United States Department of the Interior

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In Reply Refer To:
AESO/SE
22410-2007-F-099

October 15, 2007

Ms. Elaine J. Zieroth
Forest Supervisor
Apache-Sitgreaves National Forest
PO Box 640
Springerville, Arizona 85938

Dear Ms. Zieroth:

Thank you for your memorandum requesting formal consultation with the U.S. Fish and Wildlife Service (FWS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544), as amended (Act). Your request for formal consultation was dated November 14, 2006, and received by us on November 17, 2006. At issue are impacts that may result from your issuance of a Ditch Bill easement for the Rudd Creek Ditch and Diversion Maintenance for the Sipes White Mountain Wildlife Area (SWMWA) Apache County, Arizona. You requested formal consultation on the threatened Little Colorado spinedace (*Lepidomeda vittata*) and its critical habitat.

In your memorandum, you requested our concurrence that the proposed action is not likely to adversely affect the bald eagle (*Haliaeetus leucocephalus*), southwestern willow flycatcher (*Empidonax traillii extimus*), Mexican spotted owl (*Strix occidentalis lucida*) and its critical habitat, and the Chiricahua leopard frog (*Rana chiricahuensis*). We concur with your findings and provide the basis for our concurrence in Appendix A.

This biological opinion is based on information provided in the November 14, 2006, final biological assessment, numerous telephone conversations, field investigations, and other sources of information. References cited in this biological opinion are not a complete bibliography of all references available on the species of concern, the proposed activities and its effects, or on other subjects considered in this opinion. A complete administrative record of this consultation is on file at this office.

CONSULTATION HISTORY

- November 14, 2006 - The Apache Sitgreaves National Forest (ASNF) sent a final biological assessment on the effects of the proposed action and requested consultation.

- January 4, 2007 - Representatives from the ASNF, FWS, and Arizona Game and Fish Department (AGFD) met at the SWMWA to tour Rudd Creek and the project site.

- April 13, 2007 – 135 day consultation period ends.

- May 3, 2007 – FWS requests extension of the consultation period from ASNF, and ASNF agrees.

- May 24, 2007 – Representatives from the FWS and AGFD measure spinedace habitat attributes on the ASNF-portion of Rudd Creek.

- July 17, 2007 – FWS provides a draft biological opinion to the ASNF.

- September 13, 2007 - FWS requests 30-day extension of the consultation period from ASNF.

- September 26, 2007 – The AGFD provided comments to the draft biological opinion.

- October 5, 2007 – The ASNF provided comments to the draft biological opinion.

DESCRIPTION OF THE PROPOSED ACTION

Background

The AGFD purchased the White Mountain Hereford Ranch in 1993. They have since established the SWMWA on the ranch to provide opportunities to meet objectives of Arizona's Heritage Fund Program for Threatened, Endangered and Sensitive species and their habitats, as well as provide benefits for other wildlife species and recreational opportunities for the public. Rudd Creek aquatic and riparian habitats were an identified priority in the SWMWA management plan (AGFD 1996). The establishment and/or maintenance of spinedace refugia in the Rudd-Nutrioso Creek drainage, especially Rudd Creek where SWMWA and water rights have been secured, are identified goals in the spinedace recovery plan (USFWS 1998). The AGFD received a diversionary water right to Rudd Creek as part of the ranch purchase. The diversion used for irrigation is located on the ASNF.

Proposed Action

The proposed action under this consultation is the issuance of a Ditch Bill easement by the ASNF for: 1) operation of a Rudd Creek diversion to irrigate fields and fill reservoirs; and 2) construction of two volumetric flow rate devices and installation of staff and crest gages to collect flow data.

Rudd Creek Diversion Operation

Water diverted from Rudd Creek will be used to irrigate fields within the SWMWA to grow pasture grasses and oats for animal feed or left fallow for wildlife. Water would be diverted for

irrigation and storage primarily in the spring but diversion can potentially occur throughout the year. For diversions associated with this project, the AGFD has determined that water will only be diverted from Rudd Creek when its base flow is predicted to reach or exceed the threshold value of 90 percent of median runoff (see below criteria).

Because no gages exist to measure the base flow of Rudd Creek, diversions will be based on the most recent stream runoff predictions developed by the Natural Resource Conservation Service's (NRCS) bimonthly Arizona Basin Outlook Reports (NRCS 2007). These reports extrapolate snowpack information to estimate the percent of normal monthly median streamflow at major United States Geological Survey (USGS) stream gages throughout the state. Additional information on the use of snowpack monitoring stations in determining the appropriate periods for diversion is provided in Appendix B.1 of this document. It should be noted that the threshold established within this consultation for diversions from Rudd Creek is not met annually, so that diversion may not occur every year.

Diversions between September 16 and April 14 will be used to fill the Trinity and McKay reservoirs on the SWMWA property. For these diversions, the AGFD has determined that water will only be diverted from Rudd Creek when the current discharge equals or exceeds 90 percent of the median monthly flow recorded at the Little Colorado River. This period is referred to as the fill season, and water can only be diverted to fill Trinity and McKay reservoirs (B. Crawford, AGFD, pers. comm. February 1, 2007). However, water from McKay Reservoir may subsequently be used to irrigate fields in August if needed.

Median monthly flows and 90 percent values will be calculated from the USGS Gage Station 09384000 on the Little Colorado River. Appendix B.2 contains additional detail on the use of this gage, and gage station data.

Fields will primarily be irrigated from Rudd Creek for short durations of three to seven days from Mid-April until the end of May. An authorized AGFD employee would divert up to 30 percent of the observed flow into the irrigation ditch, while allowing the remaining 70 percent to continue down Rudd Creek. The diversion would be closed when the two reservoirs are full and irrigation needs are met. Fields are designed to prevent surface water return into Rudd Creek.

<u>Construction of Two Volumetric Flow Rate Devices (e.g. flumes) and Installation of Gages</u>

Because there is no stream discharge gage on Rudd Creek to provide baseline flood and base flow information for spinedace habitat, the following actions have been proposed by the ASNF and/or AGFD to collect streamflow data:

1. The ASNF will install staff gages in spinedace habitat downstream of SWMWA. Water surface elevation will be documented before and after diversion has started to determine whether water depth in spinedace habitat has been affected. Water surface elevation decreases may reduce spinedace habitat quality if fish are concentrated in smaller areas. ASNF will coordinate data collection with AGFD as needed (K. McMillan, ASNF, pers. comm. March 13, 2007).

2. The AGFD, in cooperation with the ASNF, will install crest gages in Rudd Creek near the diversion and within the irrigation ditch to measure peak flood flow elevations. This action will allow flood discharge on Rudd Creek to be determined and provide more accurate information on flood flows in spinedace habitat.

3. The AGFD, in cooperation with the ASNF, will modify the diversion to prevent spinedace from being diverted on to the irrigated fields if or when spinedace are reintroduced to the SWMWA portions of Rudd Creek or Rudd Creek above the diversion on the ASNF.

4. The AGFD, in cooperation with the ASNF, will install two flumes or other devices that will be used to measure the rate of flow in Rudd Creek. This action will allow diversion volumes to be quantified relative to total volume. These structures will be located either immediately above or below the diversion in the main channel and in the upper diversion ditch.

The diversion consists of a row of large rocks temporarily placed by hand in the active channel to divert a portion of the flow to a head gate (Appendix C, Photo 1). The head gate has a turnstile which allows the operator to control the amount of water diverted into the irrigation canal. The water is diverted down a small unlined irrigation canal to the fields on the SWMWA.

ACTION AREA DESCRIPTION

The action area is defined as those areas influenced by direct and indirect effects of the proposed action (USFWS 1998a). The action area for this project is located east of Springerville, Apache County, Arizona. It includes 4.2 miles of Rudd Creek from the diversion downstream to its confluence with Nutrioso Creek; and 10 miles of Nutrioso Creek from the Rudd Creek confluence, which is downstream of Nelson Reservoir, to the LCR. The upper five miles of Nutrioso Creek, below Nelson Reservoir, are designated as spinedace critical habitat. Rudd Creek is the largest tributary to Nutrioso Creek downstream of Nelson Reservoir. Rudd Creek is likely an important contributor of flood flows to this Nutrioso Creek reach due to the presence of the Nelson Reservoir Dam. Flood events in Nutrioso Creek are controlled by this dam.

The irrigated fields on the SWMWA are considered part of the action area because they would not exist but for the presence and influence of water delivery from the Rudd Creek diversion.

LITTLE COLORADO SPINEDACE AND ITS CRITICAL HABITAT

Listing History

We listed the Little Colorado spinedace as threatened with critical habitat on October 16, 1987 (USFWS 1987). Threats were identified as habitat alteration and destruction, predation by and competition with non-native aquatic organisms, and recreational fishery management. Forty-four stream miles of critical habitat were designated: 18 miles of East Clear Creek immediately upstream and 13 miles downstream from Blue Ridge Reservoir in Coconino County; eight miles of Chevelon Creek in Navajo County; and five miles of Nutrioso Creek in Apache County. Constituent elements of critical habitat consist of clean, permanent flowing water, with pools and a fine gravel or silt-mud substrate.

Life History

The spinedace is a small (about four inches long) minnow native to the LCR drainage. This fish occurs in disjunct populations throughout much of the LCR drainage in Apache, Coconino, and Navajo counties. Extensive collections summarized by Miller (1963) indicated that the spinedace had been extirpated from much of the historical range during the period 1939 to 1960. Although few collections were made of the species prior to 1939, the species is believed to have inhabited the northward flowing LCR tributaries of the Mogollon Rim, including the northern slopes of the White Mountains.

Food habits of spinedace include chironomid larvae, dipterans, filamentous green algae, and crustaceans (Runck and Blinn 1993, Blinn and Runck 1990). Spinedace are late spring to early summer spawners (Blinn 1993, Blinn and Runck 1990, Miller 1961, Minckley 1973, Minckley and Carufel 1967), although some females have been found to contain mature eggs as late as October (Minckley and Carufel 1967). A complete discussion of the taxonomic, distributional, and life history information of the spinedace has been compiled in the Little Colorado Spinedace Recovery Plan (USFWS 1998b).

As would be expected for a species adapted to fluctuating physical conditions, the spinedace is found in a variety of habitats (Blinn and Runck 1990, Miller 1963, Miller and Hubbs 1960, Nisselson and Blinn 1989). It is unclear whether occupancy of these habitats reflects the local preferences of the species or its ability to tolerate less than optimal conditions. Available information indicates that suitable habitat for the Little Colorado spinedace is characterized by clear, flowing pools with slow to moderate currents, moderate depths and gravel substrates (Miller 1963, Minckley and Carufel 1967). Cover and shade from undercut banks or large rocks is often a feature. Spinedace have also been found in pools and flowing water conditions over a variety of substrates, with or without aquatic vegetation, in turbid and clear water (Denova and Abarca 1992, Nisselson and Blinn 1991). Water temperatures in occupied habitats ranged from 58 to 78 degrees Fahrenheit (Miller 1963). Miller (1963) called the spinedace “trout like” in behavior and habitat requirements, and it is likely that prior to 1900 the spinedace used habitats now dominated by non-native salmonids.

The spinedace is still found in the streams it is known from historically (Chevelon, Silver, Nutrioso, East Clear Creek, and the LCR proper), but populations are generally small and the true population size for any occupied stream is unknown due to the yearly fluctuations and difficulty in locating fish. Spinedace have a tendency to disappear from sampling sites from one year to the next and may not be found for several years. For example, the Silver Creek population was considered extirpated until fish were collected from the creek again in 1997. Spinedace were not found again in Silver Creek during 2003 and 2004 surveys.

Non-native fish may compete with, prey upon, harass, and alter habitat utilized by native fish. In the last 100 years, at least ten non-native fish species have been introduced into spinedace habitats. These include rainbow trout (*Oncorhynchus mykiss*), fathead minnow (*Pimephales promelas*) and golden shiner (*Notemigonus crysoleucas*). Surveys in East Clear Creek have documented the presence of these three non-native species and brown trout (*Salmo trutta*) in the watershed (Denova and Abarca 1992). Data from research experiments and field observations indicate that at least the rainbow trout is a predator and potential competitor with the spinedace (Blinn *et al*. 1993).

ENVIRONMENTAL BASELINE

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

Status of the Species and Its Critical Habitat in the Action Area

Spinedace habitat is located in Rudd Creek approximately 2.2 miles downstream of the diversion. There is no designated critical habitat in Rudd Creek. Currently, spinedace are not found on the SWMWA; populations are located downstream on the ASNF. Rudd Creek on the SWMWA is seasonally dry in sections. ANSF has authorized AGFD to divert water from Rudd Creek since 1993. Spinedace are prevented from moving above this portion of Rudd Creek because of elevated culverts within the abandoned diversion found approximately 0.5 miles below Forest Road 57 crossing. There are additional elevated culverts located at the Forest Road 57 crossing. The spinedace population in Rudd Creek fluctuates as shown in AGFD survey data. AGFD found 301 spinedace in Rudd Creek during surveys in 1994. In May 2005, one spinedace was found in Rudd Creek (McKell 2005). In April 2006, no spinedace were found (Carter 2006). Two months later, 76 spinedace were found in Rudd Creek (Lopez 2006). Rudd Creek has been affected by drought and resultant low water conditions in the recent past. In dry years much of the habitat dries up in the upper Rudd Creek reaches; this is likely the limiting factor in maintaining spinedace populations in those Rudd Creek reaches (Carter 2006). Portions of occupied spinedace habitat in Rudd Creek, downstream of SWMWA, also become dry during drier years (S. Hedwall, USFWS, pers. comm. February 25, 2007). Portions of Rudd Creek on the SWMWA and immediately downstream on the ASNF contain small, isolated pools which have characteristics indicating permanency even in extremely dry years. Rudd Creek fish surveys of these pools conducted in 2006 yielded mature bluehead suckers (*Catostomus discobolus*) and speckled dace (*Rhinicthys osculus*).

Spinedace are also found in Nutrioso Creek, above and below Nelson Reservoir. Spinedace critical habitat was designated on Nutrioso Creek from the ASNF boundary upstream five miles to the Nelson Reservoir dam (USFWS 1987). In 2006, AGFD surveys in Nutrioso Creek above Nelson Reservoir found 128 spinedace; however, no spinedace were found downstream of the reservoir (Carter 2006, USFS 2006). Spinedace in Nutrioso Creek, downstream of Nelson Reservoir, were commonly found in earlier surveys (1994 to 2000). It has been anticipated that these survey results have been caused by the ongoing drought causing desiccation of the creek, lack of spill from the Nelson Reservoir Dam, and the presence of non-native species such as green sunfish (*Lepomis cyanellus*) and fathead minnows (Carter 2006).

Rudd Creek

Rudd Creek is a northeast flowing, second order stream tributary to Nutrioso Creek, which is a tributary to the LCR. The Rudd Creek watershed vegetation communities include spruce-fir (*Picea and Abics spp.*), ponderosa pine (*Pinus ponderosa*) and piñon-juniper (*Pinus and Juniperus spp.*). Precipitation varies from 23 inches at the higher elevations (Greer, Arizona) to 12 inches near the SWMWA (Springerville, Arizona) (Western Regional Climate Center 2007).

Milligan Creek and unnamed ephemeral tributaries to Rudd Creek occur within the action area. Milligan Creek, an intermittent tributary to Rudd Creek along the southern boundary of the project area, was surveyed in July of 1992 and found to be dry except for a few fishless pools. The upper portion of Rudd Creek (above and immediately below the diversion) is located in a canyon. Rudd Creek flows out of the canyon into the broad valley where SWMWA is located. It becomes entrenched in a deep, narrow arroyo at this point. Most of this reach has been excluded from elk use by an electric fence. The lower Rudd Creek reaches at the northeast boundary of the SWMWA and ASNF, hereafter referred to as lower Rudd Creek, flow from the entrenched areas to a wider channel and floodplain.

The lower Rudd Creek active stream channel is narrow and deep which is typical for channels in valleys containing fine sediments as observed during our May 24, 2007, site visit. Stable channels with a silt-clay substrate maintain deep, narrow channels because the cohesiveness of the silt-clay soils limits lateral erosion and the channel does not widen as fast as it deepens (Schumm 1960). Rudd Creek is located within a soil classified as a Nutrioso loam. The silt-clay percentage for this soil is 56 percent at this site (NCSS 2006). Schumm (1960) predicts a channel with a width-depth ratio between 3 and 4 for these soil substrate values. During our site visit, lower Rudd Creeks' active stream channel width-depth ratio was measured at 4.7. Five longitudinal profiles (approximately 1,800 feet) of the stream bottom were measured during a low flow period. The profiles indicate that the stream bottom has very little fluctuation between riffles and pools. Pools are often 100 to 150 feet in length. Pools that could become isolated if water surface levels drop sufficiently are rare. During the current low flow period, long stream reaches with pool habitat are separated by shallow reaches that flow through emergent vegetation.

Rudd Creek supports dense herbaceous wetland plants on its streambanks, further providing for streambank stability (Rosgen 1996). Spinedace occupied habitat in Lower Rudd Creek is located in deep, low gradient reaches with little surface agitation (Appendix C, Photos 2 and 3).

There is no stream discharge gage on Rudd Creek to provide baseline flood and base flow information. The nearest active USGS gage is located 20 miles north on the LCR above Lyman Lake near St. Johns, Arizona (USGS gage number 09384000). Two other USGS stream gages were operated in the area until 1982 on Nutrioso Creek below Nelson Reservoir (USGS gage number 09383500) and on the Little Colorado River at Greer, Arizona (USGS gage number 09383400). Streamflow measurements at the USGS gages on the LCR and nearby Nutrioso Creek are currently or were greatly influenced by diversions and dams in the past. In order to estimate Rudd Creek flood flows and their return intervals, data from the USGS stream gage from the LCR at Greer (USGS gage number 09383400) was used. The upper watershed to this LCR reach is adjacent to that of Rudd Creek. The LCR at Greer stream gage was in operation for 23 years between 1960 and 1982. Because there is no gage, Rudd Creek peak flood flows

were estimated using two different methods; index-flood method (Riggs 1982, J. Fogge, Bureau of Land Management, pers. comm. April 4, 2007) and the peak discharge regression equations developed by the USGS (1999). The two-year return interval flood flow was calculated to be 136 to 138 cubic feet per second (cfs) based upon these two methods (Appendix B.3).

Seventy percent of annual peak flows on the LCR stream gage at Greer occur in April as a result of snowmelt. The remaining 30 percent of peak flows occurred from August to October as a result of summer thunderstorms. It can be assumed that the majority of Rudd Creek peak flows also occur in April. This is concurrent with the early part of the proposed irrigation period of April to late May.

Sipes White Mountain Wildlife Area

The SWMWA is open to the public for wildlife viewing, hiking and hunting. There are a visitor center and hiking trails on the property. AGFD currently irrigates up to 76 acres, a decrease from the original 321 acres irrigated by the previous landowner. The remaining 245 acres were retired and are currently managed as dry land pasture. The primary crop irrigated is pasture grasses, including western wheatgrass, crested wheatgrass, tall fescue, and smooth brome. Oats are sometimes planted in the summer when there are adequate summer thunderstorms (B. Crawford, AGFD, pers. comm. February 1, 2007). Some pasture grass fields are mowed and baled as a fulfillment to retain the existing water rights. Cut fields are mowed at a height that provides sufficient amounts of residual cover for soil retention and wildlife habitat. Other fields are left standing to provide wildlife feed and cover needs.

Fertilizer use on the fields will be limited to dry urea and applied in April or May. Fertilizer will be applied at a rate of approximately 75 pounds per acre immediately prior to receiving irrigation water. Fields will be monitored to insure no surface runoff of irrigation water goes outside of the agriculture fields.

The maintenance of pasture grasses on the SWMWA may also limit the establishment and spread of invasive and/or noxious weeds (Rose *et al*. 2001). To date, the only invasive weed present on the SWMWA is musk thistle (*Cardus nutans*). It is at numbers in which control is effective (B. Crawford, AGFD, pers. comm. February 1, 2007).

Elk use on Rudd Creek can be high during certain times of year. Excessive elk use can negatively impact riparian habitats by bank trampling, excessive use of both woody and herbaceous plants, and soil compaction (Zeigenfuss *et al*. 2004). The AGFD has implemented actions to reduce elk related impacts to Rudd Creek. Extensive portions of Rudd Creek are currently fenced or scheduled for elk standard electric and exclusionary fencing. To date, approximately 60 percent of Rudd Creek on the SWMWA has been excluded from elk. The long term goal is to eventually exclude 80 percent from elk use (D. Cagle, AGFD pers. comm. February 5, 2007). Denying elk access has increased herbaceous wetland vegetative cover, reduced head cutting and allowed the expansion of willow and other woody vegetative communities.

Elk herbivory reduction has multiple benefits to spinedace and other native fish. Riparian vegetation, especially sedges, rushes, and spikerush are very effective in trapping fine sediment as it is transported downstream. Stream channels tend to narrow and deepen as herbaceous

vegetation establishes and traps sediment (Rosgen 1996, Anderson *et al*. 2004). The spinedace-occupied reaches in Rudd Creek are narrow and deep channels. Streambanks that are comprised of fine sediments also store large quantities of water and help to prolong base flows during drier times of the year. In wider valleys such as SWMWA that contain finer sediments, stream baseflows can be maintained for a longer period of time. Coarser sediments may hold more water, but they drain more quickly. Finer sediments hold less water but release it over a much longer time period which is likely to overlap the next flood event (Whiting and Pomeranets 1997). The wider the valley bottom the more water is stored for later bank release. Lower Rudd Creek is buffered by wide bands of moist soil, vegetated by sedges and rushes that range between 20 and 50 feet in width (Site field visit, May 24, 2007). This moist soil slowly releases water into lower Rudd Creek to maintain baseflow.

There is another diversion located near the SWMWA headquarters approximately 1.25 miles downstream of the primary diversion. The diversion is actually the original Rudd Creek streambed, as the creek was re-routed utilizing heavy equipment prior to 1975. This diversion is used to water a pocket of riparian vegetation, primarily strap leaf willows, and supply water to a small oxbow lake, which flows back into Rudd Creek. Water can be diverted into Trinity Reservoir by utilizing this diversion. This diversion to Trinity Reservoir has been utilized three times during the last 13 years of AGFD operation. Water will primarily be diverted into the ditch supplying Trinity Reservoir during spring flood events, and at least 70 percent of the flow in the creek, as determined by the installed volumetric flow rate devices (e.g. flumes), will be allowed to remain in the stream to maintain downstream vegetation and aquatic wildlife habitats. The operation of this diversion is not part of the proposed action.

ASNF Portions of Rudd and Nutrioso Creeks

There is no livestock grazing along Rudd Creek or Nutrioso Creek below SWMWA. The Picnic Allotment located on lower Nutrioso Creek excludes grazing along the drainage corridor. With exception of the St. Mary Allotment, above the diversion are also excluded from livestock grazing. This reach may also be impacted by wintering elk; however, there are no data to substantiate this.

EFFECTS OF THE PROPOSED ACTION

Effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action, which will be added to the environmental baseline. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

Direct Effects

Elevated culverts under Forest Road 57 are located one mile upstream of the spinedace-occupied portion of Rudd Creek. Another set of elevated culverts within an abandoned diversion are located approximately 0.5 mile upstream of the spinedace occupied habitat. These culverts are elevated sufficiently at the downstream ends to prevent spinedace from swimming upstream towards the proposed diversion. This will prevent the accidental diverting of spinedace on to the irrigated fields. The Forest Road 57 culverts also eliminate the effects of vehicle crossings since it protects the only road crossing on Rudd Creek.

The two proposed volumetric flow rate devices will be constructed upstream of the spinedace habitat with one placed above the diversion in Rudd Creek and one placed in the diversion ditch. Rudd Creek is not likely to be affected by this construction since an access road leads to the project site. Spinedace habitat is over two miles downstream from the proposed site. Excessive sedimentation is not likely to reach spinedace habitat given the dense herbaceous vegetation in and adjacent to the creek and the best management practices mitigation features that will be required by the ASNF (K. McMillan, ASNF, pers comm. February 21, 2007).

Indirect Effects

The effects of diversions and dams on downstream flow, sediment transport, channel substrate, aquatic organisms, and vegetation have been reported for large rivers and dams (Williams and Wolman 1984). Few studies have examined the effects of small diversions on stream channel morphology and aquatic resources. Chavez (1996) studied stream channel conditions above and below diversion sites on 20 Colorado streams. The majority had decreased bankfull cross-sectional area, bankfull width and depth, and median substrate size below the diversion. However, Bohn and King (2000) found no statistically significant difference in sediment transport or channel substrate size above and below diversion sites on 21 Idaho streams. They speculated that flood flows were able to top over the diversions allowing flushing flows to continue carrying sediment downstream. Ryan (1997) studied partial diversions on creeks in the Rocky Mountains. Very subtle or non-existent changes to stream channels were observed as a result of partial diversion. Periodic flooding still occurred but at higher return intervals; floods that occurred every 1.5 years now occurred every two to three years (Ryan and Caine 1993, Ryan 1997). Flood events were able to flow over and around diversions and produced a more naturalized hydrograph. Flushing flows occurred during these events and provided for a stable stream channel.

Generally, diversions may affect fish habitat by decreasing stream flow which lowers water depth. This is especially important during the low base flow period in summer. Riffles and streambanks are the first habitats to be affected by lower flows (Armstrong *et al*. 2001, Nehring 1979). If water surface level drops sufficiently, riffles become impassable and fish may become concentrated in the remaining pool habitats. Fish can become stressed, especially in warm summer months if water quality declines, when they are concentrated in small pools. Smaller fish may also suffer increased predation under these circumstances (Armstrong *et al*. 2001). Lower water levels may also decrease fish habitat quality when streambank cover, woody debris, and overhanging banks are no longer accessible to fish. Fish not only lose cover for protection from predation and foraging habitat, but water temperatures may rise if shoreline vegetation is no longer shading portions of the channel. Both riffles and streambanks with large woody debris,

overhanging banks, and shoreline vegetation are important aquatic insect habitats, and aquatic insects are an important food source for spinedace (Myers and Resh 2000, USFWS 1998b). These bank cover sites are not used for spinedace spawning but they do provide important hiding cover for fry and small fish (S. Hedwall, USFWS, pers. comm. April 2, 2007).

Potential impacts would be minimized in the proposed action because irrigation generally occurs from early-April to the end of May. This period normally coincides with the peak spring stream runoff in Rudd Creek. In addition, irrigation would not occur in drier years when prolonged snowmelt runoff is not likely to occur. Irrigation would also not occur during the drier summer months when there are lower base flows. Lower Rudd Creek spinedace habitats are deep, narrow pools that are often 100 to 150 feet in length (Appendix C, Photos 2 and 3). These deeper habitats are not as susceptible to low flows as shallow riffle habitats. Spinedace would not become trapped in isolated pools during years when snow pack levels reach the threshold in which diversion would be allowed because remaining flows would be sufficient to keep the pools connected. In addition, the primary irrigation season occurs during peak runoff (April to mid-May), when impacts to downstream spinedace habitat would be minimized.

In addition, the diversion and ditch system are designed to handle a restricted amount of water flow. A smaller percentage of actual stream flow will be diverted as flood flows increase. The irrigation ditch measures two feet deep and three feet wide (D. Cagle AGFD, pers. comm. February 13, 2007). The gradient of the irrigation ditch, measured from a 7.5" topographic map, is approximately 0.03. The maximum discharge that can be carried down the ditch ranges between 12 to 24 cfs depending upon the amount of vegetation growing in the ditch. An irrigation ditch recently cleared of vegetative growth will be smoother and allow for higher flow velocity and discharge than a ditch with vegetative growth (Gribben 1997). The irrigation ditch when well-maintained will only be diverting up to 30 percent of the Rudd Creek discharge at flows at or less than 80 cfs. As discharges increase above 80 cfs the overall percentage of flow being diverted will decrease. For example, if 136 cfs were flowing above the diversion, the maximum diversion of 24 cfs would only be 18 percent of that total discharge.

Bankfull discharge is important in supporting spinedace habitat since these are the stream channel maintenance flows. These flows form, maintain and stabilize the stream channel and aquatic habitats. Occurring once every one to three years (return intervals), bankfull flows are responsible for carrying most sediment loads through the stream system and maintaining stability (Leopold 1994, Rosgen 1996). If there is no local stream flow measurement data available, the discharge estimated at the 1.5 year return interval is generally considered the bankfull discharge (Leopold 1994). Large diversions can increase the return interval in which bankfull discharge occurs; instead of occurring every 1.5 years, previous bankfull flows may occur only every five to ten years. Spinedace habitat can be adversely affected by increased flood return intervals or less frequent flooding, as follows:

- Sediment transport is decreased allowing for aggradation and embeddedness in the spinedace habitat. Aggradation results in shallower channels which increase water temperatures and reduces available habitat during low flow periods.

- Overbank flows which occur at bankfull discharge decrease in frequency which decreases streambank and floodplain water table recharge and storage levels. This decrease can adversely affect riparian plants which depend upon a shallow water table. Riparian

vegetation losses can result in increased water temperatures. Additionally, the loss of riparian vegetation can result in streambank erosion and collapse causing excessive sediment in spinedace habitat. Streambank recharge also supports stream base flow in spinedace habitat during the drier periods.

- Frequent flooding, bankfull discharge or greater, clears colonizing vegetation from the active stream channel. The lack of flooding over a longer period of time allows vegetation to establish within the stream channel. The increased roughness slows flow velocity, reducing the flows' ability to move sediment through the system and causing aggradation and sedimentation. Large vegetation in the channel bottom can divert flow into streambanks causing lateral erosion which increases sedimentation and widens the channel. As described above, stream temperatures increase as the channel widens and becomes shallower. This adversely affects spinedace habitat availability in low flow periods.

The estimated bankfull discharge, with a 1.5 year return interval, for Rudd Creek at the diversion is estimated to be 49 cfs (Appendix B.3, Table 3). The spinedace habitat receives 70 cfs at this time because it is downstream and influenced by additional drainages and a larger watershed (Appendix B.3, Table 3). If up to 30 percent of this discharge is diverted (15 cfs), 34 cfs is left immediately downstream in Rudd Creek. Additionally, other drainages below the diversion would be contributing approximately 21 cfs at these times for a total of 55 cfs at the spinedace habitat.

However during diversion, the estimated 1.5 year return interval Rudd Creek bankfull flows are decreased and do not fully function as channel maintenance flows. Higher flood flows, those with a return interval period of two years or more, would have to occur during irrigation diversion to fulfill the normal channel maintenance flows in the downstream spinedace habitat. These higher flood flows must occur for sufficient channel maintenance flows to bypass the diversion and reach spinedace habitat.

There are two factors in place that reduce the effects of the diversion on bankfull discharge and spinedace habitat:

- The bankfull or higher discharge may occur at a time when actual diversion is not occurring. Because irrigation generally occurs over a short three-to seven-day period in the spring, and peak flood flows occur over a short period of time as well, there is a good opportunity for channel maintenance flows to occur outside of the diversion period;

- The bankfull or higher discharge could occur whether or not conditions exist to allow diversion and irrigation. Periods of warm temperatures, rain-on-snow events, and/or large precipitation events can cause flooding regardless of the current snowpack or precipitation conditions.

These stream flow and channel attributes support the assumption that the partial diversion of Rudd Creek may have limited adverse effects to downstream spinedace habitats. Rudd Creek will only be diverted in years where snowpack levels are higher than a pre-determined threshold. In most years the project would have no effect on spinedace. Diversion generally occurs for short three-to seven-day periods. Important channel maintenance flows in spinedace habitat

could therefore still occur when diversion is not taking place. Large flood events needed for channel maintenance are not dependant upon heavy snow pack and they may occur during non-diversion years.

These assumptions are supported by data extrapolated from a river in an adjacent watershed because there is no current flow data available from Rudd Creek. The proposed action includes numerous conservation measures to be implemented by the ASNF and /or AGFD. These measures include collecting stream flow measurement and water depth data from installed flumes or other flow measuring devices, and staff and crest gages. This data would allow more accurate determination of the effects of the Rudd Creek diversion on spinedace and their habitats in the future.

Diversion and Flume Construction and Gage Installation

The two volumetric flow rate devices (e.g. flumes) will be constructed upstream of the spinedace habitat with one placed above the diversion in Rudd Creek and one placed in the diversion ditch. Rudd Creek is not likely to be affected by this construction since an access road leads to the project site. Spinedace habitat is over two miles downstream from the proposed site. Excessive sedimentation is not likely to reach spinedace habitat given the dense herbaceous vegetation in and adjacent to the creek and the best management practices mitigation features that will be required by the ASNF (K. McMillan, ASNF, pers comm. February 21, 2007).

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation following section 7 of the Act.

The SWMWA is open to the public and does receive visitation. Perennial portions of Rudd Creek adjacent to the facilities are surrounded by an elk-proof electric fence which also protects the creek from visitors. There is no vehicle access allowed to the lower Rudd Creek portions of the SWMWA. AGFD plans to continue expanding the elk fencing which would allow riparian and aquatic habitat conditions to improve.

The final BA described future riparian and stream improvement projects that AGFD has proposed for Rudd Creek on the SWMWA. It was determined by AGFD that Rudd Creek is not near its potential condition. AGFD has funded an analysis to inventory the present habitat conditions and make management decisions to accelerate recovery with spinedace as the emphasis species. These future projects include stream bank reconfiguration, removal of fish barriers, and modification of the diversion to prevent accidental fish mortalities if or when spinedace are returned to the Rudd Creek reaches of the SWMWA.

CONCLUSION

After reviewing the current status of spinedace, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the threatened

spinedace or adversely modify or destroy critical habitat. We base this conclusion on the information below:

- The AGFD is voluntarily not irrigating 245 acres of the original 321 irrigated acres. Generally only 46 acres are now irrigated. An additional 30 acres are irrigated on an irregular basis. This has significantly decreased the amount of water diverted from spinedace habitat in the action area.

- AGFD raises only pasture grasses at the SWMWA. These species are fairly drought-resistant and do not require large amounts of irrigation.

- Field will be monitored to insure no surface runoff of irrigation water goes outside of the agricultural fields and steps have been taken, (as described above) to insure that surface runoff potential is low. Dry urea will be used as fertilizer, and is known to breakdown in two to four days of application when exposed to water.

- While important channel maintenance flows, and streambank and floodplain water storage recharge have the potential to occur ever year, AGFD will not divert water every year.

- AGFD will only irrigate if the following two conditions are met:

    - Predicted runoff for the LCR above Lyman Lake reaches or exceeds 90 percent of median flow based upon the NRCS bi-monthly Arizona Basin Outlook Reports before mid-April through late May diversions can occur;

    - Nearby gaged streams, such as the Little Colorado River above Lyman Lake, are at or above 90 percent monthly median flow before the September 16 to April 16 diversions can occur.

- AGFD has fenced portions of Rudd Creek to protect streambanks and vegetation from elk. Authorized livestock grazing is not permitted on ASNF-administered lands within or adjacent to most of the length of Rudd Creek. Vegetative recovery will improve aquatic habitat, trap excessive sediment, and stabilize the stream channel. Streambank contribution to base flow will increase as a result.

- The continued use of AGFD's surface water right will prevent the agency from losing it from non-use. This water right will be important in protecting future Rudd Creek base flows if or when the private parcels on the watershed receive additional rural home development.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is defined (50 CFR 17.3) to include significant habitat

modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. "Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this incidental take statement.

I. AMOUNT OR EXTENT OF TAKE

Recent court cases have brought attention to many biological opinions in Arizona. The courts have specified that two standards must be met in biological opinions. The Fish and Wildlife Service, together with the action agency, must determine that: 1) a listed species occurs or is reasonably certain to occur in the project area during the life of the proposed action; and 2) take will or is reasonably certain to result from the action under consultation.

Spinedace have been found in surveys by AGFD in Rudd Creek downstream of the SWMWA as recently as May 2006. Spinedace have not been found in Nutrioso Creek, downstream of Nelson Reservoir, during the last 2005 and 2006 surveys. Despite the numerous conservation measures established in the proposed action we believe adverse effects to spinedace may occur as a result of partially diverting flows from Rudd Creek. Decreased flow may lower water surface elevation and water quality in spinedace habitat. We do not know how much the water surface elevation will drop as a result of the diversion. Therefore we do not know how severely this will affect spinedace. Because there is no information specific to Rudd Creek regarding flow discharge during years that would meet the criteria established to allow for irrigation diversion, our effects analysis relied on extrapolation of flow information from a river in an adjacent watershed. At this time and given the limited information specific to Rudd Creek and the impacts of the diversion, we are unable to conclude that incidental take of spinedace is reasonably certain to occur. If the Rudd Creek flow monitoring, to be implemented as part of the proposed action, determines that significant impacts to spinedace habitat may be occurring with the continued implementation of the proposed action and that these habitat changes can be attributed to the proposed action as determined by the ASNF Springerville District fisheries biologist or other ASNF fisheries biologists, we recommend that the ASNF re-initiate consultation for this project.

Disposition of Dead or Injured Listed Animals

Upon finding a dead or injured threatened or endangered animal, initial notification must be made to the Fish and Wildlife Service's Law Enforcement Office, 2450 W. Broadway Road #113, Mesa, Arizona 85202 (480/967-7900) within three working days of its finding. Written notification must be made within five calendar days and include the date, time, and location of the animal, and any other pertinent information. Care must be taken in handling injured animals to ensure effective treatment and care and in handling dead specimens to preserve biological material in the best possible condition. If feasible, the remains of intact specimens of listed

animal species shall be submitted as soon as possible to this office or the nearest AGFD office, educational, or research institutions (e.g., Arizona State University in Tempe) holding appropriate State and Federal permits.

Arrangements regarding proper disposition of potential museum specimens shall be made with the institution before implementation of the action. A qualified biologist should transport injured animals to a qualified veterinarian. Should any treated listed animal survive, FWS should be contacted regarding the final disposition of the animal.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. We recommend that:

- The ASNF work with the AGFD and USFWS to evaluate Rudd Creek, upstream of the diversion, to determine the feasibility of re-introducing spinedace and other native fish species in this reach.

- The ASNF evaluate whether elk use is negatively affecting the portions of Rudd Creek that are under their administration. If it is determined that elk are adversely affecting spinedace habitat, consider fencing important habitat areas.

- The ASNF applies for and collects data for an instream flow right to Rudd Creek with the Arizona Department of Water Resources to further protect Rudd Creek base flows from future development on the upstream private lands.

In order for FWS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

REINITIATION STATEMENT

This concludes the formal consultation and conference on the Apache Sitgreaves National Forest's proposal to authorize operation and maintenance of the Rudd Creek diversion. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may adversely affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a way that causes an effect to a listed species or critical habitat that was not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by this action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation, if it is determined that the impact of such taking will cause an irreversible and adverse impact to the species.

We appreciate the Apache Sitgreaves National Forest's efforts to identify and minimize effects to listed species on Rudd Creek. For further information please contact Dave Smith (928) 226-0614 (x109) or Mary Richardson (602) 242-0210 (x242). Please refer to consultation number 22410-2007-F-099 in future correspondence concerning this project.

Sincerely,

/s/ Steven L. Spangle
Field Supervisor

cc: Regional Supervisor, Arizona Game and Fish Department, Pinetop, AZ
District Ranger, Springerville Ranger District, Apache Sitgreaves National Forest, Springerville, AZ

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Bald Eagle

An average of four to five bald eagles are present at McKay Reservoir when water has been diverted to the reservoir from Rudd Creek. If McKay Reservoir is dry in the winter, bald eagles are only intermittently seen. Large ponderosa pine trees are common in the vicinity of the action area, especially on the ASNF immediately to the west of the SWMWA. These trees provide numerous potential roost sites. Open water in any of the reservoirs attracts numerous waterfowl species and numbers.

Management of the SWMWA protects wintering bald eagle habitat by closing all three wetlands to vehicular access, which reduces human disturbance levels. When the two reservoirs on the SWMWA are not full, wintering eagles may roost nearby at Nelson Reservoir. The proposed action, which diverts water to one or both SWMWA reservoirs, would not adversely effect bald eagles as it creates additional habitat for eagles. However, should the decision be made to not divert water to these two reservoirs, bald eagles would not be affected as the nearby Nelson Reservoir provides an alternate foraging and roosting site.
We concur with the finding of "may affect, not likely to adversely affect," for the bald eagle from the proposed action.

Southwestern Willow Flycatcher

The action area currently has limited suitable and potential migratory/transient flycatcher habitat. There are limited amounts of dense willow near the SWMWA headquarters and upstream along Rudd Creek to the diversion. Rudd Creek has not been specifically surveyed for willow flycatchers; however, migrating birds have been documented on the SWMWA.

The proposed action includes several conservation measures to reduce negative impacts to riparian habitat in the action area. The diversion and irrigation of crops on SWMWA do not occur when flows are below a certain threshold. Maintaining and improving the riparian habitat associated with the action area is an identified priority within the AGFD's SWMWA Management Plan, and providing a baseflow of water to the riparian system takes precedence over irrigating pastures or filling reservoirs. Livestock have been removed from the ASNF portion of the action area, and elk are excluded along approximately one mile of Rudd Creek with more fencing planned. Public vehicular traffic has been excluded along Rudd Creek. Woody riparian species are recovering along Rudd Creek. This enhancement of riparian conditions in Rudd Creek should provide migratory and breeding habitat for southwestern willow flycatcher. We concur with the finding of "may affect, not likely to adversely affect," for the willow flycatcher from the proposed action.

Mexican Spotted Owl

The Rudd Creek diversion is located in suitable Mexican spotted owl habitat. However, the quality of the habitat is low since several key components, such as rocky canyons and mixed conifer vegetation, are not present. No components of suitable or critical habitat such as large trees, downed logs or snags would be affected by the proposed action. Neither documented PACs nor critical habitat are in the action area. In addition, any maintenance and other operations at the diversion and upper ditch would be conducted in the daylight hours. We concur

with the finding of "may affect, not likely to adversely affect," for the Mexican spotted owl and critical habitat from the proposed action.

Chiricahua Leopard Frog

Chiricahua leopard frogs are considered to be extirpated from the Little Colorado River watersheds found in the action area (USFWS 2002). Although Little Colorado watersheds are known to contain historical leopard frog sites, none of these sites occur within the action area. We concur with the finding of "may affect, not likely to adversely affect," for the Chiricahua leopard frog from the proposed action.

APPENDIX B.

B.1 Use of Snowpack Monitoring Stations to Develop Median Monthly Streamflow Predictions.

There are nine snow pack monitoring stations within the LCR Basin of which five are manually monitored snow courses and four are automated SNOWTEL stations (NRCS 2007). The closest automated SNOWTEL station, Baldy, is approximately five miles west of the Rudd Creek Watershed.

Monthly median streamflow varies greatly in this area as shown in Table 1 (NRCS 2007). There is a significant correlation between precipitation data from the Baldy SNOWTEL and the combined data from all sites for the LCR Basin ($r^2 = 0.957$).

Table 1. Percent of 30 year average snowpack level for the Little Colorado River above Lyman Lake, Apache County, Arizona (1996 to 2006) (NRCS Arizona Basin Outlook Reports).

Year	Percent of 30 Year Average Snowpack Level
2006	8
2005	256
2004	35
2003	95
2002	4
2001	68
2000	17
1999	4
1998	255
1997	45

B.2 Use of USGS Gage Station Data to Calculate Monthly Median Flows from USGS Gage 09384000.

Calculated monthly median flows and 90 percent values from this USGS gage station for water years 1940 to 2005 (S. Rascona, AZ Department of Water Resources, pers. comm. November 29, 2006) are listed in Table 2. The monthly median flows are low as a result of numerous diversions located upstream of this gage. For example during 2005 predicted LCR runoff was 256 percent of normal. The monthly median flows for June, July and August 2005 were 11, 2.25 and 20 cfs, respectively. In 2004 predicted LCR runoff was 35 percent of normal. The monthly median flows for June, July and August 2004 were much lower at 0.1, 0.3, and 3.1, respectively (NRCS 2007).

Table 2. The monthly median flows in cubic feet per second (cfs) and their 90 percent values for the Little Colorado River above Lyman Lake (USGS stream gaging station 09384000), Apache County, Arizona.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Median Discharge	7.2	9	11	31	8.6	4	3	8.5	4.9	3.8	5	6.1
90 percent	6.5	8.1	9.9	27.9	7.7	3.6	2.7	7.7	4.4	3.4	4.5	5.5

B.3 Estimating Rudd Creek Peak Flows

Rudd Creek peak flood flows were estimated using two different methods; index-flood method (Riggs 1982, J. Fogge, Bureau of Land Management, pers. comm. April 4, 2007) and the peak discharge regression equations developed by the USGS (1999).

1) Index-flood method - There is a 29 square mile (mi^2) watershed above the LCR at Greer gage. The Rudd Creek watersheds above the diversion and spinedace habitat are 13 mi^2 and 19 mi^2 respectively. Annual peak flow data from the LCR at Greer was multiplied by 0.45 (13 mi^2/29 mi^2 = 0.45) and 0.65 (19 mi^2/29 mi^2 = 0.65) to provide estimates of Rudd Creek peak flows at the diversion and spinedace habitat (Table 3).

Table 3. Peak flows estimates and return intervals for Rudd Creek at the diversion and above the spinedace habitat.

LCR @ Greer (cfs)	Rudd Creek @ Diversion (cfs)	Rudd Creek @ spinedace habitat (cfs)	Return Interval (years)
615	277	400	24[1]
444	200	289	12
414	186	269	8
212	95	138	2
108	49	70	1.5[2]
45	20	29	1

[1]The maximum flood event that can be calculated with 23 years of flow data is a 24-year event.

[2] 1.5 return interval flows are generally considered the bankfull or channel maintenance flows unless actual discharge data is available.

2) Peak discharge regression equation - Equations developed by the USGS National Flood Frequency for Arizona were used to determine flood flow return intervals (R.I.) for Rudd Creek (USGS 1999). The minimum R.I. calculated by this method is two years. The Region 1 (high elevation) regression equation, $Q_2 = 0.124AREA^{0.845}PREC^{1.44}$, calculated a two year R.I. of 136 cfs. This figure is very close to the 2 year R.I. estimate, 138 cfs, calculated in the above method (Table 3).

APPENDIX C. Action Areas Photos

Photo 1. Downstream view from above the Rudd Creek Diversion located on the ASNF. The turnstile and irrigation channel bypass is located on the right. Water flows for a majority of the time through the concrete bypass on the left.

Photo 2. Typical spinedace pool habitat on Rudd Creek on the ASNF, downstream of SWMWA

(photo by M. Lopez, AGFD).

Photo 3. Long, narrow channel spinedace habitat on Rudd Creek on the ASNF, downstream of SWMWA (photo by M. Lopez, AGFD).