CHAPTER 3
EXISTING RESOURCE CONDITIONS

3.1 ASSESSMENT OF THE NEED FOR CHANGE

The Potholes Reservoir Management Area has a rich diversity of natural resources and is recognized locally and regionally for its recreation opportunities. The reservoir offers fishing, camping, swimming, boating, wildlife observation, and other recreation opportunities to thousands of visitors annually. There is an inherent need for a comprehensive management plan in each of the defined management areas to conserve and protect the land and water resources so the public may continue to enjoy all the recreation opportunities available at Potholes Reservoir.

Arid ecosystems, like the lands surrounding Potholes Reservoir, tend to be more susceptible to human disturbance and require longer periods of time to recover than do wetter areas that receive more rainfall. Drier landscapes usually require restoration to expedite vegetative succession, but some disturbed areas never recover. Other factors influencing the fragility of the acreage around Potholes Reservoir include precipitation events and erosion. While xeric landscapes receive little rainfall annually (< 12"/year) compared to other mesic areas, the precipitation events are characterized by short, intense thunderstorms. When they occur, these storm bursts inevitably wash the soil into the reservoir, and water resources/quality begin to be effected. Arid landscapes are prone to erosion, and the soil loss is rapid following the disturbance. Consequently, land use effects water resources and vice versa. Proper land and water management practices will prevent or reduce potential environmental and resource-related problems. The implementation of a RMP for the Potholes Reservoir Management Area will only further contribute to the uniqueness of the area by providing a safe and beautiful place for people and natural resources to exist together.

With increased use from the recreating public, the quality of the natural resources found at Potholes Reservoir is projected to decline as well as accelerate conflicts between future recreation and natural resource protection needs. This trend is expected to continue unless future resource and recreation management decisions are made through a coordinated and integrated RMP tailored to the existing resource conditions and needs.

3.2 NATURAL RESOURCE SUMMARY

This chapter summarizes existing resource conditions in the Potholes Reservoir Management Area at the time of implementing the RMP (see Figures 3.2-1 and 3.2-2 “Current Conditions”). Natural, cultural, and aesthetic resources are addressed, followed by a general description of the local and regional management area relative to social and economic resources.

North of the dam, pothole wetlands, riparian, and shrub-steppe plant communities and sand dunes characterize the area. A unique system of sand islands was created when the shifting sand dunes were inundated. Over time, wetland and riparian plant communities recolonized the dynamic island and reservoir shoreline. Emergent wetland communities developed, and riparian forest and shrub communities dominated by willow matured in these shoreline areas. These changes have created new or enhanced habitat for some wildlife populations along with additional recreation opportunities.

Potholes Reservoir is managed by WDFW under the CBWA Management Plan. The CBWA includes eastern Washington lands within Grant, Adams, Franklin, and Douglas Counties. The WDFW owns 43,000 acres fee title, leases some tracts from the WDNR, and has agreements for management of federal lands with the USFWS, the U.S. Department of Energy (USDOE), the BLM, and Reclamation. The WDFW manages a total of 260,000 acres under the plan. To date, no specific CBWA management plan for the Potholes Reservoir unit has been developed.

3.2.1 Climate

The Cascade Range and the Rocky Mountains greatly influence the climate in the Columbia Basin and Potholes Reservoir Management Area. The Rocky Mountains shield the Columbia Basin from the more severe winter storms moving southward across Canada, while the Cascade Range forms a barrier to the easterly movement of moist air from the Pacific Ocean (SCS, 1984). However, some air from each of these sources reaches the Columbia Basin and affects the climate at Potholes Reservoir.

Due to Pacific high pressure systems from May through September, the recreation season is generally hot and dry. From late June until September, sunshine is abundant. Summer precipitation mainly occurs either as brief showers or as short, intense thunderstorms. In the winter, the average temperature at Quincy (the nearest climatological station) is 30°F. The average daily minimum temperature is 21°F. In the summer, the average temperature is 83°F. The total annual precipitation is about eight inches and the average snowfall is 22 inches. Chinook winds which blow down slope and are warm and dry, often melt and evaporate the snow. The prevailing wind is from the west-northwest. Average windspeed is highest in the spring at eight miles per hour (Soil Survey of Grant County Washington). The water at Potholes Reservoir can be extremely rough and dangerous within minutes of a storm's approach, requiring boaters to seek shoreline refuge as quickly as possible.

R27E R28E

North Potholes Reserve

Moses Lake

Upper Crab Creek Arm

North Outlet

South Outlet

Peninsula North

Sand Dunes Road

Cartop Boat Launch

Powerline Boat Launch

Powerline Road

Sand Dunes Road

Peninsula South

Upper West Arm

Job Corps Dike Boat Launch

Lower Crab Creek Arm

Eastern Dunes

Eastern Bluffs

Dunes/Sand Islands

O'Sullivan Site - North

T18N

T17N

Winchester Wasteway

Lower West Arm

Main Reservoir

See Figure 3.2-2

Potholes State Park

Frenchman Hills Wasteway

Developed Corridor

Proposed Campground Expansion Area

Proposed Bike/Pedestrian Trail

Mar Don Resort

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Grant County

Study Area

Washington State

Current Conditions

Potholes Reservoir Resource Management Plan

RMP Study Area

Management Areas

Grant County ORV Area

Designated Dispersed Camping Areas

Watchable Wildlife Areas

North Potholes Vehicle Route

Open Access

Restricted Access

Developed Recreation Area

Dispersed Camping Areas

Closed Year Round

Open Year Round

Seasonally Open (Closed March 15-June 30)

Designated Dispersed Camping Areas

Grazing Permit TP-01

Seasonal Grazing March 15 - April 15

Seasonal Grazing November 1 - March 15

Misc. Improvements

Dikes

Powerline

Install Vault Toilet

Provide Seasonal Toilets

Provide Courtesy Dock

Roads

Highway/Improved Roads

Primitive (Closed)

Primitive (Open)

ORV Trails

Gate

N

0.5 0 0.5 1 1.5 2 Miles

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DAMES & MOORE GROUP

A DAMES & MOORE GROUP COMPANY

Current Conditions - Potholes Reservoir RMP

Figure 3.2-1

R28E

5 SE

5 SE

'K' SE

'L' SE

'M' SE

6 SE

T18N

T17N

O'Sullivan Site - South

Road 'M'
Boat Launch

Lind Coulee North Arm
Watchable Wildlife Area

E. Lind Coulee Arm

W. Lind Coulee Arm

See Figure 3.2-1

Glen Williams
Boat Launch

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W. Lind Coulee Boat Launch

Seasonal Road Closure
October1-January1

Developed Corridor

Current Conditions
Potholes Reservoir Resource Management Plan

RMP Study Area

Management Areas

Watchable Wildlife Areas

Developed Recreation Area

Dispersed Camping Areas

Open Year-Round

Roads

Highway/Improved Roads

Primitive (Closed)

Primitive (Open)

Gate

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N

Scale 1:24,000

0.5 0 0.5 Miles

Grant County

Study Area

Washington State

Current Conditions - Potholes Reservoir RMP
Figure 3.2-2

3.2.2 Air Quality

The Washington State Department of Ecology's (WDOE) Eastern Regional Air Pollution Control Authority Office and the U.S. Environmental Protection Agency (EPA) monitor air quality in the Columbia Basin region under the provisions of the Clean Air Act, as amended. Washington has developed a State Implementation Plan (SIP) in part to maintain Ambient Air Quality Standards. The status of criteria pollutants, the six principal pollutants regulated by the EPA, are tracked statewide. The six criteria pollutants are particulate matter 10 microns or smaller in diameter (PM_{10}), sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), ozone (O_3), and lead (Pb).

Grant County does not have permanent or mobile monitoring stations. Therefore, air quality information in the area is limited. The closest monitoring sites to Potholes Reservoir are Spokane to the northeast, and Yakima to the west. These cities also are the nearest non-attainment areas for CO and PM_{10}. Although air quality information for the region is limited, the WDOE and the EPA have designated Grant County as an area currently in attainment for all standards (Seheibner, 1999).

Class I areas have the highest air quality classification and include all international parks, wilderness areas, memorial parks which exceed 5,000 acres, and all national parks which exceed 6,000 acres. Class I areas have land and resource use restrictions to prevent damage to visibility, plant, soil, and other resources. The closest Class I area to Potholes Reservoir is the Spokane Indian Reservation to the east. WDOE's plans for protecting and improving visibility in Class I areas are contained in the air quality SIP.

Locally, particulates are generated from area sources such as dirt roads and plowed fields. Wind erosion is a significant factor in particulate distribution, particularly in the spring and fall when high winds and dry soil conditions create dust storms. The agricultural practice of burning field residue following harvest can also produce high levels of particulate matter. The burning season lasts about one month during late August and September. Although the typical management practice directs smoke away from population centers, total emissions within the airshed are not reduced (Grant County, 1999).

High ORV use at Potholes Reservoir contributes increased air emissions on peak weekends when as many as four thousand ORV recreationists may use the ORV area (Cooke et al., 1997). Specifically these pollutants include hydrocarbons, particulate matter, nitrogen oxides, carbon monoxide, and carbon dioxide. The amount of pollutants generated by current activities has not been estimated.

3.2.3 Geology

The Columbia River flows in a deep valley along the southwestern boundary of the county. The northern part of the county is characterized by loess (windblown silt) mantled hills that have been dissected by the Channeled Scablands (land eroded by cataclysmic flooding in excess of 13,000 years ago). The southern part is generally smooth with a southward-sloping plain that is deeply dissected and is interrupted by the Saddle Mountains and Frenchman Hills. Babcock Ridge and Beezly Hills border the northern part of the plain (USDA, 1984).

The Potholes Reservoir Management Area lies within the Colombia Basin subprovince of the Columbia Intermontane Province. The Columbia Intermontane Province is the product of Miocene flood basalt volcanism and regional deformation that occurred over the past 17 million years. The Columbia Plateau is that portion of the Columbia Intermontane Province that is underlain by the Columbia River Basalt Group.

The Potholes Reservoir is located in the Quincy Basin, a synclinal trough in the folded Columbia Plateau. The Pleistocene floodwaters formed a fast draining lake as they entered this broad basin and as a result dumped large quantities of sediment completely burying the basalt bedrock. Most of the floodwater drained through the Drumheller channels south of the Potholes Reservoir into the Othello Basin where it ponded again to make another temporary lake.

Since the end of the Pleistocene, winds have locally reworked the flood sediments, depositing dune sands in the lower elevations and loess at higher elevations.

The Eastern Bluffs management zone area has a steep relief, generally unvegetated, with the slopes composed of unconsolidated materials (i.e., silt/sand, cobble). These slopes are highly vulnerable to erosion and border directly on the reservoir. This limits possible development and use of the area. The Potholes Reservoir has a continuing inflow of suspended sediment from the wasteways that result in a build-up of sediment which is deposited near mouths of these wasteways. The boat launch area at the State Park is highly impacted by this sediment build-up.

3.2.4 Topography

The landscape of the Potholes Reservoir Management Area is dominated by low relief plains. The surface topography has been modified within the past several million years by several geomorphic processes such as, Pleistocene cataclysmic flooding Holocene eolian activity. Cataclysmic flooding occurred when ice dams in western Washington and northern Montana were breached, allowing large volumes of water to spill across eastern and central Washington forming the channeled scablands and depositing sediment in the Potholes Reservoir area. The last major flood occurred about 13,000 years

ago during the late Pleistocene Epoch. Anastomosing flood channels, giant current ripples, bergmounds, and giant flood bars are among the landforms created by the floods (Easterbrook *et al.*, 1970.)

3.2.5 Soils

Grant County resides in a regional structural basin. The County rests on the lower limb of the Grand Coulee Monocline to the north/northwest and the northern limb of the Frenchman Hills Anticline to the southwest. The region to the northeast, including the Potholes Management Area, is subjected to a 0 to 5 degree dip in the southwest direction. The effect of these structural features is the formation of a regional sediment and groundwater cache basin in and around Potholes Reservoir. In addition to groundwater, this structural low has been the deposition location for southwest prevailing wind-borne silt and sand, making the area an eolian depositional basin as well.

Nearly all of the soils on the Columbia Plateau and in the Columbia drainage basin have been formed under grassland or shrub-grassland vegetation. Soil parent materials in this region include basalt, volcanic ash, sedimentary deposits, glacial outwash, and alluvial, fluvial, and colluvial deposits. Soils are generally covered with windblown sand and silt. Caliche layers occur in most of the soils and are generally seven feet deep. Loess dominated subsoils are moderately saline and contain a moderate amount of exchangeable sodium.

The most recent and comprehensive soils data available for the Potholes Management Area was obtained from the *Soil Survey of Grant County Washington* (SCS, 1984) prepared by the U.S. Department of Agriculture's Natural Resources and Conservation Service (NRCS), formerly the Soil Conservation Service (SCS). The soil survey is an inventory and evaluation of the soils found in Grant County which includes the Potholes Management Area. The survey can be used to adjust existing land uses and land use plans to the limitations and natural potentials of soil resources and their environment (USDA, 1984).

Potholes Reservoir is in the southeast part of Grant County. The RMP Management Area in and around the reservoir includes about 36,200 acres. At high water, about 18,500 acres of soil are exposed, and at low water this number increases considerably. Soils in the RMP management area consist of two broad soil groups and a total of seven general soil map units. Each of the general soil units identifies a broad area that has a distinctive pattern of soils, relief, drainage, and landscape. There is a total of 56 detailed soil map units within the Potholes Reservoir Management Area.

Soils on terraces, active dunes, and alluvial fans are primarily found in the north and western portion of the RMP area (Units 2-7, see Table 3.2-1).

Soils on benches, terraces, hillsides, and ridgetops in areas of channeled scablands dominate the soil types (Units 11 and 12) found only in the southern portion of the management area.

Tables 3.2-1, 3.2-2, 3.2-3and 3.2-4 summarizes Erosion Susceptibility, Limitation Ranges for Building Site Development, Potential Ranges for Providing Wildlife Habitat, and Limitation Ranges for Recreation Development at Potholes Reservoir, respectively.

Table 3.2-1
Soil Unit Erosion Susceptibility
Potholes Reservoir, Washington

Soil Unit	Water Erosion Hazard Range	Wind Erosion Hazard Range
Unit 2: Timmerman-Quincy	Slight to Moderate	Highly Erodible to Extremely Erodible
Unit 4: Ephrata-Malaga	Slight to Moderate	Erodible to Extremely Erodible
Unit 5: Burbank-Quincy	Slight to Moderate	Very Slightly Erodible to Highly Erodible
Unit 6: Quincy	Slight to Moderate	Highly Erodible to Extremely Erodible
Unit 7: Taunton-Scoon	Slight to High	Highly Erodible
Unit 11: Starbuck-Bakeoven-Prosser	Slight to Moderate	None to Highly Erodible
Unit 12: Schawana	Moderate	Slightly Erodible to Highly Erodible

Table 3.2-2
Soil Unit Limitation Ranges for Building Site Development

Soil Unit	Shallow Excavation	Dwelling Without Basement	Local Roads and Streets	Lawns and Landscaping	Septic Tank Absorption Fields
Unit 2: Timmerman-Quincy	Severe	Slight to severe	Slight to severe	Moderate to severe	Severe
Unit 4: Ephrata-Malaga	Severe	Slight to moderate	Moderate	Slight to severe	Severe
Unit 5: Burbank-Quincy	Severe	Slight to severe	Slight to severe	Moderate to severe	Severe
Unit 6: Quincy	Severe	Slight to severe	Slight to severe	Moderate to severe	Severe
Unit 7: Taunton-Scoon	Severe	Moderate to severe	Moderate to severe	Moderate to severe	Severe
Unit 11: Starbuck-Bakeoven-Prosser	Severe	Moderate to severe	Severe	Severe	Severe
Unit 12: Schawana	Severe	Severe	Severe	Severe	Severe

Table 3.2-3
General Soil Unit Potential Ranges for Providing Wildlife Habitat at Potholes Reservoir, Washington

Soil Unit	Openland Wildlife	Wetland Wildlife	Rangeland Wildlife
Unit 2: Timmerman-Quincy	Poor to Good	Very Poor	Not Rated
Unit 4: Ephrata-Malaga	Very Poor to Good	Very Poor	Not Rated
Unit 5: Burbank-Quincy	Poor to Fair	Very Poor	Poor
Unit 6: Quincy	Poor to Fair	Very Poor	Poor
Unit 7: Taunton-Scoon	Fair to Good	Very Poor to Fair	Not Rated
Unit 11: Starbuck-Bakeoven-Prosser	Very Poor to Poor	Very Poor	Poor to Fair
Unit 12: Schawana	Very Poor	Very Poor	Very Poor

Table 3.2-4
Soil Unit Limitation Ranges for Recreation Development Potholes Reservoir, Washington

Soil Unit	Camp Areas	Picnic Areas	Playgrounds	Paths and Trails
Unit 2: Timmerman-Quincy	Slight to Severe	Slight to severe	Slight to severe	Slight to Severe
Unit 4: Ephrata-Malaga	Slight to moderate	Slight to moderate	Moderate to severe	Slight to severe
Unit 5: Burbank-Quincy	Slight to Severe	Slight to severe	Moderate to severe	Slight to severe
Unit 6: Quincy	Slight to Severe	Slight to severe	Severe	Slight to severe
Unit 7: Taunton-Scoon	Slight to Severe	Slight to Severe	Slight to Severe	Slight to Severe
Unit 11: Starbuck-Bakeoven-Prosser	Moderate to severe	Moderate to severe	Severe	Severe
Unit 12: Schawana	Severe	Severe	Severe	Slight to moderate

3.2.6 Water Quality

The CBP was started in the early 1930's to provide irrigation water to the fertile but arid lands of the Columbia River basin in central Washington. Water for the CBP originates from the Columbia River where it is pumped from Lake Roosevelt at Grand Coulee Dam into Banks Lake - one of the CBP's principal reservoirs. At the south end of Banks Lake, irrigation diversions are made into the Main Canal at Dry Falls Dam. Main Canal waters flow through lined and unlined sections, tunnels, and siphons before terminating downstream from Billy Clapp Lake into the East Low Canal and West Canal which more or less form the CBP's project's east and west boundaries.

Annually, the CBP diverts about 2.6 million acre-feet of water out of the Columbia River to deliver irrigation water to agricultural lands that normally receive less than 10 inches of precipitation a year. After use in the north half of the CBP (on the Quincy and East Columbia Basin Irrigation Districts), much of the water is collected and returned through a series of wasteways to Potholes Reservoir for reuse in the southern half of the CBP by the South Columbia Basin Irrigation District.

Moses Lake, the largest natural lake in the area, receives its water in the form of natural inflow, irrigation return flows, and canal water originating from the Columbia River. Natural inflow comes from Upper Crab Creek, an intermittent tributary with its headwaters west of Spokane, Rocky Ford Creek, a year-round spring-fed creek that originates southeast of Soap Lake, and a few small drainages to the east. Moses Lake serves as the main supply route for water passing from the East Low Canal, Upper Crab Creek, and Rocky Ford Creek south to Potholes Reservoir.

Created by O'Sullivan Dam, Potholes Reservoir lies immediately downstream of Moses Lake in the Lower Crab Creek Basin. Built as part of the CBP, the reservoir's main water supply is operational waste and irrigation return flow from northern CBP lands irrigated from the East Low and West Canals. This water supply is supplemented by natural flows in Crab Creek, Rocky Coulee, Weber Coulee, and Lind Coulee. Reservoir inflows originate from Moses Lake through the Crab Creek channel on the north side, from the Lind Coulee Wasteway on the east side, and from the Winchester and Frenchman Hills Wasteways on the west side. Shallow groundwater seepage is also a water source entering Potholes Reservoir. Irrigation water for the southern part of the CBP is distributed via the Potholes East Canal which begins at O'Sullivan Dam.

At a full pool elevation of 1,046.5 feet, Potholes Reservoir covers an estimated 27,800 acres and has a total storage capacity of 511,700 acre-feet. Of this capacity, 179,200 acre-feet is inactive, 300 acre-feet is dead pool, and 332,200 acre-feet is active conservation allocated for irrigation use. The reservoir has an average depth of 18 feet and a maximum depth of 142 feet.

When the difference between outflow and inflow (outflow being higher) is greatest, from June to August, the reservoir elevation on average is about 12 feet below full pool. At low water levels, many of the dunes/sand islands located in the northern half of the reservoir area become exposed and difficult to access. These islands are very popular for dispersed camping, sunbathing, and other recreational activities in the spring and early summer when reservoir elevations are high and optimal for boat-in accessibility. As reservoir water surface elevations decline, so does recreational visitation and use within the Potholes Management Area.

Surface Water Quality

Updated in November 1997, the surface water quality standards for the State of Washington are described in Chapter 173-201A of Washington's Administrative Code (WAC). The chapter establishes surface water quality standards consistent with public health and enjoyment, and the propagation and protection of fish, shellfish, and wildlife (WAC 173-201A-010). In conformance with present and potential uses of the state's surface waters and in consideration of natural water quality limitations and potential, the state has classified its waters according to the beneficial uses that can be obtained from them and has established water quality criteria for each classification.

The water quality standards and beneficial use criteria applicable to Potholes Reservoir are defined under the "Lake Class" designation. Lake Class waters are expected to meet or exceed the requirements for water supply (domestic, industrial, agricultural), stock watering, fish and shellfish (salmonid and fish migration, rearing, spawning and harvesting, and clam, mussel and crayfish rearing, spawning, and harvesting), wildlife habitat, recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment), and commerce and navigation.

Although there is a general lack of water quality data specific to Potholes Reservoir, water samples collected from various reservoir locations on September 4 and October 3, 1998 were reviewed to assess potential lake conditions and/or limitations.

Under the State's Lake Water Quality Assessment Program, a lake specific study was conducted at Potholes Reservoir during the summers of 1998 and 1999 by the WDOE. The assessment was conducted to determine appropriate total phosphorus concentrations to protect characteristic lake uses.

None of the water quality data gathered to date show constituent concentrations above the maximum contaminant levels (MCLs) established under the National Primary Drinking Water Regulations (EPA, 1997). These determinations consider the criteria for chemical, biological, or physical parameters which have been established to provide a level of water quality that supports designated beneficial uses (Planning File).

Environmental Contaminants and Biota

Potholes Reservoir fish and bottom sediment samples were collected and analyzed in 1992-1993. Whole-body largescale suckers were analyzed for EPA priority pollutant metals, organophosphate pesticides, chlorinated pesticides, and polychlorinated biphenyls (PCBs). Fish muscle tissue samples were analyzed for mercury, chlorinated pesticides, organophosphate pesticides, and PCBs. Bottom

sediment samples were analyzed for all of the above constituents as well as semivolatile organics and triazine herbicides.

Of the five lakes which underwent the WDOE's comprehensive survey, the overall contamination of sediment and fish at Potholes Reservoir was the lowest. None of the Potholes sediment samples exceeded the Ontario Province Sediment Quality Guidelines for metals or organic compounds, and low concentrations of nine chlorinated pesticides, including, were detected in Potholes fish. Only lake whitefish and largemouth bass muscle tissues exceeded the EPA human health criterion for dieldrin.

On the basis of the dieldrin concentrations measured, Potholes Reservoir remains listed on the State's 1998 Section 303(d) list submitted to EPA. Under the Clean Water Act, the 303(d) list identifies water quality limited, impaired, and threatened waters needing additional work beyond existing controls to achieve or maintain the surface water quality standards established (WDOE, 1996). Also listed on the 303(d) list is Potholes East Canal.

Ground Water Quality

Existing data for the public water supply wells found within or near the Potholes RMP boundary were reviewed to determine whether the MCLs established for ground water were being met. Sulfate concentrations ranged from 9.0 to 87.0 mg/L, with a mean of 42.8 mg/L. Sodium ranged from 21.0 to 60.0 mg/L (mean of 38 mg/L); chloride from 5.0 to 58.0 mg/L(mean of 32.8 mg/L); nitrate from 4.2 to 16.7 mg/L (mean of 8.63 mg/L); iron from 0.01 to 1.09 mg/L (mean of 0.20 mg/L); and manganese from 0.01 to 0.07 mg/L (mean of 0.022 mg/L). Cumulatively, these total dissolved solids (TDS) ranged from 286 to 609 mg/L, with an average value of 480 mg/L. In general, ground-water from shallow wells was the most contaminated and water taken at depth was the least contaminated.

With the exception of the Sunrise Water Association, whose well is screened off below 500 feet, all the public groundwater systems examined had water quality problems and MCL exceedances. Of the eleven wells examined, four wells exceeded the 10 mg/L MCL for nitrate, eight wells exceeded the MCL for lead, three exceeded the MCL for TDS, two exceeded the MCL for manganese, and one exceeded the MCL for iron. Overall, the well data generally indicate that groundwaters pumped from the shallower overburden aquifer around Potholes Reservoir are suitable for agriculture and industrial use, and those pumped from depths equivalent to the lower aquifer units are suitable for all beneficial uses including public drinking water supplies.

Nitrate concentrations in ground water supplies are currently monitored by the Washington Department of Health (WDOH), in cooperation with the county health districts, since they are a good indicator of potentially acute public health effects. The WIGWC report noted that irrigation and agricultural

practices account for a majority of the nitrogen loading. Shallow wells (less than 300 feet in depth) appear to be at much greater risk for nitrate contamination than deeper wells. Most larger public water supply wells are drilled deep to maximize the volume of water available, and most private domestic drinking water wells are shallow and rarely exceed the first major water bearing zone encountered. This practice places the shallow domestic wells at higher risk for water quality problems (WIGWC, 1996).

3.2.7 Vegetation

The Potholes Reservoir Management Area is within the shrub-steppe vegetation zone described by Franklin and Dyrness (1973). This upland zone is dominated by sagebrush, bitterbrush, and large perennial bunchgrasses such as bluebunch wheatgrass (*Agropyron spicatum*) and Idaho fescue (*Festuca idahoensis*). Community composition depends upon many factors including substrate, topography, wind action, and human disturbances (Franklin and Dyrness, 1973).

Before the construction of O'Sullivan Dam, vegetation within the Potholes Management Area was arranged in zones along a moisture gradient. These zones from dry to wet were: (1) no vegetation on high, dry, shifting sand dunes; (2) *Psoralea* sp. on the windward faces of lower shifting dunes with sand dock and willows on the leeward faces; (3) rabbitbrush, sagebrush, spiny hopsage, cheatgrass, Indian ricegrass and alkali cordgrass on semi-stable sand dunes; (4) Baltic rush-sedge meadows; (5) bulrush-cattail wetlands; and (6) submerged aquatic plants (USFWS, 2000). Permanent and temporary potholes (800-1,000), flooded flats, creeks fed by springs fed potholes, and extensive marshlands covered the area (Harris 1954).

Overgrazing in the early part of the century resulted in the destruction of native plant cover and the formation of a broad area of active sand dunes (Zook, 1978). Fire also likely impacted the native shrub-steppe plant communities. Due to the area's arid climate and presence of sandy soils, however, native plant community recovery is slow. As indicated by Franklin and Dyrness (1973), such recovery is further hampered in the fragile uplands due to their susceptibility to invader plant establishment on disturbed sites.

The upland vegetation currently found at the reservoir is dominated by native shrubs and introduced annual grasses. There are only remnant patches of native vegetation (as described by Franklin and Dryness, 1973) remaining. Since the creation of Potholes Reservoir, the aerial extent of riparian habitat, particularly riparian shrub and riparian forest, has increased considerably and is dominated by woody species such as willow. Large areas of emergent herbaceous wetlands are also present, while some areas have only minimal vegetative cover.

The USFWS conducted a HEP study at Potholes Reservoir in 1999 (USFWS, 2000) to acquire baseline data on current habitat conditions and to determine impacts from recreational use on wildlife and vegetative communities. Based on the vegetative data collected, the USFWS concluded "it appears that recreational activities, especially ORV use, have lowered habitat quality, or at least prevented it from recovering from previous conditions." Specifically, the study showed that the areas subjected to ORV use have less vegetative cover and fewer desirable native species.

Aside from ORV use, other dispersed activities have impacted the area's vegetative communities. These disturbances have also allowed various weeds to proliferate along the edges of roads, "informal" roads leading to popular fishing spots, undeveloped boat launch sites, camping sites, have all removed a certain amount of habitat. Camping and parking areas have caused similar losses and changes (USFWS, 2000).

Dominant Cover Types and Conditions by Management Area

Table 3.2-5 lists the dominant vegetative cover types by management area and identifies their relative condition (very poor to excellent) by acreage. The lesser cover types occurring within the management area are not represented. The Main Reservoir Management Area is comprised of water year round and is not applicable.

Table 3.2-5
Dominant Cover Types, Condition, and Acreage by Management Area

Management Area	Cover Type	Condition	Acreage
North Potholes Reserve	Shrub Grass	good	749
	Shrubland	good	1838
	Riparian Forest	good to excellent	595
Peninsula North	Shrub Grass	good to excellent	454
	Shrubland	good to excellent	1616
Peninsula South	Exposed	poor	189
	Shrub Grass	fair to good	185
	Shrubland	good to excellent	1497
	Dense Shrubland	good to excellent	159
Upper Crab Creek Arm	Shrubland	fair to good	757

Table 3.2-5
Dominant Cover Types, Condition, and Acreage by Management Area

Management Area	Cover Type	Condition	Acreage
	Emergent Wetland	poor to fair	491
	Riparian Forest	fair to good	244
	Shrub Grass	fair to good	201
	Grassland	fair to good	112
	Dense Shrubland	good	79
Lower Crab Creek Arm	Shrubland	fair	124
	Emergent Wetland	poor to good	95
	Riparian Forest	poor to good	99
	Riparian Shrub	poor to good	464
	Grassland	poor to good	93
Eastern Dunes	Exposed	very poor	191
	Shrubland	poor	394
	Shrub Grass	poor to fair	62
Eastern Bluffs	Shrubland	poor to good	82
	Agriculture	good	29
Upper West Arm	Shrubland	good	1027
	Riparian Shrub	good	230
	Riparian Forest	good to excellent	379
	Shrub Grass	good to excellent	128
Lower West Arm	Shrub Grass	fair to good	137
	Shrubland	good	600
	Dense Shrubland	good	200
	Very Dense Shrubland	good	122
	Riparian Shrub	good	135
Developed Corridor	Shrubland	good	143
	Very Dense Shrubland	good to excellent	49
	Riparian Forest	good	41

Table 3.2-5
Dominant Cover Types, Condition, and Acreage by Management Area

Management Area	Cover Type	Condition	Acreage
	Dense Shrubland	good to excellent	117
Dunes/Sand Islands	Grassland	fair	84
	Riparian Shrub	fair to good	1144
O'Sullivan (North and South)	Grassland	very poor	98
	Shrub Grass	poor	21
	Shrubland	poor to fair	39
West Lind Coulee Arm	Grassland	poor	313
	Shrub Grass	poor	108
	Dense Shrubland	poor to good	83
	Shrubland	poor to good	44
	Riparian Shrub	poor to fair	27
	Riparian Forest	poor to fair	14
East Lind Coulee Arm	Grassland	fair to good	190
	Shrub Grass	good	206
	Shrubland	good	333
	Dense Shrubland	good	155
	Riparian Forest	good	102

Invasive Plants and Noxious Weeds

Invasive plants, or weeds, interfere with the maintenance of healthy and diverse ecosystems and can degrade or destroy native plant communities, wildlife habitat, recreational opportunities, and agricultural use of the land. Weeds are a common problem throughout the Potholes Management Area and generally colonize and occupy sites that have been previously disturbed by fire, livestock grazing, motorized vehicular travel, and/or dispersed camping. Non-native plants can displace native plants and generally are of lower forage value to wildlife, livestock, and wildlife requisites such as cover and nesting habitat. They are difficult to control or eliminate once established, and generally colonize and occupy sites where the native plant community or ground cover has been lost or severely disturbed. Consequently, weed control is an integral part of any resource management program.

Noxious weeds are defined by the Washington State Noxious Weed Control Board (1999) as "non-native plants that are destructive, competitive, or difficult to control due to their aggressive growth and lack of natural enemies." These species are regulated by the Board and are categorized into three classes (A, B, and C) on the State Noxious Weed List. The categories are based on the seriousness of the threat they pose in the State. Class A weeds have the highest priority for control with eradication required by law, followed by Class B and C weeds. For species in any class, new infestations with limited distribution generally have the highest priority because the potential for contamination is greater than for more widely distributed species.

Class A weeds are those that are not yet abundant across the State, so the potential for eliminating them is high. Saltcedar or tamarisk (*Tamarix ramosissima*) is the only Class A weed known to occur at Potholes Reservoir. Because the Potholes environment is suitable for the establishment of saltcedar, a yearly monitoring "search and destroy" program is recommended by the Grant County Noxious Weed Board for this species. *Tamarix* spp. is discussed by Leonard (1996) as the species originally found at Potholes. However, species of this genus are notoriously difficult to identify and have confusing taxonomy and synonymy; it is best to assume that the species in question is the invasive, Class A species.

Class B weeds are limited to small portions of the State. The control emphasis is to prevent new infestations from becoming established in other parts of the State. The Class B weeds known to occur within the Potholes Management Area include kochia, purple loosestrife, puncture vine, perennial pepperweed, Eurasian water milfoil, Swainson pea, and the knapweeds (diffuse, spotted and Russian).

Because they are widespread, Class C weed control is dependent on the feasibility of control and the level of harm the weed poses locally. Class C weeds known to occur at Potholes Reservoir include Canada thistle and reed canary grass.

Weeds are associated with certain kinds of disturbance, plant communities, or land use activities that enhance their ability to proliferate. Roads, ORV travel, and dispersed camping are disturbance activities that promote the proliferation of Russian thistle, kochia, knapweeds, Dalmatian toadflax, and cheatgrass. Roads (vehicular travel) and recreationists function as weed dispersers and serve as vectors for introducing new weed species into new areas. This can be seen at staging areas or dispersed campsites. A typical scenario is the removal of vegetation through ground disturbance, bare soil exposure, and new weed seed deposition - creating ideal conditions for the establishment of a new weed population. Grazing promotes the proliferation of cheatgrass and knapweeds. The knapweeds are dispersed by cattle as the seed heads cling to animal fur. Reservoir fluctuations provide good conditions for purple loosestrife and cocklebur proliferation.

At present, purple loosestrife is firmly established throughout most of the Potholes Management Area; particularly thick stands have become established at the Winchester and Frenchman Hills Wasteway outlets. There is currently no reasonable control method for eliminating this species from areas where it has become established to the extent that has occurred at Potholes Reservoir. Herbicides (those approved for use near water) or hand removals are recommended for controlling individual plants and small populations only (Swearington, 1997). Biological control insects are seen as the most likely method of effective long term control of large populations (Swearington, 1997), due to the high cost and relatively ineffective results of herbicide application.

Cheatgrass, knapweeds, and Canada thistle are currently the most prolific weeds present at Potholes Reservoir regardless of the disturbance level. Canada thistle can invade any moderately wet site although it reaches higher densities in disturbed areas where it can easily outcompete native species. Canada thistle is a particularly difficult weed to control due to its vast underground root system (Whitson et al., 1999).

Weed invasion in wetlands is also a predominant problem. In general, weeds are more difficult to eradicate from wetlands because there are a limited number of herbicides that can be used near water. Also, wetlands often have dense vegetation with desirable native species having noxious weeds intermixed. Targeting only the weeds is sometimes impossible.

The proliferation of undesirable plants within the Potholes Management Area is managed through the integrated weed management program established between Reclamation, the State, and the Noxious Weed Control Board of Grant County. The various Reclamation and state issued land use agreements (i.e., grazing and agricultural leases) require the lessee, licensee or permittee to maintain a weed control program to prevent the spread or establishment of noxious weeds. Herbicides that are highly toxic to people, fish or wildlife are not allowed. Each entity is responsible for either taking appropriate weed control measures, or is required to reimburse the administering agency for any weed control costs incurred as a result of that entity's failure to control weeds on the involved property.

According to information obtained from the Noxious Weed Control Board of Grant County, the Potholes Management Area is monitored for weed control by the County, but treatment is administered by the WDFW and Reclamation. On occasion, subcontractors conduct the County's prescribed weed control measures. Reclamation is generally concerned with Eurasian water milfoil control because infestation is a source of propagules for other waters in eastern Washington (Reclamation, 1989). Current control measures and management techniques involve water level manipulation, mechanical control, herbicides, biological controls, and light-screening measures (Remaley, 1999). Mechanical control is effective only if all parts of the plant are removed. Light manipulation is done through bankside plantings, dyes, or shade barriers that block light to the plants. Water level manipulations up or down can also be used - raising the level "drowns" the plants by preventing light from reaching them

and lowering the level exposes the plants and roots to the elements. This technique is highly effective in controlling the plant, but has not eliminated it. Complete eradication does not appear to be practical, but one or some combination of these techniques may be the most effective.

3.2.8 Fish

Fish habitat at Potholes Reservoir is changing over time. Willows and water smartweed are increasing along the shoreline. These plants provide cover for fish from winter through early summer. Bulrushes and other emergent and aquatic plants provide cover and sites for insect eggs. When water levels drop in the summer, fish often must move to open water with less cover where they are more vulnerable to predation (McMahon and Bennett, 1996). A lack of available cover during low water levels could be a limiting factor for adult fish populations, particularly for black crappie and largemouth bass (Zook, 1978).

Beaver lodges provide considerable cover for fish, especially during low water levels. Zook (1978) has found up to one hundred bass at a single beaver lodge site. Beaver structures provide some of the limited cover at low water. Beaver numbers generally fluctuate depending upon annual trapping pressure, and their lodges break down quickly once abandoned. Fewer beavers means less structural cover for fish during low water.

Recreational users can affect shoreline habitats. In particular, personal watercraft (PWC), due to their low draft and internal water jet design, are able to travel into areas too shallow for other boats. When they jet around in these shallow and sometimes vegetated shoreline areas, their fast movement creates waves that disturb and erode shorelines, and they may uproot emergent plants and disturb submerged plants and shoreline animals like fish and aquatic insects. These watercraft can therefore have a detrimental effect on shoreline habitat, especially during low water levels (Field Observations by Jim Tabor, WDFW).

A biological fish survey was conducted in September, 1978 to collect age composition and growth data for major game species, and the relative abundance of all major fish species in the reservoir (Zook, 1978).

The most recent biological survey of fish at Potholes Reservoir was conducted September 11-21, 1978. The goal of the preliminary survey was to determine species composition, relative abundance of warmwater fishes, and age class and growth data for game fishes. Perch were the most abundant species, and carp were second in abundance (Zook, 1978). Other species found at Potholes were largemouth and smallmouth bass, bluegill, long-nose sucker, black crappie, pumpkinseed, sculpin, rainbow trout, brown bullhead, and walleye. The same fish species are present today, but the relative

abundances are no doubt considerably different than they were 22 years ago. For example, anglers at Potholes Reservoir have reported a substantial decline in the abundance of yellow perch.

Fish introduced into the Columbia River system have the potential to enter Potholes Reservoir from Moses Lake via the Crab Creek Arm. Most reservoir fish species were introduced into the Columbia River system in the late 1800's and early 1900's (Wydoski and Whitney, 1979).

Prior to the start of this RMP process, the last creel census was conducted in 1973-74. A stomach content analysis conducted on major game fish at the reservoir was completed in 1973 (Tate). Growth was considered average for perch and bluegill and higher than average in other eastern Washington waters for black crappie and largemouth bass.

The WDFW has stocked Potholes Reservoir with rainbow trout since 1959 (Zook, 1977). Approximately 100,000 to 150,000 trout have been stocked each year since the 1970's. Fish are generally stocked in the fall and measure 5-6 inches in length. To improve growth and recruitment, 60,000 trout were retained in net pens in 1996 for a spring release of trout in 1997, averaging 9-10 inches. Rather than stocking rainbow trout directly into the reservoir, these fish are transferred into net pens to enhance survival and growth before release into the reservoir. This net pen experiment appeared successful with trout making up the majority of fish caught at the reservoir through mid-July that year. More pens will likely be added until all 150,000 trout can be accommodated (Personal Communication with Jeff Korth, WDFW). Small numbers of walleye have also been stocked, but other reservoir fisheries are not maintained by stocking.

Fish predators in Potholes Reservoir include established predatory fish, birds, and humans. Walleye, bass, and bullheads are some of the main fish predators present. Walleye, first observed in the reservoir in 1973, continue to feed all year while other species slow down during cooler months. They feed heavily on yellow perch, bullheads, and sculpins (Wydoski and Whitney, 1979).

Some fish-eating bird populations, such as double-crested cormorants and great egrets, have increased in recent years. Cormorants have recently become one of the most abundant colony nesting, fish-eating birds at the reservoir. The number of cormorant nests surveyed increased from 30 nests in 1983 to 652 nests in 1997. The diet of cormorants may include yellow perch, bullheads, crappies, carp, and sunfishes. Other fish-eating birds found in large breeding colonies include grebes, gulls, terns, and herons. The Western grebe consumes carp, perch, bluegills, grasshoppers, mayflies, and beetles (Terres, 1995). Large flocks of white pelicans can sometimes be found foraging in the reservoir or wasteways in late summer. Many other fish-eating marsh and shorebirds migrate through the area in fall and spring. Overall, these breeding and migrating birds consume large numbers of juvenile and small adult fish.

Angling pressure by humans may also have an effect on fish populations. While most fish are released, fishing contests still may have an impact on target populations. Rough estimates of visitors from car counter data, field observations, and questionnaires show an increase from 130,000 anglers in 1981 to 245,915 anglers in 1995 (Columbia Basin Wildlife Area Use Report Data).

The Job Corps Dike effectively isolated the North Potholes portion of the reservoir from the main reservoir body. This enabled biologists to eliminate all carp and other fish in the northern area. Largemouth bass and bluegill were subsequently restocked in 1977. Soon after carp were removed, the density of aquatic plants, invertebrates, muskrat, waterfowl, and other wildlife increased dramatically and the water became visibly clearer (Zook, 1978, Field Observations by Jim Tabor, WDFW). Bass and bluegill reproduced and showed a higher initial growth rate than in the main reservoir (Zook, 1978).

Although the Potholes Reservoir remains a popular fishing area, experienced Potholes anglers claim that some game species like perch, bluegill, crappie, and even largemouth bass appear to be declining. While carp, bullhead, smallmouth bass, and walleye populations appear to be on the rise this decade. Many factors may be contributing to the apparent declines in some species, including interactions of predatory fish, fish-eating birds, increased carp abundance, changes in habitat structure, water quality changes, reservoir productivity, annual water level fluctuations, and reservoir management. Fish diseases or parasites could also be factors. No systematic studies have been conducted to identify causal factors.

Today the goals of fisheries management at Potholes Reservoir include maintaining game fish species diversity and abundance with an emphasis on warm water species, and maintaining and enhancing recreational fishing opportunities. Although rainbow trout stocking is currently a major component of fisheries management, it is of secondary importance to maintaining other desired fish like perch, walleye, bluegill, crappie, and bass.

3.2.9 Wildlife

Construction of O'Sullivan Dam caused dramatic vegetative community changes within the RMP boundary. Wetland emergent and riparian habitats increased at the expense of shrub-steppe. This change was beneficial to some wildlife species because it created extensive emergent wetland and riparian habitat in an area where it had been limited.

Dispersed recreation within the Potholes area has also altered the vegetative communities at Potholes. Unlike the vegetative changes caused by dam construction, dispersed recreation has had a negative impact on wildlife habitat within the RMP area.

Irrespective of any past or current impacts, Potholes Reservoir provides suitable habitat for several classes of common and sensitive terrestrial game and nongame wildlife species (Figures 3.2-3 and 3.2-4 "Wildlife Resources Map"). The diverse habitat types, ranging from exposed sand dunes to lush riparian forests, are utilized by numerous wildlife groups including: mammals, birds, reptiles, and amphibians. Descriptions of the wildlife that occurs at Potholes Reservoir are listed below by group. Sections may be further subdivided into descriptive categories such as "game" or "nongame" where appropriate.

Mammals

Big game species within the reservoir area include mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*). Mule deer are more common with a population approaching 300-400 individuals, including the Winchester and Frenchman Hills Wasteways. The mule deer population has increased in the past few years. Fawn/doe ratios climbed to 100 fawns per 100 does in 1996 from a ratio of about 15 fawns per 100 does in the past (Tabor, 1996).

White-tailed deer sightings are rare near the reservoir. The most recent sighting was recorded in October 1996 near Potholes State Park (Tabor, 1996).

Furbearing Species

Furbearers in the Potholes Management Area include beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), raccoon (*Procyon lotor*), coyote (*Canis latrans*), long-tailed weasel (*Mustela frenata*), badger (*Taxidea taxus*), striped skunk (*Mephitis mephitis*)(Tabor, 1996, Foster *et al*. 1982) and rabbits (black-tailed jackrabbit *Lepus californicus* and Nuttall's cottontail rabbit *Silvilagus nuttallii*). Potholes Reservoir is also considered a major concentration area for beavers (Foster *et al.*, 1982). Although no official surveys have been conducted to quantify beaver population size, incomplete counts and observations indicate that at least one hundred beaver colonies (approximately 500 beaver) populate the Potholes Management Area (Tabor, 1996). The highest beaver concentrations occur in the northern section of the Potholes Reservoir Management Area in the West Arm, North Potholes Reserve, the Dune/Sand Islands, and the Crab Creek Arm. These areas are comprised of numerous pothole wetlands with a mixture of tree and shrub willow cover. Wetland plant community composition and the presence of many ponded areas are closely related to the dam building activities of beaver. Beaver lodges are key habitat structures in Potholes Reservoir. They provide nurseries for fish when the water level drops and shoreline areas are no longer available for cover (Zook, 1978), perches for herons and other birds, and basking sites for western painted turtles.

R28E

5 SE

"K" SE

"L" SE

"M" SE

5 SE

6 SE

T18N

T17N

O'Sullivan Site - South

Washington Ground Squirrel

Washington Ground Squirrel

E. Lind Coulee Arm

W. Lind Coulee Arm

Caspian Tern

Viceroy

Sage Thrasher

W. Lind Coulee Boat Launch

Developed Corridor

Washington Ground Squirrel

Wildlife Resources
Potholes Reservoir Resource Management Plan

Boundaries
- RMP Study Area
- Management Areas

Roads
- Highway/Improved Roads
- Primitive (Closed)
- Primitive (Open)
- Gate

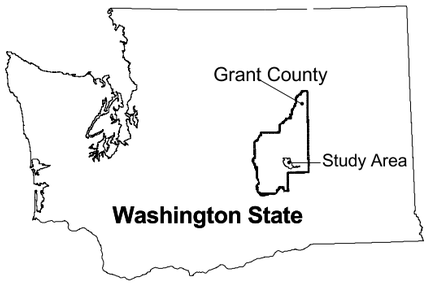
Priority Species
- Breeding Occurance
- Individual Occurance
- Regular Small Occurance

Shorebird and Waterfowl Concentrations
- Bald Eagle Wintering Habitat
- Waterfowl Breeding Concentrations
- Waterfowl Large Concentrations

N

Scale 1:30,000

0.4 0 0.4 0.8 Miles



Wildlife Resources
Potholes Reservoir RMP **Figure 3.2-4**

R27E R28E

T18N

T17N

North Potholes Reserve

Peninsula North

Peninsula South

Upper Crab Creek Arm

Lower Crab Creek Arm

Upper West Arm

Lower West Arm

Eastern Dunes

Eastern Bluffs

Dunes/Sand Islands

Main Reservoir

Moses Lake

Burrowing Owl

Great Blue Heron
Black-Crowned Night-Heron

Western Grebe

Clark's Grebe
Western Grebe

Clark's Grebe

Black-Crowned Night-Heron

North Outlet

South Outlet

Clark's Grebe
Western Grebe

Sand Dunes Road

Great Blue Heron
Forester's Tern
Great Egret

Double-crested Cormorant

Black-Crowned Night Heron

Loggerhead Shrike

Great Blue Heron
Great Egret

Job Corps Dike Boat Launch

Caspian Tern

Western Grebes

California Gull
Ring-billed Gull
Caspian Tern

Long-Billed Curlew

Ring-billed Gull\Caspian Tern

Western Grebes
Clarks Grebes

Western Grebes

Western Grebes
Clarks Grebes

California Gull
Ring-billed Gull

Forester'sTern (Abandoned)

Forester'sTern

Forester'sTern

California Gull
Ring-billed Gull
Caspian Tern

Ring-billed Gull

Caspian Tern
Caspian Tern

Caspian Tern

Forester'sTern

Forester'sTern

Forester'sTern (Abandoned)

O'Sullivan Site - North

Winchester Wasteway

Frenchman Hills Wasteway

Potholes State Park

Swainson's Hawk

BlackTern

Forester'sTern

CaspianTern

Burrowing Owl
American White Pelican

Developed Corridor

Loggerhead Shrike

Swainson's Hawk

Mar Don Resort

262

Grant County

Study Area

Washington State

Boundaries
- RMP Study Area
- Management Areas

Roads
- Highway/Improved Roads
- Primitive (Closed)
- Primitive (Open)
- ORV Trails
- Gate

Misc. Improvements
- Dikes
- Powerline

Priority Species
- Breeding Occurence
- Individual Occurence
- Regular Small Concentration
- Nesting Colony

Shorebird and Waterfowl Concentrations
- Shorebird Breeding Area
- Shorebird Large Concentrations
- American White Pelican Regular Concentration
- Bald Eagle Wintering Habitat
- Burrowing Owl Breeding Occurrence
- Clark's Grebe Breeding Occurrence
- Great Blue Heron Breeding Occurrence
- Priority Habitat Island
- Western Grebe Breeding Occurrence
- Waterfowl Large Concentrations

Wildlife Resources

Potholes Reservoir Resource Management Plan

N

0.5 0 0.5 1 1.5 2 Miles

Wildlife Resources
Potholes Reservoir RMP
Figure 3.2-3

Nongame Species/Small Mammals

Pocket mice and pocket gophers are dominant species in sandy areas, and montane voles are abundant in association with moist sites. Washington ground squirrels are limited to the Lind Coulee Arm where soils are silt loam rather than sand. Several bat species are known to occur in the Potholes Management Area. However, the paucity, or shortage, of caves, rock outcrops, and mature trees limits bat roost sites in the reservoir area.

Birds

Upland game birds in the Potholes Management Area include ring-necked pheasants (*Phasianus colchicus*), California quail (*Callipepla californica*), mourning dove (*Zenaida macroura*), and gray partridge (*Perdix perdix*). Ring-necked pheasants are locally abundant in wetland and adjacent upland areas. In winter, they congregate under coyote willows in the East Lind Coulee Arm, and in Russian olive thickets (WDFW, 1997). Pheasants are hunted in all areas surrounding the reservoir. California quail are most abundant in the Potholes State Park and Crab Creek Arm, and a few quail are hunted along the West Arm each year. Mourning doves nest and winter in the dense wetland habitats surrounding the reservoir (Tabor, 1996). The gray partridge population is low but possibly increasing (Tabor, 1997).

Waterfowl

Potholes Reservoir is a major waterfowl hunting area of statewide importance. The North Potholes Reserve is located north of the Job Corps Dike and extends north to Interstate 90. No hunting or trapping is allowed in this reserve, which serves as a resting area for thousands of ducks and geese. During the hunting season the reserve promotes hunting on other parts of the reservoir by holding ducks in the area (Foster et al., 1984). The reserve also serves as an important Canada goose rearing area.

Canada geese in the Columbia Basin nest primarily on islands found within the reservoirs and other large water bodies of the region (Foster et al., 1984). At Potholes Reservoir, geese nest at the edges and on the highest points of the Sand Islands, on gull colony islands, on beaver lodges, and in trees also used by nesting herons.

The reservoir has limited high quality breeding habitat and food resources for ducks. Prime breeding and foraging habitat is found predominantly near carp-free waters along the reservoir perimeter. It has been hypothesized that the presence of carp reduces quality duck breeding and foraging habitat. For example, duck brood count numbers were relatively high for several species during a study conducted

prior to the construction of O'Sullivan Dam: coots (156 in 1950 and 180 in 1951), mallards (43 in 1950 and 58 in 1951), and blue-winged and/or cinnamon teal (40 in 1950 and 34 in 1951). However, waterfowl were not observed in pothole ponds with carp (Harris, 1954). More recently, the presence of carp in Columbia Basin ponds has been correlated with a lack of submergent vegetation, and significantly lower waterfowl abundances (Foster et al., 1984) than carp-free ponds for mallards, gadwalls, northern shovelers, cinnamon teal, blue-winged teal, American coot, ruddy duck, and redheads (Clement, 1980; Tabor, 1996).

Colonial Nesting Birds

Three areas are particularly conducive to colony nesting. North Potholes Reserve, the reservoir arms (West Arm, Job Corps, and Crab Creek Arm), and the Sand Islands collectively provide nesting habitat for all the colonial nesting birds that occur at the reservoir.

North Potholes Reserve

Many factors make the North Potholes Reserve ideal habitat for large colonial nesting birds. At the North Potholes Rookery, tall peachleaf willow stands loom above a complex of willow shrub, emergent, and open water wetlands. These willow trees, up to 50 feet tall, have matured since the 1970's to provide nesting habitat for black-crowned night herons, great blue herons, great egrets, and double-crested cormorants. The numerous ponds at this site and the reservoir supply these birds with food (i.e., fish and other aquatic organisms). Human disturbances within the reserve are minimal as motorized boats and automobiles are prohibited except in the vicinity of Job Corps Dike.

The Reserve has provided unique bird watching opportunities for many years. It contains the largest black-crowned night heron rookery and the first great egret breeding record in Washington state (Clement, 1980; Fitzner et al., 1979). In addition, three of the four main colony nesting birds here have State protective status as monitor species including the black-crowned night heron, great blue heron, and great egret. Breeding areas for all four species are considered priority habitats by the WDFW.

Reservoir Arms

The reservoir arms (West Arm, Job Corps, and Crab Creek Arm) are characterized by scattered tree willows, shrub willow dominated shorelines, and numerous ponds and islands bordered by emergent wetland vegetation. Black-crowned night herons and great blue herons have nested in relatively low

densities in Crab Creek rookeries. Fishing and PWC uses are sometimes concentrated in these arms (Finger and Tabor, 1997) especially at high water when access is not limited.

Sand Islands

Gulls and terns have nested on the Sand Islands since the 1950's (Harris and Yocom, 1952; Johnsgard, 1954). Islands selected by nesting gulls and terns are usually bare to sparsely vegetated with steppe grasses or shrubs. The shorelines may support willows and emergent plants. At Potholes Reservoir, these ground nesting birds scrape cup-shaped nests into the sand and line them with twigs and feathers (Finger and Tabor, 1997). Island colonies are very dynamic, with birds selecting different islands for nest sites, sometimes on a yearly basis.

The abandonment of entire island colonies appears to be relatively common at Potholes. Three out of five gull and tern colony islands containing approximately 673 ring-billed gull, 94 California gull, and 119 Caspian tern nests were abandoned a few weeks after Memorial Day 1997. After these abandonments another island colony was established. However, this newly established colony was also abandoned by June 23. In addition, two out of three Forester's tern island colonies were abandoned in 1997 (Finger and Tabor, 1997). It is not known whether the increase in human activity in the spring and summer contributes to the abandonment of nests and colonies.

Western Grebe - Grebe breeding areas are classified as priority habitat by the WDFW. Western grebe observations at Moses Lake and Potholes Reservoir date from the 1950's during early reservoir development (Harris and Yocom, 1952; Johnsgard, 1954). In 1997, the estimated number of western grebe breeding pairs was greater than 1,000, despite a large percentage of nest failures due to changing water levels, and wave action from boats and other water craft (Field Observations by Jim Tabor, WDFW). Grebes nested primarily in thick stands of bulrush in the Crab Creek Arm in the early 1990's (Tabor, 1997).

In 1997, western grebes nested along the West and Job Corps Arms, and Clark's grebes nested along the West Arm (see Figures 3.2-3 and 3.2-4 "Wildlife Resources Map"). There were 240 active western grebe nests, and at least 13 Clark's grebes nests. Nests were made of smartweed and bulrush. The first nests were observed on June 29 (Finger and Tabor, 1997). Grebes did not nest in the Crab Creek Arm in 1997.

Cormorant - The double-crested cormorant colony became established in the late 1970's. The colony has grown in recent years to become one of the largest fish-eating bird colonies in North Potholes Reserve. Before establishing nesting populations at Potholes, cormorants were noted as common migrants in the area (Johnsgard, 1954). In 1978, approximately 16 adult birds were observed in North

Potholes Reserve. By 1982, the cormorant population was very productive with at least 30 nests, each containing 3-4 young. The colony grew to approximately 425 nesting pairs in 1991. Nest production was high with many nests containing 4-5 young. Large numbers of non-breeding birds (up to 100 in 1983) were also using the reservoir (Friesz, 1997). In 1997, 652 nests were active with incubation in May and hatching in June (Finger and Tabor, 1997).

Double-crested cormorants are diving foragers rather than shallow water waders (Terres, 1995). The double-crested cormorant is presently one of the dominant fish-eating birds nesting in the tree willows. During the past ten years, the cormorant and egret colonies have had the highest growth rates of all of the colony nesting birds.

Other Water Birds and Shorebires

Water bird and shorebird breeding at Potholes Reservoir include sora rail, Virginia rail, American coot, killdeer, long-billed curlew, common snipe, and spotted sandpiper. Long-billed curlews nest in steppe grasslands and in high quality shrub-steppe habitat such as found within the Peninsula North, Peninsula South, and North Potholes Reserve Management Areas.

The white pelican is a state endangered species and is one of the more sought after birds by bird watchers. As such, the white pelican is a "high profile" species of concern at the reservoir. White pelicans are very opportunistic foragers and they will flock to areas with a rich supply of available fish. At Potholes Reservoir this supply of fish is most readily available when the water levels are low, causing fish to be restricted to pools where they are more vulnerable to predation. Significant numbers of white pelicans are present in the late summer and early fall, and in recent years their summer presence has increased. Counts of white pelicans have varied between 200 and 1,600 birds from 1978 to 1990 (WDFW, 1997). About 1,000 pelicans were observed in September 1996 foraging and resting in the wasteways. Part of the population is believed to be associated with the breeding colony of William Lake, B.C., estimated to be around 200-300 birds (Personal Communication with Jim Tabor, WDFW).

Reptiles

Sagebrush lizards (*Sceloporus graciosus)* are found in shrub-steppe habitats surrounding the reservoir. The Sand Islands and the uplands around the reservoir provide habitat for Northern sagebrush lizards, horned lizards (*Phrynosoma douglassii*), racers (*Coluber constrictor*), gopher snakes (*Pituophis catenifer*), and garter snakes (*Thamnophis spp*.). Painted turtles (*Chrysemys picta*) are abundant in the North Potholes Reserve and Crab Creek Arm. Painted turtles are often seen sunning themselves

on logs or hummocks in the pothole wetlands, and their tracks are often visible crossing the sandy ORV trails within the Lower Crab Creek Arm.

Although there are no known records of night snakes (*Hypsiglena troquata*) within the Potholes Management Area, habitat is available in basalt rocks at the southern end of the reservoir and in rodent burrows in the sandy soils found throughout the area. There is record of a night snake south of the West Lind Coulee Arm (WDFW, 1997).

Amphibians

Northern leopard frogs (*Rana pipiens*) are only known to occur in two Washington state locations. These most recent records are at Potholes Reservoir and in parts of Crab Creek north of Moses Lake. The Potholes Management Area's small, localized population is found in the Crab Creek Arm and North Potholes Reserve where they seem to prefer moist soil grown over with cockleburs during late summer and fall. Little is known about their breeding habits in this area (Friesz, 1997).

Tiger salamanders (*Ambystoma tigrinum*) are found in and near fish-free ponds along the Potholes Reservoir perimeter. They attach their eggs to submerged vegetation in shallow water where larva may take from one to two summers to metamorphose into terrestrial adults.

3.2.10 Threatened and Endangered Species

Information on federal and state special status plant and wildlife species in the Potholes Reservoir Management Area was obtained from databases maintained by the Washington Natural Heritage Program (WNHP) and USFWS. Included are those federally listed as Threatened or as "Species of Concern," and those with Endangered, Threatened, Sensitive or Review State status. In general, however, the presence or absence of a special status species at the site-specific location remains undetermined without additional field inventories.

Special Status Plant Species

Species with Federal Status

The WNHP indicated that there are no federally listed species known or suspected to occur in the project area (1996, 1999). However, the USFWS (March 29, 1999) included Ute ladies'-tresses (*Spiranthes diluvialis*) in their list of federally listed species that may occur at Potholes Reservoir.

The probability is very low that Ute ladies'-tresses occur in the Potholes Management Area due to the lack of appropriate habitat conditions. The USFWS (1998) states that Ute ladies'-tresses do not occur along slow meandering streams out in the flats - a good description of the streams near the Potholes Management Area. Most wetlands within the area are subject to long periods of inundation followed by severe drawdowns during the irrigation season, another condition specifically discussed by the USFWS as inappropriate. Lastly, the microclimates and elevations found at Potholes Reservoir are generally not conducive to the species.

Species with State Status

A Washington State Sensitive Species is defined by WNHP as "a species that is vulnerable or declining and could become Endangered or Threatened in the State without active management or removal of threats." According to the WNHP (WNHP, 1999), gray cryptantha (*Cryptantha leucophaea*), an upland forb and state sensitive species, occurs at one location in the Peninsula South management area and west of the Lower West Arm management area near the Winchester Wasteway. It typically grows in dry, often sandy places and is associated with rabbitbrush (*Chrysothamnus* spp.) and/or sagebrush (*Artemisia tridentata*) shrub communities and with cheatgrass (*Bromus tectorum*) and bluebunch wheatgrass (*Agropyron spicatum*) (WNHP, 1981). There is a large amount of this habitat type in the Potholes Management Area, though most of it is degraded. The cause of its rarity is unknown. Also, it is unknown how this species responds to disturbance.

Special Status Wildlife Species

Special status species are species that have been classified by the USFWS or WDFW as Threatened, Endangered, Species of Concern, or Monitor species.

Species with Federal Status

The bald eagle is the only federally listed Threatened species that occurs within the Potholes Management Area. There are no federal Endangered species listed within the overall management area since the de-listing of the peregrine falcon.

Individual adult bald eagles have been observed during the spring and summer months around the North Potholes rookery area in the last five years, leading to the speculation that at least one pair may be attempting to nest in the area. However, no nest has been found (Field Observations, WDFW).

The Washington ground squirrel is the only federally listed Candidate species within the Potholes Management Area.

Species with State Status

There are three State listed Endangered species (American white pelican, sandhill crane, and peregrine falcon) and two state listed Threatened species (Ferruginous hawk and bald eagle) that use the Potholes Management Area. In addition, there are nine State candidates for listing as Threatened and Endangered (western big-eared bat, Washington ground squirrel, common loon, western burrowing owl, sage thrasher, loggerhead shrike, sage sparrow, Columbia spotted frog, and northern leopard frog) and fifteen species on the state Monitor list (fringed myotis (bat), small-footed myotis, Kincaid's meadow vole, western grebe, Clark's grebe, Forster's tern, great blue heron, great egret, black-crowned night heron, black-necked stilt, long-billed curlew, prairie falcon, grasshopper sparrow, night snake, and tiger salamander).

Special Status Fish Species

No fish species with State or federal status (Endangered, Threatened, Species of Concern, or Monitor) are known to occur within the Potholes Management Area. However, State priority game fish including large and smallmouth bass, walleye, and rainbow trout are present.

3.3 CULTURAL RESOURCES SUMMARY

Cultural resources are defined as buildings, sites, structures, or objects, each of which may have historical, architectural, archeological or scientific importance. There are several laws and regulations directing federal agencies to locate, identify, evaluate, preserve, protect and manage cultural resources significant to the nation's heritage and history, the focus of which, is the National Register of Historic Places.

3.3.1 Findings

A Class III cultural resource survey was conducted for the Potholes RMP area (36,200 acres) in 1999. Of the 18,597 acres of dry land, including islands, 13,235 acres were surveyed. The 5,362 acres not covered by on-the-ground reconnaissance were inaccessible. Ten sites, all dating to the historic era, were recorded, along with 44 isolated finds (Axton *et al,* 2000). Of the 44 isolated finds,

all but four also dated to the historic era. The four non-historic represented American Indian occupations. Thus the dominant human occupation of the Potholes vicinity, as determined by cultural resources surveys, relates to the post American Indian occupation, especially the 20th century. No cultural resources identified were deemed eligible for National Register consideration.

Were it not for the completion of Grand Coulee Dam in 1942 located in the north CBP, and the development of the vast agricultural potential of the Columbia Basin, the Potholes area would have likely remained the dry, sand-blown desert described by those who traveled through the region a century before. Because of both the importance to the success of the CBP, as well as meeting the minimum 50 year-old criterion, O'Sullivan Dam itself is potentially eligible for the National Register.

Indian Trust Assets

Indian Trust Assets (ITAs) are legal interests in property held in trust by the United States for Indian Tribes or individuals. While most ITAs are on-reservation, they may also be found off-reservation. Examples of trust assets include lands, minerals, hunting and fishing rights, and water rights. Sometimes there is disagreement between the government and the tribes regarding what is considered to be an ITA, and who holds the right. This document does not judge the validity of rights claimed by any tribe.

The United States has a trust responsibility to protect and maintain rights reserved or granted to Indian Tribes or individuals by treaties, statutes and executive orders. This responsibility is sometimes further interpreted through court decisions and regulations. This trust responsibility requires that Federal agencies take reasonable actions to protect trust assets when administering programs under their control.

Findings

The Potholes Reservoir Management Area falls within the area ceded under the Treaty of 1855 in which rights to fishing and privileges for hunting and gathering of roots and berries were retained by the tribes signing the treaty.

While much of the Potholes Reservoir Management Area retains resources that support hunting, fishing and gathering activities, some areas may have been disturbed to the extent that they no longer can support such traditional uses. Currently, these activities are allowed throughout the Potholes Reservoir Management Area except that hunting is not permitted in Potholes State Park and in the North Potholes Reserve.

3.4 PALEONTOLOGICAL RESOURCE SUMMARY

The Columbia Basin basalts in the vicinity of Potholes Reservoir do not lend themselves to fossil preservation. Some vertebrates and invertebrates are occasionally reported in the area, but not with any frequency. Preserved plant species are present elsewhere in the Basin.

3.5 AESTHETIC RESOURCE SUMMARY

3.5.1 Visual

Fieldwork to inventory the scenic quality of the Potholes Management Area consisted of driving and hiking the area surrounding the reservoir as well as boating on Potholes Reservoir to qualitatively determine general visibility of the major landforms, recreation facilities, manmade structures, and reservoir-related facilities. In 1999, a visitor profile and recreational use study provided information on viewer sensitivity and key viewpoints. This information was presented in the Potholes Reservoir EIS and used to establish goals and objectives for visual resources.

Visual Character

Landscape character gives a geographic area its visual and cultural image, and consists of the physical, biological and cultural attributes that make each landscape identifiable or unique. (SMS, 1995). The upland landscape surrounding Potholes Reservoir is semi-arid and characterized by upland shrub-steppe cover types that include native shrubs and introduce annual grasses. Typically, these appear homogenous to the casual viewer and are not highly regarded. However, changes are more noticeable in this landscape type than in other more diverse landscapes.

Widely dispersed ranches, orchards, and farm operations are visible along the eastern boundary of the Potholes Reservoir Management Area. Riparian forest and riparian shrub cover types are common along reservoir and island shorelines, in natural drainages, and along wasteways. Wind breaks and shade trees are found in developed areas where they have been planted and irrigated. Sandy beaches, wind-blown dunes, and mudflats (at low water) characterize many of the undeveloped shoreline areas found around the reservoir. Most of the dispersed campsites have fire rings, and some are visually compromised each season by the presence of trash and human waste.

At Potholes Reservoir, sensitive viewpoints include travel routes (SR 262, SR 17 and Dodson Road). In addition, there is an established network of primitive dirt, sand or gravel surfaced roads visible throughout the Potholes Reservoir Management Area. Recreation sites and areas are also considered

sensitive view points at Potholes Reservoir. Most recreation users at Potholes Reservoir are boaters and campers who utilize the facilities in the Developed Corridor. These visitors expect developed amenities and modifications to the landscape. Visitors who camp at dispersed areas tend to prefer a more primitive experience and tend to be sensitive to changes in landscape character. The ORV Area experiences high use during the Memorial Weekend, but residual trash would suggest a general disregard for the visual quality of the area.

3.5.2 Noise

Noise (generally defined as undesirable sound) can be annoying to area visitors as well as wildlife. Unfortunately, the subjective effects of noise (annoyance, nuisance, dissatisfaction) cannot as yet be measured in any completely satisfactory way. This is primarily because of the wide variation in individual thresholds of annoyance and the habituation to noise of differing individuals due to their past experiences. In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be judged by those hearing it.

The most sensitive noise receptors in the Potholes Reservoir Management Area are the existing developed recreation areas (Potholes State Park and Mar Don Resort) and important wildlife areas (Dunes/Sand Islands and North Pothole Reserve). Ambient sound levels throughout most of the Potholes Reservoir Management Area are generally rural to residential in nature. These ambient levels are affected by noise from vehicular traffic on nearby roads, motor boats and personal watercraft (jet skis) on the reservoir, and general recreational activities (ORVs), all of which exert a greater influence, individually and cumulatively, during seasonal peak-use periods.

The impacts of noise on colonial nesting birds, Neotropical Migratory Birds (NTMB), large and small mammals, and other wildlife species are not well understood. While various species probably adapt to some noise, the limits to the amount of adaption that can be made are not known. Although some species have little tolerance of noise (e.g., Canada geese) and others tolerate noise at very high levels (e.g., great egrets), noise can have other effects that are not readily apparent, such as relocation or prevention of mating and nesting behavior.

3.6 ECONOMIC AND SOCIAL RESOURCES SUMMARY

From 1930 to 1962, Grant County experienced rapid growth from 6,000 people to over 54,000. This increase was due mainly to the military installations and major construction projects dealing with the allocation and manipulation of the water resources. Since 1970, Grant County has had a relatively constant population showing only a slight overall increase. From 1989 to 1996, however, Office of

Financial Management figures show an increase to 66,400 ranking Grant County 17th in the State for population size.

Some population increases can be attributed to the migration of people from cities to rural communities. This commuting culture has created its own economic and ecological changes. For the Potholes area this mobility and desire for solitude has contributed to the influx of the recreating public. However, the majority of increase in population and changes to the Potholes and Grant County area is due to the introduction of water to several new irrigation blocks. This creates a "ripple" affect for the growth of small industry to accommodate the increased need for homes and home services. This was the case for the county leading up to the 1980's.

3.6.1 Economic Setting

Farming is the major industry in Grant County. The surrounding region produced 42 percent of the potatoes, 20 percent of the wheat, 54 percent of the sweet corn, 32 percent of the hay, and 43 percent of the peppermint in Washington state.

In 1993, one out of every four employees in the region was a farm worker. Statewide, less than 4 percent of all workers are farm workers. In Grant County there were over 5,700 farm workers. Employment rates vary greatly throughout the year and are directly related to the seasonality of farm work.

Farm income is the primary factor in the per capita average and reflects the relative volatility of farm income. Fifteen percent of Grant County income is farm related, compared with 1 percent statewide. Income distribution, measured by median household income, was $26,288 in Grant County, compared to a state median household income of $36,648 for 1992.

Grant County construction employment closely matches the State average of 5 percent. Manufacturing employment for Grant County and the State in 1993 was 17 percent and 15 percent, respectively. Seventy three percent of Grant County manufacturing is in food processing.

Since 1986, per capita income has been below the state and national averages. The national per capita income average in 1992 was $20,105. Grant County per capita income has remained relatively flat and below the state and national averages since the mid-1970's. In 1992, per capita income in Grant County was $16,289, 77 percent of the statewide average, and ranked 31st in the State.

3.6.2 Recreation/Visitation

In 1998 and 1999, "a visitor profile and recreational use survey" was conducted to gather information about visitor use and satisfaction, crowding, conflicts, recreation needs, as well as demographic and economic data pertinent to the Potholes Reservoir Management Area.

The recreation survey indicated that most Potholes Reservoir respondents were from the Puget Sound area, with 31 percent from the Seattle area. Fourteen percent of the respondents were locals from Grant County, 13 percent were from the Tacoma area, and 10 percent were from the Everett area.

About 35 percent of the respondents were return visitors, and 59 percent identified Potholes Reservoir as one of their favorite reservoirs to visit. Seventy-six percent of all users came to Potholes to be with friends, and about half of the respondents were satisfied with their trip. In support of their satisfaction, about half of the respondents would be willing to pay user fees from $1 to $10 per year. However, 26 percent indicated they were not willing to pay for facility use.

The average length of stay was five days. Twenty-three percent of respondents made arrangements and planned to stay at Potholes Reservoir one week to one month in advance of their visit. Thirty-three percent of the visitors have been coming to Potholes Reservoir for more than 10 years, 24 percent from 6 to 10 years, and 21 percent from 3 to 5 years. Thirty-four percent stayed in public dispersed camping areas and 26 percent camped at Potholes State Park. Nineteen percent of the respondents stayed at Mar Don Resort.

Overall survey use included camping (72 percent), fishing (63 percent), sunbathing (46 percent), and swimming (45 percent), however 36 percent of the survey respondents ranked fishing as the most important activity while 24 percent consider camping the most important recreation activity. Anglers ranked walleye and bass as the preferred catch, followed by trout and perch. Thirty-eight percent of the respondents used powerboats and 21 percent used PWC.

3.6.3 Solid Waste Management

Several sites surrounding Potholes Reservoir have been identified as areas where scattered litter is a common, recurring problem. To address this issue, establishing improved litter control procedures at each formal and informal day use and overnight site within the Potholes Reservoir Management Area should be a priority.

Establishing a reporting/monitoring system for litter control can include a monthly drive-by or visual site investigation of heavy use areas for loose trash, full trash receptacles, etc. Initial inspections should

record areas where receptacles need to be serviced more frequently, or problem locations where receptacles are not available (i.e., Sand Dunes and other informal camping areas). Monitoring results can direct where sanitation facilities and services should be improved or supplemented as necessary (i.e., during peak weekends). Discouraging trash dumping on public lands could be accomplished through educational programs, signage, brochures, increased monitoring, and/or law enforcement with strict penalty by Federal, State, and local officials. Adopting and encouraging "pack-in/pack-out" procedures and promoting the solid waste management survey program should be a priority in visitor brochures, and on appropriate signage.