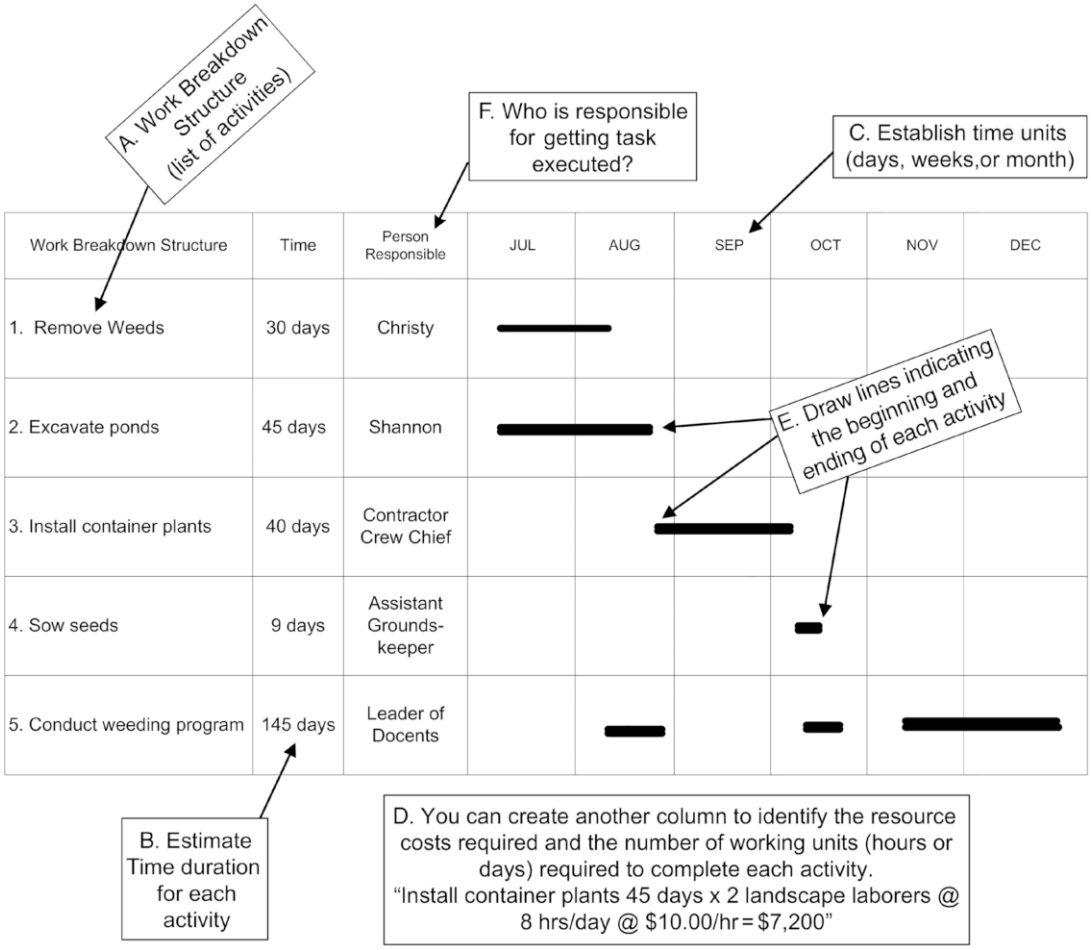
Appendix 1. Gantt Chart Primer



Work Breakdown Structure	Time	Person Responsible	JUL	AUG	SEP	OCT	NOV	DEC
1. Remove Weeds	30 days	Christy						
2. Excavate ponds	45 days	Shannon						
3. Install container plants	40 days	Contractor Crew Chief						
4. Sow seeds	9 days	Assistant Grounds-keeper						
5. Conduct weeding program	145 days	Leader of Docents						

A1-1. A quick primer on developing a Gantt chart diagram.

The numbered items are discussed below.

A. The Work Breakdown Structure column lists a set of discrete actions needed to do the project.
B. Estimate the time duration for each activity—that is, the number of days or hours each activity will take.
C. Establish time units, such as days, weeks, or months. This is a graphic representation of item B showing start and end dates for each activity.
D. Create a column to identify resource needs for the task, such resources as labor, equipment, or money needed for a task.

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DOI 10.5822/ 978-1-61091-566-3,

E. Draw lines indicating the beginning and ending of each activity. Organize these time duration bars in order from start to finish based on any dependent relationships with other activities.
F. Identify by name or position a single party responsible for executing each task. To eliminate miscommunication, avoid shared roles.

How a Gantt Chart Can Help with Scheduling a Project

In this example, you are planning this project to be completed in time for the local fair, which opens October 1. After building your Gantt chart and examining the various entries, you discover an issue: the project finishes late. Referring to figure A1-1, note that the task "Install container plants" has a duration of forty days. You want to begin the activity on August 1 and complete the work on September 15. However, before tree planting can begin, site preparation work must be completed—tasks #1 and #2, "Remove weeds" and "Excavate ponds." The weed-removal task finishes in time, but excavating the ponds does not. Restrictions prevent starting before July 8, causing the end date for the pond excavation to be August 21. With seed sowing to do, planting cannot begin before August 21. This conflict of dates and durations requires problem solving and decisions to meet the October 1 date. The chart illustrates the conflict and assists in choosing which tasks can be managed to meet the desired finish date.

Appendix 2. Project Cost Estimate Worksheet

Project:
Date:

Project Phase	Tasks	Labor	Equipment	Material	Total
PROJECT INITIATION	Project management				
	Develop goals and objectives				
	Project description				
	Candidate site selection				
	Initial cost estimate				
	Needs assessment				

Project Phase	Tasks	Labor	Equipment	Material	Total
ANALYSIS	Site analysis				
	Aerial photography				
	Soil sampling and analysis				
	Well survey and/or installation				
	Land use analysis				
	Hydrologic analysis				
	Water quality				
	Identify degradation sources				
	Assess degradation extent				
	Hazardous waste investigation				
	Groundwater monitoring				
	Resources surveys: biology, geology				
	Topographic analysis				

Project Phase	Tasks	Labor	Equipment	Material	Total
DESIGN	Concept plan				
	Plant palette selection				
	Species assemblages and pattern				
	Vegetative clearing/trash removal				
	Exotic plant eradication				

DOI 10.5822/ 978-1-61091-566-3,

Project Phase	Tasks	Labor	Equipment	Material	Total
IMPLEMENTATION	Initial grading areas and quantities				
	Seed application method				
	Topsoil handling and quantities				
	Salvage and storage plant, rock, logs				
	Soil preparation method				
	Erosion control material				
	Erosion control installation				
	Biotechnical applications				
	Drainage devices and installation				
	Placement of topsoil				
	Fencing				
	Plant protection				
	Soil amendment: chemical				
	Soil amendment: mulch				
	Import topsoil and or fill				
	Confirm ownership of property				
	Resolve any rights to use of land				
	Finalize plant species list				
	Determine plant propagule types				
	Calculate habitat plan areas				
	Calculate plant material quantities				
	Verify availability of species list				
	Order species needing advance time				
	If collecting seed, arrange for preparation and storage				
	Arrange for contract collection and/or growing of seed and plants				
	Transporting plant material to site				
	Supplemental irrigation design				
	Installation and cost of irrigation material				

	If growing nursery stock, determine greenhouse needs and storage area and maintenance until planting				
	Seed application				
	Hydroseeding supplies				
	Purchase of soil amendments				
	Installation of soil amendments				
	Purchase of mulch				
	Installation of mulch				
	Planting of container stock				
	Temporary water devices				
	Flagging and construction barriers				
	Permanent fencing/barriers, etc.				
	Site preparation				
	Auger/ditching service				
	Inspection services: plant storage				
	Inspection services: installation				
	Final plans				
	Grading plans				
	Planting plans				
	Irrigation plans				
	Specifications				
	Development of time estimate				
	Development of budget				
	Application for permit required				
	Hearings, meetings, coordination				

Project Phase	Tasks	Labor	Equipment	Material	Total
AFTERCARE	Supplemental water				
	Cost of water				
	System inspection and repair				
	Operation of system, manual				
	Weed control				
	Herbicide treatments				

	Pest control: insect and others				
	Plant protection maintenance and removal				
	Replacement planting				
	Removal of dead plantings				
	Data recording of maintenance				
	Erosion inspection and repair				
	Site inspection				
	Fencing maintenance, relocation, and repair				
	Litter and debris removal				
	Data retrieval				
	Monitor plant growth				
	Survival				
	Diversity				
	Health				
	Reproductive activity				
	Fire, controlled burns				
	Grazing rotation and durations				
	Fencing relocation				
	Survey animals				
	Birds				
	Mammals				
	Reptiles				
	Amphibians				
	Fish				
	Insect				
	Write up report for surveys				
	Photodocumentation activities				
	Develop maintenance manual for others				
	Training of maintenance staff				

Appendix 3. Risk Management Steps

Identify all known risks (item or task) that could likely occur. Ask: "What can go wrong?"

Assess the probability, or the likelihood, of that item occurring sometime during your project. We use the simple H–High, M–Moderate, and L–Low categories. Enter this rating in column 2 of the risk management worksheet (fig. A3-1).

Risk Management Worksheet

Scope, Schedule, Cost	Probability	Impact	Exposure	
Task or Item	(H,M,L)	(H,M,L)	Col 2 and Col 3 (HH,MH etc)	Response Measure or Action

A3-1. Risk management worksheet.

Determine what impact the item will have on the project should it occur. Use H, M, or L. Combine the two ratings you have reached to develop a "Total Risk" rating. It is important to keep the order of each rating because they have different meanings. The order of ratings highest to lowest is HH, MH, and HM. The top three ratings generally are all you will have time to analyze and develop an action to implement. A general rule is to handle between eight and twelve of the top issues at a time.

DOI 10.5822/ 978-1-61091-566-3,

For each item in the top three ratings, develop an appropriate action that will correct the event should it occur. Ask: "How can this be prevented or handled when the problem occurs?" Assign a person to monitor and manage each risk event. The risk management plan allows you to implement immediate responses when risk issues become realities. It can also help reduce or avoid crisis management and may permit you to maintain the project as originally scheduled, despite setbacks or problems that would normally result in delays while the team scrambles for a solution to the problem.

Appendix 4. Project Evaluation and Review Technique

The Project Evaluation and Review Technique (PERT) is a technique for estimating time duration. At times, you will need to estimate work on tasks that have a high number of variables and for which the time required cannot be routinely estimated from a chart. In these cases where a number of variables may influence the duration, using the PERT is a convenient approach. The key is to interview knowledgeable people who are familiar with the task. Ask them a series of three questions:

1. What will be the most likely amount of time in days that it will take to do this task as you understand the project now? (most likely)
2. What is the least amount of time it will take? (optimistic)
3. What is the longest it will take? (pessimistic)

The rule of thumb is that the pessimistic duration should be not more than three times the most likely duration. If this situation does occur, you should obtain more information so that the estimates come closer together.

$$\text{Estimate (duration)} = \frac{\text{Optimistic} + (4 \times \text{Most Likely}) + \text{Pessimistic}}{6}$$

Terms Defined:

Optimistic value is the time it would take to do the task or project without setbacks, delays, or interruption.

Most likely value is the time when personal experience is included and you know what typically will occur during the period of the task or project.

Pessimistic value incorporates those events that can cause delay, such as weather, delivery problems, shortage of materials, labor shortages, and so forth.

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DOI 10.5822/ 978-1-61091-566-3,

Appendix 5. Site Analysis Checklist

	SWOT-C	OBSERVATIONS
GENERAL FACTORS		
Ownership of candidate site		
Easements, prior rights, other conditions		
Historical context		
Prior land use		
Unique site features, structures, landforms		
Current land use		
Political considerations		
Access/access control/human use patterns		
Cultural resources (historical, archaeological)		
Agricultural or other quarantines		
Hazardous waste, debris, etc.		
Stressors on existing ecosystem		
PHYSICAL FACTORS		
Topography		
Slope and aspect		
Elevation		
Geology		
Soils		
Soil chemistry and nutrient status issues		
Topsoil profile and subsoil profile		
Hydrology		
Groundwater status		

DOI 10.5822/ 978-1-61091-566-3,

Surface runoff		
Water quality status		
Landscape ecology consideration for movement of animals, pollinators, etc.		
BIOLOGICAL FACTORS		
Existing vegetation communities		
Vegetation dynamics of existing communities		
Assess degree of degradation		
Invasive nonnative species		
Habitat value and features		
Wildlife resources		
Endangered, threatened, species at risk, sensitive species presence, or habitat of seasonal use		
ANTICIPATED SITE IMPROVEMENTS OR CONSIDERATIONS		
Grading		
Soil import/export		
Water features		
Drainage/flood control		
Irrigation system		
Buffer zone issues or requirements		
Access control and access to site		
Vandalism issues, need for control features		
Defined candidate area for work		
ADDITIONAL TOPICS:		

Appendix 6. Seed Quantity and Cost Calculation

Figure A6-1 depicts a spreadsheet for calculating the quantity of seed and its cost. Because seed comes in bulk form, it is important to know the quantity of pure live seed in the bulk so that the amount specified for a project is applied. The figure is arranged so it can be used with standard computer spreadsheet software. The example illustrates the different calculations needed to derive a final bulk seed quantity and cost. These calculations are valid only for a particular seed lot with an identified P and G value provided by the supplier, grower, or testing lab. When ordering seed, verify that it comes from one or more lots and determine their respective P and G values.

Seed Quantity and Cost Calculations												
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
No.	Species	Cost/ Bulk Weight	%P	%G	%PLS	PLS Cost	Design PLS/Unit Area	Bulk Quantity/ Unit Area	Cost/Unit Area	Total Area Units	Total Bulk Weight	Total Cost
					D x E	**C/F**		**H / F**	**CxI** or **GxH**		**I x K**	**C x L**
1	Species A	$4.75	0.6513	0.6592	42.93%	$11.06	5	11.65 lbs	$55.32	1.5	17.47 lbs	$82.98
2	Species B	$3.25	0.3258	0.1525	4.97%	$65.41	4	80.51	$261.65	2.5	201.27	$654.13
3	Species C	$15.50	0.8573	0.7562	64.83%	$23.91	1	1.54	$23.91	4	6.17	$95.64
4	Species D	$4.00	0.5598	0.2599	14.55%	$27.49	3	20.62	$82.48	2.5	51.55	$206.20
5	Species E	$6.35	0.7584	0.6573	49.85%	$12.74	2	4.01	$25.48	0.5	2.01	$12.74
	Total Cost of Seed Order											$1051.68

Notes:
C,D,E and frequently F are provided by seed supplier or calculated by testing seed
H,K are determined by your design and knowledge of species or advice of seed supplier/grower

A6-1. Seed quantity and cost calculation form.

DOI 10.5822/ 978-1-61091-566-3,

Column Notes:

A— Number each species to facilitate communication with others and reduce confusion. You can consider this a built-in "plan B," especially if you are ordering several species of the same genus.

B— Use scientific names. There is no substitute for this, especially when dealing with subspecies or variants.

C— This is the cost of bulk seed per unit weight.

D— Purity percentage is a measurement of viable seed and other material in bulk seed. Use four digits (for E also) because this is critical for deriving accurate figures at the end of the calculations.

E— Germination rate reflects the percentage of seed that can germinate. Not all seed is alive, and this factor eliminates those seeds in the final calculations.

F— The product of D and E, which reflects the amount of live seed in a bulk pound of seed.

G— PLS (pure live seed) cost/unit weight is derived using the cost per bulk pound divided by the PLS. In the example, Species B costs only $3.25 per pound and seems like a deal, but when you calculate out the nonseed and dead seed elements, the cost of the seed you want comes to $65.41 per pound!

H— This is the amount of live seed you have decided to put on your site. It is typically given as weight per unit area.

I— Bulk quantity is the calculated amount of units required to apply to a unit area.

J— Cost of seed for the unit area of application. Unit cost will be used to determine the cost of seed for the project or application area.

K— Total area to be seeded by this species. In this example, the areas are different, indicating individual application and not a mix.

L— Total bulk seed for design area to be applied. This is the final quantity required to be applied at the amount identified in column H and is the amount to be ordered from suppliers. In many cases, suppliers can provide you with the quantity by just simply ordering PLS units.

M— Total cost for each species in the seed material list. The sum is the seed amount for this project. Labor and other expenses will need to be entered into the project cost estimate worksheet (appendix 3).

Appendix 7. Plant and Planting Specifications Worksheet

A restoration project has the potential to use a wide array of plant material, from small to large, from seed to mature plant. A plant summary sheet is used to track several aspects of the plant material, including quantities, special soil amendments, type of planting holes, patterns, and spacing. Typically, seed material is placed on a separate sheet, but it can be included here if desired.

Figure A7-1 shows a typical plant sheet that we have used on numerous projects. It clearly identifies important data, from the quantities and sizes of each species to unusual items unique to the project. Soil amendments can be diverse; thus, having clearly identified what is needed will allow for quick calculations in preparing a construction bid estimate. Whether you have your own nursery or intend to purchase plants from a commercial nursery, this sheet will facilitate your plant acquisition. If you cannot confirm the availability of species, you may want to keep a list of acceptable substitutes in your file, in case the contractor cannot locate species on the plant list.

Plant List and Planting Specifications

A plant table has been provided. This table can be modified to meet your needs and conditions.

The summary table is a valuable tool to use in the overall scheduling and installation of the site. At a glance, you can determine the plant quantities, material type, and sizes you need. More importantly, you can compare the list against the material delivered to your site or the material collected by volunteers or contract laborers. This table also serves as a valuable resource when calculating estimates for plant cost and labor needs. Following are some comments on the table by column.

Plant Number—The first column is a useful way to keep track of the different material. Different sizes of the same plant species receive a different number. Doing this with the plant number will permit you to clearly communicate to others even if they do not know plants.

Symbol—Symbols are of your own choosing. They may be a single symbol, as shown in our example, or a pattern, for where larger areas are being planted and it is not helpful to have ten thousand planting symbols of the same plant material in a hectare!

Botanical Name—On the botanical name, you may not want to use the technique shown. These abbreviations are unique to this set of plans and would not necessarily apply to other plans. Abbreviations used by landscape architects in North America are another useful option for clearly labeling plans without cluttering the plan with fully written out names. There may not always be a common name, so inserting "No Common Name" or "NCN" is acceptable.

Size—Any number of choices is available. Using a simple code of numbers that remains constant from project to project, unlike abbreviations, simplifies this table. Measurements may include the size of the container across the top; the shape and length of tubes frequently are given as total length. For larger sizes, "1 gallon," "5 gallon," and so forth are used in the United States. For transplant specimens, the size is the width of the box. This category also includes any material that may be unusual, such as cuttings, rooted cuttings, bare root, or pads (in the case of cacti).

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DOI 10.5822/ 978-1-61091-566-3,

Plant and Planting Specifications

Plant No.	Symbol	Botanical Name	Common Name	Size	Quantity Each	Hole Size		Basin Type	Commercial Fertilizer		Mulch	Staking	Planting On Center Inches	Remarks
						Diameter Inches	Depth Inches		Planting	Plt Estb				
1	@	Cercis occidentalis	Western Redbud	5	84	18	36	-	1 Tab	.5lb	4	1, 2	60	Shrub
2	%	Prunus llicifolia	Holl-leaf Cherry	5	67	18	36	1	-	-	4	1, 2	120	Shrub
3	*	Rhamnus californica	Coffeberry	1	171	12	24	1	1 Tab	.5lb	4	-	84	Shrub
4	+	Quercus kelloggii	California Black Oak	1	184	12	24	-	-	-	3,4	-	198	Tree
5	^	Quercus wislizenii	Interior Live Oak	1	127	12	24	-	-	-	3,4	-	154	Tree
6	#	Populus fremontii	Fremont's Cottonwood	15	45	24	36	1	-	-	-	1, 2	216	Tree

Note: Underlined portions of botanical name indicate abbreviations used on Planting Plans

Abbreviations
Amend---Amendment
Dia -------Diameter
Ea --------Each
Oz---------Ounces
In ----------Inches
Yd ---------Yard
Lbs --------Pounds
Max -------Maximum
Min --------Minimum

Plt Estb –Plant Establishment
Tab -------Tablet(s)

1 –See Detail X
2 –See Special Provisions
3 –15.0 Feet Diameter Area
4 –In Mulched Areas

Calculated/ Designed by		Date	Revised By			
Checked by			Date Revised			

A7-1. Plant and planting specification worksheet.

Hole Size—Measurement is typically related to the type of material being planted. There are special situations, such as poor soil or the need to reach a groundwater level, that may deviate from the typical planting hole.

Basin Type—Typically in a restoration project, the basin is not used because this would either prevent water from accessing the root ball or keep water close to the plant. This needs to be evaluated with the circumstances taken into account. Planting on slopes will require some type of containment to prevent erosion of the root ball.

Commercial Fertilizer—In most situations, this will not be necessary; however, where needed, this clearly identifies which plants and what quantities.

Mulch—Mulching is a common method to control moisture conditions, provide a limited control to weeds, and provide nutrients into the soil over an extended time. The specifications

should describe the type of mulch and the dimensions of application, such as area of coverage or a distance from the plant stem and thickness of application.

Staking—This is sometimes required on restoration projects in unusual conditions. Plants raised for restoration should never be staked from the onset of propagation. When staking is required, it is typically done on larger-sized plants. If your site is subjected to extreme environmental conditions, such as constant or sporadic strong winds or similar weather conditions, then staking would be a logical interim method to get plants established. A specification should show exactly how you want the plant, with the sizes of ties and arrangements.

Planting on Center Inches—The distance between plants is another way to check your numbers and to gauge how dense some plantings will be after they are installed. Generally, the distance is an approximation. One thing to remember is the difference between planting distance between any other plant and the distance between the same species. Trees, for instance, can be spaced anywhere from ten to thirty feet; however, shrubs and herbaceous plants will more than likely be planted between these two trees.

Remarks—This column is simply a way of communicating the type of growth form you want. If there is a possibility of confusing plants or forms, this is the place to make a note. Coastal forms of the same species have much different characteristics, as do plants growing on unique soil formations. The plant taxonomy may not have caught up with what we as restoration designers see and need to maintain.

This plant list table is an extremely effective tool for use in your project. However, it is only as good as the information that is entered. You may want to adapt it to meet your project or style of working. The important point is to have some place where you can obtain similar information easily. Whether you are buying plants from a nursery or propagating them yourself, you will still need to know how many plants of each species and size to produce. Cuttings are another matter and require coordination, so cuttings can be collected at the appropriate time of year. This may be a note for the Remarks column of this table.

Appendix 8. Checklist for Plan Review

When going through the process of developing a restoration design or program, it is always a good idea to review the work. The following checklist has been compiled from the authors' projects or experiences of colleagues. It is designed not as a check-off list but as a prompter or springboard. Although a specific question may not apply to your project, it may cause you to think of something that is related to your project. We encourage you to talk about your project with others; additional points of view can only improve the final outcome.

Project, General

1. Have goals been identified for the project?
2. Are objectives clearly stated for each goal?
3. Are areas identified numerically by vegetation type or habitat type?
4. Are areas and time frames established for different land management techniques, such as controlled fires, grazing, trampling, flooding, and so forth?
5. Have performance criteria been developed with quantitative measurements or clearly understandable qualitative descriptions?
6. Have construction or nonconstruction dates been established to avoid impacting sensitive noise receptors (e.g., residential land uses, nesting)?
7. Are elevations clearly identified?

Site Issues

1. Are there sensitive species in or near the project site?
2. Have sensitive areas, construction, utility and other easements, storage, and staging areas been identified on plans?
3. Have adjacent land uses or potential future land uses been identified from zoning or general plans and incorporated into the design?
4. Is a buffer zone planned for areas adjacent to potentially conflicting land uses or environmentally sensitive areas?
5. Are areas of sensitive resources clearly identified?
6. Are limits of work clearly marked?
7. Are signs, flagging, and fences to be installed in no-work areas?
8. Are work roads, access roads, haul roads, and storage areas identified and clearly marked?
9. Are there provisions for construction-related activities to be identified by the contractor and cleared by appropriate personnel prior to work?

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10. Are physical and biological erosion control measures in place?
11. Is solar orientation of the site important for selected species?

Site Preparation

1. Is grading a part of the site preparation?
2. Will tidal channels or creeks be excavated?
3. Is the disposal area of sufficient size to receive the quantity of earth excavated?
4. Will excavation work occur in the vicinity of sensitive areas (e.g., sensitive habitat, endangered species, cultural resources, or any other unique resource)?
5. Are provisions included to control the work in sensitive areas?
6. Is there an erosion control feature for the disposal area?
7. Will the disposal area impact adjacent waters as a result of erosion or sedimentation?
8. Will a portion of the excavated material be placed as a topsoil following final grading?
9. Is a specific topsoil storage area identified on the plans? If not, are conditions described to prevent damaging salvaged topsoil resulting from contamination and erosion.
10. Will soil decompaction be performed before planting, to assist in plant establishment?
11. Will the soil require amending?
12. If mulching, how will mulch remain on the surface during flooding or heavy rainfall?
13. Does the design rely on the use of the topsoil or duff as a source for seed and bulbs, mycorrhizae, and mulch?
14. Will the top layer be mixed with recently exposed parent material to form a mixture of soils?
15. Will the material used for the top layer improve soil texture and provide nutrients?
16. How will irregular surfaces be handled to prevent ponding in unacceptable locations?
17. Will the final grade elevation flood on a regular basis, or will it rely on infrequent storm events?
18. How will the soil be handled to prevent significant loss during flooding?
19. For use as a seed source, do instructions identify a specific method of storing the topsoil, duff, or imported soil and time duration?
20. Are there extensive slopes above graded areas with water runoff features to control erosion onto the site?
21. Do structures have a maintenance obligation?

Vegetation

1. Is the planting density reasonable when compared to the objectives and success criteria?
2. If planting seems thin, are the species involved vigorous growers or quick to reproduce on-site or is recruitment from adjacent natural areas expected?
3. Do the objectives include reference to plant cover, height, or similar structural diversity?
4. Do plant size quantities reflect the demands of the success criteria or time to meet criteria?

5. Are the planting locations reflective of the natural elevations and locations for each species?
6. Have clear and concise planting instructions for each species or group, plant stock type, and size been provided?
7. If planting holes are dug by machinery, is glazing of the hole an issue? (Roughen sides prior to planting.)
8. If cuttings are used, has a source for collecting been identified? Are controls in place? Will the plans ensure implementation at the correct time of year? Are provisions included that allow changing to container plants if the time requirements cannot be met? Are substitute species acceptable?
9. Have provisions been included to adequately address the change in cost when changing plant size or types?
10. Have provisions identified all the necessary biological material, such as seed, mycorrhizae, and so forth?
11. Is there a requirement to the contractor to provide proof of retaining plant material in the quantity and sizes specified by the plans at the beginning of project? If not, what other provisions have been made to ensure the availability of plant materials at the appropriate stage of site construction?
12. Is site-specific plant material required? Has scheduling included sufficient and practical time to collect or grow in advance to maintain the project completion schedule?
13. Are all species included in the design available either commercially or by contract collector or grower and at the quantities specified?
14. Do any species presently occur on an official endangered or threatened list? If any species do occur on the list, have appropriate permits been obtained? Or is the contractor or installer required to obtain the appropriate permits?
15. Is there an inspection requirement with a rejection basis for any material, plant, or work?
16. Do seed mixes include species with both common and scientific names, total pound per acre, germination, and purity levels?
17. Are there inspection methods for checking seed germination and purity rates?
18. Is there a provision for the project inspector, project manager, or other responsible person to retain a small sampling of the seed before application?
19. Are re-application methods described?
20. Is a provision included addressing alternative seeding time if unable to apply during optimum time?
21. Is there a specification that controls the duration time between planting and first watering?
22. If staking is required, has a detailed program been discussed outlining the process of checking straps to prevent damage to plants and eliminating the stakes during the maintenance period?

Water

1. Have the flood stage and water table depths been investigated?
2. Is the final elevation of the project site low enough to permit consistent flow through the site?

3. Will existing structures be eliminated or modified to permit water to enter the project site?
4. Is supplemental irrigation required for the project?
5. Has the water source to be used for irrigation or flooding been described?
6. Is irrigation or flooding included in the plan?
7. Is a consistent and predictable water source with good water quality being used for the site?
8. Will all areas of the restoration project have equal requirements for supplemental watering? (If not, the irrigation system should be designed for independent operation in each of the specific locations.)
9. If overhead impact sprinklers are used, is there sufficient overlap designed to offset the obstruction from the planting? Are sprinklers elevated higher than normal to offset the obstruction from seedlings, plants, and weeds?
10. If installed aboveground, have measures been included to ensure reliable operation?
11. Have flow and pressure calculations been made for irrigation system demand?
12. Are drip irrigation emitters sufficiently large to prevent clogging by algae, mineral deposition, and insect activity?
13. Is water accessing the site through a structure that will not impede the flow rate?
14. Have appropriate features been included with culverts to prevent scouring?
15. Will rock slope protection be used? Is there sufficient clearance to prevent clogging or impeding water flow?
16. If there is more than one water feature included in the design, what controls the water level and will the features act independently?
17. For water features designed for foraging habitat, have water depths been calculated to meet the requirements of targeted animal groups?
18. Will the culverts have screens that preclude fish moving into the project area?
19. Will a "natural opening" be created within the vegetation? How will it be kept open? Is a maintenance schedule included?
20. If water is introduced into the project by a pump, is it sized correctly to provide adequate volume to compensate for percolation, evaporation, and transpiration during the hottest period of the year?
21. If using a siphon inlet, what measures have been included to prevent vandalism?
22. If a tidal gate is used, will algae mats and flotsam be controlled to prevent gate malfunction?
23. If water source is from a water utility company, have capacity fees been included in the estimate?

Maintenance

1. Do specifications address weeding maintenance? Is there a definition of what constitutes a weed, and the maximum size, age, or coverage? Is there a removal schedule?
2. Is there a provision for maintaining protection devices after they are installed?
3. Is there provision for removal of stakes, protections screens, plant sleeves, and so forth when no longer required?

4. If fertilizer is being applied topically, are provisions made to control weed growth, if surface applied?
5. Is there a requirement to install fencing or other barriers, including plant protection screens and so forth?
6. Will maintenance of the project be absorbed into an existing maintenance department budget? If not, is separate funding allocated?
7. Are domestic ducks present in the location? (Consider them predators on new plantings.)
8. What provisions have been included to handle possible vandalism of plantings, fencing, signage, and irrigation equipment?
9. Is replacement planting included in the maintenance contract?

Operations and Programs

1. Is a supply of water accounted for through agreement or water rights?
2. Has a budget been developed for controlled burning operations?
3. Has the frequency of burning been included in a program budget?
4. Has coordination been conducted with any agency or department having jurisdiction over burning in your area?
5. Have appropriate buffer or fuel lines been planned to contain a burn?
6. Is there a constant supply of cattle and horses for grazing operations?
7. Are there provisions for keeping herd numbers stable? Are there established introduction and removal dates?
8. Will additional sources of feed be required for a maintained herd?
9. If the herd is from another source, have agreements, contracts, or other arrangements been finalized, with introduction and removal dates?
10. Are introduction and removal dates for maintained herds based on calendar or vegetation removal effect?
11. If the goal is trampling or soil disturbance by cattle, has testing been conducted to know the number and duration of cattle visiting on-site?
12. For projects emphasizing weed removal and natural recruitment, has a schedule been developed for monitoring?
13. Are provisions made for replacement of any equipment needed on-site?
14. If using herbicides, have necessary application permits been obtained? Is more than one person holding a permit?
15. Have arrangements been made for disposal or processing of weed biomass off-site or on-site?
16. Have life histories of the weeds involved been identified (i.e., germination, seed set)?
17. What post–weed removal maintenance will be required to ensure native plant reestablishment?
18. If burning removed weeds is a part of the plan, is an air quality permit required? Are there date or seasonal restrictions?

Special Considerations

1. Will there be pest removal or animal control programs?
2. If so, have appropriate agencies been contacted and permits obtained?
3. Have approved equipment, traps, bait, and other devices been included in the budget?
4. How will you address flotsam from watercourses? Will there be a range of tolerable debris buildup before needing removal?
5. For exclosures, will there be a maintenance program to ensure fence integrity?
6. Has replacement material been included in the budget along with personnel hours to install and maintain?
7. If excavation is near a sensitive area, will resources require noise or dust abatement conditions? Is there some other work restriction that may control the type of equipment being used?
8. Is there a concise list of activities and items that are the responsibility of the contractor during installation, during plant establishment, and during longer time periods?
9. Is it anticipated that beaver, deer, elk, rabbit, or other animals may frequent the site?
10. Are there provisions to protect the site from cattle, horses, wildlife, people, or off-road vehicles during the initial establishment stages?
11. If there is current recreational activity on the property, have restrictions been applied to this activity during the construction and establishment stages?

Appendix 9. Permits, Agreements, and Consultations That May Be Required for Ecological Restoration Projects in the United States

Permit, Agreement, or Consultation	Implementing Agency	Enabling Legislation	Critical Resources or Concerns	Circumstances Typically Required
Federal Government				
Archaeological Survey and/or Excavation Permit	Federal or Tribal Agency managing public/tribal lands	Archaeological Resources Protection Act of 1979 (ARPA)	Protection of archaeological resources	Required to conduct an archaeological survey and/or excavation on federal or tribal lands.
Bird Banding and Marking Permit	U.S. Geological Survey (USGS) Bird Banding Laboratory	Migratory Bird Treaty Act of 1918 as amended	Protection of migratory birds	Required to capture and handle any migratory bird for banding or marking purposes. A state permit may also be required.
Coastal Zone Federal Consistency Review	Lead State Agency in cooperation with National Oceanic and Atmospheric Administration's National Ocean Service Office of Ocean and Coastal Resource Management	Coastal Zone Management Act (CZMA) of 1972	Protection of coastal resources	Federal consistency is the CZMA requirement where federal agency activities (consistency determinations, financing, or other administrative actions) that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone.
Enhancement of Survival Permit via Candidate Conservation Agreement with Assurances (CCAA)	US Fish and Wildlife Service (USFWS)	Endangered Species Act (ESA) of 1973	Protection of habitat for proposed, listed or candidate endangered or threatened plant or animal species	Landowner voluntarily commits to conservation actions that will help stabilize or restore the species with the goal that listing will become unnecessary. Agreement provides landowners with assurances that their conservation efforts will not result in future regulatory obligations in excess of those they agree to at the time of entering into the agreement.
Enhancement of Survival Permit via Safe Harbor Agreement (SHA)	US Fish and Wildlife Service (USFWS) or National Oceanic and Atmospheric Administration (NOAA)	Endangered Species Act (ESA) of 1973	Federally listed threatened and endangered species	Voluntary agreement with nonfederal landowner that protects private or other nonfederal property owners whose actions contribute to the recovery of a species listed as threatened or endangered under the Endangered Species Act. Participating property owners receive formal assurances that the federal government will not require any additional or different management activities without the property owner's consent.

DOI 10.5822/ 978-1-61091-566-3,

Permit, Agreement, or Consultation	Implementing Agency	Enabling Legislation	Critical Resources or Concerns	Circumstances Typically Required
Endangered Species Consultation and/or Biological Opinion (USFWS)	US Fish and Wildlife Service (USFWS)	Endangered Species Act (ESA) of 1973	Federally listed species and critical habitat	Required for wildlife habitat restoration projects on any federal lands or that use federal funds, in any areas designated as critical habitat for the recovery of a listed species. Required for stream restoration projects where federally listed freshwater fish species and other listed aquatic species (e.g., amphibians, snails) are known to occur.
Endangered Species Consultation and/or Biological Opinion (NMFS)	National Marine Fisheries Service (NMFS)	Endangered Species Act (ESA) of 1973	Listed species (marine and anadromous salmon) and critical habitat	Required for stream restoration projects that may affect anadromous fish species and critical habitat.
FEMA Letter of Map Revision (LOMR)	Federal Emergency Management Agency (FEMA)	National Flood Insurance Act of 1968, as amended, and the Flood Disaster Protection Act of 1973, as amended	Protection of floodways and prevention of flood hazard	A Letter of Map Revision (LOMR) is generally based on the implementation of physical measures that affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway. Applies to restoration projects involving dam removal—if the floodplain or flood elevations change as a result of dam removal. May also need to do this to prove that a restoration project is not in a regulated floodplain.
Incidental Take Permit—Section 10(a)(1)(B) Permit	US Fish and Wildlife Service (USFWS)	Endangered Species Act (ESA) of 1973: Section 10(a)(1)(B)	Protection of all federally listed animal species	Incidental Take Permits are associated with Habitat Conservation Plans. Additional reasons for a permit include but are not limited to construction and development and in-stream and watershed activities that may impact listed species.
Incidental Take Permit via Habitat Conservation Plan	US Fish and Wildlife Service (USFWS)	Endangered Species Act (ESA) of 1973: Section 10(a)(1)(B)	Protection of all federally listed animal species	Permits otherwise legal activities that result in the "incidental" taking of a listed species as long as there is an approved Habitat Conservation Plan (HCP).
MMPA Incidental Take Authorization or Letter of Authorization	National Marine Fisheries Service (NMFS)	Marine Mammal Protection Act of 1972	All marine mammals	Restoration project that "takes" or harasses a marine mammal, including the relocation of marine mammals.
Pesticide Use Permit	Multiple agencies	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	Protection of wildlife and water quality	Application of herbicides to control weeds on federal lands.
Research/Recovery Permit (Recovery and Interstate Commerce Permit)—Section 10(a)(1)(A) Permit	US Fish and Wildlife Service (USFWS)	Endangered Species Act (ESA) of 1973: Section 10(a)(1)(A)	Protection of all federally listed species	Scientific research or activities to enhance a listed species propagation or survival that would directly "take" a wildlife species. Activities include abundance surveys, genetic research, relocations, capture and marking, telemetric monitoring, and seed collecting from endangered plant populations.

Permit, Agreement, or Consultation	Implementing Agency	Enabling Legislation	Critical Resources or Concerns	Circumstances Typically Required
Research/Recovery Permit (Recovery and Interstate Commerce Permit)—Section 10(a)(1)(A) Permit	National Marine Fisheries Service (NMFS)	Endangered Species Act (ESA) of 1973: Section 10(a)(1)(A)	Protection of federally listed anadromous fish species	Same as above but addresses specifically anadromous species, including salmon. Examples include fish surveys, genetic research, hatchery operations, relocations, capture and marking, and telemetric monitoring.
USACE General Permit Program—Programmatic General Permit	US Army Corps of Engineers (USACE)	Rivers and Harbors Act of 1899: Section 10, and Clean Water Act of 1972: Section 404, as amended	All navigable waters, tidal waters, wetlands, and waters of the United States	Programmatic General Permits are issued by the USACE on a state-by-state basis.
USACE Nationwide Permit (NWP) Program—Pre-Construction Notification	US Army Corps of Engineers (USACE)	Rivers and Harbors Act of 1899: Section 10, and Clean Water Act of 1972: Section 404, as amended	All navigable waters, tidal waters, wetlands, and waters of the United States	Nationwide Permits related to restoration include NWP 5 (Scientific Measurement Devices), NWP 6 (Survey Activities), NWP 13 (Bank Stabilization), NWP 27 (Aquatic Habitat Restoration, Establishment and Enhancement Activities), NWP 33 (Temporary Construction, Access, and Dewatering), NWP 37 (Emergency Watershed Protection and Rehabilitation), and NWP 43 (Stormwater Management Facilities). USACE District Offices may set additional requirements.
USACE Section 10 Permit	US Army Corps of Engineers (USACE)	Rivers and Harbors Act of 1899: Section 10	All navigable waters and tidal waters	Required for construction of piers, breakwaters, bulkheads, jetties, weirs, and intake structures; dredging or disposal of dredged material; and excavation, filling, or other modifications to waters of the United States. Work in, over, or under navigable waters or that affects course, location, condition, or capacity of such waters.
USACE Section 404 Permit	US Army Corps of Engineers (USACE) (also requires state approval under Section 401)	Clean Water Act of 1972: Section 404, as amended	Wetlands and waters of the United States	Required for projects that involve (1) discharge of fill or dredged material into the waters of the United States, including wetlands; (2) site development fill for residential, commercial, or recreational developments; (3) construction of revetments, groins, breakwaters, levees, dams, dikes, and weirs; and (4) placement of riprap and road fills. Applies to any restoration projects on federal lands or that use federal funds.
State and/or Regional Government				
Archaeological Investigation Permit	State Historic Preservation Office (SHPO)	State Statutes	Archaeological resources located on state lands	Required to conduct archaeological field studies on state lands or within state-controlled waters.
Clean Water Act Section 401 Water Quality Certification and/or Waste Discharge Requirements Determination	State Water Resources Control Board or Water Quality Control Board or State Dept. of Environmental Protection, etc.	Federal Clean Water Act of 1972: Section 401, as amended	Compliance with state water quality standards	Any restoration project that involves dredge or fill activities that may result in a discharge to US surface waters and/or "Waters of the State" is required to obtain a CWA Section 401 Water Quality Certification and/or Waste Discharge Requirements (dredge/fill projects) Determination. Also applies to any restoration project that requires a federal permit.

Permit, Agreement, or Consultation	Implementing Agency	Enabling Legislation	Critical Resources or Concerns	Circumstances Typically Required
Coastal Development Permit	State Coastal Commission or Local Coastal Zone Commission	Federal Coastal Zone Management Act of 1972 and State Coastal Zone Management Acts	Protection of coastal resources	Projects located within a state-designated Coastal Zone, including projects to return a project site to a predevelopment condition. Includes wetland and coastal lagoon restoration projects.
Cultural Resources Consultation	State Historic Preservation Office (SHPO) and/or Tribal Historic Preservation Office (THPO)	National Historic Preservation Act (NHPA) of 1966 and State Historic Preservation Acts	Protection of archaeological and cultural resources	Consultation with SHPO and/or THPO for projects potentially affecting sites of archaeological and cultural resources on state and federal lands (NHPA Section 106).
Historic Area Work Permit or Historic Structure Modification—Project Authorization	State Historic Preservation Office (SHPO) and/or Tribal Historic Preservation Office (THPO)	National Historic Preservation Act (NHPA) of 1966 and State Historic Preservation Acts	Protection of historic structures	Same as above but for historic structures, such as breaching a historic dam.
Hydraulic or Hydrology Project Approval or Permit	State Division or Department of Fish & Wildlife or other State Agency	State Statute	Stream channel within the Ordinary High-Water Mark (OHWM)	Any construction activity that uses, diverts, changes, or obstructs the bed or flow for state waters. Required for salmonid habitat restoration projects in some states, including log, logjam, or debris removal.
Incidental Take Permit	State Division or Department of Fish & Wildlife	State Endangered Species Act	Rare, endangered, and threatened species	Activities likely to impact state-listed species, including habitat enhancements for the species.
Lake or Streambed Alteration Agreement	State Division or Department of Fish & Wildlife	State Fish and Wildlife Code	Lakes, streambeds, and stream banks	Activities that could significantly modify a lake, stream, or river by substantially changing the bed, channel, or bank of a river, stream, or lake. May apply to alteration of riparian vegetation, including the removal of exotic vegetation.
Levee Plantings Notification and/or Approval	Levee District and/or Reclamation District and/or Flood Protection Board	USACE O&M Guidelines and State Flood Management Agency Guidelines	Levee and floodway maintenance	Applies to plant species selection on, or near, flood control levees and the management of plants on or in proximity to a levee.
Mosquito Control Consultation	Mosquito Abatement District	State and Local Laws and Regulations	Mosquito production: mosquito vectors of mosquito-borne diseases	Projects resulting in creating increased larval habitat for mosquitoes. Sometimes applies to stream restoration projects.
National Pollution Discharge Elimination System Permit	Environmental Protection Agency (EPA) regional office and/or cooperating local agencies	Federal Clean Water Act	Protection of surface water quality and prevention of sedimentation	Project sites greater than one acre that expose soil to potential soil erosion. May need a Stormwater Pollution Prevention Plan (SWPPP) to prevent polluted runoff.
Pesticide Use Recommendation Form	State Department of Pesticide Regulation	State Statute or Policy	Protection of fish, wildlife, and aquatic resources	When pesticides and/or herbicides are used.

Permit, Agreement, or Consultation	Implementing Agency	Enabling Legislation	Critical Resources or Concerns	Circumstances Typically Required
Prescribed Burn Permit	State-Regional Air Quality Control Board	State-Regional Air Quality Code and Regulations	Protection of air quality	Use of prescribed fire as a management tool.
Plant Collecting Permit or Plant Research Permit	State Division or Department of Fish & Wildlife	State Endangered Species Act and/or State Native Plant Protection Act	Rare, threatened, and endangered plant species	Projects involving state-listed plant species, including seed collection or other propagules for propagation or recovery actions, transplanting of a threatened or endangered plant species.
Scientific Collecting Permit or Scientific Take Permit	State Division or Department of Fish & Wildlife	State Endangered Species Act and/or State Statute	Protection of wildlife resources and State-listed species	Monitoring programs that involve sampling involving live trapping or other forms of sampling that may injure protected wildlife species. Also for sampling fish populations before, during, and/or after a project.
Timber Harvesting Permit	State Department or Division of Forestry	State Forest Practices Act and Code	Protection of forest resources	Projects that involve removal of merchantable timber (trees); may be required for projects involving tree thinning and/or tree removal.
Trapping Permit or License	State Division or Department of Fish & Wildlife	State Fish and Wildlife Code		Temporary trapping and removal of native wildlife nuisance species (e.g., beaver) that could potentially destroy plantings.
Water Rights Permit or Water Diversion Limited License	State Water Board or State Division of Water Rights	State Water Resources Code	Use of water resources without water rights	Projects needing to divert (including pumping) and use water from a stream on a short-term or fixed duration for irrigating nonriparian land.
Local Government				
Agricultural Land Use Conversion Permit	County, Parish, Township, City or Town	Local Land Use Conversion Ordinance	Preservation of agricultural lands	May be required for conversion of agricultural lands to wildlife habitat. In some states, state has jurisdiction.
Burning Permit	County, Parish, Township, or Town Air Quality Control District and/or Local Fire District	County, City, etc. Ordinance or Agricultural Commissioner Policy	Air quality and fire hazard	Burning to eliminate debris. Burning to control weeds. Prescribed fire.
Encroachment Permit	Flood Protection Board or Flood Control District, or County, Parish, Township, City, or Town	State Stature or Policy	Potential hydraulic impacts of development (including plantings) in floodways	Encroachment into rivers, waterways, floodways, and floodplains. Assessment of project site "improvements" on flood flows and elevations. A flood-neutral planting design may be required.
Erosion Control Permit	County, Parish, Township, City, or Town	County, City, etc. Erosion Control Ordinance	Soil erosion and sedimentation	Any land-disturbing activity in excess of a specified area (square feet), or on a slope greater than a certain percent, or exceeding volume quantity of grading, or along a waterway or shoreland zone.
Grading Permit	County, Parish, Township, City, or Town	County or City Grading Ordinance	Whenever construction involves moving a certain amount of earth	Projects involving channel relocation or reconfiguration. Projects that involve lowering of land elevation relative to water surface elevation (e.g., wetland, riparian).

Permit, Agreement, or Consultation	Implementing Agency	Enabling Legislation	Critical Resources or Concerns	Circumstances Typically Required
Herbicide Use Report	County, Parish, Township, or Town Agricultural Commission	County, etc. Agricultural Commissioner Policy	Documentation of herbicide use	Herbicide spraying to control weeds.
Reclaimed Water Use Permit	County, Parish, Township, City, or Town	County, City, etc. Ordinance or Policy	Protection of water quality	Projects that intend to use treated wastewater for wetlands and possibly for the irrigation of upland plantings.
Stormwater Management Permit	County, Parish, Township, City, or Town	County, City, etc. Stormwater Management Ordinance	Protection of water quality	Activities that may significantly increase runoff, flooding, soil erosion, or water pollution or significantly impact a lake, stream, or wetland area.
Tree Removal Permit	County, Parish, Township, City, or Town	County, City, etc. Tree Protection Ordinance	Protection of designated heritage trees and trees over a certain diameter	Where tree protection ordinances are in effect.
Well Deconstruction or Destruction Permit	County, Parish, Township, City, or Town Environmental Health Agency	State Standards and County, City, etc. Ordinances	Prevention of groundwater contamination	Decommissioning of unused or abandoned wells. Must follow state standards and any additional local requirements.
Well Drilling Permit	County, Parish, Township, City, or Town	County, City, etc. Well Drilling Ordinance	Prevention of groundwater contamination	Drilling of a production well for watering plantings or other purposes.

Appendix 10. Completed Site Analysis Checklist for Los Peñasquitos Canyon Preserve

General Factors	SWOT-C	Comments
Political considerations	S	Removal of tall skyline eucalyptus—visual impacts for park users and nearby residences.
		Consult with landscape architects for visual study.
Historical context	S	Canyon area operated as a ranch beginning in mid-1800s; preserve staff says the canyon was used mainly for cattle grazing; photos in the old adobe show sycamores, oaks, and cottonwoods in early years of ranch operations.
Hazardous waste	—	No evidence of old fuel tanks or washout pads.
		Check county records for any information regarding historic Rancho operations.
Resource constraints	C	Existing native vegetation in area; stream is live.
		Flag off areas; develop bypass system for water.
Historical/Archaeology	C	Grave site near large oak; Spring House (foundation is being undermined by palms); Rancho adobe is on National Registry.
		Coordinate with preserve staff on requirements and restrictions.
Wildlife	S	Great horned owl's nest in eucalyptus grove.
		Preserve and relocate nest; consult with Biology to determine best time or season for relocation.
Human use patterns	T	Trails proliferate throughout project area; daily use includes hikers, joggers, equestrians, mountain bikers; school programs near Rancho.
		Coordinate with preserve staff regarding trail closure during construction and plant establishment.
Identify ecosystem stress points	W	Large stands of eucalyptus trees cover streambed; large eucalyptus grove at headwaters of Peñasquitos Creek; several individual eucalypts scattered throughout canyon.
	W	Volunteer palms (*Phoenix* spp.) dominate the Spring House and creek area.
	W	Large quantity of leaf litter and shallow roots.
Ownership of candidate site	S	Entire site is owned by County.
		Obtain parcel map from County records.

DOI 10.5822/ 978-1-61091-566-3,

Constraints	C	Will trails need to be kept open during construction and plant establishment?
	C	Heavy trail use in a.m./p.m. periods; may require work windows during installation.
Easements, prior rights	T	Utility corridors crisscross the site; sewer manholes are visible on main service road; water main runs north/south; overhead electrical lines share same easement.
		Request easement restrictions and details from utility companies.
	T	Surface erosion along main service road.
Agricultural quarantines		None.
Land use	S	Project site is within an open space park operated by the County; residential land uses are located at the top of the north and south canyon rims.

Physical Factors		
Define candidate area		Three-acre site within the park; project area is covered with non-native eucalyptus.
Landscape ecology considerations	S	Part of a large riparian vegetation community with direct connection to adjacent hillsides. Wildlife can reach site easily and move up and downstream without any obstacles. Stream flows through vegetation with several channels present. Migration of fish only downstream as waterfall below site prevents upstream movement.
Hydrology	S	Peñasquitos Creek flows year-round; three minor overflow channels run parallel through site and appear to carry water during storm events.
Groundwater	S	Natural spring feeds creek at Spring House.
Surface water	S	Appears clean; is free from debris and sedimentation though urban runoff must contribute to status as year-round creek.
	T	Ranch House trail has potential sedimentation problem.
Water quality	?	Order test for salinity/nitrogen/phosphates/boron/and heavy metals.
Topography	S	Wide canyon bottom; runs east to west relatively flat; mesas located on the north and south of canyon.
Elevation	S	~ 200 feet +/– MSL

Slope and aspect	S	South canyon wall is steep (~30%) and covered with chaparral; north canyon wall is flatter and dominated by nonnative grasses; gets full sun; canyon bottom in full sun.
Soil testing	O	Loamy sand in project area, with sandy and gravelly loam near main service road and trails.
		Determine whether any data are available from County.

Biological Factors	SWOT	Comments
Determine successional patterns of existing vegetation	W	Vegetation currently in "climax" condition with mature and developing eucalyptus trees and lack of understory. Small area on perimeter still exhibiting diversity of native plants but in small clusters. Some areas with young eucalyptus indicating the process of degradation is ongoing. Native vegetation adjacent to eucalyptus colonies shows typical pattern riparian altered regularly by flood flows.
		Establishing willow scrub woodland in area will serve to bring the upstream and downstream vegetation into one continuous cluster, providing enhanced microhabitats.
Identify habitat values and features	O	Tall trees provide roosting and nesting habitat for raptors and larger birds. Owl nesting and several hawks observed roosting in various locations. Small fishes in water from upstream; no access from downstream. Mammals frequent area; bobcat, fox, raccoon, and skunk are common in this area of the park. Signs of deer seen along riparian area on trails.
		Project will provide foraging areas within the current eucalyptus grove. The project will encourage more frequent visitation and increase the diversity of animals using the vegetation to more than the larger predatory birds.
Assess degree of degradation	W	Large areas along creek banks devoid of native understory; eucalyptus dominates.
	W	Soil surface appears to have about 6 to 10 inches of eucalyptus leaves and seeds.
		Talk with team about removing top soil layer to rid the site of eucalyptus seed bank.

Wildlife resources	C	Great horned owl nesting on-site in eucalyptus.
		Move nest into sycamore tree nearby.
Anticipated Site Improvements		
Grading	S	Only minor grading may be necessary to clean up after tree stump removal.
Soil import/export	W	Remove 6 to 10 inches of soil in eucalyptus groves to remove seed bank?
Drainage/flood control	O	Use existing overflow channels to divert stream during construction.
		Consider enhancing stream crossing and reducing sedimentation potential.
Buffer requirements		None.
Access/access control	W	Temporary fencing around restoration areas will be necessary to protect new plantings.
		Provide access gates for plant establishment.
		Coordinate with preserve staff regarding fence locations.
Utility service	O	Electrical service connection at Ranch House; north side of creek approximately 400 feet from site.
Water		Point of connection for city water service located on north side of creek approximately 600 feet away from site.
Electric		Consider solar-powered controller, especially because irrigation will be temporary.
Irrigation		Required for two years.

S–Strength
W–Weakness
O–Opportunity
T–Threat
C–Constraint

Glossary

actions. Measures that are undertaken to achieve stated objectives.

adaptive management. A structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.

anthropogenic environmental stressor. A human-induced environmental condition or recurring event that is detrimental to the stability or development of an ecosystem.

best management practices (BMPs). Techniques, processes, activities, or structures used to mitigate direct or indirect impacts.

bioengineering. A branch of engineering in which live plants and plant parts are used as building material for erosion control and landscape restoration in contrast to conventional engineering where only dead materials are used. Also referred to as soil bioengineering.

biotechnical stabilization. The integrated or combined use of living vegetation and inert structural components to stabilize a slope.

buffer zone. Areas between core protected areas and the surrounding landscape or seascape that protect the core area from potentially damaging external influences; they are essentially transitional areas.

community. An assemblage of organisms occurring in a landscape or at a specified location; typically used in combination with a taxonomic group (plant community, insect community, epiphyte community).

compensatory mitigation. An approach or strategy used by government agencies to require that unavoidable environmental damage is compensated by ecological restoration or another activity (rehabilitation, reclamation, enhancement, and so forth).

connectivity. Landscape connectivity can be defined as the degree to which the landscape facilitates or impedes movement of materials between resources patches.

corridors. A narrow strip landscape used by wildlife and potentially allowing movement of biotic factors between two areas.

creation. The intentional replacement of an ecosystem with another kind of ecosystem of alleged greater value, as has commonly been required for satisfying compensatory mitigation requirements.

cultural ecosystems. Ecosystems that have developed under the joint influence of natural processes and human-imposed organization.

design-build contractor. A contractor who prepares restoration project plans for stakeholder approval and then constructs the project under a single contract.

ecological attributes. Biophysical (composition, structure, abiotic/landscape support) and emergent (functionality, complexity, self-organization, resilience, self-sustainability, biosphere support) properties of ecosystems.

ecological engineering. The manipulation and use of living organisms or other materials of biological origin to solve problems that affect people.

John Rieger, John Stanley and Ray Traynor, Project Planning and Management for Ecological Restoration,
DOI 10.5822/ 978-1-61091-566-3,

ecological integrity. Ecological integrity is the state or condition of an ecosystem that displays the biodiversity characteristic of the reference—such as species composition and community structure—and is fully capable of sustaining normal ecosystem functioning.

ecological restoration. The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

ecological restoration practitioner. An individual who is actively engaged in the various phases and aspects of ecological restoration and who is knowledgeable in the concepts of restoration ecology and the principles and practices of ecological restoration.

ecological restoration project. A planned undertaking designed to recover degraded, damaged, or destroyed ecosystems at specific project sites within defined (i.e., mapped) boundaries. Ecological restoration projects attempt to restore most if not all of the attributes of restored ecosystems.

ecological trajectory. The projected developmental pathway of the ecological attributes—biotic and abiotic—of an ecosystem through time.

ecosystem degradation. The incremental and progressive impairment of an ecosystem on account of continuing stress events or punctuated minor disturbances that occur with such a frequency that natural recovery does not have time to occur.

ecosystem processes. The underlying processes of an ecosystem, such as energy transfer, primary production, food chain dynamics, hydrological pathways, and nutrient cycling. Inextricably linked with ecosystem structure but not synonymous with ecosystem functioning.

ecosystem recovery. The rate and manner in which the ecosystem subsequently returns to its unstressed condition or follows a chronological sequence of development (often termed trajectory) that would coincide with an unstressed reference condition, if recovery indeed occurs.

ecotone. A transition zone between ecosystems.

edge effect. The phenomenon of increased wildlife abundance and diversity along the edge between two adjacent plant communities.

electroconductivity. Conductivity of electricity through water or an extract of soil. Commonly used to estimate the soluble salt content in solution. See also **soil electrical conductivity**.

environmental engineering. The integration of science and engineering principles to improve the natural environment (air, water, or land resources); to provide healthy water, air, and land for human habitation (house or home) and for other organisms, and to remediate pollution sites.

environmental stressor. A normally occurring condition or recurring event that is more detrimental to some species than to others and that largely determines species composition and abundance in an ecosystem. Examples of stressors include freezing temperatures, drought, salinity, fire, and unavailability of nutrients.

fabric mulch. Synthetic material placed on the ground around plants to control weed growth. Also referred to as a weed mat.

fabrication. Establishment of an ecosystem on land that previously did not have this ecosystem. Also called creation.

flaming. Eradication of weeds and invasive plants by means of burning plant parts using a propane torch.

function. The dynamic aspects of ecosystems, such as photosynthesis, primary production, sequestering and recycling of mineral nutrients, and maintenance of food webs. Sometimes restricted in meaning to these metabolic activities and sometimes expanded to include all ecosystem processes.

geomorphology. The description and study of landforms.

girdling. The complete removal of a strip of bark (consisting of cork cambium, phloem, cambium, and sometimes going into the xylem) from around the entire circumference of either a branch or trunk of a woody plant. Girdling results in the death of wood tissues above the damage. Also called ring barking or ring-barking.

habitat. The resources and conditions present in an area that produce occupancy—including survival and reproduction—by an organism: habitat is organism specific.

hard seed. Any seed with a tough impervious outer coat that will not allow the entry of water. Germination cannot occur until the seed coat is ruptured, either by scarification or by microbial action.

hardpan. A soil layer with physical characteristics that limit root penetration and restrict water movement.

herbivore. An animal that feeds on plants. *Herbivory* is the state or condition of feeding on plants.

hydroperiod. The duration that a soil or substrate is saturated or inundated over the course of a year or other time period.

imprinter. A roller that makes microcatchments with teeth, cones, or V-shaped ridges arranged in a pattern to direct water flow; typically towed by a tractor, bulldozer, or other heavy equipment.

indigenous. Native to a given location.

indigenous people. A body of persons having originated in and being produced, growing, living, or occurring naturally in a particular region or environment united by a common culture, tradition, and kinship; exhibiting the practice of common social, economic, environmental, and spiritual beliefs.

inoculation. The act of introducing mycorrhizae or bacteria (inoculum) to a plant.

keystone species. A species that has a substantially greater positive influence on other species than would be predicted by its abundance or size.

landscape. An assemblage of ecosystems that are arranged in recognizable patterns and that exchange organisms and materials such as water.

landscape ecology. The study of dynamic interactions between the connected ecosystems forming a landscape and the environment, including human activities.

landscape mosaic. A patchwork of different components pieced together to form an overall landscape. The actual composition of the mosaic and the pattern in which the components are distributed will be unique to each landscape.

leach tube. A reusable cone-shaped plastic container used for growing seedlings. The containers can be mounted in a rack for easy transport and were named after inventor Ray Leach.

liner. A plant seedling grown in a long narrow tube (typically 10 inches tall and 1.5 inches in diameter) for convenient transplanting onto a revegetation site.

local ecological knowledge (LEK). Current and ever-expanding, useful knowledge about species and ecosystems, as gathered by people who live in rural landscapes in a sustainable manner. See also **traditional ecological knowledge (TEK)**.

macronutrient. A plant nutrient found at relatively high concentrations (> 500 mg kg-1) in plants. Usually refers to nitrogen, phosphorus, and potassium but may include calcium, magnesium, and sulfur.

microclimate. Ameliorated atmospheric conditions, relative to those of the macroclimate in the region, caused by community structure (e.g., shade, windbreaks) and processes (e.g., transpiration) in an ecosystem.

micronutrient. A plant nutrient found in relatively small amounts (< 100 mg kg-1) in plants. These are usually boron, chlorine, copper, iron, manganese, molybdenum, nickel, cobalt, and zinc.

mitigation. Mitigation includes (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensating for the impact by replacing or providing substitute resources or environments. The word *mitigation* is often used to refer to compensatory mitigation. See also **compensatory mitigation.**

mycorrhiza. A mutualistic symbiosis between plant and fungus localized in a root or rootlike structure in which energy moves primarily from plant to fungus and inorganic resources move from fungus to plant.

nurse plants. Plant species that protect or promote the growth of associated plants.

nutrient holding capacity. The ability of soil to absorb and retain nutrients so they will be available to the roots of plants.

organic matter present/content. The weight of decomposed plant and animal residue; expressed as a weight percentage of the soil material less than 2 millimeters in diameter.

passive restoration. Autonomous or autogenic recovery of a degraded ecosystem by means of the unassisted processes of resilience, succession, or natural regeneration.

performance standard. A value or threshold condition that is determined by monitoring and that, when attained, verifies that a particular objective has been achieved.

perturbation. An alteration of the function of a biological system, induced by external or internal mechanisms.

plant band. A long, narrow container for growing plants.

plant establishment period. The period of time following plant installation that is required to ensure success of the plantings installed at a restoration site without external support.

plant palette. The combination of plant species that are introduced to a restoration site. Also referred to as plant species palette or just species palette.

plugs. Herbaceous plants grown in small cylindrical or square containers that are longer than they are wide. The longer shape allows the plant to build root mass prior to transplanting. Also referred to as tubelings.

power auger. Motorized auger for boring shallow holes in the ground. Generally handheld by two workers.

prescribed fire or burning. The deliberate use of fire to manage a forest or some other type of natural area conducted for a single purpose or multiple purposes, including hazard reduction, control of understory vegetation, site preparation, disease control, and wildlife habitat enhancement as well as to kill targeted plant species or to favor the growth or presence of fire-dependent species of plants and animals.

prevegetated mats. Flat layers of vegetation (generally grasses, sedges, and forbs) grown in a soil medium incorporated into the top layer of a netting material made of polypropylene or plant fiber layers.

process. Dynamic aspect of an ecosystem or landscape, sometimes considered synonymous with function and including such interactions as transpiration, competition, parasitism, animal-mediated pollination and seed dispersal, mycorrhizal relationships, and other symbiotic relationships.

project requirements. A summarization of all of the site needs, stakeholder expectations, and imposed requirements for a restoration project.

project scope statement. A written statement describing the dimensions of a restoration project, including project goals and objectives, project requirements, the project budget, the project schedule, and any assumptions made by the project team.

propagule. Any plant reproductive structure, sexual and vegetative, such as a seed, spore, or rootstock, that proliferates.

pure live seed (PLS). The quantity of viable seed in harvested seed material derived by multiplying the germination and purity rates by the bulk quantity of seed.

purity rate. A measurement of bulk seed indicating the amount of seed and nonseed material.

reclamation. Conversion of land perceived as being relatively useless to a productive condition, commonly for agriculture and silviculture. Recovery of productivity is the main goal.

reference. One or more actual ecosystems (called reference sites), their written ecological descriptions, or information from secondary sources (e.g., historical photographs or accounts, paleoecological data) that serves as a basis for guiding the development of an ecological restoration project. See also **reference site(s)** and **reference model**.

reference model. An ecological description of an ecosystem that serves as a basis for preparing restoration plans; derived from the study of reference sites or from secondary sources of information.

reference site(s). One or more actual ecosystems on which restoration planning is based and that can serve as a basis for evaluating a completed restoration project.

rehabilitation. The recovery of ecosystem processes to regain normal function and ecosystem services without necessarily restoring the biodiversity of the reference or its projected trajectory.

resilience. The capacity of an ecosystem to tolerate or fully recover spontaneously from disturbance.

resistance. The capacity of an ecosystem to absorb the effects of disturbances with little or no change in structure and function.

resoiling. The process of artificially building or reconstructing a soil profile.

restoration ecology. The science on which the practice of ecological restoration is based and that provides the concepts and models on which practitioners depend. The science that advances the frontiers of theoretical ecology through studies of restored ecosystems and those that are undergoing restoration.

restrictive layer. A layer of earth that has one or more physical, chemical, or thermal properties that significantly reduce the movement of water and air through the soil. Restrictive layers limit plant growth by restricting the limits of the rooting zone.

revegetation. Establishment of plant cover on open land, usually with a limited number of species, irrespective of their provenance.

reverse backfilling. The refilling of a previously excavated area in reverse order from which the material was excavated (parent material, subsoil, topsoil).

rhizome. Stem of a plant that is capable of vegetative reproduction. Differing anatomically from true roots, rhizomes produce shoots above and roots below and are distinguished from a true root in possessing buds, nodes, and usually scalelike leaves.

salinization. Process by which soil comprising the root zone becomes increasingly more saline (salty) on account of the evaporation of irrigation water or another cause generally related to land use.

scarify. To break, scratch, or modify the surface of the soil. Also, to scratch the impervious seed coat of a hard seed.

seed bank. Location where seeds are stored for later purchase and use.

seed increase. A method of seed production using planted seedbeds to produce higher quantities of seeds in a controlled environment.

smothering. Technique for killing unwanted vegetation or preventing germination by covering the soil with some type of material (e.g., wood chips, weed control fabric, plastic) to exclude sunlight.

sod slabs. Blocks of sod removed from a wetland or native grassland or meadow containing the soil, the plant roots, and the aboveground vegetation.

soil electrical conductivity. The ability of soil to conduct electricity.

soil horizon. A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics, such as color, structure, texture, consistency, kinds and number of organisms present, and degree of acidity or alkalinity.

soil imprinting. A technique of using an angular tooth or foot (generally attached to a heavy roller) to create funnel-shaped depressions in the soil surface to promote plant growth. The technique differs from conventional methods of tillage (e.g., plowing, discing, cultivating, or drill seeding) in that it does not turn over the soil and entails minimal disruption of the surface litter. The depth of the depression is designed to permit sufficient water collection to allow germination of slower-growing plants.

soil inversion. A process of turning over the topsoil and bringing up the subsoil from three feet below the surface.

soil permeability. The ease with which gases, liquids, or plant roots penetrate or pass through a bulk mass of soil or a layer of soil.

soil ripping. The process of pulling a steel shank (tine or ripper) through soil to break up compacted subsurface layers. The shanks are more than forty-five centimeters long and spaced about the same distance apart. Also called subsoiling, deep ripping, or deep tillage.

soil seed bank. Viable seeds stored in the soil that are capable of germinating when appropriate conditions occur and that can replenish the vegetation after disturbance.

soil texture. The relative proportions of the various soil separates in a soil as described by the classes of soil texture (e.g., clay, clay loam, loam).

soil type. The lowest unit in the natural system of soil classification; a subdivision of a soil series and consisting of, or describing, soils that are alike in all characteristics, including the texture of the A horizon or plow layer. In terms of soil texture, soil type generally refers to the different sizes of mineral particles in a particular soil sample.

solarization. The use of solar energy to kill unwanted seeds and soil disease organisms; soil is tilled, irrigated, and covered with clear plastic.

species reintroduction. An attempt to reestablish a species in an area that was once part of its historical range but from which it has been extirpated.

stakeholder. A person or organization that is actively involved in the project or whose interests may be positively or negatively affected by execution or completion of the project.

state. The appearance, expression, or manifestation of an ecosystem or landscape as determined by species composition, the life-forms, sizes and abundance of individuals, and community structure.

stratification. The use of chemical and mechanical systems to break dormancy of seeds and promote germination.

structure. The physical appearance of a community as determined by the sizes, life-forms, abundance, and distribution of the predominant plant species. Also referred to as community structure.

swailing. Controlled burning for hazard reduction; also used for managing heath in Great Britain.

target. The intended long-term outcome (endpoint or goal) of a restoration project, which sometimes is not fully achieved until long after restoration project work has ceased.

target species. List of species (often special status species) for which habitat is being created. Restoration design is based on the combined habitat requirements of these species.

traditional cultural practices (TCPs). The application of traditional ecological knowledge that leads to the development and maintenance of cultural ecosystems.

traditional ecological knowledge (TEK). Ecological knowledge derived through societal experiences and perceptions that are accumulated within a traditional society through interaction with nature and natural resources. TEK commonly originates through trial and error and is frequently passed down to subsequent generations by oral tradition. See also **local ecological knowledge (LEK)**.

tree spade. A specialized machine consisting of a number of blades that encircle a tree, digging into the ground and then lifting the entire tree, including its roots and soil, out of the ground for relocation.

vegetation zonation. A vegetation pattern wherein certain assemblages of plant species occur in zones—often in bands adjacent to water bodies.

vegetative propagation. Propagation without pollination by way of separating vegetative parts (e.g., branches, stolons, rhizomes, buds) from the mother plant and planting them so they take root and grow.

viability. Determination of whether a seed is capable of germinating by establishing the presence of an embryo plant within the seed coat.

water budget. The determination of water needs for an area by totaling the various inputs from precipitation, groundwater, and other sources against the amount of water loss through runoff, transpiration, and ground infiltration.

water holding capacity. The ability of soils to hold water against the force of gravity and keep it available for use by most plants.

waterjet stinger. A high-pressure water pump plumbed to a long hollow pipe ("stinger"). The stinger is inserted into the ground, and the waterjet creates a long narrow hole. Used for planting woody cuttings along stream banks.

watershed. The line separating the waters flowing into different rivers or river basins; a narrow, elevated tract of ground between two drainage areas.

wattles. Long tubular rolls of plant material wrapped in twine or plastic netting used for erosion control and bank or slope stabilization. Wattles can be constructed from dormant stem cuttings or any other vegetative material (e.g., coir, rice straw, pine needles). The term *wattle* also refers to a fabrication of closely set posts interwoven with slender branches or reeds (wattle fences). See also **willow wattles**.

weed. Any undesired, uncultivated plant that grows in profusion so as to crowd out a desired crop or desired native vegetation.

weed-free straw. Harvested plant material that has been certified to be free from noxious weeds for use in straw bales, straw mulch, and straw wattles.

whips. Long woody cuttings.

willow wattles. Cylindrical bundles of live shrubby stems constructed from dormant willow cuttings; usually tied with twine or wire, varying in length and tapering at the ends. Used for erosion control and bank stabilization, dormant stem wattles can be constructed using any woody species that will root when in contact with moist soil. Also called fascines. See also **wattles**.

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John Rieger

John Rieger has spent the past thirty years of his professional career involved with various aspects of ecological restoration. As cofounder of the Society for Ecological Restoration (SER) in 1987, John became its first president in 1988. John has worked to promote ecological restoration, presenting workshops throughout the United States and in Canada and England. He was presented the SER Service Award in 1995 and the Golden Trowel Award in 1997.

Educated as a wildlife biologist at San Diego State University, John became a Certified Wildlife Biologist in 1978 from The Wildlife Society. John was hired as the first district biologist at Caltrans in San Diego in 1979. He performed some of the pioneering work on endangered Least Bell's (Vireo bellii pusillus) habitat restoration, working with his fellow biologists and landscape architects at Caltrans. John and Ray Traynor led the team that received the SER 1996 Model Project of the Year Award. John achieved a Project Management Professional designation from the Project Management Institute in 2004. He was a senior biologist and project manager for Caltrans.

John continues his involvement with ecological restoration by volunteering on committees for SER, conducting ecological restoration workshops, and managing his consulting firm, which he founded in 1984 with his wife, Mary F. Platter-Rieger.

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John Stanley is a restoration ecologist with WWWRESTORATION, a consulting firm specializing in the protection, restoration, and management of watersheds, waterways, and wetlands. John Stanley has more than forty years of academic, agency, nonprofit, and consulting experience in environmental planning, biotic impact analysis, habitat mitigation, soil conservation, ecological restoration, and watershed management.

Formerly a principal and licensed landscape contractor with The Habitat Restoration Group, John was responsible for the planning, design, construction/installation, maintenance, and monitoring of land reclamation, habitat mitigation, and ecological restoration projects throughout northern and central California.

John is a founding member of the Society for Ecological Restoration (SER). He recently completed serving as SER's US western regional representative and is continuing to serve as the chair of SER's ad hoc committee for Ecological Restoration Practitioner Certification. He lives in Paradise, California.

John Rieger, John Stanley and Ray Traynor, Project Planning and Management for Ecological Restoration,
DOI 10.5822/ 978-1-61091-566-3,

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Ray's interest in ecological restoration began in the mid 1980s when he worked as a landscape architect for the California Department of Transportation. Ray's thirty-year career has included work in landscape architecture, ecological restoration, project management, business development, product management, mobile applications development, and transportation planning.

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Island Press gratefully acknowledges major support of our work by The Agua Fund, The Andrew W. Mellon Foundation, Betsy & Jesse Fink Foundation, The Bobolink Foundation, The Curtis and Edith Munson Foundation, Forrest C. and Frances H. Lattner Foundation, G.O. Forward Fund of the Saint Paul Foundation, Gordon and Betty Moore Foundation, The Kresge Foundation, The Margaret A. Cargill Foundation, New Mexico Water Initiative, a project of Hanuman Foundation, The Overbrook Foundation, The S.D. Bechtel, Jr. Foundation, The Summit Charitable Foundation, Inc., V. Kann Rasmussen Foundation, The Wallace Alexander Gerbode Foundation, and other generous supporters.

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