

INVENTORY AND HABITAT ASSESSMENT OF THE RELICT LEOPARD FROG (*RANA ONCA*) IN ARIZONA

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EXECUTIVE SUMMARY

The relict leopard frog (*Rana onca*) was recently resurrected after genetic and morphologic work determined populations of lowland leopard frogs (*R. yavapiensis*) around Lake Mead and the Virgin River drainage were genetically distinct and fit the type description of the relict leopard frog. The historical and current distribution of most species of amphibians and reptiles on the Arizona Strip are unknown. The objectives of this study were to 1) determine the current range for relict leopard frogs in Arizona, 2) gather additional information on potential habitat useful for the development of conservation and management strategies for relict leopard frogs, and 3) determine potential locations for repatriation of relict leopard frogs in Arizona. Visual encounter surveys at 74 locations detected no relict leopard frogs, but detected southwestern (or Arizona) toads (*B. microscaphus*), red spotted toads (*Bufo punctatus*), Woodhouse's toads (*B. woodhousei*), and canyon treefrogs (*Hyla arenicolor*). We recommend continuing to survey locations in the historical range of the relict leopard frog in Arizona focusing on the lower Grand Canyon and areas below Davis Dam, assessing the feasibility of using translocation to reestablish populations at Grapevine Spring, Jacobs Well, and Unnamed Tank on Cabin Canyon Road, and assessing the feasibility of eradicating nonnative predatory species at sites with adequate habitat for relict leopard frogs.

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INTRODUCTION

The relict leopard frog (*Rana onca*) was recently resurrected after genetic and morphologic work determined populations of leopard frogs around Lake Mead and in the Virgin River drainage were genetically distinct and fit the type description of the relict leopard frog (Jaeger and others 2001). Jaeger and others (2001) identified relict leopard frogs in Arizona near the town of Littlefield, previously considered to be lowland leopard frogs (*R. yavapaiensis*). The historical distribution of relict leopard frogs in Nevada and Utah is such that these frogs could potentially occur in the Virgin River drainage of Arizona, as well as in the drainages of smaller tributaries to the Colorado River from the lower Grand Canyon to Davis Dam, from elevations <1000 m (Bradford and others forthcoming A). Prior to 1997, the Arizona Game and Fish Department (AGFD) conducted limited surveys within the historical range of the relict leopard frog in Arizona, and found relict leopard frogs only at Littlefield (Sredl and others 1997). Recent surveys of springs along the Black Canyon of the Colorado River (D. Bradford, pers. comm.) and in springs adjacent to Lake Mead (R. Haley, pers. comm.) failed to find relict leopard frogs in Arizona.

Like other leopard frogs, the relict leopard frog is an aquatic habitat generalist. Relict leopard frogs require perennial water for long-term persistence (Bradford and others forthcoming B), but will use ephemeral waters in close proximity to perennial water to breed and disperse when adequate precipitation allows. The distribution of leopard frogs in the Southwest is limited primarily by the availability of perennial water and factors that influence the suitability of this perennial water. These factors include flow rate, distribution of competing or predatory species (for example, native garter snakes or nonnative fish, crayfish, or bullfrogs), and land use practices near this water (Blomquist 2003; Clarkson and Rorabaugh 1989; Degenhardt and others 1996; Rosen and Schwalbe 1998; Sredl and others 1997). Relict leopard frogs currently occupy 7 desert springs (6 natural and 1 translocated) on the Northshore of Lake Mead and in the Black Canyon of the Colorado River (Relict Leopard Frog Conservation Team [RLFCT] 2003). In Arizona, these frogs are thought to be extirpated from the only known historical location near the town of Littlefield, where they were last observed in 1998 (D. Bradford, pers. comm.). Translocations starting in 2002 restored a known population of these frogs to Arizona at 1 spring in the Black Canyon of the Colorado River. While the specific habitat requirements of the relict leopard frog remain unknown, the closely related lowland leopard frog occurs in 82% natural lotic systems and 18% lentic habitats from sea level to approximately 1800 m elevation in Arizona (Clarkson and Rorabaugh 1989; Sredl and others 1997).

Few herpetologists have worked on the Arizona Strip compared to other parts of Arizona, and historical and current distribution of most species of amphibians and reptiles are poorly known

(see review in Blomquist and Sredl 2002). The goal of this study was to survey sites within the historical range of relict leopard frogs and determine the current range for relict leopard frogs in Arizona. By thoroughly surveying the range of relict leopard frogs in Arizona, we will have data on species occurrence and habitat suitability in the state, complementary to the information already being gathered in Nevada and Utah (D. Bradford, R. Haley, J. Sjoberg, and K. Wheeler pers. comm.). We use information on potential habitat to make recommendations for the conservation and management of relict leopard frogs.

METHODS

We conducted an inventory of amphibian species occurring in potential habitat for relict leopard frogs in Arizona during the activity season (February – November, although activity may be influenced by local water temperature; Bradford and others forthcoming). The objectives of these surveys were to determine the current range for relict leopard frogs in Arizona and determine potential locations for reintroduction of relict leopard frogs in Arizona. For the purpose of selecting sites to survey, we defined potential habitat for relict leopard frogs as any perennial body of water. The United States Geological Survey (USGS) defines perennial waters as those that remain through the entire year and intermittent (or ephemeral) waters as those that dry at certain times of year (USGS 1998). We systematically selected sites to survey by reviewing digitized USGS 7.5-minute topographic maps in the program Terrain Navigator (MapTech 2002). We selected all perennial bodies of water (including springs, ponds, and riverine habitat) within 5 miles (8 km) of the mainstem Virgin and Colorado rivers in Arizona. From within this 5-mile buffer, we surveyed all bodies of water that were <1200 m and within logistical constraints. In addition, we surveyed ephemeral waters near perennial water, because these waters could serve as corridors for movement of leopard frogs. All surveys were conducted by personnel with training and experience conducting surveys for amphibians.

We used visual encounter surveys (VES) to survey potential sites. During VES, personnel search for animals visually, and may use additional means of locating individuals, such as sweeping the grass with a dip net to cause movement and detection of an individual (Crump and Scott 1994). We used standardized VES for all surveys (Appendix 1). During each VES, we collected data on the amphibian species present at the site, habitat characteristics, and other variables, such as weather and time of day. During each VES, personnel assessed the suitability of the habitat to leopard frogs by noting potential threats to amphibians and other factors that could affect the persistence of relict leopard frogs (for example, evidence of land use practices, nonnative and predatory species). We considered a site suitable if it had > 400 m² surface area for a lentic system or 400 m of water for a lotic system. Lotic systems must have had pools with a surface area >1 m² and a depth >1 m to allow breeding. All sites must have had adequate habitat heterogeneity to provide cover and oviposition sites and were free of nonnative predators.

RESULTS

We surveyed a total of 74 locations between 30 March 2001 and 11 June 2003 (Fig. 1; Table 1). Of these locations, we classified 30 as lentic and 44 as lotic systems. Lentic systems included earthen tanks, spring-fed wetlands, and concrete spring boxes. Lotic systems included creeks, washes, and rivers. We conducted 1 – 3 surveys at each site. Twenty-five of the sites lacked surface water. We conducted both daytime and nighttime surveys at Reber Springs, the only known historical location for relict leopard frogs. All other sites were surveyed with at least daytime surveys and night surveys as logistical constraints allowed. Three sites, Grapevine Spring, Jacobs Well, and Unnamed Tank on Cabin Canyon Road, fit our definition of habitat for relict leopard frogs. In addition, we noted 3 sites, Burro Spring, Pakoon Springs, and Unnamed Spring Littlefield Bridge, which would be habitat if nonnative species were removed.

We found a total of 4 native amphibian species: southwestern toads (*Bufo microscaphus*), red spotted toads (*B. punctatus*), Woodhouse's toads (*B. woodhousii*), and canyon treefrogs (*Hyla arenicolor*). We found no relict leopard frogs. We found bufonid or anuran larvae at 9 locations. We could not confidently identify the larvae to species due to the small size and lack of development. We observed a metamorphosed ranid at Reber Springs that we were unable to capture and identify.

We identified the following 2 possible threats to relict leopard frogs in Arizona. 1) Nonnative predators, including bullfrogs (*R. catesbeiana*) and red swamp crayfish (*Procambarus clarkii*), were found at 4 sites. Nonnative predatory fish were also detected at the 3 mainstem river sites and 2 other locations. These sites may have otherwise been suitable habitat for relict leopard frogs. 2) Water use and modification by humans is prevalent in the Virgin and Colorado rivers and adjacent springs.

DISCUSSION

Relict leopard frogs could exist at the sites surveyed or elsewhere in Arizona, despite our negative results. Several observations of leopard frogs in the historical range of relict leopard frogs indicate undiscovered populations might exist. Three individual leopard frogs have been observed on different occasions in 2000, 2001, and 2002 at the fish hatchery at Willow Beach, Arizona, located 10 km downstream from Bighorn Sheep Spring in Black Canyon (C. Fiegel, pers. comm.). Two of these individuals were confirmed as relict leopard frogs (J. Jaeger, unpublished data). An unknown species of leopard frog has been found in Surprise Canyon, a tributary to the Colorado River in the lower Grand Canyon on 2 occasions (M. Douglas and L. Stevens, pers. comm.). While subsequent surveys have proved unsuccessful, the area surrounding Surprise Canyon is remote and not well surveyed. We were unable to survey this area, but potential exists for a population of leopard frogs in this area. A study is currently underway to thoroughly survey and determine the genetic relationship of leopard frogs in the

Grand Canyon (C. Drost, pers. comm.). While it is possible that relict leopard frog populations may occur in unsurveyed areas, it is unlikely that many other occupied sites exist given the efforts made to date by various researchers (BIO-WEST Inc. 2001; Bradford and others 2003; Jennings and others 1995; Platz 1984; RLFCT 2003; Vitt and Ohmart 1978).

Two reasons are likely responsible for the current scarcity of relict leopard frogs in Arizona. First, nonnative aquatic predators are present in much of the potential habitat in the range of relict leopard frogs. Second, severe habitat fragmentation now exists with the management of the Colorado River for human use. Further discussion of the threats facing relict leopard frogs and leopard frogs in northern Arizona is available in Blomquist and Sredl (2002) and RLFCT (2003).

The sites identified for reintroduction of relict leopard frogs should be further assessed, taking into account what is known about threats and metapopulation dynamics of relict leopard frogs. We used a broad definition of suitable habitat where any site (for example, creek, river, stock tank, lake, spring pool) with perennial water free of predatory, nonnative species (for example, crayfish, fish, bullfrogs) and adequate habitat structure was suitable. The sites that met our broad definition of habitat are likely adequate to support local populations of relict leopard frogs with proper management. While frogs may potentially persist for a limited time and successfully breed at all of these sites, the sites alone are not adequate to support a self-sustaining metapopulation of frogs. A metapopulation of leopard frogs requires a matrix of sites with habitat that is great enough in size and diversity to support a self-sustaining population.

MANAGEMENT RECOMMENDATIONS

We found no extant populations of relict leopard frogs and know of only 1 historical record of this species in Arizona. Therefore, we have little basis from which to develop the concrete management strategies that comprise a conservation plan for the species in Arizona. However, we can make the following recommendations that may benefit relict leopard frogs and other amphibians within the historical range that will enhance the conservation work being planned by RLFCT (2003).

- 1) Continue to survey locations in the historical range of the relict leopard frog. The lower Grand Canyon of the Colorado River and sites south of Davis Dam were not included in this study. If populations of leopard frogs are found in the presumed historical range of the relict leopard frog, a) initiate a monitoring program of occupied and unoccupied habitats to determine the status of this frog in the local area (within 8 km; USFWS 2002); and b) determine the genetic relationship of these frogs to the nearest populations of leopard frogs.
- 2) Assess the feasibility of using translocation to reestablish populations at Grapevine Spring, Jacobs Well, and Unnamed Tank on Cabin Canyon Road, taking the genetic relationship of the source and known populations into consideration. These sites are the only sites that met our definition of habitat that were surveyed during this study.

- 3) Where feasible, actively attempt to eradicate nonnative predatory species at sites with low or no recreational value and where chance of recolonization (artificial or natural) is low. We identified Pakoon Springs, Burro Spring, and Unnamed Spring Littlefield Bridge as potential sites that, except for the nonnative species at the site, had characteristics of habitat. These sites should be examined further for the feasibility of removing nonnatives and reestablishing relict leopard frogs. In addition, monitor aquatic habitats near extant populations and habitat to detect nonnative aquatic species such as fish, bullfrogs, and crayfish.

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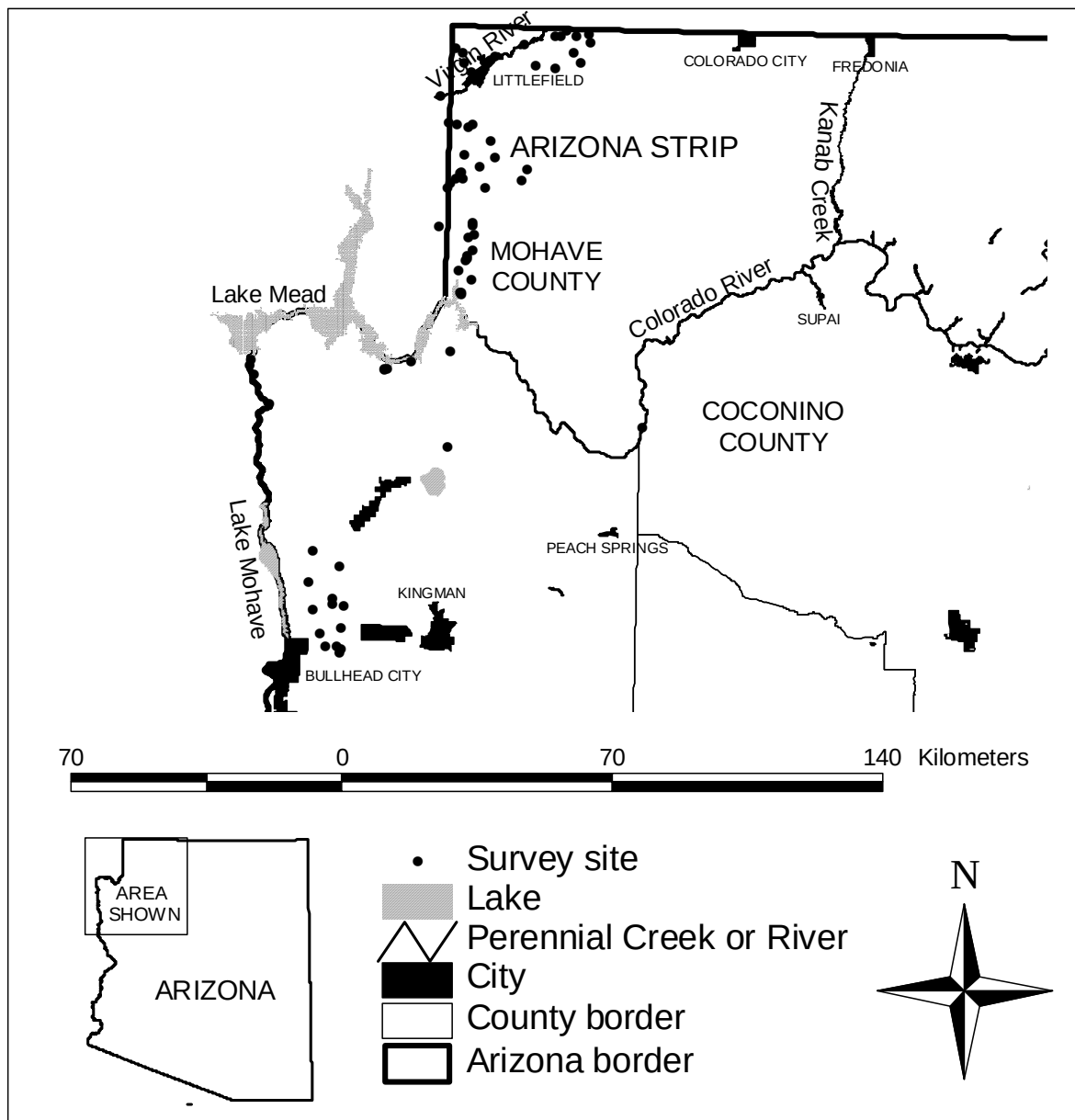


Figure 1. Northwestern Arizona showing land features, political boundaries, and surveys for relict leopard frogs performed 2001 – 2003.

Table 1. Sites surveyed and amphibian species found during surveys for relict leopard frogs 2001-2003..						
AGFD #	Site Name	Easting	Northing	Zone	Species	Life Stage
BLM-0123	Allen Well	235195	4030793	12	Dry	
NPS-0025	Arizona Hot Springs	705171	3981765	11	<i>Bufo punctatus</i>	J, L
NPS-0027	Arizona Hot Spring Colorado River	703671	3984485	11	None	
BLM-0131	Big Spring	764091	4045841	11	Dry	
BLM-0107	Black Rock Gulch Water Tanks	261720	4084844	12	None	
BLM-0087	Black Willow Spring	235077	4025890	12	<i>Bufo punctatus</i> <i>Bufo woodhousii</i>	L L
BLM-0099	Box Spring	728740	3906842	11	<i>Bufo spp.</i>	A
BLM-0115	Buck Spring	234837	4066516	12	None	
BLM-0126	Buckhorn Spring	233125	4023272	12	None	
PVT-0366	Burns Spring	735112	3910808	11	Anura	L
BLM-0124	Burro Spring	233396	4029741	12	Dry	
NPS-0029	Burro Spring ²	755658	3988860	11	None	
NPS-0012	Burro Spring	769167	4019314	11	<i>Bufo punctatus</i> <i>Bufo woodhousii</i>	A A
BLM-0085	Calles Spring	726715	3915537	11	None	
BLM-0117	Cedar Spring	767721	4050759	11	Dry	
NPS-0036	Chill Heal Spring	231404	4011937	12	<i>Bufo punctatus</i> <i>Bufo woodhousii</i>	A, L, E A
BLM-0120	Cove Spring	231648	4048829	12	Dry	
BLM-0122	Eds Spring	234709	4034877	12	Dry	
BLM-0125	Grapevine Spring	233156	4023909	12	None	
NPS-0037	Grapevine Spring	768017	3992785	11	<i>Bufo spp.</i>	
BLM-0092	Jacobs Ranch	766813	4047889	11	Dry	
BLM-0133	Jacobs Well	240741	4061099	12	<i>Bufo spp.</i>	L
BLM-0116	Lead Mine Spring	233627	4065713	12	None	
BLM-0134	Little Arizona Spring	233586	4025139	12	Dry	
BLM-0101	Lizard Spring	267753	4089980	12	None	
BLM-0086	Lost Cabin Spring	727574	3925603	11	None	
BLM-0110	Mesquite Diversion ³	759645	4075275	11	<i>Bufo microscaphus</i> <i>Bufo woodhousii</i>	A A
BLM-0132	Middle Spring	764647	4047173	11	None	
BLM-0130	Middle Tank	736318	3921531	11	Dry	
BLM-0095	Mokaac Reservoir	273272	4092933	12	None	
BLM-0071	Pakoon Springs	234940	4033900	12	<i>Rana catesbeiana</i> <i>Bufo woodhousii</i> <i>Bufo punctatus</i>	A A, J, L A, J, L
NPS-0033	Rattlesnake Spring	769273	3962040	11	Dry	
PVT-0163	Reber Springs ^{1,3}	241970	4088350	12	<i>Rana catesbeiana</i> <i>Rana spp.</i> <i>Bufo woodhousii</i>	A A A, L

BLM-0089	Red Pockets Tank	232303	4056647	12	None	
BLM-0091	Red Rock Spring	766420	4048987	11	None	
BLM-0080	Rhyolite Spring	734845	3908930	11	None	
NPS-0030	Salt Spring	747349	3985949	11	<i>Bufo punctatus</i> <i>Bufo woodhousii</i>	A, L L
BLM-0106	State Line Reservoir	261694	4095281	12	Dry	
BLM-0102	State Line Reservoir	272789	4095672	12	Dry	
NPS-0013	Sugarloaf Spring	704058	3986265	11	<i>Bufo punctatus</i>	A, J, L
NPS-0011	Tassi Spring ³	234289	4016281	12	<i>Bufo woodhousii</i> <i>Bufo punctatus</i> <i>Bufo spp.</i>	A, J A, J L
NPS-0022	Trail Canyon	290010	3968480	12	<i>Bufo punctatus</i> <i>Hyla arenicolor</i>	L, E L
BLM-0083	Unnamed Spring east of Thumb Butte	737266	3895596	11	<i>Bufo spp.</i>	L
BLM-0129	Unnamed Spring Jump Canyon	252811	4051977	12	None	
ARZ-0087	Unnamed Spring Littlefield Bridge ^{2,3}	239889	4086555	12	None	
BLM-0081	Unnamed Spring northeast of Secret Pass Spring	738386	3893082	11	None	
BLM-0098	Unnamed Spring northeast of Sugarloaf Mountain	738187	3901502	11	<i>Bufo spp.</i>	L
NPS-0034	Unnamed Spring northwest of Chill Heal Spring 1	230757	4012356	12	None	
NPS-0035	Unnamed Spring northwest of Chill Heal Spring 2	231020	4012219	12	None	
PVT-0367	Unnamed Spring northwest of Sugarloaf Mountain	731336	3899353	11	<i>Bufo spp.</i>	L
BLM-0084	Unnamed Spring south of Thumb Butte	733719	3895002	11	<i>Bufo spp.</i>	L
BLM-0082	Unnamed Spring southeast of Thumb Butte	738694	3894545	11	None	
PVT-0368	Unnamed Spring north of Littlefield Bridge	240156	4087058	12	None	
PVT-0369	Unnamed Tank Littlefield	240814	4087470	12	None	
BLM-0108	Unnamed Tank Big Bend Wash	234582	4083496	12	Dry	
BLM-0096	Unnamed Tank Cabin Canyon Road	763028	4067107	11	<i>Bufo woodhousii</i>	L
BLM-0113	Unnamed Tank Coon Creek	766952	4086887	11	Dry	
BLM-0105	Unnamed Tank east of Black Rock Mountain	255139	4086036	12	Dry	
BLM-0114	Unnamed Tank Lime Canyon Road	765699	4066406	11	Dry	
BLM-0103	Unnamed Tank Lizard Wash	268587	4095307	12	None	
BLM-0112	Unnamed Tank north of Big Bend Wash	766420	4089744	11	Dry	
BLM-0088	Unnamed Tank north of Cottonwood Wash	237375	4052994	12	None	
BLM-0109	Unnamed Tank northeast of Big Bend	235544	4081500	12	Dry	
BLM-0094	Unnamed Tank northeast of Black Rock Interchange	265407	4097183	12	Dry	
BLM-0128	Unnamed Tank Pocum Wash	251004	4048719	12	Dry	
BLM-0111	Unnamed Tank Sand Hollow Wash	763722	4090887	11	Dry	
BLM-0119	Unnamed Tank south of Cottonwood Wash	239067	4046429	12	Dry	
BLM-0104	Unnamed Tank southwest of of Black Rock Interchange	263535	4095589	12	Dry	
PVT-0370	Unnamed Tank Virgin River	237888	4084159	12	None	
BLM-0118	Unnamed Tanks east of Cow Canyon	242245	4055749	12	Dry	

BLM-0121	Unnamed Tanks Greasewood Basin	762178	4033192	11	Dry	
BUM-0053	Virgin River east of Cedar Pocket Wash Confluence ³	251700	4092480	12	None	
BLM-0127	Whiskey Spring	232417	4022644	12	<i>Bufo punctatus</i> <i>Bufo woodhousii</i>	L L
BLM-0090	White Saddle Spring	768231	4051395	11	None	A
NPS-0028	Willow Beach Fish Hatchery	710768	3972537	11	None	

¹ historical site for relict leopard frogs

² site with crayfish

³ site with nonnative fish

Appendix 1: Nongame Branch Amphibians and Reptiles Program General Visual Encounter Survey Protocol, Riparian Herp Survey Form, and Riparian Herp Survey Form Instructions (May 2002; S.M. Blomquist, K.J. Field and M.J. Sredl; Arizona Game and Fish Department).

**Nongame Branch Amphibian and Reptile Program
General Visual Encounter Survey Protocol (May 2002)**

This standard visual encounter survey (VES) protocol is to be used for all NGB Herp Surveys. This protocol was adopted from Heyer et al. (1994) and modified based on statewide surveys in Arizona. The protocol is designed to be simple and repeatable with minimal training of personnel. However, all personnel should be trained and have survey technique checked periodically by a more experienced individual. The VES protocol described here will generate presence/absence data if used independently and generate information from which inferences about abundance and trends can be made if used in a statistically valid monitoring program. Before designing a monitoring program, it is recommended that the user consult Gibbs' (1996) program MONITOR or Gerodette's (1987, 1993) program TRENDS to test the statistical power of the proposed monitoring program.

Equipment needed:

The observer should always have the following when conducting a VES:

- a dip net
- a Global Positioning System unit (currently Garmin III+) set to read in the North American Datum 1927 (NAD27Conus) and the appropriate Universal Transverse Mercator (UTM) Zone
- a clipboard with the NGB Riparian Herp Survey Form and instructions
- a pen with waterproof ink
- a time piece set to Mountain Standard Time with a stop watch
- a pH meter
- 2 thermometers
- a conductivity meter
- a sling psychrometer or hygrometer
- binoculars
- the appropriate United States Geologic Survey quadrangles
- bleach or Quat128 for disinfecting all gear before and after surveying each site

Other suggested items are the following:

- a counter or clicker for keeping a tally of frogs observed
- a field notebook
- a headlamp or spotlight for night surveys
- rubber boots, hip waders, or chest waders depending on the habitat
- guides to identification of aquatic insects, fish, amphibian larvae, and adult amphibians
- the "Arizona Herpetofauna List derived from Stebbins (1985)"
- a camera with slide film

- the appropriate land ownership maps
- database reports of historic surveys done in the area
- wind meter
- measuring tape
- “dead box” (whirl pack or ziplock bags, MS 222, and formalin for collecting specimens)
- pocket magnifier (to help identify tadpoles, look at mouthparts, etc.)
- tape player (for call backs)
- compass

Survey Protocol:

Lentic systems:

Upon approaching a survey site, stop approximately 20 meters (m) from the bank and search the site with binoculars. Search for frogs floating in water away from the bank as well as scanning the bank as best as possible. Proceed to walk around the entire perimeter of site if the site is a small lentic system. If the site is a large lentic system and the entire perimeter cannot be surveyed, record the start and stop points as UTM coordinates. While walking along banks, use a dip net to sweep vegetation to flush frogs that do not respond to the observer’s approach. After the initial perimeter survey, search mud cracks, divots, under rocks and downed branches, and any other places where frogs might find cover. If the lentic system allows, walk through the site in a zigzag fashion to further flush frogs that may be sitting on the bottom of the water. Dip net to determine the presence of amphibian larvae, fish, and aquatic insects. Record all visual observations and audible “plops” of frogs escaping into water. Be careful not to count frogs more than once.

Lotic systems:

Upon arriving at the starting point of a lotic system, record the starting point (or the most downstream point of the site) as UTM coordinates. Proceed upstream searching the banks, surrounding vegetation, and water along a minimum of 400 m of a lotic system. Search under rocks, downed branches, undercut banks, and any other places where frogs might find cover as best as possible. Where the lotic system allows, walk through the site in a zigzag fashion to further flush frogs that may be sitting on the bottom of the water. Dip net to determine the presence of amphibian larvae, fish, and aquatic insects. Record all visual observations and audible “plops” of frogs escaping into water. Be careful not to count frogs more than once.

Data collection:

Data should be collected according to the Complete Riparian Herp Survey Form Instructions. Collect the following data at the specified locations, but note any major changes that occurred during the survey on the data form. Record the site name, UTM points, elevation, USGS quad, date, observers, and time the survey starts at the starting point of the survey. Record time the survey stops, time spent actively searching for herps, effort, any voucher specimens taken, water

class, water type, search methods, water pH, relative humidity, air and water temperature, habitat characteristics (water clarity, vegetation types present, primary substrate, site width and/or length), weather conditions (wind, cloud cover, precipitation), land use, sign of potential vertebrate and invertebrate predators, as well as comments at the end point of the survey. Record any herps observations when observed.

[illegible]

COMPLETE RIPARIAN HERP SURVEY FORM INSTRUCTIONS (May 2002)

- All fields are to be filled out for historical sites and sites with target riparian herpetofauna.
- Fields with an asterisk (*) are to be filled out for every survey, regardless of results.
- If the site has never been surveyed according to the Herp Database, circle Y (yes) at the top of the form. Otherwise circle N (no) and check the site's Locality Data upon returning to the office for consistency.
- Upon return to the office, check each Survey Form for completeness, conciseness, and clarity prior to submitting for entry into the Herp Database.

Locality Data:

- *SITE:** A "site" is any aquatic system (or piece of an aquatic system) that is > 1 mile from any other survey locality, or if less than 1 mile apart, represents a **distinct** change in aquatic habitat types (e.g., riverine vs. lake or cienega). Features with unique names are considered unique sites regardless of how far apart they are. Record the site name as it is marked on the United States Geologic Survey (USGS) quadrangle (hereafter quadrangle or quad). If the site is unnamed on the quad, refer to the corresponding land management map (e.g., U.S. Forest Service map, Surface Management Responsibility map). If the site doesn't have a name, write "unnamed" preceding the feature; similarly, if the site is not marked on any map, write "unmarked" preceding the feature (e.g., Unnamed Wash, Unmarked Tank).
- SITE AT:** This field should always be filled out for unnamed and unmarked sites and for large/long aquatic systems. For other localities, use this field as *needed* to enhance a site name (i.e., to verbally pin-point a site in space). Use such features as the nearest road crossing (e.g., East Verde River at **Highway 87**) stream confluence (e.g., East Verde River at **Webber Creek**) or topographic feature (e.g., East Verde River **N of Piety Hill**) in the description.
- *NUM:** Write the site number. A site number is a unique number that, once assigned to a site, will always be used in conjunction with that site. The site number starts with a 3-letter code that describes the land manager. These 3 letters are followed by a hyphen and then a 4-digit number (e.g., TON-0001, COC-0153). Sites are numbered in ascending, consecutive order within each management unit. Management unit codes are as follows:
- Arizona Game and Fish -- AGF
 - Bureau of Land Management -- BLM
 - Land Grants -- LGR
 - Military -- MIL
 - National Forests -- APA, COC, COR, KAI, PRE, TON
 - National Parks/Monuments -- NPS
 - National Wildlife Refuges -- NWR
 - Private Lands -- PVT
 - State Lands -- ARZ
 - Tribal Lands (note: the final "R" = Reservation):
 - Ak Chin -- AKR
 - Fort Apache -- APR
 - Cocopah -- CCR
 - Chemehuevi -- CHR
 - Fort McDowell -- MCR
 - Fort Mojave -- MOR
 - Navajo -- NAR
 - San Carlos -- SCR

Colorado River -- CRR	Salt River -- SRR
Camp Verde -- CVR	San Xavier -- SXR
Gila Bend -- GBR	Tonto-Apache -- TAR
Gila River -- GRR	Tohono O'odham -- TOR
Havasupai -- HAR	Yavapai-Prescott -- YPR
Hopi -- HOR	Fort Yuma -- YUR
Hualapai -- HUR	Zuni -- ZUR
Kaibab -- KAR	

*UTM ZONE: Circle "11" or "12" to note whether the **starting point** of the survey is in UTM grid zone 11 (west of 114 degrees longitude) or 12 (east of 114 degrees longitude). Most of Arizona except for the extreme western portion of the state is Zone 12.

*EASTING: Record the **starting point** of the survey as a 6-digit number. An example of a UTM x-coordinate is 295440E. Use a Global Positioning System (GPS) unit to measure the UTM coordinate. The UTM coordinate should be measured in North American Datum 1927 (NAD27Conus for Garmin units). Check that the GPS unit is set to the appropriate Zone (most of Arizona is Zone 12). Alternatively, read the UTM coordinate from the quad. The first 3 numbers will be found on the top or bottom edge of the quad. These numbers are in 100,000-meter increments. The fourth number describes a point with ± 100 -meters accuracy. The fifth number describes a point with ± 10 -meters accuracy. The last number will be a zero. Use a coordinate scale to determine the fourth and fifth numbers.

*NORTHING: Record the **starting point** of the survey as a 7-digit number. An example of a UTM y-coordinate is 4318410N. Use a Global Positioning System (GPS) unit to measure the UTM coordinate. The UTM coordinate should be measured in North American Datum 1927 (NAD27). Check that the GPS unit is set to the appropriate Zone (most of Arizona is Zone 12). Alternatively, read the UTM coordinate from the quad. The first 4 numbers will be found along the left or right edge of the quad. These numbers are in 1,000,000-meter increments that tell you how far north of the equator you are. The fifth number describes a point with ± 100 -meter accuracy. The sixth number describes a point with ± 10 -meter accuracy. The last number will be a zero. Use a coordinate scale to determine the fifth and sixth numbers.

*ELEVATION: Record the elevation at which the **starting point** of the survey occurs. Read the elevation off of the survey quad. Be sure to indicate the elevation in meters (m). The contour interval and unit (meters or feet) is written in the center of the bottom margin of the quadrangle. To convert feet to meters multiply by 0.3048.

*QUAD: Record the quadrangle name as it appears on the quadrangle except in the situations outlined below. The name of the quadrangle appears in the upper and lower right hand corners of the quadrangle. If more than 1 quad is used in the survey, record the name of the quad in which the survey starts and note the name(s) of the other quad(s) in the DIRECTIONS.

- Do not use periods.
- Do not use apostrophes.
- Change the word "Mountain" to "Mtn" if it appears anywhere in the quad name other than the first word.

- Composite polar coordinates (e.g., Southeast, Northwest) should be abbreviated (e.g., SE, NW) if they appear anywhere in the quad name other than the first word
- Never abbreviate the 4 cardinal directions

*MIN: Circle "7.5" or "15" to note whether the quadrangle series is 7.5 or 15 minutes. The series of the quadrangle can be found in the upper right hand corner of the quadrangle.

*YEAR: Record the year of the quadrangle as it is printed in the lower right corner of the quadrangle. If more than 1 year appears on the map, record the year of the most recent revision.

*COUNTY: Record the state abbreviation (e.g., AZ) followed by a hyphen and then the first 4 letters of the county (e.g., AZ-MARI, AZ-YAVA). The county name can be found in the upper right corner of the quadrangle if the quad covers an area within a single county. For quads that cover areas in 2 or more counties, the names of the counties will appear somewhere in the topographic region of the quad. National Forest maps and the Arizona Highway road map, and the Arizona Atlas & Gazetteer are also useful in identifying counties. Please use the following abbreviations for county: APAC, COCH, COCO, GILA, GRAH, GREE, LAPA, MARI, MOHA, NAVA, PIMA, PINA, SANT, YAVA, YUMA

DIRECTIONS: Write the directions to the site. **Keep them short and pertinent** (e.g., on FS 105 –4.3 MI N of FS 105/FS 393 jct.). Directions are especially important when there are no roads or when existing roads are not marked on your maps. Use the directions N, NE, E, SE, S, SW, W, and NW instead of "turn right" or "veer left". This field can also contain any information or comments you want to convey to other field personnel. For example: "Dry 05/1994"; "Contact landowner for permission to access (602)555-9683"; "Also survey adjacent tank and draw"; etc.

Site and Visit Conditions:

*DATE: Record the date of the survey as 8 numbers giving the month first, followed by the day then the year (e.g., 10-27-1993, 06-02-1994).

*START TIME: Record the time the surveyor begins searching for herps using a 24-hour clock.

*STOP TIME: Record the time the surveyor stops searching for herps using a 24-hour clock.

*SEARCH TIME: Record the time spent actively searching for herps in minutes. The time recorded should include only time spent actively searching for herps and should not include time taken to write field notes, complete data sheets, read data sheet instructions, or other activities that may be performed while at the site.

*OBSERVERS: List the names of all people present during the survey. Record the names as: first initial, second initial, and full last name (e.g., M.J. Sredl, K.J. Field, and S.M. Blomquist).

*EFFORT: There are 5 categories of effort:

TP = Total Perimeter
PP = Partial Perimeter
LB = Left Bank
RB = Right Bank
BB = Both Banks

Circle all category(s) that apply. For all categories other than TP, record the distance surveyed in meters. The minimum acceptable survey distance for linear systems and large lentic systems (> 20 acres) is 400m (0.25 mile). Use category BB for any lotic system in which it is possible for you to access both banks (i.e., to meander from shore to shore). Use categories LB and RB for large, deep, and/or swiftly flowing lotic systems in which you are unable to meander shore to shore. LB and RB should always be filled out together even if you didn't survey, or were unable to access, 1 of the shores (e.g., LB = 0000m, RB = 0350m; RB = 0050m, LB = 0200m). Left and right banks are in reference to a person looking upstream. To calculate meters walked use a map wheel, range finder, or measuring tape. If using a map wheel to determine the distance in kilometers (or miles), be sure to use the scale on the map wheel that corresponds to the scale of your map or quad. Multiply your result by 1000 to get meters. Round the final result to the nearest 25-meter value. Alternatively, multiply the value generated from the map wheel in miles by 5,280 feet/mile. Multiply this new value by 0.3048 meters/foot. Remember, during the course of any survey, the surveyor should dip net, comb through bushes and grasses, turn over rocks, and scan the water and shore for herpetofauna.

***VOUCHERS:** Note how many photo vouchers of specimens were taken at a site. Write the number as 2 digits (e.g., 00 or 13). Photo vouchers of specimens should be close-ups (i.e., macro shots) of diagnostic characters (e.g., thigh pattern and dorsolateral folds of leopard frogs, scale row of lateral stripes in garter snakes, dorsal and cranial views of Arizona toads). Note how many habitat photographs were taken at a site. Write the number as 2 digits (e.g., 00 or 02). Habitat photos should be taken at any site in which target riparian herps were found, at any historical locality regardless of results, and at any survey site that has suitable habitat even if no target riparian herps were found. Keep a detailed log of all photos taken with the camera. Circle "Y" (yes) or "N" (no) as an indication of whether voucher specimens were collected at a site. If "Y" is circled, the collection tag number(s) should be written in the Specimen #s field.

***H₂OCLASS:** Circle 1 category that best describes the hydrological class of the water system you have surveyed.

Lentic = still water
Lotic = flowing water

***H₂OTYPE:** Circle 1 category that best describes the type of water you have surveyed. The categories are based upon lotic/lentic characteristics as well as the size/magnitude of the water body:

Canal = manmade (metal, concrete or earthen) diversion of riverine water
Plant outflow = sewage and electric plants; any chemical or mechanical processing of water; storm drainages
Riverine = natural flow, from raging rivers to streams to seeps

Wetland = an inland body of water that is primarily emergent vegetation (e.g., cienega)

Stock tank = an earthen-dammed or dredged basin that catches run-off for livestock or wildlife

Lake = an inland body of water that is primarily open water

Reservoir = a dammed riverine system that is primarily used for recreation and/or human water supply

Small metal/concrete tanks and drinkers = manmade water holding structures

***SEARCH METHODS:** Circle all methods used to search for herps. If needed, include a description of other techniques used to search in the SITE / SURVEY NOTES with a footnote reference. Remember, during the course of any survey, the surveyor should dip net, comb through bushes and grasses, turn over rocks, and scan the water and shore for herpetofauna.

TDS: Use a dissolved solids meter to measure. The water sample should be taken 1 centimeter below waters' surface and 1 meter from shore. For bodies of water less than 2 meters wide, take the sample from the center. Record value as μS (micro-Seimens). Be sure to: 1) take the cap off the meter before using, 2) keep the level of the water sample below the mark on the meter, 3) turn the meter on before measuring the conductivity of the sample, and 4) turn the meter off when finished sampling. Meters should be calibrated monthly.

pH: Measure pH using a pH meter. The water sample should be taken from water column 1 meter from shore. For bodies of water less than 2 meters wide, take the sample from the center. Be sure to: 1) take the cap off the meter before using, 2) keep the level of the water sample below the mark on the meter, 3) turn the meter on before measuring the pH of the sample, and 4) turn the meter off when finished sampling. Meters should be calibrated monthly.

RH: With a sling psychrometer or hygrometer, measure relative humidity 1.5 meters above ground and 1.5 meters from water. Record as percent.

***T_{AIR}:** Measure air temperature to the nearest 10th of a degree (degrees Celsius) 1.5 meters above ground and 1.5 meters from the water. Be sure thermometer is shaded and completely dry.

***T_{WATER}:** Measure water temperature to the nearest degree (degrees Celsius) 1 centimeter below water's surface and 1 meter from shore. For bodies of water less than 2 meters wide, measure temperature at the center. Be sure to shade the thermometer.

WATER CLARITY: Circle 1 phrase that best describes the survey area.

***LENTIC LENGTH:** For lentic systems, record the length (i.e., longest axis) of the system in meters. Measure the entire system (not just the portion surveyed), and use the standing water at the time of the survey as your boundaries. Do not measure the normal waterline or highwater mark. For large systems, estimate the length using a map. Do not rely on a visual estimate for large systems.

***LENTIC WIDTH:** For lentic systems, record the width (i.e., shortest axis) of the system in meters. The width should be the maximum distance perpendicular to the length axis. As with the

length, the width should reference the entire lentic system, not just the portion surveyed, and should be determined based upon the standing water present at the time of the survey, not the usual waterline or high water mark. Use a map as a guide for larger systems.

*LOTIC WIDTH: For lotic systems, select 1 range that best describes the width of water at the time of the survey. Do not measure the normal waterline or the high water mark.

*RIPARIAN WIDTH: Circle the category that includes the maximum width of the riparian area in meters. Riparian width should be measured from the boundary of riparian vegetation and upland vegetation. For a lentic system, include the area of riparian vegetation along the shore of the body of water and any vegetated waters. For a small lotic system in which both banks can be surveyed simultaneously, include the zone of riparian vegetation on both banks of the body of water surveyed and any vegetated waters. For large or swiftly flowing lotic systems, include only bank that was surveyed or the maximum width of riparian vegetation on both banks. Riparian width is measured for the area surveyed.

*PRIMARY SUBSTRATE: Circle from 1 to 3 categories as appropriate. All substrate types may be present, but choose only those that best describe the area potentially inhabited by target species.

Mud/Silt = 0.001-0.1 mm
Sand = 0.1-2 mm
Gravel = 2-32 mm
Cobble = 32-256 mm
Boulder >256 mm
Bedrock = exposed sheet of rock

*WIND: Circle 1 category as appropriate. Wind should be measured 1.5 meters above the ground and 1.5 meters from the water. If using a wind meter, be sure to: 1) hold meter near the top so that you are not blocking any holes, 2) face into the direction of the wind while reading the meter, and 3) use the left scale for wind strengths < 10 mph, and use the right scale (by putting your index finger over the red knob on top of the meter) for wind strengths ≥10 mph. Wind categories are those used in the Beaufort scale:

≤1 mph = smoke rises vertically
1-3 mph = wind direction shown by smoke drift
4-7 mph = wind felt on face, leaves rustle
8-12 mph = leaves and small twigs in constant motion, wind extends light flag
13-18 mph = raises dust and loose paper, small branches are moved
19-24 mph = small trees begin to sway, crested wavelets form on inland waters
>24 mph = greater effect than above

*CLOUD COVER: Circle 1 category as appropriate. Categories are based on percent cover.

*PRECIPITATION: Circle 1 category as appropriate.

*LAND USE: Circle all categories that best indicate the land use at a survey site. For noteworthy land uses that are not immediately at the survey site but which may potentially impact the study site (e.g., large agricultural fields within 1 mile of survey site, active mining

operation 0.5 mile upstream of survey area), fill out the land use field as described here, and also make written comments about the land use in the SITE / SURVEY NOTES. The land-use categories are:

Agric = agriculture (include agriculture fields, diversion canals, etc.)
Dev = human development (include road construction, dam site, housing development, etc.)
Graze = cattle grazing (include manure, hoofprints, invading species and grass length as evidence of grazing use); note elk/deer grazing in OTHER ORGANISMS and OTHER ORG. NOTES, but only if heavy
Log = logging
Mine = mining (include 50+ year tailings/shafts, currently active mines, small claims, and large developments)
Rec = recreation (include developed and primitive campsites trails, litter, etc.)

VEGETATION % & PROMINENT SPECIES: Record the percent of the area potentially inhabited by target species that is covered by floating vegetation (e.g., broad-leafed macrophytes and dense algal mats), submerged vegetation, emergent vegetation (e.g., cattails, sedges, rushes), perimeter vegetation (i.e., up to 1 m from waters edge), and canopy vegetation. Use increments of 5% (i.e., 1% effectively = 0). Record the genus name or common name (only if positively identified) of the 1-4 most prominent species that best describe the surveyed area.

*PREDATORS: Circle all predators seen or otherwise detected at a survey site. Most predator categories lump together similar organisms and/or organisms with similar effects on riparian herps. Record herp predators in the Herpetofauna Observations table. For **crayfish**, include claws and carapaces as evidence of presence. For **dragonflies**, do not include damselflies. For **beetles**, include any large aquatic beetles observed, such as hydrophilids and dytiscids. **Warm water fish** include bass, carp, catfish, perch, sunfish, and walleye. **Cold water fish** include trout and pike. **Large wading birds** include American bittern, black-crowned night heron, egrets, great blue heron, and green-backed night heron. **Mammals** include only medium-sized mammals such as skunk, ring-tail, and raccoon.

*OTHER ORGANISMS: This field is to be used for observations of species other than riparian herpetofauna. Riparian herps are to be recorded in the "Herpetofauna Observations" table. List all non-riparian herps by 4-letter genus/species code (see Herpetofauna List -Derived from Stebbins (1985). List federal or state sensitive species of other organismal groups or any other species whose occurrence merits noting by common name. No words other than the species name(s) should be listed (e.g., UXOR, SCC, great horned owl, elk). Use the OTHER ORG. NOTES field as needed to expand upon why you listed a species.

OTHER ORG. NOTES: Use this field to write out noteworthy observations about any or all of the species listed in OTHER ORGANISMS (e.g., UXOR observed mating, great horned owl roost site observed, area heavily impacted by elk grazing).

SITE / SURVEY NOTES: Use this field to describe the most outstanding features of a survey or site. **Don't be redundant** with fields already completed. Write short, specific comments that emphasize habitat quality and why you think you did or did not find herps. Be sure to

comment on any land use in, around, or in proximity of the survey area that may potentially impact the study site (e.g., large mining operation 0.5 mile upstream of survey site, agricultural spraying 1 mile from survey site). You can also use this field to describe any noteworthy similarities or dissimilarities between the area searched and the total area (e.g., wash devoid of vegetation except in area of survey, survey covered the north end of the lake which was the only area with emergent vegetation).

Herpetofauna Observations:

- *SPECIES:** Record all riparian herp species (target or non-target) detected during a survey in this column. Record non-riparian herpetofauna in the OTHER ORGANISMS and OTHER ORG. NOTES. If no species are observed, record "NONE." Use the unique 4-letter Genus-species code (see "Herpetofauna List - Derived from Stebbins (1985)") for all riparian herp species. When an organism cannot be identified to species (e.g., "I saw a ranid-like frog", or "I saw an anuran egg mass"), use the 4-letter code corresponding to the taxonomic classification for which you are confident in your identification. For the examples above, the ranid-like frog would be assigned the code "RANA", and the egg mass would be coded as "ANUR". If you are confident you saw a leopard frog but are not certain which species you saw, use the code "RAPC." Do not use historic information to bias your decision on species identification. Record your most confident observation and justify it in the NOTES or COMMENTS.
- CERTAINTY:** Circle 1 word to indicate your level of certainty about your identification of each species. Certainty of identification should be based on species-specific diagnostic characters (e.g., thigh pattern and dorsolateral folds in leopard frogs, scale row of lateral stripes in garter snakes, lack of dorsal stripe and cranial crests in Arizona toads). For information on diagnostic characters of species, see Stebbins (1985), "Characteristics of Arizona Leopard Frogs", and "Garter Snakes of Coconino National Forest."
- LIFE STAGE:** Circle the life stage of each species observed. Use separate rows for different life stages of the same species. A juvenile leopard frog is usually < 55 mm SVL, while an adult is > 55 mm SVL or exhibits obvious sign of breeding condition (e.g., swollen thumbpads, stretched vocal sacs)
- # OBSERVED:** Enter the number of individuals of each species and life stage you encountered. Do not estimate total numbers within the survey area, but record only the number that you saw. For egg masses, estimate the number of eggs, note the overall size of mass, condition, and stage of embryos in the NOTES or COMMENTS sections (see Gosner 1960).
- NOTES:** Record any relevant notes specific to the species or life stage observed. Types of observations to include are as follows: 1) what criteria were used to identify a species; 2) if species identification is uncertain, what was observed including both physical features and behaviors would be of use (e.g., "dorsal spots obs.," "ranid like plop," "no bullfrog peep"); 3) record the collection number (AGFD field tag #) of any voucher specimens taken; 4) record any photo vouchers taken; and 5) note the presence of disease or deformities.

COMMENTS: Use this field to elaborate upon species observations. Be sure to reference your comments with the species observation to which it relates by using numbers or letters (i.e., a footnote).