

Las Vegas Wash Coordination Committee

Rainbow Gardens Weir Planting Plan



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Coordination
Committee



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1.0 Purpose and Goals of the Planting Plan

A variety of erosion control activities are currently being implemented along the Las Vegas Wash (Wash) as part of a comprehensive stabilization strategy. These activities include the construction of weirs and bank stabilization structures. Because these structures are constructed within the boundaries of jurisdictional waters of the U.S., they are subject to regulatory compliance as outlined by the Clean Water Act. Erosion control structures that are constructed along the Wash are typically permitted under the nationwide permit program. Nationwide permits (NWP) are a type of general permit issued by the U.S. Army Corps of Engineers (Corps) and are designed to regulate with little, if any, delay or paperwork certain activities having minimal impacts to jurisdictional waters of the U.S. Current stabilization activities in the Wash are permitted under NWP 27 (stream and wetland restoration activities) and NWP 3 (maintenance). Although stabilization activities are permitted under the NWP program, post-construction mitigation is required; and mitigation activities typically consist of planting native vegetation on areas adjoining the erosion control structure. This plan was developed to meet Corps requirements for erosion control activities engaged by the Southern Nevada Water Authority (SNWA) along the Wash.

The purpose of this plan is to describe the revegetation strategies to be implemented at the recently completed Rainbow Gardens weir. Not only do these revegetation activities help us meet our regulatory requirements, but they also provide for additional erosion control and habitat for the diverse fauna found in the Wash ecosystem. The general goals for this and other revegetation activities along the Wash are to develop ecologically functioning wetland, riparian, and upland areas that are self-sustaining in the long-term. Revegetation activities are coordinated by staff from the SNWA's Las Vegas Wash Project Coordination Team (Project Team) as part of wetland mitigation requirements specified by the Corps.

Specific activities required to successfully revegetate areas along the Wash are described herein. Typically these activities include removal of non-native invasive species, investigation of soil condition, identification of the subsurface hydrologic condition, and planting native vegetation. Also included in this document are brief descriptions of monitoring strategies for revegetation sites, water quality and an array of biological resources found along the Wash. Revegetation site monitoring provides us with an indication of site success while monitoring additional biological resources provide us with an indication of proper ecosystem functioning.

2.0 Project Summary

2.1 Site Location and Weir Description

The Rainbow Gardens weir (Figure 1 and Figure 2) is located along the lower Wash, approximately 0.5 miles upstream of the channel intake structure for the Lake Las Vegas Resort development. The weir was completed in June 2004. The Weir is a roller compacted concrete (RCC) structure founded on drilled concrete piles (Appendix A). The design is based upon technical criteria codified by the Clark County Regional Flood Control District, where applicable. In cases where criteria were not applicable or not

present, design procedures and criteria available from the U.S. Bureau of Reclamation and the Corps were applied.

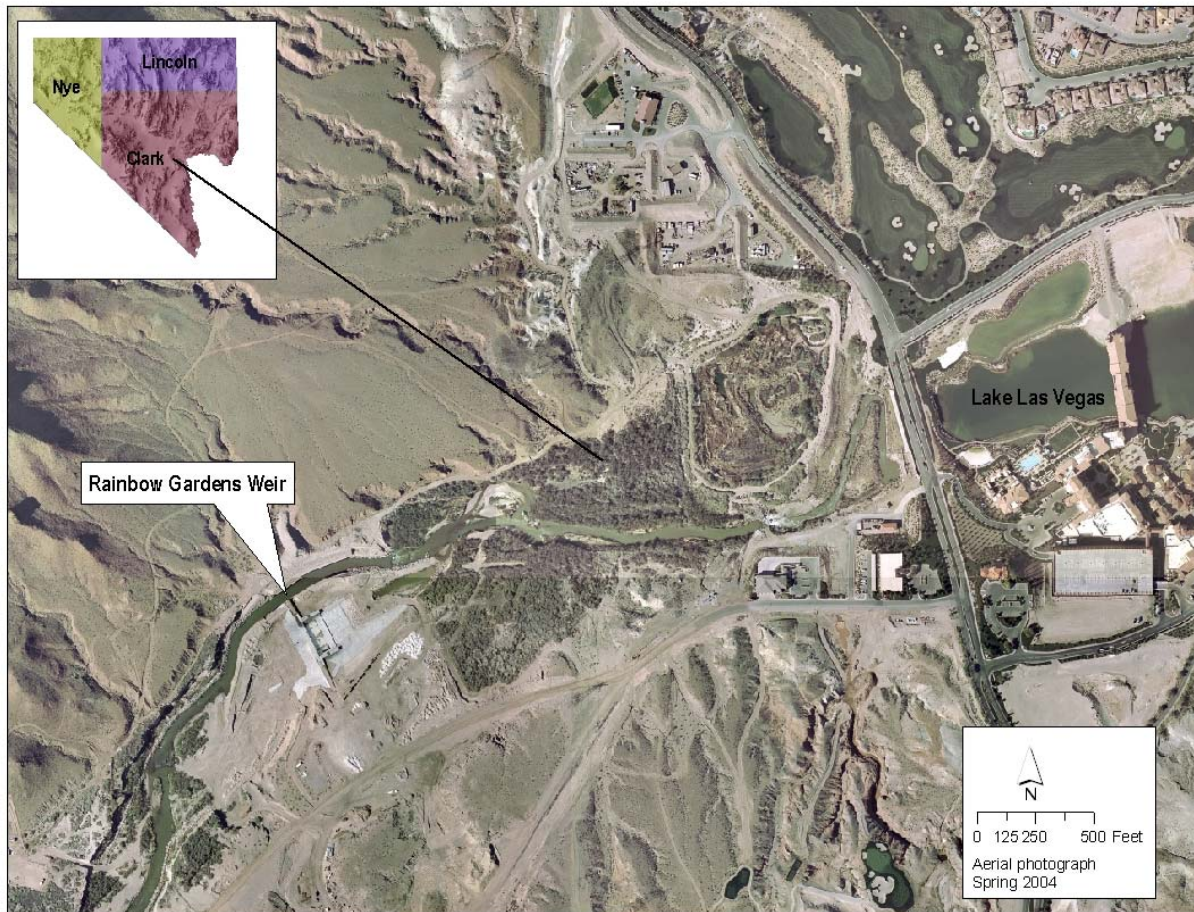


Figure 1: Rainbow Gardens weir site vicinity.

The structure is designed as a gravity concrete dam founded on drilled concrete piles with a broad crested weir and stepped chute spillway. The stepped chute spillway is set at a 2:1 slope, with 1-foot by 2-foot steps, and the weir section has a width of 15 feet and a length of 164 feet. The RCC stilling basin is 40 feet long with sidewalls at a 1:1 backslope. The structure has a low flow weir elevation of 1,435 feet. The existing channel bed immediately below the weir section lies at approximately 1,426 feet. To meet expected future channel bed scour conditions, the structure's invert is set at an elevation of 1,423 feet. The structure is founded on 147 3-foot diameter drilled concrete piles spaced on 14-foot centers. The piles are drilled into bedrock, which lies approximately 30 feet below the structure. The exposed concrete along the access ramp on both sides of the weir includes a coloring admixture to provide an aesthetically pleasing viewshed. The structure has a permanent footprint of 1 acre.



Figure 2: Completed Rainbow Gardens weir.

2.2 Site Conditions

2.2.1 Vegetation

Prior to construction, the Rainbow Gardens weir site was fully bordered on the north and south by linear strips of riparian and wetland vegetation (see Appendix A). Because the active channel is entrenched approximately 50 feet below the historical flood plain, the riparian and wetland vegetation that is found near the site is physically and hydrologically disconnected from the upland plants found above. Riparian plant species that were found near the site include salt cedar (*Tamarix ramosissima*) and quailbush (*Atriplex lentiformis*) while wetland species include common reed (*Phragmites australis*) and southern cattail (*Typha domingensis*). On the historical floodplain, creosote (*Larrea tridentata*) and salt cedar dominate. Other plants, however, have been observed in the vicinity of the site (Appendix B). In order to construct the Rainbow Gardens weir, most of this vegetation was cleared within the project site. Vegetation that remains is primarily located upstream of the recently created impoundment and consists primarily of salt cedar and quailbush.

2.2.2 Soils

Soils data is important to investigate prior to developing site revegetation strategies. Soil composition and profile are important indicators for determining the potential success of a revegetation project as it can detail the subsurface conditions that plants will be exposed to. Soil texture (i.e., the amount of sands, silts, and clays) and below ground moisture gradients can often be the limiting factors for plant survival and growth. Along the Wash, soil descriptions and analyses can be helpful to determine their suitability, limitations, and management for specific uses.

Project Team staff conducted soils investigations at potential planting sites adjacent to the Rainbow Gardens weir on September 23, 2004 (Figure 3). Soil pits were excavated with a backhoe. Pits were dug to help develop conceptual models of the soil profile across each of the potential planting sites. Landscape features, as well as historical information about the sites were used to determine locations for each of the soil pits. Soil samples collected at 18 inches below ground surface were submitted to Utah State University Analytical Laboratories (USUAL) for analysis. There were no observable conditions reported for the samples that would be detrimental to plant development. Salinity values did indicate, however, that soils would likely need ample irrigation. Soil texture did not differ substantially between pits (Table 1).

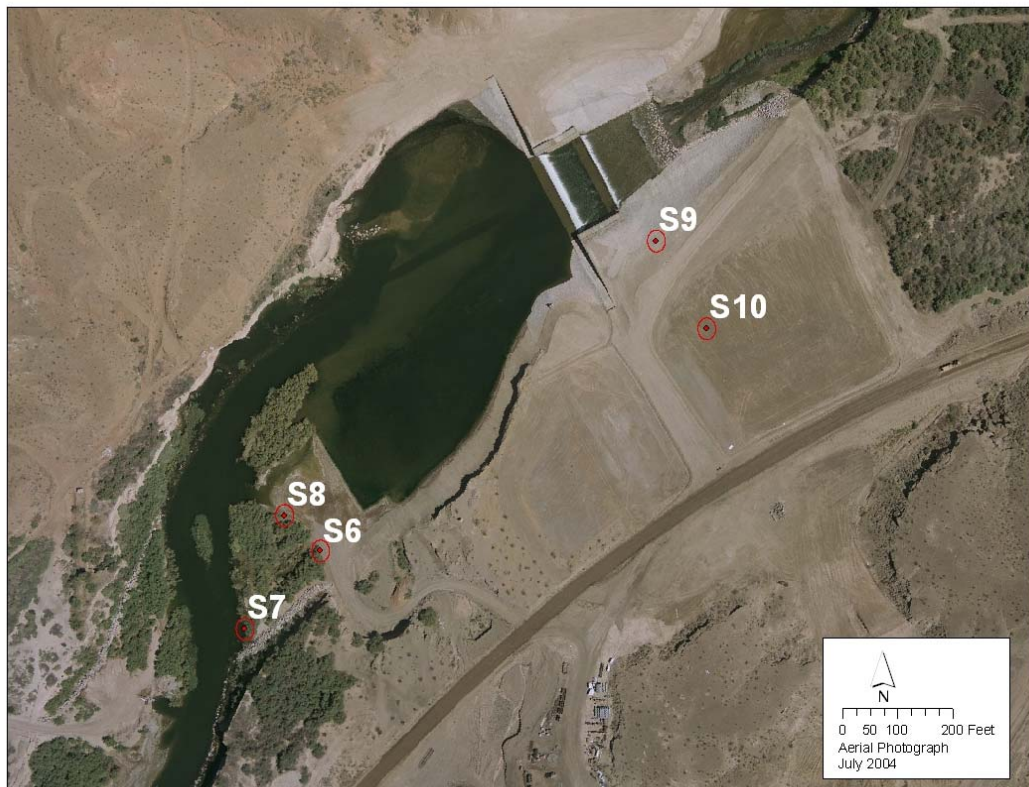


Figure 3: Soil pit locations.

Soil Pit Number	Total Depth (bgs)	Depth to groundwater (bgs)	Profile Depth (bgs)	Texture	Moisture
S6	60"	51"	0-10"	Loamy sand, some fine gravels	Dry
			10-38"	Loamy sand, some fine gravels, some coarse gravel	Moist
			38-51"	Loamy sand, some fine gravels, some coarse gravel	Very moist
			51-60"	Loamy sand, some fine gravels, some coarse gravel	Wet
S7	60"	N/A	0-25"	Loamy sand, little coarse gravels	Dry
			25-60"	Loamy sand	Slightly moist
S8	34"	34"	0-3"	Loamy sand, some coarse gravels	Dry
			3-34"	Loamy sand, some coarse gravels	Very moist
S9	58"	N/A	0-58"	Loamy sand	Dry
S10	54"	N/A	0-6"	Non-decomposed organic matter; roots, limbs, etc.	Dry
			6-54"	Loamy sand, some coarse gravel	Dry

Table 1: Soil pit profile data.

Depth to groundwater for pit numbers S6 and S8 was less than 60 inches, which is adequate for riparian plants. In other areas, the depth to groundwater was not observed and therefore likely exceeds 60 inches. These areas will be planted with plants that do not require a high water table. Soil texture for all pits was loamy sand with various amounts of fine gravels and coarse gravels. Loamy sands are adequate for providing good drainage and sufficient water holding capacity. These investigations have determined that soil should not limit plant growth at revegetation sites.

2.2.3 Wildlife

Studies by Bradley and Niles (1973) in the early 1970's identified the presence of 2 fish, 6 amphibians, 29 reptiles (1 tortoise, 13 lizards, and 15 snakes), 39 mammals (1 shrew, 10 bats, 16 rodents, 2 rabbits, 9 carnivores, and 1 ungulate), and 161 birds along the Wash corridor (Appendix C). These data were compiled from a variety of sources including biological inventory studies, personal records and notes, and published literature. Quantitative information collected from this historical account may prove useful for comparative purposes. As a result of increasing water flows, habitat that is available to animals has changed dramatically since this time. Wetland habitat, consisting primarily of emergent vegetation (i.e., cattails, bulrush, etc.), has been reduced more significantly than transitional vegetative communities such as saltbush scrub and mixed shrub-woodlands.

Current systematic biological inventory studies have shown that wildlife along the Wash has been altered, however, many of the species that were found in the 1970's are still found along the Wash today. Further, some taxa that have been observed

recently were previously not recorded along the Wash. Of the 231 species that were reported by Bradley and Niles (1973), 67% of them have been observed during current inventory studies. So far, recent studies indicate that there are 7 fish, 2 amphibians, 15 reptiles (13 lizards and 2 snakes), 26 mammals (1 shrew, 10 bats, 9 rodents, 2 rabbits, 4 carnivores), and 128 birds along the Wash corridor

3.0 Revegetation Design

The Wash plays an important role in the ecological integrity of the region. Prior to modern settlement of the Las Vegas Valley, the Wash was a typical ephemeral desert wash. Vegetation was characteristic of a desert drainage. As the population of Las Vegas grew, the discharge of reclaimed water into the Wash increased. With the addition of this new and seemingly replenishable supply of water in the Wash, the once ephemeral desert wash underwent dramatic changes. Hydrologic changes resulted in permanent surface water flows and elevated groundwater levels, which caused a transition from xeric and mesic plant communities to more hydric plant communities. The Wash slowly started to transform from a desert wash to a desert riparian ecosystem. During this change, pioneering plants, many of which are non-native, came to dominate. Revegetation activities along the Wash do not attempt to restore the pre-settlement desert vegetation nor the post-settlement non-native vegetation; rather, these activities attempt to create similar vegetative conditions found along many of the riparian drainages of the lower Colorado River basin.

Typical native vegetation found in the lower Colorado River basin includes Fremont cottonwood (*Populus fremontii*), willows (*Salix* spp.), mesquites (*Prosopis* spp.), arrowweed (*Pluchea sericea*), wolfberry (*Lycium* spp.), seepwillow (*Baccharis salicifolia*), saltbush (*Atriplex* spp.), cattails (*Typha* spp.), and bulrush (*Schoenoplectus* spp.). These species are found in areas where hydrologic and edaphic conditions permit. Revegetation sites along the Wash provide suitable environmental conditions for these species as well as for other more desert adapted species like creosote (*L. tridentata*) and white bursage (*Ambrosia dumosa*). Revegetation sites are generally designed to maximize native vegetative coverage, while also providing for physiognomic features that mimic native riparian conditions.

Hydrologic and edaphic conditions near the Rainbow Gardens weir are suitable to plant much of the native vegetative features that are typical of a southwestern riparian area. Three distinct planting conditions in order of decreasing water availability, wetland, riparian, and upland, are found adjacent to the Rainbow Gardens weir (Figure 3). Wetland areas are located within and adjacent to the channel where saturated soils or standing water is present. Plants that can be planted here include spikerush (*Eleocharis macrostachya*), Torrey spikerush (*E. rostellata*), alkali bulrush (*Schoenoplectus maritimus*), Olney's threesquare (*S. americanus*), california bulrush (*S. californicus*), hardstem bulrush (*S. acutus*), common threesquare (*S. pungens*), baltic rush (*Juncus balticus*), and cooper rush (*J. cooperi*). Riparian areas are those areas leading from the waters edge towards the upland. The width of the riparian zone can change depending on the availability of water. Plants that are planted in this area include Fremont cottonwood, Gooding willow (*Salix goodingii*), sandbar willow (*Salix exigua*), screwbean mesquite (*Prosopis pubescens*), honey mesquite (*Prosopis glandulosa* var. *toreyana*), arrowweed, seepwillow, salt

grass (*Distichlis spicata*), yerba mansa (*Anemopsis californica*), salt heliotrope (*Heliotropium curassavicum*), alkali sacaton (*Sporobolus airoides*), velvet ash (*Fraxinus velutina*), wolfberry and quailbush. Where groundwater depths have become too deep for riparian plants to use, xeric upland plants start to dominate. Plants that are used to revegetate these areas include creosote, white bursage, catclaw acacia (*Acacia greggii*), desert willow (*Chilopsis linearis*), broom baccharis (*Baccharis sarothroides*), fourwing saltbush (*Atriplex canescens*), shadscale (*A. confertifolia*), and desert saltbush (*A. polycarpa*). To meet mitigation requirements, wetland followed by riparian and upland acreage will be planted.

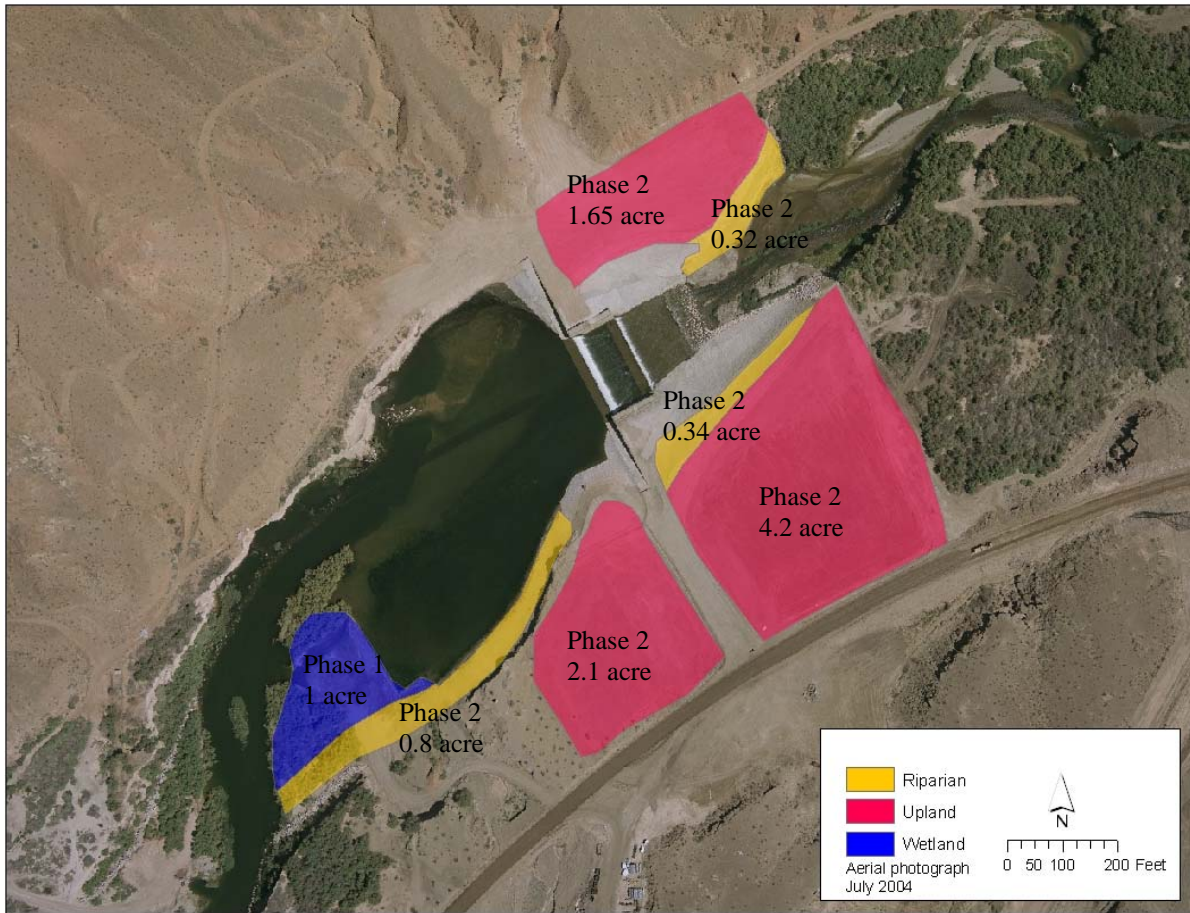


Figure 4: Rainbow Gardens weir planting site locations.

3.1 Phase 1 Revegetation

The first phase of revegetation surrounding the Rainbow Gardens weir will focus on the wetland area located upstream of the weir (Figure 4). The wetland area is approximately 1 acre in size. The site was planted in December 2004. Plants that were planted here include spikerush, Torrey spikerush, alkali bulrush, Olney’s threesquare, california bulrush, hardstem bulrush, common threesquare, baltic rush, and cooper rush. On the southern portions of the site, there are areas that are suitable for many types of riparian plants. On these areas, some of the plants that will likely be planted include Gooding

willow, sandbar willow, screwbean mesquite, honey mesquite, arrowweed, seepwillow, salt grass, and alkali sacaton.

3.2 Phase 2 Revegetation

The second phase of revegetation occurring at the Rainbow Gardens weir will include the riparian and upland areas (Figure 4). Riparian areas adjacent to the weir approximate 1.44 acres in area while upland areas approximate 7.95 acres in area. These sites will likely be planted in the fall of 2005 or spring of 2006. Riparian areas will likely be planted with the following species; Gooding willow, sandbar willow, screwbean mesquite, honey mesquite, arrowweed, seepwillow, salt grass, and alkali sacaton. Revegetation in upland areas will likely be with the following species; creosote, white bursage, catclaw acacia, desert willow, broom baccharis, fourwing saltbush, shadscale, and desert saltbush.

4.0 Project Implementation

4.1 Planting Methods and Materials

Data gathered from past and present monitoring activities have helped us refine our planting methods and materials. This includes determining the best period of the year to plant and a list of plants that perform well in our area (see species lists under Revegetation Design). Through these efforts, we have identified that October-November and February-April are the best planting periods of the year. Vegetation planted during these periods is helped by above average precipitation that generally falls during the summer and winter months in Las Vegas. Rainbow Gardens weir planting events will be conducted during these peak periods of success.

Riparian and upland plants that will be used to revegetate the Rainbow Gardens weir will primarily be containerized stock, however, pole cuttings may also be used. Both one-gallon and five-gallon stock will be used. Tree species are often planted as five-gallons while shrubs and other low vegetation is planted as one-gallons. Wetland plants that we use typically grow as multiple stems and therefore they are usually grown in flats of various sizes. There are two local nurseries where we normally purchase plant material from for our planting projects, the Nevada Division of Forestry nursery at Floyd Lamb State Park and the National Park Service nursery at Lake Mead National Recreation Area. If desirable species are not available from either nursery, local commercial native plant nurseries are used. Prior to planting, sites will be tilled with a soil ripper. This is done because areas within construction easements are sprayed with dust suppressant after weir completion. The dust suppressant hardens the surface of the soil and does not beneficially contribute to native plant recruitment.

After the soil surface has been prepared, and an irrigation strategy has been designed (see discussion below), holes are pre-dug using either shovels or a Bobcat[®] skid-steer loader with an attached auger. Depressions are created around shrubs and trees so that moisture is retained close to the plant. Trees are interspersed within a planting zone and are

spaced approximately 5-15 feet apart (depending on type). Shrubs and other low vegetation are planted at closer distances in tree interspaces. Planting densities at our revegetation sites have ranged from 100-700 plants/acre, depending on site configuration. The greatest success that we have observed is from sites that have been planted densely and with a diverse species palette. Therefore our strategy for the Rainbow Gardens weir is to plant densities around 300-700 plants/acre with as many species as possible. Although high-density plantings may be most successful in the short-term, long-term competition between species will likely reduce total plant survivability. This is to be expected; but by crafting revegetation strategies for high diversity and density, the most well adapted species will ultimately dominate. This “shot gun” approach has proven effective at our mitigation sites, since underlying, obscured site conditions are not always determined prior to implementation.

4.2 Invasive Species Management

The federal government defines an "invasive species" as 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Once vegetation has been provided general survival requirements (i.e., water, sunlight, air, minerals, and space), competition with other plants for these resources may be the only impediment towards achieving a successful planting site. Typically, invasive species out-compete native species for resources and therefore displace native species to marginal habitats. This often results in the decline of native taxa. At revegetation sites along the Wash, invasive species are controlled by a variety of methods. These activities allow the optimal conditions for native plants to succeed. The Nevada Noxious Weed List outlines particularly harmful species in our state and it serves as the list of species that we manage at our planting sites. Some of these species have been reported along the Wash and management strategies for their control are discussed herein.

4.2.1 Salt Cedar (*Tamarix ramosissima*)

Salt cedar is a highly invasive non-native species that has been present in the Wash for over 30 years. It is currently the most dominant tree taxa found along the Wash and estimates of its infestation exceed 1,500 acres. The primary goal for managing salt cedar is to prevent the invasion of this taxa into newly revegetated areas. Since typically salt cedar is cleared around erosion control structure facilities, we are able to control its re-infestation by implementing a variety of suppression techniques. A summary of the techniques used to control salt cedar along the Wash during pre- and post-construction of erosion control structures is as follows.

Chemical application techniques have proven to be effective in controlling salt cedar. Garlon[®] 4 (triclopyr; Dow AgroSciences, Indianapolis, IN) herbicide can be applied basally to the cut stumps of salt cedar trees. This method involves cutting the tree at ground level with a chain saw, and then immediately spraying the remaining stump with the herbicide. The material can then be moved to a stockpile location to await permanent disposal (i.e., by controlled burn). For extensive infestations, mechanical

clearing can be an effective control technique. Mechanical clearing is achieved by removing the plants root crown from the soil using a root plow. This method can be followed up by herbicide applications if required. Another form of mechanical clearing is achieved by simply hand-pulling re-sprouting plants. This technique is labor intensive, however, under the right circumstances it can be quite effective. These methods may be used to control salt cedar at the Rainbow Gardens weir planting sites.

4.2.2 Tall Whitetop (*Lepium latifolium*) and Giant Reed (*Arundo donax*)

Tall whitetop and giant reed, non-native invasive weeds found in many western riparian drainages, have only recently been found in the Wash. Tall whitetop infests considerably more acreage than giant reed but because their distributions in the Wash are still somewhat limited, there is an aggressive campaign to remove them before they further spread. Herbicide application to the foliage is the method of choice for controlling these species. Rodeo[®] (glyphosate; Dow AgroSciences, Indianapolis, IN) and Escort[®] (metsulfuron methyl; DuPont, Wilmington, DE) is applied as needed to reduce the infestation. If tall whitetop or giant reed is found on Rainbow Gardens weir planting sites, they will be controlled by these methods.

4.3 Irrigation

Supplemental irrigation is important for plant establishment since precipitation near the Wash is generally less than five inches a year. Wetland plants, however, do not require supplemental irrigation as long as they are in saturated or standing water conditions. Wetland plants will not be planted away from these areas, and therefore supplemental irrigation is not required. Instead, our irrigation strategies primarily concentrate on riparian and upland plants. Riparian plants quickly develop extensive root systems that exploit groundwater sources, which allows them to depend less on supplemental irrigation. Upland plants, however, require extensive irrigation to become established.

Initially, riparian and upland plants will be planted with DRiWATER[®] (DRiWATER Inc., Santa Rosa, CA) cartons adjacent to the root ball. DRiWATER[®] provides a source of water directly to the roots during the critical establishment period. It has been proven effective at planting areas along the Wash and at other restoration sites in the U.S. DRiWATER[®] is composed of 98% purified water and 2% food grade ingredients. Typically, DRiWATER[®] can provide adequate moisture to the root system of a developing plant for up to three months. We have observed, however, that it lasts for up to two months; but it is still an excellent method for delivering water to the plant during this period.

In addition to DRiWATER[®], riparian and upland plants will be manually watered throughout the growing season. Manual watering includes both hand watering plant depressions with a hose and using impact sprinklers. Hand watering is an intensive irrigation strategy that will be limited to the hottest, driest part of the year. Although intensive, it has proven effective at our mitigation sites because it delivers large quantities

of water directly to the plant. Impact sprinklers have been shown to be the most efficient form of irrigation. Generally, impact sprinkler systems consist of a subsurface pipe infrastructure, fire hose assembly, and a gasoline generated water pump. The subsurface infrastructure consists of a buried grid of PVC pipe along which a series of 1-3 feet high stub-ups are created. Stub-ups are fitted with quick-connect pipe connectors that fasten to impact sprinkler heads. Quick-connect fittings allow easy removal of impact sprinkler heads, which helps reduce potential acts of vandalism or theft. Stub-ups are properly spaced so that water delivered through the impact sprinklers can cover the entire site. Pipe diameter and impact sprinkler head sizing is determined based upon site conditions. Water is delivered from the Wash to the pipe infrastructure by a length of fire hose attached to a gasoline generated water pump. The fire hose, water pump, and impact sprinkler heads are all easily transported between sites, which maximizes irrigation efficiencies and minimizes capital investment. Sprinkler systems can deliver large quantities of water across a revegetation site and since all portions of a site are irrigated, plant recruitment also benefits. Irrigation is applied to revegetation sites throughout the year on a regular basis.

5.0 Project Maintenance and Monitoring

5.1 Maintenance

5.1.1 Replanting and Contingency

Although this planting plan aims to create functioning wetland, riparian, and upland areas that are self-sustaining in the long-term, it is possible that environmental (e.g. flood events) and/or anthropogenic (e.g. vegetation destruction by off highway vehicle users) disturbances reduce the success of planted vegetation. Further, although every effort is made to pair plants with locations that appear to provide edaphic and hydrologic conditions favorable for their survival, it is possible that other, more obscured site conditions do not permit plant success. For this reason additional vegetation may need to be planted during future periods.

If permit requirements of 80% survival of native species planted with less than 20% encroachment of invasive species is not reached within the two year monitoring period, further mitigation activities will be developed and implemented at the site to ensure the objective of developing long-term, self-sustaining wetlands that are not dependent on further human intervention after the establishment period is reached.

5.2 Monitoring

5.2.1 Vegetation

In order to determine the effectiveness of revegetation activities, a variety of general vegetation parameters could be measured. Parameters that will be monitored for Wash revegetation projects, and have been approved by the Corp, include species composition, percent cover, survival rates, and encroachment of non-native weeds.

In order to determine species composition, field personnel walk random transects within the boundaries of the revegetation site until the *n*th species is found. This method allows for a complete inventory of all plants on a revegetation site.

Percent cover is an important characteristic to monitor in a stand of vegetation because it can serve as a criterion for relative dominance within the community. Cover is expressed as a percentage value and in a multi-layered community it can often exceed 100%. In a multi-layered community it may be important to separate cover estimates into different strata. In order to determine percent cover for revegetation sites, line-intercept and/or aerial photographic interpretation methods are used. In the line-intercept method, a tape is stretched between two stakes, and the canopy of a species that vertically projects over the tape is measured along its length. The total length of tape that is intercepted by the vertical projections of a species by the total length of tape is the percent cover. Line-intercepts are of sufficient length to reflect the community and allow for an accurate estimate of percent cover by species. Line-intercept data also provides an estimate of cover for both native (i.e., planted and passive) and non-native weed encroachment. As community physiognomy changes, the line-intercept method may prove too difficult to implement and other methods may have to be used (e.g., cover estimates from aerial photographs, Braun-Blanquet cover class, etc.). Methodologies to determine percent cover are dictated by site conditions.

Revegetation sites are often deemed a success by the number of plants that survive after plantings have stopped and a period of time has passed since intensive management. This is a general indicator that plants will continue to survive in the environment after revegetation activities have been completed. An appropriate method of measuring survival for a revegetation project is to simply count the number of planted plants that remain viable during the growing season. Using this method, survival can be expressed as a percentage where the number of plants that are viable is divided by the total number of plants on a site and then multiplied by 100. This survivability measure can be compared from growing season to growing season and ultimately expressed as a rate of survival.

The procedures for which survivability and survival rates are estimated is as follow. After a planting site is completed an absolute count of all planted plants within the site are attained using Global Positioning System technologies. Each plant is attributed a species designation and a coordinate location. This data is loaded into a Geographic Information System (GIS) format for future landscape analysis (i.e., density measures, cover estimates, etc.). The absolute count represents a baseline measure of instantaneous survivability (nearing 100%) from which additional years of data can be compared against. If a site were revegetated during the growing season, the absolute count following site completion would serve as the measure of survivability for that year and would be reported to the Corp. If a site were revegetated outside of the growing season, an absolute count would be conducted following site completion and an estimate of survivability would be completed

during the following growing season. Site survivability and site survival rates will be reported where applicable. In order to determine post-planting survivability (i.e., after an absolute count has been completed for a site) and survival rates, estimations are made using strip-transect methods and/or random point sampling. Strip-transects are of sufficient length and width to accurately estimate survivability measures and random sample points are identified with the aid of GIS. As community physiognomy changes, the strip-transect and/or random point sampling method may prove too difficult to implement and other methods may have to be used (e.g., infra-red aerial photographic interpretation, plot sampling, etc.). Methodologies to determine survivability and survival rate are dictated by site conditions.

5.2.2 Water Quality

Wash water quality is an important feature to monitor since we use this water to irrigate our revegetation sites. Water in the Wash comes from a variety of sources in the Las Vegas Valley, including stormwater, urban runoff, shallow ground water, and reclaimed water. Each water source has a unique chemical signature. For example, shallow groundwater is typically high in salt content while reclaimed water is not. In an effort to monitor water quality for this program and other watershed management initiatives, SNWA engages in a comprehensive monitoring program. Water quality monitoring includes real-time mainstream, monthly mainstream, and quarterly tributary monitoring. A variety of water quality parameters are evaluated including, nutrients, metals, temperature, pH, dissolved oxygen, and electrical conductivity. Monitoring data provides us with valuable information to facilitate successful irrigation strategies at our revegetation sites.

5.2.3 Additional Biological Resources

Revegetation activities may potentially benefit many of the biological resources found along the Wash (Appendix C). In order to document these benefits, multiple fish and wildlife monitoring studies have been implemented. Species that are currently being monitored include, birds, bats, and amphibians. Other monitoring activities that have been completed include studies for small mammals, reptiles, and fish.

Birds are the most probable taxa to quickly benefit from the construction of erosion control structures and subsequent revegetation activities. Habitat values for water dependent species will increase in the ponded areas behind the erosion control structures while riparian and wetland revegetation activities adjacent to the channel will improve habitat for other taxa. This is important since 80% of the breeding bird population in North America and 50% of the protected migratory bird population rely on riparian zones. In the southwestern U.S., most riparian areas are in decline as a result of anthropogenic disturbances or water resource management. Unique ecosystem enhancement projects like that found along the Wash aim to reverse these trends.

Appendix A
Photographs of Rainbow Gardens Weir



June 2003 image of the Rainbow Gardens weir location (prior to construction)



August 2004 image of the Rainbow Gardens weir location (after construction)



During Construction



During Construction



During Construction



During Construction



During Construction



During Construction



After Construction



After Construction

Appendix B
Plants Observed Along the Las Vegas Wash

Family		Species	
Scientific Name	Common Name	Scientific Name	Common Name
AMARANTHACEAE	Amaranth Family		
		<i>Amaranthus albus</i>	Tumbleweed
		<i>Amaranthus ca. powellii</i>	Amaranth
		<i>Tidestromia oblongifolia</i>	Honey sweet
ASTERACEAE	Aster Family		
		<i>Acroptilon repens</i>	Russian Knapweed
		<i>Ambrosia dumosa</i>	Burro bush
		<i>Amphipappus fremontii</i>	Chaff bush
		<i>Aster subulatus</i> var. <i>ligulatus</i>	Alkali aster
		<i>Atrichoseris platyphylla</i>	Gravel ghost
		<i>Baccharis emoryi</i>	Emory waterweed
		<i>Baileya multiradiata</i>	Desert marigold
		<i>Chaenactis carphoclinia</i>	Pebble pincushion
		<i>Cirsium vulgare</i>	Bull thistle
		<i>Conyza bonariensis</i>	Horseweed
		<i>Conyza canadensis</i>	Horseweed
		<i>Conyza coulteri</i>	Horseweed
		<i>Cotula coronopifolia</i>	Brass buttons
		<i>Eclipta prostrata</i>	False daisy
		<i>Encelia farinosa</i>	Brittle bush
		<i>Encelia virginensis</i>	Brittle bush
		<i>Enceliopsis nudicaulis</i>	Naked-stem daisy
		<i>Erigeron divergens</i>	Fleabane
		<i>Eriophyllum ambiguum</i>	wooly daisy
		<i>Gnaphalium luteo-album</i>	Cudweed
		<i>Helianthus annuus</i>	Sunflower
		<i>Heterotheca</i> cf. <i>psammophila</i>	Camphorweed
		<i>Hymenoclea salsola</i> var. <i>salsola</i>	Cheesebush
		<i>Isocoma acradenia</i> var. <i>eremophila</i>	Goldenbush
		<i>Lactuca</i> cf. <i>biennis</i>	Prickly lettuce
		<i>Lactuca serriola</i>	Prickly lettuce
		<i>Machaeranthera pinnatifida</i> var. <i>goodingii</i>	Gooding aster
		<i>Malacothrix glabrata</i>	Desert dandelion
		<i>Peucephyllum schottii</i>	Pygmy cedar

		<i>Pluchea odorata</i>	Salt marsh fleabane
		<i>Pluchea sericea</i>	Arrow weed
		<i>Psathyrotes ramosissima</i>	Turtle plant
		<i>Psilostrophe cooperi</i>	Paper flower
		<i>Senecio flaccidus</i> var. <i>monoensis</i>	Wash groundsel
		<i>Sonchus asper</i>	Prickly sow thistle
		<i>Sonchus oleraceus</i>	Sow thistle
		<i>Stephanomeria pauciflora</i> var. <i>pauciflora</i>	Wire lettuce
		<i>Stylocline micropoides</i>	Desert nest straw
		<i>Xanthium strumarium</i>	Cocklebur
AZOLLACEAE	Mosquito Fern Family		
		<i>Azolla</i> sp.	Mosquito fern
BIGNONIACEAE	Aster Family		
		<i>Chilopsis linearis</i> ssp. <i>arcuata</i>	Desert willow
BORAGINACEAE	Borage Family		
		<i>Amsinckia tessellata</i> var. <i>tessellata</i>	Devil's lettuce
		<i>Cryptantha angustifolia</i>	Narrow-leaved cryptantha
		<i>Cryptantha barbiger</i>	Bearded cryptantha
		<i>Cryptantha maritima</i>	cryptantha
		<i>Cryptantha nevadensis</i>	Cryptantha
		<i>Cryptantha pterocarya</i>	Wing-nut cryptantha
		<i>Cryptantha recurvata</i>	Cryptantha
		<i>Heliotropium curassavicum</i>	Salt heliotrope
		<i>Pectocarya heterocarpa</i>	Comb-bur
		<i>Pectocarya platycarpa</i>	Comb-bur
BRASSICACEAE	Mustard Family		
		<i>Descuriana pinnata</i> ssp. <i>glabra</i>	Tansy mustard
		<i>Guillenia lasiophylla</i>	California mustard
		<i>Lepidium fremontii</i> var. <i>fremontii</i>	Desert alyssum
		<i>Lepidium lasiocarpum</i>	peppergrass
		<i>Lepidium latifolium</i>	Broad-leaved peppergrass
		<i>Lesquerella tenella</i>	Bead pod
		<i>Rorippa nasturium-aquatica</i>	Water Cress
		<i>Sisymbrium irio</i>	London rocket
		<i>Streptanthella longirostris</i>	Streptanthella
CACTACEACE	Cactus Family		
		<i>Cylindropuntia echinocarpa</i>	Golden cholla
		<i>Cylindropuntia ramosissima</i>	Diamond cholla

		<i>Opuntia basilaris</i>	Beavertail
CAMPANULACEAE	Bellflower Family		
		<i>Nemacladus glanduliferus</i> var. <i>orientalis</i>	Thread plant
CHENOPODIACEAE	Goosefoot Family		
		<i>Allenrolfea occidentalis</i>	Iodine bush
		<i>Atriplex canescens</i> ssp. <i>canescens</i>	Four-wing saltbush
		<i>Atriplex confertifolia</i>	Shadscale
		<i>Atriplex elegans</i> var. <i>fasciculata</i>	Wheelscale
		<i>Atriplex hymenelytra</i>	Desert holly
		<i>Atriplex lentiformis</i> var. <i>lentiformis</i>	Quail bush
		<i>Atriplex polycarpa</i>	Allscale
		<i>Bassia hyssopifolia</i>	Bassia
		<i>Chenopodium album</i>	Lamb's quarters
		<i>Chenopodium ambrosioides</i>	Mexican tea
		<i>Chenopodium</i> sp.	Lamb's quarters
		<i>Salsola paulsenii</i>	Russian thistle
		<i>Salsola tragus</i>	Russian thistle
		<i>Suaeda moquinii</i>	Bush seepweed
CONVOLVULACEAE	Morning Glory Family		
		<i>Convolvulus arvensis</i>	Bind weed
CYPERACE	Sedge Family		
		<i>Cyperus erythrorhizos</i>	Nut-sedge
		<i>Eleocharis</i> cf. <i>macrostachya</i>	Spike-rush
		<i>Eleocharis</i> cf. <i>montevidensis</i>	Spike-rush
		<i>Scirpus acutus</i> var. <i>occidentalis</i>	Tule
		<i>Scirpus americanus</i>	Olney three-square
		<i>Scirpus californicus</i>	California tule
		<i>Scirpus</i> cf. <i>pungens</i>	Common three-square
		<i>Scirpus maritimus</i>	Bulrush
EPHEDRACEAE	Joint-Fir Family		
		<i>Ephedra torreyana</i>	Torrey joint-fir
EUPHORBIACEAE	Spurge Family		
		<i>Euphorbia micromeria</i>	Sonoran sand-mat
		<i>Euphorbia prostrata</i>	spurge
FABACEAE	Legume Family		
		<i>Acacia greggii</i>	Catclaw
		<i>Medicago sativa</i>	Alfalfa

		Melilotus cf. Indica	Yellow sweet-clover
		Prosopis glandulosa var. torreyana	Honey mesquite
		Prosopis pubescens	Screw-bean mesquite
		Prosopis sp. (alba)	White mesquite
		Prosopis velutina	Velvet mesquite
		Psoralea fremontii var. fremontii	Indigo Bush
		Senna armata	Desert senna
GERANIACEAE	Geranium Family		
		Erodium cicutarium	Red-leaf filaree
		Erodium texanum	Texas filaree
HYDROPHYLLACEAE	Waterleaf Family		
		Eucrypta micrantha	Eucrypta
		Phacelia crenulata var. crenulata	Purple phacelia
		Phacelia ivesiana	phacelia
		Phacelia pulchella var. goodingii	Gooding phacelia
JUNCACEAE	Rush Family		
		Juncus balticus	Wire rush
KRAMERIACEAE	Krameria Family		
		Krameria erecta	Range rhatany
LAMIACEAE	Mint Family		
		Marrubium vulgare	Horehound
LEMNACEAE	Duckweed Family		
		Lemna sp. (ca. minor)	Duckweed
LOASACEAE	Loasa Family		
		Mentzelia sp. (ca. albicaulis)	Stick-leaf
		Mentzelia tricuspis	Stick-leaf
		Petalonyx nitidus	Shining sandpaper plant
MALVACEAE	Mallow Family		
		Malva parviflora	Cheeseweed
		Sphaeralcea ambigua var. rugosa	Desert mallow
		Sphaeralcea emoryi	Emory mallow
MORACEAE	Mulberry Family		
		Morus alba	White mulberry!!
NYCTAGINACEAE	Four O'Clock Family		
		Allionia incarnata	Pink windmills
		Mirabilis bigelovii var. bigelovii	Four o'clock
OLEACEAE	Olive Family		
		Fraxinus velutina	Velvet ash

ONAGRACEAE	Evening Primrose Family		
		Camissonia boothii ssp. condensata	Woody bottle washer
		Camissonia brevipes var. brevipes	Sun cup
		Camissonia refracta	evening primrose
PAPAVERACEAE	Poppy Family		
		Arctomecon californica	Bear poppy
		Eschscholzia californica	California poppy
		Eschscholzia glyptosperma	Desert poppy
PLANTAGINACEAE	Plantain Family		
		Plantago major	Common plantain
		Plantago ovata	Desert plantain
PLUMBAGINACEAE	Plumbago Family		
		Limonium californicum	Sea lavender
POACEAE	Grass Family		
		Agrostis viridis	Bent grass
		Aristida purpurea var.	Purple three-awn
		Arrundo donax	Giant reed
		Bromus madritensis ssp. Rubens	Foxtail chess
		Cynodon dactylon	Bermuda grass
		Distichlis spicata	Saltgrass
		Echinochloa crus-gallii	Barnyard grass
		Leptochloa uninerva	Mexican sprangletop
		Panicum capillare	Witchgrass
		Phragmites australis	Common reed
		Pleuraphis rigida	Galleta grass
		Polypogon monspeliensis	Rabbit's foot grass
		Schismus barbatus	Splitgrass
		Setaria pumila	Bristlegrass
		Sorghum halapense	Johnsongrass
		Sporobolus airoides	Alkali sacaton
		Vulpia octoflora var. hirtella	Six weeks fescue
POLEMONIACEAE	Phlox Family		
		Aliciella leptomeria	Gilia
		Gilia cf. inconspicua	Gilia
		Gilia scopulorum	Rock gilia
		Gilia stellata	Gilia
POLYGONACEAE	Buckwheat Family		
		Chorizanthe brevicornu	Brittle spineplant

		Chorizanthe rigida	Rigid spineplant
		Eriogonum deflexum var. deflexum	Buckwheat
		Eriogonum inflatum var. inflatum	Desert trumpet
		Eriogonum thomasii	Thomas buckwheat
		Eriogonum trichopes var. trichopes	Little trumpet
		Polygonum lapathifolium	Willow weed
		Rumex stenophyllus	Dock
RESEDACEAE	Reseda Family		
		Oligomeris linifolia	Mignonette
SALICACEAE	Willow Family		
		Populus fremontii	Fremont cottonwood
		Salix exigua	Narrow-leaved willow
		Salix goodingii	Gooding willow
		Salix laevigata	Red willow
SAURURACEAE	Lizard's-tail Family		
		Anemopsis californica	Yerba Mansa
SCROPHULARIACEAE	Figwort Family		
		Veronica anagallis-aquatica	Water speedwell
SOLANACEAE	Nightshade Family		
		Datura wrightii	Sacred datura
		Lycium andersonii var. andersonii	Anderson thornbush
		Nicotiana glauca	Tree tobacco
		Nicotiana obtusifolia	Desert tobacco
		Physalis crassifolia	ground cherry
		Solanum americanum	Nightshade
		Solanum elaeagnifolium	Silver-leaf nightshade
TAMARACACEAE	Tamarisk Family		
		Tamarix cf. ramosissima	Salt cedar
TYPHACACEAE	Cattail Family		
		Typha domingensis	Southern cattail
ULMACEAE	Elm Family		
		Ulmus sp.	Elm
VISCACEAE	Mistletoe Family		
		Phorodendron californicum	Desert mistletoe
ZYGOPHYLLACEAE	Caltrop Family		
		Larrea tridentata	Creosote bush

Appendix C
Wildlife Observed Along the Las Vegas Wash

1973

Common Name	Scientific Name
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Fish

Common carp	<i>Cyprinus carpio</i>
Mosquitofish	<i>Gambusia affinis</i>

Reptiles

Arizona Lyre Snake	<i>Trimorphodon lambda</i>
Chuckwalla	<i>Sauromalus obesis</i>
Collared Lizard	<i>Crotaphytus collaris</i>
Common King Snake	<i>Lampropeltis getulus</i>
Common Whipsnake	<i>Masticophis flagellum</i>
Desert Crested Lizard	<i>Dipsosaurus dorsalis</i>
Desert Horned Lizard	<i>Phrynosoma platyrhinos</i>
Desert Spiny Lizard	<i>Sceloporus magister</i>
Desert Tortoise	<i>Gopherus agassizi</i>
Gila Monster	<i>Heloderma suspectum</i>
Glossy Snake	<i>Arizona elegans</i>
Great Basin Gopher Snake	<i>Pituophis catenifer</i>
Leopard Lizard	<i>Crotaphytus wislizeni</i>
Long-Nosed Snake	<i>Rhinocheilus lecontei</i>
Long-Tailed Brush Lizard	<i>Uta graciosa</i>
Mojave Rattlesnake	<i>Crotalus scutulatus</i>
Side-Blotched Lizard	<i>Uta stansburiana</i>
Sidewinder	<i>Crotalus cerastes</i>
Speckled Rattlesnake	<i>Crotalus mitchelli</i>
Spotted Leaf-Nosed Snake	<i>Phyllorhynchus decurtatus</i>
Spotted Night Snake	<i>Hypsiglena torquata</i>
Western Banded Gecko	<i>Coleonyx variegates</i>
Western Ground Snake	<i>Sonora semiannualata</i>
Western Patch Nosed Snake	<i>Salvadora hexalepis</i>

2004

Common Name	Scientific Name
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Black bullhead	<i>Ameiurus melas</i>
Common carp	<i>Cyprinus carpio</i>
Fathead minnow	<i>Pimephales promelas</i>
Green sunfish	<i>Lepomis cyanellus</i>
Mosquitofish	<i>Gambusia affinis</i>
Red shiner	<i>Cyprinella lutrensis</i>
Suckermouth catfish	<i>Hypostomus plecostomus</i>

Common kingsnake	<i>Lampropeltis getulus</i>
Desert common night lizard	<i>Xantusia vigilis</i>
Desert horned lizard	<i>Phrynosoma platyrhinos</i>
Desert iguana	<i>Dipsosaurus dorsalis</i>
Desert spiny lizard	<i>Sceloporus magister</i>
Great Basin collared lizard	<i>Crotaphytus bicinctores</i>
Great Basin gopher snake	<i>Pituophis melanoleucus</i>
Long-nosed leopard lizard	<i>Gambelia wislizenii</i>
Red coachwip	<i>Masticophis flagellum</i>
Side-blotched lizard	<i>Uta stansburiana</i>
Sidewinder	<i>Crotalus cerastes</i>
Western banded gecko	<i>Coleonyx variegatus</i>
Western blind snake	<i>Leptotyphlops humilis</i>
Western whiptail lizard	<i>Cnemidophorus tigris</i>
Zebra-tailed lizard	<i>Callisaurus draconoides</i>

Western Shovel-Nosed Snake	<i>Chionactis occipitalis</i>
Western Whiptail	<i>Cnemidophorus tigris</i>
Western Worm Snake	<i>Leptotyphlops humilis</i>
Yucca Night Lizard	<i>Xantusia vigilis</i>
Zebra-Tailed Lizard	<i>Callisaurus draconoides</i>

Small Mammals (non-volant)

White-tailed antelope squirrel	<i>Citellus leucurus</i>	Cactus mouse	<i>Peromyscus eremicus</i>
Brush Mouse	<i>Peromyscus boylii</i>	Desert pocket mouse	<i>Chaetodipus penicillatus</i>
Cactus Mouse	<i>Peromyscus eremicus</i>	Desert shrew	<i>Notiosorex crawfordi</i>
Canyon Mouse	<i>Peromyscus crinitus</i>	Desert woodrat	<i>Neotoma lepida</i>
Deer Mouse	<i>Peromyscus maniculatus</i>	House mouse	<i>Mus musculus</i>
Desert Kangaroo Rat	<i>Dipodomys deserti</i>	Little pocket mouse	<i>Perognathus longimembris</i>
Desert Shrew	<i>Notiosorex crawfordi</i>	Long-tailed pocket mouse	<i>Chaetodipus formosus</i>
Desert Wood Rat	<i>Neotoma lepida</i>	Merriam's kangaroo rat	<i>Dipodomys merriami</i>
House Mouse	<i>Mus musculus</i>	Round-Tailed Ground Squirrel	<i>Citellus tereticaudus</i>
Little Pocket Mouse	<i>Perognathus longimembris</i>	Southern Grasshopper Mouse	<i>Onychomys torridus</i>
Long-Tailed Pocket Mouse	<i>Perognathus formosus</i>	White-tailed antelope squirrel	<i>Ammospermophilus leucurus</i>
Merriam Kangaroo Rat	<i>Dipodomys merriami</i>		
Muskrat	<i>Onadatra zibethica</i>		
Pocket Gopher	<i>Thomomys umbrinus</i>		
Round-Tailed Ground Squirrel	<i>Citellus tereticaudus</i>		
Southern Grasshopper Mouse	<i>Onychomys torridus</i>		
Western Harvest Mouse	<i>Reithrodontomys megalotis</i>		

Bats

Big Brown Bat	<i>Eptesicus fuscus</i>	Allen's big-eared bat	<i>Idionycteris phyllotis</i>
Big Free-Tailed Bat	<i>Tadarida molossa</i>	Big brown bat	<i>Eptesicus fuscus</i>
California Leaf-Nosed Bat	<i>Macrotus californicus</i>	Brazilian free-tailed bat	<i>Tadarida brasiliensis</i>
California Myotis	<i>Myotis californicus</i>	California leaf-nosed bat	<i>Macrotus californicus</i>
Hoary Bat	<i>Lasiurus cinereus</i>	California myotis	<i>Myotis californicus</i>
Mexican Free-Tailed Bat	<i>Tadarida brasiliensis</i>	Greater mastiff bat	<i>Eumops perotis</i>
Pallid Bat	<i>Antrozous pallidus</i>	Hoary bat	<i>Lasiurus cinereus</i>
Red Bat	<i>Lasiurus borealis</i>	Pallid bat	<i>Antrozous pallidus</i>
Silvery-Haired Bat	<i>Lasionycteris noctivagans</i>	Townsend's big-eared bat	<i>Corynorhinos townsendii</i>
Western Pipistrelle	<i>Pipistrellus Hesperus</i>	Western pipistrelle bat	<i>Pipistrellus hesperus</i>
		Western red bat	<i>Lasiurus blossevillii</i>
		Western small footed bat	<i>Myotis ciliolabrum</i>

Western yellow bat
Yuma myotis

Lasiurus xanthinus
Myotis yumanensis

Amphibians

Bullfrog *Rana catesbeiana*
Desert toad *Bufo punctatus*
Leopard frog *Rana pipiens*
Pacific tree-frog *Hyla regilla*
Tiger salamander *Ambystoma tigrinum*
Woodhouse's toad *Bufo woodhousii*

Bullfrog *Rana catesbeiana*
Woodhouse's toad *Bufo woodhousii*

Large Mammals

Audubon Cottontail *Sylvilagus audubonii*
Badger *Taxidea taxus*
Bighorn Sheep *Ovis canadensis*
Black-Tailed Jack Rabbit *Lepus californicus*
Bobcat *Lynx rufus*
Coyote *Canis latrans*
Gray Fox *Urocyon cinereoargenteus*
Kit Fox *Vulpes macrotis*
Raccoon *Procyon lotor*
Ring-Tailed Cat *Bassariscus astutus*
Spotted Skunk *Spilogale gracilis*
Striped Skunk *Mephitis mephitis*

Audubon Cottontail *Sylvilagus audubonii*
Beaver *Castor canadensis*
Black-Tailed Jack Rabbit *Lepus californicus*
Coyote *Canis latrans*
Raccoon *Procyon lotor*

Common Name	Scientific Name	1973	2004
Waterfowl	Anatidae		
Canada Goose	<i>Branta canadensis</i>	x	x
Tundra Swan	<i>Cygnus columbianus</i>		
Wood Duck	<i>Aix sponsa</i>		x
Gadwall	<i>Anas strepera</i>	x	x
American Wigeon	<i>Anas americana</i>	x	x
Mallard	<i>Anas platyrhynchos</i>	x	x
Blue-winged Teal	<i>Anas discors</i>	x	
Cinnamon Teal	<i>Anas cyanoptera</i>	x	x
Northern Shoveler	<i>Anas clypeata</i>	x	x
Northern Pintail	<i>Anas acuta</i>	x	x
Green-winged Teal	<i>Anas carolinensis</i>	x	x
Canvasback	<i>Aythya valisineria</i>	x	
Redhead	<i>Aythya Americana</i>	x	x
Ring-necked Duck	<i>Aythya collaris</i>	x	
Lesser Scaup	<i>Aythya affinis</i>	x	
Bufflehead	<i>Bucephala albeola</i>	x	
Common Goldeneye	<i>Bucephala clangula</i>	x	x
Common Merganser	<i>Mergus merganser</i>	x	x
Red-breasted Merganser	<i>Mergus serrator</i>	x	
White-winged Scoter	<i>Melanitta deglandi</i>		
Ruddy Duck	<i>Oxyura jamaicensis</i>	x	x
New World Quail	Odontophoridae		
Gambel's Quail	<i>Callipepla gambelii</i>	x	x
Loons	Gaviidae		
Common Loon	<i>Gavia immer</i>	x	
Grebes	Podicipedidae		
Pied-billed Grebe	<i>Podilymbus podiceps</i>	x	x
Horned Grebe	<i>Podiceps caspicus</i>		
Eared Grebe	<i>Podiceps nigricollis</i>	x	x
Western Grebe	<i>Aechmophorus occidentalis</i>	x	x
Clark's Grebe	<i>Aechmophorus clarkii*</i>	x	x

Pelicans

American White Pelican

Cormorants

Double-crested Cormorant

Bitterns & Herons

American Bittern

Great Blue Heron

Great Egret

Snowy Egret

Little Blue Heron

Green Heron

Black-crowned Night-Heron

Ibises

White-faced Ibis

New World Vultures

Turkey Vulture

Hawks

Osprey

Northern Harrier

Sharp-shinned Hawk

Cooper's Hawk

Northern Goshawk

Red-shouldered Hawk

Swainson's Hawk

Red-tailed Hawk

Ferruginous Hawk

Rough-legged Hawk

Golden Eagle

Falcons

American Kestrel

Merlin

Peregrine Falcon

Prairie Falcon

Pelecanidae*Pelecanus erythrorhynchos***Phalacrocoracidae***Phalacrocorax auritus***Ardeidae***Botaurus lentiginosus**Ardea herodias**Ardea alba**Egretta thula**Egretta caerulea**Butorides virescens**Nycticorax nycticorax***Threskiornithidae***Plegadis chihi***Cathartidae***Cathartes aura***Accipitridae***Pandion haliaetus**Circus cyaneus**Accipiter striatus**Accipiter cooperii**Accipiter gentilis**Buteo lineatus**Buteo swainsoni**Buteo jamaicensis**Buteo regalis**Buteo lagopus**Aquila chrysaetos***Falconidae***Falco sparverius**Falco columbarius**Falco peregrinus**Falco mexicanus*

x x

x x

x x

x x

x x

x

x x

x x

x x

x x

x

x x

x x

x x

x

x x

x x

x

x

x x

Rails, Gallinules & Coots

Virginia Rail

Sora

Common Moorhen

American Coot

Rallidae*Rallus limicola**Porzana carolina**Gallinula chloropus**Fulica americana*

x x

x x

x x

x x

Plovers

Black-bellied Plover

American Golden-Plover

Snowy Plover

Semipalmated Plover

Killdeer

Mountain Plover

Charadriidae*Pluvialis squatarola**Pluvialis dominica**Charadrius alexandrinus**Charadrius semipalmatus**Charadrius vociferous**Charadrius montanus*

x

x

x x

Stilts & Avocets

Black-necked Stilt

American Avocet

Recurvirostridae*Himantopus mexicanus**Recurvirostra americana*

x x

x x

Sandpipers

Greater Yellowlegs

Lesser Yellowlegs

Solitary Sandpiper

Willet

Spotted Sandpiper

Upland Sandpiper

Whimbrel

Long-billed Curlew

Marbled Godwit

Red Knot

Semipalmated Sandpiper

Western Sandpiper

Least Sandpiper

Baird's Sandpiper

Pectoral Sandpiper

Dunlin

Stilt Sandpiper

Short-billed Dowitcher

Long-billed Dowitcher

Scolopacidae*Tringa melanoleuca**Tringa flavipes**Tringa solitaria**Catoptrophorus semipalmatus**Actitis macularia**Bartramia longicauda**Numenius phaeopus**Numenius americanus**Limosa fedoa**Calidris canutus**Calidris pusilla**Calidris mauri**Calidris minutilla**Calidris bairdii**Calidris melanotos**Calidris alpina**Calidris himantopus**Limnodromus griseus**Limnodromus scolopaceus*

x x

x x

x x

x

x x

x

x

x x

x x

x

x

x x

Wilson's Snipe	<i>Gallinago delicata</i>	x	x
Wilson's Phalarope	<i>Phalaropus tricolor</i>	x	
Red-necked Phalarope	<i>Phalaropus lobatus</i>	x	

Gulls

Franklin's Gull	<i>Larus pipixcan</i>		
Bonaparte's Gull	<i>Larus Philadelphia</i>	x	
Mew Gull	<i>Larus canus</i>		
Ring-billed Gull	<i>Larus delawarensis</i>	x	x
California Gull	<i>Larus californicus</i>		
Herring Gull	<i>Larus argentatus</i>		
Glaucous-winged Gull	<i>Larus glaucescens</i>		
Caspian Tern	<i>Sterna caspia</i>		
Common Tern	<i>Sterna hirundo</i>		
Forster's Tern	<i>Sterna forsteri</i>		
Least Tern	<i>Sterna antillarum</i>		
Black Tern	<i>Chlidonias niger</i>		

Laridae

Doves

Rock Pigeon	<i>Columbia livia</i>		x
White-winged Dove	<i>Zenaida asiatica</i>		x
Mourning Dove	<i>Zenaida macroura</i>	x	x
Common Ground-Dove	<i>Columbina passerina</i>		

Columbidae

Roadrunners

Greater Roadrunner	<i>Geococcyx californianus</i>	x	x
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Cuculidae

Barn Owls

Barn Owl	<i>Tyto alba</i>		x
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Tytonidae

Typical Owls

Great Horned Owl	<i>Bubo virginianus</i>	x	
Burrowing Owl	<i>Athene cunicularia</i>		
Short-eared Owl	<i>Asio flammeus</i>	x	
Northern Saw-whet Owl	<i>Aegolius acadicus</i>		x

Strigidae

Nightjars

Lesser Nighthawk	<i>Chordeiles acutipennis</i>	x	x
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Caprimulgidae

Common Nighthawk	<i>Chordeiles minor</i>		
Swifts	Apodidae		
Vaux's Swift	<i>Chaetura vauxi</i>		X
White-throated Swift	<i>Aeronautes saxatalis</i>	X	X
Hummingbirds	Trochilidae		
Black-chinned Hummingbird	<i>Archilochus alexandri</i>		X
Anna's Hummingbird	<i>Calypte anna</i>		X
Costa's Hummingbird	<i>Calypte costae</i>		
Broad-tailed Hummingbird	<i>Selasphorus playcercus</i>	X	X
Rufous Hummingbird	<i>Selasphorus rufus</i>		
Kingfishers	Alcedinidae		
Belted Kingfisher	<i>Ceryle alcyon</i>	X	X
Woodpeckers	Picidae		
Lewis's Woodpecker	<i>Melanerpes lewis</i>		
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>		
Ladder-backed Woodpecker	<i>Picoides scalaris</i>	X	
Northern Flicker	<i>Colaptes auratus</i>	X	X
Tyrant Flycatchers	Tyrannidae		
Olive-sided Flycatcher	<i>Contopus cooperi</i>	X	
Western Wood-Pewee	<i>Contopus sordidulus</i>	X	X
Willow Flycatcher	<i>Empidonax trailli</i>		
Hammond's Flycatcher	<i>Empidonax hamondii</i>	X	
Gray Flycatcher	<i>Empidonax wrightii</i>		
Dusky Flycatcher	<i>Empidonax oberholseri</i>	X	
Western Flycatcher	<i>Empidonax difficilis</i>	X	
Black Phoebe	<i>Sayornis nigricans</i>	X	X
Say's Phoebe	<i>Sayornis saya</i>	X	X
Vermilion Flycatcher	<i>Pyrocephalus rubinus</i>		
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>		X
Cassin's Kingbird	<i>Tyrannus vociferans</i>	X	X
Western Kingbird	<i>Tyrannus verticalis</i>	X	X
Eastern Kingbird	<i>Tyrannus tyrannus</i>		
Scissor-tailed Flycatcher	<i>Tyrannus forficatus</i>	X	
Shrikes	Laniidae		

Loggerhead Shrike	<i>Lanius ludovicianus</i>	x	x
Northern Shrike	<i>Lanius excubitor</i>	x	

Vireos

Bell's Vireo
Solitary Vireo
Hutton's Vireo
Warbling Vireo
Red-eyed Vireo

Vireonidae

Vireo bellii
Vireo solitarius x
Vireo huttoni
Vireo gilvus x
Vireo olivaceus

Crows & Jays

Western Scrub-Jay
Pinyon Jay
Common Raven

Corvidae

Aphelocoma coerulescens x x
Gymnorhinus cyanocephalus x
Corvus corax x x

Larks

Horned Lark

Alaudidae

Eremophila alpestris x x

Swallows

Purple Martin
Tree Swallow
Violet-green Swallow
Northern Rough-winged Swallow
Bank Swallow
Cliff Swallow
Barn Swallow

Hirundinidae

Progne subis x
Tachycineta bicolor x x
Tachycineta thalassina x x
Stelgidopteryx serripennis x x
Riparia riparia x x
Petrochelidon pyrrhonota x x
Hirundo rustica x x

Verdins

Verdin

Remizidae

Auriparus flaviceps x x

Bushtits

Bushtit

Aegithalidae

Psaltriparus minimus x x

Nuthatches

Red-breasted Nuthatch
White-breasted Nuthatch

Sittidae

Sitta canadensis
Sitta carolinensis

Creepers

Brown Creeper

Certhiidae

Certhia americana

Wrens

Cactus Wren

Rock Wren

Bewick's Wren

House Wren

Winter Wren

Marsh Wren

Troglodytidae*Campylorhynchus brunneicapillus**Salpinctes obsoletus**Thryomanes bewickii**Troglodytes aedon**Troglodytes troglodytes**Cistothorus palustris*

x

x

x

x

x

x

Kinglets

Golden-crowned Kinglet

Ruby-crowned Kinglet

Regulidae*Regulus satrapa**Regulus calendula*

x

x

x

x

Gnatcatchers

Blue-gray Gnatcatcher

Black-tailed Gnatcatcher

Sylviidae*Polioptila caerulea**Polioptila melanura*

x

x

x

x

Thrushes

Western Bluebird

Mountain Bluebird

Townsend's Solitaire

Swainson's Thrush

Hermit Thrush

American Robin

Turdidae*Sialia mexicana**Sialia currucoides**Myadestes townsendi**Catharus ustulatus**Catharus guttatus**Turdus migratorius*

x

x

x

x

x

x

x

x

Mockingbirds & Thrashers

Northern Mockingbird

Sage Thrasher

Crissal Thrasher

Le Conte's Thrasher

Mimidae*Mimus polyglottos**Oreoscoptes montanus**Toxostoma crissale**Toxostoma lecontei*

x

x

x

x

x

Starlings

European Starling

Sturnidae*Sturnus vulgaris*

x

x

Pipits

American Pipit

Motacillidae*Anthus rubescens*

x

x

Waxwings

Bohemian Waxwing

Bombycillidae*Bombycilla garrulus*

x

Cedar Waxwing	<i>Bombycilla cedrorum</i>		X
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Silky Flycatchers

Ptilonotidae

Phainopepla	<i>Phainopepla nitens</i>	X	X
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Wood-Warblers

Parulidae

Orange-crowned Warbler	<i>Vermivora celata</i>	X	X
Nashville's Warbler	<i>Vermivora ruficapilla</i>		
Virginia's Warbler	<i>Vermivora virginiae</i>		
Lucy's Warbler	<i>Vermivora luciae</i>	X	X
Yellow Warbler	<i>Dendroica petechia</i>	X	X
Yellow-rumped warbler	<i>Dendroica coronata</i>	X	X
Black-throated Gray Warbler	<i>Dendroica nigrescens</i>		
Townsend's Warbler	<i>Dendroica townsendi</i>	X	
Palm Warbler	<i>Dendroica palmarum</i>		X
American Redstart	<i>Setophaga ruticilla</i>		
MacGillivray's Warbler	<i>Oporornis tolmiei</i>	X	X
Common Yellowthroat	<i>Geothlypis trichas</i>	X	X
Wilson's Warbler	<i>Wilsonia pusilla</i>	X	X
Yellow-breasted Chat	<i>Icteria virens</i>	X	X

Tanagers

Thraupidae

Summer Tanager	<i>Piranga rubra</i>		
Western Tanager	<i>Piranga ludoviciana</i>	X	X

Emberizids

Emberizidae

Green-tailed Towhee	<i>Pipilo chlorurus</i>	X	
Spotted Towhee	<i>Pipilo maculatus</i>		X
Eastern Towhee	<i>Pipilo erythrophthalmus</i>		
Abert's Towhee	<i>Pipilo aberti</i>	X	X
American Tree Sparrow	<i>Spizella arborea</i>		
Chipping Sparrow	<i>Spizella passerina</i>	X	X
Brewer's Sparrow	<i>Spizella breweri</i>	X	X
Vesper Sparrow	<i>Pooecetes gramineus</i>		X
Lark Sparrow	<i>Chondestes grammacus</i>		X
Black-throated Sparrow	<i>Amphispiza bilineata</i>	X	X
Sage Sparrow	<i>Amphispiza belli</i>	X	
Savannah Sparrow	<i>Passerculus sandwichensis</i>		X

Fox Sparrow	<i>Passerella iliaca</i>		X
Song Sparrow	<i>Melospiza melodia</i>	X	X
Lincoln's Sparrow	<i>Melospiza lincolni</i>	X	X
Swamp Sparrow	<i>Melospiza georgiana</i>		
White-throated Sparrow	<i>Zonotrichia albicollis</i>		
Harris's Sparrow	<i>Zonotrichia querula</i>		
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	X	X
Golden-crowned Sparrow	<i>Zonotrichia atricapilla</i>		
Dark-eyed Junco	<i>Junco hyemalis</i>		X
Lapland Longspur	<i>Calcarius lapponicus</i>		

Cardinals, Grosbeaks & Buntings

Cardinalidae

Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	X	X
Blue Grosbeak	<i>Passerina caerulea</i>	X	X
Lazuli Bunting	<i>Passerina amoena</i>	X	X
Indigo Bunting	<i>Passerina cyanea</i>		X

Blackbirds

Icteridae

Bobolink	<i>Dolichonyx oryzivorus</i>		
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	X	X
Western Meadowlark	<i>Sturnella neglecta</i>	X	X
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	X	X
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	X	X
Great-tailed Grackle	<i>Quiscalus mexicanus</i>		X
Brown-headed Cowbird	<i>Molothrus ater</i>	X	X
Hooded Oriole	<i>Icterus cucullatus</i>		
Bullock's Oriole	<i>Icterus bullockii</i>		X
Scott's Oriole	<i>Icterus parisorum</i>	X	

Finches

Fringillidae

House Finch	<i>Carpodacus mexicanus</i>	X	X
Pine Siskin	<i>Carduelis pinus</i>		
Lesser Goldfinch	<i>Carduelis psaltria</i>	X	X
American Goldfinch	<i>Carduelis tristis</i>		

Old World Sparrows

Passeridae

House Sparrow	<i>Passer domesticus</i>	X	X
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Bird names reported for 1973 and 2004 follow the 1988 A.O.U. checklist, including supplements 42 - 44. Bird names reported in 1973 but not in 2004 follow the 1957 A.O.U. checklist