FINAL ENVIRONMENTAL ASSESSMENT (09-149)

LONG-TERM CONTRACT FOR THE EXCHANGE OF WATER BETWEEN THE BUREAU OF RECLAMATION AND BYRON-BETHANY IRRIGATION DISTRICT – DELTA DIVISION AND SAN LUIS UNIT

Appendix H
U.S. Fish and Wildlife Service Biological Opinion

December 2013

United States Department of the Interior

FISH AND WILDLIFE SERVICE
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2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In Reply Refer To:
08ESMF00-2012-F-0159-2

DEC 0 9 2013

Memorandum

To: Mr. David E. Hyatt, Supervisory Biologist, South-Central California Area Office, Mid-Pacific Region, Bureau of Reclamation, Fresno, California

From: Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Biological Opinion for the Byron-Bethany Irrigation District's (BBID) Long Term Water Exchange Contract, Alameda County, California (EA- 09-149)

This memorandum is in response to the Bureau of Reclamation's (Reclamation) March 28, 2013 request to continue formal consultation with the U.S. Fish and Wildlife Service (Service) on Byron-Bethany Irrigation District's (BBID) Long Term Water Exchange Contract, Alameda County, California. Your letter was received in our office on April 2, 2013. This document represents the Service's biological opinion on the effects of the construction and maintenance of the pump station and pipeline for the Long Term Water Exchange Contract on the threatened California red-legged frog (*Rana draytonii*) and its critical habitat, Central California Distinct Population Segment (DPS) of the California tiger salamander (*Ambystoma californiense*) (Central California tiger salamander), and endangered San Joaquin kit fox (*Vulpes macrotis mutica*). This document is issued pursuant to section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

Reclamation's proposed action, as stated in the 2013 Supplemental Biological Assessment, is the execution of a 40-year Water Exchange Contract and a long-term license with BBID. Reclamation has limited their proposed action to the conveyance of non-project water for BBID and the effects associated with the construction of the pipeline. Reclamation has not requested consultation on effects of BBID's subsequent water movement or use, including the future Tracy Hills Development. Therefore, this biological opinion only addresses the effects of the construction and maintenance of the pump station and pipeline. This consultation does not exempt BBID, the City of Tracy, and/or private parties from the prohibitions of section 9 of the Act for incidental take that may result from the use or application of this conveyed water.

The following sources of information were used to develop this biological opinion: (1) the March 2013 Supplemental Biological Assessment; (2) correspondence between the Service, Reclamation, BBID and their consultants; and (3) other information available to the Service.

Consultation History

December 2010: Reclamation and the Service exchanged emails regarding preliminary information on listed species effects and the East Alameda County Conservation Strategy.

January 4, 2012: The Service received a consultation request and biological assessment from Reclamation for the *Byron-Bethany Irrigation District Long-term Water Exchange Contract with the Bureau of Reclamation for the Tracy Hills Water Supply Project (EA-09-149).*

January 2012: The Service and Reclamation exchanged emails regarding the Tracy Hills development and the potential for vernal pool fairy shrimp (*Branchinecta lynchi*) to occur within the facilities construction area.

May 31, 2012: The Service called Reclamation to discuss the interrelated and interdependent effects of the water contract resulting in the construction of the Tracy Hills development.

October 15, 2012: The Service received a memorandum from Reclamation stating alternative water from existing City of Tracy water supplies would be used to meet the needs of the Tracy Hills development and that Reclamation action is limited to conveyance of water for BBID and affects associated with conveyance facilities construction. Based on this information, Reclamation requested conclusion to the consultation and a draft biological opinion.

November 13, 2012: The Service discussed BBID's intent to purchase species credits at a conservation bank prior to the issuance of a biological opinion with BBID's attorney.

November 14, 2012: The Service and Reclamation exchanged emails regarding the East Alameda County Conservation Strategy and clarifications in the biological assessment.

February 2013: The Service received Reclamation's emailed responses to the Service's November 2012 email.

March 13, 2013: The Service, Reclamation, and BBID participated in a conference call regarding outstanding issues.

March 2013: The Service and Reclamation exchanged emails and discussed project footprint and conservation ratios using the East Alameda County Conservation Strategy.

April 2, 2013: The Service received the *Supplemental Biological Assessment for the Long-Term Contract for the Exchange of Water between the Bureau of Reclamation and Byron-Bethany Irrigation District* and request to continue formal consultation.

May 2013:	The Service, Reclamation, BBID, and CH2MHILL discussed the project and conservation bank credits sales.
June 2013:	The Service, Reclamation, BBID, and CH2MHILL discussed the project and timing of the issuance of the draft biological opinion.
July 30, 2013	The Service issues a draft biological opinion on the proposed project
August 29, 2013	The Service receives comments back from Reclamation on the draft biological opinion

BIOLOGICAL OPINION

Description of the Action

Background

BBID provides water to Alameda, Contra Costa, and San Joaquin Counties. BBID has two water service areas: a Central Valley Project (CVP) water service area (approximately 5,800 acres) and the Byron Service Area (approximately 16,300 acres) which is served by non-CVP water (Figure 1). The Byron Service Area is southwest of the City of Tracy, and includes an approximately 6,000-acre area within BBID's Raw Water Service Area 2 also known as the Tracy Hills Development Raw Water Service Area #2 (Figure 2). Although primarily an agricultural district, portions of BBID are within the sphere of influence of the City of Tracy. Urban development has resulted in increased conversion of lands currently in agriculture to municipal and industrial (M&I) uses. Since the 1990's, approximately 6,000 acres of land have been converted to M&I use (Tracy Hills Specific Plan EIR 1997 as cited in the biological assessment). Under agreements with the City of Tracy, the District provides raw water for treatment and final delivery back to M&I customers located within BBID's boundaries.

Proposed Action

Reclamation's Final Environmental Impact Report looked at 14 different water supply options to meet the M&I needs of the Tracy Hills Development. In addition, BBID's proposed long-term Operational Water Exchange Contract with Reclamation is in addition to the 14 sources analyzed in the Final EIR. The City also has multiple sources of water that could meet Tracy Hills need. Water supply for the Tracy Hills development could be developed without this proposed project. Alternative supplies from existing City of Tracy supplies would be available for use within the Tracy Hills Development on a temporary basis should the introduction of BBID's non-CVP water and/or the exchanged water be subject to excess capacity or operational constraints.

Reclamation's proposed action is the execution of a 40-year Water Exchange Contract and a long-term license with BBID. The license would allow BBID to access Federal land to install an underground pipeline to the Delta-Mendota Canal (DMC) at milepost (MP) 3.32R, as well as maintain and operate the structure on Reclamation's right-of-way. BBID would construct facilities required to supply up to 4,500 acre-feet per year of non-CVP water to Reclamation, when space is available in the DMC. The water would be delivered over a 4- to 8-month period during the historical irrigation season. Delivered water would be used by Reclamation to meet CVP downstream demands and in exchange, a like amount of CVP water would be delivered over a 12-month period to the City of Tracy's existing turnout at MP 15.88L for treatment at their Water Treatment Plant. The Water Exchange Contract also allows for non-CVP water introduced into the DMC to be directly delivered to the City of Tracy via the DMC when BBID's non-CVP water could not be used by Reclamation for other DMC demands.

Facilities for the Exchange

No construction or modifications to the DMC are required for the water contract; however, improvements to existing BBID facilities and a new underground pipeline would be required for delivery of the non-CVP water to the DMC. Specific construction activities would include the following:

Pump Station

Proposed Pump Station 3 improvements include a new pump, motor, and associated facilities. The current Pump Station 3 site would need to be modified to improve access by installing a retaining wall and a perimeter fence. The existing 16-cubic-foot-per-second (cfs) pump and motor would be replaced with a larger 20-cfs pump and approximately 500-horsepower motor to accommodate increased pumping requirements. A new precast building would replace, in the same location, the existing motor control center equipment. A new reinforced concrete pad and larger transformer would replace the existing pole-mounted transformers and would be located directly below the existing transformers. Upon completion of construction activities, the temporarily disturbed areas will be re-contoured to pre-disturbance conditions and hydro seeded with a compatible seed mix for final stabilization.

Pipeline

The proposed 30-inch-diameter pipeline would be approximately 0.4 mile long. A geotechnical investigation would be performed prior to construction. The investigation would consist of excavating, by backhoe, up to three test pits equally spaced along the pipeline route at a depth of 6 to 7 feet, and an area of 6 by 10 feet at the ground surface. The pits would be backfilled after soil samples were obtained.

The proposed pipeline would be aligned and buried in a general southern direction directly between Pump Station 3 and the DMC. A turnout would be provided to deliver water at the intersection with Canal 155 to supplement the existing Canal 155 pump (11-cfs) as needed.

The proposed pipeline would transition from belowground to aboveground at the DMC and discharge near the head wall of the DMC. A concrete pad would be poured where the pipe leaves the ground. Pipe support would be installed to support the aboveground pipe as well. The discharge would consist of a 45 degree elbow angled toward the DMC and located approximately three feet above the high-water level of the DMC to prevent siphoning.

An underground corrugated pipe currently connects Canal 155 to an existing stock pond located west of Canal 155. Water leaves Canal 155 through a manmade feature that supplies a short surface flow of water before it goes back into the underground corrugated pipe and resurfaces to continue surface flow into a stock pond. The underground pipe would be temporarily removed during construction and replaced above the proposed pipeline after its installation. Water would be rerouted over the trench to the stock pond during construction. After construction, the entire length of the corrugated pipeline would be restored to its existing condition.

Installation of the pipeline would require a temporary 60 foot-wide disturbance area to accommodate the actual pipe trench, construction equipment, excavated materials, pipe laydown, and access. Access along the pipeline corridor would be provided within the proposed 60-foot temporary work space required to install the pipeline. There is little vegetation that would require clearing. The use of pesticides is not anticipated. Prior to excavation of the trench, topsoil (if evident) would be removed and stockpiled and then later returned to the trench surface. Upon completion of construction activities, the excavated soil would be used as backfill (if it fulfills engineering and construction standards) with the stockpiled topsoil placed as the final layer to encourage revegetation. The area would be re-contoured and compacted to pre-disturbance conditions and hydroseeded for final stabilization.

The need for dewatering the newly excavated trenches along the pipeline route or near the DMC is not anticipated; however, if needed, trenches would be dewatered using portable sump pumps in accordance with the Storm water Pollution Prevention Plan (SWPPP).

Laydown and Stockpiling Area

An approximately 2-acre temporary laydown and stockpiling area would also be required adjacent to and west of Pump Station 3. The laydown area would be used to temporarily store contractor equipment, spoils, and other materials, including pipe. The laydown area would require minimal grading and would be stabilized with the temporary placement of clean gravel/rock (no fines). Upon completion of construction activities, the gravel would be removed and either incorporated into the project site or transported offsite. The area would be re-contoured to pre-disturbance conditions and hydroseeded with a compatible seed mix for final stabilization.

Access

Access to the project site would be via a pre-existing gravel road connecting Kelso Road to the pumping plant and proposed laydown area. Approximately 250 yards of the existing access road directly north of Pump Station 3 would be permanently stabilized with a 30-foot-wide by 4-inch-thick layer of compacted aggregate base to allow for everyday construction traffic. The existing road footprint will not be enlarged.

Construction Timing

Staging the site would take approximately one month, which would include stabilizing the access road, clearing and grubbing the pipeline corridor, and demolishing the pump station facilities needing replacement. Work would begin concurrently on the pipeline installation and Pump Station 3 improvements.

Construction is anticipated to take approximately 8 to 12 months and is scheduled to be initiated in 2013. Pipeline installation is anticipated to take approximately 3 months, and work associated with the pump 3 station improvements would likely take 6 to 7 months. Ground disturbing construction will be limited to April 1 through October 31.

Equipment

Onsite construction equipment would include one excavator, one loader, one dump truck, one compactor, and one small crane. The approximate volume of earthwork required would be about 600 cubic yards of total cut, which would be spread out along the pipeline corridor upon completion. It is anticipated that no borrow material (from onsite sources) would be needed, but import material from a commercial source might be required for fill around the pipeline.

Operation and Maintenance

Operation and maintenance of the proposed pipeline by BBID is expected to be limited to repairing leaks, if any, and if needed, obtaining corrosion test readings annually to monitor pipeline resistance to corrosion. Existing roads (dirt and gravel) would be used for access when needed.

<u>Conservation Measures</u>

The staff of BBID and/or its subcontractors will implement the following Conservation Measures to reduce effects to listed species associated with the action area. The project will incorporate some of the East Alameda County Conservation Strategy standard and subsequent Service issued programmatic biological opinion minimization and conservation measures. Project activities would not begin until the project proponent has received written approval by a Reclamation biologist.

1. At least 15 days prior to any ground disturbing activities, the applicant will submit to the Service, for review, the qualifications of the proposed biological monitor(s). Upon Service approval, the biologist(s) will be given the authority to stop any work that may result in the take of listed species. If the on-site biologist(s) exercises this authority, the Service and Reclamation will be notified by telephone and electronic mail within one (1) working day. The on-site biologist will be the contact for any employee or contractor who might inadvertently kill or injure a California red-legged frog, Central California tiger salamander, or San Joaquin kit fox, or anyone who finds a dead, injured, or entrapped individual of these species. The on-site biologist will possess a working cellular telephone whose number will be provided to the Service. Should take occur of a California red-legged frog, Central California tiger salamander, or San Joaquin kit fox individual, the Service-approved biologist will contact Reclamation, Service, and California Department of Fish and Wildlife (CDFW) within 24 hours of the discovered occurrence.

2. Preconstruction surveys for the California red-legged frog, Central California tiger salamander, and the San Joaquin kit fox will be performed immediately prior to groundbreaking activities. Service-approved biologists will conduct surveys and results provided to Reclamation for review. If, at any point, activities associated with the project cease for more than 15 consecutive days, additional preconstruction surveys will be conducted prior to the resumption of these actions.

3. Preconstruction surveys for San Joaquin kit fox dens will be conducted within a minimum of 200 feet of the project area. Results would be provided to Reclamation for review. Any natal dens encountered will be avoided, in consultation with the Service, by

a minimum of 100 feet for known dens and a minimum of 50 feet for potential dens. Non-natal dens will be monitored for a minimum of three days to determine their current use. If no San Joaquin kit fox activity is observed during this period, the den will be destroyed to prevent future use by San Joaquin kit fox. If San Joaquin kit fox activity is observed at the den during this period, the den will be monitored for at least five (5) consecutive days from the time of the observation to allow any resident animal to move to another den during its normal activity. Use of the den will be discouraged during this period by partially plugging its entrance(s) with soil in such a manner that any resident animal can escape easily. Only when the den is determined to be unoccupied will it be excavated under the direction of the biologist. If the animal is still present after 5 or more consecutive days of plugging and monitoring, the den will be excavated when, as determined by the biologist, it is temporarily vacant (for example, during the San Joaquin kit fox 's normal foraging activity). Potential dens will be temporarily marked for avoidance by a minimum of 50 feet and further studied by the qualified biologist. Destruction of potential dens will occur only after the biologist determines that no San Joaquin kit fox are inside. To determine the presence of San Joaquin kit fox, the potential den will be fully excavated to the end by either hand or machinery. Once determined empty, the den will be filled with dirt and compacted to ensure that San Joaquin kit fox cannot enter or use the den during the construction period. If any potential den is determined to be currently or previously used by San Joaquin kit foxes, the measures described above for natal and non-natal dens (as applicable) will be followed.

4. The approved biologist will monitor any California red-legged frogs or Central California tiger salamanders observed during preconstruction surveys and submit a report to Reclamation for review. Any California red-legged frogs or Central California tiger salamanders would be allowed to passively leave the site or, if determined necessary by the Service-approved biologist, removed from the work area(s) and relocated to an appropriate location.

5. Prior to the start of groundbreaking activities, all construction personnel will receive worker education training on listed species and their habitats by a Service-approved biologist or a video recording of this biologist. The importance of these species and their habitat will be described to all employees as well as the minimization and avoidance measures that are to be implemented as part of the project. An educational brochure containing color photographs of all listed species in the work area(s) will be distributed to all employees working within the project site(s). Workers will also be informed of appropriate measures to take should a toxic materials spill occur. A list of employees who attend the training sessions will be maintained by the applicant to be made available for review by the Service and the CDFW upon request. Contractor training will be incorporated into construction contracts and will be a component of weekly project meetings.

6. Wildlife exclusion fencing will be established around the perimeter of the 0.8-acre pump facility, 2-acre laydown area, 0.5-acre access road, and 3.73-acre pipeline corridor. All fencing will be, at minimum, buried six (6) inches into the ground and extend 36 inches above ground level to discourage listed animals from entering the site. Exclusion fencing will remain around the specified work areas for the duration of ground disturbing activities.

7. The monitoring biologist will be onsite at all times during initial ground-breaking activities until wildlife exclusion fencing is installed around the pump facility, access road, laydown area, and pipeline corridor. Upon completion of these activities, the monitoring biologist will inspect all wildlife and wetland exclusion fencing as well as construction zone fencing or flagging associated with the specified areas each week, at minimum, for the duration of construction to ensure fencing integrity. The Service-approved monitor will also survey wildlife exclusion and construction perimeter fencing on a daily basis to look for tears and to ensure no California red-legged frogs or Central California tiger salamanders have become trapped along the fence line. The applicant will maintain and/or replace these barriers immediately if necessary.

8. All work areas and designated temporary travel corridors will be clearly delineated via flagging, signage, or other similar methods to minimize construction disturbances beyond the work area. Vehicles will only enter temporary travel corridors when dry soil conditions exist to avoid the creation of tire ruts or other impacts to the ground surface.

9. If measure 8 is not feasible and the BBID needs to access the work area during the winter months, then the BBID would implement stabilization measures (i.e. construction mats) to prevent rutting in the temporary travel corridors.

10. The Service-approved biological monitor and construction manager will be notified immediately if a California red-legged frog, Central California tiger salamander, or San Joaquin kit fox are observed anywhere within the property. If the observed animal is a California red-legged frog or Central California tiger salamander, the Service-approved biologist will monitor these animals and determine if they are in danger of take from construction activities, predators, or entrapment. If they are, all construction in the immediate area will cease until the animal is allowed to passively leave the site. If this is not possible, the Service-approved biological monitor will remove the California red-legged frog or Central California tiger salamander from the property in a cool, moist container and relocate these individuals to an appropriate location. Upon release of these animals, the Service-approved biologist will monitor the individual until it is determined that it is in no imminent danger. If a San Joaquin kit fox is observed on the site, construction activities that will directly affect the individual will cease until the animal passively leaves the site. Field survey forms will be completed for all California red-legged frog, Central California tiger salamander, or San Joaquin kit fox observations. These forms will be submitted to Reclamation and to the California Natural Diversity Data Base (CNDDB) prior to completion of construction activities.

11. To the maximum extent practicable, fossorial mammal burrows that may provide refugia habitat for California red-legged frogs and Central California tiger salamanders will be avoided during the construction and long-term operation of the pipeline. Exclusion fence and/or plywood will be placed around areas with high concentrations of burrows during the course of construction activities to avoid the destruction of these features.

12. All potentially occupied small mammal burrows and other refugia suitable for Central California tiger salamander habitat (e.g., underground holes, cracks, or niches) within fenced construction areas will be excavated in order to salvage and relocate Central California tiger salamanders that would otherwise be harmed. A mini-excavator and hand tools will be used to excavate these burrows, under the supervision of a Service-

approved biologist.

13. Topsoil removed from the temporary laydown area, access road, pump facility, and pipeline trenching locations will be stockpiled and reserved for the duration of construction activities. Upon completion of these actions, temporarily disturbed areas will be graded and restored with reserved topsoil to facilitate the re-establishment of fossoral mammal populations and upland listed species habitats. Any surplus topsoil will be hauled off site and disposed of at an appropriate facility.

14. Potential effects to water quality from contaminated runoff-or airborne dust will be avoided by the implementation of standard erosion and/or sedimentation control devices, fugitive dust management, avoidance, and other best management practices (BMPs) prescribed by BBID's approved SWPPP and Fugitive Dust Mitigation Plan. As-needed dust control measures (e.g., wetting dry ground) will minimize airborne transmission of soil particles into aquatic habitats. Equipment fueling, maintenance, and repairs as well as storage of hazardous materials such as fuels and lubricants will be limited to areas 250 feet or greater from any wetlands or drainage areas. Other hazardous material BMPs, including but not limited to secondary containment and not topping off fuel tanks will be enforced to prevent soil contamination. Prior to the start of construction activities, an emergency spill plan will be developed as part of SWPPP requirements and will be readily available to all employees throughout the duration of work activities. This plan will include appropriate prevention and cleanup measures for both upland and aquatic areas.

15. Plastic monofilament netting or similar material will not be used for erosion control matting at the project site to avoid the entanglement or entrapment of California red-legged frog or Central California tiger salamander individuals.

16. To prevent the accidental entrapment of listed species during construction, all excavated holes or trenches deeper than six inches will be covered at the end of each workday with plywood or similar materials. Foundation trenches or larger excavations that cannot easily be covered will be ramped at the end of the workday to allow trapped animals an escape method. Prior to the filling of such holes, these areas will be thoroughly inspected for listed species by Service-approved biologists. In the event of a trapped animal is observed, construction will cease until the individual has been relocated to an appropriate location and Reclamation notified.

17. All construction pipes, culverts, or similar structures greater than four inches in diameter that are stored at the laydown area overnight will be securely capped before storage or will be thoroughly inspected for San Joaquin kit foxes and other sensitive species prior to pipe installation or capping to avoid entrapment or injury of this animal. If a San Joaquin kit fox or other sensitive species is discovered inside a pipe, that section of pipe will not be moved until Reclamation, the Service, and CDFW have been contacted by the Service-approved biologist to determine the appropriate course of action.

18. No discharge of pollutants from vehicle and equipment cleaning, maintenance, or repair will be allowed into storm drains, wetlands, or watercourses. No discharge of sediment-laden water from project-related activities will be allowed into storm drains, wetlands, or watercourses.

19. All trash and debris within the work area will be placed in containers with secure lids before the end of each work day in order reduce the likelihood of predators being attracted to the site by discarded food wrappers and other rubbish that may be left on-site. Containers will be emptied as necessary to prevent trash overflow onto the site and all rubbish will be disposed of at an appropriate off-site location.

20. To the maximum extent practicable, construction will only occur between 7 a.m. and 7 p.m. to limit the need for night lighting, which could attract California red-legged frogs and Central California tiger salamander into the construction area and/or provide additional light for nighttime predators, increasing mortality of these animals.

21. All vehicles entering the work area(s) will be confined to existing roads or approved temporary routes. Speed limits within the work area(s) will be limited to 15 miles per hour. Trash dumping, firearms, and pets will be prohibited in the project area(s).

22. Upon completion of construction activities, all debris and materials associated with construction will be removed and areas not needed for the long-term operation of the site will be recontoured to match adjoining grades. Post construction BMPs (as prescribed in the SWPPP) will be implemented, including reseeding all areas as necessary to facilitate timely vegetative restoration.

23. To minimize the effects of temporal and permanent habitat loss, BBID will purchase 8.49 acres of credits at the Mountain House Conservation Bank. The calculations of the credits are based on the ratios provided in the East Alameda County Conservation Strategy and the East Alameda County Conservation Strategy programmatic biological opinion.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of the effects assessment, the action area contains the 7.03-acre footprint including the limits of construction for the pump station, pipeline, and access and staging areas. Also included is the adjacent stock pond, areas that are hyrdologically connected to the stock pond and surrounding areas where the existing corrugated water supply pipe would be removed, rerouted, and then replaced. Water conveyance facilities and water usage outside of this construction footprint are not considered in this analysis.

Analytical Framework for the Jeopardy Determination

<u>Jeopardy Determination</u>

In accordance with policy and regulation, the jeopardy analysis in this biological opinion relies on four components: (1) the *Status of the Species*, which evaluates the California red-legged frog, Central California tiger salamander, and San Joaquin kit fox's range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of these listed animals; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the California red-legged frog, Central California tiger salamander, and San Joaquin kit fox; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on these species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the California red-legged frog, Central California tiger salamander, and San Joaquin kit fox's current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of these species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on consideration of the range-wide survival and recovery needs of the California red-legged frog, Central California tiger salamander, and San Joaquin kit fox and the role of the action area in their survival and recovery as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the *Status of Critical Habitat*, which evaluates the range wide condition of proposed critical habitat for the California red-legged frog in terms of Primary Constituent Elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat at the provincial and range-wide scale; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units and; (4) *Cumulative Effects* which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on the California red-legged frog critical habitat are evaluated in the context of the range-wide condition of the critical habitat at the provincial and range-wide scales, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the California red-legged frog.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of California red-legged frog critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species

California Red-Legged Frog

Listing Status: The California red-legged frog was listed as a threatened species on May 23, 1996 (61 FR 25813) (Service 1996). Critical habitat was designated for this species on April 13, 2006 (71 FR 19244) (Service 2006) and revisions to the critical habitat designation were published on March 17, 2010 (75 FR 12816) (Service 2010a). At this time, the Service recognized the taxonomic change from *Rana aurora draytonii* to *Rana draytonii* (Shaffer *et al.* 2010). A recovery plan was published for the California red-legged frog on September 12, 2002 (Service 2002).

Description: The California red-legged frog is the largest native frog in the western United States (Wright and Wright 1949), ranging from 1.5 to 5.1 inches in length (Stebbins 2003). The abdomen and hind legs of adults are largely red, while the back is characterized by small black flecks and larger irregular dark blotches with indistinct outlines on a brown, gray, olive, or reddish background color. Dorsal spots usually have light centers (Stebbins 2003), and dorsolateral folds are prominent on the back. Larvae (tadpoles) range from 0.6 to 3.1 inches in length, and the background color of the body is dark brown and yellow with darker spots (Storer 1925).

Distribution: The historic range of the California red-legged frog extended from the vicinity of Elk Creek in Mendocino County, California, along the coast inland to the vicinity of Redding in Shasta County, California, and southward to northwestern Baja California, Mexico (Fellers 2005; Jennings and Hayes 1985; Hayes and Krempels 1986). The species was historically documented in 46 counties but the taxa now remains in 238 streams or drainages within 23 counties, representing a loss of 70 percent of its former range (Service 2002). California red-legged frogs are still locally abundant within portions of the San Francisco Bay area and the Central California Coast. Isolated populations have been documented in the Sierra Nevada, northern Coast, and northern Transverse Ranges. The species is believed to be extirpated from the southern Transverse and Peninsular ranges, but is still present in Baja California, Mexico (CDFW 2013).

Status and Natural History: California red-legged frogs predominately inhabit permanent water sources such as streams, lakes, marshes, natural and manmade ponds, and ephemeral drainages in valley bottoms and foothills up to 4,921 feet in elevation (Jennings and Hayes 1994, Bulger *et al.* 2003, Stebbins 2003). However, they also inhabit ephemeral creeks, drainages and ponds with minimal riparian and emergent vegetation. California red-legged frogs breed from November to April, although earlier breeding records have been reported in southern localities. Breeding generally occurs in still or slow-moving water often associated with emergent vegetation, such as cattails, tules or overhanging willows (Storer 1925, Hayes and Jennings 1988). Female frogs deposit egg masses on emergent vegetation so that the egg mass floats on or near the surface of the water (Hayes and Miyamoto 1984).

Habitat includes nearly any area within 1-2 miles of a breeding site that stays moist and cool through the summer including vegetated areas with coyote brush, California blackberry thickets, and root masses associated with willow and California bay trees (Fellers 2005). Sheltering habitat for California red-legged frogs potentially includes all aquatic, riparian, and upland areas within the range of the species and includes any landscape feature that provides cover, such as animal burrows, boulders or rocks, organic debris such as downed trees or logs, and industrial debris. Agricultural features such as drains, watering troughs, spring boxes, abandoned sheds, or hay stacks may also be used. Incised stream channels with portions narrower and depths greater than 18 inches also may provide important summer sheltering habitat. Accessibility to sheltering habitat is essential for the survival of California red-legged frogs within a watershed, and can be a factor limiting frog population numbers and survival.

California red-legged frogs do not have a distinct breeding migration (Fellers 2005). Adults are often associated with permanent bodies of water. Some individuals remain at breeding sites year-round, while others disperse to neighboring water features. Dispersal distances are typically less than 0.5-mile, with a few individuals moving up to 1-2 miles (Fellers 2005). Movements are typically along riparian corridors, but some individuals, especially on rainy nights, move directly from one site to another through normally inhospitable habitats, such as heavily grazed pastures or oak-grassland savannas (Fellers 2005).

In a study of California red-legged frog terrestrial activity in a mesic area of the Santa Cruz Mountains, Bulger *et al.* (2003) categorized terrestrial use as migratory and non-migratory. The latter occurred from one to several days and was associated with precipitation events. Migratory movements were characterized as the movement between aquatic sites and were most often associated with breeding activities. Bulger *et al.* (2003) reported that non-migrating frogs typically stayed within 200 feet of aquatic habitat 90 percent of the time and were most often associated with dense vegetative cover, i.e., California blackberry, poison oak, and coyote brush. Dispersing frogs in northern Santa Cruz County traveled distances from 0.25-mile to more than 2 miles without apparent regard to topography, vegetation type, or riparian corridors (Bulger *et al.* 2003).

In a study of California red-legged frog terrestrial activity in eastern Contra Costa County, Tatarian (2008) noted that a 57 percent majority of frogs fitted with radio transmitters in the Round Valley study area stayed at their breeding pools, whereas 43 percent moved into adjacent upland habitat or to other aquatic sites. Her study reported a peak seasonal terrestrial movement occurring in the fall months associated with the first 0.2-inch of precipitation and tapering off into spring. Upland movement activities ranged from 3 to 233 feet, averaging 80 feet, and were associated with a variety of refugia, including grass thatch, crevices, cow hoof prints, ground squirrel burrows at the base of trees or rocks, logs, and under man-made structures; others were associated with upland sites lacking refugia (Tatarian 2008). The majority of terrestrial movements lasted from 1 to 4 days; however, one adult female was reported to remain in upland habitat for 50 days (Tatarian 2008). Upland refugia closer to aquatic sites were used more often and were more commonly associated with areas exhibiting higher object cover, e.g., woody debris, rocks, and vegetative cover. Subterranean cover was not significantly different between occupied upland habitat and non-occupied upland habitat.

California red-legged frogs are often prolific breeders, laying their eggs during or shortly after large rainfall events in late winter and early spring (Hayes and Miyamoto 1984). Egg masses containing 2,000 to 5,000 eggs are attached to vegetation below the surface and hatch after 6 to 14 days (Storer 1925, Jennings and Hayes 1994). In coastal lagoons, the most significant mortality factor in the pre-hatching stage is water salinity (Jennings *et al.* 1992). Eggs exposed to salinity levels greater than 4.5 parts per thousand resulted in 100 percent mortality (Jennings and Hayes 1990). Increased siltation during the breeding season can cause asphyxiation of eggs and small larvae. Larvae undergo metamorphosis 3.5 to 7 months following hatching and reach sexual maturity at 2 to 3 years of age (Storer 1925; Wright and Wright 1949; Jennings and Hayes 1985, 1990, 1994). Of the various life stages, larvae probably experience the highest mortality rates, with less than 1 percent of eggs laid reaching metamorphosis (Jennings *et al.* 1992). California red-legged frogs may live 8 to 10 years (Jennings *et al.* 1992). Populations can fluctuate from year to year; favorable conditions allow the species to have extremely high rates of reproduction and thus produce large numbers of dispersing young and a concomitant increase in the number of occupied sites. In contrast, the animal may temporarily disappear from an area when conditions are stressful (e.g., during periods of drought, disease, etc.).

The diet of California red-legged frogs is highly variable and changes with the life history stage. The diet of the larvae is not well studied, but is likely similar to that of other ranid frogs which feed on algae, diatoms, and detritus by grazing on the surface of rocks and vegetation (Fellers 2005; Kupferberg 1996a, 1996b, 1997). Hayes and Tennant (1985) analyzed the diets of California red-legged frogs from Cañada de la Gaviota in Santa Barbara County during the winter of 1981 and found invertebrates (comprising 42 taxa) to be the most common prey item consumed; however, they speculated that this was opportunistic and varied based on prey availability. They ascertained that larger frogs consumed larger prey and were recorded to have preyed on Pacific chorus frog, three-spined stickleback and, to a limited extent, California mice, which were abundant at the study site (Hayes and Tennant 1985, Fellers 2005). Although larger vertebrate prey was consumed less frequently, it represented over half of the prey mass eaten by larger frogs suggesting that such prey may play an energetically important role in their diets (Hayes and Tennant 1985). Juvenile and subadult/adult frogs varied in their feeding activity periods; juveniles fed for longer periods throughout the day and night, while subadult/adults fed nocturnally (Hayes and Tennant 1985). Juveniles were significantly less successful at capturing prey and all life history stages exhibited poor prey discrimination, feeding on several inanimate objects that moved through their field of view (Hayes and Tennant 1985).

Recovery Plan: The recovery plan for the California red-legged frog identifies eight recovery units (Service 2002). The establishment of these recovery units is based on the determination that various regional areas of the species' range are essential to its survival and recovery. These recovery units are delineated by major watershed boundaries as defined by U.S. Geological Survey hydrologic units and the limits of its range. The goal of the recovery plan is to protect the long-term viability of all extant populations within each recovery unit. Within each recovery unit, core areas have been delineated and represent contiguous areas of moderate to high California red-legged frog densities that are relatively free of exotic species such as bullfrogs. The goal of designating core areas is to protect metapopulations. Thus when combined with suitable dispersal habitat, it will allow for the long term viability within existing populations. The management strategy identified within the recovery plan will allow for the recolonization of habitats within and adjacent to core areas that are naturally subjected to periodic localized extinctions, thus assuring the long-term survival and recovery of California red-legged frogs.

Threats: Habitat loss, non-native species introduction, and urban encroachment are the primary factors that have adversely affected the California red-legged frog throughout its range. Several researchers in central California have noted the decline and eventual local disappearance of California and northern red-legged frogs in systems supporting bullfrogs (Jennings and Hayes 1990; Twedt 1993), red swamp crayfish, signal crayfish, and several species of warm water fish, including sunfish, goldfish, common carp, and mosquitofish (Moyle 1976; Barry 1992; Hunt 1993; Fisher and Schaffer 1996). This has been attributed to predation, competition, and reproduction interference. Twedt (1993) documented bullfrog predation of juvenile northern red-legged frogs, and suggested that bullfrogs could prey on subadult California red-legged frogs as well. Bullfrogs may also have a competitive advantage over California red-legged frogs. For instance, bullfrogs are larger and possess more generalized food habits (Bury and Whelan 1984). In addition, bullfrogs have an extended breeding season (Storer 1933) during which an individual female can produce as many as 20,000 eggs (Emlen 1977). Furthermore, bullfrog larvae are unpalatable to predatory fish (Kruse and Francis 1977). Bullfrogs also interfere with California red-legged frog reproduction. Both California and northern red-legged frogs have been observed in amplexus (mounted on) with both male and female bullfrogs (Jennings and Hayes 1990; Twedt 1993; Jennings 1993). Thus bullfrogs are able to prey upon and out-compete California red-legged frogs, especially in sub-optimal habitat.

The urbanization of land within and adjacent to California red-legged frog habitat has also affected the threatened amphibian. These declines are attributed to channelization of riparian areas, enclosure of the channels by urban development that blocks dispersal, and the introduction of predatory fishes and bullfrogs. Diseases may also pose a significant threat, although the specific effects of disease on the California red-legged frog are not known. Pathogens are suspected of causing global amphibian declines (Davidson *et al.* 2003). Chytridiomycosis and ranaviruses are a potential threat because these diseases have been found to adversely affect other amphibians, including the listed species (Davidson *et al.* 2003; Lips *et al.* 2006). Mao *et al.* (1999 cited in Fellers 2005) reported northern red-legged frogs infected with an iridovirus, which was also presented in sympatric threespine sticklebacks in northwestern California. Non-native species, such as bullfrogs and non-native tiger salamanders that live within the range of the California red-legged frog have been identified as potential carriers of these diseases (Garner *et al.* 2006). Humans can facilitate the spread of disease by encouraging the further introduction of non-native carriers and by acting as carriers themselves (i.e., contaminated boots, waders or fishing equipment). Human activities can also introduce stress by other means, such as habitat fragmentation, that results in the listed species being more susceptible to the effects of disease.

California Red-Legged Frog Critical Habitat

The Service designated critical habitat for the California red-legged frog on April 13, 2006 (Service 2006) and a revised designation to the critical habitat was published on March 17, 2010 (Service 2010a). At this time, the Service recognized the taxonomic change from *Rana aurora draytonii* to *Rana draytonii* (Shaffer *et al.* 2010). Critical habitat is defined in Section 3 of the Act as: (1) The specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (a) essential to the conservation of the species and (b) that may require special management considerations or protection and; (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR 424.12(b)). The Service is required to list the known Primary Constituent Elements (PCEs) together with the critical habitat description. Such physical and biological features include, but are not limited to, the following: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements;

(3) cover or shelter; (4) sites for breeding, reproduction, rearing of offspring, or dispersal and; (5) generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The PCEs defined for the California red-legged frog were derived from its biological needs. The area designated as revised critical habitat provides aquatic habitat for breeding and non-breeding activities and upland habitat for shelter, foraging, predator avoidance, and dispersal across its range. The PCEs and, therefore, the resulting physical and biological features essential for the conservation of the species were determined from studies of California red-legged frog ecology. Based on the above needs and our current knowledge of the life history, biology, and ecology of the species, and the habitat requirements for sustaining the essential life-history functions of the species, the Service determined that the PCEs essential to the conservation of the California red-legged frog are: (1) aquatic breeding habitat defined as standing bodies of fresh water (with salinities less than 7.0 parts per thousand), including: natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years; (2) non-breeding aquatic habitat defined as freshwater and wetted riparian habitats, as described above, that may not hold water long enough for the subspecies to hatch and complete its aquatic life cycle but that do provide for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult California red-legged frogs. Other wetland habitats that would be considered to meet these elements include, but are not limited to: plunge pools within intermittent creeks; seeps; quiet water refugia during high water flows; and springs of sufficient flow to withstand the summer dry period; (3) upland habitat defined as upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mile in most cases and comprised of various vegetational series such as grasslands, woodlands, wetland, or riparian plant species that provides the frog shelter, forage, and predator avoidance.

Upland features are also essential in that they are needed to maintain the hydrologic, geographic, topographic, ecological, and edaphic features that support and surround the wetland or riparian habitat. These upland features contribute to the filling and drying of the wetland or riparian habitat and are responsible for maintaining suitable periods of pool inundation for larval frogs and their food sources, and provide breeding, non-breeding, feeding, and sheltering habitat for juvenile and adult frogs (e.g., shelter, shade, moisture, cooler temperatures, a prey base, foraging opportunities, and areas for predator avoidance). Upland habitat should include structural features such as boulders, rocks and organic debris (e.g., downed trees, logs), as well as small mammal burrows and moist leaf litter and; (4) dispersal habitat defined as accessible upland or riparian dispersal habitat within designated units and between occupied locations within a minimum of 1 mile of each other and that allows for movement between such sites. Dispersal habitat includes various natural habitats and altered habitats such as agricultural fields, which do not contain barriers (e.g., heavily traveled road without bridges or culverts) to dispersal. Dispersal habitat does not include moderate- to high-density urban or industrial developments with large expanses of asphalt or concrete, nor does it include large reservoirs over 50 acres in size, or other areas that do not contain those features identified in PCEs 1, 2, or 3 as essential to the conservation of the subspecies.

With the revised designation of critical habitat, the Service intends to conserve the geographic areas containing the physical and biological features that are essential to the conservation of the species, through the identification of the appropriate quantity and spatial arrangement of the

PCEs sufficient to support the life-history functions of the species. Not all life-history functions require all the PCEs and not all areas designated as critical habitat will contain all the PCEs. Refer to the final designation of critical habitat for California red-legged frog for additional information.

Central California Tiger Salamander

Listing Status: On May 23, 2003, we proposed to list the Central California DPS of the tiger salamander as threatened. At that time, we also proposed reclassification of the Santa Barbara County DPS and Sonoma County DPS from endangered to threatened (Service 2003). In the same notice, we also proposed a special rule under section 4(d) of the Act to exempt take for routine ranching operations for the Central California DPS and, if reclassified to threatened, for the Santa Barbara and Sonoma County DPSs (Service 2003). On August 4, 2004, after determining that the listed Central California population of the California DPS of the Central California tiger salamander was threatened (Service 2004), we determined that the Santa Barbara and Sonoma County populations were threatened as well, and reclassified the Central California tiger salamander as threatened throughout its range (Service 2004), removing the Santa Barbara and Sonoma County populations as separately listed DPSs (Service 2004). In this notice, we also finalized the special rule to exempt take for routine ranching operations for the Central California tiger salamander throughout its range (Service 2004).

On August 18, 2005, as a result of litigation of the August 4, 2004, final rule on the reclassification of the California tiger salamander DPSs (*Center for Biological Diversity et al. v. United States Fish and Wildlife Service et al.*, C 04-04324 WHA (N.D. Cal. 2005), the District Court of Northern California sustained the portion of the 2004 rule pertaining to listing the Central California tiger salamander as threatened with a special rule, but vacated the portion of the 2004 rule that re-classified the Santa Barbara and Sonoma DPSs to threatened status thereby reinstating their status as endangered. On August 31, 2011, the List of Endangered and Threatened Wildlife in part 17, subchapter B of Chapter I, title 50 of the Code of Federal Regulations (CFR) was amended to reflect the vacatures contained in the 2005 court order, classifying the Santa Barbara DPS and the Sonoma DPS of the California tiger salamander as endangered, and the Central DPS of the California tiger salamander as threatened with a special rule to exempt routine ranching operations from take (Service 2011).

Species Description: The California tiger salamander is a large, stocky, terrestrial salamander with a broad, rounded snout. Recorded adult measurements have been as much as 8.2 inches long (Petranka 1998; Stebbins 2003). California tiger salamanders exhibit sexual dimorphism (differences in body appearance based on gender) with males tending to be larger than females. The coloration of the adults generally consists of random white or yellowish markings against a black body. The markings tend to be more concentrated on the lateral sides of the body; whereas other salamander species tend to have brighter yellow spotting that is heaviest on the dorsal surface.

Distribution: The California tiger salamander is endemic to California and historically inhabited the low-elevation grassland and oak savanna plant communities of the Central Valley, adjacent foothills, and Inner Coast Ranges (Jennings and Hayes 1994; Storer 1925; Shaffer *et al.* 1993). The species has been recorded from near sea level to approximately 3,900 feet in the Coast Ranges and to approximately 1,600 feet in the Sierra Nevada foothills (Shaffer and Trenham 2004). Along the Coast Ranges, the species occurred from the Santa Rosa area of

Sonoma County, south to the vicinity of Buellton in Santa Barbara County. The historic distribution in the Central Valley and surrounding foothills included northern Yolo County southward to northwestern Kern County and northern Tulare County.

The Central California tiger salamander occupies the Bay Area (central and southern Alameda, Santa Clara, western Stanislaus, western Merced, and the majority of San Benito counties), Central Valley (Yolo, Sacramento, Solano, eastern Contra Costa, northeastern Alameda, Calaveras, San Joaquin, Stanislaus, Merced, and northwestern Madera counties), southern San Joaquin Valley (portions of Madera, central Fresno, and northern Tulare and Kings Counties), and the Central Coast Range (southern Santa Cruz, Monterey, northern San Luis Obispo, and portions of western San Benito, Fresno, and Kern counties).

Life History: The California tiger salamander has an obligate biphasic life cycle (Shaffer *et al.* 2004). Although the larvae develop in the vernal pools and ponds in which they were born, the species is otherwise terrestrial and spend most of their post-metamorphic lives in widely dispersed underground retreats (Shaffer *et al.* 2004; Trenham *et al.* 2001). Because they spend most of their lives underground, the animals rarely are encountered even in areas where California tiger salamanders are abundant. Subadult and adult California tiger salamanders typically spend the dry summer and fall months in the burrows of small mammals, such as California ground squirrels and Botta's pocket gopher (Storer 1925; Loredo and Van Vuren 1996; Petranka 1998; Trenham 1998a). Although ground squirrels have been known to eat these amphibians, the relationship with their burrowing hosts is primarily commensal (an association that benefits one member while the other is not affected) (Loredo *et al.* 1996; Semonsen 1998).

California tiger salamanders may also use landscape features such as leaf litter or desiccation cracks in the soil for upland refugia. Burrows often harbor camel crickets and other invertebrates that provide likely prey for the amphibians. Underground refugia also provide protection from the sun and wind associated with the dry California climate that can cause excessive drying of amphibian skin. Although California tiger salamanders are members of a family of "burrowing" salamanders, they are not known to create their own burrows. This may be due to the hardness of soils in the California ecosystems in which they are found. California tiger salamanders depend on persistent small mammal activity to create, maintain, and sustain sufficient underground refugia for the species. Burrows are short lived without continued small mammal activity and typically collapse within approximately 18 months (Loredo *et al.* 1996).

Upland burrows inhabited by California tiger salamanders have often been referred to as aestivation-sites. However, "aestivation" implies a state of inactivity, while most evidence suggests that the animals remain active in their underground dwellings. One study has found that salamanders move, feed, and remain active in their burrows (Van Hattem 2004). Because the adults arrive at breeding ponds in good condition and are heavier when entering the pond than when leaving, researchers have long inferred that they are feeding while underground. A number of direct observations have confirmed this (Trenham 2001; Van Hattem 2004). Thus, "upland habitat" is a more accurate description of the terrestrial areas used by California tiger salamanders.

California tiger salamanders typically emerge from their underground refugia at night during the fall or winter rainy season (November-May) to migrate to their breeding ponds (Stebbins 1985, 1989; Shaffer *et al.* 1993; Trenham *et al.* 2000). The breeding period is closely associated with the rainfall patterns in any given year with less adults migrating and breeding in drought years

(Loredo and Van Vuren 1996; Trenham *et al.* 2000). Male California tiger salamander are typically first to arrive and generally remain in the ponds longer than females. Results from a 7-year study in Monterey County suggested that males remained in the breeding ponds for an average of 44.7 days while females remained for an average of only 11.8 days (Trenham *et al.* 2000). Historically, breeding ponds were likely limited to vernal pools, but now include livestock stock ponds. Ideal breeding ponds are typically fishless, free of non-native predators, and seasonal or semi-permanent (Barry and Shaffer 1994; Petranka 1998).

While in the ponds, adult California tiger salamanders mate and then the females lay their eggs in the water (Twitty 1941; Shaffer *et al.* 1993; Petranka 1998). Egg laying typically reaches a peak in January (Loredo and Van Vuren 1996; Trenham *et al.* 2000). Females attach their eggs singly, or in rare circumstances, in groups of two to four, to twigs, grass stems, vegetation, or debris (Storer 1925; Twitty 1941). Eggs are often attached to objects, such as rocks and boards in ponds with no or limited vegetation (Jennings and Hayes 1994). Clutch sizes from a Monterey County study had an average of 814 eggs (Trenham *et al.* 2000). Seasonal pools may not exhibit sufficient depth, persistence, or other necessary parameters for adult breeding during times of drought (Barry and Shaffer 1994). After breeding and egg laying is complete, adults leave the pool and return to their upland refugia (Loredo *et al.* 1996; Trenham 1998a). Adult California tiger salamanders often continue to emerge nightly for approximately the next two weeks to feed amongst their upland habitat (Shaffer *et al.* 1993).

California tiger salamander larvae typically hatch within 10 to 24 days after eggs are laid (Storer 1925). The larvae are totally aquatic and range in length from approximately 0.45 to 0.56 inches (Petranka 1998). They have yellowish gray bodies, broad fat heads, large, feathery external gills, and broad dorsal fins that extend well up their back. The larvae feed on zooplankton, small crustaceans, and aquatic insects for about six weeks after hatching, after which they switch to larger prey (J. Anderson 1968). Larger larvae have been known to consume the tadpoles of Pacific tree frogs, western spadefoot toads, and California red-legged frogs (J. Anderson 1968; P. Anderson 1968). California tiger salamander larvae are among the top aquatic predators in seasonal pool ecosystems. When not feeding, they often rest on the bottom in shallow water but are also found throughout the water column in deeper water. Young California tiger salamanders are wary and typically escape into vegetation at the bottom of the pool when approached by potential predators (Storer 1925).

The California tiger salamander larval stage is typically completed in 3 to 6 months with most metamorphs entering upland habitat during the summer (Petranka 1998). In order to be successful, the aquatic phase of this species' life history must correspond with the persistence of its seasonal aquatic habitat. Most seasonal ponds and pools dry up completely during the summer. Amphibian larvae must grow to a critical minimum body size before they can metamorphose (change into a different physical form) to the terrestrial stage (Wilbur and Collins 1973). Larval development and metamorphosis can vary and is often site-dependent. Larvae collected near Stockton in the Central Valley during April varied between 1.88 to 2.32 inches in length (Storer 1925). Feaver (1971) found that larvae metamorphosed and left breeding pools 60 to 94 days after eggs had been laid, with larvae developing faster in smaller, more rapidly drying pools. Longer ponding duration typically results in larger larvae and metamorphosed juveniles that are more likely to survive and reproduce (Pechmann *et al.* 1989; Semlitsch *et al.* 1988; Morey 1998; Trenham 1998b). Larvae will perish if a breeding pond dries before metamorphosis is complete (P. Anderson 1968; Feaver 1971). Pechmann *et al.* (1989) found a strong positive correlation between ponding duration and total number of metamorphosing juveniles in five