Figure 16: Distribution of Warm Desert Riparian in Nevada.
KEY HABITAT: WARM DESERT RIPARIAN

Things to Know....
- Warm desert riparian include the drainages of the Colorado River and its tributaries. Fremont cottonwood, Goodding willow, velvet ash, honey and screwbean mesquite are the dominant woody plants.
- The cottonwood overstory, mesquite/willow understory, and herbaceous understory support their own wildlife communities.
- Development and invasive species are the greatest habitat threats.
- Climate change effects will likely increase desertification (entrenchment) and expansion or new invasion of invasive plants.
- Recommended prescriptive actions include weed monitoring and treatment and streambank stabilization, such as rip-rap installation.

Ecoregions:

Southwest ReGAP 2005

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<thead>
<tr>
<th></th>
<th>hectares</th>
<th>acres</th>
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<tr>
<td>Mojave</td>
<td>10,812</td>
<td>26,717</td>
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<tr>
<td>Great Basin</td>
<td>7,778</td>
<td>19,220</td>
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<td>Total</td>
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Ecological Systems

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<th>TNC Biophysical Settings</th>
<th>SWReGAP Ecological Systems</th>
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<tr>
<td>Warm Desert Riparian</td>
<td>S094 North American Warm Desert Lower Montane Riparian Woodland and Shrubland</td>
</tr>
<tr>
<td></td>
<td>S097 North American Warm Desert Riparian Woodland and Shrubland</td>
</tr>
<tr>
<td></td>
<td>S024 Rocky Mountain Bigtooth Maple Ravine Woodland</td>
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<td></td>
<td>D04 Invasive Southwest Riparian Woodland and Shrubland</td>
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<td></td>
<td>A008 Mojave Streams</td>
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<td>A009 Mojave Rivers</td>
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Key Habitat Description

The Warm Desert Riparian key habitat type includes the drainages of the Colorado River and its tributaries, the Amargosa River flow system. Dominant woodland species include Fremont cottonwood, Goodding willow, velvet ash, honey mesquite, and screwbean mesquite. Key shrubs include quailbush, seepwillow, coyote willow, wolfberry, and arrowweed. California fan palm oases are present sporadically in the Mojave drainages. Much of the Colorado River system that has not been inundated by major power dams has seen its riparian plant communities invaded by tamarisk. Where tamarisk has successfully invaded the Mojave floodplains, it has largely replaced native woody vegetation. Mojave Desert montane streams occur primarily in the Spring Mountains, and are largely characterized by the presence of arroyo willow.

Aquatic systems within this key habitat type vary tremendously. Mojave River habitats include a segment of the mainstem Colorado River, the Virgin River, and Muddy River. Riverine reaches of the Colorado River are highly
modified and channelized with variable flows but many reservoir-like characteristics. The Virgin River is a semi-ephemeral system dependent on seasonal runoff to maintain aquatic habitat characteristics compared to the Muddy River which is a relatively stable flow system dependent on spring discharge. The great variability among Mojave rivers maintains unique aquatic species assemblages in each flow system. Mojave stream systems are generally disconnected stream segments that may be seasonally ephemeral, such as the Amargosa River in Oasis Valley, or represent lower order segments of primarily spring fed discharge systems such as in Pahranagat Valley or Meadow Valley Wash. Again, the isolation and variable aquatic habitat characteristics of these stream systems have resulted in their support of unique aquatic species assemblages across the landscape.

**Value to Wildlife**

The rivers and streams coursing through the Mojave Desert truly serve as oases in an otherwise dry and largely inhospitable landscape. There are three distinct elements of the Mojave lowland riparian community that each more or less support their own wildlife community – cottonwood overstory, mesquite/willow midstory, and herbaceous understory. The cottonwood overstory is the least prevalent of the three, but where it is present its contribution to wildlife diversity in the Mojave biome is unique and considerable. The scattered cottonwoods on the Colorado River tributaries (Virgin, Muddy, and Pahranagat) are the last places in Nevada where the Yellow-billed Cuckoo can reliably be expected to occur. Sharing preference with the cuckoo for the cottonwood canopy are the Summer Tanager and Brown-crested Flycatcher, each of which occur in Nevada in cottonwood on the Colorado tributaries as well as in some of the creeks of the Spring Range. Western red bats also prefer cottonwood canopy for roosting. Goodding willow can reach overstory sizes and surrogates for cottonwood in some places.

The native mesquite/willow midstory was probably much more prevalent on the floodplains of the Colorado system than cottonwood ever was, and was much more prevalent historically than it is today because it has been severely invaded and replaced along many stretches by tamarisk. This midstory is populated by a diverse avifauna, including several species that thrive in the interface between mesquite and the creosote bush-dominated bajadas (Black-tailed Gnatcatcher, Crissal Thrasher, and Verdin). Of the species that depend on the midstory habitat layer, the Bell’s Vireo and the endangered Southwestern Willow Flycatcher are the key species of management priority. In some instances, both species have shifted their habitat use to tamarisk out of necessity, and the presence of the Southwestern Willow Flycatcher in tamarisk complicates native habitat restoration planning and strategy. Lucy’s Warblers are cavity nesters; therefore they require mature stands of mesquite large enough and old enough to have opened up some cavities. Older-aged mesquite stands are also more susceptible to mistletoe infection, thus enhancing their value to mistletoe-berry-feeding Phainopeplas. While Yellow-billed Cuckoos prefer to forage in cottonwood canopy, they are known mostly to nest in willow, making integrated management of overstory and midstory along the same floodplain stretch critical to the maintenance of the species.

The herbaceous understory is home to Abert’s Towhee, and in Pahranagat Valley, to the Pahranagat Valley montane vole. Various species make use of the features of the channels of the Colorado system, including Spotted Sandpipers, Great Blue Herons, foraging Common Nighthawks, and various species of foraging bats.

The rarity and frequent isolation of lotic aquatic habitats within the Mojave Desert Ecoregion speaks to their significant value for aquatic-dependent species of conservation priority. As in other Nevada key habitats, the isolation and the unique characteristics of individual river and stream systems has resulted in a high level of endemism and adaptation in the distribution of species assemblages within those systems. Pahranagat Valley, the Oasis Valley/Amargosa River flow system, the Virgin and the Muddy rivers all contain individual species
assemblages with endemic species of global significance and uniqueness. As such, these habitats are critically important for the conservation and persistence of the component species of their aquatic biota.

Although severely altered from historic conditions by the development of large dams and associated water delivery infrastructure which have permanently altered the physical and dynamic attributes of its aquatic habitats, the Colorado River still maintains important relict populations of mainstem endemic fishes and the reach of the river in Nevada, below Lake Mohave, has a critical role and value in the conservation and recovery of those fishes as one of the few remaining riverine mainstem habitats in the lower Colorado River basin. It provides connectivity to adult populations of both razorback sucker and bonytail in Lake Havasu downstream, refugia to maintain adult fish populations and their genetic resources, and opportunities for research into potential recovery strategies for these altered habitats. Potential exists in Nevada and associated areas of Arizona and California to develop functional backwater habitats within the river’s historic floodplain which may have a valuable future role in these species’ recovery.

Key Elements of Warm Desert Riparian of Importance to Wildlife

*Terrestrial Species*

**COTTONWOOD OVERSTORY/WILLOW MID-STORY**
- Scott’s Oriole
- Yellow-billed Cuckoo
- western red bat

**HERBACEOUS UNDERSTORY**
- Pahranagat Valley Montane Vole

**WILLOW/MESQUITE/TAMARISK**
- Loggerhead Shrike
- Bell’s Vireo
- Southwestern Willow Flycatcher
- Virginia’s Warbler
- western brush lizard
- mule deer

**DUFF/LITTER/DOWNED WOOD**
- ring-necked snake
- Southwest blackhead snake
- western threathdsnake
- Western red-tailed skink

**CUT BANKS**
- Bank Swallow

**OPEN FLOODPLAIN**
- Western Burrowing Owl
- bighorn sheep
OPEN AIR OVER WATER FORAGING
Common Nighthawk
Allen’s big-eared bat
cave myotis
spotted bat

Aquatic Species

RIVERS
Colorado River
bonytail
razorback sucker
flannelmouth sucker

Virgin River
Virgin River chub
woundfin
flannelmouth sucker
Virgin spinedace
relict leopard frog

Muddy River
Moapa dace
Moapa White River springfish
Virgin River chub
Moapa speckled dace
southwestern toad

STREAMS
Oasis Valley/Amargosa River
Amargosa toad
Oasis Valley speckled dace

Pahranagat Valley
Pahranagat roundtail chub
Pahranagat speckled dace

Existing Environment

Land Uses
• Urban/suburban development
• Agriculture
• Livestock grazing
• Hydroelectric power production
• Irrigation diversion
• Flood Control
• Motorized Recreation
• Non-motorized Recreation
• Wood products extraction (mesquite)
• Species Harvest

**Historic and Current Conditions**

Almost all of the historic riparian habitats of the mainstem Colorado River as it passes through Nevada have been lost due to the construction of Hoover and Davis dams. What little natural Colorado River floodplain that remains along the Nevada stretch occurs between Davis Dam and the Fort Mohave Indian Reservation. Much of that floodplain has been significantly modified by agriculture and urban development around the city of Laughlin. The remaining habitat has been severely invaded by tamarisk and disconnected from natural floodplain maintenance processes because of altered river flows and channelization. The Virgin and Muddy rivers, Meadow Valley Wash, and the Pahranagat River all have significant stretches of natural riparian vegetation left, but most stretches of these streams have also been severely invaded by tamarisk. Along the Virgin River through Mesquite, much of the floodplain was initially converted to agriculture, but is now undergoing conversion to urban/suburban development, including casinos, residences, and golf courses.

All aquatic habitat systems within this key habitat type have been altered or modified to some degree from historic conditions through actions such as channelization, regulation of flows or diversion of flows for agriculture, recreational and urban development, and the introduction of non-native aquatic species. The level of this alteration ranges from severe (e.g., on the Colorado River below Davis Dam where river flows are highly regulated and confined between constructed dike structures) to relatively minor (e.g., in areas of the Lower Virgin River and Meadow Valley Wash where highly variable, unregulated flows maintain a semblance of natural channel and floodplain characteristics). Seasonal dewatering of certain stream and river reaches occurs in most years on the Virgin River and lower Meadow Valley Wash as a result of land use changes and legal diversion of flows for agriculture.

**Problems Facing the Species and Habitats**

Urban and suburban development on floodplains is currently resulting in a rapid loss of native wildlife habitat in Warm Desert Riparian habitats. Tamarisk has invaded most areas of these systems, reducing the distribution of native plant communities. More recently, occurrence of the invasive tamarisk leaf beetle (*Diorhabda elongata*), which has moved into riparian habitats on the Virgin and Muddy Rivers and Meadow Valley Wash after releases in adjoining states, has resulted in patchy but widespread defoliation of these monoculture tamarisk stands. As these large areas of tamarisk are lost in the future, this could result in an increased occurrence of even less desirable invasive plant species and at least a short term decline in existing riparian cover in the absence of an effective program for large-scale re-vegetation using desirable native plant species. Understory and vertical vegetative structure are lacking along some stretches of the Colorado River system.

Aquatic habitats in this key habitat type are particularly affected by the presence of large areas of tamarisk monoculture, resulting in increased channel stability that is interrupting normal geomorphic processes from high flow events that would normally maintain aquatic habitat variability and quality. Most aquatic habitat systems also contain introduced and invasive non-native fishes, amphibians and/or crayfish, which are significant stressors on species of conservation concern through competition and predation. Fragmentation of aquatic habitats through agricultural diversions and seasonal dewatering, channelization, regulation of flows, and direct alteration of aquatic habitats through development and construction activities, are critical problems across this key habitat type, in that they affect natural geomorphic processes and negatively alter aquatic habitat characteristics, especially for early life stages of native fishes. Proposed large-scale projects to develop surface
water and groundwater resources that include infrastructure to export water outside of the source basin or drainage, have significant potential to negatively affect aquatic habitats through alteration of hydrologic processes or reduction of source and in-channel base flows on the Virgin and Muddy rivers, and within other isolated aquatic systems dependent on local and carbonate aquifer groundwater sources.

**Predicted Climate Change Effects**

Warm Desert Riparian vegetation was identified in three regions – Mojave, Clover, and Tonopah – with 84% of it occurring in the Mojave region and 15% of it in the Tonopah region. Our analysis indicated that 85 to 100% of Warm Desert Riparian vegetation was currently in the early or mid-closed classes – indicative of conditions one to 19 years after flooding. Only in the Mojave region was any Warm Desert Riparian vegetation classified in any of the later characteristic classes that would indicate closed canopies of either willow/mesquite or gallery cottonwood. Fifty-year projections predicted that 100% of all Warm Desert Riparian in the Mojave and Tonopah regions would transition to uncharacteristic classes with or without climate change. Most of the transition was to “desertified” (incised channel) and did not necessarily mean that functional wildlife habitat would disappear immediately. Up to 25% of the BpS would be invaded by exotic forbs and/or exotic trees (tamarisk); the rest would be incised with varying amounts of native vegetation present. The cause is not specifically related to climate change, but is more indicative of generally unstable floodplains influenced by the processes described in the previous section. While functional wildlife habitat might persist on larger floodplains with incision through the first 50 years, the long-term implications of desertification coupled with exotic forb/tree invasion are not encouraging.

Large areas of the upper Colorado River basin are anticipated to see moderate to substantive increases in precipitation in the next 50 years with much of this occurring in the winter period as increased total snowfall. While this benefit to downstream aquatic habitats may be somewhat mitigated by expected temperature rise with resultant earlier onset of spring runoff events, the management of total net flows in the highly regulated Colorado River system should minimize resultant effects on Colorado River aquatic habitats downstream of Davis Dam, although the potential thermal effects from average air temperature rise and modified reservoir storage patterns are largely unknown. Potential climate change effects on tributary river and stream habitats including the Virgin and Muddy Rivers and Meadow Valley Wash are less well understood, largely because of the uncertainty at a more local scale of available precipitation models. In general, systems partially or largely dependent on local snowpack runoff to maintain spring and early summer base flows such as the Virgin River and Meadow Valley Wash may be affected by earlier onset of spring runoff events and resultant lower base flows in the late spring and summer periods. Most available models also predict increased summer monsoonal storm events and a temporal shift of those events to earlier in the summer period, potentially resulting in higher stochasticity of flows compared to recent historical periods, with a net effect of more frequent channel and floodplain-modifying flow events.

**Possible Wildlife Responses To Climate Change**

*Cottonwood Overstory/Willow Midstory Species*

- Scott’s Oriole
- Yellow-billed Cuckoo
- *western red bat*
It is likely that the species guild most impacted by the predicted transitions would continue to be those associated with cottonwood overstory/willow midstory. If Warm Desert Riparian floodplains cannot be stabilized long enough to facilitate the regeneration and maturation of cottonwood and willow to suitable age, Yellow-billed Cuckoos, Scott’s Orioles, western red bats, and other cottonwood associated birds and bats would have difficulty maintaining viable populations in the region.

In 169 Warm Desert Riparian survey points, no Scott’s Orioles were ever observed during Nevada Bird Count surveys over the 10-year implementation period, casting significant doubt on the importance of Warm Desert Riparian to Scott’s Oriole conservation in Nevada. Yellow-billed Cuckoos are encountered at such low densities as to require specially-designed single-species survey to monitor effectively.

**Willow/Mesquite/Tamarisk Species**

<table>
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<tbody>
<tr>
<td>Loggerhead Shrike</td>
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<tr>
<td>Bell’s Vireo</td>
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<tr>
<td>Southwestern Willow Flycatcher</td>
</tr>
<tr>
<td>Virginia’s Warbler</td>
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<tr>
<td>western brush lizard</td>
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The six vertebrate species in this group have a long history of coping with transition of willow to mesquite to tamarisk in this region. The species most likely to be affected over the next 50 years would be any that could not transition themselves from willow to either mesquite or tamarisk. Of these five, all have demonstrated adaptability to shift to replacement types as long as structural habitat elements such as crown density are sufficient to hide nests from predators. GBBO reported that Bell’s Vireo appeared generally neutral to tamarisk invasion until tamarisk cover exceeded 90%, above which the species tended to be absent, suggesting that monotypic stands of tamarisk might reduce Bell’s Vireo populations through its range in Nevada (Nevada Comprehensive Bird Conservation Plan 2010). Southwestern Willow Flycatchers also seem to value the added parameter of saturated soils around their nest sites (perhaps the elevated humidity protects their nestlings from the harsh desert temperatures or wet soils deter certain terrestrial predators). Because desertification results in the lowering of water tables away from standing midstory trees and the surrounding soils can no longer stand saturated through a nesting cycle, Southwestern Willow Flycatchers could be targeted for differential impacts of the predicted transitions over the next 50 years. Without action, the 50 years following 2022 could be even more detrimental to this group.

The GBBO Report was unable to predict population response for Bell’s Vireo or Loggerhead Shrike even though it had workable sample sizes of observations because the desertified classes of Warm Desert Riparian were not mapped in LANDFIRE; therefore, relative densities could not be computed for those classes and the species’ tolerance for desertification and exotic invasion was not very well understood and could only be inferred from very sparse data (with respect to exotic forb invasion only). Southwestern Willow Flycatcher was not analyzed in the GBBO Report because of inadequate sample size, and Virginia’s Warbler had no detections in Warm Desert Riparian survey points during the 10-year implementation period.

**Herbaceous Understory Species**

Pahranagat Valley Montane Vole

One species, the Pahranagat Valley montane vole, a lowland remnant subspecies long isolated from its source populations which retreated upslope with climate change post-Pleistocene, is particularly associated with meadow vegetation in the Warm Desert Riparian BpS. Should the extensive degree of desertification predicted by the 50-year modeling result in the draining of the floodplains where this species occurs to the extent that
meadows could no longer be maintained naturally (and were no longer sustained by irrigation), the Pahranagat Valley montane vole could be negatively impacted and brought to increased conservation risk over the next 50 years. Its lack of connectivity to source populations that could provide replacement and sustain the evolutionary processes that have allowed this subspecies to stay in place for centuries would make maintenance of the species particularly challenging.

Duff/Litter/Downed Wood Species

- ring-necked snake
- Southwest blackhead snake
- western threadsnake
- Western red-tailed skink

Four reptiles are placed in a habitat guild associated with leaf litter and downed wood that accumulates on the riparian thicket floor, particularly under mature cottonwood/willow. Accumulated vegetative material provides escape cover and retains moisture that assists these reptiles in thermoregulation against the hot, arid climate. Should the transition from cottonwood/willow to mesquite/tamarisk create a significant change in the quantity or nature of vegetative litter on the floodplain that results in decreased capacity to provide for those needs, these four reptiles could be expected to be impacted by the changes predicted over the next 50 years. For instance, a loss of mature cottonwood could result in a loss of source for peeled bark and larger-diameter limbs that typically shed off dying or dead trees. Downed limbs from mesquite would be smaller and less numerous than those from cottonwood or black willow. Broad-diameter leaves such as fall from cottonwood or sycamore would be replaced by the smaller pinnate leaves of mesquite or the tiny scaled “needles” of tamarisk. These shifts in quantity and quality might be expected to be less effective at retaining microsite moisture and providing adequate escape cover, ultimately resulting in loss of habitat suitability for these ground-dwelling reptiles.

Other Species

- Western Burrowing Owl
- Common Nighthawk
- Allen’s big-eared bat
- cave myotis
- spotted bat
- bighorn sheep

“Open floodplain” species such as Burrowing Owl and desert bighorn are not expected to be significantly impacted by the predicted transitions. Burrowing Owls are adapted to persist in disturbed habitats as long as an adequate prey source (small mammals, reptiles, and large arthropods) is available. Bighorns were added to this discussion mostly from a standpoint of watering at streamside in certain occupied landscapes. Otherwise, bighorns spend the majority of their time in upland habitats. Unless the desertification of riparian vegetation significantly impacts the availability of the insects they feed on, Bank Swallows are expected to be facilitated by increased bank-cutting and incision. Other open-channel-over-water foragers such as Common Nighthawks and the bats are not expected to be impacted significantly by vegetation change, unless there is a negative impact on certain moths or other large flying arthropods particularly favored by any of these species, relationships and preferences that are currently very poorly known.

Aquatic species – Colorado River

- Bonytail
- Razorback sucker
- Flannelmouth sucker

- Colorado River Bonytail
- Razorback sucker
- Flannelmouth sucker
The native fish species endemic to the main stem Colorado River system in Nevada exist in the highly altered habitats of Lakes Mead and Mohave and the Colorado River downstream of Davis Dam. Potential climate change effects to reservoir habitats and associated priority species are addressed in that chapter of this plan. Because little change in operational characteristics can be predicted for Lake Mohave which regulates discharge to the Colorado River downstream, no substantive impacts from climate change are projected for bonytail, razorback sucker and flannelmouth sucker within that river reach. To the extent that lower storage elevations in Lake Mohave could increase seasonal water temperatures discharging to the river, some minor benefits could accrue to flannelmouth and razorback sucker through elevated temperature regimes during the spring through early summer spawning period, but such effects are difficult to predict with any certainty because river flow and temperature characteristics are dictated to such a large degree by independent water delivery requirements.

Aquatic species – Virgin River

Virgin River chub
Woundfin
Flannelmouth sucker
Virgin spinedace
Relict leopard frog

Increased stochasticity in summer flow events and temporal shifts in precipitation patterns potentially reducing late spring and fall base flows would likely be detrimental to priority native fish species dependent on deeper run and pool habits, e.g. Virgin River chub and flannelmouth sucker. Although woundfin superficially might benefit from altered main stem river flow characteristics such as more frequent channel modifying events which may tend to shift available habitats towards sandy run braided channels, this must be balanced against the potential of decreased base flows during critical late summer periods, increasing the time period when resident fishes of all species would be exposed to critical thermal maxima. Relict leopard frogs primarily utilize floodplain based wetland and seep/spring habitats, and projected trends for desertification of these associated off-channel habitats suggest negative effects to frog populations within the watershed.

Aquatic species – Muddy River

Moapa dace
Moapa White River springfish
Virgin River chub
Moapa speckled dace
Arizona toad

Because base flow conditions for much of the Muddy River system are highly dependent on discharge from regional spring complexes tied to carbonate aquifer systems, little effect can be predicted at least through 2022 to priority aquatic species that can be attributed to specific climate change scenarios for precipitation and temperature, independent from anthropogenic impacts from groundwater and surface water development.

Aquatic species – Medlow Valley Wash

Meadow Valley Wash desert sucker
Meadow Valley Wash speckled dace
Much like the Virgin River system, increased stochasticity in summer flow events and temporal shifts in precipitation patterns potentially reducing seasonal base flows would likely be detrimental to these priority aquatic species through substantive but unpredictable changes in physical habitat distribution and quality and increased thermal loading during critical low flow periods; as for the Virgin River, the high uncertainty in predictive models makes qualitative assessments of effect difficult if not impossible.

Aquatic species – Pahranagat Valley, Oasis Valley and Amargosa River

- Pahranagat roundtail chub
- Pahranagat speckled dace
- Amargosa toad
- Oasis Valley speckled dace

Both Pahranagat and Oasis Valley stream habitats are, like the Muddy River closely tied to regional spring systems associated with carbonate province geology to support base flows, and as such are likely to show relatively minor effects from climate change in the near term independent of effects from groundwater development and other anthropogenic impacts. For Oasis Valley and Amargosa River species in particular, most predictive models suggest an increased potential for summer monsoonal precipitation patterns which could increase and extend base flow conditions for associated stream habitats, but also could increase the frequency of stochastic rain events with increased potential for flood events, channel scouring and channelization. Given the high uncertainty of most predictive models, net effects to these species are likely to be neutral through 2022.

Priority Research Needs

- Factors limiting distribution of aquatic species in apparently suitable aquatic habitats in the Muddy River system
- Thermal characteristics of low base flows and availability of low-flow thermal refugia in the Virgin River
- Effective methods for control and eradication of invasive aquatic species
- Population viability of Pahranagat Valley montane vole
- Status and distribution of western red bat
- Distribution and habitat requirements of the southwestern toad
- Habitat restoration needs of the relict leopard frog within its historic but unoccupied range on the Virgin and Muddy rivers
- Occurrence and habitat preferences for ring-necked snake, Southwest blackhead snake, western threadsnake, and Western red-tailed skink
- Impacts of exotic vegetation invasion on habitat suitability for bats and reptiles

Conservation Strategy

*Goal: Healthy, self-sustaining wildlife populations in diverse native plant communities on functional floodplains; thriving mature cottonwood overstory with healthy prospect of regeneration; willow and mesquite midstory under cottonwood or overstory where cottonwood is absent; arrested spread of tamarisk into intact native vegetation; thriving herbaceous understory.*
Objective: Increase the linear extent of native riparian habitat in recovery on the floodplains of Mojave rivers and streams by 15% by 2022.

("in recovery" – native willows, mesquite, cottonwoods established by restoration treatment post-flood-event tracking toward stand maturity)

Action: With local working groups and in cooperation with landowners, convert tamarisk-invaded riparian habitats to native trees and shrubs through tamarisk control and native revegetation efforts at a rate conducive to no-net-loss of Southwestern Willow Flycatcher nesting pairs over any five-year period.

Action: : Restore cottonwood and Goodding willow overstory and coyote willow mid-story through sapling planting and the restoration of natural channel-scouring processes in all sites after all flood events.

Action: Through extension services and management incentives, encourage landowners to apply livestock grazing prescriptions in balance with the ability of the native riparian vegetation to regenerate and maintain itself.

Action: Retard the spread of invasive weeds and grasses into unaffected understories; restore invaded areas through weed control and revegetation.

Action: Assess the condition of montane riparian habitats in the Mojave region and apply appropriate restoration management where necessary. Manage montane riparian habitats for multi-storied vertical vegetation structure to maximize species diversity.

Objective: Maintain 50 breeding pairs of Southwestern Willow Flycatchers in suitable habitat through 2022.

("50 breeding pairs" based on a statewide population estimate of 90 birds (Nevada Comprehensive Bird Conservation Plan 2010).

Action: Continue to pursue conservation protection for designated critical Southwestern Willow Flycatcher habitat.

Action: Continue intensive inventory and nest monitoring project throughout Southwestern Willow Flycatcher range in Nevada.

Objective: Maintain five occupied Yellow-billed Cuckoo “territories” through 2022.

“Occupied territory” – a site producing Yellow-billed Cuckoo response to taped call playback surveys during the breeding season.

Action: Inventory potential Yellow-billed Cuckoo habitats and assess them for habitat suitability. Apply remedial restoration aimed at supplementing/replacing cottonwood overstory and establishing willow mid-story at depleted sites.
Objective: Maintain other warm desert riparian birds of conservation priority at stable or increasing trend in suitable habitats through 2022.

("other birds" include Loggerhead Shrike, Bell’s Vireo, Virginia Warbler, Scott’s Oriole, Western Burrowing Owl, and Common Nighthawk.)

("stable or increasing trend" – as measured by the Nevada Bird Count and/or supplementary monitoring transects or by USGS Breeding Bird Survey analysis appropriate to the Nevada Mojave Desert.)

Action: Continue partner-based funding for the Nevada Bird Count.

Action: Continue to pursue volunteer staffing of all USGS Breeding Bird Survey routes in Nevada.

Action: Adopt the nightjar (Common Nighthawk) survey protocol developed by Partners In Flight as implemented by the PIF Western Working Group. Share data and participate in both local and regional population trend analysis.

Objective: Maintain Pahranagat Valley montane vole populations at detectable levels through 2022.

("detectable levels" – as measured by routine live trapping annually or at scheduled intervals not to exceed five years.)

Action: Document range and distribution, develop a population estimate and perform population viability analysis for the Pahranagat Valley montane vole.

Action: Direct targeted private lands assistance funding and technical support to landowners to secure community-based habitat conservation for the Pahranagat Valley montane vole within its range.

Objective: Maintain populations of warm desert riparian bats at detectable levels through 2022.

("detectable levels" – as measured by routine ANABAT or mist-netting monitoring protocols annually or at scheduled intervals not to exceed five years.)

Action: Develop random-plot ANABAT monitoring networks with differential objectives for monitoring summer residency and migration using presence/absence occupancy analysis to establish status and trend statewide for bats of conservation priority.

Action: Determine occurrence and habitat functionality for western red bat, Allen’s big-eared bat, cave myotis, and spotted bat in Warm Desert Riparian habitats. Determine through targeted research the consequences of transition from native to exotic vegetation on occurrence and habitat suitability.
Objective: Maintain populations of warm desert riparian reptiles at detectable levels through 2022.

(“detectable levels” – as measured by visual or pit-trapping protocols as yet undeveloped annually or at scheduled intervals not to exceed five years.)

Action: Develop monitoring protocols for warm desert riparian reptiles of conservation priority with the intent of generating target detectability (occupancy) rates for the purpose of setting future conservation objectives.

Action: Determine occurrence and habitat functionality for for ring-necked snake, Southwest blackhead snake, western threadsnake, and Western red-tailed skink in warm desert riparian habitats. Determine through targeted research the consequences of transition from native to exotic vegetation on occurrence and habitat suitability.

Goal: Fully-functioning aquatic habitat ecosystems that support diverse natural species assemblages; maintenance of natural floodplain function with dynamic interaction of riparian and aquatic habitats within constraints of human need and existing infrastructure development; reduced impacts on aquatic habitats from invasive plant and animal species.

Objective: Increase total linear extent of fully functioning floodplain aquatic habitat on Mojave rivers and streams by 2022.

Action: Pursue implementation of floodplain maintenance and restoration actions through the Virgin River HCRP and associated recovery implementation program

Action: Pursue development and implementation of coordinated river channel and floodplain management strategies for the Amargosa River in Oasis Valley in cooperation with Nye County, BLM and other private and public cooperators.

Action: Identify and implement opportunities for restoration or creation of at least 40 acres of connected and isolated backwaters for Colorado River endemic fish species within historic floodplain below Davis Dam in Nevada through 2022.

Action: Maximize the extent of connectivity in Mojave tributary river lotic habitats through maintenance of flows and by prioritizing the location of fish movement barriers to isolate invasive species to the downstream extent practicable.

Action: Identify and implement strategies to maintain minimum low-flow period base flows on the Virgin River to limit exposure of priority aquatic species to extended periods above thermal maxima and/or provide thermal refuge habitat.
Objective: Maintain healthy populations of aquatic Species of Conservation Priority at stable or increasing trend.

Action: Implement private landowner cooperative agreements to restore or maintain aquatic habitats in Pahranagat and Oasis Valleys for priority aquatic species, including implementation of the Pahranagat Valley Programmatic Safe Harbor Agreement, development of Candidate Conservation Agreements with Assurances and utilization of Landowner Incentive Program opportunities.

Action: Implement cooperative strategies and management plans for native aquatic species of concern in Oasis Valley through implementation of the Amargosa Toad Conservation Agreement and Strategy.

Action: Develop a cooperative management strategy with USBR, USFWS and State of Arizona for Colorado River native fishes below Davis Dam, including cooperative implementation of the Lower Colorado River MSCP and the Rangewide Conservation Agreement and Strategy for Flannelmouth Sucker.

Action: Continue implementation of the Pahranagat Valley Recovery Implementation Team process for Federally listed and associated aquatic species.

Action: Support full implementation of the Virgin River HCRP and Muddy River Recovery Implementation Program (RIT)

Action: Evaluate potential for entrainment of native aquatic species of concern in water diversions on the Virgin River and implement strategies to reduce fish loss

Action: Continue cooperative efforts with the states of Utah and Arizona to implement control and eradication of red shiners in the mainstem Virgin River


Action: Complete and implement the Relict Leopard Frog Programmatic CCAA to support conservation actions for relict leopard frog on non-Federal lands in Clark County.

Action: Identify opportunities to establish additional relict leopard frog populations within historic range in the Virgin and Muddy river drainages on public and private lands and pursue population establishments using the CCAA and other available tools.

Action: Implement the Razorback Sucker and Bonytail Programmatic SHA in Clark County to establish additional refuge and grow-out pond facilities for those species.

Action: Actively pursue strategies for control and removal of nuisance aquatic species including nonnative crayfish, aquarium fish species, carp, tilapia and red shiner.
Partnerships

**Land Management/Ownership**

<table>
<thead>
<tr>
<th>Land Owner/Manager</th>
<th>Percent</th>
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Existing partnerships, plans, and programs

**Recovery Implementation Teams (RITs)**
- Muddy River
- Pahranagat Valley
- Meadow Valley Wash
- Virgin River
- Colorado River Fishes

**Habitat Conservation Plans**
- Clark County MSHCP
- Lower Colorado River MSCP
- Virgin River HCRP
- Southeast Lincoln County MSHCP

**Conservation Agreements and Strategies**
- Amargosa Toad
- Relict Leopard Frog
- Spring Mountains National Recreation Area

**Federal & State Agencies**
- U.S. Fish and Wildlife Service
- National Park Service
- Bureau of Land Management
- U.S. Geological Survey (Biological Resources Division)
- U.S. Forest Service
- U.S. Bureau of Reclamation
- Natural Resources Conservation Service & Conservation Districts
- Nevada Department of Wildlife
- Nevada Division of Forestry
Conservation Organizations
- The Nature Conservancy
- National Audubon Society/Red Rock Audubon Society

Bird Conservation Initiatives
- Partners In Flight
- Partners In Flight North American Land Bird Conservation Plan
- Nevada Partners In Flight & Nevada Bird Conservation Plan
- North American Waterbird Conservation Plan
- Intermountain West Waterbird Conservation Plan

Other Key Partners
- University of Nevada (UNLV)
- Intermountain West Joint Venture and State Steering Committee

Focal Areas
- Amargosa Desert  Lower Meadow Valley Wash
- Bitter Spring Valley  Moapa Valley East
- Bullfrog Hills  Moapa Valley West
- Lake Mead  Oasis Valley
- Las Vegas Wash  Virgin River Valley

Also:
- Amargosa River  Muddy River
- Colorado River  Virgin River
Springs & Springbrooks

Figure 17: Distribution of Springs and Springbrooks in Nevada.
KEY HABITAT: SPRINGS AND SPRINGBROOKS

Things to Know....
- Nevada has the most springs in the U.S. with over 4,000 springs.
- Springs and springbrooks provide habitat for 165 of Nevada’s 173 endemic species, which includes fish and aquatic invertebrates.
- This habitat is primarily threatened by water diversion, excessive livestock grazing, groundwater depletion, recreation, mining (de-watering activities), and establishment of non-native species.
- Springs tied to carbonate aquifer systems will likely experience little effects from climate change; however, non-carbonate systems are more dependent on recharge and seasonal flow which can be greatly affected by climate change.

Ecoregions

Southwest ReGAP 2005

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<td>Mojave</td>
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Ecological Systems

SWReGAP Ecological Systems

- A012 Ephemeral springs/springbrooks
- A013 Cold perennial springs/springbrooks
- A014 Thermal (warm) and hot perennial springs/springbrooks

*No TNC biophysical settings were developed

Key Habitat Description

Nevada has the most known springs of any state in the U.S. Over 4,000 springs of various temperatures and flow have been mapped. A spring occurs where deep or shallow ground water flows from bedrock or natural fill onto the land surface and forms surface flow or a body of water. Springbrooks are the areas of flowing water linked to the spring source. Springs are generally divided into three main categories: cold springs (springs near or below mean annual air temperature), warm or thermal springs (springs 5 to 10°C (40 to 50°F) above mean annual air temperature), and hot springs (springs more than 10°C (50°F) above mean annual air temperature). Over 100 of the known springs in Nevada have surface temperatures 38°C (100°F) or higher. The source and subterranean pathway of water may be local or regional. Thousands of springs occur in a variety of landform settings throughout the state.

In addition to thermal conditions, the characteristics of individual spring and spring brook systems can vary tremendously in terms of flow, water chemistry, and habitats provided for terrestrial and aquatic wildlife species. Many spring systems important to wildlife represent little more than seeps. Even relatively small spring and spring outflows can support important populations of endemic gastropods and other aquatic invertebrates.
Several locations in Nevada also contain individuals or groupings of large, regionally important springs which are in most cases thermal or hot water systems associated with regional aquifer flow systems. Big Warm Spring in Railroad Valley, Nye County, for example, has a recorded discharge varying from 22 to 24 cubic meters per second (780 to 850 cubic feet per second) at 30° to 33° C (86 to 91°F), from a source pool 24 m (80 ft) in diameter (U. S. Fish and Wildlife Service 1997). Similar regional spring discharge areas such as Soldier Meadow, Upper White River Valley, Pahranagat Valley, Ash Meadows, and the Warm Springs area of Clark County support important diverse assemblages of spring-dependent endemic species. These larger (and some smaller) spring systems generally support extensive springbrook outflow habitats, downstream wetland and marsh habitats, and may also contribute significant flow to associated tributary and first order stream and river systems, such as the upper White River and Muddy River.

Value to Wildlife

Gains in scientific knowledge about the contribution of spring habitats to biodiversity and the longevity of “ancient” water supply sources and gains in knowledge regarding the importance of ground water to the springs and the distribution or morphology of underground flow systems have drawn attention to spring conservation and management.

Early studies described many unique fishes endemic to spring and springbrook habitats, and studies since the mid-1980s have described a number of endemic spring-dwelling macroinvertebrates (primarily gastropods and aquatic insects). Other surveys document endemic mammals, amphibians, crustacea, and plants from spring-fed wetlands. Of Nevada’s 173 endemic species, 165 are associated with spring-fed habitats (Abele, 2011).

An important aspect of thermal aquatic systems is that fish are able to move within the system to meet their temperature needs; during winter months they can move closer to the spring source to meet thermal maintenance requirements, while using cooler outflow systems during warm weather periods. Springs provide crucial habitat to a significant percentage of Nevada’s federally-listed and state protected aquatic species.

In addition to springs’ critical role in the survival and conservation of endemic aquatic species, they also play a very important role for other wildlife species. Nevada, which has the lowest annual rainfall in the U.S., has limited surface water resources, particularly during drought. Springs provide a vital water source between infrequent surface waters, providing water availability and food resources for a wide range of Nevada’s wildlife, from bighorn sheep, elk, and deer; to birds and bats. The broad distribution of functional spring and spring outflow systems of all types across Nevada’s landscape is an important element in maintaining Nevada’s wildlife diversity.

Key Elements of Springs and Springbrooks of Importance to Wildlife

**EPHEMERAL SPRINGS**
- Columbia Spotted Frog (Great Basin pop)
- Northern leopard frog

**THERMAL (WARM)/HOT SPRINGS AND SPRINGBROOKS**
- Relict leopard frog
- Ash Meadows speckled dace
- Relict dace
- Warm Springs Amargosa pupfish
- Ash Meadows Amargosa pupfish
- Meadow Valley speckled dace
- Devil’s Hole pupfish
- Moapa dace
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<tr>
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**COLD SPRINGS AND SPRINGBROOKS**

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<td>Independence Valley speckled dace</td>
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<td>Relict leopard frog</td>
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<td>Western toad</td>
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</tr>
<tr>
<td>minute tryonia</td>
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Existing Environment

Habitat Conditions

Like other water-associated habitats, dewatering, diversion works, channelization, and invasion of non-native plants and animals have altered springs (Bureau of Land Management 2001). The introduction of non-native aquatic organisms into spring and springbrook habitats, particularly the establishment of thermally tolerant invasive species into warm and thermal spring systems, has significantly impacted resident endemic species through competition and predation and represents the single greatest threat to a number of the aquatic species of conservation priority. The establishment of emergent invasive plant species such as cattails and *Phragmites* in spring pools and outflows has severely modified and altered some spring habitat and flow characteristics. In some basins, groundwater pumping has been found to depress spring flow and a small number of larger regional springs have demonstrated temporary or permanent dewatering as a result of groundwater development. Field studies have documented degraded habitat conditions, declines in sensitive plant and animal populations, and species extinctions. Similar to other wetlands, springs are intensively used. Livestock, wild horses, and diversions were the predominant disturbances found in a study of 511 northern Nevada springs (Sada, 2001), and disturbance from trampling can be particularly detrimental to water quality and spring pool and springbrook habitat characteristics.

A substantial number of springs on private and public lands have been historically altered by piping of outflows or the construction of spring head boxes. These practices eliminate or significantly modify spring pool and spring outflow habitats for wildlife and can eliminate important source water locations for use by resident wildlife species. More recent efforts to provide wildlife access to these modified spring systems are important, but have focused on terrestrial species needs with limited attention to restoring natural spring system functions to support spring-dependent endemic aquatic communities. There are concerns that current protection and management attention is not sufficient to maintain endemic species, sustain spring ecological site integrity and long-term water production. Scorecard 2006 lists over 69 sites throughout the state that house globally rare and endemic species in areas that are currently in need of management due to urgent threats. Of these 69 sites, approximately 75% are springs (NNHP, 2006). Springs, particularly larger regional complexes, are also popular centers of human recreational activities. Although recreation can be managed to minimize effects on spring ecosystems in most cases, uncontrolled or poorly planned recreational use can have significant negative effects on spring habitats and biota.

Land Uses

- Groundwater development
- Road development
- Development and diversion of flow
- Motorized and non-motorized recreation
• Livestock grazing
• Urban/suburban and industrial development

Problems Facing the Species and Habitats

Spring and springbrook habitats and associated species are primarily threatened by water diversion, excessive livestock grazing, groundwater depletion, recreation, mining (de-watering activities), and establishment of non-native species. Detrimental introduced plant species include saltcedar, purple loosestrife, Canada thistle, knapweed, and tall whitetop. Detrimental introduced animals include mosquito fish, goldfish, mollies, bullfrogs, crayfish, a snail, and several introduced sport fish (rainbow trout, largemouth bass). Improper grazing by cattle can also cause significant damage by eliminating riparian vegetation and/or trampling (leading to topsoil loss during rainfall and snowmelt events, and to “sealing” of the spring in areas with high clay content). The same impacts can also occur with wild horse and burro use. Species such as elk can also impact springs; in areas where large populations exist, their impacts can be similar to those of livestock.

The development of springs and seeps, a common historic practice for livestock watering, domestic water supply and other reasons, is a significant concern because of the critical importance of spring resources as a source of surface water for terrestrial wildlife and also because many springs and seeps of all sizes support unique endemic aquatic biota. The development and modification of spring sources and source pools directly alters or removes important aquatic habitats, modifications can limit access to remaining surface water by wildlife, and the diversion of water away from outflow channels modifies and can reduce or destroy associated riparian and wetland habitat, as well as limit or eliminate flowing water habitat for springbrook-associated endemic species. Although not directly related to the development and alteration of spring systems, groundwater development has been a historic stressor on Nevada wildlife and habitats and continues to represent a significant ongoing threat. As demonstrated in areas such as Ash Meadows and Pahrump Valley in southern Nevada, excessive groundwater withdrawal can alter groundwater flow and recharge patterns, resulting in loss of connectivity between groundwater and surface water habitats and concurrent impacts to vegetative communities and surface flow of ground water from springs and seeps. These impacts are often not well understood, and can vary considerably depending on local geology, the characteristics of groundwater development actions, and the nature of the groundwater resources being accessed.

Springs are also susceptible to pollution because they are often supplied by shallow aquifers that can easily become polluted if spilled chemicals percolate from the surface through rock fractures or joints. Some potential sources are refuse disposal, hazardous material, injection fields, oil and gas development, and ungulate fecal material. Recreational use impacts include bleach and soap added to the springs, soil compaction, removal of vegetation and resulting erosion from camping along the edges of springs, and manipulation of spring flow from installing tubs and water diversions.

Predicted Climate Change Effects

The potential effect of climate change on groundwater recharge and subsequent surface discharge will, to a great extent, be dependent on the underlying geology. Great Basin hydrogeology is complex and impacts on individual spring systems will be dependent not only on their specific correlation to carbonate or non-carbonate regional groundwater aquifers, but also the physical location and elevation of individual sites within a given basin system or watershed. Generally speaking, large (often thermal) springs and spring complexes tied to regional or intermediate carbonate aquifer flow systems are likely to show minimal effects from projected changes in seasonal precipitation patterns and increasing air temperatures over the next 20 to 30 years. Big
Warm Spring in Railroad Valley, Hot Creek in White River Valley, and Ash Spring in Pahranagat Valley are examples of these types of spring systems which are characterized by their connection to deep regional flow systems encompassing multiple valley basins and discharge of “old” water at warmer temperatures because of the depth of the connection to groundwater. Where effects can be associated with these regional springs, it primarily will be expected in the springbrook components of the systems where increased air temperatures and transpiration could have potential effects on springbrook length, total wetted area, and thermal characteristics of the springbrooks affecting habitat suitability for certain species.

The majority of springs in Nevada, however, are not directly associated with deep carbonate regional flow systems and are more dependent on local recharge and short-term changes in precipitation and runoff patterns. Both valley bottom springs associated with non-carbonate groundwater aquifers, and intermediate and higher elevation (mountain block) springs are generally characterized by discharge of “younger” (often less than 60 years old) water and are highly dependent on groundwater recharge from winter precipitation in local mountain systems to maintain flows, and even under existing climatic conditions can show inter-annual variability in discharge greater than that typically shown by carbonate based regional springs. Because these spring systems are much more dependent on relatively shallow groundwater flow and local recharge, anticipated effects from climate change will be substantially greater. Warming air temperatures will affect not only springbrook characteristics but have the potential to modify precipitation characteristics; increased snowline elevations, early spring onset, and temporal changes in precipitation timing all have the potential to alter groundwater recharge characteristics with corollary effects on individual spring total discharge and increased interannual variability in flow.

**Possible Wildlife Responses to Climate Change**

Because spring systems are biodiversity hotspots in an otherwise arid landscape, and because of historic isolation from other aquatic systems and often unique physical and chemical characteristics, they support an outsized proportion of Nevada’s locally endemic biota. Larger regional spring systems tied to deep carbonate aquifer systems are likely to show the least short-term effects from climate change through 2025 because of the relative stability of these groundwater sources. Substantive effects in many cases may be limited to changes in total springbrook length, total wetted area and aquatic habitat characteristics and quality in extended springbrooks associated with changes in thermal characteristics. Thus, effects on resident biota may be largely limited to species dependent on lower springbrook habitats that are unable to fully utilize warmer water temperatures favored by thermal endemic species. In spring systems associated with non-carbonate and local recharge zones, anticipated species-related effects beginning within the next 20 years could be more substantive but will be highly variable between sites depending on local and often unpredictable changes in precipitation patterns and shallow groundwater recharge rates. In general, negative effects on springbrook habitats will be similar to that for larger regional springs but will likely extend upstream closer to spring sources with the higher potential in these springs for reduced total discharge due to changes in local conditions. The net result for resident endemic aquatic species is a reduction in total available habitat within these systems. Of potentially greater concern in local recharge spring systems is a potential increase in seasonal and interannual variability of spring discharge. Certain species, such as endemic gastropods, are highly dependent on habitat stability and increases in discharge variability will likely restrict the available range of habitat for these species in some systems and could potentially lead to local extinctions at some sites.

**Priority Research Needs**

- Impacts of groundwater withdrawals on a regional scale
- Groundwater interbasin connections and recharge intervals
• Determine status of Great Plains toad at springs in Lincoln County
• Invertebrate adaptability to alterations in water level, water chemistry, and other tolerance parameters
• Effective methods for control and removal of invasive and non-native animal species, particularly in larger regional spring systems where flow and physical characteristics make conventional physical and chemical control methods impractical
• Effective methods for restoration and reconstruction of fully-functioning spring habitats

Conservation Strategy

*Goal: Springs and springbrook habitats functioning naturally within the natural fluctuation inherent to the spring type (recognizing that regional springs are inherently much more stable than those supported by local aquifers).*

**Objective:** A measurable increase in the number of springs and springbrooks functioning naturally and supporting the natural ecological community expected for each spring by 2022.

**Action:** Continue to assess the current functional status of Nevada’s springs.

**Action:** Establish a working group to contribute expertise, pool data, and develop and implement a management plan for Nevada springs. (Springs already addressed under other management plans will be noted in the plan)

**Action:** Map springs and digitally document their historical condition, desired condition, and restoration potential.

**Action:** Prioritize management and restoration activities by spring.

**Action:** Restore degraded springs and associated riparian areas. Identify factors affecting site potential and adjust land uses to allow for natural spring and springbrook recovery.

**Action:** Acquire and maintain water rights holdings for the benefit of wildlife use.

**Action:** Work with the Desert Fish Habitat Partnership and National Fish Habitat Action Partnership to identify and implement restoration projects for spring systems supporting priority DFHP fish species and spring-associated strategic goals of the DFHP Framework Action Plan.

**Action:** Maintain the ecological structure and function of spring habitats by stabilizing discharge and springbrook morphology.

**Action:** Manage springs and their riparian areas as a unit using guidelines appropriate to these systems, such as those used to manage wetland areas and riparian zones.

**Action:** Identify locations where passage barriers fragment springbrook habitats for priority fish species and implement corrective actions where appropriate.

**Action:** Manage for a minimal standard of proper functioning condition (PFC) for springs and associated riparian areas on public lands, utilizing existing guidance and standards for spring and springbrook ecosystems.
**Action:** Incorporate standardized biological assessment as an adaptive management feedback mechanism to assess spring management effectiveness.

**Action:** Work with landowners to manage spring habitats, including providing information about optimum habitat, invasive species, and available grant and other funding opportunities.

**Action:** Establish conservation easements, Safe Harbors Agreements, and Candidate Conservation Agreements with willing landowners, MOAs, or acquire key habitats or water rights from willing sellers.

**Objective:** No net loss of spring/springbrook-dependent Species of Conservation Priority.

**Action:** Develop a public outreach program utilizing interpretive programs, watchable wildlife opportunities, and other educational approaches regarding the importance of springs in partnership with BLM, USFWS, NPS and other cooperators.

**Action:** Actively pursue strategies to prevent introduction of nuisance aquatic plant and animal species, including educational campaigns targeted at pet stores, nurseries, classrooms, researchers, biologists, and others.

**Action:** Support actions by land management partners and local governments to control invasive and noxious plants and weeds, especially saltcedar and emergent plant species which directly impact functioning of spring and springbrook aquatic habitats.

**Action:** Continue implementation of existing recovery and conservation programs for spring and springbrook dependent Species of Conservation Priority including endemic amphibians, and species occurring within the upper White River, Pahranagat Valley, Muddy River, Railroad Valley, Independence Valley, and Clover Valley systems.

**Action:** Organize cooperative conservation implementation working groups to develop and implement conservation strategies for Desert Dace and Ash Meadows endemic fishes.

**Action:** Develop and implement a regional Conservation Agreement and Strategy for isolated spring systems and dependent Species of Conservation Priority including land management partners and adjacent state responsible entities.

**Action:** Encourage research on innovative methods and strategies for the control and removal of invasive and nuisance animal species from spring and springbrook systems, particularly crayfish and thermally dependent non-native fishes.
Partnerships

**Land Management/Ownership**

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Existing Partnerships, Plans, and Programs

**Species Teams, Recovery Plans, and Conservation Agreements**
- White River Recovery Implementation Team
- Railroad Valley Recovery Implementation Team
- Big Spring Spinedace Recovery Implementation Team
- Muddy River Recovery Implementation Program
- Pahrump Poolfish Recovery Implementation Team
- Soldier Meadow Recovery Working Group
- Pahranagat Valley Recovery Implementation Team

**Conservation Agreements and Strategies**
- Amargosa Toad Conservation Agreement and Strategy
- Amargosa Toad Management Plan
- Relict Leopard Frog Conservation Agreement and Strategy
- Northeast Nevada Columbia Spotted Frog Conservation Agreement and Strategy
- Toiyabe Columbia Spotted Frog Conservation Agreement and Strategy
- Draft Tui Chub Species Management Plan
- Big Spring Spinedace Recovery Plan and Recovery Implementation Plans
- Recovery Plan for the Endangered Species of Clover and Independence Valleys
- Railroad Valley Springfish Recovery Plan
- Recovery Plan for the Aquatic and Riparian Species of Pahranagat Valley
- Pahranagat Valley Native Fishes Management Plan
- Recovery Plan for the Pahrump Killifish
- White River Native Fishes Management Plan
- Indian Spring Candidate Conservation Agreement with Assurances
- Recovery Plan for the Endangered and Threatened Species of Ash Meadows, Nevada
- Recovery Plan for the Rare Aquatic Species of the Muddy River Ecosystem
- Recovery Plan for the Rare Species of Soldier Meadows
- Spring Mountains National Recreation Area Conservation Agreement
Federal & State Agencies
- Bureau of Land Management
- U.S. Forest Service
- U.S. Fish and Wildlife Service
- Natural Resources Conservation Service/Conservation Districts
- Bureau of Reclamation
- National Park Service
- U.S. Geological Survey (Biological Resources Division)
- Nevada Natural Heritage Program
- Nevada Department of Wildlife
- Nevada Division of Forestry
- Nevada Department of Agriculture

Conservation Organizations
- The Nature Conservancy
- Sierra Club
- National Audubon Society/Lahontan Audubon Society/Red Rock Audubon Society

Partner-based Restoration and Management Efforts
- Muddy River Regional Environmental Impact Alleviation Committee (MRREIAC)
- Desert Fish Habitat Partnership
- Muddy River Project (TNC)
- Oasis Valley Project (TNC)

Habitat Conservation Plans
- Clark County Multiple Species Habitat Conservation Plan
- Spring Mountain Ranch Habitat Conservation Plan
- Nevada Springs Conservation Plan (2011)

Other Key Partners
- Counties
- Tribes
  - Duckwater Shoshone Tribe
  - Moapa Band of Paiutes
- University of Nevada (UNR, UNLV, Cooperative Extension)
- Desert Research Institute
- Southern Nevada Water Authority

Focal Areas
<table>
<thead>
<tr>
<th>Amargosa Desert</th>
<th>Goshute Mountains</th>
<th>Oasis Valley</th>
<th>Spring Valley</th>
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<tbody>
<tr>
<td>Big Smoky Valley</td>
<td>Independence Valley</td>
<td>Pahrangat Valley</td>
<td>White River Valley</td>
</tr>
<tr>
<td>Black Rock Desert Wash</td>
<td>Lower Meadow Valley Wash</td>
<td>Railroad Valley</td>
<td></td>
</tr>
<tr>
<td>El Dorado Mountain</td>
<td>Moapa Valley East</td>
<td>Roberts Creek Mountains</td>
<td></td>
</tr>
<tr>
<td>Fish Lake Valley</td>
<td>Monitor Valley</td>
<td>Spring Mountains</td>
<td></td>
</tr>
</tbody>
</table>

Also: Condor Canyon
Figure 18: Distribution of Mequite Bosques and Desert Washes in Nevada.
KEY HABITAT: MESQUITE BOSQUES AND DESERT WASHES

Things to Know....

- Mesquite bosques and desert washes are found in areas with deep soils and shallow water tables along washes and riparian areas in the Mojave Desert.
- This habitat contributes significantly to local wildlife diversity; key priority species include Bell’s Vireo, desert pocket mouse, and Great Plains toad.
- Habitat threats include OHV use and invasive plants, such as salt cedar, both resulting in loss of native vegetation.
- Desert washes (but not necessarily mesquite bosques) were predicted to increase in extent over the next 50 years with climate change.

Ecoregions

Southwest ReGAP 2005

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Hectares</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mojave</td>
<td>31,206</td>
<td>77,111</td>
</tr>
<tr>
<td>Great Basin</td>
<td>159</td>
<td>393</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>31,359</strong></td>
<td><strong>77,504</strong></td>
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</table>

Ecological Systems

TNC Biophysical Setting     SWReGAP Ecological Systems

<table>
<thead>
<tr>
<th>Washes</th>
<th>SO20 North American Warm Desert Wash</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SO98 North American Warm Desert Riparian Mesquite Bosque</strong></td>
<td></td>
</tr>
</tbody>
</table>

**SO98 was included in TNC Biophysical Setting “Warm Desert Riparian” in another chapter.

Key Habitat Description

Mesquite bosques and desert washes are found in areas with deep soils and shallow water tables along washes and riparian areas, and also in isolated patches in low-lying areas such as the edges of dry lake beds. In riparian corridors, mature mesquite bosques often occupy the higher terraces above the 100-year event floodplain. The characteristic plant species in this habitat type are honey mesquite and catclaw. Honey mesquite is distributed throughout Clark County and parts of southern Lincoln and Nye counties, while catclaw acacia is generally distributed along washes, particularly in extreme southern Nevada. Distribution of the two species tends to be linear, as in wash systems, although mesquite also occurs as isolated clumps or in small woodlands associated with sandy dunes. Both habitat types can be infected with mistletoe, which enhances their value to fruit-eating birds.

The growth form of mesquite varies from thorny, impenetrable thickets to large trees that can reach heights as great as 30 feet with stems approaching 3 feet in diameter. Catclaw forms thorny thickets along linear wash systems as well as isolated clumps across the desert. Other plant species occurring in these habitats include screwbean mesquite, quailbush, desert willow, seeppwillow, and wolfberry. Common grasses found in mesquite habitat include Great Basin wildrye, saltgrass, and alkali sacaton. Desert mistletoe is a hemi-parasitic plant that uses mesquite and catclaw as its host.
Value to Wildlife

Like Mojave Rivers and Streams, Mesquite Bosques and Desert Washes contribute significantly to the wildlife diversity of the Mojave Desert to an inordinate scale when their acreage is compared to the surrounding bajada vegetation. Not only are there species in the bosques and washes that would not appear in the Mojave Desert if these habitats were not there, but the juxtaposition of bosques and washes to the upland matrix also defines the upland territories of highest productivity and desirability to upland species. In effect, the wildlife activity of the Mojave Desert is concentrated around the bosques and washes. While none of the species listed in the assemblages below are solely dependent on this key habitat, the statewide population maintenance of all of them is greatly enhanced by it. Of the birds that use bosques and washes, Yellow-breasted Chat, Verdin, Lucy’s Warbler, Crissal Thrasher, and Phainopepla almost certainly would not be found in the desert landscape without the presence of mesquite. The sandy soils deposited and maintained by desert washes are critical to the needs and distribution of the desert pocket mouse. Nevada represents the northernmost extent of the species’ range, and the Nevada subspecies, *Chaetodipus penicillatus sobrinus*, has been demonstrated to be geographically isolated from any other populations of the species, making conservation in Nevada particularly critical (Marshall, et al., 2004).

Although desert washes do not generally contain permanent water, with the rare exception of occasional spring and seep features, they serve as seasonal conduits of higher soil moisture and occasional surface flow which can often leave remaining ephemeral pools and sinks well after the end of precipitation events. Because of this they are particularly important for species such as Great Plains toad which utilize ephemeral and temporary breeding pools, and can serve as valuable corridors for the movement of terrestrial wildlife, including endemic amphibians. As such they may have an important role in amphibian distribution and metapopulation maintenance within these arid landscapes. Moreover, desert washes in the Mojave Desert are preferred habitat for desert tortoise because they use wash slopes to excavate burrows, especially underneath hardpan benches, and to forage on the more productive herbaceous vegetation associated with greater soil moisture.

Key Elements of Mesquite Bosques and Desert Washes Habitat Important to Wildlife

**MESQUITE** – nesting structure, protection from predators, foraging, thermal cover
- Loggerhead Shrike
- Bendire’s Thrasher
- LeConte’s Thrasher
- Arizona Bell’s Vireo
- Brewer’s Sparrow
- desert night lizard
- western brush lizard

**SANDY BOTTOMS** – burrowing
- Burrowing Owl
- desert pocket mouse
- desert iguana
- desert tortoise
- long-nosed leopard lizard
- desert horned lizard
- rosy boa
shovel-nose snake
spotted leaf-nosed snake

GRASSY MESIC – foraging, burrowing
western threadsnake
ring-necked snake
western red-tailed skink
Panamint alligator lizard

GRAVELLY BOTTOMS – nesting substrate
Common Nighthawk
Arizona toad
Great Plains toad
Amargosa toad

ROCKS AND CANYONS – foraging, burrowing, protection from predators, movement corridors
bighorn sheep
Gila monster
western banded gecko
chuckwalla
Great Basin collared lizard

Existing Environment

Land Uses
- Urban/suburban development
- Industrial development
- Motorized recreation
- Sand and gravel extraction
- Wood products extraction
- Military mission
- Road development
- Utility rights-of-way
- Species harvest

Habitat Conditions

Mesquite bosques and catclaw washes are being lost at an unprecedented rate to urban and suburban development and the attendant activities of mesquite woodcutting, sand and gravel mining, and human-caused wildfire. Mesquite bosques have been significantly invaded by tamarisk in many areas, and the native understory has been replaced by red brome and cheatgrass. Considering the importance of the contribution this key habitat type makes to its landscape in terms of wildlife diversity, this is likely one of the state’s most endangered habitats.
Problems Facing the Species and Habitats

Maintenance of the habitat type itself in the face of burgeoning urban and suburban development is the most difficult problem facing mesquite bosques and catclaw washes. Off-road vehicular activity can result in serious structural damage to shrubs, stripping them of their value as wildlife cover, and soil disturbance can lead to accelerated erosion. With increased levels of disturbance, the value of these habitats for burrowing species, such as desert tortoise, is diminishing. There is also concern for the viability of the Nevada population of desert pocket mouse (Marshall, et al., 2004) given its limited preference of suitable habitats that has resulted in the fragmentation of local populations.

The U.S. Breeding Bird Survey (BBS) documented a population decline of 50% or greater for Bendire’s Thrasher between 1966 and 1999. The PIF North American Landbird Conservation Plan has identified Bendire’s Thrasher as a Watch List Species in need of Immediate Action in the Mojave Bird Conservation Region due to the combination of significant population decline and restricted distribution. Similarly the BBS documented a population decline of 50% or greater for Brewer’s Sparrow, and while the stewardship responsibility for Brewer’s Sparrow is much greater in the neighboring Great Basin; the Mojave Desert ecoregion provides important wintering habitats for the species.

Predicted Climate Change Effects

Mesquite Bosques

The predicted climate change effects for mesquite habitats in linear warm desert riparian habitats are discussed in the Warm Desert Riparian chapter. It is difficult to predict if playa-edge mesquite bosques will be subject to the same degree and nature of threat from exotic invasive plants as riparian floodplains or not. It does not appear that water quantity will have an impact, but timing of recharge and duration of inundation and percolation might have an impact on the health of these playa-edge bosque habitats with unknown long-term effects.

Desert Washes

Desert washes were predicted to increase in extent over the next 50 years with climate change mostly recipient to conversions of non-carbonate montane riparian systems that will lose their perennial water flow. It is difficult to evaluate the loss of perennial water and conversions to intermittent flow in positive terms.

Taking Prescriptive Action

Prescriptive actions were not specifically developed for mesquite bosques or the Desert Washes BPS as part of the TNC Climate Change Analysis, but prescriptive actions appropriate for mesquite bosques are discussed in the Warm Desert Riparian chapter. Most prescriptive actions germane to desert wash management involve preventing non-carbonate montane riparian and warm desert riparian habitats from losing their perennial flow and converting to desert washes. Although not modeled, actions that can slow the drop of the water table and lengthen the retention of flowing water in perennial streams into desert washes would involve currently-used best management grazing practices (for example, fencing perennial reaches and deploying water gaps), creating low-technology pool and riffles systems, and removing encroaching pinyon and juniper in the narrow floodplain of streams. Desert washes that experienced bank incisions and loss of fine sediment can sometimes be reclaimed using shallow, handmade rock dams and strategically placed woody debris.
Priority Research Needs

- Hydrologic dynamics of playa-edge bosques and strategies for long-term maintenance
- Quantification of desert wash/bosque influence on distribution patterns of upland desert priority species
- Distribution and habitat relationships models for western brush lizard
- Distribution, habitat relationships models, and decline factors for Bendire’s Thrasher
- Population viability analysis for desert pocket mouse
- Population status and ecology of gila monster
- Distribution and population status of Panamint alligator lizard
- Habitat relationships models for all reptiles of Conservation Priority
- Importance of desert washes to endemic amphibian movement and metapopulation maintenance

Conservation Strategy

**Goal:** Thriving self sustaining wildlife populations in healthy plant communities on stable substrates resistant to destructive erosion and sustained by intermittent flow and/or high water tables; thriving mature mesquite overstory sustained by high water tables; vigorous catclaw acacia stands on corridors where high water tables are absent.

**Objective:** Expand protected status for Mesquite Bosque and Desert Wash ecological systems by 2022.

“expand protected status” – moving acreage from “multiple use” (public) or “unmanaged” (private) designations to any of several “protected” designations on public lands or through easements or purchases for private lands.

**Action:** Protect mesquite and catclaw habitats from urban and suburban development through mitigation achieved under the Clark County Multiple Species Habitat Conservation Plan (MSHCP).

**Action:** Support the designation of new Areas of Critical Environmental Concern (ACEC’s) as proposed in discussions regarding the BLM’s Las Vegas District RMP revision.

**Action:** Secure mesquite bosque protection through conservation easements on private lands or purchases from willing sellers.

**Action:** Increase protection from illegal cutting of mesquite through increased enforcement and education.

**Action:** Increase protection for desert washes from off-highway vehicle damage through the appropriate land use planning processes.

**Action:** Increase protection for desert washes from gravel mining in critical habitats for priority species.

**Action:** Develop restoration and mitigation techniques to reduce the long-term net impact of gravel mining on desert washes in critical areas for priority species.
Objective: Stabilize declining trends for Bendire’s Thrasher, LeConte’s Thrasher, and Loggerhead Shrike by 2022.

“declining trends” as projected by USGS Breeding Bird Survey analysis and measured by BBS or Nevada Bird Count surveys conducted at regular intervals not to exceed five years.

Action: Develop predictive models and inventory occupied habitat for declining species for the purpose of developing reliable population estimates and meaningful conservation objectives.

Action: Restore and maintain mesquite bosque habitats to suitable habitat conditions for these species as described in the Nevada Comprehensive Bird Conservation Plan.

Objective: Maintain Bell’s Vireo, Virginia’s Warbler, and Western Burrowing Owl populations at stable or increasing trend through 2022.

“stable or increasing trend” as projected by USGS Breeding Bird Survey analysis and measured by BBS or Nevada Bird Count surveys conducted at regular intervals not to exceed five years.

Action: Monitor and mitigate losses of Burrowing Owl habitat to urban/suburban development through appropriate land management planning processes.

Action: Monitor and mitigate local impacts of OHV recreation on burrowing owl nesting areas.

Action: Restore and maintain mesquite bosque habitats to suitable habitat conditions for these species as described in the Nevada Comprehensive Bird Conservation Plan.

Objective: Maintain bighorn sheep populations at stable or increasing trend through 2022.

Action: Continue to provide reliable water sources for bighorn sheep in desert washes using applied water development techniques where warranted.

Objective: Maintain desert pocket mouse populations at self-sustaining levels with connectivity and gene flow occurring between population centers through 2022.

“self-sustaining levels” – populations that maintain themselves on the landscape without artificial assistance or manipulation with no danger of extirpation at local scales.

“connectivity and gene flow” – one of the stated conservation challenges for desert pocket mouse is that the specificity of their habitat preferences creates patchy, disjunct distributions on the landscape that can become isolated with minimum or no connectivity to adjacent populations, effectively restricting free genetic exchange and risking deterioration in population health, vigor, and persistence through genetic stagnation.

Action: Perform population viability and connectivity analysis for desert pocket mouse and apply appropriate conservation actions based on results.
Objective: Maintain current value of mesquite bosque and desert wash systems as movement and breeding habitats associated with priority amphibian species through 2022.

“current value” is defined as clear, utilizable corridors without impediments to free movement up and down washes and maintenance of hydrological function and protection of hibernacula beds

Action: Determine the importance of desert washes and mesquite bosques on local distribution of priority toad species in relation to surrounding upland vegetation and perennial water sources.

Action: Determine the importance of desert wash habitats for amphibian movement and metapopulation maintenance, and provision of ephemeral amphibian breeding habitat.

Action: Incorporate recommendations for these habitats into existing amphibian species conservation and land use planning efforts to protect movement corridors and amphibian metapopulation dynamics.

Partnerships

Land Management/Ownership

<table>
<thead>
<tr>
<th>Land Owner/Manager</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bureau of Land Management</td>
<td>100</td>
</tr>
</tbody>
</table>

Existing partnerships, plans, and programs

- Clark County Multiple Species Habitat Conservation Plan
- Southern Nevada Mesquite Woodland Habitat Management Plan

Federal & State Agencies

- Bureau of Land Management
- National Park Service
- Nevada Department of Wildlife
- Nevada Division of Forestry

Conservation Organizations

- The Nature Conservancy
- National Audubon Society/Lahontan Audubon Society (Important Bird Areas Program)
- Sierra Club

Bird Initiatives

- Partners In Flight North American Land Bird Conservation Plan
- Nevada Partners In Flight
- Nevada Bird Conservation Plan

Amphibian Initiatives

- Amargosa Toad Conservation Agreement and Strategy
Other Key Partners

- Intermountain West Joint Venture
- Great Basin Bird Observatory
- University of Nevada (UNR, UNLV)

Focal Areas

Amargosa Desert
Bitter Spring Valley
Las Vegas Valley
Las Vegas Wash
Lower Meadow Valley Wash
Moapa Valley – East
Moapa Valley-West
Virgin River Valley

Amargosa Toad

Photo Courtesy of NV IBA Program