East Contra Costa County Habitat Conservation Plan Association

HCPA Coordination Group Meeting

Thursday, December 16, 2004
1 p.m. to 3 p.m.

City of Pittsburg Council Chambers
65 Civic Drive in Pittsburg, 3rd Floor
(see map on reverse)

Agenda

1:00 Introductions. Review contents of meeting packet. Review and approve Draft Meeting Record of the November 18, 2004 Coordination Group meeting.

1:15 Updates:

- Request for exemption from Critical Habitat Designation related to East Contra Costa County HCP submitted to USFWS (letter was included in November packet);
- Revised rural road fee proposal (see attached)

1:40 Adaptive Management component: discussion of completely revised draft of Adaptive Management Chapter (attached)

2:25 Wetlands Permitting:

- Status update from staff
- Comments due by December 16 on draft wetlands permit strategy and inventory (presented at October Coordination Group meeting and included in that packet; see also the Documents section of the HCPA website)
- Roundtable discussion of Coordination Group comments on wetlands permitting matters.

2:50 Confirm upcoming meeting dates. Upcoming Coordination Group meetings are scheduled as follows for the City of Pittsburg Council Chambers (usually 3rd Thursdays):

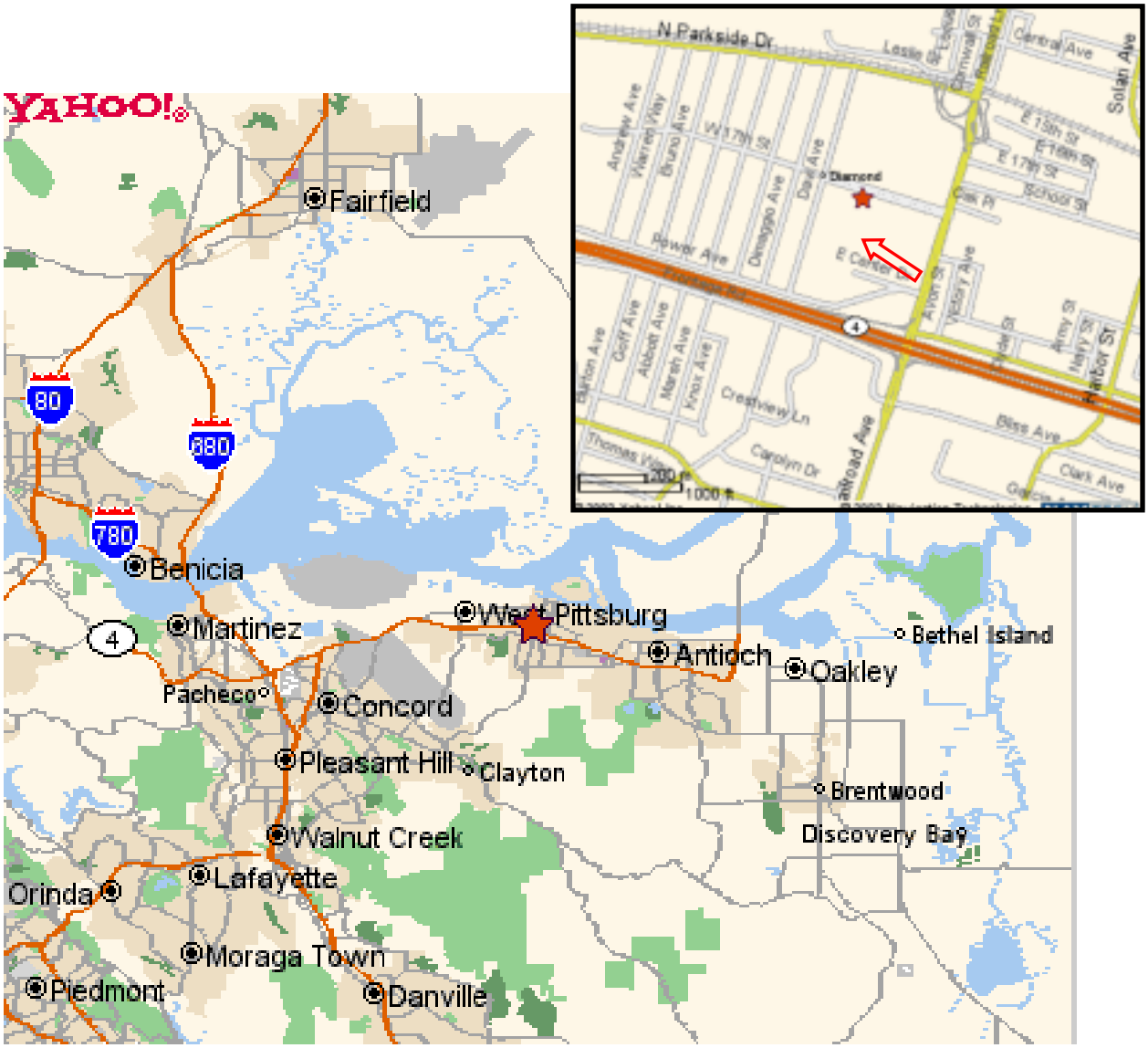
Thursday, January 20, 1 p.m. to 3 p.m.
HCPA Executive Governing Committee: January meeting date pending

2:55 Public comment.

3:00 Adjourn.

Times are approximate. If you have questions about this agenda or desire additional meeting materials, you may contact Abby Fateman of the Contra Costa County Community Development Department at 925-335-1272. The HCPA will provide reasonable accommodation for persons with disabilities planning to participate in this meeting who contact staff at least 72 hours before the meeting.

Map and Directions to Pittsburg City Hall
65 Civic Drive



*** Special Directions to Pittsburg City Hall from Eastbound Highway 4 During Construction

(exit to northbound Railroad is closed during Hwy 4 widening project):

1. Exit at Bailey Road, North (instead of Railroad), crossing under freeway
2. Continue on Bailey Road 0.5 miles
3. Turn right on WILLOW PASS RD
4. Continue eastbound on Willow Pass Road 1.2 mi
2. Continue on N PARKSIDE DR - go 1.6 mi
3. Turn right on DAVI AVE - go 0.2 mi
4. Turn left on POWER AVE - go 0.1 mi
5. Turn left into parking lot for 65 CIVIC AVE, PITTSBURG

(See map on reverse)

DRAFT MEETING RECORD

East Contra Costa County Habitat Conservation Plan Association (HCPA) Coordination Group Meeting

Thursday, November 18, 2004
1 p.m. to 3 p.m.

City of Pittsburg Council Chambers

1:00 Welcome and Introductions. Meeting attendees introduced themselves. Coordination Group members and staff in attendance were:

Seth Adams, Save Mount Diablo
Chris Barton, City of Pittsburg
Bradley Brownlow, MoFo
Abigail Fateman, CCC Community Dev.
Janice Gan, CA DFG
John Kopchik, CC County Community Dev.
Dee Munk, CCC Farm Bureau
Cece Sellgren, CCC Public Works
Dick Vrmeer, CNPS
Mike Vukelich, CCC Farm Bureau
Christina Wilson, City of Oakley

Also in attendance: Phillip Torres; Cheryl Morgan; Joe Ciolek, Ag Trust of CCC; and John Hopkins, Institue for Ecological Health.

1:00 Introductions. Review contents of meeting packet. Review and approve Draft Meeting Record of the October 21, 2004 Coordination Group meeting. Meeting record was approved.

1:15 Updates:

- John Kopchik and John Hopkins and others provided a summary of the workshop held on November 16th in Vacaville.
- **Request for exemption from Critical Habitat Designation related to East Contra Costa County HCP submitted to USFWS (see attached);** John Kopchik provided some background to the request and reviewed the letter that was submitted.
- **Wetlands permitting:**
  - **4-County White Paper with Army Corps and other Regulatory Agencies is done (see website);** John Kopchik reported that the White Paper was made available at the Workshop in Vacaville and can be found on the HCPA website.
  - **Comments due by December 16 on draft wetlands permit strategy and inventory (presented at Nov Coordination Group meeting and included in that packet).** John Kopchik reported that the U.S. A.C.E. is supportive of the concept of proceeding with the Regional Permit Program for 404 permits. Outreach to the State and Regional Boards is just beginning and wil require significantly more work. Conversations will continue.

1:40 Funding:

- **Review revised draft of Chapter 8 (attached).** A number of comments were received regarding the revised Chapter 8 that was included in the meeting packets. Below is a brief summary:

  Some suggestions for page 8-6, 1st paragraph that should clarify meaning:

- Zone 6 cost assumptions: suggest adding the following after, "90% of the fee title value", "(assumes a combination of fee title and easement purchases)".

Page 8-18 does not indicate that buffers will be purchased - needs to be clarified.

Table 8-1 and 8-2: maybe bold or italic or underline the "Initial Permit Area" and "Max Permit Area" part of the title for these tables so the difference between 8-1 and 8-2 is more immediately clear.

Periodic Reviews: Some participants asked that in addition to reviewing funding/fees periodically, the plan should require a more holistic evaluation of implementation periodically. Commentors suggestion may have been addressed already in the revised Adaptive Management chapter.

The Group expressed interest in hearing about the revised Adaptive Management chapter in more detail and discussion will be scheduled for the December meeting.

One participant suggested that we should consider a use fee related to public access to new preserves. EBMUD does this in it trail use fee (trail users pay a fee multi-year taril permit that allows access to all EBMUD public trails). Such a use fee might help offset minor management/insurance/access upkeep costs. And it might have a benefit in terms of making recreation less impacting. Should be explored further for potential inclusion in the plan or as a measure that the Implementing Entity can implement.

The group spent a significant amount of time discussing the issues of management costs after 30 years. The HCPA funding plan focuses on management costs for the first 30 years, and relies on future work during that 30 years to identify funding sources beyond year 30. The wildlife agencies have indicated that they would like to see a more definite plan for funding beyond year 30. Endowments and the costs and constraints of this approach were discussed, as was the proposal that is currently part of the plan to allow developers to pay up to one third of their fee through inflation-adjusted, on-going annual charges on the new structures.

- **Review excerpts of Coordination Group's recommendations on fees and funding, including refinements proposed by staff (see especially proposed refinements to the proposed rural road fees) (pending).** Cece Sellgren reviewed the rural road fee proposals and the factors/multipliers that would determine the fee. The Group generally felt that the distinct and indirect effects of linear projects through rural areas were not described completely enough. In addition to the direct footprint impacts and habitat fragmentation impacts, linear rural projects can also be a direct cause of mortality and can increase edge effects. The group understood that making the fee formula even more complicated by adding extra terms might not help us to arrive at a more robust basis for calculating fees, but the group did want a more detailed explanation of these distinct impacts in the Plan. John Kopchik reported that the details of a revised road fee proposal would be presented at the December meeting.

2:20 Consider concept of modifying the conservation strategy to replace the requirement for cropland conservation with requirements for additional riparian and coastal plain acquisition/restoration. John Kopchik briefly introduced this topic, but due to time constraints this will be covered at another Coordination Group meeting. Generally this topic refers to making the conservation actions for Swainson's Hawk and other

species more geographically explicit than they are today and to focus on opportunities in the Oakley area.

2:50 Confirm upcoming meeting dates. Upcoming Coordination Group meetings are scheduled as follows for the City of Pittsburg Council Chambers (usually 3rd Thursdays):

Thursday, December 16, 2004, 1 pm to 3 pm.

2:55 Public comment. None

3:00 Adjourn.

Draft Fee Calculator.

ROADS (Option 1)

Name	Footprint Estimate[1] (best available)	(lower)	(higher)	Base fee Fee Zone	Base Fee[2]	Fee Multipliers A) Unavoidable effects beyond footprint[3]	B) Avoidable effects (pay only if Design Measures not	Net Multiplier If optional Design Measures Not	Design Measures are Implemented	Fee Per Acre (if Design Measures Implemented)	Estimated Total Fee (all design measures) Footprint= Best Avaialble	Footprint= Lower	Footprint= Higher
Bethel Is/Cypress Road Bridge Widening				ag	$9,046	1	1	1.00	1.00	$9,046			
Buchannan Bypass	42	35	50	natural	$18,093	1.5	1.3	1.95	1.50	$27,140	$1,139,900	$949,900	$1,357,000
Byron Highway Extension (northern)	15	10	20	ag	$9,046	1	1	1.00	1.00	$9,046	$135,700	$90,500	$180,900
Byron Highway Widening	25	20	30	mixed	$13,500	1.1	1.0	1.10	1.10	$14,850	$371,300	$297,000	$445,500
EBART				ag	$9,046	1	1.0	1.00	1.00	$9,046			
Kirker Pass Widening (Truck Climbing Lane)	25	20	30	natural	$18,093	1.25	1.3	1.63	1.25	$22,616	$565,400	$452,300	$678,500
Marsh Creek Road Realignment				natural	$18,093	1.25	1.0	1.25	1.25	$22,616			
SR4 Widening Oakley to Disco Bay	40	30	50	ag	$9,046	1	1	1.00	1.00	$9,046	$361,800	$271,400	$452,300
SR239 (S of Vasco Connector, not along Byron Highway)*				mixed	$13,500	1.1	1.0	1.10	1.10	$14,850			
Vasco-Byron Hwy Connector (S of Byron Hot Springs)*	3	2	5	natural	$18,093	1.5	1.0	1.50	1.50	$27,140	$81,400	$54,300	$135,700
Vasco-Byron Hwy Connector (N of Byron Hot Springs)	10	7	15	natural	$18,093	1.5	1.0	1.50	1.50	$27,140	$271,400	$190,000	$407,100
Vasco Road Widening	100	70	200	natural	$18,093	1.25	1.0	1.25	1.25	$22,616	$2,261,600	$1,583,100	$4,523,300
TOTAL (projects marked w/ * not included in total)	257	192	395								$5,107,100	$3,834,200	$8,044,600

ROADS (Option 2)

Name	Footprint Estimate[1] (best available)	(lower)	(higher)	Base fee Fee Zone	Base Fee[2]	Fee Multipliers A) Unavoidable effects beyond footprint[3]	B) Avoidable effects (pay only if Design Measures not Implemented[4])	Net Multiplier If optional Design Measures Not Implemented	lif optional Design Measures are Implemented	Fee Per Acre (if Design Measures Implemented)	Estimated Total Fee (all design measures) Footprint= Best Avaialble	Footprint= Lower	Footprint= Higher
Bethel Is/Cypress Road Bridge Widening				ag	$9,046	1	1	1.00	1.00	$9,046			
Buchannan Bypass	42	35	50	natural	$18,093	1.75	1.5	2.63	1.75	$31,663	$1,329,800	$1,108,200	$1,583,100
Byron Highway Extension (northern)	15	10	20	ag	$9,046	1	1	1.00	1.00	$9,046	$135,700	$90,500	$180,900
Byron Highway Widening	25	20	30	mixed	$13,500	1.25	1.0	1.25	1.25	$16,875	$421,900	$337,500	$506,300
EBART				ag	$9,046	1	1.0	1.00	1.00	$9,046			
Kirker Pass Widening (Truck Climbing Lane)	25	20	30	natural	$18,093	1.5	1.5	2.25	1.50	$27,140	$678,500	$542,800	$814,200
Marsh Creek Road Realignment				natural	$18,093	1.5	1.0	1.50	1.50	$27,140			
SR4 Widening Oakley to Disco Bay	40	30	50	ag	$9,046	1	1	1.00	1.00	$9,046	$361,800	$271,400	$452,300
SR239 (S of Vasco Connector, not along Byron Highway)*				mixed	$13,500	1.25	1.0	1.25	1.25	$16,875			
Vasco-Byron Hwy Connector (S of Byron Hot Springs)*	3	2	5	natural	$18,093	1.75	1.0	1.75	1.75	$31,663	$95,000	$63,300	$158,300
Vasco-Byron Hwy Connector (N of Byron Hot Springs)	10	7	15	natural	$18,093	1.75	1.0	1.75	1.75	$31,663	$316,600	$221,600	$474,900
Vasco Road Widening	100	70	200	natural	$18,093	1.5	1.0	1.50	1.50	$27,140	$2,714,000	$1,899,800	$5,427,900
TOTAL (projects marked w/ * not included in total)	257	192	395								$5,958,300	$4,471,800	$9,439,600

ROADS (Option 3)

Name	Footprint Estimate[1] (best available)	(lower)	(higher)	Base fee Fee Zone	Base Fee[2]	Fee Multipliers A) Unavoidable effects beyond footprint[3]	B) Avoidable effects (pay only if Design Measures not	Net Multiplier If optional Design Measures Not	Design Measures are Implemented	Fee Per Acre (if Design Measures Implemented)	Estimated Total Fee (all design measures) Footprint= Best Avaialble	Footprint= Lower	Footprint= Higher
Bethel Is/Cypress Road Bridge Widening				ag	$9,046	1	1	1.00	1.00	$9,046			
Buchannan Bypass	42	35	50	natural	$18,093	2	2.0	4.00	2.00	$36,186	$1,519,800	$1,266,500	$1,809,300
Byron Highway Extension (northern)	15	10	20	ag	$9,046	1	1	1.00	1.00	$9,046	$135,700	$90,500	$180,900
Byron Highway Widening	25	20	30	mixed	$13,500	1.5	1.0	1.50	1.50	$20,250	$506,300	$405,000	$607,500
EBART				ag	$9,046	1	1.0	1.00	1.00	$9,046			
Kirker Pass Widening (Truck Climbing Lane)	25	20	30	natural	$18,093	1.75	2.0	3.50	1.75	$31,663	$791,600	$633,300	$949,900
Marsh Creek Road Realignment				natural	$18,093	1.75	1.0	1.75	1.75	$31,663			
SR4 Widening Oakley to Disco Bay	40	30	50	ag	$9,046	1	1	1.00	1.00	$9,046	$361,800	$271,400	$452,300
SR239 (S of Vasco Connector, not along Byron Highway)*				mixed	$13,500	1.5	1.0	1.50	1.50	$20,250			
Vasco-Byron Hwy Connector (S of Byron Hot Springs)*	3	2	5	natural	$18,093	2	1.0	2.00	2.00	$36,186	$108,600	$72,400	$180,900
Vasco-Byron Hwy Connector (N of Byron Hot Springs)	10	7	15	natural	$18,093	2	1.0	2.00	2.00	$36,186	$361,900	$253,300	$542,800
Vasco Road Widening	100	70	200	natural	$18,093	1.75	1.0	1.75	1.75	$31,663	$3,166,300	$2,216,400	$6,332,600
TOTAL (projects marked w/ * not included in total)	257	192	395								$6,843,400	$5,136,400	$10,875,300

Footnotes:

1 Rough estimates only. Design specifications for most of these facilities have not been completed. Footprint includes area of cut & fill. Fee would be charged against entire disturbed area.

2 Base fee for projects that cross more than one fee zone have been roughly estimated. Actual fee would be based on proprotion of impacts in the applicable fee zone.

3 Beyond direct footprint impacts, rural roads have more severe fragmentation, edge, and increased-mortality effects than other projects. The extent of these additional impacts depend on whether the propoesed facility is new or expanded, on the length of the facility, on the type of habitat traversed by the road, and other factors. Some of these additional imapcts can be partially reduced by wildlife-friendly design measures (see fee multiplier (B)). Other indirect effects of rural road projects (growth inducement, etc.) are addressed by the fee on new development. Consequently, multipliers are lower than they might be outside the HCP.

Table 5-5. Conditions on Rural Road Projects Covered by the HCP/NCCP

	Natural Lands Projects						Ag. Area Projects						Small Projects			
Road Conservation Measure	Buchannan Bypass	Kirker Pass Widening	Marsh Creek Rd Realign.	Vasco-Byron Hwy Connector (North of Byron Hot Springs)	Vasco-Byron Hwy Connector (South of Byron Hot Springs)	Vasco Road Widening	Bethel/Cypress Isl Widening	SR4 Widening to Disco Bay	EBART	Byron Hwy Extension	Byron Highway Widening	Proposed Hwy 239	Bridge Repair, Retrofit, Replace	Road Safety Improvements	Bicycle Trails	Portion of Fee Multiplier (last term in formula) that can be waived if design feature is performed
Siting Requirements																
Site in least sensitive locations	R	R	R	R	R	R	R	R	R	R	R	R	N/A	N/A	R	
Site equipment storage away from sensitive areas	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
Conduct project surveys well in advance of design	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
Planning survey requirements apply to r-o-way	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
Widlife Design Requirements																
Design requirements superceded by latest research	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
Collect data on wildlife movement for at least 1 yr prior to design	R	O	R	R	R	R	N/A	N/A	N/A	N/A	R	R	N/A	N/A	N/A	up to 50%
Use bridges, viaducts, or causeways	O	N/A	P	P	R	R	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	up to 50%
Construct road undercrossings at freq. Intervals	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	up to 50%
Install crossing facilities at known travel routes	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	up to 50%
Large wildlife crossings every mile or less	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	up to 50%
Small wildlife crossings every 1,000 feet or less	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	up to 50%
Minimum sizing for culverts	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	up to 10%
Use grating over tunnels/culverts for light penetration	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	up to 10%
Fencing designs to maximize crossing use	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	up to 10%
Discourage trails within 500 feet	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	0
Road median designs for wildlife	P	O	P	P	R	R	O	O	N/A	O	R	R	N/A	O	N/A	up to 25%
Construction Actions																
Best management practices	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
Install monitoring boxes (cameras)	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	
Post-Construction Actions																
Control roadside vegetation adj to preserves and OS	R	R	R	R	R	R	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Revegetate cut/fill slopes with natives	R	R	R	R	R	R	N/A	N/A	N/A	N/A	N/A	N/A	R	R	R	
Monitor structures for wildlife use	P	O	P	P	R	R	N/A	N/A	N/A	N/A	P	P	N/A	N/A	N/A	

Key

R = Required

P = Possible (required unless data demonstrate measure would not benefit wildlife and CDFG and USFWS agree to omit)

O = Optional (measure can be implemented at agency's discretion; if implemented, it will reduce mitigation fee; fee reduction determined case-by-case by Implementing Entity)

N/A = Not applicable or not needed

Fee Calculator: Preferred Alternative with Minor Changes Recommended by Staff

1. FAIR SHARE (assumes Max. Permit Area)

	Urban Acres	Irrigated Ag. Acres	Total "Developed" Ac.	Conservation Acres	Conservation Ratio	Fair Share Ratio	Fair Share of New Conservation Acres	Fair Share	
Existing	23,828	33,028	40,342	44,746	1.11	1.47	14,732	48%	(public share)
Affected during HCP	15,000	(8,000)	11,000	30,950	2.81	1.47	16,218	52%	(new development share)
Status after HCP	38,828	25,028	51,342	75,696	1.47	1.47	30,950	100%	

2. Gross Cost Allocations

	Item	Amount: Initial Permit Area	Amount: Max. Permit Area
a	Total Plan Cost	$245,000,000	$300,000,000
b	**Wetland Mitigation Cost** (Creation & Restoration) (to be paid by wetland fee)	**$7,000,000**	**$11,793,000**
c	Adjusted Plan Cost	$238,000,000	$288,207,000
d	Future Urban Development's "Fair Share" %	42%	52%
e=c*d	**Future Impacts "Fair Share" $**	**$99,660,640**	**$149,867,640**
f	**Contribution by Rural Infrastructure Projects**	**$7,053,300**	**$7,053,300**
g=c-e-f	**Remaining Cost** (to be funded by a variety of public sources	**$131,286,060**	**$131,286,060**
i=b+e+f+g	Total revenues	$245,000,000	$300,000,000

Key Assumptions:	
Ag. habitat & open space value relative to natural land	50%
New development's share of rural infrastructure mitigation costs	0%
Rural road mitigation costs	$6,053,300
Other rural infra. mitigation costs	$1,000,000
Total rural infra. mitigation costs	$7,053,300
Fee zone ratio:	
Zone 1, Eastern and Ag:	2
Zone 2: S/W and Natural:	4
Zone 3: Infill:	1
Paying acres contingency	10%
Units / acre	4

3. Estimated Basic Development Fee by Fee Zone

Item	Fee Zones: Eastern and Agricultural Zone I	South + West Natural Areas Zone II	Infill (less 10 acres) Zone III	Total/ Avg
Total Fee Zone Acreages				
Initial Plan Area	6,500	3,000	136	9,636
Maximum Plan Area	8,500	5,500	136	14,136
Fee Zone Acreages -- Less Roads				
Initial Plan Area	6,436	2,808	136	9,379
Maximum Plan Area	8,436	5,308	136	13,879
Relative Fee Weighting by Zone (1)	2	4	1	2.33
Relative Funding Burden by Zone -- Percent (2)				
Initial Plan Area	53%	46%	0.6%	100%
Maximum Plan Area	44%	56%	0.4%	100%
Relative Funding Burden by Zone -- Amount (3)				
Initial Plan Area	$52,925,622	$46,177,821	$557,197	$99,660,640
Maximum Plan Area	$66,125,734	$83,210,795	$531,111	$149,867,640
Fee Per Developed Acre (4)				
Initial Plan Area	$9,046	$18,093	$4,523	$10,554
Maximum Plan Area	$8,623	$17,246	$4,311	$10,060
Fee Per Housing Unit (5)				
Initial Plan Area	$2,262	$4,523	$1,131	$2,639
Maximum Plan Area	$2,156	$4,311	$1,078	$2,515

(1) Relative contribution of an acre in each zone from a conservation perspective.
(2) Relative funding contribution of each zone, taking into account total zone acreage and fee weighting factor.
(3) Relative funding burden times total fee-funded HCP costs.
(4) Funding burden divided by zone acreage. Also includes a 10% contingency factor to account for incomplete buildout.
(5) Assumes average housing density of 4.0 units per acre.

Chapter 7

Monitoring and Adaptive Management Program

7.1 Introduction

This chapter describes the HCP/NCCP monitoring and adaptive management program. The purpose of this program is to assess the condition of species and natural communities within the Preserve System and to provide for their ongoing conservation and recovery. The adaptive management component of the program will guide how information is collected by the Implementing Entity and how it will be evaluated and used to improve management of the Preserve System. Collecting and analyzing data through monitoring and focused experiments are essential components of adaptive management. The monitoring component of the program will track the success of the management activities in conserving and recovering species and natural communities within the Preserve System. Management activities and monitoring efforts will change adaptively to improve conservation and to increase the usefulness of the monitoring data.

7.2 Process Overview

Designing a biological monitoring and adaptive management program that is logistically feasible and scientifically sound is a complicated task that will take many years. Many of the components of this program are expected to be modified during Plan implementation. As much as possible, this Plan has sought to incorporate recommendations for monitoring and adaptive management based on recent guidelines provided by the U.S. Geological Survey Biological Resources Division (USGS), CDFG, and USFWS (Atkinson et al. 2004). The following is an overview of monitoring and adaptive management framework based on the steps recommended in that document.

Purpose. The purpose of the monitoring and adaptive management program is to inform and improve the conservation strategy and to ensure that the Plan achieves its biological goals and objectives.

Scope. The geographic scope of the monitoring and adaptive management program will be determined by the lands acquired for the Preserve System. Because lands for the Preserve System will be assembled over the course of the 30-year permit, the exact configuration of the Preserve System is unknown. However, the general location is well defined (see Figures 5-2 and 5-3). As the

Preserve System grows, on-the-ground monitoring will grow. For planning purposes, the monitoring and adaptive management program will focus on the areas targeted for acquisition (Zones 1-6).

Like the conservation measures described in Chapter 5, the monitoring and adaptive management program will function at multiple scales—landscape, natural community, and species.

Data Compilation. The management program described in Chapter 5 and the adaptive management and monitoring program described herein were based on relevant biological information from a variety of sources. These include programmatic documents such as recovery plans; USFWS biological opinions; reserve management plans; spatial data integrated into GIS; and technical information, including relevant articles in the scientific literature, consultant reports, and expert opinion, including from the Science Advisors for this Plan. Species models for 20 of the 28 covered species were generated and will form an important component of the adaptive management and monitoring program. As new data become available, they will be used to improve management and monitoring operations through adaptive management.

Divide the System and Set Priorities. The monitoring and adaptive management program, like the Plan as a whole, is based upon a multi-species, habitat-focused approach. This holistic approach focuses on preserving and creating functional natural communities that provide habitat for numerous native species. To that end, adaptive management and monitoring will be centered on the six broad natural communities addressed in this Plan: grassland, oak woodland, chaparral/scrub, riparian woodland, wetlands, and aquatic. The functional integrity of these natural community types will be reviewed as the Implementing Entity develops the adaptive management and monitoring program. For the purposes of this document, these community types help provide a geographic and biological framework for the program.

The monitoring and adaptive management program will address three primary areas to meet ESA and NCCPA requirements and to ensure the success of the Plan:

1. effects of management on landscape, communities, and species
2. ecosystem function; and
3. status of key covered species;

As the monitoring and adaptive management program is implemented, covered species will be grouped beyond the natural-community types currently proposed to facilitate monitoring and to prioritize goals.

Develop Conceptual Models. Conceptual ecological models will be created during the initial years of implementation. These models will inform the monitoring program by identifying data gaps for additional research and helping establish biotic and abiotic indicators for ecosystem function. As the monitoring

program collects additional data, these "living" models will serve as a framework for management and function as reference points for the Implementing Entity's understanding of the ecosystems within the Preserve System.

Determine What to Monitor. Using the conceptual models, the Implementing Entity will select the appropriate attributes to be monitored for each system. Objectives for monitoring will be stated and the appropriate variables selected. Also based on the conceptual models, critical uncertainties will be identified and targeted for monitoring.

Determine a Strategy. Based on USGS, CDFG, and USFWS guidelines on regional monitoring, the following steps should be implemented to guide the monitoring and adaptive management program:

- develop a work plan,
- coordinate with existing programs,
- develop good monitoring protocols, and
- avoid statistical pitfalls in developing sampling design.

Further guidance on these items can be found in Atkinson et al. (2004) and below in the subsections of this chapter.

Develop Data and Reporting Strategies. The importance of analyzing data in a timely and accessible way is paramount to the success of the monitoring and adaptive management program. Initial reporting and analysis strategies are described throughout this chapter and, specifically, in the *Reporting* section below.

7.2.1 Regulatory Requirements

An NCCP must incorporate an integrated adaptive management strategy that is periodically reviewed and modified on the basis of the results of monitoring efforts and other sources of new information (California Fish and Game Code Section 2820(a)(2)). Accordingly, an NCCP must also have a monitoring program, including surveys to determine the status of biological resources, periodic accountings and assessments of take, and a schedule for conducting monitoring activities.

An HCP must incorporate monitoring of conservation measures and species responses to these measures (50 CFR 17.22(b)(1)(iii) and 50 CFR 222.22(b)(5)(iii)). The Five-Point Policy (65 FR 35241-35257), which guides the development of adaptive management in HCPs, describes adaptive management as an integrated method for addressing uncertainty in natural resource management. In order to be successfully implemented, adaptive management must be linked to measurable biological goals and monitoring.

Effectiveness monitoring, therefore, must be designed to provide the information necessary to verify progress toward the Plan's biological goals.

According to USFWS, a successful adaptive management strategy should (1) identify the uncertainty in question, (2) develop alternative strategies for management, (3) integrate monitoring to assess the strategy, and (4) incorporate feedback loops that link implementation to monitoring.

7.2.2 Program Goals

The monitoring and adaptive management program will incorporate important principles of "learning by doing" into the operations of the Preserve System. The goals of the adaptive management program are to

- provide an organizational framework and decision-making process for evaluating monitoring, research, and other data to adjust management actions;
- establish the baseline condition of biological resources in the Preserve System using existing geographic information, species models, and the results of pre-acquisition surveys;
- develop conceptual models that can be used as the basis for collecting information, verifying hypotheses, and changing management practices;
- incorporate hypothesis testing and experimental management, including pilot studies and directed research, into Plan implementation to address questions of uncertainty;
- develop and implement scientifically valid monitoring protocols at multiple scales to ensure that data collected will inform management;
- collect the data necessary to refine and implement effective conservation measures; and
- ensure that monitoring data are collected, analyzed, stored, and organized so the data are accessible to the Implementing Entity, local jurisdictions, local land managers, regulatory agencies, scientists, and the public.

7.2.3 Integration of Monitoring and Adaptive Management

The integration of adaptive management and monitoring is critical to the successful implementation of the conservation strategy. Monitoring is the foundation of an adaptive approach, and adaptive management actions are borne, in part, from the results of monitoring. In this Plan, the two components are integrated into a single program.

The monitoring and adaptive management program will inform reserve managers and other decision makers of the status of covered species, natural communities, and essential ecological processes such that management actions can be revised to meet the biological goals of the plan. The effectiveness of conservation efforts will be evaluated following the model outlined in Figure 7-1: *Flowchart of the Adaptive Management Process.* Using monitoring to provide information for adaptive management actions will require a framework for measuring responses (Figure 7-2). In general, management actions will be treated as experiments, and monitoring will be used to evaluate each action. This will allow management to proceed without complete knowledge of the species or processes.

7.2.4 Organizational Structure

The organizational structure of the monitoring and adaptive management decision-making process is described in detail in Chapter 8 and is depicted in Figure 8-1. In summary, the Implementing Entity oversees all facets of the adaptive management and monitoring program. The Implementing Entity has ultimate responsibility for implementing and evaluating the program and instituting changes through adaptive management. Additional responsibilities include prioritizing actions of NCCP components, disseminating information, developing annual and long-term work plans, and facilitating input from the public and outside scientists. As described in Chapter 8, the Executive Director of the Implementing Entity will work with senior scientists and managers in the Implementing Entity to implement the adaptive management and monitoring program. Preserve managers, who will be in charge of day-to-day activities within the preserves, will also contribute to annual work plans and formulate adaptive management recommendations for the plan as a whole.

A pool of Science Advisors will provide outside input regarding implementation of the monitoring and adaptive management program. Input will be provided regularly as needed to help guide monitoring protocols and experimental design, to interpret results and generate hypotheses, and to comment on the overall success of the monitoring and adaptive management program in achieving the biological goals of the plan. The Science Advisors will meet formally at least once a year at first to review the progress of the Plan. Formal reviews will occur less frequently as the Plan progresses.

The Resource Agencies (CDFG, USFWS) will provide feedback on the implementation of the adaptive management and monitoring program as described in the annual work plans. Individuals within the Resource Agencies with particular expertise in management may also choose to participate as Science Advisors. All forms of input will be collected by the Implementing Entity and incorporated into management and monitoring practices, as appropriate (see Chapter 8 *Implementation* for more details).

An Independent Conservation Assessment Team, distinct from the Science Advisors, will provide periodic additional input on the overall implementation of

the HCP/NCCP, including implementation of the monitoring and adaptive management program.

A Local Land Managers Forum may be established to solicit information and feedback regarding the effects of preserve management on adjacent lands, to make recommendations for changing specific aspects of the HCP/NCCP, and to facilitate communication between local landowners and the Implementing Entity.

7.3 Implementation Schedule

Biological monitoring will be phased. Information collected during the initial implementation of the plan will shape future monitoring efforts by helping to determine the appropriate level and type of ongoing monitoring (Atkinson et al. 2004).

The initial "planning phase" of monitoring will take place over the first five years of implementation and will lay the foundation of the overarching monitoring program. Because the Preserve System will take years to assemble, the planning phase will focus on the development of conceptual ecological models, prioritization and implementation of pilot programs, the identification of key species or groups of species for more intensive monitoring, and the selection of biotic and abiotic indicators for ecosystem health.

In the "inventory phase" of monitoring, the Implementing Entity will inventory and assess landscapes, natural communities, and species, as appropriate, within the Preserve System. Activities within this phase will begin when the first lands are incorporated into the Preserve System. The amount of activity within this phase will be proportional to the amount of land in the Preserve System.

Both the planning phase and the inventory phase will be followed by long-term monitoring to address the status and trends of landscapes, natural communities and species and the effectiveness of the conservation strategy in achieving its biological goals (Figure 7-3). The long-term monitoring phase will occur once a strategy has been developed (planning phase) and baseline studies are complete (inventory phase). Long-term monitoring will use the framework developed during the planning and inventory phases to carry out effectiveness monitoring and, subsequently, to implement adaptive management.

Key tasks in each phase are described below. In general, activities in the planning phase will occur during the first five years of Plan implementation (see Chapter 8 for the overall schedule of Plan implementation). Activities in the inventory phase will vary depending on the timing of land acquisition. For an individual site, the inventory phase will begin immediately after land acquisition. Activities in the long-term monitoring phase will begin on each site after the activities in the inventory phase are complete. Because the Preserve System is being created over a 30-year span, there will likely be extensive overlap between

activities in each phase during the first 10 to 20 years of Plan implementation (Figures 7-3).

7.3.1 Planning Phase

The planning phase comprises the following tasks:

- Compile relevant information from the HCP/NCCP and other sources (e.g., existing species models [Appendix D], GIS data layers, aerial photos, maps, plans and data from adjacent regional parks, USFWS recovery plans, critical-habitat designations, technical reports, monitoring methods).
- Develop conceptual ecological models for the six natural-community types in the inventory area.
- Identify key threats to covered species, covered species that may be declining, or changes to key ecological processes to determine monitoring priorities within each natural community.
- Identify key species or group species such that monitoring of covered species can be carried out efficiently and cost-effectively.
- Identify abiotic or biotic indicators for natural-community function.
- Develop preliminary strategies for monitoring species and natural communities (protocols, schedules, time intervals for monitoring, multi-species approaches).
- Begin pre-treatment monitoring of sites considered for restoration. Develop criteria for measuring success. Prioritize and begin restoration efforts.
- Use aerial photos or satellite imagery to update land-cover mapping in inventory area to provide baseline conditions (Plan land-cover data based on 2001 aerial photos with field and other updates to 2004 conditions).

7.3.2 Inventory Phase

The inventory phase consists of the following tasks:

- Inventory resources as the Preserve System is assembled. The results of the planning surveys for land acquisition (i.e., pre-acquisition surveys) will be the first source of baseline data.
- Use pre-acquisition surveys to validate and refine species models as lands are surveyed and acquired (note that data collected during pre-acquisition surveys on lands not acquired by the Implementing Entity will be kept confidential to the extent allowable by law).

- Use aerial photos and ground surveys, as needed, to assess quality and location of habitat linkages between unprotected natural areas and adjacent protected lands.
- Refine conceptual ecological models for the six natural-community types in the inventory area based on inventory data and other new information.
- Prioritize, design, and initiate pilot studies to test management and monitoring methods.
- Conduct post-acquisition biological inventories. Additional surveys may be needed to provide more resolution and detail than gathered in pre-acquisition surveys.
- Initiate management actions and management planning (e.g., Preserve System Recreation Plan, Preserve System Exotic Species Plan, Preserve Management Plans, or updates to these plans, as needed) described in Conservation Strategy.
- Monitor restoration sites for success; remediate sites if initial success criteria are not being met.

7.3.3 Long-Term Monitoring Phase

The long-term monitoring phase includes the following tasks:

- Update GIS layer of land-cover every five years through aerial photos or satellite imagery. Assess status and trends at the landscape and natural-community levels.
- Monitor species response to habitat creation, restoration, and enhancement.
- Refine species models and conceptual ecosystem models as more information becomes available.
- Monitor key covered species using methodologies developed in planning phase. Assess status and trends of covered species by monitoring covered species populations, groups, or guilds of species or indicators over time.
- Continue to evaluate and modify monitoring protocols as necessary.
- When restoration projects are complete and meet final success criteria, scale back monitoring effort to be consistent with the rest of the Preserve System.
- Work with other individuals and organizations (e.g., EBRPD, local universities) to facilitate research on the Preserve System that is relevant to management.

7.4 Monitoring and Adaptive Management Program

The Implementing Entity is responsible for monitoring the status of key covered species, ecosystem function, and the effectiveness of the conservation strategy. The monitoring and adaptive management program will evaluate the following items:

- the success of conservation measures in achieving the desired habitat conditions,
- the species response to the desired habitat condition, and
- the general status and trends at the landscape, natural community, and species levels.

Additionally, the monitoring and adaptive management program will seek to identify and develop the following:

- management actions in response to unanticipated changes and threats, and
- management actions to address changed circumstances.

The framework and guidelines for the monitoring and adaptive management program is described below.

7.4.1 Adaptive Approach

Based on the best scientific information currently available, the HCPA believes that the Plan's conservation measures will effectively achieve the biological goals and objectives. However, conditions within the inventory area, regional habitat conditions, and the status of covered species and natural communities may change during Plan implementation. It is possible that additional and different conservation measures not identified in the Plan will be suggested and proven to be more effective in achieving biological goals and objectives than those currently identified. Results of effectiveness monitoring may also indicate that some conservation measures are less effective than anticipated. To address these uncertainties, the monitoring and adaptive management program will

- gauge, in cooperation with USFWS and CDFG, the effectiveness of conservation measures and techniques to implement them; and
- propose alternative or modified conservation measures as the need arises.

The cornerstone of the monitoring and adaptive management program is an experimental approach—monitoring will be established to yield results that inform management decisions (Figures 7-2 and 7-4). Information collected through monitoring and other experiments will be used to manage preserve lands and protect covered species habitat and natural communities. The adaptive management process will be administered by the Implementing Entity. Through

the local land-managers forum, the Implementing Entity will also coordinate and share monitoring and other experimental results, as appropriate, with other regional restoration and management programs. Programs and organizations with which the Implementing Entity should coordinate include the following:

- Los Vaqueros Watershed Management and Habitat Restoration (CCWD);
- Management of East Bay Regional Park District units in the inventory area (EBRPD; see Table 2-4);
- Management of Mt. Diablo and Cowell Ranch State Parks (CDPR);
- Past management of Byron Airport Conservation Easements by Contra Costa County Airports (these lands may be incorporated into the HCP/NCCP Preserve System);
- Restoration Program for Dutch Slough (California Coastal Conservancy and California Department of Water Resources);
- Marsh Creek Habitat Enhancement (City of Brentwood, City of Oakley, Natural Heritage Institute, Contra Costa County Flood Control and Water Conservation District);
- Marsh Creek Reservoir Expansion Project (Contra Costa County Flood Control and Water Conservation District);
- Mitchell Canyon Creek Restoration Project (Mt. Diablo State Park, Save Mount Diablo); and
- Kirker Creek Watershed Management Plan (Contra Costa Resource Conservation District).

The monitoring and adaptive management program will also provide for scientific reviews to evaluate the effectiveness of existing or proposed conservation measures. The Implementing Entity will incorporate recommendations provided by these reviews, where appropriate, into Plan implementation. It is also intended that the adaptive management program will provide the basis for budget and funding decisions throughout the term of the Plan. Figure 7-4 conceptually illustrates the adaptive management process that will be used in this plan. The adaptive management process, in conjunction with monitoring and other experiments, will provide the Implementing Entity with a process to effectively address uncertainties.

7.4.2 Definitions

The Plan primarily utilizes a habitat-based approach for ensuring that covered species and natural communities are conserved in the Plan area. However, our knowledge of the covered species, their habitats, and the ecological systems that support them are generally poor. This lack of data introduces uncertainty into the effectiveness of Plan conservation measures. Uncertainty is also an inherent component of ecological systems because of natural variation (e.g., rainfall, climate, and species behavior and responses). Land use changes outside the

influence of this Plan (e.g., development in Antioch and other non-participating jurisdictions) also introduce uncertainty. Ecosystems are inherently complex, which makes predicting species and habitat responses to management actions difficult. To address such uncertainties, the monitoring and adaptive management program is based on the principles of adaptive management, which allow conservation measures to be adjusted over time based on results of monitoring and other experiments. This approach provides greater certainty that Plan goals and objectives for covered species and natural communities will be achieved.

According to Kershner (1997):

> Adaptive management is the process whereby management is initiated, evaluated, and refined (Holling 1978, Walters 1986). It differs from traditional management by recognizing and preparing for the uncertainty that underlies resource management decisions. Adaptive management is typically incremental in that it uses information from monitoring and research to continually evaluate and modify management practices. It promotes long-term objectives for ecosystem management and recognizes that the ability to predict results is limited by knowledge of the system. Adaptive management uses information gained from past management experiences to evaluate both success and failure, and to explore new management options.

USFWS's Five-Point Policy for HCPs (65 FR 106, June 1, 2000) defines adaptive management as

> a method for examining alternative strategies for meeting measurable biological goals and objectives, and then if necessary, adjusting future conservation management actions according to what is learned.

The California NCCPA of 2002 as amended (California Fish and Game Code 2805(a)) defines adaptive management as follows:

> us[ing] the results of new information gathered through the monitoring program of the plan and from other sources to adjust management strategies and practices to assist in providing for the conservation of covered species.

The HCP/NCCP adaptive management process described in this section is designed to be consistent with these definitions. The Plan's adaptive management program incorporates the four elements USFWS recommends for adaptive management strategies in HCPs (65 FR 35252):

- Identify uncertainties and the questions that need to be addressed to resolve the uncertainties.
- Develop alternative strategies and determine which experimental strategies to implement.
- Integrate a monitoring program that is able to detect the necessary information for strategy evaluation.

- Incorporate feedback loops that link implementation and monitoring to a decision-making process.

The Plan embraces the concepts of passive and active adaptive management advocated by USFWS for implementing HCPs (65 FR 35250–35257). Through passive adaptive management, the Implementing Entity will learn how to ensure better attainment of the Plan's biological goals and objectives based on the measured success of various approaches to implementing the Plan (as indicated by effectiveness monitoring results). The Implementing Entity will also take an active adaptive management approach, including directed research, to resolve uncertainties related to the best approaches for achieving specific Plan objectives. Under this concept, the Implementing Entity would design and implement experimental pilot projects to test the relative efficacy of several approaches for attaining an objective.

7.4.3 Scientific Principles

Because the biological outcome of management actions is uncertain, the monitoring and adaptive management program is based on scientific principles that continually refine conservation efforts in order to achieve the biological goals of the plan. The adaptive management program will develop alternative management strategies and test the effectiveness of these strategies in the Preserve System. To that end, there is a continuum of management actions that incorporate scientific principles of adaptive management to varying degrees (Figure 7-2). At one end of the spectrum is simply monitoring effects once a management action has been taken, without any replication, controls, or comparison of management treatments. At the other end of the spectrum is directed research that tests a hypothesis in a manner that can be validated through statistical inference. Even simple experimental methods will yield important results to help guide and improve management. The following scientific principles will guide the adaptive management program:

- Management actions, especially early in Plan implementation, should incorporate scientific principles of replication, control, and pre- and post-treatment monitoring, where feasible.
- Management actions should be linked to hypotheses about species' ecological relationships and responses to management actions, when possible.
- When feasible, adaptive management or directed research should include an experimental design with appropriate significance levels (alpha level) as well as sufficient power to detect effects (beta level).

Adaptive management, and the design of experimental research, should be driven by hypotheses about key factors in the natural community in which the management is applied. For example, if the goal of the management is to improve populations of small mammals to serve as a prey base for covered species, land managers must develop hypotheses about what controls small

mammal abundance and distribution. Management actions and monitoring should be directed towards confirming or disproving those hypotheses. For key management questions, directed research should be employed on a small scale using an experimental design that will yield statistically valid results.

In addition to the scientific guidelines described above, the following steps will precede experimental design:

1. **Define the question.** Monitoring strategies should be designed to address specific hypotheses. Conceptual, statistical, or spatially explicit models will define those hypotheses. Conceptual models are described below.

2. **Develop monitoring protocols.** Questions to be explored in the monitoring program can be at the species, natural community or landscape level. Monitoring protocols will vary with scale and with the target of the monitoring. Monitoring protocols should be developed in accordance with the guidelines provided below.

3. **Use indicator species.** In order to streamline monitoring, groups of species or indicator species may be selected when appropriate (see Table 7-1). Indicators are selected because they are easy to survey and provide usable information on the species or system in question. Guidelines for selecting and using indicators are described in detail below.

4. **Consider sampling design**. Sampling design needs to be a consideration prior to initiating the experiment. The experimental-management approach of the HCP requires that questions of site selection, pseudo-replication, power, and significance be incorporated, as much as possible, into the monitoring and adaptive management program. Sampling design is described in detail below.

Conceptual Models

Conceptual models describe our current understanding of a functioning ecosystem. They provide a framework for learning about a system and help formulate hypotheses about cause-and-effect relationships. Conceptual models are useful for management because they can help to identify which factors may be important in a system and which of these factors may be influenced by management. Conceptual models can inform the monitoring program in several important ways: by providing a basis from which to test assumptions about the relative importance of certain processes, by helping to identify threats or stressors that require monitoring, by identifying species or other attributes that function as indicators, and by serving as a repository of our changing understanding of the system as more data become available. Conceptual models can also be used to communicate understanding of the system to other scientists and the public and to facilitate review by outside experts.

As a multi-species, habitat-based plan, models will provide a useful framework for understanding how individual species react to the same management actions. Therefore, models must be sufficiently complex as to capture the relationships that drive the system and translate these relationships to covered species but streamlined enough to be useful as management and monitoring tools. Models can be either narrative or diagrammatic. In most cases, diagrams show the hypothesized relationships that characterize the ecosystem and are supplemented by written materials. Several types of models can be used including stress-response models and habitat models. In the stress-response model (shown in Figure 7-5), stressors and threats are aligned along the left tier of the model; the central tier displays habitat responses, and the right tier shows hypothesized responses of covered species. A more complex stress-response model is seen in Figure 7-6. This model incorporates the following concepts.

- **Drivers/sources:** natural or anthropogenic forces having large-scale influence on natural systems.
- **Stressors:** physical or chemical changes to the system brought about by the drivers that cause subsequent changes to the relationships or components of the natural system.
- **Ecological effects:** the biological response caused by the stressor.
- **Attributes:** a streamlined set of key biological elements that best represent the overall ecological elements of the system. These items should function as indicators of the hypothesized effects of the stressors and are useful to identify for the purposes of monitoring. Covered species may also be incorporated as attributes such that the effect of stressors on these species may be evaluated.
- **Performance measures:** the specific features of each attribute to be measured.

Habitat modeling uses GIS to hypothesize a relationship between land-cover type and other habitat associations and the distribution and abundance of covered species. Habitat models were developed for this plan for most covered species (Appendix D) and have served as the basis for estimating impacts and prioritizing land acquisition. Information from the planning surveys will further refine these models such that they can be used to predict distribution, occupancy, and assess trends.

In the planning phase of monitoring, the Implementing Entity will develop conceptual ecological models for the six natural-community types. A critical task in the development of these models is the identification of uncertainties and threats or pressures. The identification of uncertainties provides a springboard for additional targeted studies. The following steps are recommended to develop conceptual ecological models (Atkinson et al. 2004):

1. Complete conceptual models for each covered species (existing species models and species profiles can be used).
2. Identify critical uncertainties for covered species requiring additional study.

3. Identify pressures on natural-community types including species-specific, local, and regional or global pressures.
4. Develop conceptual models for natural-community types and include relationships to covered species.
5. Select monitoring variables for ecosystem function and for covered species based on conceptual models. Species groups or indicators may be monitored when applicable.
6. Refine landscape and natural-community level studies described in section *Adaptive Management and Monitoring by Natural Community Type* below based on conceptual models.
7. Develop landscape-level model across multiple natural-community types including interactions with processes and pressures. Identify regional pressures such as fragmentation, catastrophic fire, etc.

These models will inform the selection of indicator species and guide the monitoring that is to take place. The section *Adaptive Management and Monitoring by Natural Community Type* provides background on each natural-community type and describes potential model components (stressors, ecological effects, etc.) when known.

Monitoring Protocols

When possible, accepted monitoring protocols will be adopted to facilitate data comparison with other studies. Monitoring protocols should be appropriate to the task, accurate, and as cost-effective as possible. Monitoring protocols should be standardized across the entire Preserve System and should be incorporated into all preserve management plans. To be successful, the monitoring protocols must be applied consistently by different observers and across seasons. Ongoing training will be necessary by Implementing Entity staff or their contractors to ensure this consistency. The National Park Service's Inventory and Monitoring Program guidelines for monitoring protocols (Oakley et al. 2003) or the Bureau of Land Management's guidelines (Elzinga et al. 1998) can be used a reference for developing monitoring protocols.

Monitoring protocols will vary by covered species. For a species that is difficult to detect such as Alameda whipsnake or silvery legless lizard, monitoring may be limited to whether the species persists from sample period to sample period, what features define its habitat, and what threats it faces. Monitoring for a less rare (or more detectable) species such as California tiger salamander or golden eagle may address whether its range is increasing or decreasing, again coupled with monitoring for threats. For a species that is sufficiently detectable to obtain estimations of population size or probability of detection such as western burrowing owl or many covered plants, monitoring a randomly selected subset of the population in order to make statistical inference to the whole population can be achieved through adherence to the following principles:

- Develop and state the assumptions in the hypotheses and models *before* collecting monitoring data or conducting manipulations such as experiments and adaptive management.
- When designing an experiment or using adaptive management, select the number and location of sampling units so as to apply sufficient scientific rigor for evaluating the hypothesis being advanced.
- Replicate in space and time the number of the sites surveyed for population estimates and/or those receiving a management action. Use controls when appropriate.
- Adjust the sensitivity of the data to reflect true changes in the resource being sampled. When appropriate, adjust counts, measures of species richness and patch occupancy (i.e., presence/absence) with an estimate of detection probability as described by Lancia and others (1994), Yoccoz and others (2001), and Pollock and others (2002).

Indicators

Indicators can be used in many ways: to predict species richness (MacNally and Fleishman 2004), to estimate biodiversity (Kati et al. 2004), to assess levels of disturbance, or to provide targeted information on a system or species (Caro and O'Doherty 1999, Carignan and Villard 2004). Landres and others (1988) define an indicator species as

> an organism whose characteristics are used as an index of attributes too difficult, inconvenient, or expensive to measure of other species or environmental conditions of interest.

In this plan indicators will be used, when appropriate, to provide information on covered species that are difficult to survey and to provide information on natural-community or ecosystem function. For the purposes of this plan, indicators are abiotic and biotic variables that are selected to facilitate monitoring of systems or species that are otherwise difficult to examine.

In cases where an indicator species is being used to monitor covered species (population indicator species) (Caro and O'Doherty 1999), we assume that impacts to the species being monitored are the same as impacts to the target species. In cases where an indicator is being used to monitor an ecosystem or natural community (health indicator species), the conceptual models will be used to help identify an appropriate indicator species or variable**.** Draft performance indicators for natural community enhancement, restoration, and creation measures are presented in Table 7-2. Indicators, in general, are easy to monitor and will demonstrate a change or trend that is quantifiable. Indicators need not be species, but may be ecological variables or structure-based indicators such as diameter and age-class of trees, interpatch distances between habitat, or key structural features of certain habitat types (e.g., snags or downed logs in forests, woody debris in rivers) (Noss 1999, Lindenmayer et al. 2000). Effective

indicators have some or all of the following characteristics (Carignan and Villard 2002, Atkinson et al. 2004).

- They are relevant to program goals and objectives and can assess the program performance at the appropriate spatial and temporal scales.
- They are sensitive to changes in the ecosystem providing early warning of response to environmental (or management) impacts.
- They indicate the cause of change, not just the existence of change.
- They give a continuum of responses to a range of stresses such that the indicator will not bottom out or stabilize at certain thresholds.
- They have known statistical properties, with baseline data, references, or benchmarks available.
- They are technically feasible, easily understood, and cost-effective to measure by all personnel involved in the monitoring.

If possible, the variables should also be coordinated with existing programs and data sets. Once monitoring variables have been selected, the following descriptions should be made:

- "what" will be monitored,
- "why" the monitoring is useful (i.e., the specific question the variable is designed to address),
- the conceptual ecological model underlying the selection of the monitoring variable,
- the geographical area where it will be monitored,
- the specific variable that will be measured and the protocol that will be used,
- the range of values the monitoring can produce and what these would mean,
- the expected response (as in response to management or outside pressures) and the magnitude of change expected, and
- the time frame and spatial scale over which change is expected to be demonstrated.

Finally, it is important to consider how the results will be interpreted and how they can be used to create change, if necessary.

Sampling Design

Sampling design will vary with the goals and phases of monitoring. During the Inventory Phase, baseline inventories will require a less rigorous sampling design, relying, for example, on visual surveys for detecting presence/absence. As the on-the-ground monitoring progresses, site selection and replication merit increased attention based on the goals of the monitoring at that time.

An important goal in sampling and experimental design is to minimize variance of estimators. Selection of estimators should be guided by a thorough knowledge of the ecological relationships that drive natural communities. Sampling intensity and probability of detection should be considered, as much as possible, to ensure that rare species are adequately inventoried and monitored. The way the data will be analyzed should be established prior to designing a study and a statistician or biologist with sufficient statistical expertise should be consulted. Issues to consider include (Scheiner and Gurevitch 1993):

- availability of sites on which treatments can be applied,
- the site-selection process (is it random?),
- systematic versus opportunistic sampling,
- detection probability of the protocol,
- replication versus pseudo-replication (Hurlbert 1984),
- the clarity of hypotheses, and
- sufficient power ($1-\beta$) or significance level (α).

Pilot Projects

Pilot projects provide an opportunity to test methodologies and refine hypotheses on a small scale prior to initiating large-scale management actions or experiments. Pilot projects should be used extensively in this Plan to ascertain which management actions may ultimately yield the desired conservation gains prior to initiating a large-scale project. Pilot projects are also a cost-effective way to test management actions.

A brief implementation plan will be developed by the Implementing Entity for each pilot project describing the study design, the hypotheses and variables being tested, and the monitoring and analytical methods that will be employed to assess the success of the pilot project. Results of these pilot projects will provide the information necessary to inform the Implementing Entity on how to proceed with full implementation of the conservation measures. Table 7-3 provides potential pilot projects for several key conservation measures.

Directed Research

Directed research is the most scientifically rigorous and, consequently, the most time-consuming and costly form of experimental management. Directed research employs an experimental approach that includes pre- and post-treatment monitoring, replication in time and space, and controls (Figure 7-2). Ideally, directed research can detect both false negatives and false positives yielding statistically valid results. The Implementing Entity may undertake directed research to provide targeted information necessary to adaptively implement the

Conservation Strategy. It is anticipated that directed research would be undertaken to answer specific management-related questions that arise based on results of monitoring and to address data gaps to provide information necessary to successfully implement conservation measures. The Implementing Entity may undertake research to reduce the levels of uncertainty related to achieving biological goals and objectives. These uncertainties are generally related to the following items:

- the efficacy of natural community enhancement/creation/restoration techniques,
- the ecological requirements of covered species, and
- the likely response of covered species to implementation of conservation measures.

Results of research conducted under the Plan will inform management and ensure attainment of the biological goals and objectives.

It is expected that most or all directed research will be conducted by or in partnership with outside scientists from academic institutions. It is anticipated that funding provided by the Implementing Entity for directed research could be matched by other entities to achieve broader results. The amount of directed research will be limited by funding available to the Implementing Entity (see Chapter 9). In addition to directed research undertaken by the Implementing Entity, it is also expected that scientists within the Implementing Entity (Executive Director, biological staff) will develop partnerships with academic institutions (undergraduate student projects, Masters theses, Ph.D. dissertations) to help direct research within the Preserve System that will inform and improve management and monitoring techniques.

7.4.4 Monitoring at Multiple Scales

Because the conservation strategy addresses the preservation of species and natural communities at multiple scales, the monitoring program must evaluate success at the species, natural community, and landscape levels. Typically, biological monitoring is focused on individual species, and clear guidelines for monitoring habitats and assessing trends are lacking. Therefore, it is necessary to create a system that is flexible enough to adjust to each species' situation but formal enough to allow evaluations of entire preserves. The subsequent description details the framework for a three-tiered approach involving landscape-, natural community–, and species-level monitoring.

Landscape-level monitoring is designed to detect large-scale changes, including changes in ecosystem processes, shifts in natural-community distribution, and the integrity of habitat connectivity. Community-level monitoring is designed to detect changes in the composition of natural communities, populations of key predator or prey populations, invasive species, and other important habitat factors for covered species. Species-level monitoring addresses the impacts of covered

activities on selected covered species and tracking the abundance, distribution, and other parameters of covered species in the Preserve System and the inventory area.

Specific monitoring items are described in the section below on *Adaptive Management and Monitoring by Natural Community Type*. In some cases the landscape-level monitoring could also be considered natural community–level monitoring, or the natural-community monitoring could be considered species monitoring. As with all questions of scale the distinction between levels is, in some way, subjective. As much as possible we have sought to adhere to the definitions of scale described in this document, acknowledging that the division between scales is not always clear-cut.

Landscape-Level Monitoring

Landscape-level monitoring is directed at geographically large areas that maintain essential ecological processes. Functioning landscapes encompass multiple ecosystems and natural communities and the movement of nutrients or materials between those units. Landscape-level monitoring addresses the following issues relevant to the HCP/NCCP:

- the amount and distribution of land-cover types in the Preserve System and their relationship to each other (e.g., succession or conversion from one community type to another, transitions zones between communities),
- the status and trends of land-cover types, natural communities, and other landscape features,
- the quality of habitat linkages and their potential role as dispersal and movement corridors,
- the delineation and function of watersheds, and
- regional weather patterns and groundwater levels that affect natural communities.

The purpose of monitoring changes in the extent of land-cover types within the planning area is to track long-term, landscape-level changes and, by inference, changes to the habitats and natural communities contained therein. Long-term changes can indicate local, regional, or global problems such as unanticipated impacts of covered activities, influence of invasive species, and effects of climate change. Monitoring long-term changes will also track the contribution of the HCP/NCCP toward maintaining or improving the extent, distribution, and continuity of natural land-cover types. Changes in land-cover type should result from landscape-level management actions (e.g., conversion of unvegetated streams to riparian woodland/forest; see Chapter 5). If landscape-level changes differ from the expected outcomes due to management actions, the Implementing Entity will attempt to identify reasons for the changes and address them through the adaptive management program.

Some possible approaches to landscape-level monitoring are discussed below.

2.4.4.1.1 Planning Surveys

Information on the status and trends of landscape features will be collected mainly through planning and other surveys that provide information on the amount and distributions of land-cover types in the Preserve System. These data will be used to refine currently existing species models. Additionally, this information will be combined with similar information being collected by others in the region (e.g., EPA, USFWS, CDFG, EBRPD) to provide resource managers, including the Implementing Entity, with an understanding of how critical biological resources are generally trending under the influence of Plan implementation as well as under the influence of other human activities and other environmental factors (e.g., fire, drought, disease).

2.4.4.1.2 Remote Sensing

At the landscape level, the Implementing Entity will monitor, using aerial photos or satellite imagery, the extent and distribution of HCP/NCCP land-cover types within the inventory area every 5 years. Current species models (Appendix D) reflect the landscape-level data available at the time of the writing of this plan. Species models will be improved as new data become available.

Additionally, landscape-scale information generated through survey reports will be cross-checked against periodic updates to the land-cover map from aerial photos or satellite imagery. The Implementing Entity will coordinate landscape-level monitoring with ongoing or future efforts that may be conducted by others within the Plan Area (e.g., EBRPD).

Natural Community–Level Monitoring

The Implementing Entity will conduct monitoring to assess ecosystem and natural-community function and to determine the response of natural communities to management. Natural community–level monitoring focuses on local threats to communities and habitats (such as specific invasive species) and the habitat attributes that may affect the status of covered species. Natural-community monitoring addresses the following issues relevant to the HCP/NCCP:

- the extent and quality of natural communities and the relationships between their constituent elements;
- the ability of natural communities to withstand natural and anthropogenic stressors/threats;

- the effectiveness of the conservation measures in enhancing/creating/ restoring natural communities and their associated features (ponds, riparian areas, etc.) and the ability of these areas to provide their intended ecological functions and values;
- the response of keystone species (i.e., species that affect the community out of proportion to their relative abundance) to management actions;
- community dynamics such as grassland burrow systems; and
- the presence/absence and abundance of key nonnative invasive species.

2.4.4.1.3 Monitoring Habitat

Natural-community monitoring will inform enhancement/creation/restoration techniques through the adaptive-management program. Specifically, monitoring will be established using an experimental approach (described under *Principles of Monitoring* above) such that results can be evaluated and future management actions improved. Monitoring of habitat restoration, along with other conservation measures, will focus on both the community or habitat response and, when applicable, the species response. This monitoring will ensure that the restored natural communities are functioning as habitat for a particular covered species or suite of species associated with the subject communities. Table 7-2 lists specific standards and objectives that will be the basis for assessing success natural community enhancement/creation/restoration conservation measures. Standards are the minimum required response, and objectives are the target response for each management action.

Conceptual Models. Ecological models will be used as a tool for monitoring ecosystem and natural community function, and, to some extent, the success of the conservation strategy in creating, enhancing, and restoring habitat. These models will lay out the relationships between threats/stressors, habitat, and covered species. Successful conceptual models will help identify indicators for natural community function.

Mapping invasive plants. Within the Preserve System, the implementing entity will delineate occurrences of invasive, nonnative plants as they are identified (by planning and other surveys) and periodically monitor these occurrences. The frequency of monitoring will depend on the threat that species pose to native biological diversity (see Conservation Measure 1.4.1 for details of the required Exotic Plant Control Plan for the Preserve System). For example, nonnative plants that occur within the preserves and have the ability to spread rapidly will be monitored more frequently (e.g., several times per year). Species that spread slowly will be monitored less frequently (e.g., every 3–5 years). Additionally, Implementing Entity field staff will continually monitor HCP/NCCP preserves informally for occurrences of new invasive plants that require immediate eradication or control actions.

Monitoring protocols for invasive plants will be coordinated with those of other local entities (e.g., EBRPD, CDPR, CCWD) to ensure consistency with these programs and facilitate the sharing of monitoring results. This monitoring information will be used to determine the need for management actions to control the spread of existing invasive plants and future, potential invasions. The effectiveness of control methods will also be reviewed. This monitoring information will be shared with the Alameda–Contra Costa Weed Management Area, EBRPD, CDPR, CCWD, and other state and local land-management agencies charged with the control of invasive plants as well as with managers of adjacent public lands.

Community Inventory Protocols. In addition to the planning surveys for land acquisition, once the parcels have been acquired, a vegetation and wildlife community inventory will be conducted. This inventory and mapping will draw as much as possible, from accepted protocols for typing vegetation communities and wildlife habitats. These typing protocols include the California Native Plant Society "Vegetation Rapid Assessment Protocol" (CNPS 2002) and "Releve Protocol" (CNPS 2003) for plants. Similarly, acquired parcels will be surveyed for wildlife communities including covered species, invasive species, and other potential disturbances. These protocols will be developed by the Implementing Entity during the initial phase of implementation. Additional specific protocols that may be used for wildlife include live trapping, vocalizations/recordings, mist netting, observation scans, search transects/plots, infrared camera stations, and identification of tracks and scat.

Along with the existing species models, the California Wildlife Habitat Relationships (CWHR) classification will be used, to the extent possible, to understand the relationship between natural communities, their habitat, and wildlife species. Information from CWHR, the results of protocol surveys, and any other relevant, new information will be incorporated into species and community models throughout the lifetime of the plan. When feasible, the Implementing Entity will seek to develop protocols that use a multi-species or habitat-based approach.

Species-Level Monitoring

The Implementing Entity will conduct monitoring to assess the status of covered species and to determine the extent to which the biological goals and objectives for species are being met. Species monitoring will address the following issues relevant to the HCP/NCCP:

- the response of covered species to HCP/NCCP conservation measures and adaptive management,
- status and trends of key covered species and other relevant species within preserve lands, and
- trends in abundance for selected wildlife indicator species over the term of the Plan.

Indicator Species. When appropriate, species can be used as indicators of ecosystem function (e.g., use of ground squirrels as an indicator of grassland health) and as surrogates for covered species that are difficult to monitor.

Species monitoring will provide data for use by USFWS, CDFG, universities, and wildlife conservation organizations to assess the overall health of species populations; to identify species conservation needs; and to direct future conservation efforts. This information may also be used to redirect, within the terms and conditions of permits, HCP/NCCP conservation efforts in future years (e.g., preserve management prescriptions) to improve conditions on preserve lands for declining species.

Key Covered Species. The status of all covered species will be addressed during the 30-year permit term. To facilitate the monitoring of covered species, a multi-species approach will be used, to the extent possible, for long-term monitoring. Key covered species or species groups will be monitored routinely to provide the data most likely to influence the conservation strategy and to manage costs effectively. In some cases, indicator species may be used when/if information on some species is highly correlated with other species, and therefore, intensively monitoring all species provides little additional information. Indicator species could also be used when monitoring covered species would have unacceptable adverse effects.

When appropriate, covered species will be used as indicators of overall ecosystem function within the Preserve System. Where feasible, species will be grouped into categories for ease in collecting data per individual species. If appropriate, sampling stations may be used to collect information on multiple species. Table 7-1 lists sample inventory periods and potential species groupings.

Monitoring Habitat to Assess Species. Selecting the best attributes to measure status and trends increases the effectiveness of monitoring. Monitoring adult abundance and distribution of Covered Species is often the most appropriate, direct measure of status. However, in many cases monitoring protocols for certain species yield variable and imprecise results or require a prohibitively expensive amount of sampling effort. In these cases key habitat variables may be used—in conjunction with other information—to evaluate species status. This method requires pilot studies to verify the relationship between the habitat attribute and the species status and should be periodically re-tested to ensure that the relationship between the indirect indicator and the condition of the species does not change. See section on *Indicators* above for additional information on selection of biotic and abiotic variables. An effective monitoring program balances efficiency and cost-effectiveness with the reliability of the information obtained.

Species Habitat Models. Parameters for the existing species models (Appendix D) will be refined and revised as more information becomes available. If possible, species models will be developed for the eight species for which models

were not be developed for this Plan (Townsend's big-eared bat, four vernal pool invertebrates, brittlescale, showy madia, and adobe navarretia).

Protocols. The Implementing Entity will be assembling the Preserve System throughout the 30 years of the permit term. Upon implementation of the Plan, the Implementing Entity will establish baseline conditions along with survey methods and monitoring schedules based on the scientific principles described above. Survey protocols and schedules will be established in the initial phase of implementation (years 1-5). These protocols and schedules will provide the overarching framework that will be implemented in each management unit. Where feasible, the Implementing Entity will draw from relevant and established protocols (i.e., CDFG and USFWS survey protocols) and will adapt them as more information becomes available.

7.5 Monitoring and Adaptive Management by Natural Community Type

The following sections describe an integrated approach to monitoring and adaptive management for each natural-community type. Under this framework, covered species will be affiliated with one or more of the six natural community/habitat assemblages: Grassland, chaparral/scrub, oak woodland, riparian woodland/scrub, wetlands, and aquatic. Within each of these habitat associations, monitoring and adaptive-management protocols are described at the landscape, natural community/habitat, and species level. Species can be associated with one or more natural-community type. In these cases, species-specific management and monitoring measures are described in the community type with which the species is most strongly associated. If equally associated with more than one community type, the measures are described in the first natural-community type in the document with which the species is associated. Each section below presents ecological information and recommended monitoring and adaptive management actions. The natural community types and their associated species mirror those of the Plan biological goals and objectives (see Table 5-X).

Additional information on natural communities is found in Chapter 3; additional information on species ecology is found in Appendix G.

7.5.1 Grassland

Associated Land-Cover Type:

- Annual grassland
- Native grassland
- Alkali grassland

- Ruderal

Associated Covered Species:

- San Joaquin kit fox
- Western burrowing owl
- Swainson's hawk
- Golden eagle
- Townsend's big-eared bat
- Silvery legless lizard
- Alameda whipsnake
- California red-legged frog
- California tiger salamander
- Western pond turtle
- Tricolored blackbird
- Big tarplant
- Mount Diablo fairy lantern
- San Joaquin spearscale
- Brittlescale
- Recurved larkspur
- Round-leaved filaree
- Showy madia

Grasslands found in the inventory area are dominated by grasses and forbs. The key processes creating and maintaining these grasslands are fire and grazing. Most of the grassland in the inventory area is currently grazed by cattle. Some areas have also been disked to improve foraging conditions for livestock. Native grasslands are very rare within the inventory area, and most native grassland species have been replaced by exotic grasses. The invasion of native grasslands by exotic grasses was facilitated in the past by drought conditions and improper grazing management. Currently native grasslands occur either as pockets within the larger annual grasslands or as subdominant components.

The key threats facing grasslands include alteration of the disturbance regime (i.e., fire); improper grazing management (degradation of native grasses and continued replacement by nonnative species, compaction and loss of cover leading to erosion, disking); conversion to urban development; or conversion to cultivated agriculture, primarily vineyards.

Biologists at EBRPD, in cooperation with Drs. James Bartolome and Reginald Barrett of the University of California, Berkeley, are currently experimenting with monitoring methods in grasslands in the inventory area for wildlife and plant communities. Their grassland-monitoring project began in 2002 on eight EBRPD units, including two in the inventory area: Vasco Caves and Morgan Territory Regional Preserves. The goals of the project are to establish baseline conditions in grassland species composition and to determine the response of these species to management. The project is expected to run for at least 10 years. Permanent plots have been established at each preserve to measure plant composition and density, soil chemistry, slope, aspect, bird species and abundance, and small mammal species occurrence. Other variables and plots may be added in the future. The methods and analyses developed for this long-term monitoring study can serve as a model for the Implementing Entity to use in establishing its own baseline conditions and monitoring the response of the grassland natural community to management actions. Whenever possible, monitoring methods on HCP/NCCP Preserves should be consistent with methods used on other public lands in the region to allow comparisons across sites.

Grassland: Landscape

Monitoring and adaptive management actions at the landscape level relevant to grasslands include the following:

- Map all stands of grassland with at least 25% relative cover of native species (grasses or forbs) within the Preserve System to identify areas for enhancement practices (*Conservation Measure 2.3.1 Enhance Native Grasslands*).
- Quantitatively classify each grassland stand to the alliance level according to the CNDDB vegetation classification scheme (California Department of Fish and Game 2002) to aid in cataloguing habitat diversity and in tracking habitat responses to management.
- Develop a pilot program to determine the feasibility of enhancement activities on a large scale. The pilot program will investigate the effect of management actions, including grazing and burning regimes, on native grassland species. Guidance for the development of a pilot program is found in Chapter 5 (*Conservation Measure Conservation Measure 2.3.1. Enhance Native Grassland*).
- Assess grassland landscape connectivity between preserves to ensure grassland species such as San Joaquin kit fox can traverse the inventory area.
- Monitor the frequency, location, and ignition source of all wildland fires within this community to develop a long-term fire record.

Grassland: Natural Community

Monitoring and adaptive management actions at the natural-community level relevant to grasslands include the following:

- Develop a conceptual ecological model for grasslands that includes important factors such as the effects of rainfall, temperature, fire, herbivory (i.e., grazing) and succession to woody communities such as chaparral/scrub or oak woodland.
- Assess and monitor exotic invasive plants, including developing maps and descriptions of their distribution and abundance; their known or potential effects on ecosystem function, native biological diversity, sensitive natural communities, and covered species; and the means and risk of their spread to other areas within and outside the preserves (see *Conservation Measure 1.4.1. Prepare and Implement an Exotic Plant Control Program for the Preserve System*).
- Conduct inventories to assess the quality of vegetation and wildlife habitat once lands have been acquired.
- Develop projects that test the effect of different grazing practices (e.g., grazing intensity, duration, season, type of livestock) on the maintenance and regeneration of native grasses and forbs. If possible, combine grazing treatments with other management techniques such as prescribed burns and hand seeding to detect interactions among management treatments.
- Monitor impacts from recreation use on biological resources and manage adaptively to reduce or eliminate impacts.
- Develop a pilot program of management methods to enhance rodent prey base (see *Conservation Measure 2.3.2. Enhance Prey Base and Natural Burrow Availability in Grassla*nds).
- Monitor ground squirrel and other small-mammal populations to determine the abundance of prey and burrows for several covered species (e.g., western burrowing owl, golden eagle, California red-legged frog, California tiger salamander) and many common species.

Grassland: Species

Monitoring and adaptive management actions at the species level relevant to grasslands include the following:

- Determine if populations of covered species are being maintained and enhanced.
- Estimate relevant demographic parameters such as adult survivorship and age structure of some covered species (e.g., San Joaquin kit fox, western burrowing owl) to help estimate population trends. (Construction of complete demographic models will not be feasible for most species.)

- Conduct monitoring for Swainson's hawk within low-elevation grassland in the inventory area within the range of the species to refine the estimate of the species' range. This will aid with preserve assembly and in riparian-restoration efforts to create breeding sites for the species.
- Conduct soil sampling to determine soil associations in the inventory area for San Joaquin spearscale, brittlescale, recurved larkspur, showy madia, and round-leaved filaree.
- Verify suitability of modeled habitat for silvery legless lizard with field data, as much as possible. Assess habitat suitability and identify occupied habitat prior to acquisition of preserve lands. Results of these surveys will be used to guide acquisition of occupied or suitable habitat to the maximum extent practicable. Record any occurrences of silvery legless lizard.
- Track movements of California red-legged frog, California tiger salamanders, and western pond turtles between breeding sites to determine average and maximum upland habitat movements through grassland. This will verify the key assumption in the habitat models regarding movement habitat and inform preserve assembly. Use recent literature to guide study design (e.g., Petranka et al. 2004)
- Map all locations of active golden eagle and tricolored blackbird nests in and adjacent to the inventory area to determine the most likely foraging habitat for these species. The Contra Costa Water District monitors the location of all active golden eagles nests on their land in the Los Vaqueros Watershed. Monitoring data collected by the Implementing Entity should be combined with the CCWD data on golden eagles.
- Using a bat detector, monitor for Townsend's big-eared bat in acquired lands with potential habitat features (rocky outcrops, caves, mines, old structures).
- Evaluate use of artificial burrows and artificial perches by Western burrowing owl (*Conservation Measure 3.3.1. Create Artificial Burrows in Grasslands and Conservation Measure 3.3.2. Establish Artificial Perches*).
- Consider research to determine the circumstances in which Alameda whipsnake forages or breeds in grassland outside of well-documented chaparral/scrub habitats.
- Further refine species models in this Plan and develop models, if feasible, for brittlescale and showy madia.

7.5.2 Chaparral/Scrub

Associated Land-Cover Type:

- Chaparral
- Coastal sage scrub

Associated Covered Species:

- Alameda whipsnake
- Mount Diablo manzanita
- Mount Diablo fairy lantern
- Diablo helianthella
- Brewer's dwarf flax

Chaparral and scrub consists of woody vegetation dominated by shrubs. Within the inventory area, this natural-community type is generally found on south-facing slopes and ridges . Dominant shrub species include chamise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos* spp.), and buckbrush (*Ceanothus* spp.). Within the study area, chaparral is uncommon (2% of land cover) and primarily occurs in scattered mid-elevation patches near Mt. Diablo. In addition to shrubs, scattered trees and small stands of trees, such as foothill pine (*Pinus sabiniana*) and oaks (*Quercus* spp.) are present, but they are not the dominant species.

Chaparral shrubs form a nearly continuous stand and, thus, herbaceous vegetation is rare except immediately following fire. Fire is an important determinant of chaparral communities, and fire frequency helps delimit the distribution of chaparral vegetation: areas with more frequent fires may tend toward grassland while areas with less frequent fires may tend toward oak woodland.

Threats to this natural-community type may include fire suppression, conversion to grasslands through grazing, and urban or rural development. The natural fire interval for chaparral/scrub in the inventory area is not known. The increased frequency of severe weather conditions due to climate change (e.g., low humidity, high winds, high temperature, and drought) and the number of people with access to stands (providing an ignition source) may have increased fire frequency relative to historic conditions. Ecosystem modeling and review of historic conditions will attempt to identify stressors (i.e., changes to fire regime) to this system and provide an understanding of cause-and-effect relationship between community function and these and other stressors.

Chaparral/Scrub: Landscape

Monitoring and adaptive-management actions at the landscape level relevant to chaparral/scrub include the following:

- Monitor chaparral and coastal sage scrub stands within preserves through vegetation sampling and periodic interpretation of aerial photographs to ensure that the overall extent of these stands is not declining.
- Use planning surveys and other ground truthing to establish the distribution and abundance of small stands of chapparal/scrub (< 10 acres) not mapped for this Plan that may be important in increasing connectivity between larger stands.

- Assess the historic extent, conditions, and fire frequency of chaparral and coastal sage scrub stands within the Preserve System using aerial photographs and historic records of fire in the area. This information will be used to determine whether active management is required to maintain these stands in their current extent and condition (see *Conservation Measure 2.5.1 Maintain or Improve Quality of Chaparral/Scrub Habitat through Adaptive Management*).
- In cooperation with the California Department of Forestry and Fire Protection and local fire agencies, determine whether prescribed burns might be necessary. If so, prepare Burn Plans that describe pre- and post-burn monitoring to determine effects.
- Assess connectivity between patches of chaparral/scrub within and outside preserves.
- Monitor the frequency, location, and ignition source of all wildland fires within this community to develop a long-term fire record.

Chaparral/Scrub: Natural Community

Monitoring and adaptive-management actions at the natural-community level relevant to chaparral/scrub include the following:

- Develop conceptual ecological model for grassland/shrub community type.
- Determine the habitat function of chaparral/scrub for Alameda whipsnake and the need for active management measures to maintain or enhance this species.
- Assess exotic invasive plants, including maps and descriptions of their distribution and abundance; their known or potential effects on ecosystem function, native biological diversity, sensitive natural communities, and covered species; and the means and risk of their spread to other areas within and outside the preserves (see *Conservation Measures 1.4.1 Prepare and Implement an Exotic Plant Control Program for the Preserve System*).
- Document any signs of disturbance within the Preserve System from recreational uses, and assess annually.
- Quantitatively classify each major chaparral stand to the alliance level according to the CNDDB vegetation classification scheme (California Department of Fish and Game 2002) to aid in cataloguing habitat diversity and in tracking habitat responses to management.
- Estimate the age of chaparral stands; map and monitor the successional stage of chaparral to ensure an adequate diversity of stand ages and an adequate distribution of canopy gaps to sustain chaparral herbs.

Chaparral/Scrub: Species

- If prescribed fire is necessary**,** monitor impacts of relocation and/or overall response of Alameda whipsnake population to prescribed burn (see *Conservation Measure 2.5.1 Maintain or Improve Quality of Chaparral/Scrub Habitat through Adaptive Management*). Consider new research results from CDFG on the effects of prescribed burning on Alameda whipsnake within its range (due in 2005).
- Map and monitor stands of Mount Diablo manzanita; determine the age structure of stands and their ability to reproduce without fire.
- Map and monitor populations of Mount Diablo fairy lantern, Diablo helianthella, and Brewer's dwarf flax and develop pilot projects to determine each species' response to management.
- Further refine species models.

7.5.3 Oak Woodland

Associated Land-Cover Type:

- Oak woodland
- Oak savanna
- Mixed evergreen woodland

Associated Covered Species:

- San Joaquin kit fox
- Golden eagle
- Silvery legless lizard
- California red-legged frog
- California tiger salamander
- Western pond turtle
- Mount Diablo fairy lantern
- Diablo helianthella
- Brewer's dwarf flax
- Showy madia

Oak woodland is common in the inventory area (17%) and is primarily found in the mid- to high-elevation zones in the southwestern portion. Common species include blue oak (*Quercus douglasii*), interior live oak (*Quercus wislizenii*), valley oak (*Quercus lobata*), and coast live oak (*Q. agrifolia*). Oak woodland grades into mixed evergreen forest at higher elevations in which codominant

species in the oak woodland, such as California bay (*Umbellularia californica*), California buckeye (*Aesculus californica*), and foothill pine, become more prevalent. Oak woodland can also occur along ephemeral and intermittent drainages with coast live oak occurring alongside riparian woodland trees, including California buckeye, big-leaf maple (*Acer macrophyllum*), and California bay.

Many factors may influence the population dynamics of oaks (Pavlik et al. 1991). Accordingly, a site-specific assessment is required to determine the factors most important in stands within preserves. Development of ecological models will help identify the major stressors to the system, and subsequent management and monitoring will refine the models. Based on an assessment of oaks in the Kellogg Creek watershed (Jones & Stokes Associates 1995), the health of this natural community in the inventory area may be limited by a lack of oak regeneration due to a high density of invasive weeds and nonnative plants in the understory. Some studies have found browsing by deer and livestock as well as grazing by small mammals to impair recruitment (Bartolome et al. 2002, Tyler et al. 2002, Borchert et al. 1989). Fire may have negative or no effect on oak recruitment, depending on the timing, frequency, and intensity of the fire (Griffin 1977; Bartolome et al. 2002).

Wild pigs may be a serious threat to oak regeneration in the inventory area. A recent study of the effects of wild pigs in California showed that they can disturb up to 35–65% of the ground annually where they occur in high densities and that they significantly reduce acorn survival (Sweitzer and Van Vuren 2002).

Sudden oak death (SOD), caused by the pathogen *Phytophthora ramorum*, is a serious threat to oak woodlands and mixed evergreen forests in northern California. Several dominant and important trees in the inventory area have been identified as hosts to this pathogen: coast live oak, California black oak, California bay laurel, madrone, California buckeye, and big-leaf maple (Davidson et al. 2003).

Oak Woodland: Landscape

Monitoring and adaptive-management actions at the landscape level relevant to oak woodland include the following:

- Using recent aerial photographs, document the range of percent canopy coverage within the Preserve System to estimate structural habitat diversity. Also separate mapping of oak woodland stands from stands of mixed evergreen forest, which could not be done for this Plan.
- Determine the status of tree recruitment using historical aerial photographs, if available. Determine whether the current canopy coverage of oaks are increasing, decreasing, or stable within the Preserve System. Oak stands in preserves will be evaluated in accordance with the decision-making process adopted by the California Department of Forestry and Fire Protection (Jones & Stokes Associates 1988) and used for management of oak stands in the

Los Vaqueros Watershed (Brady and Associates 1997). (See *Conservation Measure 2.4.2 Maintain and Enhance Oak Woodland and Oak Savanna Vegetation*.)

- Use planning surveys and other ground truthing to establish the distribution and abundance of each species of oak within the Preserve System.
- At least every 10 years, oak savannas and woodlands within preserves will be reevaluated using aerial photographs and the oak decision-making process (Figure 5-12). More intensive management actions will be conducted if a sudden decline in oak woodland or oak savanna stands is observed.

Oak Woodland: Natural Community

Monitoring and adaptive-management actions at the natural-community level relevant to oak woodland include the following:

- Develop conceptual ecological model for oak woodland community type.
- Assess oak stands within the preserve within 2 years of acquisition to identify factors that may be limiting ecological functions.
- If canopy coverage is declining, survey stands to determine what may be limiting ecological function and determine if recruitment is adequate to replace lost trees and meet canopy coverage goals. If insufficient, adaptive management actions will be implemented to improve recruitment. These actions will be site specific and may include modifying livestock practices, replanting; fencing saplings; reducing competing herbaceous vegetation; and controlling wild pigs (see *Conservation Measure 2.4.2 Maintain and Enhance Oak Woodland and Oak Savanna Vegetation* for more detail).
- Assess exotic invasive plants, including maps and descriptions of their distribution and abundance; their known or potential effects on ecosystem function, native biological diversity, sensitive natural communities, and covered species; and the means and risk of their spread to other areas within and outside the preserves (see *Conservation Measures 1.4.1 Prepare and Implement an Exotic Plant Control Program for the Preserve System*).
- Monitor impacts from recreation use on biological resources and manage adaptively to reduce or eliminate impacts.
- Monitor oak stands for SOD.

Oak Woodland: Species

- Map known and potential nest sites for golden eagles in order to restrict construction activities or recreational uses, if needed.
- Monitor San Joaquin kit fox through oak savanna and near oak woodland to determine the effect of tree cover on species movement.

- Monitor wild pig populations to track the success of control techniques and to determine their effects on oak woodlands and oak regeneration, in particular.
- Determine if populations of covered species are being sustained and, if possible, enhanced.
- Further refine species models and develop model for showy madia, if feasible.

7.5.4 Riparian Woodland/Scrub

Associated Land-Cover Type:

- Riparian woodland
- Riparian scrub

Associated Covered Species:

- Swainson's hawk
- Foothill yellow-legged frog
- California red-legged frog
- Western pond turtle

Riparian woodland is dominated by phreatophytic trees and is associated with streams and permanent and intermittent water sources. Riparian scrub is an early successional stage of riparian woodland and, thus, is dominated by young trees and shrubs. Riparian scrub may also occur in areas too dry or with groundwater too deep to support riparian trees. Generally, riparian areas occur as narrow corridors along streams representing less than 1% of the inventory area.

Due to its dependence on stream channels, riparian vegetation is adapted to disturbance. The common riparian species of cottonwood and willow generally require bare mineral soil and high light for germination. Floods can provide these conditions through the processes of erosion and deposition.

Threats to riparian vegetation include uncontrolled livestock access to riparian areas. Livestock adversely affect existing habitats through the trampling of native vegetation, inducing bank erosion, introducing nonnative vegetation, and reducing the natural recruitment and establishment of native riparian vegetation through grazing. Moreover, introduction of animal waste can have adverse effects on water quality.

Invasive, nonnative plant species can out-compete native plant species for limited water, nutrients, light, and space. This competition results in a decrease in the overall species diversity and, consequently, in the quality of habitat. Additional threats include channelization and levee construction, hardscape construction

(e.g., riprap, concrete channel lining), and clearing for agriculture or urban development.

Riparian Woodland/Scrub: Landscape

Monitoring and adaptive-management actions at the landscape level relevant to riparian woodland/scrub include the following:

- Inventory riparian corridors within the preserves to identify stream segments suitable for enhancement or restoration (see *Conservation Measure 2.6.1. Stream and Riparian Woodland/Scrub Enhancement Program and 2.6.2. Stream and Riparian Woodland/Scrub Restoration Program*).
- Investigate and document historical natural-disturbance regimes in streams, and document hydrologic changes that may be affecting riparian systems.
- Use data from USGS gauging stations and/or weather stations to collect information on flood processes and their effect on riparian communities.
- Assess connectivity of riparian corridors for use by native species.

Riparian Woodland/Scrub: Natural Community

Monitoring and adaptive-management actions at the natural-community level relevant to riparian woodland/scrub include the following:

- Develop conceptual ecological model for riparian natural community.
- Monitor effects of livestock access and livestock exclusion on community composition and recruitment of dominant trees and shrubs.
- Assess exotic invasive plants, including maps and descriptions of their distribution and abundance; their known or potential effects on ecosystem function, native biological diversity, sensitive natural communities, and covered species; and the means and risk of their spread to other areas within and outside the preserves (see *Conservation Measures 1.4.1 Prepare and Implement an Exotic Plant Control Program for the Preserve System*).
- Develop restoration measures for individual sites or steam reaches based on specific geomorphic, hydraulic, and hydrologic conditions; extent and quality of existing habitats (e.g., percent native vegetation and presence/absence of exotic wildlife such as bullfrogs or cowbirds); existing wildlife use; and the potential for adverse effects (e.g., disturbance and/or removal of existing wetland habitat). These measures will include descriptions of plant material requirements (e.g., collected and propagated from local sources); planting and construction methods; and adaptive management and monitoring requirements including indicators and success criteria.
- Determine indicator species for monitoring restoration and develop criteria for successful restoration of riparian areas.

- Monitor success of restored areas in recreating native cover and natural processes.
- Monitor impacts from recreation use on biological resources and manage adaptively to reduce or eliminate impacts.
- Monitor restored riparian areas for presence of bullfrogs and other nonnative species including fish that have the potential to prey on native amphibians.

Riparian Woodland/Scrub: Species

- Determine if populations of covered species are being restored and/or sustained.
- More precisely map stream reaches with perennial water to improve the model for foothill yellow-legged frog and western pond turtle.
- Monitor active nests of Swainson's hawk to determine use patterns and specific habitat needs for breeding sites.
- Monitor use of riparian forest as a movement corridor by native mammals.
- Further refine species models.

7.5.5 Wetlands

Associated Land-Cover Type:

- Permanent wetlands
- Seasonal wetlands
- Alkali wetlands

Associated Covered Species:

- California red-legged frog
- California tiger salamander
- Western pond turtle
- Tricolored blackbird
- Vernal pool fairy shrimp
- Vernal pool tadpole shrimp
- Longhorn fairy shrimp
- Midvalley fairy shrimp
- Brittlescale
- Adobe navarretia

Wetlands are dominated by herbaceous species that grow in wet or flooded soils. Within the inventory area, wetlands can be classified as permanent (characterized by a year-round water source), seasonal (ponded during winter and spring and dry through the summer and fall), and alkali (distinguished by alkali substrate). Vernal pools could not be mapped in the Plan but are included in the seasonal wetland land-cover type. Vernal pools pond water for extended durations during winter and spring and dry completely during late spring and summer; they support numerous specialized plant and animal species, including endangered species such as longhorn fairy shrimp (*Brachinecta longiantenna*).

Threats to wetlands include urban development, clearing or filling for agricultural, and altered surface hydrology due to changes in land use. Perennial wetlands are also threatened by invasion of exotic plants and wildlife.

Wetlands: Landscape

Monitoring and adaptive-management actions at the landscape level relevant to wetlands include the following:

- Identify and map distribution of wetlands within the Preserve System.
- Assess connectivity between the wetlands, including vernal pools.
- Assess the integrity of the regional hydrologic system that feeds the wetlands.
- Determine and quantify changes in habitat that result from management activities (wetland restoration) and quantify other changes that may affect covered species.

Wetlands: Natural Community

Monitoring and adaptive-management actions at the natural-community level relevant to wetlands include the following:

- Develop conceptual ecological model for wetlands.
- Survey wetlands within preserves to determine the watershed position and hydrologic context of a particular wetland or pond and whether they support covered species or have the potential to support these species.
- Prioritize wetlands for restoration and enhancement efforts (see *Conservation Measure 2.2.X. Wetland and Pond Enhancement and Management Program and Conservation Measure 2.2.3. Wetland Restoration and Pond Creation Program*). Potential restoration sites will be identified and selected on the basis of their physical processes and hydrologic, geomorphic, and soil conditions to ensure that successful restoration can occur and be self-sustaining.

- Develop criteria for evaluating success of enhancement and restoration. These criteria should evaluate whether restored habitat increased hydro-geomorphic and ecologic functions, improved habitat value, and enhanced the habitats' ability to support existing and new populations of covered species.
- Monitor restored habitat using scientific principles described above (*Scientific Principles for Monitoring*).
- Assess exotic invasive plants, including maps and descriptions of their distribution and abundance; their known or potential effects on ecosystem function, native biological diversity, sensitive natural communities, and covered species; and the means and risk of their spread to other areas within and outside the preserves (see *Conservation Measures 1.4.1 Prepare and Implement an Exotic Plant Control Program for the Preserve System*).
- Design a pilot program to test the effects of different livestock grazing regimes (including exclosures) on seasonal alkali wetlands.
- Design a pilot program to determine the benefit of small checkdams in arresting stream channel erosion in seasonal alkali wetlands.
- Monitor impacts from recreation use on biological resources and manage adaptively to reduce or eliminate impacts.
- Monitor the effectiveness of techniques implemented to enhance and manage wetlands (see *Conservation Measure x.x.x. Wetland and Pond Enhancement and Management Program*).
- Monitor predation on tricolored blackbird nesting colonies by black-crowned night heron (*Conservation Measure 3.1.1. Minimize Predation on Tricolored Blackbird Colonies*).

Wetlands: Species

- Determine species response of tricolored blackbird, California red-legged frog, western pond turtle, and vernal pool invertebrates to wetland restoration (see *Conservation Measure 2.2.2*).
- Conduct surveys for vernal pool invertebrates in preserve to refine our understanding of suitable habitat for these species in the inventory area.
- Evaluate restored vernal pools to determine if covered vernal-pool crustaceans are present at frequencies similar to those in natural vernal-pool complexes. If not, the Implementing Entity will assess the feasibility of transplanting species from occupied pools to restored pools to establish new populations.
- Survey populations of brittlescale and adobe navarretia to refine our understanding of suitable microhabitats for these species. Monitor populations to determine responses to management.
- Further refine species models and develop models, if feasible, for vernal pool invertebrates, brittlescale, and adobe navarretia.

7.5.6 Aquatic

Associated Land-Cover Type:

- Stream
- Reservoir
- Ponds
- Slough/channel

Associated Covered Species:

- Foothill yellow-legged frog
- California red-legged frog
- California tiger salamander
- Western pond turtle
- Giant garter snake

Aquatic land-cover types are open water or aquatic habitats such as lakes, reservoirs, water-treatment ponds, sloughs, channels, streams, and ponds (including stock ponds) that do not support emergent vegetation. Streams include ephemeral, intermittent, and perennial watercourses characterized by defined channel boundaries. Marsh Creek, Kirker Creek, and lower Sand and Deer Creeks are the only perennial streams within the inventory area. Sloughs and channels are features with perennial water and artificial banks (e.g., levees) constructed of natural soil materials with little or no in-channel vegetation. Streams that have been channelized and leveed were mapped as sloughs/channels. Ponds are small perennial or seasonal water bodies that either lack vegetation or have submerged or floating vegetation. Ponds with submerged or emergent vegetation can provide important habitat for amphibians. Ponds can either be natural features or have been created by ranchers as watering sites. The inventory area also includes four reservoirs—Los Vaqueros, Contra Loma, Antioch, and Marsh Creek Reservoirs.

Aquatic: Landscape

Monitoring and adaptive-management actions at the landscape level relevant to aquatic include the following:

- Determine and quantify changes in land-cover type that result from management activities (pond and stream restoration), and quantify other changes that may affect covered species.

- Map the distribution of ponds, streams, and sloughs in and adjacent to the Preserve System and assess connectivity between the aquatic habitat types and between aquatic habitat and associated upland habitat types.

Aquatic: Natural Community

Monitoring and adaptive-management actions at the natural-community level relevant to aquatic include the following:

- Survey streams and ponds within preserves to determine whether they support aquatic or amphibian covered species or have the potential to support these species.
- Prioritize ponds and streams for restoration and enhancement efforts (see *Conservation Measure x.x.x. Wetland and Pond Enhancement and Management Program and Conservation Measure 2.2.3. Wetland Restoration and Pond Creation Program*) and develop criteria for evaluating success. Potential restoration sites will be identified and selected on the basis of their governing physical processes and hydrologic, geomorphic, and soil conditions to ensure that successful restoration can occur and be self-sustaining.
- Monitor success of restoration and enhancement efforts.
- Assess whether stockponds can maintain water in average rainfall years to support covered species.
- Assess exotic invasive plants within the Preserve System, including maps and descriptions of their distribution and abundance; their known or potential effects on ecosystem function, native biological diversity, sensitive natural communities, and covered species; and the means and risk of their spread to other areas within and outside the preserves (see *Conservation Measures 1.4.1 Prepare and Implement an Exotic Plant Control Program for the Preserve System*).

Aquatic: Species

- Conduct pilot program to determine the relative benefit to California red-legged frog, California tiger salamander, and western pond turtle of different pond treatments such as access/exclusion by livestock, vegetated/unvegetated banks, and pond depth and duration.
- Conduct surveys to assess habitat suitability and identify habitat occupied by foothill yellow-legged frog in potential preserve lands; results of these surveys will be used to guide acquisition of preserves to include occupied habitat to the maximum extent practicable.
- Determine species response of tricolored blackbird, California red-legged frog, foothill yellow-legged frog, and western pond turtle to stream restoration and pond creation (see *Conservation Measure 2.2.2*).

- Determine if populations of foothill yellow-legged frog are being restored and/or sustained. Monitor results of restoration efforts to support yellow-legged frog populations. Estimate adult survivorship and age structure of populations, if appropriate.
- Survey for giant garter snake within the Preserve System and develop specific monitoring protocols for this species.
- Further refine species models.

7.6 Database Development and Maintenance

The Implementing Entity will develop and maintain a comprehensive GIS-linked database to track implementation of all aspects of the HCP/NCCP. The database should be structured to be "user friendly" such that a trained staffer (as opposed to a technician or programmer) can enter data. Additionally, the database will allow for future expansion and integration with external databases (e.g., linkage to agency or other GIS map libraries). The database should be structured to facilitate the following requirements:

- data documentation such that future users can determine why, how, and where data were collected (documentation standards [i.e., data about the data] should be consistent for all types of monitoring and over time; adequate documentation will facilitate the future use of monitoring data);
- quality assurance and quality control of the data; and
- access and use of the most current information in assessment and decision making (the database should allow repeated access to current and past information over time).

The primary types of information for which the GIS-linked database will be developed and maintained are

- monitoring and research results;
- HCP/NCCP funding and expenditures;
- status of covered activities, including implementation and impacts on covered species and natural communities;
- status of HCP/NCCP natural community preservation/enhancement/ creation/restoration conservation measures;
- status of HCP/NCCP research investigations;
- adopted changes to the HCP/NCCP; and
- all reports/documents generated by the Implementing Entity.

The Implementing Entity may choose to develop a web-linked database to facilitate controlled transference of information by others into and out of the

database. Examples of benefits that could be associated with maintaining controlled web-linked access to selected elements of the comprehensive HCP/NCCP database include the following:

- development of database entry forms or use Personal Digital Assistants (PDAs) that could allow direct input of information into the database by entities/individuals charged with implementing covered activities, conservation measures, monitoring surveys, and research studies;
- access by HCP/NCCP Partners to digital monitoring, research, and other data for purposes of generating internal reports that may be needed to facilitate their participation in the HCP/NCCP; and
- access by HCP/NCCP Partners, other ecosystem restoration programs, outside researchers, and other interested parties to HCP/NCCP reports and documents.

The Implementing Entity will comply with the data-sharing requirements of the permit. If the Implementing Entity allows additional access to the comprehensive database, such access will require strict controls and monitoring to ensure that the integrity of the database is maintained (e.g., use of passwords to limit access of a particular entity to selected database functions, sampling data entry forms to ensure that entered information is complete and accurate).

7.7 Reporting

The Implementing Entity will prepare annual monitoring and research reports over the term of the HCP/NCCP. The annual reports will summarize the previous calendar year's monitoring and research results and be completed by March 1 following the reporting year. Annual reports will require synthesis of data and reporting on important trends such as land acquisition, fee collection, and habitat restoration. A due date of March 1 will allow time for the data from the previous year to be assembled and presented in a clear and concise format.

Reports will be submitted to the HCP/NCCP Governing Board, HCP/NCCP Partners, designated representatives of USFWS and CDFG and will be posted on the website. The Implementing Entity will also distribute these reports to the Independent Conservation Assessment Team and Science Advisors, as appropriate, for their review. These advisory bodies will use results presented in the monitoring reports and other available information to assess success of the HCP/NCCP in meeting the biological goals and objectives and to formulate recommendations to the HCP/NCCP Governing Board and Implementing Entity for Plan implementation in subsequent years. The Implementing Entity may also distribute monitoring reports to other entities engaged in various aspects of ecosystem management/research that could benefit from sharing monitoring data.

At a minimum, monitoring and research reports should include the following:

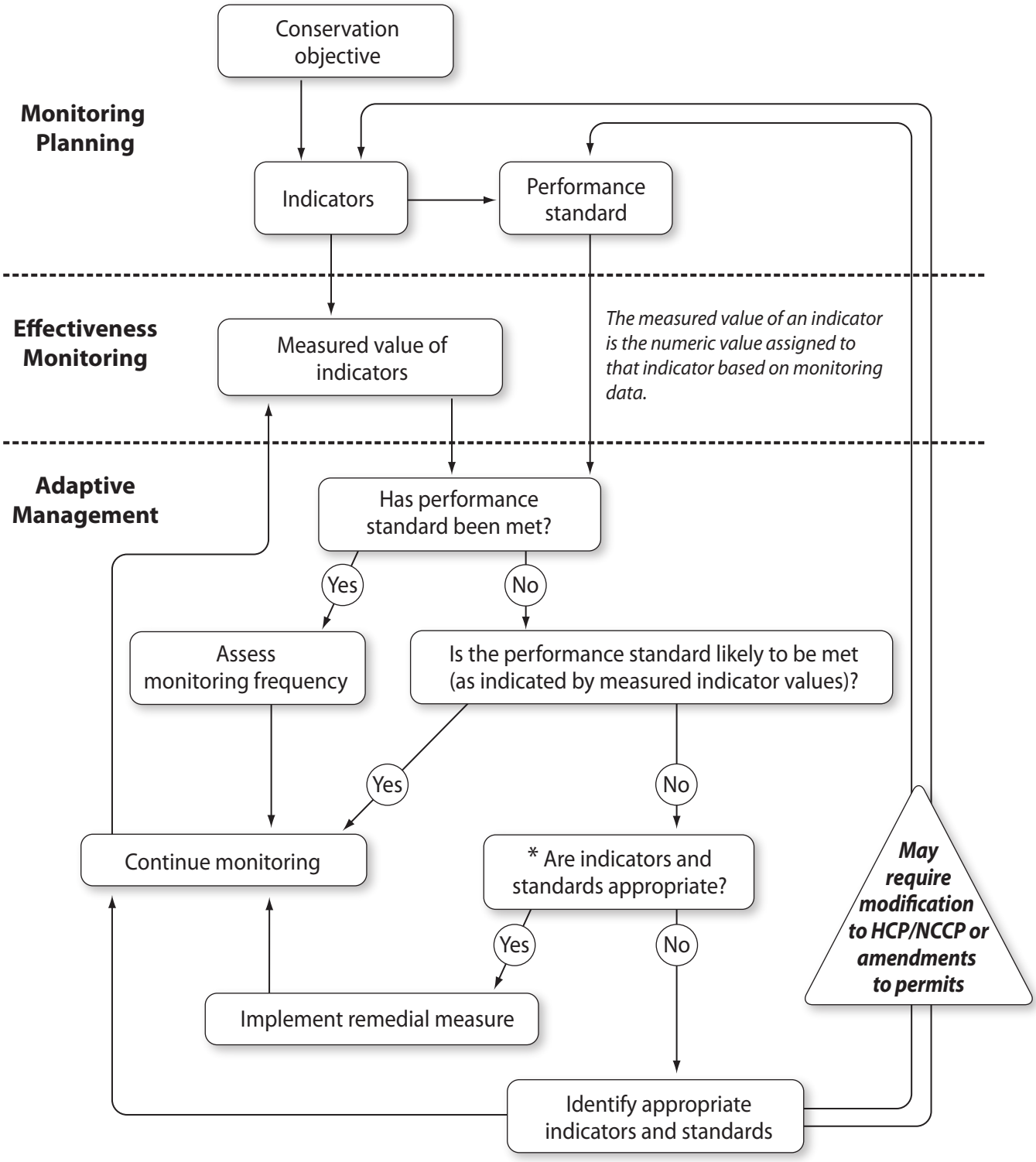
- a description of all covered activities implemented during the reporting period;
- a description of all HCP/NCCP natural community protection/enhancement/creation/restoration conservation measures implemented during the reporting period;
- a year-to-date summary of the extent of protected/enhanced/created/restored natural communities;
- a summary of impacts on natural-community types and covered species associated with implementation of covered activities and conservation measures;
- a description of avoidance, minimization, and mitigation conservation measures implemented to address impacts of covered activities and conservation measures;
- a presentation of the conceptual models developed and any changes to them that have taken place;
- a description of the effectiveness monitoring undertaken during the reporting period and an analysis of monitoring results;
- a description of performance monitoring undertaken during the reporting period, an analysis of monitoring results, and a description of remedial actions, if undertaken during the reporting period;
- a description of status and trends monitoring undertaken during the reporting period and an analysis of monitoring results;
- a description of all HCP/NCCP research undertaken during the reporting period, an analysis of research results, and a description of integration with monitoring, assessment, and compliance elements;
- an assessment of the efficacy of the monitoring and research program and recommended changes to the program based on interpretation of monitoring results and research findings;
- an assessment of the efficacy of habitat enhancement/creation/restoration methods in achieving performance objectives and recommended changes to improve the efficacy of the methods; and
- an assessment of the appropriateness of performance indicators and objectives (Table 7-2) based on results of effectiveness monitoring and recommended changes to performance indicators and objectives (Figure 7-1).

7.8 Budget

The Implementing Entity will prepare annual budgets for monitoring, adaptive management, and directed-research costs (see Chapter 9 for a complete discussion of Plan costs). Monitoring and adaptive-management costs include the cost of planning, conducting, analyzing, and reporting on implementation

monitoring, planning surveys within preserves, preconstruction surveys within preserves, construction monitoring within preserves, and effectiveness monitoring. Monitoring costs also include the funding of pilot programs and limited directed research.

Monitoring costs are perhaps the most uncertain element of the HCP/NCCP because of the wide range of monitoring options available (location, frequency, intensity, number of variables, number of monitoring staff, analysis complexity, etc.). For this reason, it is critical that the Implementing Entity establish clear monitoring goals that are linked to the available budget. Monitoring priorities and budgets should be reassessed frequently to ensure that all monitoring goals can be met.



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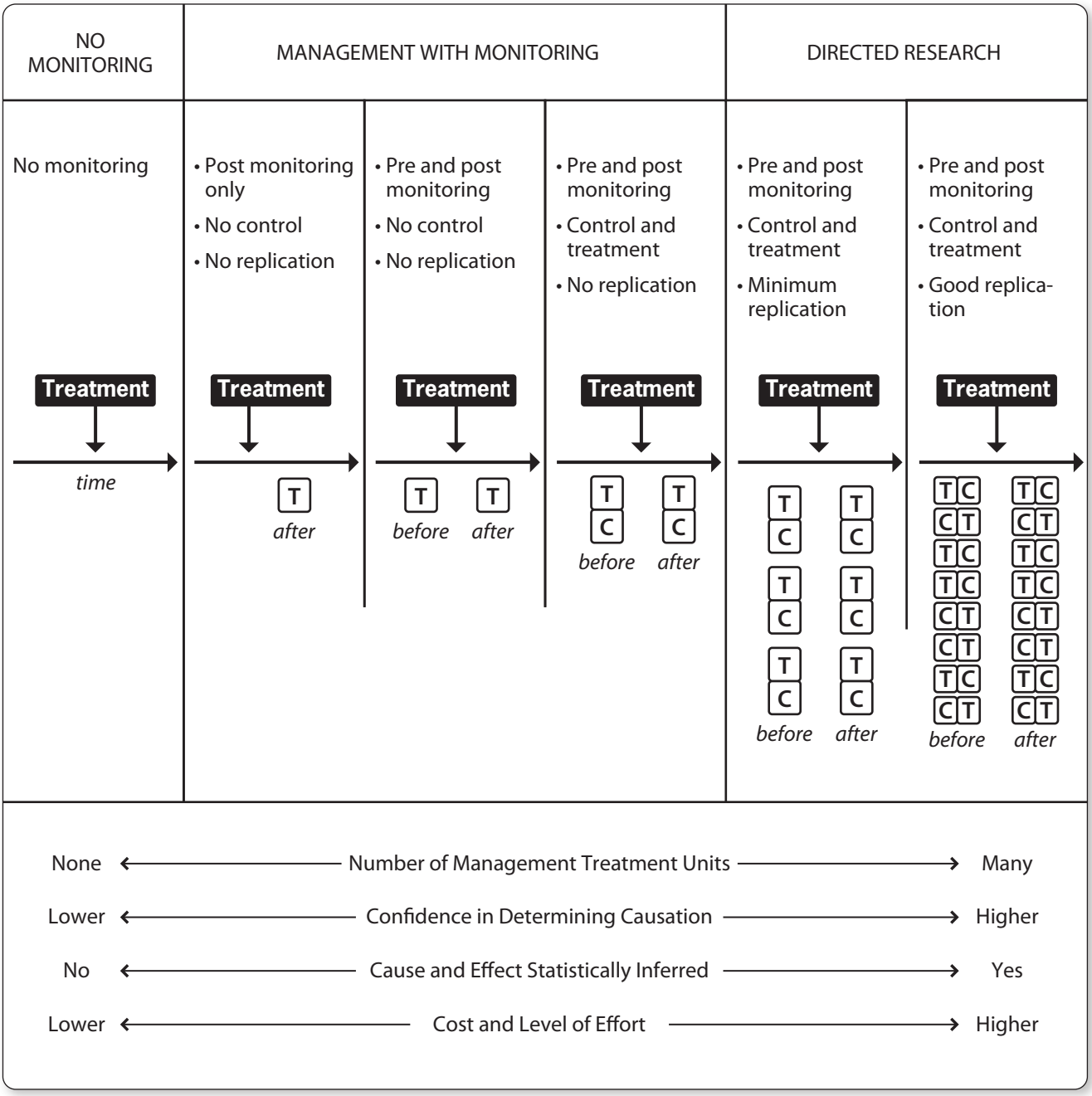
Source: Adapted from Draft Guadalupe River Project, Downtown San Jose, California, Mitigation Monitoring Report (Jones & Stokes 2002)

* determined through scientific Review by SAC

Jones & Stokes

Figure 7-1
Flowchart of the Adaptive Management Process



Adapted from: Elzinga et al. 1998.

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Figure 7-2
Continuum of Experimental Management

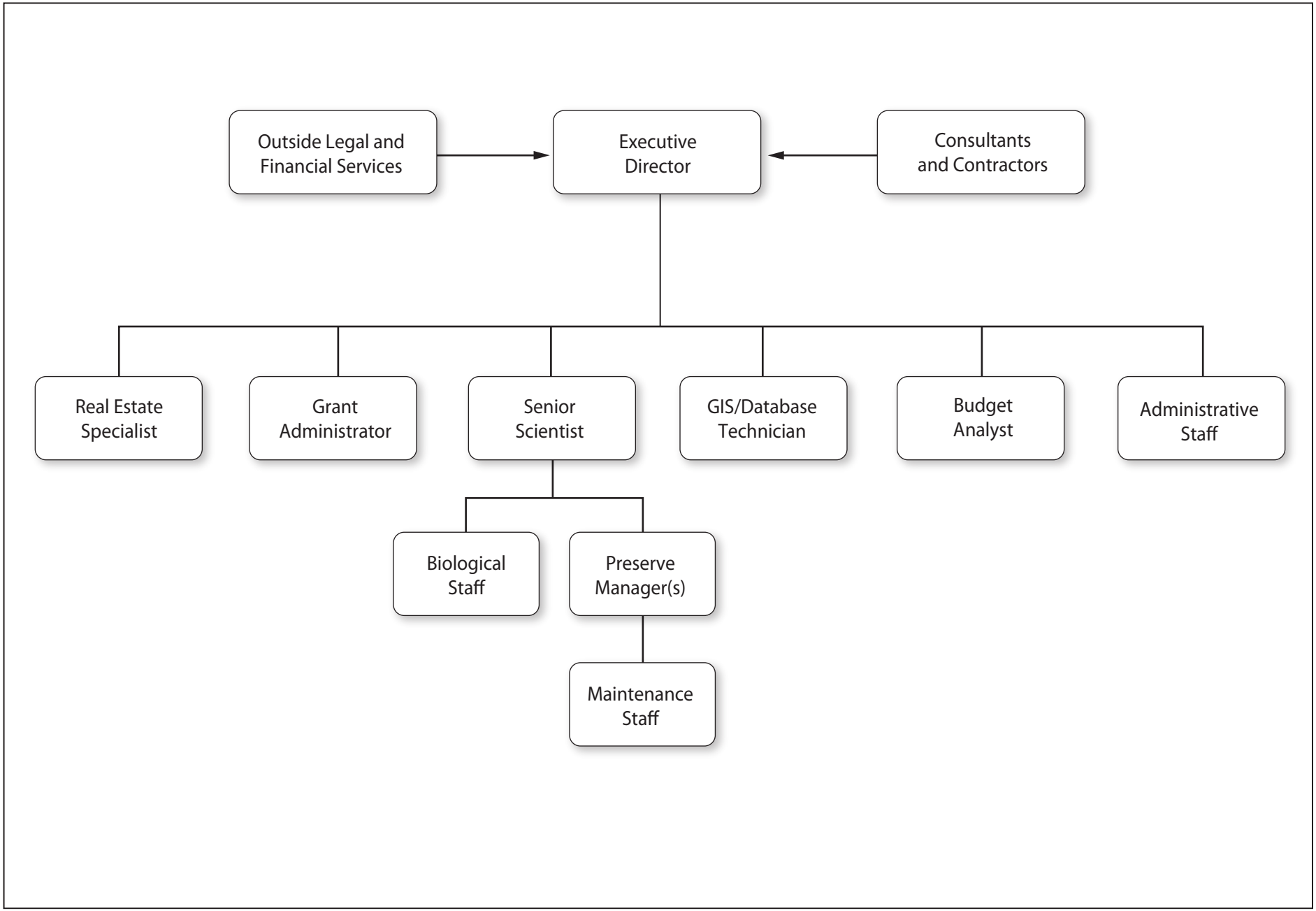

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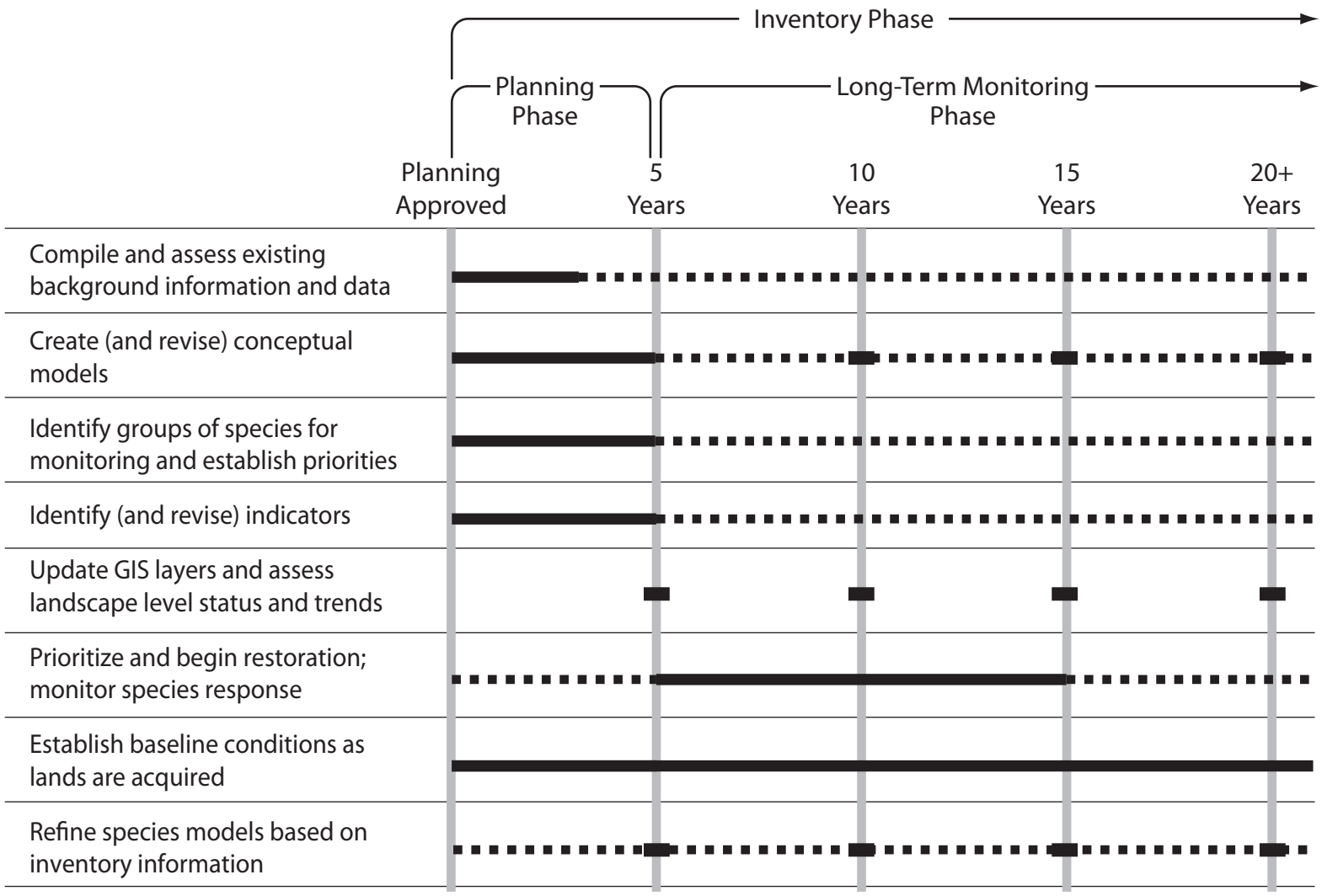
Figure 7-2b
Potential Organizational Structure of Implementing Entity



Adapted from: Atkinson et al. 2004.

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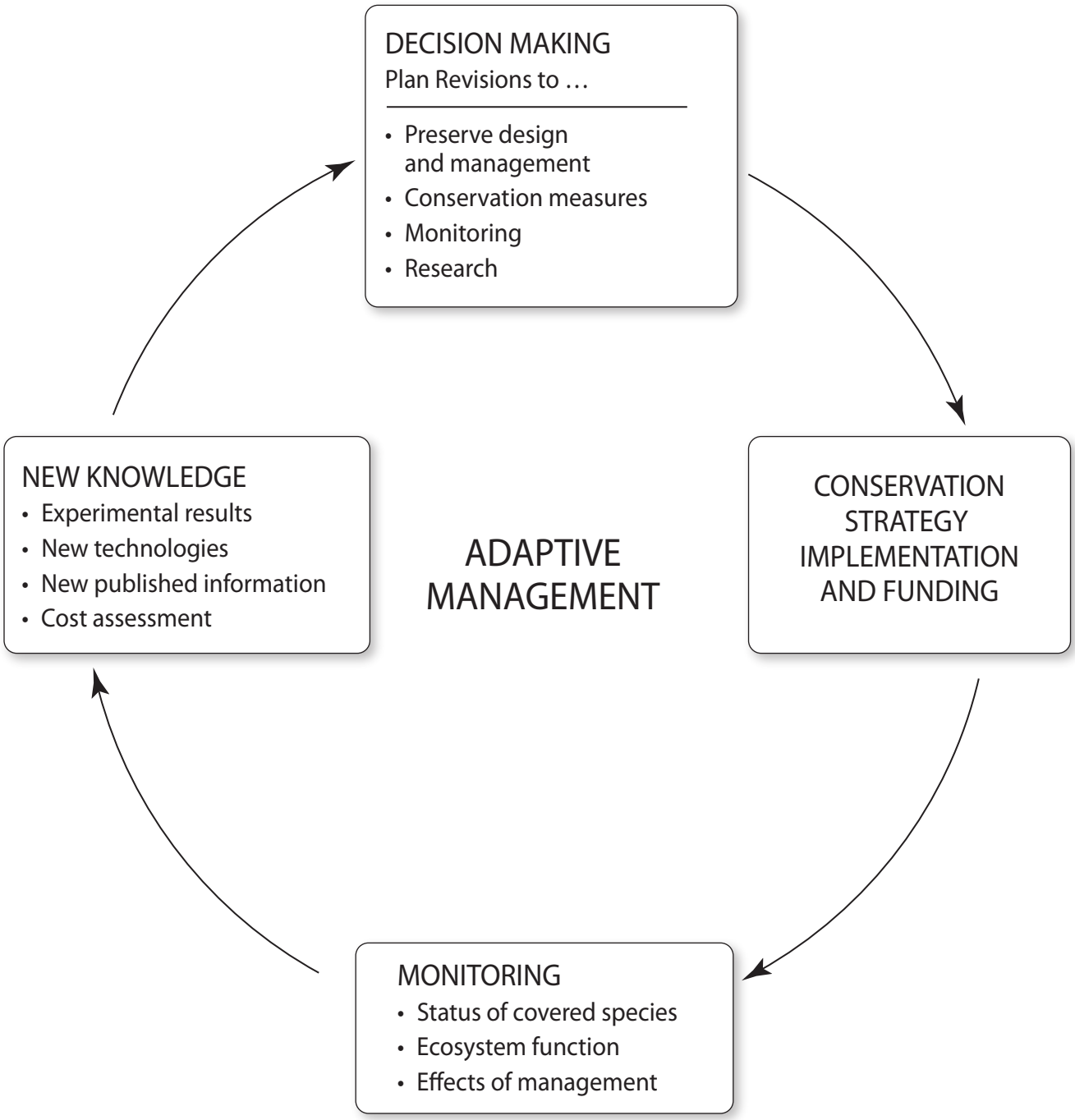
Figure 7-3
Timing of Implementation Phase



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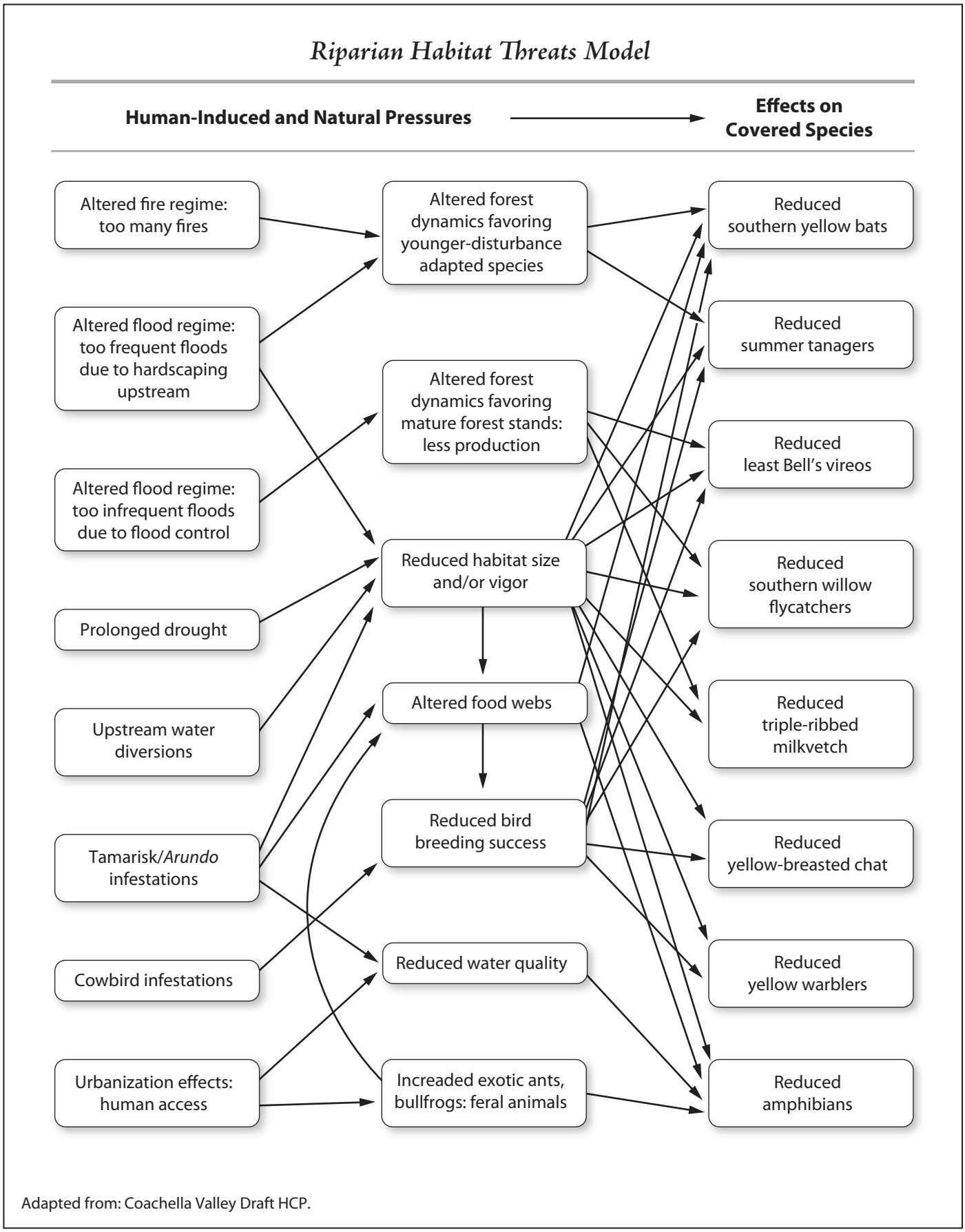
Source: Adapted from *Statewide Strategy to Recover Salmon* (Washington State Joint Resources Cabinet 1999).

Figure 7-4
Adaptive Management Process



Adapted from: Coachella Valley Draft HCP.

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Figure 7-5
Example Stress-Response Model 1

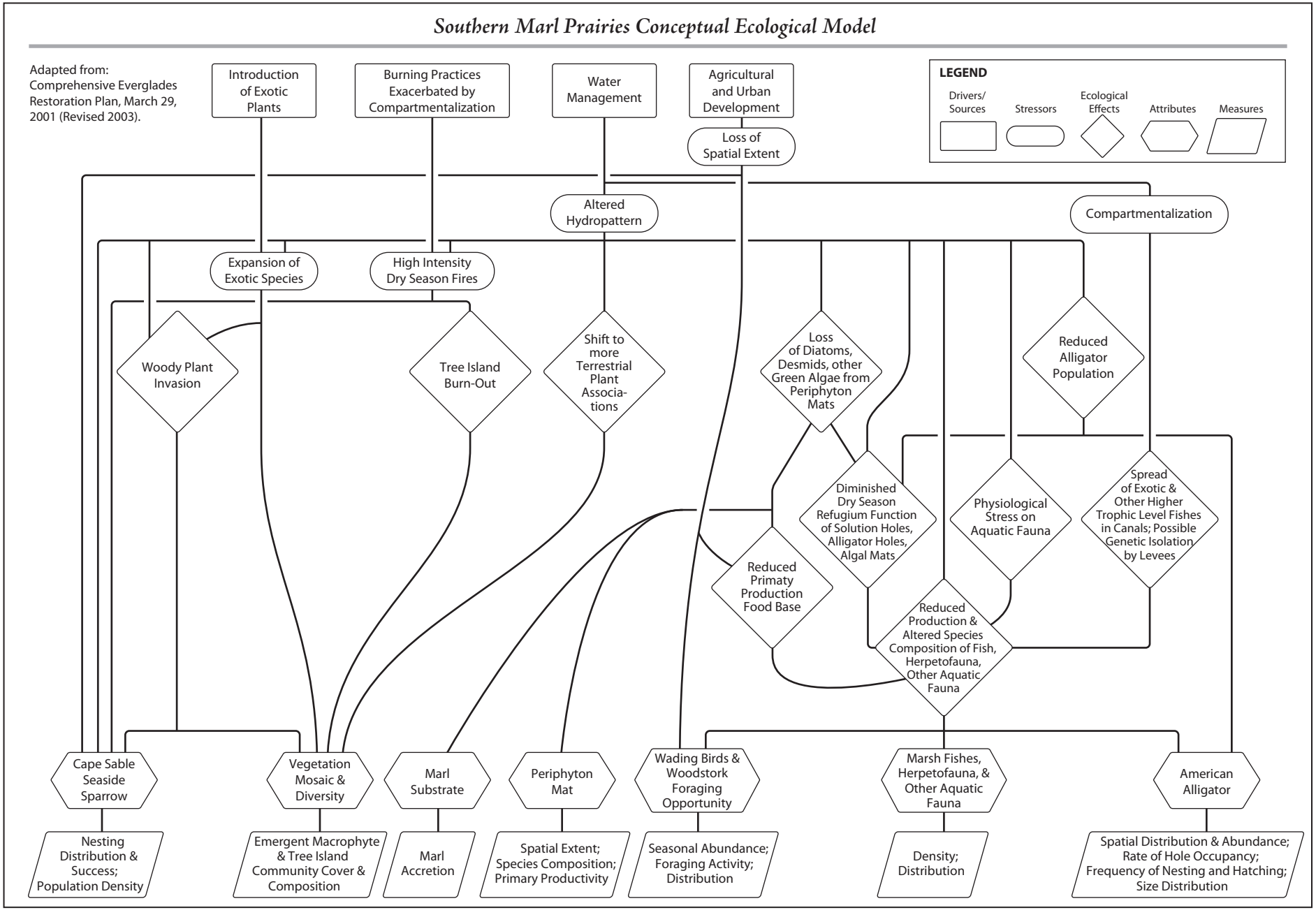

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Figure 7-6
Example Stress Response Model 2

Table 7.1 Potential Species Grouping and Monitoring Timelines for Covered Species.

Common Name	Planning Survey for Land Acquisition	Grouping*	Monitor Distribution every "x" years	Monitor Abundance every "x" years	Monitor Reproduction every "x" years
burrowing owl	X	open	5	5	
San Joaquin kit fox	X	open	5	5	5
tricolored blackbird	X	wetland	5	5	
golden eagle	X	open	10	5	
Swainson's hawk	X	open	10	5	5
Townsend's Western big-eared bat	X		5		
silvery legless lizard	X		10	10	
Alameda whipsnake	X		5	5	
giant garter snake	X		10		
California tiger salamander	X	wetland	5	5	
California red-legged frog	X	wetland	5	5	
Foothill yellow-legged frog	X	wetland	5	5	
longhorn fairy shrimp	X	vernal pool	5		
vernal pool fairy shrimp	X	vernal pool	5		
midvalley fairy shrimp	X	vernal pool	5		
vernal pool tadpole shrimp	X	vernal pool	5		
Mt. Diablo manzanita	X	plant	10		10
brittlescale	X	plant	5	5	
San Joaquin spearscale	X	plant	5	5	
big tarplant	X	plant	5	5	
Mt. Diablo fairy Lantern	X	plant	5	5	
recurved larkspur	X	plant	5	5	

Table 6-1~~2~~. Continued

Common Name	Planning Survey for Land Acquisition	Grouping*	Monitor Distribution every "x" years	Monitor Abundance every "x" years	Monitor Reproduction every "x" years
Diablo helianthella	X	plant	5	5	
Brewer's dwarf flax	X	plant	5	5	
showy madia	X	plant	5	5	
adobe navarretia	X	plant	5	5	

* When feasible, Covered Species will be grouped to facilitate monitoring efforts. The groupings suggested here will be finalized by the Implementing Entity during the Planning Phase of Monitoring.

Table 7-2. Draft Performance Indicators for Monitoring Natural Community Enhancement, Restoration, and Creation

Conservation Measure	Performance Period[1]	Draft Performance Indictors[2]	
		Draft Performance Standard[3]	Draft Performance Objective[4]
2.2.1 Wetland and Pond Enhancement and Management Program: native wetlands	5 years following acquisition of native wetlands	*% relative native plant cover:* • Demonstrate an upward trend in % native plant cover relative to existing conditions	*% relative native plant cover:* • Increase % native plant cover by 50% from existing conditions
2.2.1 Wetland and Pond Enhancement and Management Program: Stock ponds and permanent wetlands	5 years following acquisition of stock ponds and permanent wetlands	*Nonnative predators:* • Maintain 75% of all stock ponds and permanent wetlands free of nonnative fish (except mosquitofish) and bullfrogs in any given year *Emergent vegetation cover-margins:* • Maintain native emergent vegetation along at least 25% of pond and wetland edges *Emergent vegetation cover-pond surface:* • For ponds designed to support tricolored blackbird breeding: Maintain native emergent vegetation over at least 20% of pond surface area	*Nonnative predators:* • Maintain all stock ponds and permanent wetlands free of nonnative fish (except mosquitofish) and bullfrogs annually *Emergent vegetation cover-margins:* • Maintain native emergent vegetation along at least 50% of pond and wetland edges *Emergent vegetation cover-pond surface:* • For ponds designed to support tricolored blackbird breeding: Maintain native emergent vegetation over at least 40% of pond surface area
2.2.2 Wetland Restoration and Pond Creation Program: alkali wetland	5 years following wetland restoration	*Extent restored:* • 15 acres[5] *Relative native alkali wetland plant cover:* • 65% *Native plant diversity* • 50% of species in reference alkali wetlands	*Extent restored:* • 15 acres[5] *Relative native alkali wetland plant cover:* • 80% *Native plant diversity* • 75% of species in reference alkali wetlands

Table 7-2. Continued

Conservation Measure	Performance Period[1]	Draft Performance Indictors[2]	
		Draft Performance Standard[3]	Draft Performance Objective[4]
2.2.2 Wetland Restoration and Pond Creation Program: seasonal wetland	5 years following wetland restoration	*Extent restored:* • 45 acres[5] *Relative native seasonal wetland plant cover:* • 35% *Native plant diversity* • 50% of species in reference seasonal wetlands	*Extent restored:* • 45 acres[5] *Relative native seasonal wetland plant cover:* • 65% *Native plant diversity* • 75% of species in reference seasonal wetlands
2.2.2 Wetland Restoration and Pond Creation Program: Ponds	5 years following pond creation	*Extent created:* • 13 acres[5] *Emergent vegetation cover:* • 25% of ponds will support native emergent vegetation > 5 feet tall (e.g., cattail or tules) over at least 35% of surface area (for Tricolored Blackbird) • 50% of ponds will support emergent vegetation over at least 10% but no more than 60% of the surface area (for California red-legged frog) *% emergent vegetation cover-margins:* • Maintain native emergent vegetation along at least 25% of each pond margin *Nonnative predators:* • Maintain 75% of all ponds of free of nonnative fish (except mosquitofish) and bullfrogs in any given year *Hydrology:*	*Extent created:* • 13 acres[5] *Emergent vegetation cover:* • 25% of ponds will support native emergent vegetation > 5 feet tall (e.g., cattail or tules) over at least 50% of surface area (for Tricolored Blackbird) • 75% of ponds will support emergent vegetation over at least 30% but no more than 60% of the surface area (for California red-legged frog) *% emergent vegetation cover-margins:* • Maintain native emergent vegetation along at least 50% of each pond margin *Nonnative predators:* • Maintain all ponds free of nonnative fish (except mosquitofish) and bullfrogs annually *Hydrology:*

Table 7-2. Continued

Conservation Measure	Performance Period[1]	Draft Performance Indictors[2]	
		Draft Performance Standard[3]	Draft Performance Objective[4]
		• Maintain ponded surface water until October 1 in normal rainfall years[6]	• Maintain ponded surface water until October 1 in dry rainfall years[6]
2.2.2 Wetland Restoration and Pond Creation Program: Perennial wetlands	5 years following perennial wetland restoration	Extent created/restored: • 32 acres[5] *Emergent vegetation cover:* • 50% of perennial wetland acreage will support native emergent vegetation > 5 feet tall (e.g., cattail or tules) over at least 35% of surface area (for Tricolored Blackbird) *% emergent vegetation cover:* • Maintain native emergent vegetation along at least 35% of each wetland *Nonnative predators:* • Maintain 50% of all wetlands free of nonnative fish (except mosquitofish) and bullfrogs in any given year *Hydrology:* • Maintain wetlands year-round in normal rainfall years[6]	*Extent created/restored:* • 32 acres[5] *Emergent vegetation cover:* • 50% of perennial wetland acreage will support native emergent vegetation > 5 feet tall (e.g., cattail or tules) over at least 65% of surface area (for Tricolored Blackbird) *% emergent vegetation cover:* • Maintain native emergent vegetation along at least 65% of each wetland *Nonnative predators:* • Maintain 75% of all wetlands free of nonnative fish (except mosquitofish) and bullfrogs in any given year *Hydrology:* • Maintain wetlands year-round in dry rainfall years[6]

Table 7-2. Continued

Conservation Measure	Performance Period[1]	Draft Performance Indictors[2]	
		Draft Performance Standard[3]	Draft Performance Objective[4]
2.3.1 Enhance Native Grassland	8 years following implementation of preserve-wide management of grasslands (and after pilot study complete)	*% native forb cover:* • Demonstrate an upward trend in % native forb cover relative to existing conditions *% native grass cover:* • Demonstrate an upward trend in % native grass cover (annual or perennial) relative to existing condition *Native plant diversity:* • Demonstrate an upward trend in native plant diversity	*% native forb cover:* • Increase native forb cover by 20% relative to existing conditions *% native grass cover:* • Increase native grass cover by 20% relative to existing conditions *Native plant diversity:* • Demonstrate an upward trend in native plant diversity
2.3.2 Enhance Prey Base and Natural Burrow Availability in Grasslands	10 years following implementation of measure	*Abundance of burrows:* • Demonstrate and upward trend in burrow density within the preserve	*Abundance of burrows:* • Increase the density of burrows within preserves by 25%
2.4.2 Maintain and Enhance Oak Woodland and Oak Savanna Vegetation	Implement measures to increase oak tree establishment and densities within 3 years of detecting a decline in canopy cover	*Absolute oak tree canopy cover:* • Maintain the existing % absolute oak tree canopy cover in oak savanna and woodlands on preserves	*Absolute oak tree canopy cover:* • Maintain the existing % absolute oak tree canopy cover in oak savanna and woodlands on preserves

Table 7-2. Continued

Conservation Measure	Performance Period[1]	Draft Performance Indictors[2]	
		Draft Performance Standard[3]	Draft Performance Objective[4]
2.4.3 Restore Oak Savanna	50 years following initial plantings of oak trees	*Extent restored:* • 36 acres[5] *% oak tree canopy cover:* • % tree canopy cover equal to or up to 10% greater than the percent canopy cover in oak savanna stands removed by covered activities	*Extent restored:* • 36 acres[5] *% oak tree canopy cover:* • % tree canopy cover equal to or up to 10% greater than the percent canopy cover in oak savanna stands removed by covered activities
	20 years following initial plantings of oak trees	*Understory native plant cover:* • Develop an understory with native plant cover within 20% of existing conditions *Understory native plant diversity:* • Develop an understory with native plant diversity at least 50% of existing conditions	*Understory native plant cover:* • Develop an understory with native plant cover equal to or greater than that of existing conditions *Understory native plant diversity:* • Develop an understory with native plant diversity equal to or greater than existing conditions
2.6.1 Stream and Riparian Woodland/Scrub Enhancement Program	10 years following initial treatments	*Relative native tree canopy cover:* • Increase the existing relative native tree canopy cover by at least 10% *Relative native shrub canopy cover:* • Increase the existing relative native shrub canopy cover by at least 10%	*Relative native tree canopy cover:* • Increase the existing relative native tree canopy cover by at least 20% *Relative native shrub canopy cover:* • Increase the existing relative native shrub canopy cover by at least 15%

Table 7-2. Continued

Conservation Measure	Performance Period[1]	Draft Performance Indictors[2]	
		Draft Performance Standard[3]	Draft Performance Objective[4]
2.6.2 Stream and Riparian Woodland/Scrub Restoration Program	10 years following restoration planting	*Extent restored:* 1 acre[5] *Relative native tree canopy cover:* • Establish a relative native tree canopy cover by of at least 50% *Relative native shrub canopy cover:* • Establish a relative native shrub canopy cover of at least 25%	*Extent restored:* 1 acre[5] *Relative native tree canopy cover:* • Establish a relative native tree canopy cover by of at least 75% *Relative native shrub canopy cover:* • Establish a relative native shrub canopy cover of at least 35%
3.9.2 Compensate for Impacts on Giant Garter Snake Habitat: created habitat[7,8]	To be established by USFWS[7]	To be developed in coordination with USFWS[7]	Not applicable.
3.13.3 Compensate for Impacts on Covered Shrimp Habitat: seasonal wetland or vernal pool creation[8]	5 years following completion of seasonal wetland or vernal pool construction	*Extent created:* • 2 acres of created seasonal wetland for every affected acre of same *Hydrology:* • Maintain pooled surface water in normal rainfall years[6] similar in duration to reference sites within preserves	*Extent created:* • 2 acres of created seasonal wetland for every affected acre of same *Hydrology:* • Maintain pooled surface water in normal rainfall years[6] similar in duration to reference sites within preserves *Native plants:* • Self-sustaining populations of native vernal pool plants are maintained *Shrimp:* • Self-sustaining populations of covered shrimp affected by covered activities are maintained

Conservation Measure	Performance Period[1]	Draft Performance Indictors[2]	
		Draft Performance Standard[3]	Draft Performance Objective[4]

Notes:

1 The estimated period following enhancement/creation/restoration of a natural community at a site during which performance standards should be achieved.

2 Performance indicators are shown in italics.

3 The performance standard is the minimum measured value for each performance indicator that must be achieved during the performance period. Failure to achieve a performance standard could constitute a changed circumstance and require the need to implement remedial measures.

4 The performance objective represents the optimal desired value for each performance indicator and the design and management objectives for enhanced/created/restored natural communities. If performance objectives are not achieved, adaptive management actions may be triggered.

5 Acres restored are estimates based on the preliminary draft initial permit area and application of required restoration ratios in Table 5-20a. Actual restoration performance standard/target may vary depending on actual field-verified impacts. See applicable conservation measure for more details.

6 Normal rainfall years are defined as within 1 standard deviation of the annual average rainfall as measured at the California Irrigation Management Information System (CIMIS) Brentwood rain gauge over the hydrologic record of the gauge (October-September). Dry years are defined as less than 1 standard deviation from the annual mean.

7 These performance periods, standards, and objectives only apply if habitat is created under the HCP/NCCP to compensate for impacts on habitat with implementation of covered activities. Compensation may also be provided through purchase of mitigation credits from a USFWS approved mitigation bank.

8 It is anticipated that performance standards for created habitat will be developed in coordination with USFWS and will be based on the type and condition of habitat that is affected by covered activities.

Table ~~6-37-~~3. Potential Experimental Pilot Projects

Conservation Measure	Potential Experimental Pilot Project
Natural Community-Level Measures	
2.2.1 Wetland and Pond Enhancement and Management Program **2.4.2** Maintain and Enhance Oak Woodland and Oak Savanna Vegetation **2.6.1** Stream and Riparian Woodland/Scrub Enhancement Program	• test potential enhancement techniques through small-scale, targeted projects to identify and refine the methods for enhancing natural communities as habitat for covered species.
2.2.2 Wetland Restoration and Pond Creation Program **2.4.3** Restore Oak Savanna **2.6.2** Stream and Riparian Woodland/Scrub Restoration Program	• design restoration projects experimentally to test different creation/restoration techniques. • identify the best methods for recruiting or enhancing populations of covered species habitats for incorporation into restored habitat and use this information to influence future project design. • test alternative methods of oak plantings, irrigation, and herbivory protection to maximize sapling survival.
2.3.1 Enhance Native Grassland Alliances	• determine how grassland alliances within the preserve system are likely to respond to different burning and grazing management treatments that have been demonstrated to benefit native grassland alliances • if grassland alliances respond positively to such treatments, determine criteria for wider application of such treatments within the preserve system.
2.3.2 Enhance Prey Base and Natural Burrow Availability in Grasslands	• assess the response of ground squirrel abundance to cessation of existing ground-squirrel control efforts on preserve lands • if ground squirrel abundance does not increase with implementation of this measure, identify, test, and monitor ground-squirrel response to other population-management techniques.
2.5.1 Maintain or Improve Quality of Chaparral/Scrub Habitat	• implement experimental prescribed burns and monitor vegetation and species response to determine the appropriate timing and conditions under which to employ prescribed burns elsewhere on preserve lands.

Conservation Measure	Potential Experimental Pilot Project
Species-Level Measures	
3.5.4 Create Artificial Burrows in Grasslands	• determine the most effective artificial-burrow designs and placement strategies for attracting burrowing owls and ensuring reproductive success of owls that use artificial burrows.
3.5.5 Establish Artificial Perches	• determine the effectiveness of artificial perch sites in attracting use by burrowing owls and the most effective perch designs and placement strategies (e.g., height above ground level, location relative to available burrows).
3.17.1 Plant Salvage when Impacts are Unavoidable	• develop methods for salvaging and propagating covered-plant species from impact sites. • develop methods for reestablishing salvaged plants at new locations to establish new populations.
3.17.2 Conduct Experimental Management to Enhance Covered Plant Populations	• develop techniques for each of the covered-plant species to enhance populations within the preserve system. • develop the most cost-effective means of monitoring covered plants over the long term that yields results relevant to population dynamics.