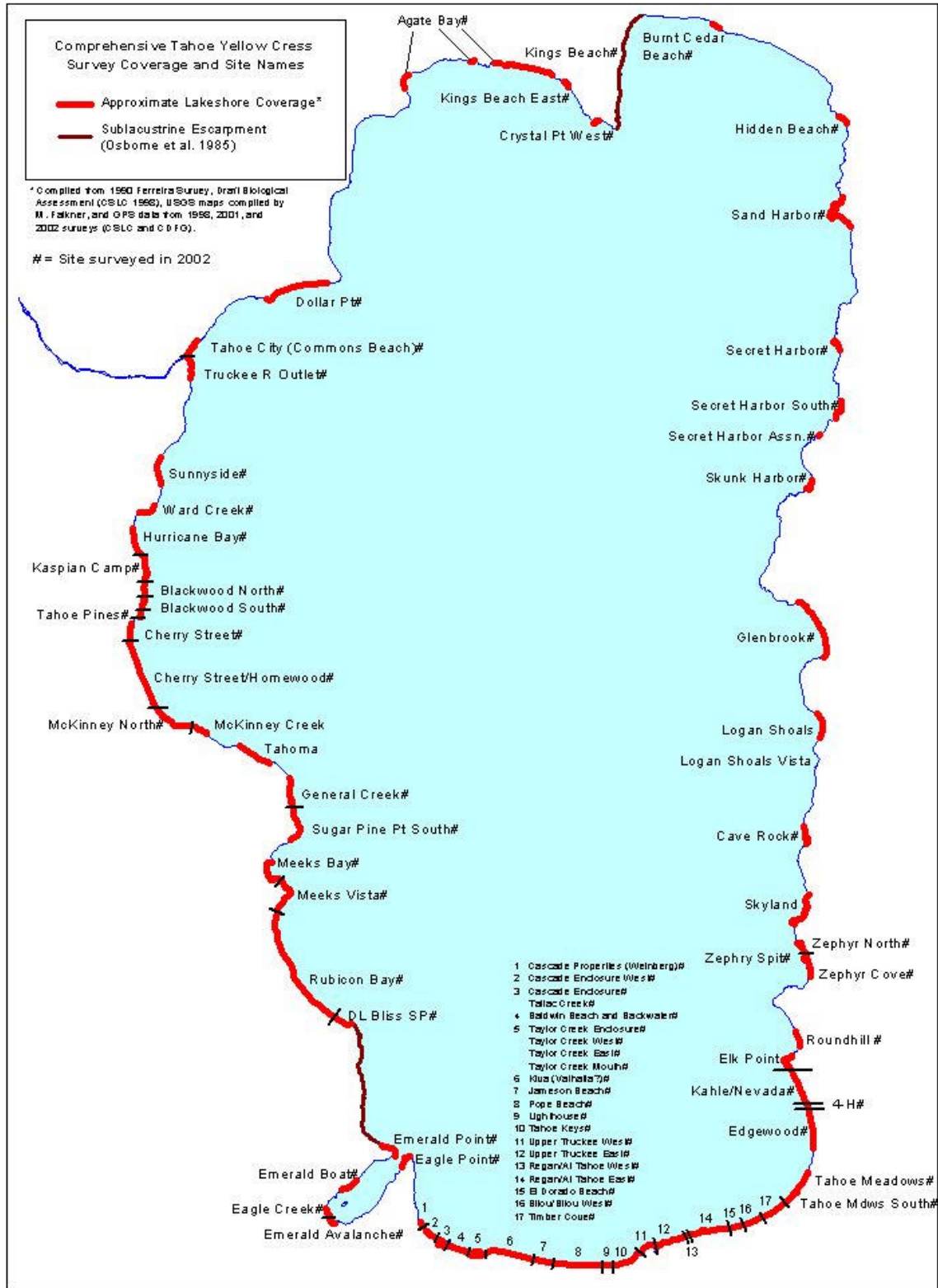
Previous survey efforts have focused on sites where TYC has been observed in the past. Similar to the goal in 2001, the 2002 survey effort was designed to intensively survey as much of the shoreline as possible. Figure 1 provides a comprehensive map of the shoreline coverage and site names based on data mapped by Ferreira (1990), maps compiled by M. Falkner, and GPS points collected in 1998, 2001, and 2002. Surveyors spent more than 5,000 person minutes during the surveys (Table 1 and 3), which amounts to over 83 person hours. Because the core sites typically support the highest number of plants, these areas required more survey time (1,570 person minutes), which was consistent with the 2001 survey. The 2002 survey committed approximately 1,800 person minutes to unranked and new or expanded sites, which was more than twice as much time as 2001. One of the issues brought up with the surveyors was the time required to thoroughly fill out the survey forms was excessive. A task for the TYC TAG prior to the upcoming field season may be to reevaluate the data being collected and ensure that only pertinent information is included.

Table 1. Summary of Person Minutes for 2001 and 2002 by Ranked Sites

TYC Ranked Sites	Approximate Survey Person Minutes	
	2001	2002
Core	1,590	1,570
High	320	540
Medium	615	937*
Low	255	180*
Unranked	845	1,770*
Miscellaneous	-	20
Total	3,625	5,017

* Several sites were surveyed but survey time was not recorded on the data sheets (see Table 3).

Figure 1. 2002 Sites



The intensive 2002 survey identified TYC at 48 of the 71 sites surveyed (68 percent occupied), up from 31 sites (53 percent occupied) in 2001. This year's effort included surveys of 13 "new" named or expanded sites, which had been inundated as far back as 1997 (Falkner, CSLC, pers. comm.) (Table 2). Twelve of the 13 "new" sites supported TYC, and the remaining site is considered potentially suitable TYC habitat. These sites are described as "low water island populations" in the CS: As lake elevation drops, the amount of available habitat and the likelihood of colonization by TYC increases (see Figure 2 and Appendix B for further discussion). A late survey by Jody Fraser (USFWS) on November 2 also found a small population at Burnt Cedar Beach in Incline Village (Table 2 and 3). Additionally, the implementation of CSLC's "TYC Project Review Guidelines" required staff to conduct site-specific surveys of 16 private properties within TYC habitat. No plants were observed at these proposed project sites.

The distribution of TYC by lake quartiles was highest for the southwest and southeast sectors, with all but five populations represented in these two sectors. Two populations were located in the northwest sector and three populations were identified in the northeast sector (excluding the Burnt Cedar site). Plants had not been recorded in the northeast sector since 1992 (Secret Harbor) and 1994 (Crystal Point West). Ten of the sites with TYC occurred in Nevada (excluding the Burnt Cedar site), which is up from four from 2001. The remaining 38 occupied sites were located in California. Approximately half of the TYC populations (20) occur on lands managed by public agencies, such as USFS, State, County, or City government. The remaining populations (28) were found on private lands.

An estimated 20,301 "individuals" were counted in 2002, up from 6,136 in 2001 (Table 2). Stem counts per site ranged from a low of one (Kahle/Nevada Beach) to a high of 14,434 (Upper Truckee East). This results in a calculated mean of 423 stems/site. Excluding Upper Truckee East, the calculated mean drops to 125 stems/site. Over 1,100 plants were found at unranked and new or expanded sites, which is nearly eight times more plants than the 2001 survey (146 plants) for the same category (CSLC 2002). This increase may be a function of lower lake elevation and the intensive nature of the survey (Table 1).

TYC was observed in a variety of substrates such as cobbles and rock during the 2002 survey. This is a departure from the typical sandy substrate where the plant has most frequently been observed. Generally, suitable habitat is considered to be composed of at least 30 percent sand; however, based on this year's results, it is apparent the species is adapted to a broader range of habitat conditions than previously thought. Based on the field data sheets where TYC was observed, composition of sandy substrate ranged from less than 5 percent to 100 percent. Nineteen percent of the TYC occupied sites had less than 30 percent sandy substrate; however, the majority of sites (70 percent) had greater than 50 percent sandy substrate (Table 4).

Table 4 also includes a summary of substrate disturbances based on an estimated percentage of footprint indentations within the sites. These data were summarized from data sheets providing information on percent substrate disturbance at occupied TYC sites, which this information was included in 43 of the 48 occupied sites. A little more than half (53 percent) of the occupied sites recorded light to lightly moderate disturbances (<25

percent) of the substrate. Sites with moderately heavy to heavy footprint disturbances (>51percent) made up 28 percent of the sites (Table 4). Collection of this information would be important to compare with high lake elevation years to ascertain recreational effects to these populations.

Similar to 2001, seed collection was conducted at several sites during the 2002 survey period. Appendix D provides a full summary of the 2001 and 2002 seed collection efforts and nursery propagation results.

The 2002 annual survey also included collection of vegetative material for use in a genetic analysis of TYC. Table 5 provides a summary of the sites and number of individual plants sampled. The 2002 survey also included soils sampling at five sites located on USFS lands, including Taylor Creek, Baldwin Beach, Cascade Enclosure, Meeks Bay, and Kahle/Nevada Beach. A total of 48 samples were taken and will be analyzed for carbon (organic matter), nitrogen, and mineralizable nitrogen. The results of the genetic analysis and soil study will be provided in the 2003 Annual Survey Report.

Conclusion

The low lake elevation (6,224 ft) (Appendix B) and intensive survey effort resulted in the greatest number of sites visited (71) and the highest individual plant count (20,249) since surveys have been conducted for this species. Last year's survey documented 58 sites surveyed and nearly doubled the previous high individual count in 1990 of 11,110 stems (Pavlik et al. 2002).

Based on the annual survey results, TYC status is at Level 1 of the Imminent Extinction Contingency Plan, which is defined as 6 core populations and at least 15 (inclusive of the core populations) total populations (each with >30 reproductive stems) or more than 60 percent of the habitat is occupied (Pavlik et al. 2002). The results of the 2002 survey met all of these criteria. Plants were observed at all 6 of the core populations, 18 sites each supported >30 reproductive stems, and 68 percent of the habitat was occupied. Attachment A of Appendix B provides the historic levels from previous survey years.

2002 ACTIVITIES BY AGENCY

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

California Department of Fish and Game

CDFG staff spent approximately 232 hours on TYC management and conservation activities during 2002. Activities included, but were not limited to: Attending TYC Executive and TYC TAG coordination meetings; participating in the annual survey; and conducting site visits to key TYC occurrences to assess proposed management activities. Staff assisted in the development of the final CS/MOU and participated in public workshops.

Staff also prepared a proposal to obtain \$58,000 Federal Endangered Species Act Section 6 funds for research into key management questions. Finally, staff administered the collection permit to BMP Ecosciences for the collection and propagation of TYC.

CDFG will continue to participate in the implementation of the CS in 2003. Activities will be commensurate with those conducted in 2002.

California Department of Parks and Recreation

CDPR staff spent approximately 155 hours on TYC management and conservation activities during 2002. Activities included, but were not limited to: Attending TYC Executive and TYC TAG coordination meetings; participating in the annual survey; maintaining the existing enclosure at D.L. Bliss State Park; and assisting with site selection for potential reintroduction of TYC on State Parks lands. Staff also assisted in the development of the final CS/MOU.

CDPR will continue to participate in the implementation of the CS in 2003. Activities will be commensurate with those conducted in 2002, such as, attending TYC Executive and TYC TAG meetings, maintaining the enclosure at D.L. Bliss State Park, participating in the annual surveys, and participating in the experimental TYC reintroductions if located on State Parks lands, including constructing enclosures, outplanting, and monitoring.

California State Lands Commission

CSLC staff spent approximately 565 hours on TYC management and conservation activities during 2002. Activities included but were not limited to: Attending TYC Executive and TYC TAG coordination meetings; coordinating and participating in the 2001 annual survey, as well as collecting and analyzing data for the 2001 and 2002 Annual Survey Reports; and revising and implementing construction and access guidelines to provide more protection to TYC sites. Staff also assisted in the development of the final CS/MOU and prepared the CS/MOU item for CSLC's approval, which occurred October 1, 2002. Finally, staff is improving the agency's project review process, which will require more site-specific surveys for TYC on properties within the shorezone in California.

CSLC will continue to participate in the implementation of the CS in 2003. Activities will be commensurate with those conducted in 2002, such as, continuing project/lease reviews that may affect TYC or its habitat; participating in the TYC Executive and TYC TAG meetings; participating in the annual surveys and preparing the 2003 Annual Survey Report, and continuing to coordinate the TYC stewardship program.

California Tahoe Conservancy (CTC)

CTC staff spent approximately 1,634 hours on TYC management and conservation activities during 2002. The majority of the hours (1,322 hours) were dedicated to land stewardship and management activities on the Upper Truckee East site, which included designing and constructing an enclosure on CTC lands; implementing beach patrols focused on educating the public and minimizing impacts to TYC and its habitat; and conducting public hearings regarding conservation actions on CTC property. Other

activities included, but were not limited to: Attending TYC Executive and TYC TAG coordination meetings and assisting in the development of the final CS/MOU.

CTC will continue to participate in the implementation of the CS in 2003. Staff estimates that approximately 1,780 hours will be spent on TYC related conservation activities. Again, the majority of the hours (approximately 1,460 hours) will be dedicated to land stewardship and management activities on the Upper Truckee East site.

Nevada Natural Heritage Program

NNHP staff spent approximately 98 hours on data management and conservation activities during 2002. Activities included, but were not limited to: Attending TYC Executive and TYC TAG coordination meetings and updating range-wide TYC databases with new survey and monitoring data as received and ensuring these data are available to all interested entities. Additionally, staff assisted in the development of the final CS/MOU. Staff anticipates that 2003 activities will be commensurate with those conducted in 2002.

Tahoe Regional Planning Agency

TRPA staff spent approximately ____ hours on TYC management and conservation activities during 2002. Activities included, but were not limited to: Organizing and facilitating TYC Executive and TYC TAG coordination meetings; finalizing, printing, and distributing the CS/MOU to partners; 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 contracting with BMP Ecosciences. Finally, the Board permitted ____ shorezone projects at Lake Tahoe during 2002.

TRPA will continue to be the lead in implementation of the CS. They will continue to organize and facilitate TYC Executive and TYC TAG meetings. Activities for 2003 include elements identified in the CS, such as, further refinement of Key Management Questions, managing the reintroduction effort at selected sites, and participating in the annual survey.

United States Fish and Wildlife Service

USFWS spent approximately 500 hours on TYC management and conservation activities during 2002. Activities included, but were not limited to: Attending TYC Executive and TYC TAG coordination meetings; assisting in development of the final CS/MOU, including editing and revising the document; assisting in the development and implementation of annual survey and monitoring program; assisting in development and implementation of outreach/education programs, including conducting public meetings; assisting in development of research priorities; and funding Forest Service for redesign and installation of fences and partial funding for ongoing activities performed by BMP Ecosciences.

USFWS will continue to participate in the implementation of the CS. Activities will be commensurate with those conducted in 2002, such as, following up on the genetics study, participating on the stewardship subcommittee of the TAG, and participating in the annual surveys. USFWS will also continue attending TYC Executive and TYC TAG meetings to ensure appropriate levels of implementation of the CS are being met.

United States Forest Service

USFS staff spent approximately 1,250 hours on TYC management and conservation activities during 2002. Activities included, but were not limited to: Attending TYC Executive and TYC TAG coordination meetings; assisting in the development of the final CS/MOU; assisting in the development and implementation of annual survey and monitoring program; assisting in the development and implementation of outreach/education programs; redesigning and reconstructing existing enclosures on USFS lands; and assisting in development, funding, and implementation of the *ex situ* seed propagation program with BMP Ecosciences.

USFS will continue to participate in the implementation of the CS. Staff anticipates approximately 1,700 hours to be dedicated to TYC planning, project implementation, research, etc., for 2003. Currently \$70,000 has been budgeted to TYC from the base budget of the Wildlife Fish and Rare Plant Program for 2003. Another \$13,000 is expected to be applied to a challenge cost-share agreement with TRPA for continuation of BMP Ecoscience's Key Management Question research, funding to grow out another 4,000 plants for next year, and labor to implement the fencing and restoration planting on USFS lands as needed.

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Table 2. 2002 Annual Survey by Named Sites

Occurrence Name	Ranking	Date	Elevation	# Stems	% Juv	% Fl	% Fr	% Fl/Fr	% Sen
Sunnyside	Unranked	9/5/2002	6,223.95	0					
Ward Creek	High	9/5/2002	6,223.95	443	52	5	19	7	17
Hurricane Bay*	Unranked	9/5/2002	6,223.95	0					
Kaspian Camp	Unranked	8/15/2002	6,224.39	0					
Blackwood North	Core	9/4/2002	6,224.00	60	20	2	23	32	23
Blackwood South	Core	9/4/2002	6,224.00	272	7	15	38	31	9
Tahoe Pines*	Unranked	9/5/2002	6,223.95	0					
Cherry Street	Unranked	9/5/2002	6,223.95	34	12	12	64	9	3
Cherry Street/Homewood**	Unranked	9/5/2002	6,223.95	2			100		
McKinney North**	Unranked	9/5/2002	6,223.95	12	50		42	8	
McKinney Creek	Unranked	NS							
Tahoma	Medium	NS							
Sugar Pine (General Cr.)*	Unranked	9/4/2002	6,224.00	6	33	67			
Sugar Pine South*	Unranked	9/4/2002	6,224.00	377	82	4	4	9	1
Meeks Bay	High	9/4/2002	6,224.00	106	72	7	10		11
Meeks Vista	Unranked	9/5/2002	6,223.95	0					
Rubicon	Medium	9/5/2002	6,223.95	39	62	3	3	20	12
DL Bliss	Unranked	9/5/2002	6,223.95	4	50				50
Emerald Point	Medium	9/4/2002	6,224.00	Yes					
Emerald Boat	Unranked	9/4/2002	6,224.00	Yes					
Eagle Creek	High	9/4/2002	6,224.00	4	50			50	
Emerald Bay Avalanche	Unranked	9/4/2002	6,224.00	31	85	5	5	5	
Eagle Point	Medium	9/4/2002	6,224.00	0					
Cascade Prop (Weinberg)*	Unranked	8/6/2002	6,224.52	17	35			59	6
Cascade West*	Unranked	9/3/2002	6,224.04	5			60		40
Cascade West 2**	Unranked	9/3/2002	6,224.04	2		50	50		
Cascade Enclosure	High	9/3/2002	6,224.04	49	4	4	47	31	14
Tallac Creek	Core	9/3/2002	6,224.04	40	25	25	35	10	5
Baldwin Beach/Lagoon	Medium	9/3/2002	6,224.04	8	62	38			
Taylor Enclosure	Core	9/3/2002	6,224.04	1,152	21	3	40	22	14
Taylor Cr. West*	Unranked	9/3/2002	6,224.04	351	51	7	19	21	2
Taylor Cr. Mouth**	Unranked	9/3/2002	6,224.04	71	70	18	2	10	
Taylor Cr. East*	Unranked	9/3/2002	6,224.04	35	15	35	44		6
Kiva/Valhalla	Low	9/3/2002	6,224.04	0					
Jameson*	Unranked	9/3/2002	6,224.04	0					
Pope	Low	9/3/2002	6,224.04	14		10	75		15
Lighthouse	Medium	9/4/2002	6,224.00	394	47	6	14	20	13
Tahoe Keys	Medium	9/4/2002	6,224.00	921	25	60	10	5	
Upper Truckee West	Medium	9/5/2002	6,223.95	253	10	50	30		15
Upper Truckee East	Core	9/3/2002	6,224.04	14,434	37	12	16	32	3
Regan/Al Tahoe West**	Unranked	9/3/2002	6,224.04	23	48	9	35	4	4
Regan/Al Tahoe	Low	9/4/2002	6,224.00	179		40	60		
Regan/Al Tahoe East**	Unranked	9/4/2002	6,224.00	8	50	30	20		

Table 2. Cont.

Occurrence Name	Ranking	Date	Elevation	# Stems	% Juv	% Fl	% Fr	% Fl/Fr	% Sen
El Dorado	Low	9/4/2002	6,224.00	0					
Bijou*	Unranked	9/4/2002	6,224.00	2	50	50			
Timber Cove	Medium	9/4/2002	6,224.00	0					
Tahoe Meadow South**	Medium	9/4/2002	6,224.00	10	90	10			
Tahoe Meadow	Medium	9/4/2002	6,224.00	50	10			58	32
Edgewood	Core	9/4/2002	6,224.00	621	49	6	14	22	9
4-H	Medium	9/4/2002	6,224.00	104	38	11	15	19	17
Kahle/Nevada	High	9/4/2002	6,224.00	1				100	
Elk Point	Unranked	NS							
Roundhill	Misc	9/16/2002	6,223.78	19	74	5	21		
Zephyr Cove	Medium	9/3/2002	6,224.04	0					
Zephyr Spit*	Unranked	9/3/2002	6,224.04	57	79	19	2		
Zephyr Cove North**	Unranked	9/5/2002	6,223.95	36	28	14	19		39
Skyland	Unranked	NS							
Cave Rock South**	Unranked	9/4/2002	6,224.00	10	90	10			
Cave Rock	Unranked	9/4/2002	6,224.00	2	100				
Logan Shoals Vista	Misc	NS							
Logan Shoals	Medium	10/2/2002	6,223.48	0					
Glenbrook	High	10/2/2002	6,223.48	0					
Skunk Harbor	Unranked	10/2/2002	6,223.48	0					
Secret Harbor Assn.**	Unranked	10/2/2002	6,223.48	27	100				
Secret Harbor South**	Unranked	10/2/2002	6,223.48	0					
Secret Harbor	Low	10/2/2002	6,223.48	0					
Sand Harbor	Low	10/2/2002	6,223.48	0					
Hidden Beach NV SP**	Unranked	10/2/2002	6,223.48	3	100				
Burnt Cedar Beach**	Unranked	11/2/2002	6,223.06	4	100				
Crystal Point East	Unranked	NS							
Crystal Point West	Unranked	9/5/2002	6,223.95	0					
Kings Beach East*	Unranked	9/5/2002	6,223.95	3	33	33		33	
Kings Beach	Unranked	9/5/2002	6,223.95	0					
Agate Bay	Unranked	9/5/2002	6,223.95	0					
Dollar Point	Unranked	9/5/2002	6,223.95	10	80	20			
Tahoe City/Commons*	Unranked	9/5/2002	6,223.95	0					
Truckee R. Outlet*	Unranked	9/5/2002	6,223.95	0					
TOTAL 2002 SURVEY				20,301					

*** Represents new sites for 2001; ** Represents new sites or expansions for 2002**

Key: Occurrence Name = Sites are in order beginning at Sunnyside continuing counterclockwise around the lake,

Date = Date Surveyed, Elevation = Lake elevation on day of survey, # Stems = Total stem count

Juv = Juvenile, Fl = flowering, Fr = Fruiting, Fl/Fr = Flowering and Fruiting, Sen = Senescent

Table 3. 2002 Annual Survey by Ranking Priority

Occurrence Name	Ranking	Date	Elevation	# Stems	% Juv	% FI	% Fr	% FI/Fr	% Sen	Effort (min)
Blackwood North	Core	9/4/2002	6,224.00	60	20	2	23	32	23	200
Blackwood South	Core	9/4/2002	6,224.00	272	7	15	38	31	9	240
Tallac Creek	Core	9/3/2002	6,224.04	40	25	25	35	10	5	60
Taylor Enclosure	Core	9/3/2002	6,224.04	1,152	21	3	40	22	14	90
Upper Truckee East	Core	9/3/2002	6,224.04	14,434	37	12	16	32	3	900
Edgewood	Core	9/4/2002	6,224.00	621	49	6	14	22	9	80
TOTAL CORE SITES				16,579						1,570
Ward Creek	High	9/5/2002	6,223.95	443	52	5	19	7	17	180
Meeks Bay	High	9/4/2002	6,224.00	106	72	7	10		11	80
Eagle Creek	High	9/4/2002	6,224.00	4	50			50		40
Cascade Enclosure	High	9/3/2002	6,224.04	49	4	4	47	31	14	60
Kahle/Nevada	High	9/4/2002	6,224.00	1				100		180
Glenbrook	High	10/2/2002	6,223.48	0						?
TOTAL HIGH SITES				603						540
Tahoma	Medium	NS								
Rubicon	Medium	9/5/2002	6,223.95	39	62	3	3	20	12	90
Emerald Point	Medium	9/4/2002	6,224.00	Yes						45
Eagle Point	Medium	9/4/2002	6,224.00	0						30
Baldwin Beach/Lagoon	Medium	9/3/2002	6,224.04	8	62	38				160
Lighthouse	Medium	9/4/2002	6,224.00	394	47	6	14	20	13	60
Tahoe Keys	Medium	9/4/2002	6,224.00	921	25	60	10	5		90
Upper Truckee West	Medium	9/5/2002	6,223.95	253	10	50	30		15	300
Timber Cove	Medium	9/4/2002	6,224.00	0						12
Tahoe Meadow	Medium	9/4/2002	6,224.00	50	10			58	32	10
4-H	Medium	9/4/2002	6,224.00	104	38	11	15	19	17	20
Zephyr Cove	Medium	9/3/2002	6,224.04	0						120
Logan Shoals	Medium	10/2/2002	6,223.48	0						?
TOTAL MEDIUM SITES				1,769						937
Kiva/Valhalla	Low	9/3/2002	6,224.04	0						30
Pope	Low	9/3/2002	6,224.04	14		10	75		15	60
Regan/Al Tahoe	Low	9/4/2002	6,224.00	179		40	60			60
El Dorado	Low	9/4/2002	6,224.00	0						30
Secret Harbor	Low	10/2/2002	6,223.48	0						?
Sand Harbor	Low	10/2/2002	6,223.48	0						?
TOTAL LOW SITES				193						180
Sunnyside	Unranked	9/5/2002	6,223.95	0						20
Hurricane Bay*	Unranked	9/5/2002	6,223.95	0						20
Kaspian Camp	Unranked	8/15/2002	6,224.39	0						15

Table 3. Cont.

Occurrence Name	Ranking	Date	Elevation	# Stems	% Juv	% Fl	% Fr	% Fl/Fr	% Sen	Effort (min)
Tahoe Pines*	Unranked	9/5/2002	6,223.95	0						20
Cherry Street	Unranked	9/5/2002	6,223.95	34	12	12	64	9	3	40
Cherry Street/Homewood**	Unranked	9/5/2002	6,223.95	2			100			15
McKinney North**	Unranked	9/5/2002	6,223.95	12	50		42	8		20
McKinney Creek	Unranked	NS								
Sugar Pine (General Cr.)*	Unranked	9/4/2002	6,224.00	6	33	67				280
Sugar Pine South*	Unranked	9/4/2002	6,224.00	377	82	4	4	9	1	180
Meeks Vista	Unranked	9/5/2002	6,223.95	0						40
DL Bliss	Unranked	9/5/2002	6,223.95	4	50				50	30
Emerald Boat	Unranked	9/4/2002	6,224.00	Yes						?
Emerald Bay Avalanche	Unranked	9/4/2002	6,224.00	31	85	5	5	5		40
Cascade Prop (Weinberg)*	Unranked	8/6/2002	6,224.52	17	35			59	6	30
Cascade West*	Unranked	9/3/2002	6,224.04	5			60		40	20
Cascade West 2**	Unranked	9/3/2002	6,224.04	2		50	50		29	20
Taylor Cr. West*	Unranked	9/3/2002	6,224.04	351	51	7	19	21	2	30
Taylor Cr. Mouth**	Unranked	9/3/2002	6,224.04	71	70	18	2	10		30
Taylor Cr. East*	Unranked	9/3/2002	6,224.04	35	15	35	44		6	180
Jameson*	Unranked	9/3/2002	6,224.04	0						10
Regan/Al Tahoe West**	Unranked	9/3/2002	6,224.04	23	48	9	35	4	4	20
Regan/Al Tahoe East**	Unranked	9/4/2002	6,224.00	8	50	30	20			60
Bijou/Bijou West*	Unranked	9/4/2002	6,224.00	2	50	50				10
Tahoe Meadow South**	Unranked	9/4/2002	6,224.00	10	90	10				25
Elk Point	Unranked	NS								
Zephyr Spit*	Unranked	9/3/2002	6,224.04	57	79	19	2			60
Zephyr Cove North**	Unranked	9/5/2002	6,223.95	36	28	14	19		39	150
Skyland	Unranked	NS								
Cave Rock South**	Unranked	9/4/2002	6,224.00	10	90	10				20
Cave Rock	Unranked	9/4/2002	6,224.00	2	100					10
Skunk Harbor	Unranked	10/2/2002	6,223.48	0						?
Secret Harbor Assn.**	Unranked	10/2/2002	6,223.48	27	100					60
Secret Harbor South**	Unranked	10/2/2002	6,223.48	0						?
Hidden Beach NV SP**	Unranked	10/2/2002	6,223.48	3	100					30
Crystal Point East	Unranked	NS								
Crystal Point West	Unranked	9/5/2002	6,223.95	0						20
Kings Beach East*	Unranked	9/5/2002	6,223.95	3	33	33		33		40
Kings Beach	Unranked	9/5/2002	6,223.95	0						50
Agate Bay	Unranked	9/5/2002	6,223.95	0						40
Dollar Point	Unranked	9/5/2002	6,223.95	10	80	20				60
Tahoe City/Commons*	Unranked	9/5/2002	6,223.95	0						40
Truckee R. Outlet*	Unranked	9/5/2002	6,223.95	0						35
TOTAL UNRANKED SITES				1,138						1,770

Table 3. Cont.

Occurrence Name	Ranking	Date	Elevation	# Stems	% Juv	% Fl	% Fr	% Fl/Fr	% Sen	Effort (min)
Round Hill	Misc	9/16/2002	6,223.78	19	74	5	21			20
Logan Shoals Vista	Misc	NS								
TOTAL MISCELLANEOUS SITES				19						20
TOTAL 2002 SURVEY				20,301						5,017
<u>Late Survey Data</u>										
Burnt Cedar Beach**	Unranked	11/2/2002	6,223.06	4	100					

*** Represents new sites for 2001; ** Represents new sites or expansions for 2002**

Key: Date = Date Surveyed, Elevation = Lake elevation (USGS gauge at Tahoe City), # Stems = Total stem count

Juv = Juvenile, Fl = flowering, Fr = Fruiting, Fl/Fr = Flowering and Fruiting, Sen = Senescent

Table 4. Composition of sandy substrate and percent disturbance (footprints) within occupied sites.

Sandy Substrate	% Occupied Sites	Soil Disturbance	% Occupied Sites
< 30 %	19	Light (<5%)	32
30-50%	11	Light-Moderate (6-25%)	21
50-90%	32	Moderate (26-50%)	19
100%	38	Moderate-Heavy (51-75%)	14
		Heavy (>76%)	14

Table 5. Sites where TYC Sampled for Genetic Analysis
(September 3-4, 2002)

Site	# Individuals sampled
Taylor Creek Enclosure*	20
Tallac Creek*	20
Tallac Creek	11
Tallac Enclosure	10
Taylor Creek East	12
Taylor Creek West	31
Taylor Creek Mouth	10
Cascade West	4
Upper Truckee East	30
Upper Truckee West	30
Regan/Al Tahoe	18
Tahoe Meadows	20
Tahoe Keys	31
Pope Beach	7
Lighthouse	31
Emerald Point	11
Emerald Bay Avalanche	21
Eagle Creek	4
D.L. Bliss	2
Meeks Bay	12
4H	21
Blackwood	28
Zephyr Spit	8
Rubicon	30
Sugar Pine	30
Total # Samples	455

* Sites where *Rorippa curvisilqua* was also sampled

Table 6. Summary of Agency Hours Spent on TYC Related Activities

Agency	Approximate Agency Time on TYC Activities (hours)	
	2001	2002
CDFG	240	232
CDPR	160	155
CSLC	575	565
CTC	1,580	1,634
NNHP	130	98
TRPA	?	?
USFWS	700	500
USFS	658	1,250
Total	6,044	6,421

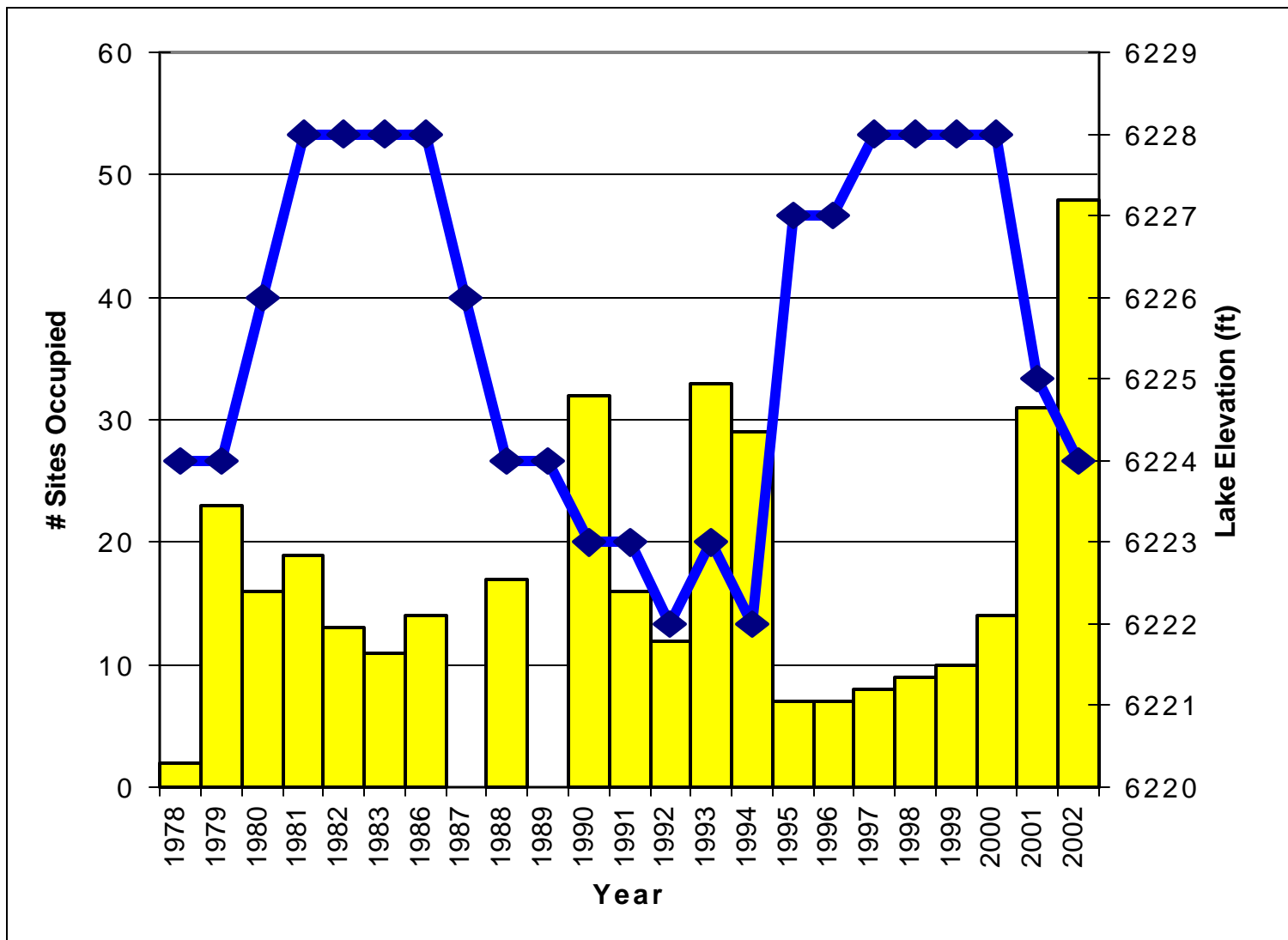


Figure 2: Lake Level and Number of TYC Sites Occupied by Survey Year (Blue line = lake level LTD)

Appendix A
Archival and Annual Survey Sheets

Appendix B
Tahoe Yellow Cress Annual Survey Assessment (1979 – 2002)
Prepared by E. Gillies (CSLC)

The 2002 annual survey for Tahoe yellow cress (TYC) (*Rorippa subumbellata* Roll.) was the 20th survey that has been conducted over a 24-year period, with more sites surveyed than in any other year (Attachment A). The 2001 and 2002 surveys have been the most comprehensive to date, with 58 and 71 sites visited, respectively. Following the 2001 annual survey, an analysis of data collected between 1979 and 2001 was performed (CSLC 2002). The purpose of the analysis was to determine if there is a relationship between how many sites are surveyed and the number of sites that support TYC, as well as provide a comparison between low and high lake elevation years. The results demonstrated that there is a significant negative relationship between high lake elevations and the presence of TYC during the survey period, which is consistent with the findings in the Conservation Strategy (CS) (Pavlik et al. 2002). The results also showed that as the number of sites surveyed increased, particularly in low lake elevation years, the probability of observing TYC at more sites was greater.

The 2002 survey was conducted during low lake elevations (6,224 feet (ft)), which was a foot lower than the 2001 survey for the same period. This analysis incorporates the 2002 survey data and examines the hypothesis proposed in 2001 stating that intensifying and covering more lakeshore areas during low lake levels results in the discovery of more occupied sites due to more habitat exposure.

Results

Simple linear regression was used to analyze all existing data between 1979 and 2002 (Appendix D of the CS (Pavlik et al. 2002); CSLC 2002). Attachment A provides a summary of these data. Based on the analysis and consistent with other analyses, the optimal lake elevation to ensure persistence of Tahoe yellow cress populations is 6,225 ft or below (Table 1). Above 6,225 ft, there is a very significant decline in the number of occupied sites (ANOVA $P = <0.001$) and mean percent occupied (ANOVA $P = <0.01$) (Figures 1 and 2).

Table 1. Comparison of low (<6,225 ft), medium (6,225 to 6,226 ft), and high lake elevation (>6,226 ft) years (1979 to 2002).

	Low Lake Elevation (n = 8)	Medium Lake Elevation (n = 2)	High Lake Elevation (n = 10)
Mean Lake Elevation (ft LTD)	6,223.1	6,225.5	6,227.8
Number of sites with Tahoe yellow cress (mean ± s.d.)	27.9 ± 10.8	23.5 ± 10.6	11.2 ± 3.8**
% Presence of Tahoe yellow cress (mean ± s.d.)	77.0 ± 8.7	55.5 ± 2.1*	35.8 ± 16.3**

Single-factor ANOVA: * $P = 0.01$; ** $P = <0.001$

Figure 1. Relationship between the total number and mean number of sites with occupied Tahoe yellow cress and lake elevation (1979 to 2002).

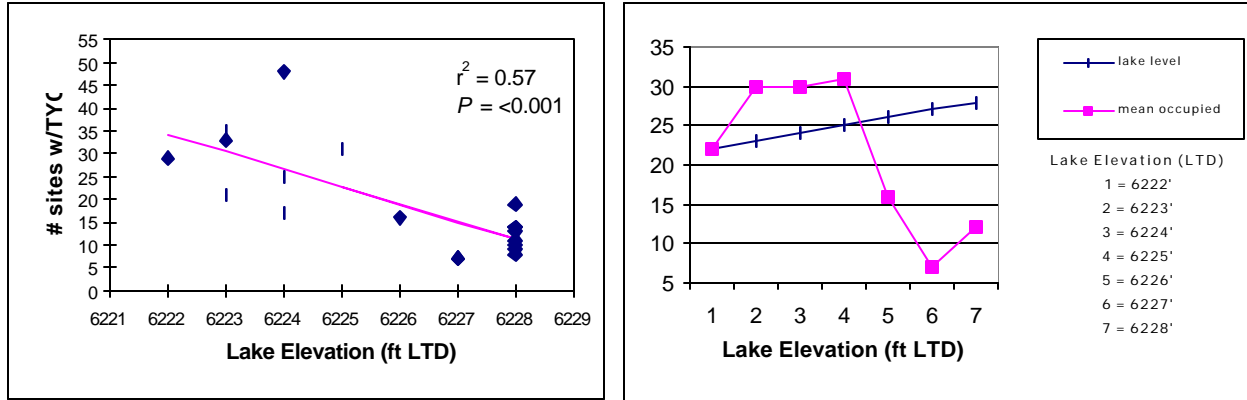
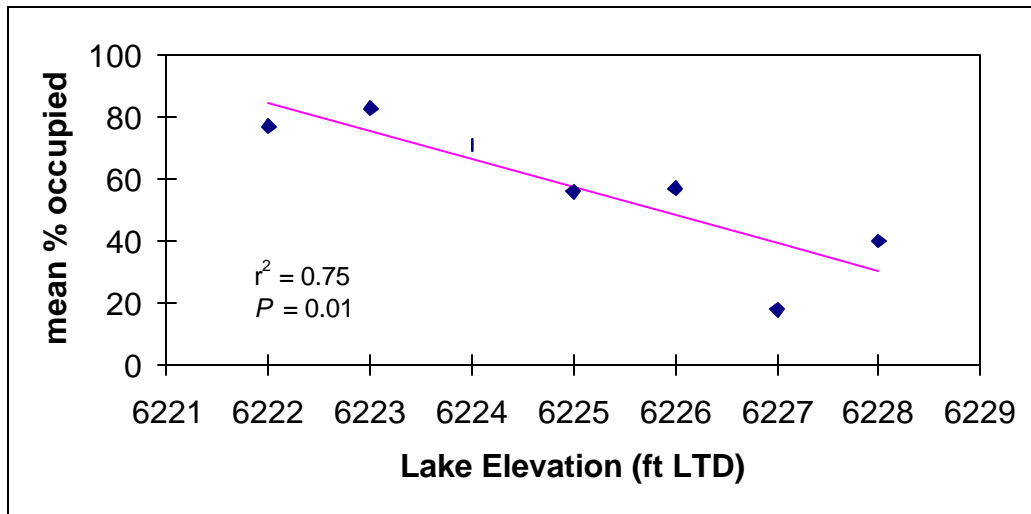


Figure 2. Mean percent occupied sites of Tahoe yellow cress and lake elevation level between the 1979 and 2002 survey period.



Based on the data described here and provided in Attachment A, there is a significant linear relationship ($P = <0.01$) between the number of sites surveyed and the number of sites where TYC is observed (Figure 3). Incorporating the 2002 survey data resulted in increased significance ($P <0.01$) compared to results of the 2001 analysis, which was only significant at the 90 percent confidence level (CSLC 2002). This strongly supports the hypothesis that as more sites containing suitable habitat are surveyed around the lakeshore during low lake elevation years, the likelihood that TYC would be observed at more sites increases.

Figure 3. Relationship between the number of sites surveyed and number of sites with Tahoe yellow cress (1979 to 2002).

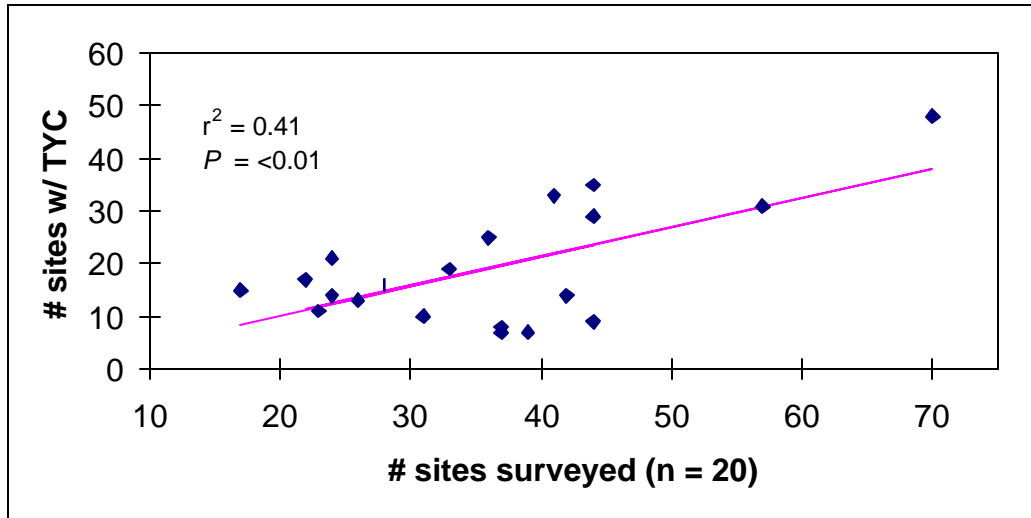


Table 2 provides TYC occurrences/persistence during high and low lake elevation years, a comparison of periods with high lake elevations (1980 to 1986 and 1995 to 2000), and suggested determination between low and high lake elevation sites. Nearly all the core, high, and medium priority sites supported TYC during both high and low lake elevations. The exceptions were all of the Emerald Bay sites (Eagle Creek, Emerald Point, Eagle Point, Emerald Boat, and Emerald Bay Avalanche), which were 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 (see 2002 Annual Survey Report). Low priority, miscellaneous, and new/expanded sites are mostly sites where TYC persists only during periods with low lake elevations. Cascade West 2, Taylor Creek Mouth, and Cave Rock South sites are examples of low lake elevation sites that were exposed during the 2002 survey year (6,224 ft) but were inundated during the 2001 survey when the lake elevation was 6,225 ft (Table 2).

Table 2. Tahoe yellow cress occurrences/persistence during high and low lake elevation years and suggested determination between low and high lake elevation sites

Occurrence Name	Xs/rec yrs ¹	Ranking	% Present High Elev. Years	High Lake Elev. Years			High/Low Elev. Sites ²
				1980- 1986	1995- 2000	% Present Low Elev. Years	
Blackwood North	14/19	Core	82	100	33	89	H/L
Blackwood South	16/18	Core	82	100	67	100	H/L
Tallac Creek	15/18	Core	82	33	100	89	H/L
Taylor Enclosure	20/20	Core	100	100	100	100	H/L
Upper Truckee East	16/16	Core	100	100	100	100	H/L
Edgewood	16/18	Core	82	100	67	100	H/L
AVERAGE CORE SITES			88	89	78	96	
Ward Creek	11/16	High	45	100	0	100	H/L
Meeks Bay	14/19	High	70	40	100	80	H/L
Eagle Creek	7/11	High	0	0	0	100	L
Cascade Enclosure	10/15	High	67	0	100	67	H/L
Kahle/Nevada	16/21	High	64	100	33	90	H/L
Glenbrook	8/15	High	44	100	0	67	H/L
AVERAGE HIGH SITES			48	57	39	84	
Tahoma	5/17	Medium	18	40	0	50	H/L
Rubicon	10/14	Medium	57	100	0	86	H/L
Emerald Point	8/18	Medium	0	ns	0	100	L
Eagle Point	4/10	Medium	0	ns	0	100	L
Baldwin Beach/Lagoon	14/20	Medium	64	40	83	78	H/L
Lighthouse/Keys	11/17	Medium	40	0	50	100	H/L
Upper Truckee West	15/18	Medium	73	100	50	100	H/L
Timber Cove	6/17	Medium	40	80	0	29	H/L
Tahoe Meadow	10/15	Medium	56	67	50	83	H/L
4-H	12/18	Medium	50	100	0	89	H/L
Zephyr Cove	6/14	Medium	14	100	0	75	H/L
Logan Shoals	9/13	Medium	43	60	0	100	H/L
AVERAGE MEDIUM SITES			35	62	18	76	
Kiva/Valhalla	10/18	Low	0	0	0	100	L
Pope	10/18	Low	11	33	0	100	H/L
Regan/Al Tahoe	6/18	Low	0	0	0	86	L
El Dorado	1/18	Low	0	0	0	14	L
Secret Harbor	5/12	Low	0	ns	0	43	L
Sand Harbor	1/14	Low	0	0	0	17	L
AVERAGE LOW SITES			2	7	0	60	
Sunnyside	1/14	Unranked	0	0	0	17	L
Kaspian Camp	2/4	Unranked	0	0	0	67	L

Table 2. Cont.

Occurrence Name	Xs/rec yrs ¹	Ranking	High Lake Elev. Years				High/Low Elev. Sites ²
			% Present High Elev. Years	1980- 1986	1995- 2000	% Present Low Elev. Years	
Cherry Street	4/11	Unranked	0	0	0	80	L
McKinney Creek	3/10	Unranked	0	0	0	60	L
Meeks Vista	3/12	Unranked	29	40	0	20	H/L
DL Bliss	2/18	Unranked	0	0	0	29	L
Emerald Boat	6/16	Unranked	0	0	0	75	L
Emerald Bay Avalanche	4/4	Unranked	0	0	0	100	L
Elk Point	4/9	Unranked	0	0	0	100	L
Skyland	4/7	Unranked	0	0	0	100	L
Cave Rock	6/11	Unranked	17	ns	17	100	H/L
Skunk Harbor	1/11	Unranked	0	ns	0	17	L
Crystal Point West	2/9	Unranked	0	ns	0	50	L
Kings Beach	1/11	Unranked	14	100	0	0	?
Agate Bay	0/14	Unranked	0	0	0	0	-
Dollar Point	4/10	Unranked	0	ns	0	80	L
AVERAGE UNRANKED SITES			4	12	1	56	
Round Hill	3/4	Misc	0	ns	0	75	L
Logan Shoals Vista	1/1	Misc	ns	ns	ns	100	?
AVERAGE MISCELLANEOUS SITES			0	-	0	88	
New or Expanded Sites for 2001-2002							
Hurricane Bay*	0/2	Unranked					-
Tahoe Pines*	0/2	Unranked					-
Cherry Street/Homewood**	1/2	Unranked					L
McKinney North**	1/2	Unranked					L
Sugar Pine (General Cr.)*	2/2	Unranked					?
Sugar Pine South*	2/2	Unranked					L
Cascade Prop (Weinberg)*	2/2	Unranked					L
Cascade West*	2/2	Unranked					?
Cascade West 2**	1/2	Unranked					L (u)
Taylor Cr. West*	2/2	Unranked					?
Taylor Cr. Mouth**	1/2	Unranked					L (u)
Taylor Cr. East*	2/2	Unranked					?
Jameson*	0/2	Unranked					-
Regan/AI Tahoe West**	1/2	Unranked					L
Regan/AI Tahoe East**	1/2	Unranked					L
Bijou/Bijou West*	1/2	Unranked					L
Tahoe Meadow South**	1/2	Unranked					L
Zephyr Spit*	1/2	Unranked					L
Zephyr Cove North**	1/2	Unranked					L
Cave Rock South**	1/2	Unranked					L (u)
Secret Harbor Assn.**	1/1	Unranked					L

Table 2. Cont.

Occurrence Name	Xs/rec yrs ¹	Ranking	High Lake Elev. Years			High/Low Elev. Sites ²
			% Present High Elev. Years	1980- 1986	1995- 2000	
Secret Harbor South**	0/1	Unranked				-
Hidden Beach NV SP**	1/1	Unranked				L
Burnt Cedar Beach**	1/1	Unranked				?
Kings Beach East*	1/2	Unranked				L
Tahoe City/Commons*	0/2	Unranked				-
Truckee R. Outlet*	0/2	Unranked				-

¹ Sites with Tahoe yellow cross (X) and total number of recorded surveys over the twenty-four year period.

² Suggested determination of sites persistent during high and low lake elevation. H/L = site persistent during both high and low lake elevation conditions, L = sites appearing persistent only at low lake elevation condition, - = no data to compare, ? = data insufficient to determine at this time, L_(u) = sites exposed in 2002 but inundated during 2001 survey year.

* New sites during 2001 survey.

** New or expanded sites during 2002 survey.

Discussion

Lake elevations between 6,222 ft to 6,224 ft appear to be optimal for TYC persistence. This analysis demonstrates that there is a significant positive relationship between the number of sites surveyed, particularly in low lake elevation years, and the probability of observing TYC. As discussed in the 2001 analysis, this is likely a result of an increase in habitat exposure and a corresponding increase in survey effort (CSLC 2002).

This analysis further clarifies the question whether the level of effort during annual surveys should be adjusted according to the lake level. For the 2002 surveys, efforts were similar to 2001, which were intensive and able to cover more lakeshore area because of the low lake elevation. Several of the new or expanded sites were found at lower elevations, which would likely be inundated or conditions too wet during high lake elevation years, e.g., Cascade West 2, Taylor Creek Mouth, Cave Rock South (Table 2). Therefore, consistent with the 2001 analysis, during periods with high lake elevations (>6,226 ft), the survey effort could focus only on the core, high, medium priority, and newly discovered sites (depending on the new site's elevation relative to lake level) since there is a strong likelihood that low priority and other unranked sites would not support TYC (CSLC 2002).

Attachment A: Summarized Annual Survey Data (1979 to 2002)

Year	Lake level (ft)	# Sites surveyed (X+0)	# Sites w/ X (TYC)	% 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

(Data source: Conservation Strategy and 2001 and Draft 2002 Annual Survey Reports)

*Imminent extinction level is based on number of core sites and percent presence following the 4 level criteria in the Conservation Strategy Section II.I.

**Assumes that several of the core sites (e.g., Upper Truckee east, Blackwood sites) not surveyed that year had plants.

Level	# yrs
1	7
2	8
3	2
4	3
Total	20

Appendix C
Qualitative Description of Known TYC Sites (1998 - 2002)
Prepared by M. Falkner and E. Gillies (CSLC)

The following includes a brief qualitative description of the various Tahoe yellow cress (TYC) (*Rorippa subumbellata* Roll.) sites around the lake 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-inch diameter plant was located approximately 80 feet 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. TYC was not observed here during the 2002 survey and cover by nonnative plant species had increased since 2001, most notably Spanish-clover (*Lotus purshianus*). This may have affected the presence of TYC 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 inches in diameter. In 2002, 60 plants were counted and habitat conditions appear to be unchanged. Plants generally appear very healthy.

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 inches in diameter) dominate 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.

Meeks Bay Enclosure: According to historical records, the USFS planted 500 individuals of TYC 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 to 6 individuals. 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 earlier than sites located on the south and west side of the lake.

Rubicon Bay (Greene Property): This site is located approximately 550 feet north of the D.L. Bliss State Park, west of a channelized creek. Plants are found in the backshore,

under the shade of several large pine trees, next to a manmade slough wall. Numbers at this site have ranged from about 30 individuals in 1999 to 4 plants in 2001. The 2002 survey found 39 plants at this location with several scattered occurrences located north of the Greene property.

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 feet from the water's edge), the plants appear moderately stressed and seem to have an accelerated growing season. The 2002 survey identified only four plants within the enclosure.

Cascade Enclosure: This site is referred to as "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 TYC habitat by other plant species appeared to inhibit TYC 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.

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.

Tallac Creek: 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 substrate disturbance evident in the area. During the 2002 survey, 40 plants were observed.

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 in that site. In 2001, four plants were identified along the margin of Baldwin Lagoon, and in 2002, eight plants were observed.

Taylor Creek: This site has expanded considerably since 1998, when approximately 50 plants were observed. During the 2001 survey, field staff counted nearly 900 plants within the enclosure. Plants were generally large and healthy looking. 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.

Several expanded areas were observed during 2001, which 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.

Pope: 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 inches in diameter) and appeared very healthy. Historic records show 25 plants immediately south of where the current plants are located. The original site is dominated by willows and does not support TYC.

Lighthouse: Nearly 500 plants were located at this site in 2001, which is divided into 2 subpopulations. One subpopulation 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 subpopulation is located along almost the entire length of the beach, adjacent to the manicured lawns and rock gardens. These plants are 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, TYC.

Upper Truckee West: Plants have been identified periodically at this site since 1979. During the 1999 survey, no plants were identified at this site. In 2000, eight plants were found at the mouth of the river, growing among various herbaceous species. By 2001, 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.

Upper Truckee East: This is an important source site for TYC 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 recorded.

Tahoe Meadows: Plants are located along the drainage ditch/unnamed creek at the northern edge of the property (abutting the marina). Plants are relatively healthy and large and have been observed in the same general area since 1979. During the 2002 survey, a new population was discovered south of this site (Tahoe Meadows South).

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 smaller pockets of TYC have been identified along the beach, often found in the “bathtub ring” where litter accumulates.

Cave Rock: In 2000, 18 plants were identified 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, a new or expanded site 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.

Appendix D

Tahoe Yellow Cress 2001-2002 Seed Collection and Nursery Propagation

Prepared by A. Stanton and B. Pavlik (BMP Ecosciences), December 1, 2002

The Tahoe yellow cress (TYC) (*Rorippa subumbellata* Roll.) conservation strategy (CS) puts forth the important goal of improving TYC populations around Lake Tahoe (Pavlik et al. 2002). To meet this conservation goal, a long-term project strategy to build up population size and increase the persistence of TYC at core and priority restoration sites has been developed. Over an 8-year period, a total of 18,800 plants could be transferred to 9 restoration sites.

The goal of this project was to obtain a crop of hardy seedlings from a genetically representative collection of seeds to use in experimental outplanting and future restoration. Seed were collected according to the Center for Plant Conservation (CPC) guidelines (1991) for rare plants and detailed information associated with the propagules (e.g. site of origin, maternal parent ID) is being tracked in order to estimate fitness components (e.g. seed output - plant size correlations) that may prove useful in evaluating the performance of reintroduced populations.

Propagation protocols were developed in cooperation with three separate nursery facilities to maximize yield of founding plants while minimizing artificial selection and ex situ loss of genetic variation. The object is to raise hardy, rather than productive, founders that will survive transplanting. A subsample of founders will be held over to the next year for aging in anticipation of an age-structured outplanting.

2001 Collection Sites

Alison Stanton collected TYC seeds on September 4-7, 2001, at nine locations in the Lake Tahoe basin (Table 1). Seed collection activities accompanied the annual population census efforts. Collection sites were selected based on the site rankings in the TYC CS. Six of the collection sites are considered "core" sites for TYC populations: Blackwood North, Blackwood South, Tallac, Taylor Creek, Upper Truckee East, and Edgewood. Cascade is ranked a high priority restoration site. Tahoe Meadows and Lighthouse are medium priority restoration sites.

2001 Collection Procedures

TYC fruits are small (<5 millimeters (mm)) siliques, with a plump, round to oblong shape. Each fruit contains 10 to 40 tiny seeds that turn dark brown at maturity. During the sampling period, fruit maturity ranged from fully dehisced pods to immature, fleshy green. Most fruits were collected while still slightly green, but not fleshy, and it appeared that the whitish seeds would mature with an after-ripening period. Darkened, obviously mature seed were found only on dehiscing fruits. Intact fruits without any obvious insect damage were collected from a variety of positions on different stems on each plant and placed in a sealed manila envelope. At each site, attempts were made to maximize the variation of the

sample by collecting from plants with the greatest range in size from as many different microhabitats as possible.

Table 1. 2001 TYC seed collection locations.

Site	Code	TRPA code	# Individuals	Total # fruits
Blackwood North	BN	4	3	45
Blackwood South	BS	5	28	317
Cascade	CD	18	24	226
Edgewood	ED	30	10	70
Lighthouse	LT	23	11	165
Tallac	TL	19	21	265
Taylor Creek	TY	21	27	319
Tahoe Meadows	TM	29	23	325
Upper Truckee East	UT	25	30	431
Total			177	2,163

Collection protocols were designed to maximize the genetic variation of the seed sample. The CPC guidelines for genetic sampling of endangered plants recommends collecting from 10 to 50 individuals per population depending on a variety of attributes of the plant species and its habitat. However, the California Department of Fish and Game seed-collecting permit for TYC prohibits collecting more than 10 percent of the total available seed for any population. We therefore established a target to collect 10 mature fruits from 30 individual plants in each population. This target was only met at Upper Truckee East, the site with the largest TYC population. The actual number of sampled individuals varied from a low of 3 at Blackwood North, to 30 at Upper Truckee East (Table 1). Accordingly, the number of fruits collected per plant was increased to a maximum of 30 to compensate for the lower per population sample sizes. Fruits were collected from a total of 177 individuals plant across the 9 population locations. Subsequent laboratory analysis revealed that the 2,163 collected fruits contained a total of 46,824 seeds.

Data collected for each plant included: GPS location, the number of fruits collected, an estimate of the total number of fruits on the plant, two measures of size, and notes on the microhabitat. We measured both the length and width of the basal rosette for each plant. Attempts were made to take a third measure of size that might correspond to fecundity (e.g. number of stems), but this was abandoned because the rhizomatous, clonal nature of the plant would have made an accurate stem count prohibitively time consuming. Fruit count was estimated on each plant by rounding the numbers of fruits on each stem to the nearest 5 and successively adding the number of stems. On several extremely large plants at Upper Truckee East, this method was applied to a proportion of the plant (e.g. 10 percent) and then scaled up to give a total fruit estimate. Fruit production varied from 5 to over several million fruits per plant. There is not an apparent minimum size threshold for fruiting, very small plants with only 2 or 3 leaves were found producing small amounts of fruit.

A hand drawn map was developed for each population showing access routes, distance to the lakeshore, and a diagrammatic sketch of sampled plant locations. Additional notes were made about site access, habitat condition, and an estimate of the total area occupied by the population.

2002 Collection

We found no correlation between any measured plant characteristics and fecundity in the 2001 collection data. Although every effort was taken to ensure uniform seed collection, any differences in greenhouse seedling establishment that may emerge between the sites or between individuals within a site may be a function of the quality of seed collected rather than any intrinsic genetic factor (i.e. seed from some individuals was underdeveloped). Therefore, we did not find it necessary to record or measure individual plants during the 2002 seed collection.

Our 2001 collection criteria that focused on green undamaged seed may have led to the collection of some under developed seed lots. In 2002, we expanded our criteria to include open, dehiscing fruits and obviously darkened, mature fruits. We still kept the collection quantity to 10 percent or less of the total seed production.

Alison Stanton collected seed from 11 sites on September 3-4, 2002. Currently the seed has not been cleaned, sorted, and counted, but the quantity is sufficient for a full-scale propagation effort in 2003. The seed is being stored in dry manila envelopes at Mills College.

Propagation

Three nurseries received contracts through the USFS to propagate TYC: USFS facility in Camino, CA; Nevada Division of Forestry facility in Washoe Valley, NV; and privately-owned Sierra Valley Farms in Beckwourth, CA. Only the facility at Washoe had previously propagated TYC for restoration efforts. We chose to put the plants at three separate facilities to diffuse the risk of an unsuccessful propagation.

The entire seed lot was hand-sorted into three equal lots in December 2001 and stored in manila envelopes at room temperature until they could be delivered to the three nurseries. Each nursery received 177 seed lots, each containing one-third of the seed collected from each of the 177 individuals. A small portion of seed was retained for laboratory germination tests at Mills College.

Unexpectedly, all efforts to germinate seed in the laboratory in fall 2001 into spring 2002 failed, thereby delaying outplanting. It did not seem prudent to put the entire seed lot in pots when we could not obtain any germination. However, in May we requested that two nurseries plant out a small number of lots as a pilot propagation. Each nursery subsequently tested slightly different seed storage and propagation methods. Results for each nursery are discussed below.

Sierra Valley Farms

Seed was stored for 90 days at 32 F in a moist environment. This method of cold stratification is often required to obtain germination in plants that experience a freeze at some point in the year. Although we had still not achieved germination in the laboratory (a shorter cold stratification had been tested), total of 1,638 supercells were planted with seed lots from 7 of the 9 sites on May 21, 2002 (the Cascade and Blackwood South lots were retained for later use).

The supercells were packed with organic soil-less mix and topped with a one-inch layer of Lake Tahoe beach sand (collected from Baldwin Beach). A variable number of seeds were planted on the soil surface and top-dressed with vermiculite. The cells were placed under fine mist with bottom heat of 78 F. Several weeks after planting when the propagules began to establish, the supercells were moved off the bottom heat source. The plants are currently in a greenhouse receiving a daily mist of ionized water without any fertilizer.

As of October, a total of 1,123 plants had established. This is a 69 percent establishment rate. Initial germination was not monitored, so the actual germination rate may have been higher. A variable number of replicates were planted of each lot (3 to 28) and establishment of the replicates varied from 0 to 100 percent. In the seed sorting process we noted that several seed lots appeared to be poorly developed. This variability in initial seed quality makes it difficult to determine differences in greenhouse establishment rates between the sites. However, further analysis may reveal trends. Table 2 shows the total number of established plants from each lot.

At the September visit, a moderate proportion of the plants were flowering and producing fruit. The seed were allowed to drop onto the greenhouse floor. It is unlikely that the second-generation seed will self sow and cross contaminate the seed sources.

USFS Camino

All seed was stored in the freezer until planting. Since we had still not obtained germination in the laboratory in May, we requested that the nursery plant out several seed lots as a pilot propagation. Five lots from Blackwood South were planted on May 24, 2002. Supercells were filled with a peat moss organic medium and three seeds were sown on the soil surface of each container and top-dressed with a thin layer of Lake Tahoe beach sand (collected at Baldwin Beach). The cells were placed outside and misted daily with ionized water (no fertilizer).

A final planting of the remaining seed lots occurred on July 10, 2002. The plants were checked on July 22, almost two months after sowing. A total of 44 plants had established in the 61 cells planted in May. This represents a 72 percent establishment rate. Three seed lots had establishment rates of 80 to 86 percent, but one had only 31 percent. During that evaluation, the July planting was beginning to germinate but it was too soon to evaluate germination percentages.

All plants were checked again on October 21, 2002. A total of 909 plants were counted as living out of a total of 1,790 planted cells. The plants were still very small, no plant was over two inches in diameter, and many were slightly chlorotic. It appeared that very little growth had occurred in the previous 3 months, perhaps due to high heat stress or over watering. Small roots were observed growing out of the bottom of the cells, but it is unclear whether these plants will survive through to the spring.

NDF Washoe Valley

Seed was stored at room temperatures in paper bags until planting. On June 25, a variable number of seed were sown on the surface of supercells packed with an organic soil-less potting mix containing vermiculite. Anywhere from 0 to 10 seedlings emerged in each pot. A total of 179 plants established from the June plantings. Initial germination was not monitored, but the establishment rate was very high, over 95 percent of the cells contained established plants in September 2002. Only 3 percent of established plants were flowering during the September evaluation.

A final planting of the remaining seed lots occurred in early September when a total of 1,231 additional cells were planted. Seven replicates were planted of most of the 177 seed lots. Prior plantings had depleted the seed supply of a few lots, but extra individuals from seed-rich lots were planted to make up the difference. As of October, a total of 510 additional seedlings had established, bringing the total number of plants up to 689 of a total of 1,410 cells that were planted (49 percent establishment rate). However, most of the 510 cells contained two seedlings each. These seedlings are being split into two separate pots, but it will take some time before we can determine the success of this transplanting effort.

Table 2. Number of established TYC propagules, by collection site and propagation facility.

	USFA Camino	Sierra Valley Farms	NDF Washoe Valley
Blackwood North	22	22	5
Blackwood South	145	Not planted	75
Cascade	103	Not planted	64
Edgewood	63	34	37
Lighthouse	55	101	23
Tallac	97	123	38
Taylor Creek	138	280	107
Tahoe Meadows	145	262	70
Upper Truckee East	141	301	91
Total Established	909	1,123	689
Total Planted	1,790	1,638	1,410

Conclusion

The three nurseries planted a total of 4,838 cells with TYC seed. More than one seedling germinated and established in some cells, but these have been counted as only one plant for our purposes. If all living plants survive to the spring, we will have 2,721 plants available for outplanting. However, one-third of the plants may not survive, but we may be able to offset this loss by splitting apart individual seedlings at the Washoe Valley facility, giving a net loss of only 400 seedlings from the current total.