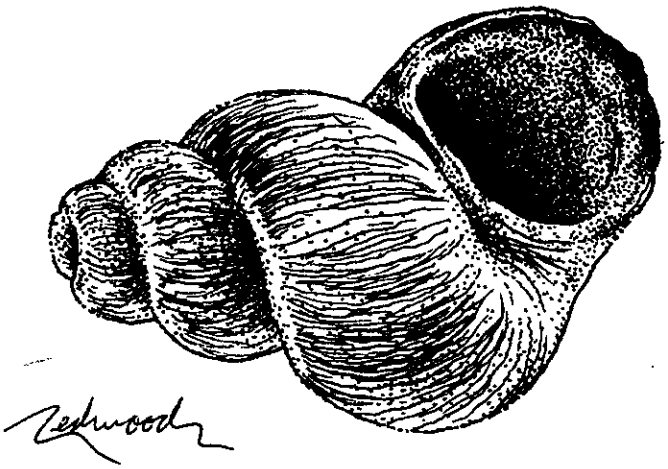
CANDIDATE CONSERVATION AGREEMENT WITH ASSURANCES FOR THE PAGE SPRINGSNAIL (*PYRGULOPSIS MORRISONI*)



March 2009

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CANDIDATE CONSERVATION AGREEMENT WITH ASSURANCES FOR THE PAGE SPRINGSNAIL (*PYRGULOPSIS MORRISONI*)

This Candidate Conservation Agreement with Assurances (CCAA), effective and binding on the date of last signature, is between Arizona Game and Fish Department and the United States Fish and Wildlife Service:

Arizona Game and Fish Department:

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Phoenix, Arizona 85086-5000

United States Fish and Wildlife Service:

Contact: Steve Spangle, Field Supervisor
Arizona Ecological Services Field Office
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021

Agreement Tracking Number: TE-174351-0

I. Introduction

Many species of freshwater mollusks across the globe and in the Southwest area of North America are threatened with extinction. In Arizona, twenty native mollusks have been tentatively identified as wildlife of special concern, and twenty-eight have been identified as "priority species" in Arizona's Comprehensive Wildlife Conservation Strategy, including the Page springsnail (*Pyrgulopsis morrisoni*). To ensure the persistence of the Page springsnail, the Arizona Game and Fish Department (AGFD) and the U.S. Fish and Wildlife Service (USFWS) have cooperated to prepare this Candidate Conservation Agreement with Assurances (CCAA). Interested landowners may participate in the future through a certificate of inclusion that will be distributed through AGFD. Landowners that have expressed interest in participating include: Lo Lo Mai Springs Resort, and landowners in the proximity of Page Springs.

For the purposes of this document, "cooperators" will refer to signatories of this document, "participating property owners" will refer to private landowners participating in this agreement, and "property owners" will refer to both landowners participating in the agreement, and landowners whose participation will be sought in the future. The cooperators believe this agreement illustrates their willingness to conserve the Page springsnail and its habitat, consistent with the Endangered Species Act of 1973 (ESA), as amended.

A CCAA is a formal agreement between the USFWS and one or more non-Federal parties, identifying the conservation needs of a proposed or candidate species before it becomes listed as endangered or threatened. Conservation agreements are used to conserve rare species by identifying threats and bringing cooperators together to alleviate those threats.

The Page springsnail is a candidate for listing as threatened or endangered, pursuant to the ESA (16 U.S.C. 1531 et seq.). The purpose of this CCAA is to: assess the current status of the Page springsnail, provide strategies to ameliorate conditions leading to its candidate status, remove biological threats and vulnerability, bolster population numbers, and maintain, enhance, and restore current and historic populations' habitats.

The cooperators in the Page springsnail CCAA voluntarily agree to implement the management strategies outlined in this document. The information and management strategies discussed in this document are products of interagency communication, landowner involvement, species expert consultation, literature reviews, and field investigations. Implementation of these management strategies is intended to reduce threats to the Page springsnail populations and their habitat, thereby stabilizing and restoring the species. These strategies provide flexibility for current and future land uses, identify and evaluate potential conflict with future development, and minimize recovery effort costs if listing is pursued.

Participating property owners agree to manage their lands as described in certificates of inclusion consistent with this agreement. In return for their participation, the USFWS assures cooperators and participating property owners that their efforts will not incur future management, financial, or other regulatory obligations beyond those agreed upon in this CCAA should the Page springsnail become listed at some time in the future.

II. Responsibilities of the Parties

By signing this agreement signatories agree to the following:

The responsibilities of AGFD are:

1. Current and future activities in managing Page Springs and Bubbling Ponds fish hatcheries will not have long term negative impacts to Page springsnail populations and habitat.

2. Hatchery management activities will minimize loss of Page springsnails and impacts on their habitat, in accordance with the proposed incidental take permit, when conducting maintenance and husbandry activities.

3. Routine AGFD hatchery maintenance activities will be conducted in a manner that will not significantly affect Page springsnails or their habitat. When hatchery activities (e.g., maintenance, renovations, modifications) are conducted that will significantly affect Page springsnails and their habitat, hatchery personnel will notify the AGFD Nongame Native Fish/Invertebrate Program Manager at least 30 days in advance to allow for alternative management activities, or to determine appropriate mitigation to offset any negative affects to the species.

4. Chemicals will be applied with the best available knowledge and used in compliance with labeled usage to limit or avoid damaging habitat and known populations of Page springsnails (Table 1).

5. AGFD and USFWS have developed a survey and monitoring protocol and schedule. The monitoring data will be shared annually with all interested parties, and permanently archived in the AGFD Heritage Data Management System.

6. AGFD will immediately notify USFWS and other cooperators if significant, unnatural declines in Page springsnail populations or significant changes in habitat occur.

The responsibilities of landowners participating through a certificate of inclusion will be described in the individual certificate of inclusion and may include:

1. The landowner agrees to allow USFWS and AGFD to introduce Page springsnails into sites on their property if suitable habitat exists.

2. The landowner will allow USFWS and AGFD biologists to survey and monitor sites for the Page springsnail.

3. The landowner will coordinate with USFWS and AGFD on land modifications, land uses, and water uses that might affect Page springsnail populations, their habitat, or potential habitat. Habitat or potential habitat includes: spring heads, spring outflow areas, spring-fed ponds, and spring-fed streams.

4. The landowner will notify USFWS and AGFD of any activities impacting the habitat of springsnails as soon as possible, so that cooperators can determine the most effective and efficient means of corrective measures.

5. The landowner will not spray or deposit harmful chemicals (e.g., chlorine, herbicides, fertilizers) in the areas in ways that will affect Page springsnail populations, their habitat, or potential habitat.

6. The landowner agrees not to modify potential or currently occupied Page springsnail habitat without express approval of USFWS and AGFD.

7. The landowner will allow USFWS and AGFD to conduct salvage and repatriation of Page springsnail when springsnail habitat will be negatively affected by management activities.

III. Enrolled Lands

This agreement covers the seeps, springs, canals, and artificial water diversions/ impoundments on AGFD properties (Fig. 1):

Arizona Game and Fish Department
Bubbling Pond and Page Springs Hatcheries, Yavapai County, Section 23, Township 16N, Range 4E. For approximate UTM coordinates see Table 1.

1600 N. Page Springs Road
Cornville, Arizona
86325-9738

IV. Authority and Purpose

Sections 2, 7, and 10 of the ESA of 1973, as amended, allow USFWS to enter into this CCAA. Section 2 of the ESA states that encouraging interested parties, through Federal financial assistance and a system of incentives, to develop and maintain conservation programs is key to safeguarding the Nation's heritage in fish, wildlife, and plants. Section 7 of the ESA requires USFWS to review programs that it administers and to utilize such programs in furtherance of the purposes of the ESA. By entering into this CCAA, USFWS is utilizing its Candidate Conservation Programs to further the conservation of the Nation's fish and wildlife. Lastly, section 10(a)(1)(A) of the ESA authorizes the issuance of incidental take permits to "enhance the survival" of a listed species.

AGFD's authority resides in Arizona Revised Stature (ARS) Title (17) and a Memorandum of Understanding (MOU) with the USFWS. The purpose of the Agreement is to facilitate joint participation, communication, coordination, and collaboration between the USFWS and AGFD regarding the implementation of the ESA. Through the Agreement, AGFD and USFWS share the

responsibilities of Candidate, Threatened, and Endangered Species management as is relevant to the ESA.

The purpose of this CCAA is to join AGFD with the USFWS to implement conservation measures for the Page springsnail by establishing a population survey and monitoring protocol, protecting existing habitat from further degradation, restoring degraded habitat, and reintroducing Page springsnails to new and historical sites when feasible. Furthermore, through certificates of inclusion this CCAA seeks to include willing landowners to assist with the conservation of the Page springsnail in exchange for assurances from USFWS that their efforts will not incur future management, financial, or other regulatory obligations beyond those agreed upon in this CCAA, should the Page springsnail be listed at some time in the future.

Participating property owners agree to manage their lands as described in certificates of inclusion consistent with this CCAA.

Legal Protections afforded to the Page springsnail in Arizona by State laws and regulations include the following:
ARS Title 17
ARS Sec. 17-101- Definitions

> A.21 "Wildlife means all wild mammals, wild birds, and the nests or eggs thereof, reptiles, amphibians, mollusks, crustaceans, and fish, including their eggs or spawn.
>
> B. 1. Aquatic wildlife are all fish, amphibians, mollusks, crustaceans, and soft-shelled turtles.

ARS Sec. 17-306 – Importation, transportation, release or possession of live wildlife

> No person shall import or transport into the state or sell, trade, or release within the state or have in his possession any live wildlife except as authorized by the Commission.

Commission Order 42 of AGFD (Mollusk and Crustacean regulations) prohibits collection or hunting of all springsnails, including the Page springsnail, in Arizona, except when done under the authority of a special permit.

Live Wildlife: Prohibited Acts
R12-4-402.A - A person shall not import or transport any live wildlife into the state, or possess, offer for sale, sell, sell as live bait, trade, give away, purchase, rent or lease, display for any purpose, propagate, stock, or release within the state any live wildlife, or export any live wildlife, or kill any captive wildlife, or operate a shooting preserve, except as authorized by this Chapter or as defined in A.R.S. Title 3, Chapter 16. A person may exhibit lawfully possessed wildlife only as authorized by this Chapter or as defined in A.R.S. Title 3, Chapter 16.

V. Description of Existing Conditions

Current Status and Listing History

The ESA requires the USFWS to identify wildlife and plant species that may become endangered or threatened, based on the best available scientific and commercial information. As part of this responsibility, the USFWS maintains a list of species that are being considered for listing. The Page springsnail first received special status designation when it was included as a Category 2 Candidate species in the Endangered and Threatened Wildlife and Plants; Annual Notice of Review on January 6, 1989 (54 FR 554). Category 2 taxa were those for which the USFWS possessed sufficient information to propose listing as threatened or endangered, but conclusive data on biological vulnerability and threats were lacking to support issuance of a proposed rule. The Page springsnail remained a Category 2 Candidate until subsequent data supported a change in status on February 28, 1996, to Category 1 Candidate (61 FR 7595). Category 1 Candidates were species for which the USFWS had sufficient information on file regarding its biological vulnerability and threats to support issuance of a proposed rule to list as threatened or endangered.

On February 28, 1996, the USFWS issued the Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that are Candidates for Listing as Endangered or Threatened Species, which proposed to discontinue maintaining a list of Category 1 or Category 2 species (61 FR 7595). When the rule was finalized on December 5, 1996, species that had been Category 1 Candidates simply became Candidates. The Page springsnail was included in the February 28, 1996 notice, and since then has maintained its status as a Candidate for listing, and has been included in the most recent review of plant and animal taxa (72 FR 69034). The USFWS has sufficient information on biological vulnerability and threats on file to support issuance of a proposed rule to list the Page springsnail, but thus far has been precluded by higher listing priorities.

Description

The Page springsnail is one of approximately 170 species of Hydrobiids (Caenogastropoda: Rissooidea) in the United States. Originally identified as a *Fontelicella* n. sp. by Landye (1973), this springsnail was fully described by Hershler and Landye in 1988 as *Pyrgulopsis morrisoni* from a type specimen collected at Cave (Page) Springs, Yavapai County, Arizona. Hershler and Landye (1998) describe the Page springsnail as a medium sized hydrobiid, with a shell height of 1.8 to 2.9 mm. The shell is ovate or ovate-conic in shape characterized by slightly convex whorls. The inner lip of the shell is thin and usually adnate (i.e. two unlike parts that are closely attached) to the body whorl. The aperture is less than half of the body whorl height and the umbilicus is open. In one of two populations studied, females are larger than males (Hershler and Landye 1988).

Body pigmentation may either be absent from the head and foot, or consist of light to moderate dusting throughout, with the exception of the tentacles. Ctenidial filaments (i.e., gills) number 15 to 19. The radula (i.e., tongue-like feeding appendage) is distinguished by many cusps on the central and inner marginal teeth. Like many terrestrial and aquatic snails, the Page springsnail's defining characteristic is the male genitalia. The Page springsnail's distinctive penis is elongate and of moderate size. It has a narrow filament of medium length and a relatively large lobe. The narrow filament rarely extends beyond the enlarged penial lobe. Near the tip of the penial lobe is a single glandular ridge on the ventral surface. The size of the seminal receptacle is equivalent to

approximately 88% - 105% of the bursa length. For a more detailed description and thorough review of the morphological characteristics of Arizona hydrobiid snails, see Hershler and Ponder (1998) and Hershler (1994).

Distribution

Hydrobiidae is an old and diverse group, containing over 1,000 extant (Boss 1971) and 400 recent and fossil genera (Kabat and Hershler 1993) dating to the late Paleozoic era. Page springsnails are locally endemic to the Verde Valley (Hershler and Landye 1988). All extant populations are known from a complex of permanent springs along the east and west sides of Oak Creek near the community of Page Springs, Yavapai County, (TI6N, R4E, Sections 14, 15, 23, 25) Arizona. The Oak Creek spring complex is approximately 1.5 km (.93 mi.) long and includes outflow at Lo Lo Mai, Bubbling, and the aforementioned sites at Page Springs (status unknown at Turtle and Fry springs). Historically, a population was recorded from Shea Springs at Tavasci Marsh, east of Clarkdale, in Yavapai County, Arizona (T16N, R3E, Sections 15 and 22). The population at Shea Springs is believed to be extirpated (Hershler and Landye 1988).

The springs and outflow channels of the Oak Creek springs complex and Shea Spring are owned by numerous landowners. These natural water sources are utilized for a variety of purposes including fish production; pasture irrigation, watering livestock, ornamental ponds, and domestic use. Three springs "Fry, Turtle, and Lo Lo Mai," are on privately owned land near the community of Page Springs. Another population was recently found along the headwaters of Spring Creek (UTM 415703, 3848273) during interagency field investigations on July 24, 2007. Their taxonomy was confirmed by experts at the Smithsonian Institution (Bob Hershler, In. Litt., 2007)

The current and historical use of Fry Springs is unknown, and the owner has indicated the site is unavailable for conservation activities (letter to USFWS on September 29, 1995). Nearby Turtle Springs is believed to have been used for watering livestock, and the new owner has indicated a willingness to participate in Page springsnail conservation efforts (pers. comm. with landowner 1998). Lo Lo Mai Springs, another privately owned spring, is located on the Lo Lo Mai Springs Resort. Discussions between resort staff and AGFD personnel suggest that the spring-fed pond was historically used for recreational sport fishing. The headwaters of Spring Creek are currently under construction for residential development.

Shea Spring, another historical locality, is currently owned by the National Park Service (NPS). Shea Spring is contiguous with Tavasci Marsh, which was once drained and managed for livestock forage (pers. comm. L. Riley; AGFD 1997c). This site has good potential for future conservation actions for the Page springsnail.

Properties managed by AGFD include Bubbling, Page (Cave), Bass House Springs, and four unnamed springs within the Page springs complex. All four springs are located on the Page Springs and Bubbling Ponds fish hatcheries and have been utilized for fish production for more than 50 years (AGFD 1997a, 1997b). Both hatcheries are located along Oak Creek, approximately 8 km (5 mi) north of Cornville, Yavapai County. The Page Springs Hatchery began operating in 1932, originally as the Arizona Trout Company. In 1938, the Arizona Game

and Fish Commission (AGFC) began leasing the property, purchasing it in 1949. Page Springs Hatchery is the state's largest coldwater fish production facility at approximately 33.2 hectares (82 acres).

Bubbling Ponds Hatchery, a warmwater hatchery, is comprised of two parcels approximately 823 m (2700 ft.) apart and totaling 47.3 hectares (117 acres). Since the property was acquired by the AGFC in 1954, it was used primarily for the production of trout, catfish, and warmwater sportfish until the mid 1990's when the hatchery started to rear threatened and endangered native fish (AGFD 1997a, 1997b). The spring sources and surrounding land at both the Bubbling Ponds and Page Spring hatcheries have been heavily used for agricultural needs since the 1870s. Despite human use of the springs and surrounding land over approximately the last 100 years, Page springsnails have persisted.

Although the primary function of Bubbling Ponds and Page Springs hatcheries is fish production, the management plans for both facilities include provisions to protect endemic invertebrates, including the Page springsnail (AGFD 1997a, 1997b) (see Figure 1).

Habitat Preference

Page springsnail habitat is found at approximately 1070 m (3,510 ft) elevation in permanently saturated, spring-fed aquatic climax communities often described as ciénegas (Hendrickson and Minckley 1984). Hydrobiid snails, like the Page springsnail, inhabit permanent water sources such as springs, seeps, marshes, spring pools, outflows, and diverse lotic (running) waters (Hershler and Lande 1988; Raisanen 1991). Page springsnails prefer to attach to firm substrates such as cobble, rocks, woody debris, and aquatic vegetation. Unaltered springsnail habitat is generally free flowing, shallow, and lacks inundation over the springhead. In inundated habitats, the substrate around spring vents tends to be sandier and silty, giving way to more gravel and cobble in outflow areas where the water velocity increases. These habitats are thought to provide a suitable environment for the production of periphytic diatoms, the primary food source of Page springsnails.

In the summer of 2001, Martinez and Thome (2006) described habitat use of Page springsnails. They found that occurrence and high density of Page springsnails were associated with gravel and pebble substrates, while absence and low density were associated with silt and sand. They also found that occurrence and high density were associated with lower levels of dissolved oxygen, low conductivity, and shallower water depths. The authors went on to speculate on the importance that water velocity plays in maintaining springsnail habitat: by influencing substrate composition and other physico-chemical variables (Martinez and Thome 2006).

Aquatic vegetation typically associated with Page springsnail habitat includes: watercress (*Nasturtium officinale*), duckweed (*Lemna minor*), water parsnip (*Berula erecta*), water pennywort (*Hydrocotyl venicillata*), water speedwell (*Veronica anagalli aquatica*), and dock (*Rumex verticillatus*). Prominent aquatic macrophytes found in Bubbling Springs and Lo Lo Mai Springs include: waterweed (*Elodea occidentalis*), pondweed (*Potamogeton gramineus*), and algae (*Rhizoclonium hieroglyphicum* and *Oscillaloria rubesens*). Dominant riparian vegetation along Oak Creek and the springs includes: velvet ash (*Fraxinus velutina*), Fremont cottonwood

(*Populus fremontii*), Arizona sycamore (*Plantanus wrightii*), willow (*Salix* spp.), mesquite (*Prosopsis* spp.), walnut (*Juglans major*), and berry bush (*Rubus* spp.).

Shea Springs is contiguous with Tavasci Marsh and is located approximately 14.5 km (9 mi.) from the Page Springs complex, near Peck Lake. The marsh, or ciénega, is an open water wetland located within an oxbow of the Verde River. Elevation is approximately 1,005 meters (3,297 ft.) and characteristic vegetation in the marsh includes cattails (*Typha* spp.), bulrush (*Scirpus* spp.), and sedge (*Carex* spp.). Surrounding the marsh are cottonwood, willow, and mesquite trees. Limited information is available on the biotic communities of Shea Springs.

Native aquatic invertebrates occurring within these springs includes: amphipods (*Crangonyx gracilis* and *Hyaella azteca*), caddiesflies (*Protoptila balmorhea* and *Metrichia volada*), other snails (*Physella virgata* and *Planorbella duiyi*), and an endemic species of leech (*Moiobdella suddenness*) at Bubbling Springs Pond (Govedich *et al.* 1998).

Page springsnails do not occur in significant numbers in man-made outflow channels. Proximity to spring vents seems to play a key role in the distribution of Hydrobiids (Hershler 1994 and 1998, O'Brien and Blinn 1999, Mladenka and Minshall 2001, Malcolm *et al.* 2005, Martinez and Thome 2006). *Pyrgulopsis* often exhibit dramatic declines in density downflow from spring sources, presumably due to their need for stable temperature, water chemistry, and flow regime characteristic of springheads (Hershler 1998). Although outflow channels downstream from springheads (e.g., irrigation ditches and overland flow) periodically contain springsnails, data are insufficient to suggest whether or not these areas are capable of supporting viable populations. A similar distributional pattern in outflow downstream channels was observed in hydrobiids at Cuatro Cienegas, Coahuila, Mexico (Hershler 1984). Hershler attributed the downstream decrease in springsnail numbers to changes in aquatic vegetation and algal composition and distribution.

Dissolved carbon dioxide (CO_2) concentration is an important environmental factor limiting the distribution of a congener, the Montezuma Well springsnail (*P. montezumensis*) (O'Brien and Blinn 1999). Research on the Montezuma Well springsnail suggests it prefers habitats with a dissolved CO_2 concentration between 110 and 315 mg/L (O'Brien and Blinn 1999). This preference for elevated dissolved CO_2 levels may have begun as an adaptive response to predation, and eventually evolved into a physiological requirement. Although springs harboring Page springsnails have significantly lower levels of dissolved CO_2 than springs harboring Montezuma springsnails (D.W. Blinn, In. Litt., Sept 1998), a different water chemistry parameter may have the same effect of limiting predators and competitors.

Another factor possibly limiting distribution is availability of calcium carbonate ($CaCO_3$). Calcium carbonate is an important component of shell formation in springsnails. Pennak (1978) found that gastropods associated with highly alkaline waters, especially in western North America, are generally smaller than those found in other habitats. AGFD monitors water quality at the hatchery inflows and outflows, and basic water quality data have been collected from springheads where Page springsnails are found. Additional research is needed to clarify the roles of habitat and water chemistry on the distribution of the Page springsnail. The attached protocol

(appendix c) is one such attempt to understand the roles of habitat and water chemistry on Page springsnails.

Population Trends, Current Status, and Natural History

Limited data are available regarding historical range, current population status, and changes in springsnail abundance over time. Page springsnails are known to be present at several sites at Page Springs and Bubbling Ponds hatcheries (Fig. 1). Several attempts have been made to search for additional sites beyond AGFD property since the efforts of Raisanen (1991). In 2002, AGFD investigated two sites around the Page Springs and Bubbling Ponds hatcheries, both sites were reported to have good habitat, but did not contain Page springsnails. In 2006 and 2007 sites at Lo Lo Mai and at Spring Creek were searched and contained extant populations of Page springsnails. More springs need to be surveyed in search of Page springsnail populations on both AGFD and private land around the hatcheries and within the watershed.

No species-specific information is available on the reproductive biology of the Page springsnail, and little exists for other hydrobiids. Most springsnails appear to have direct development, but a few estuary or brackish water taxa have a pelagic (i.e., free-swimming) larval stage (Hershler and Ponder 1998). Some hydrobiids deposit small egg capsules singly, rarely in strips, on submerged substrate. Other species brood shelled young internally, perhaps explaining why female Page springsnails are larger than males, at least in one population. Natality and mortality rates are not known. However, the typical life span of aquatic gastropods is 9 to 15 months (Pennak 1978).

Common predators of springsnails include: fish, waterfowl, shorebirds, amphibians, leeches, aquatic insects, and other snails. No information on the affect of disease or parasites is available for the Page springsnail, although other aquatic snails have been known to serve as the intermediate hosts for a variety of trematodes (Schell 1985).

A 2004 genetic study by Carla Hurt (Arizona State University) concluded that the population of snails at Bubbling Springs Pond is genetically different (different haplotypes) than the populations in the Oak Springs complex. The author went on to suggest since there were different haplotypes at the two populations, the sites should be managed separately, in order to maintain the genetic differences between populations (Hurt 2004).

Current and Potential Threats to the Page Springsnail

Under Section 4(a) of the ESA, the Secretary of the Interior is directed to determine whether a species is threatened or endangered based on the following factors:

1) Present or threatened destruction, modification, or curtailment of the species' habitat or range.
2) Over-utilization for commercial, recreational, scientific, or educational purposes.
3) Disease or predation.
4) Inadequacy of existing regulatory mechanisms.
5) Other natural or manmade factors affecting its continued existence.

For the Page springsnail, information exists which may support more than one of these factors.

1) Present or threatened destruction, modification, or curtailment of the species' habitat or range.

Springhead modification activities on private and state lands have likely reduced the availability of habitat and Page springsnail abundance (AGFD 1991; Raisanen 1991). Regional surveys and data on current population status and recent trends are needed to definitively assess the effect of habitat loss or modification on Page springsnails. Humans have likely modified all the major springs in the Oak Creek complex to some degree, either in recent times or historically. Impoundments and outflow restrictions have resulted in the inundation of privately owned Fry, Lo Lo Mai, and Turtle Springs. Likewise, most of the springs located on AGFD property have also been modified to improve or direct water flow to hatchery ponds and runways. Bubbling Springs Pond is almost entirely impounded and the springheads are inundated. Bass House Spring is highly modified resulting in springhead inundation. Fish production features at Page Springs were renovated, with completion in 1992. One of the features included the fencing (security) of the Cave Spring outfall area and concrete lining of the spillway securing the outfall area from erosion and collapse. Flows from the Page (Cave) Spring can not be altered or adjusted because a portion of the spring yield fulfills water right claims of downstream users. Two unnamed spring areas (gallery of seeps) are now collected in a French drain underground and have been covered. Renovation activities in these areas were identified in an Environmental Assessment (1988) prior to initiation of modifications. This modification resulted in the loss of approximately 0.40 hectare (1 acre) of surface water, and likely resulted in the loss of an unknown quantity of springsnails and their habitat (AGFD 1991; Raisanen 1991). The USFWS determined that the renovation project met the definition for a categorical exclusion under the National Environmental Policy Act (NEPA) for Federal Aid proposals. In an attempt to mitigate the loss of potential springsnail habitat due to the renovation, volunteers working with AGFD dug a channel [approximately 46 m (50 yards) long, 46-61 cm (18-24 inches) wide, and 30.0-46 cm (12-18 inches) deep] from the spring and lined it with rocks (site dubbed "Ash Tree Spring"). Although water is often impounded in the artificial channel, the spring supports a population of springsnails (AGFD unpublished data).

Bass House Spring had been covered with a small wooden shed since the 1950s to prevent leaves and debris from clogging the water line supplying hatchery runways. The wooden shed may have prevented most sunlight from reaching the approximately 1.5 m (5 ft) diameter springhead, limiting primary productivity and the snail's hypothesized diet of periphyte diatoms. Further modification of the spring resulted in an inundation of the springhead by creating a pond; further reducing the quality of habitat for the snail. AGFD removed the solid wooden shed in March 2001 and replaced it with an open-air sided structure. In June of 2005, the structure was further modified by AGFD; the roof was changed from a solid surface to an open air surface to increase the habitat quality for Page springsnails. The 2005 effort appears to have been unsuccessful in increasing the habitat quality at Bass House. Page springsnails have been found periodically in the outflow from Bass House Spring and have been found in the outflow weir box as recently as 2004 (AGFD unpublished data). They have not been found in the modified springhead and would need to migrate through a small culvert to colonize the springhead.

Shea Springs has also been subjected to natural and man-made modifications. Landye (1981) believed that pooling of water below the springhead was at least partially responsible for the decline of the species and possible extirpation. Alternatively, Raisanen (1991) thought dredging of the spring was the primary cause of extirpation. Regardless of the factors leading to extirpation at Shea Springs, suitable habitat for Page springsnails may still exist.

Additionally, residential development is currently planned for the area around Spring Creek where springs are located which provide habitat for the species. This development will result in placement of impermeable surfaces (i.e., asphalt and concrete) near the creek, further groundwater withdrawals, and an increase in human use of the area. Specific effects are difficult to speculate, but may include introduction of pollutants from urban runoff (i.e. motor oil, pesticides, etc.), increased stress on the regional water table or aquifer that supports these springs, and habitat modification from human and pet trampling.

Another management activity which has the potential to threaten Page springsnail populations is the mechanized, chemical, or hand removal of emergent and submerged vegetation. Aquatic vegetation and algae have been removed from Lo Lo Mai Springs for recreational benefits (Raisanen 1991) and from Bubbling Springs Pond to improve water flow. Non-native ornamental pond plants such as tam and water iris have extensively colonized large areas around some springheads and in outflow ditches down stream from Lo Lo Mai, possibly degrading the habitat for Page springsnails. Removal of native or non-native aquatic vegetation and organic debris can also result in snail mortality and habitat loss. These activities can result in direct mortality from crushing or desiccation, and indirect mortality through habitat and water quality changes.

Page springsnail mortality and habitat degradation could also occur if trespass livestock were to gain access to the springheads. A population of Chupadera springsnails (*P. chupaderae*) endemic to a spring in Socorro County, New Mexico, was extirpated due to the impacts of livestock grazing on their habitat (Arritt 1998). Trespass livestock do not appear to be a problem at Bubbling Springs Pond or Page Spring hatcheries (pers. comm. R. Sorensen 2005). The last incident of a livestock trespass was in 2002, at Bubbling Ponds hatchery. In 2001 and 2004, AGFD personnel built fences around each of the springs at the Page Springs hatchery in order to keep cattle and humans from trampling Page springsnails and habitat. A security fence around Bubbling Springs Pond was installed in 2008.

Groundwater pumping and mining from the aquifer feeding the springs could be a great threat to the Page springsnail's habitat. Groundwater depletion has been implicated in the decline of other freshwater mollusks (Landye 1973, 1981). There are numerous active (pumping), drilled, and potential wells in the immediate vicinity of Page Springs (Fig. 2). AGFD hatchery personnel (pers. comm. R. Sorensen 2002) suspected that recent wells drilled into the aquifer supporting the Oak Creek springs complex could be affecting spring flows. An analysis of the water flow rate from Page Spring between January 1, 1996 to February 9, 2000, detected a significant decline ($r = -0.802$, $p = 0.001$); approximately 2.8 km^3 (1 ft^3) per second or a 15% decline in flow (K. Mitchell 2001). However, the 5-year period in which spring flow was monitored also coincides with a drought period. The Palmer Drought Severity Index, published by the National Climatic Data Center, indicates severe to extreme drought conditions for 5 of the 7 years between 1994 and 2000 (Mitchell 2001).

Drought conditions and groundwater pumping may play a role in recent declines in spring flow (Mitchell 2001). Since 1997, Arizona Department of Water Resources records show that 3 wells have been drilled in close proximity and upgradient of Cave (Page) Spring. Two of these wells pump between 4.5 and 5.7 m^3 (1200 - 1500 gallons) per minute, and are within 1.2 km (.75 mi.) of Cave (Page) Spring. Given their proximity, production rate, and hydrological connectivity, groundwater withdrawal by these wells could have a direct impact on flow at Cave (Page) Spring (Mitchell 2001). However, the impact of these wells on the spring cannot be determined without long-term aquifer tests and simultaneous discharge monitoring at Cave (Page) Spring (Mitchell 2001).

A thorough review of the geomorphology, chemical composition, and groundwater migration in the Verde Valley can be found in Twenter and Metzger (1963), Owen-Joyce and Bell (1983), and Mitchell 2001. Twenter and Metzger concluded that permeable sandstone beds in the Supai Formation are the primary source of water for springs in the Page Springs area, and much of the perennial flow in Oak Creek is from these springs. In the Verde Valley, the regional aquifer includes Verde River alluvium, the Verde Formation and underlying basalt flows, the Supai Formation, and the Redwall Limestone, all of which are hydraulically connected (Owen-Joyce and Bell 1983). The majority of wells in the Page Spring area tap the aquifer that supports the Oak Spring's complex (Mitchell 2001).

A 1997 study indicated that the groundwater system of the Verde Valley, particularly the Verde Formation and underlying Supai Formation, had not yet been affected by development (Koniecski and Leake 1997). A 1996 study indicated groundwater pumping in the Verde Valley was probably less than 24,670 m^3 (20,000 acre-feet) per year (McGavock 1996). The base flow in the Verde River north of Clarkdale has remained virtually unchanged since 1915 (Owen-Joyce and Bell 1983). However, municipal and industrial reliance on groundwater continues to grow in the Verde Valley, and future water levels and stream base flows will eventually be affected (Owen-Joyce and Bell 1983; McGavock 1996; Koniecski and Leake 1997). Blasch et al. (2006) suggests that groundwater storage in the Verde River Watershed has already declined due to groundwater pumping and reductions in natural channel recharge resulting from streamflow diversions.

Landye, Hershler, and Williams (Landye 1973; Hershler and Williams 1996) indicated that management should focus on maintenance and protection of springheads. They speculated that if protection of Page springsnail habitat occurred, conservation of the Page springsnail would be feasible.

2) Over-utilization for commercial, recreational, scientific, or educational purposes.

The Page springsnail's minute size (<1 mm) and cryptic coloration make it an unlikely candidate for commercial or recreational uses. It is unknown whether its rarity or notoriety will make this species vulnerable to future collections by curious individuals or vandals. Page springsnails have been subjected to a limited number of scientific studies, with no long-term effects on the species or a specific population. Future studies and population monitoring efforts will likely require the

take of some individuals (intentional and unintentional), but should be conducted in a manner not threatening to population viability.

3) Disease or predation.

No information is available on the impact of disease on Page springsnail populations, and minimal specific information is available on predators. Potential predators of Page springsnails include migratory waterfowl (*Anas* spp.), aquatic invertebrates, and predatory fish. Raisanen (1991) examined the stomach contents of nonnative mosquitofish from the Oak Creek springs complex and found remnants of Page springsnail shells. Numerous species of predatory fish, including mosquitofish (*Gambusia affinis*), have occurred in, Tavasci Marsh, including Shea Springs and Bubbling springs pond.

In addition to nonnative fish, two species of nonnative snails (Chinese mystery snail *Cipangopaludina chinensis*, and decollate snail *Rumina decollata*), are sympatric with Page springsnails at Bubbling Springs and Page Springs hatchery. Exotic mollusks can be detrimental to native snails (Landye 1981), however it is unclear whether the nonnatives simply compete for resources or predate any life-stage of the Page springsnail. There is no definitive data available to conclude that competition is a limiting factor. In March 2001, non-native crayfish were discovered in a drainage ditch next to Bubbling Springs Pond (AGFD unpublished data). Crayfish are known predators of aquatic snails. (Fernandez and Rosen 1996). Crayfish and other predators may negatively affect efforts to maintain extant populations of Page springsnails and future efforts to re-establish others.

4) Inadequacy of existing regulatory mechanisms.

The Page springsnail was added to AGFD's Commission Order 42 (Crustaceans and Mollusks), as a closed-season species, prohibiting unauthorized collecting. The Commission Order regulates collection of the Page springsnail, but does not provide habitat protection. Furthermore, a scientific collection permit is required to collect or manipulate populations within the state of Arizona. Although the Page springsnail has maintained candidate status since 1989, it has no legal protection under the ESA.

Hatchery property occupied by Page springsnails is restricted from public visitation with fencing and signage, thus Page springsnail populations are protected from accidental or intentional take. AGFD management plans for the Bubbling Ponds and Page Springs hatcheries (AGFD 1997a, 1997b) include provisions to protect endemic invertebrates and provide habitat, specifically noting the Page springsnail. Construction projects at the hatcheries require an Environmental Assessment Checklist (EAC) and are evaluated by AGFD's Nongame Branch Chief and others to evaluate detrimental impact on Page springsnail populations or their habitat. EACs were developed to meet the oversight needs of AGFD and USFWS's Federal Aid Program in reviewing effects of activities on sensitive species. Neither State nor Federal law, regarding the Page springsnail, restricts habitat modification on private property. Additionally, Arizona State water laws do not protect surface waters, such as springs, seeps, and rivers, from impairment due to groundwater pumping.

5) Other natural or manmade factors affecting its continued existence.

Endemic species whose populations exhibit a high degree of geographic isolation are extremely susceptible to stochastic extinction resulting from manmade or natural catastrophic events. Events potentially affecting the continued existence of Page springsnails include: climatic change, flooding, drought, livestock grazing, water quality degradation, and others.

Chemicals used to reduce the spread of fish diseases, parasites, unwanted vegetation, and spread of non-native fish, could negatively impact Page springsnails. For example, chlorine was used to disinfect Bubbling Ponds springs in 1980 to eradicate the virus that causes Infectious Pancreatic Necrosis of salmonid fishes (AGFD 1991), and Landye (1981) believes that these disinfection treatments reduced the Page springsnail population. Chlorine is known to be toxic to fish, crustaceans, and mollusks, (Spraque 1990; Briggs et al. 1992) however; lethal doses are unknown. Rotenone and herbicides have been used at Lo Lo Mai Springs to eradicate unwanted fish and control aquatic vegetation. Rotenone inhibits respiration in fish, and could be absorbed by snails during respiration and foraging activities. The effects of these chemical treatments on Page springsnails are unknown, but some researchers believe they could adversely affect them (Landye 1981).

VI. Conservation Measures

The objective of this CCAA is to provide protection to the Page springsnail and its habitat, and to provide a framework for addressing its continued conservation. The following strategies will be undertaken to reduce or remove threats to the Page springsnail. When the identified strategies are completed and the conservation criteria achieved, the cooperators will evaluate the protection afforded the Page springsnail and its Candidate status. These strategies include the protection and enhancement of extant populations and their habitat, natural history research, restoration of degraded habitat, translocations to restore historical populations, or other activities that improve the status of Page springsnails. As new information or empirical data becomes available, these actions can be modified through adaptive management to achieve species conservation.

If known threats to the Page springsnail are not satisfactorily resolved through this CCAA, and/or the conservation actions are not completed in accordance with the implementation schedule, the USFWS may initiate listing the species.

Conservation efforts by AGFD and USFWS have been funded since the early 1990s, when concern for the Page springsnail was first raised. Both agencies have contributed significant staff time and funding in the form of monitoring, research, and renovations to conserve the species. AGFD and USFWS will continue funding staff and projects to conserve the Page springsnail. Cooperators will work diligently to secure additional funding to implement the conservation measures of this CCAA.

Cooperators agree to implement the following management strategies to ensure conservation of the Page springsnail and its habitat. Implementation is subject to availability of funds and compliance with all applicable regulations, beginning when the CCAA is signed.

An implementation schedule and approximate deadlines are outlined in Table 2. The initial strategies are structured to acquire the data necessary to refine or initiate later management strategies. The USFWS agrees to provide technical assistance in support of this CCAA, permit application development, and to seek funding sources for these activities.

The cooperators will meet annually to evaluate the effectiveness of the strategies and determine whether they should be revised or eliminated. If a strategy or some portion of this CCAA cannot be fulfilled as scheduled, or if cancellation is desired, the party requesting such action will notify the other parties within 45 days. The duration of this CCAA is five years. At least six months prior to the expiration of this CCAA, the cooperators will meet to decide whether to modify, create anew, or terminate the original CCAA.

All conservation actions will be considered for review under AGFD's EAC process. The EAC ensures that Department Federal Aid activities comply with NEPA according to AGFD's Policy I2.2. Policy I2.2 further states that AGFD will meet the objectives of NEPA on any other project or program that may have an effect on the environment. The EAC provides a systematic process for identifying issues and evaluating effects associated with proposed projects or programs.

Cooperators will implement the following conservation actions:

1. Prevent future detrimental habitat modification at known localities.

Modifications to springheads may have detrimental effects on Page springsnail populations. Springhead habitat on cooperators' property known to support, or likely to support, Page springsnails will be protected from further degradation, modification, or diversion, unless actions are determined in advance by AGFD and USFWS not to negatively impact the species. Future activities that may affect Page springsnails or their known habitats must be coordinated with AGFD and USFWS. Types of activities that may affect Page springsnails or their habitat include: the use of herbicides or other chemicals, mechanized or manual aquatic vegetation control, introduction of (unmanaged) non-native organisms, addition of material into the habitat, construction of new impoundments or other water control devices, modification of existing structures, and diversion of water. This conservation measure is already supported by agency base funding.

Benefit: Protection of Page springsnail habitat will allow populations to persist and is a crucial part of conserving the species. Notification that loss of individuals or habitat may occur will allow AGFD and USFWS an opportunity to evaluate alternatives and rescue and relocate individuals of the covered species.

Measure of Success: Habitat and Page springsnail populations will not decrease throughout the duration of the CCAA. Biological measures will be consistent with the survey protocol. Cooperators agree to notify AGFD and USFWS of any modifications that may impact Page springsnails, in writing, at least 30 days in advance.

2. Research.

Additional basic natural history and population trend information is needed to support future management decisions and evaluate conservation strategies. Cooperators agree to pursue potential funding sources to support research, and in some cases, assist in the collection of data. Cooperators have no affirmative obligation to individually provide funding unless they voluntarily choose to do so. Possible funding sources include the AGFD Heritage External Grant Program, the National Fish and Wildlife Foundation Partners for Fish and Wildlife Program, the Arizona Water Protection Fund, Section 6 ESA funds, State Wildlife Grants, other agency sources, and private contributions. Funding and investigator(s) are needed to answer the following questions:

A. Population demographics and natural history. Estimate the size of known populations, seasonal density fluctuations, abundance variations among and between springs, sex and age structure, and natality and mortality rates. Further characterize habitat preferences (e.g. CO_2 and dissolved $CaCO_3$ levels, substrate type, water temperature, flow rate), diet, predators, affect of non-native species, and factors limiting distribution.
B. Distribution. Document the current distribution (presence/absence) of Page springsnails at historical sites, and survey seeps, springs, and other water bodies on public lands and private property (with consent of landowner) in the Verde Valley.
C. Taxonomy. Additional analysis comparing shell morphology, anatomy, and genetic relationship of known populations of Page springsnails and congenerics is needed. This information could help estimate how much of the Page springsnail's total genetic diversity is due to genetic variability within populations, versus how much is due to variability among populations.

Benefit: Researching baseline biological and ecological data is essential for evaluation and documentation of trend, determining appropriate management actions, and refining management strategies.

Measure of Success: Research questions (A, B, C above) will be investigated and reported on in annual reports, and/or technical reports and the results will be included in future management strategies.

3. Implement monitoring programs.

Implement a monitoring program for all known populations and habitat types on cooperators' properties. The objective of the Page springsnail monitoring program is to measure the effectiveness of the agreed upon management strategies, and provide baseline information on abundance and population trends. AGFD and USFWS have created a survey and monitoring protocol to document snail presence/absence, population size estimates, and habitat conditions. Landowners are strongly encouraged to monitor populations of Page springsnails (annually) on their property (or provide agency access) and submit the results to AGFD. AGFD will house the data on the Heritage Data Management System, which will serve as a permanent central repository. Annual reports summarizing monitoring results should be compiled and distributed to interested parties. This conservation measure is already supported by agency base funding.

A water flow measuring device has been established at Bubbling Springs pond and will be used to measure quantity of water emerging from the site. The flow rates will be monitored and reported on in the annual report. Additional water-flow monitoring devices should be considered and established if necessary. These measuring devices will show seasonal fluctuations in water flow and unsustainable aquifer usage due to groundwater pumping.

Benefit: Page springsnail monitoring is necessary to determine and document population viability, for evaluation and documentation of population trends, and for assessing the success or failure of management activities.

Water-flow monitoring is necessary to determine baseline water levels needed for Page springsnail persistence.

Measure of Success: Water and Page springsnail monitoring protocols will be fully implemented. Springsnail monitoring will be implemented during annual surveys and water monitoring will be implemented in its most appropriate form. The protocols and monitoring results will be reported in annual reports and or technical reports.

4. Evaluate the aquifer supporting Page springsnail habitat.

Cooperators will gather, compile, review and prepare a report on hydrological information on the Oak Creek springs complex, Shea Springs, and the regional aquifer, and threats to sustaining historical flow rates from the springs. The report should evaluate current and projected water use, current or projected threats to water flow or quality, including groundwater pumping and water diversion and actions necessary to preserve adequate Page springsnail habitat. Some recommended actions may not be feasible in light of existing permitted usage, such as diversions and pumping, and are subject to valid and existing water rights.

If threats to the aquifer are identified, Cooperators will reevaluate the effectiveness of the conservation strategy and determine if the effects of groundwater pumping can be ameliorated through the Conservation Agreement process. Cooperators should initiate and maintain a working relationship with the groundwater management authority for Yavapai County and the Verde Watershed Association, to ensure the Page springsnail's needs are considered in regional water planning efforts. Also, the technical expertise of the U.S. Geological Survey may be needed.

Benefit: Knowledge of the aquifer's condition will allow for more realistic management of the Page springsnail and the amount of water available.

Measure of Success: Conduct an evaluation of the aquifer and evaluate the effectiveness of the conservation measures in light of the condition of the aquifer. Report on the condition of the aquifer and its implications on the conservation measures in either annual reports and/or technical reports.

5. Evaluate, restore, and create habitat.

Cooperators will seek opportunities for restoring and or creating habitat on private or public lands, however federal lands are not covered by the assurances provided in this CCAA. Baseline data regarding habitat suitability are needed before any habitat modification efforts can begin. Restoration activities may include removing or modifying springhead impoundments, adding substrate preferred by Page springsnails, and eradication of non-native species. Consideration should be given to water quality (i.e., dissolved CO_2, dissolved O_2, and temperature); predator density, and condition of the springhead (i.e., whether it is inundated or free-flowing); property ownership, and economic or cultural impact when evaluating sites. The feasibility and likelihood of success should be assessed before extensive remediation efforts are initiated to avoid unnecessary ecological damage, take, and waste of financial resources. When possible, habitat restoration and renovation activities will be conducted incrementally or experimentally. Efforts will be expanded if activities are determined beneficial. Specifically, the following sites will be evaluated as funding allows: Ash Tree Spring, outflow near Bubbling Springs Pond, Page (Cave) Springs, Bass House Springs, Shea Springs (Tavasci Marsh), Lo Lo Mai Springs, Turtle Springs, and other springs and ponds on the property of willing owners that are part of the Oak Creek springs complex.

Benefit: Creation/restoration of habitat will enable Page springsnail populations to use the full extent of each site by expanding into habitat that is currently suboptimal. Creation/restoration of unoccupied sites could be used for future translocation sites.

Measure of Success: Increase the overall quantity of Page springsnail habitat. Expansion of springsnails into unoccupied habitat will be used as the metric. Include restoration information in annual reports and or technical reports.

6. Identify source population(s) and translocate Page springsnails *OR* discover unknown populations.

A) Identify a population or populations of Page springsnails that can be used as a source for re-establishment efforts. AGFD and USFWS will establish a protocol determining the number of individuals needed for re-establishment efforts, transportation between sites, benchmarks for measuring translocation success, and post-release monitoring.

B) Translocate Page springsnails to suitable sites. Before the species can be translocated, release sites will have to be identified and evaluated, project funding secured, donor population(s) located, an AGFD EAC completed, and transportation guidelines established by AGFD and USFWS. Other factors to be considered prior to translocation or re-establishment include the following: presence of non-native species and the ability to remove them, risk of introducing exotic pathogens or parasites, displacement of other endemic aquatic species, likelihood of survivorship, impact on donor populations, economic and cultural impact, and wildlife-recreation conflicts. An important 2004 study indicated that significant genetic divergence exists between populations at the Page Springs Hatchery and the population at Bubbling Springs Pond (C. Hurt, 2004). These

populations should be managed separately and efforts should be made to preserve their genetic integrity.

C) With the help of private landowners, discover (through explorative surveys) new populations within the historical range of the species. Working with private landowners will be a critical component of this measure as there are many springs that may harbor populations of Page springsnails.

This conservation measure is already supported by agency base funding.

Benefit: Increasing the number of populations of Page springsnails will decrease the impact of a catastrophic event (i.e., chemical spill) that kills a large number of the species or results in a site becoming uninhabitable.

Measure of Success: Efforts will be made to either create (through translocations) or discover new populations of Page springsnails throughout the duration of this CCAA.

VII. Expected Benefits

Expected benefits from these strategies include an increase in population abundance, and the protection, enhancement, or restoration of suitable habitat when feasible. USFWS and other cooperators believe that the strategies outlined in this CCAA are sufficient toward reducing current threats and improving the species' conservation status. Management activities will be evaluated and possibly revised to minimize impacts on Page springsnails and their habitat, by monitoring population status before and after manipulations.

VIII. Level/Type of Take/Impacts

The cooperators agree to the following as acceptable levels of incidental take under this CCAA should the species become listed at some time in the future. We anticipate that the level of incidental take defined below would not significantly affect Page springsnail populations or its habitat. Any modifications to occupied springsnail habitat on Department property, beyond the amount of habitat that may be disturbed (listed below, per site) for regular activities, will undergo a Department Environmental Assessment Checklist prior to implementing those modifications, with the exception of emergency actions needed to maintain spring flow, channel integrity, and preserve springsnail habitat. The Department wants to better secure spring water for hatchery operations while still maintaining existing springsnail populations and occupied habitat on Department property.

USFWS will not provide take for the effects of groundwater pumping on the Page springsnail because conservation measures described in this CCAA do not eliminate the threat from groundwater pumping. Additonally, it is unclear how much authority and control over groundwater resides with the parties covered in this CCAA.

Cave (Page) Spring

Within a 4.5 m (15 ft) radius of the cave gate, no more than 10% of aquatic, springsnail-occupied habitat will be disturbed in the process of monitoring the spring flow, maintaining channel integrity, surveying for Page springsnails, or removing submergent or emergent vegetation, or debris (natural or un-natural) in the water. Habitat determinations will be consistent with the survey protocol. Any rocks, submergent vegetation, or other debris (natural or un-natural) removed from the water will be inspected for Page springsnails, and if present, temporarily held in water at the same site until the Page springsnails disperse. When possible, improvements or modifications within the designated area (to be determined cooperatively by AGFD and USFWS) will be incremental, and will not affect greater than 10% of springsnail habitat within a six (6) month period.

Bubbling Springs Pond

Within a 12 m (40 ft) radius of the submerged springs feeding the pond, no more than 10% of aquatic, springsnail-occupied habitat will be disturbed in the process of monitoring the spring flow, maintaining pond bank integrity, monitoring or surveying for Page springsnails, or removing submergent or emergent vegetation or debris (natural or un-natural) in the water. Page springsnails occur sporadically in the pond; areas that the species occupies will be identified and mapped. Occupied areas will be avoided when conducting maintenance activities. Any rocks, submergent vegetation, or other debris (natural or un-natural) removed from the water will be inspected for Page springsnails, and if present, temporarily held in water at the same site until the Page springsnails disperse. When possible, improvements or modifications within the designated area will be incremental, and will not affect greater than 10% of springsnail habitat within a six (6) month period.

Bass House Spring

Within a 4.5 m (15 ft) radius of the submerged spring feeding the pond (including the weir box), no more than 10% of aquatic, springsnail-occupied habitat will be disturbed in the process of monitoring the spring flow, maintaining pond bank integrity, monitoring or surveying for snails, or removing submergent or emergent vegetation or debris (natural or un-natural) in the water. Any rocks, submergent vegetation, or other debris (natural or un-natural) removed from the water will be inspected for snails, and if present, temporarily held in water at the same site until the snails disperse. When possible, improvements or modifications within the designated area will be incremental, and will not affect greater than 10% of springsnail habitat within a six (6) month period.

Un-named small seeps and springs.

Within a 4.5 m (15 ft) radius of the submerged spring or seep known to support Page springsnails, no more than 10% of aquatic, springsnail-occupied habitat will be disturbed in the process of monitoring the spring flow, maintaining spring flow or integrity, monitoring or

surveying for Page springsnails, or removing submergent and emergent vegetation or debris (natural or un-natural) in the water. Any rocks, submergent vegetation, or other debris (natural or un-natural) removed from the water will be inspected for Page springsnails, and if present, temporarily held in water at the same site until the Page springsnails disperse. When possible, improvements or modifications within the designated area will be incremental, and will not affect greater than 10% of springsnail habitat within a six (6) month period.

The USFWS and AGFD have determined that the level of take described in this agreement is consistent with the overall goal of conserving the Page springsnail. Conservation measures taken at additional properties will further benefit the species.

IX. Assurances Provided

Through this CCAA, USFWS provides AGFD with assurances that no additional conservation measures or additional land, water, or resource use restrictions, beyond those voluntarily agreed to and described in the Conservation Measures section of this CCAA, will be required should the Page springsnail become listed in the future. AGFD will issue Certificates of Inclusion to interested landowners as Cooperators under this CCAA, and they will receive the same assurances. These assurances will be authorized upon the issuance of an enhancement of survival permit under section l0(a)(1)(A) of the ESA should the species become listed. The application for the enhancement of survival permit is included as an appendix to this CCAA. The proposed permit will authorize Cooperators to incidentally take Page springsnails during the process of implementing efforts and activities intended to bolster population levels as specified in this CCAA.

USFWS will not provide assurances for the effects of groundwater pumping on the Page springsnail because conservation measures described in this CCAA do not eliminate the threat from groundwater pumping. Additionally, it is unclear how much authority and control over groundwater resides with the parties covered in this CCAA.

The assurances listed below apply to property owners with an Enhancement of Survival Permit associated with this CCAA, where the CCAA is being properly implemented.

1) Changed circumstances provided for in the CCAA: If additional conservation and mitigation measures are deemed necessary to respond to changed circumstances and were provided for in the CCAA's operating conservation program, the permittee will implement the measures specified in the CCAA.

   Changed circumstances are changes in circumstances affecting covered species or geographic areas covered by this CCAA that can reasonably be expected by CCAA developers and that can be reasonably planned for in the CCAA. Changed circumstances are not unforeseen circumstances.

   Changed circumstances not provided for in the CCAA: If additional conservation and mitigation measures are deemed necessary to respond to changed circumstances and such

measures were not provided for in the CCAA's operating conservation program, the USFWS will not require any conservation and mitigation measures in addition to those provided for in the CCAA without the consent of the Permittee, provided the CCAA is being properly implemented.

2) Unforeseen circumstances: Unforeseen circumstances are those circumstances which are not "changed circumstances" (i.e. changes in circumstances affecting a listed species or geographic area that can reasonably be expected and that can be planned for, such as fire, drought, flood or other such natural catastrophe), but that are changes affecting species or geographic areas covered by the CCAA that could not have reasonably been anticipated by Agreement developers and the USFWS at the time the CCAA was negotiated and developed, and that result in a substantial and adverse change in the status of the species covered by the CCAA. The USFWS bears the burden of demonstrating that unforeseen circumstances exist, using the best scientific and commercial data available, and considering certain other factors.

   Unforeseen/extraordinary circumstances may arise which were not anticipated in this CCAA, but which may adversely affect the Page springsnail. When any of the Cooperators in this CCAA become aware of circumstances that may adversely affect the Page springsnail, or the Cooperators' ability to implement this CCAA, the Cooperator identifying them shall notify the other party within 48 hours.

   AGFD and USFWS commit to meeting promptly to jointly review new information related to the unforeseen circumstance, and to discuss and identify possible protective measures. In keeping with USFWS's assurances, any additional protective measures shall not require the commitment by the Cooperator of additional land or financial resources beyond the level otherwise adequately provided for the Page springsnail under the terms and details of this CCAA. Effects from groundwater pumping would not be considered unforeseen circumstances.

   The following guidelines provide a framework for negotiation of response to unforeseen circumstances:

   A. USFWS will not require the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources beyond the level otherwise agreed upon for the species covered by the CCAA without the consent of the Permittee.
   B. If additional conservation and mitigation measures are deemed necessary to respond to unforeseen circumstances, the USFWS may require additional measures of the Cooperators where the CCAA is being properly implemented. Additional measures are limited to modifications within conserved habitat areas, or to the CCAA's operating conservation program for the affected species, and maintain the original terms of the CCAA to the maximum extent possible. Additional conservation and mitigation measures will *not* involve the commitment of additional land, water, or financial compensation, or additional restrictions on the use of land, water, or other natural

resources otherwise available for development or use under the original terms of the CCAA without the consent of the Permittee.

C. USFWS will have the burden of demonstrating that unforeseen circumstances exist, using the best scientific and commercial data available. These findings must be clearly documented and based upon reliable technical information regarding the status and habitat requirements of the affected species. USFWS will consider, but not be limited to, the following factors:
   i. Size of the current range of the affected species
   ii. Percentage of range adversely affected by the CCAA
   iii. Percentage of range conserved by the CCAA
   iv. Ecological significance of that portion of the range affected by the CCAA
   v. Level of knowledge about the affected species and the degree of specificity of the species' conservation program under the CCAA
   vi. Whether failure to adopt additional conservation measures would appreciably reduce the likelihood of survival and recovery of the affected species in the wild

USFWS further acknowledges the following:

A. Water rights for Page Spring hatchery are classified from two spring systems. Water will be used and diverted from Page Springs (Page [Cave] Spring tunnel) and Bubbling Ponds (Pond Spring area), in accord with existing water rights. AGFD has a legal obligation to supply other claimants with water from the tunnel spring, via an open dirt ditch (Page Springs ditch) (AGFD 1997a, 1997b). AGFD relies on two wells to provide water for native fish propagation at Bubbling Ponds Fish Hatchery.
B. Current water usage (e.g., aquaculture, domestic, irrigation) and inflow rates for AGFD and private property owners will remain unchanged. Spring flow and pond height fluctuates naturally, depending on climatic patterns and the season.
C. Invasive non-native species may be removed from the springs, pools, ponds, waterways, and other water bodies with traps, nets, other hand-held implements, and by electro-fishing. Activities will be included in the team's annual report.
D. Submerged and emergent aquatic vegetation may be removed manually (e.g., hand pulling and cutting) from waterways and ponds, between March and October each year. Reasonable attempts will be made to remove snails attached to the submerged vegetation and return them to the water. The amount of aquatic vegetation removed from the water will be approximately quantified (either by weight or volume) and included in the annual report. Reasonable attempts to reduce impacts to the snail and habitat may include: removing no more than 50% of the vegetation per month, limiting vegetative removal to no more than twice a year, avoiding areas of vegetation that harbor large numbers of snails, and other methods will be developed to reduce impacts to snails and habitat.
E. Page springsnails that colonize any portion of the hatchery operations (e.g., raceways, headgates, valves) are covered under AGFD's 10(a)1(A) permit and may be removed and relocated. Reasonable effort will be made to translocate the Page springsnails to natural or artificial sites predetermined by the Cooperators.
F. Opportunities to enhance or modify habitat, or extend the known range of the Page springsnail at the hatcheries, will be consistent with the aforementioned activities and hatchery operations.

G. Water distribution ditches, diversion devices, culverts, and embankments will continue to be maintained (e.g., submerged roots, vegetation, or leaves removed), improved (e.g., gabion construction), or repaired (e.g., addition of rocks, replacement of headgates). Page springsnails encountered during maintenance activities will be translocated to a natural or artificial site determined by the Cooperators. The amount of aquatic vegetation removed, or material added, will be approximately quantified either by weight or volume and included in the annual report.
H. If Page springsnail populations are established on private properties controlled by Cooperators (i.e, signatory to this CCAA or under a certificate of inclusion), and the species is listed as endangered or threatened, USFWS will not assert additional restrictions on cooperators beyond those agreed to in this CCAA or other written agreements.

X. Monitoring Provisions

The effectiveness of this CCAA will be monitored through annual reports, prepared by AGFD and USFWS. Progress toward each conservation measure will be evaluated, and when monitoring protocols have been implemented, biological data will be used to evaluate the effectiveness of conservation measures.

XI. Compliance Monitoring

The Property Owner will be responsible for monitoring and reporting specified herein related to implementation of the CCAA and fulfillment of its provisions. This includes implementation of agreed-upon conservation measures, and incidental take authorized by the permit.

USFWS, after reasonable prior notice to the Property Owner, may enter the enrolled lands to ascertain compliance with the CCAA.

XII. Biological Monitoring

A primary goal of AGFD and USFWS is to implement a complete monitoring program that includes both population and habitat monitoring. AGFD and USFWS have developed this program and it is included as appendix C. Habitat and species monitoring will take place on an annual basis with the bulk of the surveys being conducted by AGFD and by private landowners (participating through a certificate of inclusion). The overarching goals of this CCAA are to protect the Page springsnail by securing, and where appropriate, increasing the number and size of populations and increasing the amount and quality of habitat available to the Page springsnail.

The results of the monitoring efforts will be captured in annual reports beginning in 2008, and copies will be made available to all Parties.

By participating in this CCAA landowners agree to allow both AGFD and or USFWS, after reasonable prior notice to the Property Owner, the right to enter the enrolled lands to conduct biological/effectiveness monitoring of the Page springsnail and its habitat.

XIII. Notification of Take Requirement

By signing this CCAA, AGFD agrees to provide USFWS with an opportunity to rescue individuals of the covered species before any authorized incidental take occurs. Notification that incidental take is likely to occur must be provided to the USFWS at least 30 days in advance of the action.

By obtaining a certificate of inclusion landowners agree to provide AGFD and USFWS with an opportunity to rescue individuals of the covered species before any authorized incidental take occurs. Notification that incidental take is likely to occur must be provided to USFWS at least 30 days in advance.

XIV. Duration of CCAA and Permit

The CCAA, including any commitments related to funding under USFWS programs, will be in effect for a duration of five years following its approval and signing by USFWS and AGFD. The section 10(a)(1)(A) permit authorizing take of the species will become effective on the date of the final rule listing the covered species and will expire when this CCAA expires or is otherwise suspended or terminated. The permit and CCAA may be extended beyond the specified terms prior to permit expiration through the permit renewal process and with agreement of the Parties.

XV. Modifications

After approval of the CCAA, USFWS may not impose any new requirements or conditions on, or modify any existing requirements or conditions applicable to, a landowner or successor in interest to the landowner, to compensate for changes in the conditions or circumstances of any species or ecosystem, natural community, or habitat covered by the CCAA, except as stipulated in 50 CFR 17.22(d)(5) and 17.32(d)(5).

Any party may propose modifications or amendments to this CCAA by providing written notice to, and obtaining the written concurrence of, the other Parties. Such notice shall include a statement of the proposed modification, the reason for it, and its expected results. The Parties will use their best efforts to respond to proposed modifications within 60 days of receipt of such notice. Proposed modifications will become effective upon the other Parties' written concurrence.

XVI. Amendment of the Permit

The permit may be amended to accommodate changed circumstances in accordance with all applicable legal requirements, including but not limited to the ESA, NEPA, and the USFWS's permit regulations at 50 CFR 13 and 50 CFR 17. The party proposing the amendment shall provide a statement describing the proposed amendment and the reasons for it.

XVII. Termination of the CCAA

As provided for in Part 8 of USFWS's CCAA Policy (64 FR 32726), the Cooperator may, for good cause, terminate implementation of the CCAA's voluntary management actions prior to the CCAA's expiration date, even if the expected benefits have not been realized. If the CCAA or Certificate of Inclusion is terminated without good cause, however, the Cooperator is required to surrender the enhancement of survival permit at termination, thus relinquishing his or her take authority (if the species has become listed) and the assurances granted by the permit. The Cooperator is required to give 45 days written notice to the other Parties of its intent to terminate the CCAA or Certificate Inclusion, and must give the USFWS an opportunity to relocate affected species within ten days of the notice.

XVIII. Permit Transfer of Succession

Although not anticipated, in the event that the Department should cease operations or otherwise be unable to carry out its responsibilities as the permit holder under this Agreement, the Department's Section 10(a)(1)(A) permit may be transferred to another entity. Transfer or succession of the permit would be in accordance with Federal regulations applicable or in force at the time of the transfer (at present these are codified at 50 CFR 13.24 and 13.25). Although a permit successor is not contemplated or named in this Agreement, an appropriate permit successor in the event of a transfer could generally include a suitable State agency or conservation organization. In the event of a transfer of the permit all Participating Landowners, Participating Neighbors, and Participating State Agencies will be notified, and they may elect to terminate their Certificates of Inclusion if they wish to do so at that time. If an appropriate Permittee cannot be found, the Service shall issue individual permits under this Agreement to Certificate of Inclusion holders in good standing, recognizing original baselines and conservation measures agreed upon, as well as commitments completed or proposed in the original Certificate of Inclusion.

XIX. Permit Suspension or Revocation

The USFWS may suspend or revoke the permit for cause in accordance with the laws and regulations in force at the time of such suspension or revocation (50 CFR 13.28(a)). The suspension or revocation will only affect the party that fails to comply with permit terms and conditions. The USFWS may also, as a last resort, revoke the permit if continuation of permitted activities would likely result in jeopardy to covered species (50 CFR 17.22/32(d)(7)). The USFWS will revoke the permit because of jeopardy concerns only after first implementing all practicable measures to remedy the situation.

XX. Remedies

Each party shall have all remedies otherwise available to enforce the terms of the CCAA and the permit. In particular, the USFWS may seek specific performance of appropriate mitigation measures in the event the Property Owner terminates this CCAA or fails to comply with its terms. No party shall be liable in damages for any breach of this CCAA, any performance or failure to perform an obligation under this CCAA, or any other cause of action arising from this CCAA.

XXI. Dispute Resolution

The Parties agree to work together in good faith to resolve any disputes, using dispute resolution procedures agreed upon by all Parties.

The parties agree to engage in any alternative dispute resolution procedures authorized by their statutes, regulations and court rules, including, but not limited to, 5 U.S.C. § 575 and A.R.S. § 12-1518.

XXII. Succession and Transfer

This CCAA shall be binding on and shall benefit the Parties and their respective successors and transferees, (i.e., new owners) in accordance with applicable regulations (50 CFR 13.24 and 13.25). The rights and obligations under this CCAA shall run with the ownership of the enrolled property and are transferable to subsequent non-Federal property owners pursuant to 50 CFR 13.25. The enhancement of survival permit issued to the Property Owner is also transferable to the new owner(s) pursuant to 50 CFR 13.25. If the CCAA and permit are transferred, the new owner(s) will have the same rights and obligations with respect to the enrolled property as the original owner. The new owner(s) also will have the option of receiving CCAA assurances by signing a new Certificate of Inclusion. The Property Owner shall notify the USFWS in writing of any transfer of ownership, so that the Service can attempt to contact the new owner, explain the responsibilities applicable to the property, and seek to interest the new owner in signing the existing Certificate of Inclusion or a new one to benefit covered species on the property. Assignment or transfer of the permit shall be governed by USFWS regulations in force at the time.

XXIII. Availability of Funds

Implementation of this CCAA is subject to the requirements of the Anti-Deficiency Act and the availability of appropriated funds. Nothing in this CCAA will be construed by the Parties to require the obligation, appropriation, or expenditure of any funds from the U.S. Treasury. The Parties acknowledge that USFWS will not be required under this CCAA to expend any Federal

agency's appropriated funds unless and until an authorized official of that agency affirmatively acts to commit to such expenditures as evidenced in writing.

Every obligation of the Parties under this Agreement is conditioned upon the availability of funds appropriated or allocated for the payment of such obligation. If funds for the continuance of this Agreement are not allocated or are not available, this Agreement shall terminate automatically on the date of expiration of funding. In the event of such termination, the Parties shall incur no further obligation or liability under this Agreement other than for payment of services rendered prior to the expiration of funding.

XXIV. Relationship to Other Agreements

This CCAA will adhere to the regulations and intent of the Memorandum of Understanding between AGFD and USFWS.

XXV. No Third-Party Beneficiaries

This CCAA does not create any new right or interest in any member of the public as a third-party beneficiary, nor shall it authorize anyone not a party to this CCAA to maintain a suit for personal injuries or damages pursuant to the provisions of this CCAA. The duties, obligations, and responsibilities of the Parties to this CCAA with respect to third parties shall remain as imposed under existing law.

XXVI. Notices and Reports

Any notices and reports, including monitoring and annual reports, required by this CCAA shall be delivered to all cooperators.

XXVII. Adaptive Management

This CCAA depends upon the successful implementation of adaptive management. Adaptive management is designed to bring new information immediately into new management direction. An adaptive management program can also help to anticipate and resolve uncertainty related to the covered species or the effect of the conservation measures. Cooperators agree and recognize, consistent with the goals of this CCAA, that monitoring actions and conservation measures implemented will be conducted consistent with the concepts of adaptive management. The effectiveness of all conservation measures and monitoring methods will be periodically reviewed and evaluated by the cooperators. Based on such evaluation, appropriate modifications to strategies and actions will be made to ensure scientific rigor and the efficacy of conservation measures. The signatories to this CCAA are committed to seeking the resources necessary to ensure successful implementation of adaptive management and its principles.

The essential steps of the CCAA adaptive management strategy are summarized as follows:

Step 1. Implement CCAA conservation actions and strategies.
Step 2. Implement annual work plans for management, monitoring, and research.
Step 3. Review CCAA conservation goals, objectives, and strategies and adjust as necessary based on updated information.
Step 4. Prioritize locations for implementation of conservation actions and identify and prioritize research needs.
Step 5. Initiate site-specific actions to reduce or eliminate threats and complete identified research projects.
Step 6. Implement monitoring plan to determine effectiveness of conservation actions.
Step 7. Analyze and evaluate monitoring and research results to determine progress towards attainment of conservation objectives.
Step 8. Return to Step 3.

Signatures

This agreement, effective and binding on the date of the last signature below, is between, Arizona Game and Fish Department, and the U.S. Fish and Wildlife Service. The duration of this agreement is for five (5) years, beginning with the date of the last signature. At least six (6) months prior to the expiration of this CCAA, the cooperators will meet to decide whether to modify, create anew, or terminate the original agreement.

IN WITNESS WHEREOF, THE PARTIES HERETO have, as of the last signature date below, executed this Candidate conservation Agreement with Assurances to be in effect as of the date that the Service issues the permit.

Larry D. Voyles, Director — Date: 3/26/09
Arizona Game and Fish Department

Steven L. Spangle, Field Supervisor — Date: 8/3/09
Arizona Ecological Services Field Office

Brian A. Millsap, Deputy Regional Director — Date: 10/8/09
U.S. Fish and Wildlife Service, Region 2

Table 1. Page springsnail sites at Bubbling Ponds and Page Spring hatcheries.

Site name	Site description	Coordinates (UTM-X; UTM-Y)
Unnamed seep AKA "Rusty Pipe Spring"	Small seep below employee housing on Page Spring Hatchery	418637; 3846894
Unnamed seep AKA "Bog Spring"*	Small seep below employee housing on Page Spring Hatchery, near brush burning area	418616; 3846952
Bass House Spring (*Suspected Site*)	Small pool within fenced-in structure on Bubbling Ponds Hatchery	418424; 3847240
Bubbling Springs Pond	Near Lo Lo Mai resort fed by Bubbling Springs	417610; 3848164
Diversion pond adjacent to Bubbling Springs Pond (*Suspected Site*)	Pond fed from tailwater from Lo Lo Mai , adjacent to Bubbling Pond Springs	417610; 3848164
Page (Cave) Spring**	20 ft (6 m) section of concrete lined spillway, outside cave grate to culvert; 2 ft (0.6 m) diameter adjacent pool; Page Springs Hatchery	418626; 3846980
Unnamed seep AKA "Ash Tree Spring"	Small seep forming elongated pool (manmade), 50 ft (15.2 m) north of Page (Cave) Spring on the Page Springs Hatchery	418684; 3846784
Unnamed seep** AKA "Drain Pipe Spring"	Small seep 75 ft (22.9 m) south of Page (Cave) Spring flowing into large culvert on Page Springs Hatchery	418627; 3846968

* Martinez MA, Thome DM. (2006) designated this site 'Unnamed Spring'
** Martinez MA, Thome DM. (2006) designated this site 'Page/Cave Springs'

Figure 1. AGFD property and Page springsnail sites

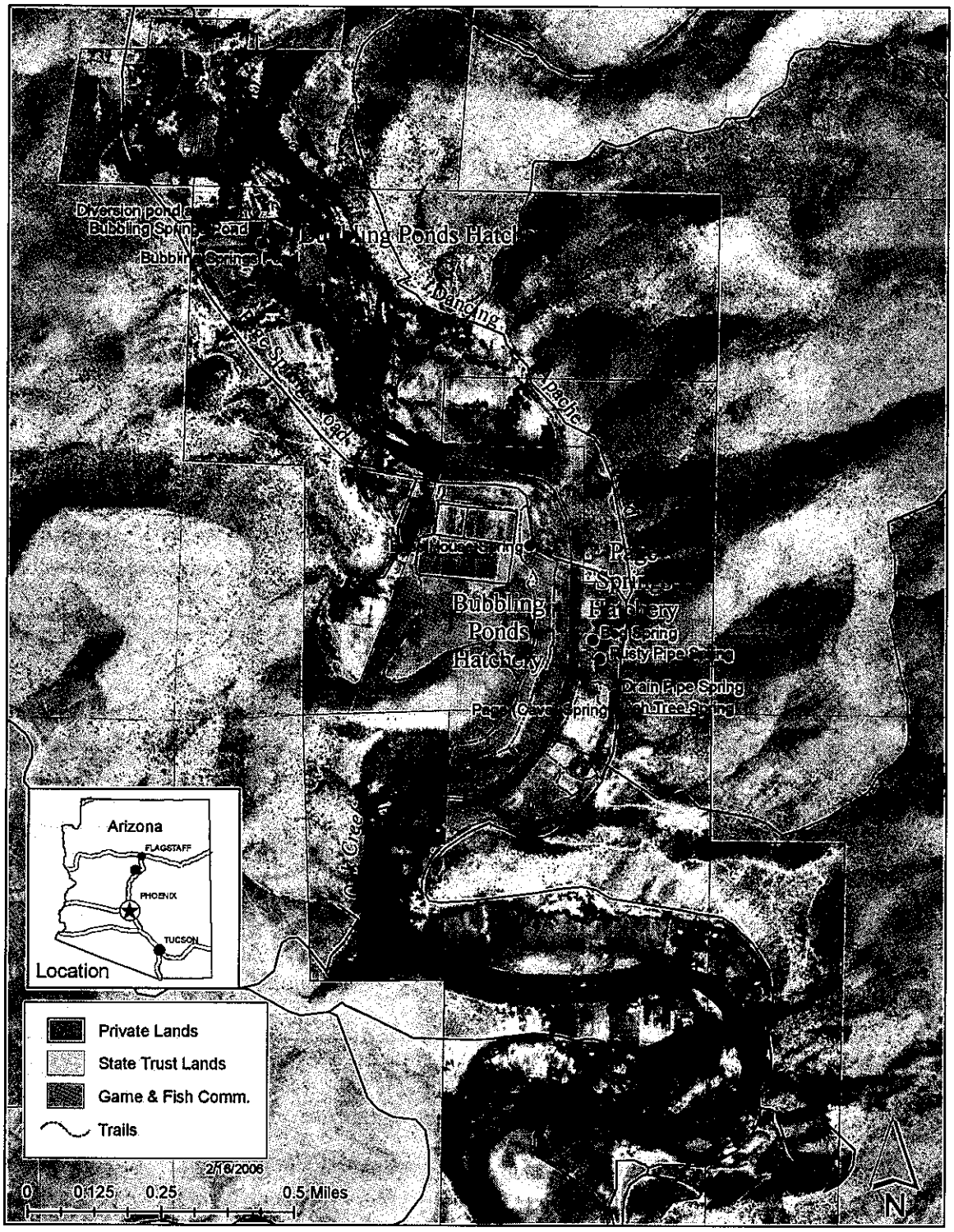
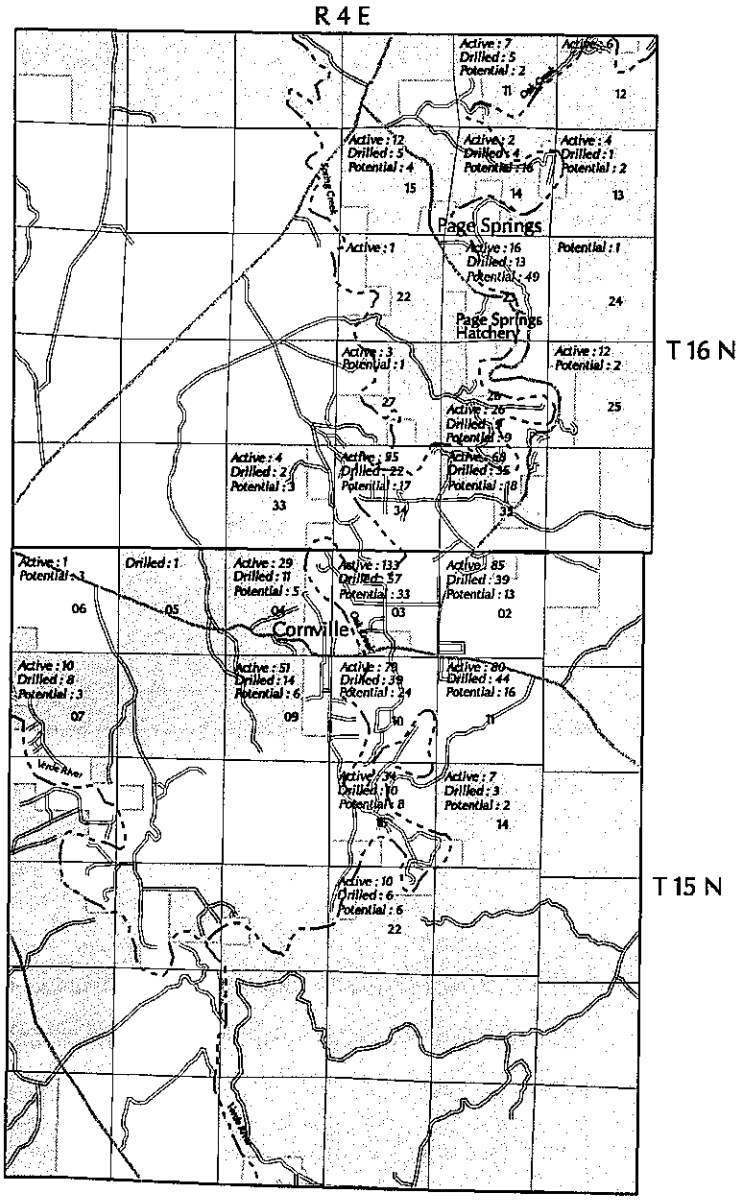


Figure 2. Wells in the vicinity of Page Springs Hatchery (Arizona Department of Water Resources data 2001 [left] and 2008 [right]). Maps are approximately the same scale.



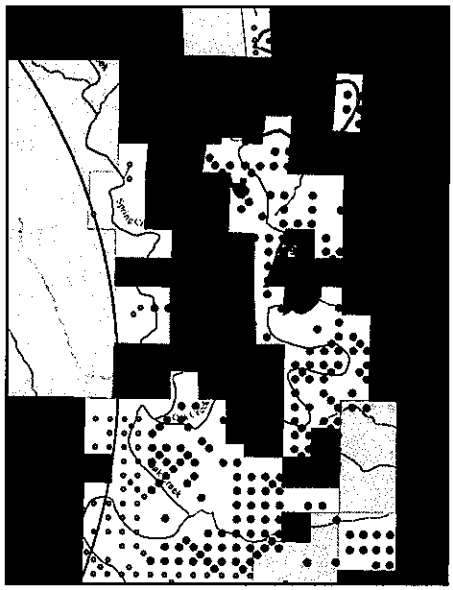


Table 2. Page springsnail strategy implementation schedule, 2009-2013

Strategy Description	Responsible Cooperators	Anticipated Completion	Funding Source
1. Prevent detrimental habitat modifications			
a. meet with landowners to discuss habitat protection	AGFD, USFWS	2010	Base funded
b. utilize landowners relations programs to provide incentives to protect habitat	AGFD, USFWS	Continuous	Base funded
c. install protective measures (if necessary)	AGFD, USFWS	Continuous	AGFD, USFWS, PLOs, NPS
2. Research			
a. identify funding sources	All	2009-2010	All
b. identify researchers	All	2009	All
c. gather data	All	Continuous	All
3. Monitoring programs			
a. fully develop springsnail monitoring programs	AGFD, USFWS	2009	Base funded
b. conduct springsnail monitoring	AGFD, USFWS, PLOs	Continuous	Base funded
c. implement hydrological monitoring program	All	As appropriate	Base funded, USGS
4. Aquifer evaluation			
a. contact Yavapai Co, and Verde Watershed Association	AGFD, USFWS	2010-2011	AGFD, USFWS
b. evaluate aquifer	AGFD, USFWS, Yavapai CO., Verde Watershed Assn.	2012	AGFD, USFWS, PLOs, Yavapai CO., Verde Watershed As.
c. reevaluate conservation strategy in relation to condition of the aquifer	All	2013	All
5. Habitat renovations			
a. evaluate sites for habitat renovation	All	2010	AGFD, USFWS, NPS, PLOs
b. get permission from landowners	AGFD, USFWS	2010	Base funded
c. secure funding for renovation	All	2011	AGFD, USFWS, PLOs, NPS
d. renovate habitat	AGFD, USFWS, PLOs	Continuous	AGFD, USFWS, PLOs, NPS
6. New populations			
a. identify source populations	AGFD, USFWS	2010	Base funded
b. translocate snails to suitable sites *OR*	AGFD, USFWS	2010	Base funded
c. discover new sites	AGFD, USFWS	Continuous	Base funded
i. identify sites to survey	AGFD, USFWS	2010	Base funded
ii. contact landowners and get permission to survey or encourage landowner to conduct survey	AGFD, USFWS	2011	Base funded
iii. survey potential sites	AGFD, USFWS	2011	Base funded
Annual progress reports	All	Annually	Base funded
Five year summary and evaluation report	All	2014	Base funded

NPS= National Park Service PLOs= Private land owners All= list

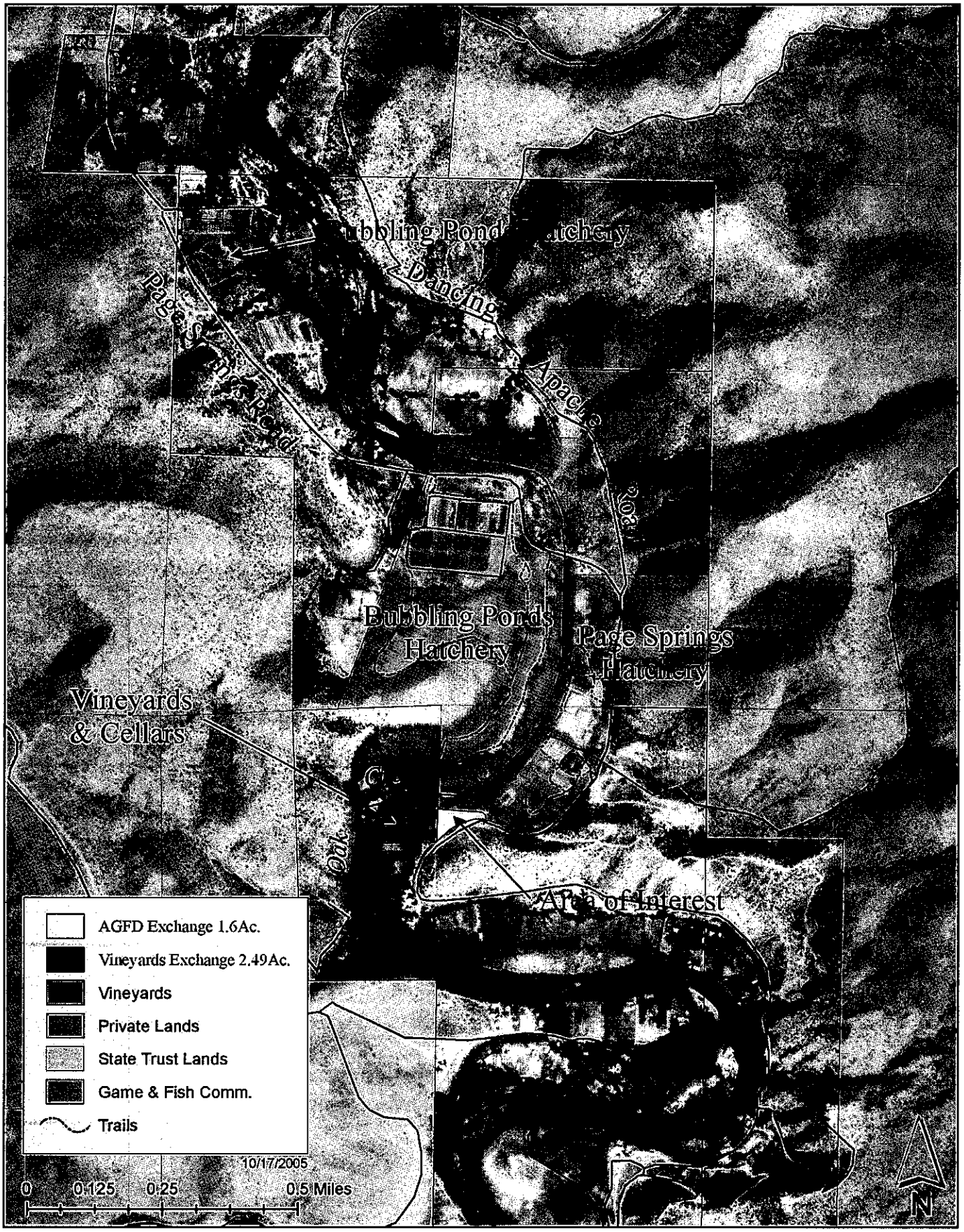
Past Conservation Measures Completed

Listed below are actions that cooperators have completed and are working on in good faith towards Page springsnail conservation. Cost estimates include funds expended for staff time and equipment/supplies used during Page springsnail conservation activities.

Table 3. Current and past conservation measures

Conservation Measure	Year(s)	Cost Estimate
AGFD and USFWS have been developing a monitoring protocol to track populations size and changes	2001- present	$10,000
AGFD has been monitoring snails at Pages Springs Hatchery and Bubbling Springs Pond hatchery to track population size, changes, and has been searching for additional populations	2001- present	$17,000
The USFWS conducted a habitat usage study to better understand habitat requirements and basic natural history. Report available at http://www.fws.gov/southwest/es/arizona/.	2001-2006	$15,000
An interim monitoring report was written to update interested parties of activities and population status of the snail	2002	$1,600
Fencing was installed around springheads at the Page Springs Hatchery to protect extant populations from wandering visitors or animals	2004	$5000
An experimental spring run was created to test the effectiveness of artificial creation of habitat. Results are not yet available.	2005	$5,000
A water flow measuring station was installed at Bubbling Springs Pond to track quantity of water through time	2006	$28,000
Fencing was installed around Bubbling Springs Pond to protect the extant population from trespassing visitors or animals	2008	$10,500

Figure 3. AGFD recent land exchange. Exchange yielded 2.49 acres of riparian habitat to AGFD.



Literature Cited

Arritt S. 1998. Imperiled invertebrates. New Mexico Partners Conserving Endangered Species. Conservation Services Division, New Mexico Department of Game and Fish. 3(1) Winter: 8-16.

Arizona Game and Fish Department. 1996. *Wildlife of Special Concern in Arizona.* Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, Arizona.

Arizona Game and Fish Department 1997a. Bubbling Ponds Hatchery Management Plan. Fisheries Branch, Arizona Game and Fish Department, Phoenix, Arizona.

Arizona Game and Fish Department 1997b. Page Springs Hatchery Management Plan. Fisheries Branch, Arizona Game and Fish Department, Phoenix, Arizona.

Arizona Game and Fish Department. 1997c. Packard Ranch / Tavasci Marsh Management Plan. Habitat Branch, Arizona Game and Fish Department, Phoenix, Arizona.

Arizona Game and Fish Department. 2005. Comprehensive Wildlife Conservation Strategy: 2005-2015. Arizona Game and Fish Department, Phoenix, Arizona.

Blasch, K.W., J.P. Hoffman, L.F. Graser, J.R. Bryson, and A.L. Flint. 2006. Hydrogeology of the upper and middle Verde River watersheds, central Arizona. U.S. Geological Survey Scientific Investigations Report 2005-5198. 101 pp.

Boss KJ. 1971. Critical estimate of the number of recent Mollusca. Occasional Papers on Mollusks, Museum of Comparative Zoology, Harvard University 3(40):81-135.

Blinn, DW. 1998. In. Litt. Letter to Mike Martinez, USFWS. September 30, 1998.

Briggs SA and the staff of Rachel Carson Council. 1992. Basic guide to pesticides: their characteristics and hazards. Taylor and Francis. Washington, D.C. 283 pages.

Cope W, Bartsch M, Rada R, Balogh, Rupprect J, Young R, Johnson D. 1999. Bioassessment of mercury, cadmium, polychlorinated biphenyls, and pesticides in the Upper Mississippi River with zebra mussels (*Dreissenapolymorpha*). Environmental Science Technology 33:4385-4390.

Eisemann JD, Beyer WN, Bennetts RE, Morton A. 1997. Mercury residues in South Florida apple snails (*Pomacea paludosa*). Environmental Contamination and Toxicology Bulletin 58:39-743.

Fernandez PJ, Rosen PC. 1996. Effects of the introduced crayfish *Orconectes virilis* on native aquatic herpetofauna in Arizona. Final Report, IIPAM Project No. 194054. Heritage Program, Arizona Game and Fish Department, Phoenix, Arizona.

Govedich FR, Blinn DW, Keim P, and Davies RW. 1998. Phylogenetic relationships of three genera of Erpobdellidae (Hirudinoidea), with a description of a new genus, *Molobdella*, and species, *Motobdella sedonensis*. Canadian Journal of Zoology 76:2164-2171.
Green H. Personal Communication. 1998

Hendrickson DA, Minckley WL. 1984. Ciénegas-vanishing climax communities of the American Southwest. Desert Plants 6(3):130-175.

Hershler R. 1984. The hydrobiid snails (Gastropoda: Rissoacea) of the Cuatro Cienegas basin: Systematic relationships and ecology of a unique fauna. Journal of the Arizona - Nevada Academy of Science 19:61-76.

Hershler R. 1994. A review of the North American freshwater snail genus *Pyrgulopsis (*Hydrobiidae*)*. Smithsonian Contributions to Zoology, Number 554. Smithsonian Institution Press. Washington D.C. 52 pages.

Hershler R, Landye JJ. 1988. Arizona Hydrobiidae (Prosobranchia: Rissoacea). Smithsonian Contributions to Zoology Number 459. Smithsonian Institution Press, Washington, D.C.

Hershler R and Williams JE. 1996. Conservation strategies for springsnails in the Great Basin: the challenge and the opportunities. Abstract in Proceedings of the Desert Fishes Council 1995 Symposium. Volume XXVII.

Hershler R, Ponder WF. 1998. A review of morphological characters of hydrobioid snails. Smithsonian Contributions to Zoology Number 600. Smithsonian Institution Press, Washington, D.C. 1998.

Hurt, C. 2004. Genetic divergence, population structure and historical demography of rare springsnails (*Pyrgulopsis*) in the lower Colorado River basin. Molecular Ecology vol. 13 (5) 1365-294X.

Kabat AR, Hershler R. 1993. The Prosobranch snail family Hydrobiidae (Gastropoda: Rissooidea): Review of classification and supraspecific taxa. Smithsonian Contributions to Zoology Number 547 94 pages.

Koniecski AD, Leake SA 1997. Hydrogeology and water chemistry of Montezuma Well in Montezuma Castle National Monument and surrounding area, Arizona. U.S. Geological Survey Water Resources Investigations Report 97-4156. Prepared in cooperation with the National Park Service. Tucson, Arizona. 49 pages.

Landye JJ. 1973. Status of the inland aquatic and semi-aquatic mollusks of the American Southwest. Report submitted to US Department of Interior, Bureau of Sport Fisheries and Wildlife, Office of Rare and Endangered Species, Washington, D.C. 60 pages.

Landye JJ. 1981. Current status of endangered, threatened, and/or rare mollusks of New Mexico and Arizona. A report submitted to the US Department of Interior, Bureau of Sport Fisheries and Wildlife, Office of Rare and Endangered Species, Albuquerque, New Mexico. 35 pages.

Martinez MA, Thome DM. 2006. Habitat usage by the Page springsnail, *Pyrgulopsis morrisoni* (Gastropoda: Hydrobiidae) from Central Arizona. The Veliger. 48: 8-16.

McGavock E. 1996. Overview of groundwater conditions in the Verde Valley, Arizona. Paper presented at the 9 annual symposium of the Arizona Hydrological Society, Prescott, Arizona. September 12-14, 1996. 3 pages.

Mitchell K. 2001. Memo (02/20/0 1) to Darrell Jordan and Mike Pearce, Arizona Department of Water Resources Hydrology Division, on depletion in Cave Spring flow at Page Spring Hatchery. Located at: Arizona Game and Fish Department office, Phoenix, Arizona.

Mladenka, GC & GW Minshall. 2001. Variation in the life history and abundance of three populations of Bruneau Hot Springsnails *Pyrgulopsis bruneauensis*. Western North American Naturalist 61(2):204-212.

Nations ID, Hevly RH, Blinn DW, Lande JJ. 1981. Paleontolgy, Paleoecology, and depositional history of the Miocene-Pliocene Verde formation, Yavapai County, Arizona. Arizona Geological Society Digest 23:133-149.

O'Brien C, Blinn DW. 1999. The endemic spring snail *Pyrgulopsis montezumensis* in a high CO_2 environment: importance of extreme chemical habitats as refugia. Freshwater Biology 42:225-234.

Owen-Joyce SI, Bell CK. 1983. Appraisal of water resources in the upper Verde River area, Yavapai and Coconino Counties, Arizona. Arizona Department of Water Resources Bulletin 2. Prepared by the U.S. Geological Survey. Phoenix, Arizona. 219 pages.

Pennak RW. 1978. Freshwater invertebrates of the United States. Ronald Press, New York, 769 pages.

Pyles, G. (Bureau of Land Management). "Re: land ownership question." E-mail. 5 December 2005.

Raisanen C. 1991. Status survey of four invertebrates of the Page/Bubbling/Lo Lo Mai springs/Oak Creek complex. A report prepared for USDI Fish and Wildlife Service, Albuquerque, NewMexico. 106pages.

Riley L. (AGFD). Personal Communication. AGFD 1997c

Schell SC. 1985. Handbook of Trematodes of North America North of Mexico. University Press of Idaho, Moscow, Idaho. 263 pages.

Spicer II, Weber RE. 1991. Respiratory impairment in crustaceans and mollusks due to exposure to heavy metals. Comparative Biochemistry and Physiology 100(3):339-342.

Sorensen R. (AGFD). Personal Communication. 2002

Sorensen R. (AGFD). Personal Communication. 22 November 2005

Sprague LB. 1990. Aquatic toxicology. Pages 491-522 in C.B. Schreck and P.B. Moyle, editors. Methods for fish biology. American Fisheries Society, Bethesda, Maryland

Twenter FR and Metzger DG. 1963. Geology and ground water in Verde Valley-the Mogollon Rim region, Arizona. U.S. Government Printing Office, 131 pages.

US Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants; Animal notice of review. Federal Register 54(4) 554-579.

US Fish and Wildlife Service. 1996. Endangered and threatened wildlife and plants; Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Federal Register 61(40) 7596-7613.

U.S. Fish and Wildlife Service. 1997. Endangered and threatened wildlife and plants; Review of plant and animal taxa that are candidates or proposed for listing as endangered or threatened, annual notice of findings on recycled petitions, and annual description of progress on listing actions. Federal Register 62(182) 49398-49411.

U.S. Fish and Wildlife Service. 1999. Safe Harbor Agreements and Candidate Conservation Agreements With Assurances; Announcement of Final Safe Harbor Policy; Announcement of Final Policy for Candidate Conservation Agreements With Assurances; Final Rule and Notices. Federal Register 64 32706-32736.

Walker D. 1991. [Memo to Bruce Palmer on environmental assessment checklist for Bubbling Ponds hatchery renovation]. Located at: Arizona Game and Fish Department office, Phoenix, Arizona.

Appendix A: Certificate of Inclusion Template

Certificate of Inclusion
In The
Candidate Conservation Agreement with Assurances
For the Page springsnail (*Pyrgulopsis morrisoni*)
Between the Arizona Game and Fish Department and U.S. Fish and Wildlife Service

This certifies that the Participating Landowner, Participating Neighbor, or Participating State Agency, as applicable, who owns or administers the property described below, is included within the scope of Permit No. xxxxx, issued by the U.S. Fish and Wildlife Service on xxxxx, 2008, to the Arizona Game and Fish Department (Department) under the authority of Section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended, 16 U.S.C. 15389(a)(1)(A). Pursuant to that permit and this Certificate, the Participating Landowner, Participating Neighbor, or Participating State Agency, as defined in Sections II and IV, respectively, of the Department's Candidate Conservation Agreement with Assurances (Agreement), is authorized to cause incidental take of Page springsnails during the course of management activities described in Sections II, VI, and VIII of the Agreement on the specific lands identified in this Certificate. Such permit authorization is subject to the carrying out of conservation measures described in this Certificate, the terms and conditions of the permit, and the terms and conditions of the Agreement entered into by the Arizona Game & Fish Department and the U.S. Fish and Wildlife Service. By signing this Certificate of Inclusion, the Participating Landowner, Participating Neighbor, or Participating State Agency, as applicable, agrees to carry out all assigned conservation measures as described in the Agreement and Certificate for a period of **xx** years.

This form documents the specific conservation commitments and enrolled sites involved for the Candidate Conservation Agreement with Assurances for the Page springsnail in Arizona. Fill in the form using footnote directions. Use additional sheets, if necessary.

A. Type of Participant(s)[1]:
Participating Landowner ___

Participating Neighbor ___

Participating State Agency ___

Arizona Game & Fish Commission ___

B. Participating Landowner's Name and Address: _____

_____

C. Participating State Agency's Name and Address: _____

_____

D. Legal Description, acreage, and/or Map Showing Baseline Conditions (if any) & Enrolled sites:

_____

E. Conservation Commitments[2]:
..... All other required conservation measures in the Agreement apply.

F. Required Conservation Period[3]:
The term of this Agreement shall begin on the date of the final signature to this Agreement and shall remain in effect for XX years.

G. Baseline Condition of the Covered Area:
Baseline condition will be set at XX Page springsnail population sites for the enrolled property. Surveys conducted on month xx, 200x.

****

Participating Landowner, **name**	Date
Participating State Agency **[Name agency, person signing, title]**	Date
Director Arizona Game and Fish Department	Date
Concurrence, U.S. Fish & Wildlife Service Field Supervisor, Arizona Ecological Services Office	Date

[1]Check as applicable. If joint Certificate of Inclusion for a Participating Landowner/Neighbor and a Participating State Agency, check both.
[2]On Line E, specify any conservation commitments to be implemented by each participant in addition to the measures described in these sections. Include Page springsnail translocations, if any, allowed on participant's lands; what, if any, conservation options as described in Sections II and VI of the Agreement will be implemented; and any funding commitments.
[3]Specify the number of years the conservation commitments described on Line E will be maintained or carried out (5-year minimum).

Appendix B: Survey and Monitoring Protocol

Page Springsnail Survey and Monitoring Protocol

April 2008

Daniel Cox[1], Michael A. Martinez[2], and Jeff Sorensen[3]*

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INTRODUCTION

This surveying and monitoring protocol was developed for use in conjunction with the implementation of a candidate conservation agreement for the Page springsnail, *Pyrgulopsis morrisoni* (Hydrobiidae). The Page springsnail is found within a complex of springs and seeps near Oak Creek and the Town of Page Springs, Arizona. For detailed information on life history, habitat, threats, and conservation measures the reader should refer to the conservation agreement. In order to ease implementation of this protocol by private landowners, who may not have a great deal of biological expertise, we have developed two levels of survey and monitoring effort that will be acceptable to both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service. Surveys should be conducted at least once annually. Survey and monitoring data sheets and description of data fields are included with this protocol for use in the field. In general the two levels of effort are as follows:

1) Track presence/absence at known, historical, and potential habitats. This survey is to be used at known sites and during explorative surveys looking for new populations.

2) Empirically monitor general population trends, habitat associations, water quality associations, and general habitat conditions.

**********Please return datasheet to AGFD Mollusk Coordinator**********

PRESENCE/ABSENCE METHOD:

Search known occupied sites for snails and use appropriate data sheet.

1) Searchers or surveyors must attend an agency sponsored workshop or training to learn to identify the Page springsnail, and rely on the guidance to identify Page springsnail in the field included with this protocol.

2) Before the survey is started, the following are recorded: Date, Site, Spring, Search Start Time.

3) Searchers should make their best effort at locating snails. Start at the springhead and work your way down the spring-run searching a variety of substrate types, including vegetation. Search various depths and distances from shore as well as various distances from the spring head. When the first snails are encountered record their distance from the springhead in the 'Start Distance from springhead' field, also fill the fields 'substrates searched' and 'substrates with snails.' A magnifying glass would be useful and searchers should note size and whorl direction in determining taxonomy. In shallow springs or spring runs, searchers should pick up gravel and pebble substrates and inspect the top, sides, and bottom for snails. Also woody debris and leaf litter should be searched in this manner. In sand/silt substrates and thick aquatic vegetation, searchers should dip with a kitchen sieve/strainer and rinse debris out while checking for captured snails. In deep ponded habitats it will likely be necessary to utilize artificial substrate samplers. It may be prudent to seek agency assistance in these situations. All snails should be returned to the aquatic environment when searching is complete.

4) When no more snails are seen, the search is stopped and the following information is recorded: end search time, Stop Distance from springhead (where snails disappeared), substrates searched, substrates with snails, invertebrates located, Fish Presence, Crayfish presence, Notes, Substrate Types that were searched, Search End Time.

5) Photos would be helpful and searchers are encouraged to take photos of snails and habitat with whatever type of camera is available to them.

EMPIRICAL METHOD:

The primary methodology will be quadrat ring sampling described in Sorensen et al. (2002), though artificial substrate sampling will be utilized where quadrats are infeasible. This method is designed to allow us to evaluate springsnail and habitat correlations, population trends, and habitat quality trends.

1) Record: date, site, spring

2) To conduct the surveys, potential habitat is measured, and one quadrat is surveyed per meter. Random numbers are used to determine how far (in that meter) the plot is placed from the springhead. The ring is tossed haphazardly at the random distance from the springhead.

3) Inside the plot ring, search for every snail and other invertebrates. For each plot ring the following information is recorded: Plot #, Distance from springhead, depth, water flow, water temp, pH, TDS, % of specific vegetation, % of specific substrate, number of PYMO, other invertebrates, comments

4) When finished move on to the next plot ring and repeat the above steps.

5) Artificial substrate samplers will be utilized where water depth prohibits quadrat use and will gather the same information as described above. Artificial substrate samplers collect springsnails at densities comparable to those found in nearby natural substrata (O'Brien and Blinn 1999, FWS unpublished data). We will use either the modified Hester-Dendy like

Martinez and Thome (2006) with an effective sampling area of 330.86 cm^2, or saltillo tile made from unsealed clay floor tile cut into blocks 7.1 x 7.1 x 1.6 cm, resulting in an effective sampling area of 146.26 cm^2. Both samplers collect springsnails at similar densities (FWS, unpublished data).

Description of data fields

Date mm/dd/yyyy (i.e. 1/1/2006)

Site Name of the property or area i.e.: 'bubbling ponds hatchery'

Spring legal or given spring name.

Plot # Sequential number of quadrats; start with the plot closest to the springhead. In most springs there should be one quadrat per meter of potential habitat.

Distance from Springhead Distance from springhead in meters, out to 2 decimal points.

Depth Maximum depth within the ring measured in centimeters.

Water Flow Qualitative description of water velocity. 1=little to no flow, 2=moderate flow, 3=high flow with causing water to be turbulent.

Water Temp Water temp in Celsius.

Water pH Water pH to one decimal.

TDS Total Dissolved Solids.

Vegetation

This field is a coverage estimate of the dominant 2 vegetation species in the quadrat. Each estimate is independent of the other and should be given as a percentage that each species covers in the plot area. Since each species is considered independently, the 2 vegetation percentages can exceed 100%.

The following plant species are the most likely encountered in the vicinity of the Page fish hatchery: Nasturtium, Filamentous algae, Brown algae, Juncus, Spirodela, Carex, Moss, Detritus, Blackberry, Unknown Species.

******See table below for help identifying vegetation*****

% Bare Ground This field is an estimate of coverage in the quadrat that is <u>not</u> covered with vegetation.

% bare ground + total % veg = 100%.

Substrate This field is an estimate of the substrate coverage in the quadrat. The different substrates in the quadrat should be given as a percentage that adds up to 100%.

%Boulder + %Cobble + %Pebble + %Sand + %Silt=100%

Boulder Boulder is defined as larger that a volleyball (>256mm).

Cobble Cobble is defined is from tennis ball to volleyball size (>64mm, <256mm).

Pebble Pebble is defined is match head to tennis ball size (>2mm, <64mm).

Sand Sand is defined as gritty when rubbed between the fingers (>0.1mm, <2mm).

Silt Silt is defined as smooth when rubbed between the fingers (>0.1mm, <2mm).

Inverts Please provide the live quantity of each species found during your search. Species most likely seen are: page springsnail (PYMO), Physa, amphipod (Amhp), clam, leech, rams horn snail (RHS), Apple snail, Chinese mystery snail.

******See table below for help identifying species*****

Other Species

Please provide the live quantity of each species found during your search. Species most likely seen are: fish, frog (leopard frog, tree frog, bullfrog, toads), other.

******See table below for help identifying species*****

Notes Space provided to make notes. Put anything of potential interest.

Equipment List:

- Aquatic plants book
- Clipboard
- Digital camera with extra flash cards and batteries
- GPS with extra batteries
- Knee pads or foam cushion
- Flashlight or head lamp
- Magnaglobe
- Field guides
- Tweezers

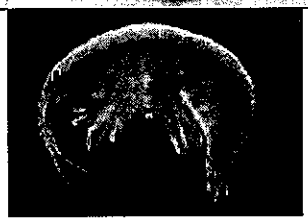
Specific to Empirical sampling:

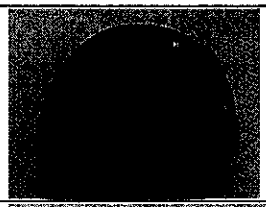
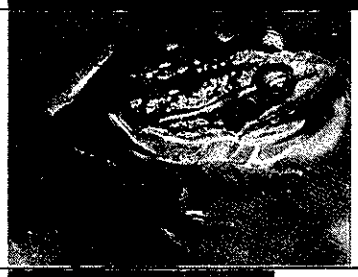
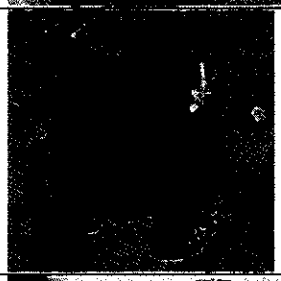
- Snail Field Kits
  - 20 cm diameter rings
  - Metric tape measurer
  - pH & TDS meter
  - Hand lens
- 50 m measuring tapes
- List of random number intervals for each spring

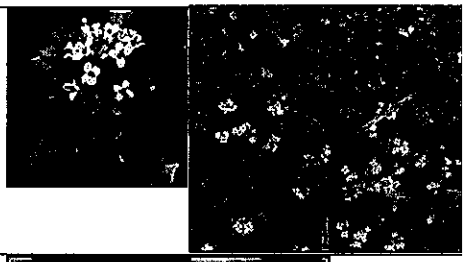
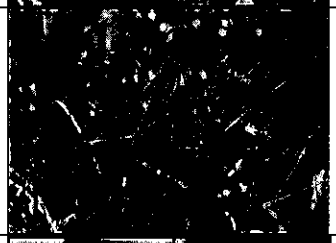
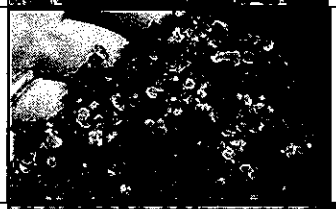
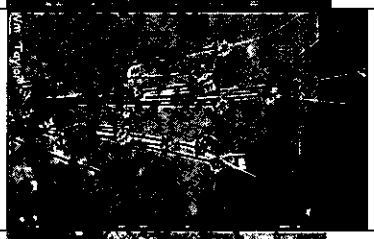
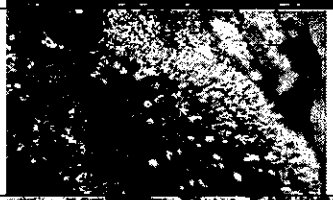
IDENTIFYING PAGE SPRINGSNAILS IN THE FIELD

Species of the springsnail group (*Pyrgulopsis*) cannot be distinguished from one another in the field. These snails can typically be identified as a springsnail purely on examination of the shell, though some pond snails (Lymnaeidae) have the potential to cause confusion. Since no other hydrobiids are known to occur in springs within the Oak Creek Watershed, we believe it is safe to assume that any snail identified as a springsnail must be the Page springsnail. The AGFD and USFWS will be responsible for validating taxonomy through their respective expertise or through coordination with other experts.

The two most important sources for identification of Page springsnail are in the journal articles by Hershler and Landye (1988) and Hershler (1994). The following discussion is based on information contained in those pieces of literature. The Page springsnail is a medium sized aquatic snail with an ovate or ovate-conic shell characterized by slightly convex whorls and typically averages 1.8 to 2.9 mm in length. Surveyors working in the Oak Creek Springs Complex will find that the shell whorl (direction of spin) is unique. If the operculum (shell opening) is oriented downwards, the operculum will be on the right side and the whorl will spin in a clockwise fashion from bottom to top (Figure 1). These are very distinctive features of springsnails. For Page springsnail the whorl count averages 3.74 – 4.5 whorls.

Species	**Description**	**Picture**
Page Springsnail	Shell opens to the right. Shell has 4-5 whorls 0.5-3mm in length. Opening of shell is round. Shell color is light to dark olive.	
Physid	Shell opens to the left. Shell has 4-7 whorls 4-20mm in length. Large aperture. Coloration is light to dark olive. Large ovate first whorl	
Amphipod	Amphipods look like small sideways swimming shrimp	

Rams-horn snail	Conspicuous, spiraled shell that opens on the left-side, with 3-8 whorls. May vary in color from opaque to almost black.	
Decollate snail	Terrestrial snail with a long, conical shell which will break off at the tip, becoming "decollated".	
Chinese mystery snail	Large snail, with a smooth shell globose in shape. Uniform; light to dark olive-green. Black pigmentation rims the entire lip.	
Mosquito fish	Between one and two inches in length, silver to gray in color. Their mouths point upward for surface feeding and their tails are rounded in shape.	
Leopard frog	A medium sized frog reaching 3.25 inches in length. Tan-brown with numerous spots on its' back. Usually found in water.	
Toad	Up to 5 inches in length. Rough skin. Short legs.	
Treefrog	A small frog reaching 2.25 inches in length. Usually gray or olive with blotches. Has rough skin.	
Bullfrog	Average size 3-5 inches. When approached, they will belly flop into the water and young bullfrogs will make a high pitched eek Green-brown without spots. Has a large eardrum that is bigger than its eyes. Usually found in water.	

Nasturtium	**Height:** Less than 45 cm **Leaf:** Dark green, succulent, alternate and pinnately divided. Up to 6" in long. **Flower:** White. Present in a rounded, terminal cluster. Pod is slender, curved, and upward-pointing with smooth, shiny skin. **Blooms:** April-August **Comments:** Floats or lies in water or mud. Succulent, reddish stems which root at nodes.	
Filamentous algae	**Filamentous** refers to the form in which a species of alga is growing. This type of algae will intertwine forming what looks like wet, wooly mats. There are many different **species** of filamentous algae and often more than one species will be present together. **Comments:** Filamentous algae provides habitat for many aquatic invertebrates	
Brown algae	**Description:** This type of algae is golden-brown in color and forms bubble-like structures that feel gelatinous to the touch.	
Juncus	**Stem: Round** **Leaf:** Round or flattened leaves usually grow from the plant base with a sheath at the leaf base **Flower:** Minute, papery, greenish to brownish flowers with 3 sepals and 3 petals that occur in clusters at the stem tips **Comments:** The round stem will differentiate this plant from Carex, which has a 3-sided stem.	
Spirodela	**Height:** Flat **Flower:** Rarely formed **Leaf:** Single fronds in clusters of 2-5, leaves are green. **Comments:** Lemnaceae's typically flourish in waters rich in nutrients, especially phosphorus and/or nitrogen	
Carex	**Stem: 3-sided** **Leaf:**, veins run parallel. **Inflorescence:** Spikelets variously clustered; flowers generally sessile in axil of flower bract. **Flower:** Flower small, generally 3 stamens. **Comments:** The 3-sided stem will differentiate this plant from *Juncus*	
Moss	**Height:** 1-10 cm tall. **Inflorescence:** They do not have flowers or seeds. Mosses produces spore capsules which may appear as beak-like capsules borne on top of thin stalks. **Description:** grows in clumps or mats in damp or shady locations. and their simple leaves cover the thin wiry stems.	
Blackberry	**Height**: up to 10 feet **Stem:** covered in prickly thorns. **Leaf:** arranged alternately along the stem with each leaf consisting of 3 to 5 leaflets. The leaves are toothed on the edges, somewhat prickly, and bright green in color.	

Literature Cited

Hershler, R. and J.J. Landye. 1988. Arizona Hydrobiidae (Prosobranchia: Rissoacea). Smithsonian Contributions to Zoology Number 459. Smithsonian Institution Press, Washington, D.C.

Hershler, R 1994. A review of the North American freshwater snail genus *Pyrgulopsis* (Hydrobiidae). Smithsonian Contributions to Zoology, Number 554. Smithsonian Institution Press. Washington D.C. 52 pp.

Martinez, MA and DM Thome. 2006. Habitat usage by the Page Springsnail, *Pyrgulopsis morrisoni* (Gastropoda: Hydrobiidae) from central Arizona. The Veliger. Vol. 48(1) 8-16.

O'Brien, C & DW Blinn. 1999. The endemic spring snail *Pyrgulopsis montezumensis* in a high CO_2 environment: importance of extreme chemical habitats as refugia. Freshwater Biology 42:225-234.

Sorensen, J.A., C.B. Nelson, and A.K. Jontz. 2002. Page springsnail monitoring interim progress report. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, Arizona.

Image Credit

Indiana Department of Natural Resources. "Aquatic Invasive Species; Chinese mystery snail" <http://www.in.gov/dnr/invasivespecies/CHINESE%20MYSTERY%20SNAIL.pdf> 15 October 2006.

Page Springs Springsnail Survey Form: Presence/Absence **Owner:**_____**Site:** _____**Surveyors:**_____

Survey Date: _____

Spring name	**Start search time**	**End search time**	**Distance from springhead PYMO *first* encountered (in meters)**	**Distance from springhead PYMO *last* encountered (in meters)**	**Substrate** (live/dead vegetation, silt, pebble, rock)	
					searched	**with snails**

Organisms Present (yes/no)						
Page springsnail	**Rams Horn**	**Physa**	**Fish**	**Crayfish**	**Frogs**	**Other:**

Notes:

Survey Date: _____

Spring name	**Start search time**	**End search time**	**Distance from springhead PYMO *first* encountered (in meters)**	**Distance from springhead PYMO *last* encountered (in meters)**	**Substrate** (live/dead vegetation, silt, pebble, rock)	
					searched	**with snails**

Organisms Present (yes/no)						
Page springsnail	**Rams Horn**	**Physa**	**Fish**	**Crayfish**	**Frogs**	**Other:**

Notes:

Short instructions:

- Search a variety of substrate types: live vegetation, dead vegetation/debris, sand/silt, pebbles, and rocks. Search various depths and distances from shore as well as various distances from the spring head. Pick up gravel, debris, and leaf litter and inspect for snails. Return snails where you found them.
- When the first snails are encountered record their distance from the springhead (in meters) in the 'Start Distance from springhead' field
- When no more snails are seen, the search is stopped. Fill in the "Stop Distance from springhead" field as well as the other applicable fields.
- Photos would be helpful and searchers are encouraged to take photos of habitat and snails with whatever type of camera is available to them.

Page Springs Springsnail Survey Form: Empirical Protocol Owner:_____ Site: _____ Surveyors:_____

Survey Date_____

Site		Water Quality						Vegetation						Substrate (percent)				
Spring Name		Plot	Depth	Velocity	Temp	pH	TDS	Spp.1	%Cover 1	%Live 1	Spp.2	%Cover 2	%Live 2	%Boulder	%Cobble	%Pebble	%Sand	%Silt
Inverts																		
Spp.	No.	Waypoint/UTM:						Northing:				Easting:						
PYMO		Other Species:																
PHY																		
RHS		Notes:																

Survey Date_____

Site		Water Quality						Vegetation						Substrate (percent)				
Spring Name		Plot	Depth	Velocity	Temp	pH	TDS	Spp.1	%Cover 1	%Live 1	Spp.2	%Cover 2	%Live 2	%Boulder	%Cobble	%Pebble	%Sand	%Silt
Inverts																		
Spp.	No.	Waypoint/UTM:						Northing:				Easting:						
PYMO		Other Species:																
PHY																		
RHS		Notes:																

Survey Date_____

Site		Water Quality						Vegetation						Substrate (percent)				
Spring Name		Plot	Depth	Velocity	Temp	pH	TDS	Spp.1	%Cover 1	%Live 1	Spp.2	%Cover 2	%Live 2	%Boulder	%Cobble	%Pebble	%Sand	%Silt
Inverts																		
Spp.	No.	Waypoint/UTM:						Northing:				Easting:						
PYMO		Other Species:																
PHY																		
RHS		Notes:																

Boulder = 256 mm (Volleyball), **Cobble** = 64 mm (Tennis Ball), **Pebbles** = 2 mm (Match Head), **Sand** = 1.5 to 0.1, **Silt** = < 0.1

Vegetation: Percent of sample that is covered by vegetation Water Velocity and Density are qualitative **High, Medium, Low**

Page Springs Springsnail = PYMO Physa-Physella = PHY Ramshorn Snails-Planorbid Snails=RH