CHANGES TO THE LEE METCALF ECOSYSTEM

SETTLEMENT AND LAND USE CHANGES

The Bitterroot Valley was a route used by native people moving from Idaho and eastern Washington/Oregon to the plains of eastern Montana where they hunted buffalo and obtained other seasonal resources. The earliest occupation of the Bitterroot Valley by native people is unknown but apparently dates to nearly 12,000 BP (Ward 1973). The Salish Indian people occupied the area immediately prior to European settlement; these people were somewhat nomadic and likely used the area for hunting, fishing, and gathering native plants and for overwintering. The Bitterroot Valley was used by the first European explorers to the western U.S., including Lewis and Clark. Following the Lewis and Clark expedition, fur traders from the Hudson's Bay Company entered the Bitterroot Valley to secure furs from the Indians, and forts and missions were established. The oldest community in Montana was initially established at the present day site of Stevensville by Catholic missionaries in 1841 (Stevensville Historical Society 1971). Father Pierre De Smet came to the Valley at the request of four separate Indian delegations from the Salish tribe to St. Louis in the late 1830s. De Smet and other priests were eventually joined by Father Anthony Ravalli in 1845. Named St. Mary's Mission, this community kindled additional settlement in the region. St. Mary's Mission was closed in 1850, and the community was renamed Fort Owen, and then later Stevensville. The primary early use of land by settlers in the Bitterroot Valley was for cattle grazing; by 1841 extensive areas of the valley were grazed and used for winter range as cattle were moved from summer grazing and calving locations in mountain slopes and foothills back into the valley in the fall (Clary et al. 2005).

In the mid 1850s, the discovery of gold in western Montana fueled immigration of settlers to the state and a short flurry of gold exploration and mining occurred in the Bitterroot Valley. Early workers in the gold camps subsisted on wild meat and the importation of produce, meat, and dairy products. At this time some local residents began growing vegetable crops to feed the miners and this demand stimulated the first agricultural development in the Bitterroot Valley. Subsequently, the Bitterroot Valley became the "breadbasket" that nourished Montana's genesis and Fort Owen was the nucleus of the first European settlement. Gold exploration was short lived in the Bitterroot region, however, and by the 1870s, the economy of the area was almost solely based on local agricultural crops and cattle production. Ravalli County was created in 1893 and by 1914 extensive settlement had occurred in the region. Timber harvest and grazing were the predominant economic uses of the area at that time (Browman et al. 1989, Clary et al. 2005).

The dry climate of the Bitterroot Valley created annual variation in the availability of water to support agricultural crops. As early as 1842, priests at St. Mary's Mission successfully planted and irrigated crops of wheat, potatoes, and oats (Stevensville Historical Society 1971), and thus by appropriation, the first water right in Montana was established. A water right on the North Burnt Fork Creek was filed in 1852 by Major John Owen, who used creek water to operate a grist mill and sawmill. Two methods of water appropriation occur in Montana. The first (used by early settlers, miners, and mill operators) applies the "relation back" rule of law. That means that the right is dated to the time when first construction began to build a ditch or means to use the water in a "beneficial" (sic) way. The second method involves posting a point of diversion on a creek or other drainage and

filing notices in the courthouse. A stream inevitably becomes over-appropriated when many people and industries make demands on it. Over-appropriation usually ends in "quick frozen" or "decreed" action and adjudication of a stream becomes necessary when rights are conflicting. For example, water in North Burnt Fork Creek was adjudicated in 1905.

In the early 1900s, the Bitterroot Valley Irrigation Company began construction of a major irrigation system for the Bitterroot Valley (U.S. Bureau of Reclamation 1939, 1982; Stevensville Historical Society 1971). The Irrigation Company developed an extensive irrigation network of water storage and conveyance facilities along the Bitterroot River and its tributaries including constructing several reservoirs, including Lake Como west of Darby, and a diversion dam on Rock Creek. In 1905 the existing dam at Lake Como was raised 50 feet and by winter 1906, 17 miles of canal were built to convey water from Lake Como north in the Bitterroot Valley. Eventually, a channel was built from Lake Como to the Bitterroot River, at which point it was siphoned under the river bed and into a 24 foot wide canal, capable of carrying water six feet deep. Water was then flumed across several small gulches and Sleeping Child Valley and around the foothills for 75 miles to the Eight Mile country east of Florence. By 1909, 56 miles of canal had been built northward to North Burnt Fork Creek. Subsequently about 14,000 acres of cropland were sold and irrigation water was delivered to the acreage. The main Supply Canal originally was constructed to primarily deliver water to apple orchards. The canal, however, was only able to supply about ½ inch of water/acre, which was barely enough to support fruit trees and only about half enough for other crops. The land was bought by local farmers and then resold in promotional schemes to eastern families for mainly apple production. Limited water and poor yields collapsed orchard production and by 1918 the "Big Ditch Company" (i.e., the Bitterroot Valley Irrigation Company) went bankrupt.

In 1920, a reorganized Bitterroot Irrigation District was formed and the newly formed district issued bonds to purchase water rights and to develop water storage/distribution works. Drought conditions in the late 1920 and 1930s coupled with the Depression era economics, further exacerbated water problems in the valley and curtailed agricultural expansion in the region during this period (Cappious 1939, Stevensville Historical Society 1971). Following further financial difficulty, in 1930 Congress authorized the Bureau of Reclamation to liquidate private indebtedness and rehabilitate the Bitterroot Irrigation District (U.S. Bureau of Reclamation 1939). Extensive rehabilitation to the main "Supply Canal" and its distribution system was conducted from 1963 to 1967. Flood damage occurred in 1974 and extensive repairs were made on many structures. Currently the Bitterroot Irrigation District provides water to about 16,665 acres on the east side of the Bitterroot River (U.S. Bureau of Reclamation 1982). The Main Supply Canal for the Bitterroot Irrigation District runs ca. one-mile east of the Lee Metcalf NWR and primary distribution ditches on the refuge include the McElhaney, Warburton, and Alleman ditches (Fig. 14).

The majority of the Bitterroot Valley was unfenced in the early era of settlement from 1850 to 1910. However, in the early 1900s, the "apple boomers" that bought much land in the Valley began fencing most of the area. By the mid 1930s, more than 50,000 sheep and 30,000 cattle were present in the Bitterroot Valley; only about 22% of the valley was harvested cropland (Richey 1998). Generally wet conditions in the late 1940s and early 1950s stimulated agricultural production in the Bitterroot Valley and large scale cattle grazing and haying operations, and some small grain farming, expanded in and near the Lee Metcalf NWR area. Most native riparian forest and grassland in the Lee Metcalf NWR region had been cut, cleared, and/or converted to alternate land uses by the mid 1900s (Fig. 15). Two of the larger minor floodplain channels, Nickerson and McPherson creeks (now called ditches), were partly ditched in the mid 1900s and some minor impoundment of low elevation depressions and drainages occurred. By the 1960s, lands that became part of Lee Metcalf NWR were controlled by about 13 ownerships that heavily cropped and grazed the area (Fig. 16). Much of the site was irrigated crop and pastureland using the extensive ditch and irrigation diversion system constructed across the floodplain (Fig. 14). These impounded "ponds" probably were created for water sources for livestock. Another interesting development, a golf course, was established on the southwest side of Lee Metcalf in 1933.

Numerous roads have been built in the Bitterroot Valley starting with a stage coach road in 1867 (Stevensville Historical Society 1971). This route eventually became U.S. Highway 93. Other early roads in area were constructed from 1870 to 1900. These roads skirted higher ground and avoided the river, but eventually bridges were built across the Bitterroot River beginning in the late 1800s. These bridges often

were destroyed by high water levels and floods. The Bitterroot Branch of the Northern Pacific Railroad was constructed from Missoula to Grantsdale in 1889 and soon thereafter was extended to Darby. This rail line was built primarily to transport timber from the slopes of the Bitterroot Mountains and sawmills sprang up all along the west side of the valley. Rail spurs connected mills and eventually logging and mills expanded to the east side of the valley. Transporting lumber from the east side of the Valley eventually led to the construction of rail bridge crossings over the Bitterroot River including the bridge and line at the northern boundary of Lee Metcalf NWR. In 1927 and 1928, the railroad was relocated from south of Florence to the east side of the river

By the late 1970s, farm sizes in the Bitterroot Valley increased greatly, but agricultural economies prevented more extensive small grain farming in the valley and landowners began subdividing holdings for residential development (Richey 1998). By the early 1990s, Ravalli County had the fastest growing population and residential expansion in Montana, expanding from about 25,000 residents in 1990 to > 38,000 in 2007 (U.S. Bureau of the Census, issued annually). Most of the residents of Ravalli County live on the Bitterroot Valley floor within a few miles of the river. Much of the increase in population occurred outside of established towns and became concentrated in areas where each dwelling or subdivision has its own well and septic systems. Several hundred residential structures now essentially surround Lee Metcalf NWR (Fig. 17).

HYDRO-GEOMORPHOLOGIC CHANGES

The Bitterroot River stretch at Lee Metcalf NWR lies near the geomorphic threshold between a highly braided river channel pattern from Hamilton to Stevensville and a straight or sinuous channel pattern immediately downstream (Fig. 3). Consequently, the river channel pattern for the area is metastable and highly sensitive to perturbation (Gaeuman 1997). The combination of irrigation development and land use changes, mainly in the 1900s, significantly altered hydrology and river channel morphology and movement in the Bitterroot Valley and its floodplains and facilitated degradation and loss of wetlands in this ecosystem (e.g., Kudray and Schemm 2008). The extensive irrigation network of the Bitterroot Irrigation District led to construction of reservoirs, ditches, water diversion structures, and modified natural drainage routes (Fig. 14, Table 2). Stream channel networks, common in the Bitterroot Valley near Lee Metcalf NWR, were altered by culvert and bridge crossings, railroad levees and beds, and extensive channelization of tributaries. Many stream channels, including sections of the Bitterroot River, were lined with rip-rap rock and car bodies to slow stream migration and in-channel bank erosion (Fig. 18). In addition to local physical disruptions to topography and hydraulics, the larger-scale entire fluvial system of the Bitterroot River has been altered by historic land use changes. The valleys and lower hill slopes have been grazed and farmed, while the upper valleys and mountains have been partly deforested. Overgrazing was common on many valley terraces and, when coupled with deforestation in adjacent mountains and slope areas, led to erosion and increased sediment loading in the Bitterroot River (Briar and Dutton 2000). Subsequently, extensive sedimentation has occurred in drainages

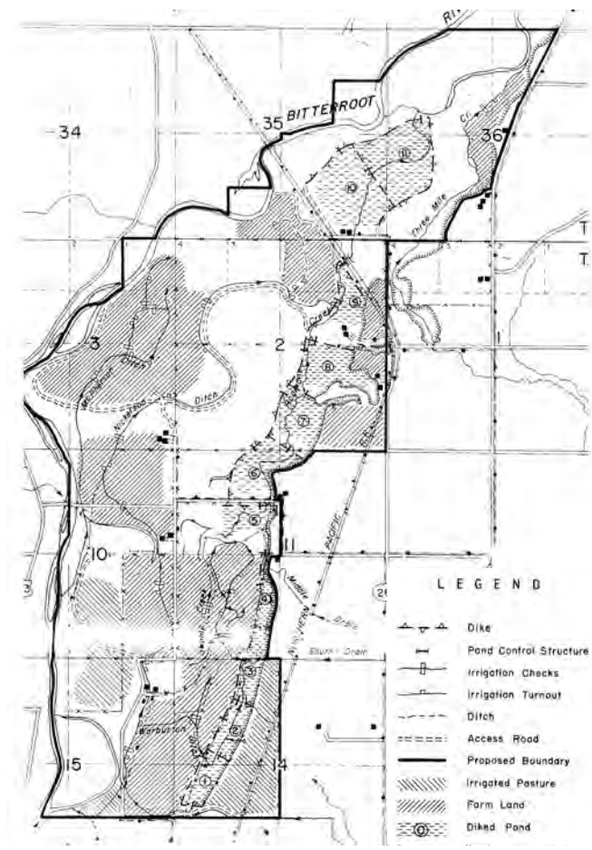
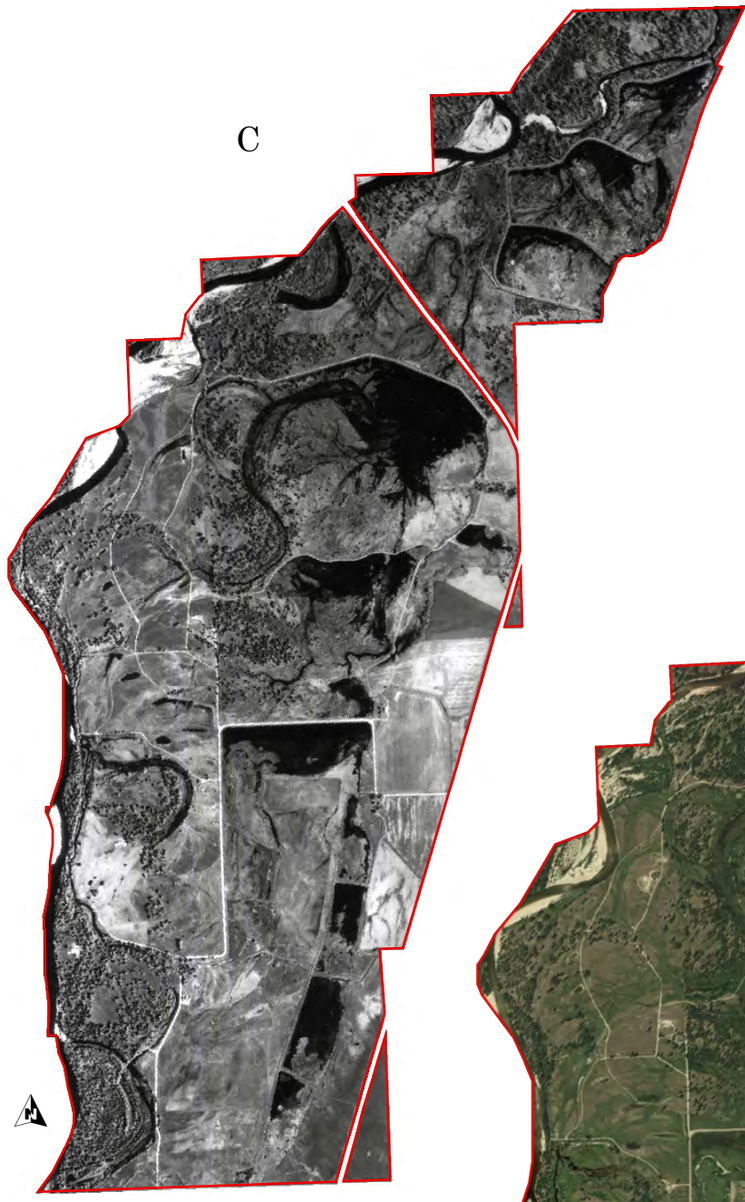


Figure 14. Drainage and irrigation ditches and infrastructure and land use on Lee Metcalf National Wildlife Refuge in the early 1960s.

Figure 15. Sequence of aerial photographs of Lee Metcalf National Wildlife Refuge in a) 1960s, b) 1970s, c) 1983, and d) 2006.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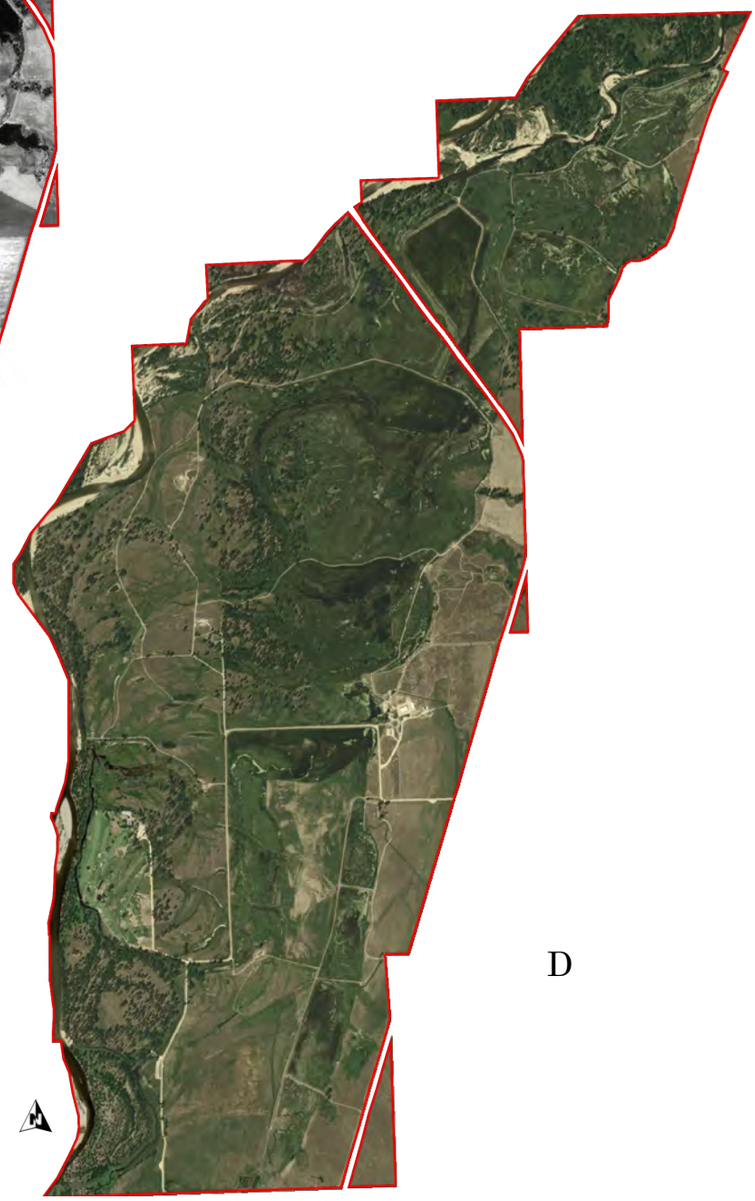
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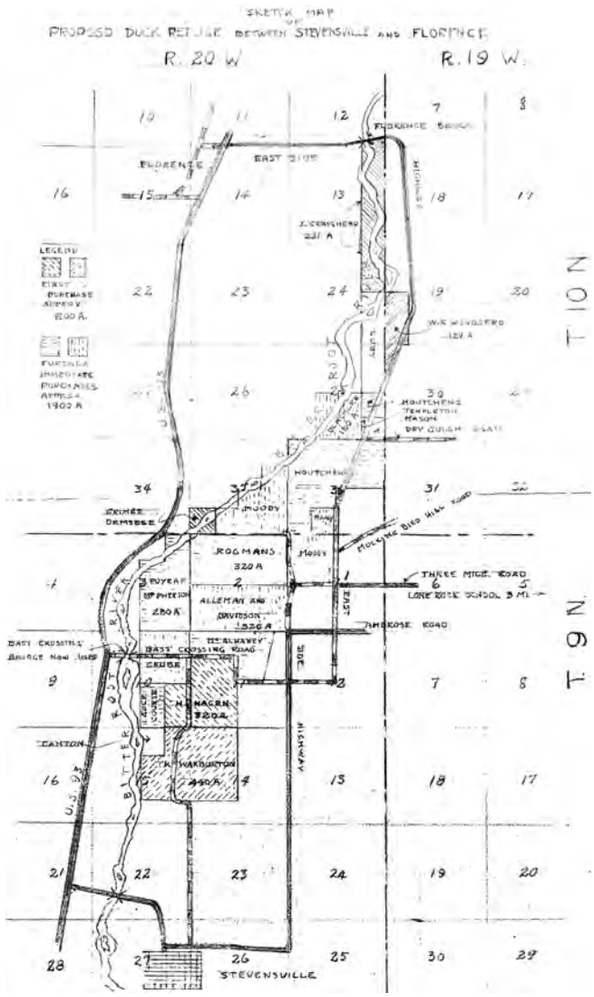


Figure 16. Ownership map of lands within the eventual Lee Metcalf National Wildlife Refuge in the late 1950s.

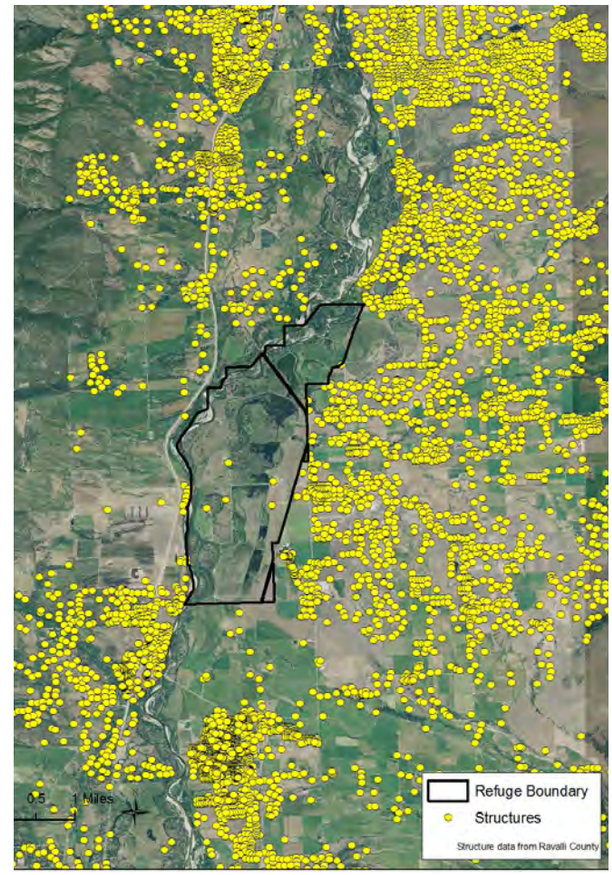


Figure 17. Location of residential structures in the vicinity of Lee Metcalf National Wildlife Refuge (data from Ravalli County, Montana).

and floodplain depressions on Lee Metcalf NWR (Lee Metcalf NWR, unpublished annual narratives).

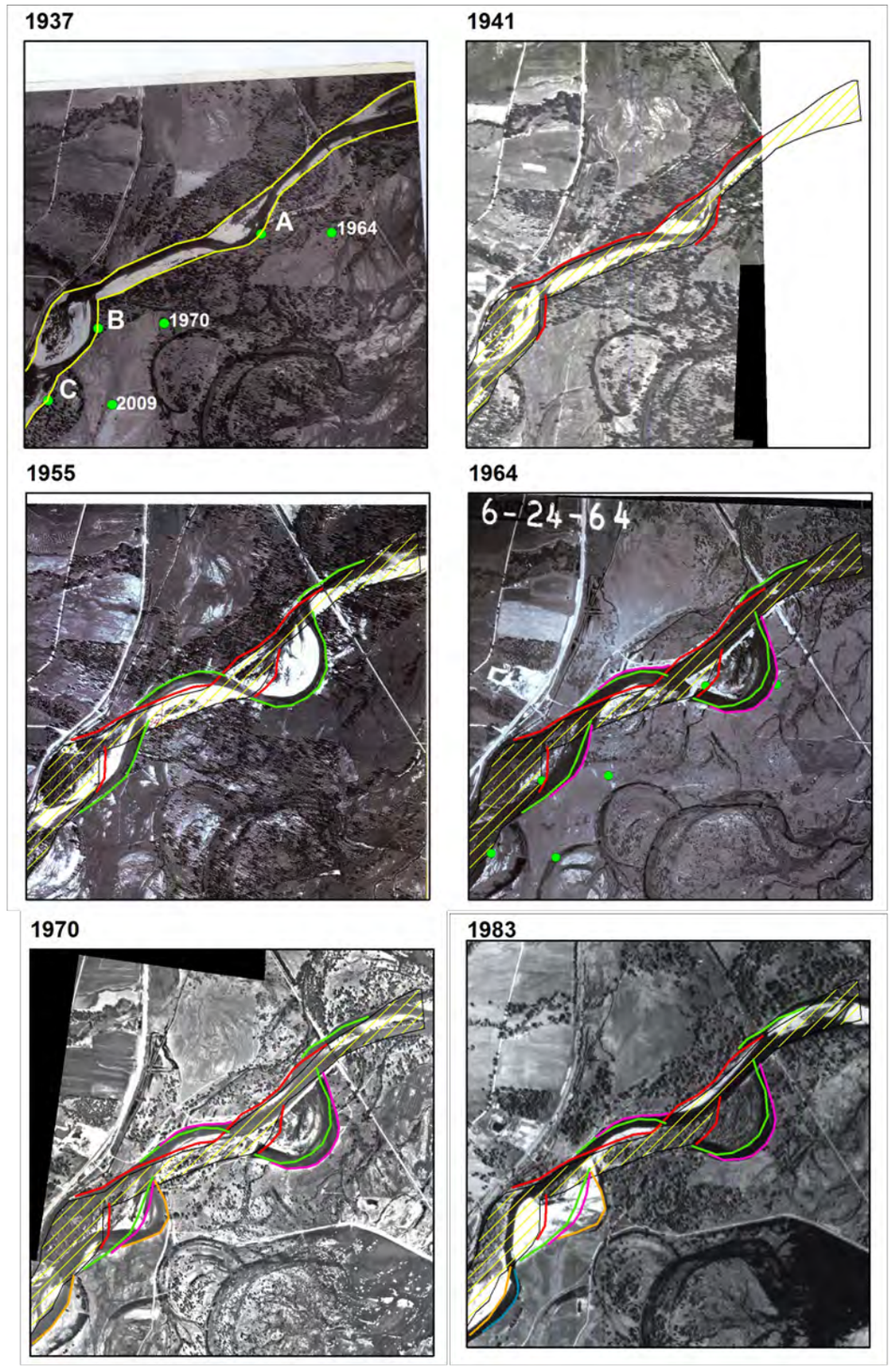
The channel morphology and discharge of the Bitterroot River also has been affected by land and water use in the valley (Gaeuman 1997). Certain evidence suggests the sediment bed load of the river has increased and now delivers about 300,000 metric tons of sediment to the Clark Fork River each year. During the period of 1936 to 1972, the Bitterroot River underwent significant adjustments in sinuosity and braided character causing a nearly 4% reduction in channel length between Darby and Missoula (Cartier 1984). Other data suggest increased instability, channel migration, and overall widening of the river "braid belt" in the last decade from Hamilton to Stevensville compared to other above and below reaches of the Bitterroot River (Gaeuman 1997). This instability has caused rapid erosion of river banks on Lee Metcalf NWR (Fig. 19) and increased physical dynamics of sediment and water flow that facilitate rapid lateral channel migration across the Lee Metcalf NWR floodplain. In contrast to the highly active river migration physics from Hamilton to Stevensville, substantial narrowing of the Bitterroot River occurred near Stevensville and Lee Metcalf NWR after 1937 in part because of artificial control structures. Part of the river has been channelized immediately upstream of rip-rap bank stabilization structures near the railroad embankment on the refuge (Fig. 18). This artificial narrowing of the Bitterroot River to control river migration and bank erosion actually has heightened river migration tendencies immediately upstream of structures and currently is threatening to carve new channels across the floodplain at Lee Metcalf NWR (Fig. 19).

Figure 18. Photograph of car bodies, acting as rip-rap material along the Bitterroot River on the north end of Lee Metcalf National Wildlife Refuge.

Aerial photograph maps of a 2.5 mile stretch of the Bitterroot River on the north end of Lee Metcalf NWR from 1937 to 2009 demonstrate the highly unstable channel location of the river (Fig. 20). Three key points (labeled A, B, and C on the photographs) of river migration are apparent through the time-series of photographs and typical movement of the outer river banks average about 2.5 m/year. During more active periods of river channel bank migration, the rate of erosion is > 10 m/year. The 1955 photograph indicates that the river migrated significantly to the south and was deemed a threat to the existing railroad bank and trestle. Subsequently, actions were taken by the railroad to stop the river migration by placing car bodies (Fig. 18) along the river bank, to act as rip-rap and cut off the river, which created an oxbow that still is present. The most active area of river migration in 2009-2010 is at Point "C." Between 2004 and 2009, the river migrated about 60 m east, or about 12 m/year. If this rate of river migration continues, then the river may reach the main road on Lee Metcalf NWR in about 15 years and effectively remove about 10.5 acres of current floodplain land.

The Bitterroot Irrigation District Main Supply Canal continues to transport water to most of the eastern benches in the Bitterroot Valley, including

Figure 19. Photograph of bank and levee erosion along the Bitterroot River on the west side of Lee Metcalf National Wildlife Refuge.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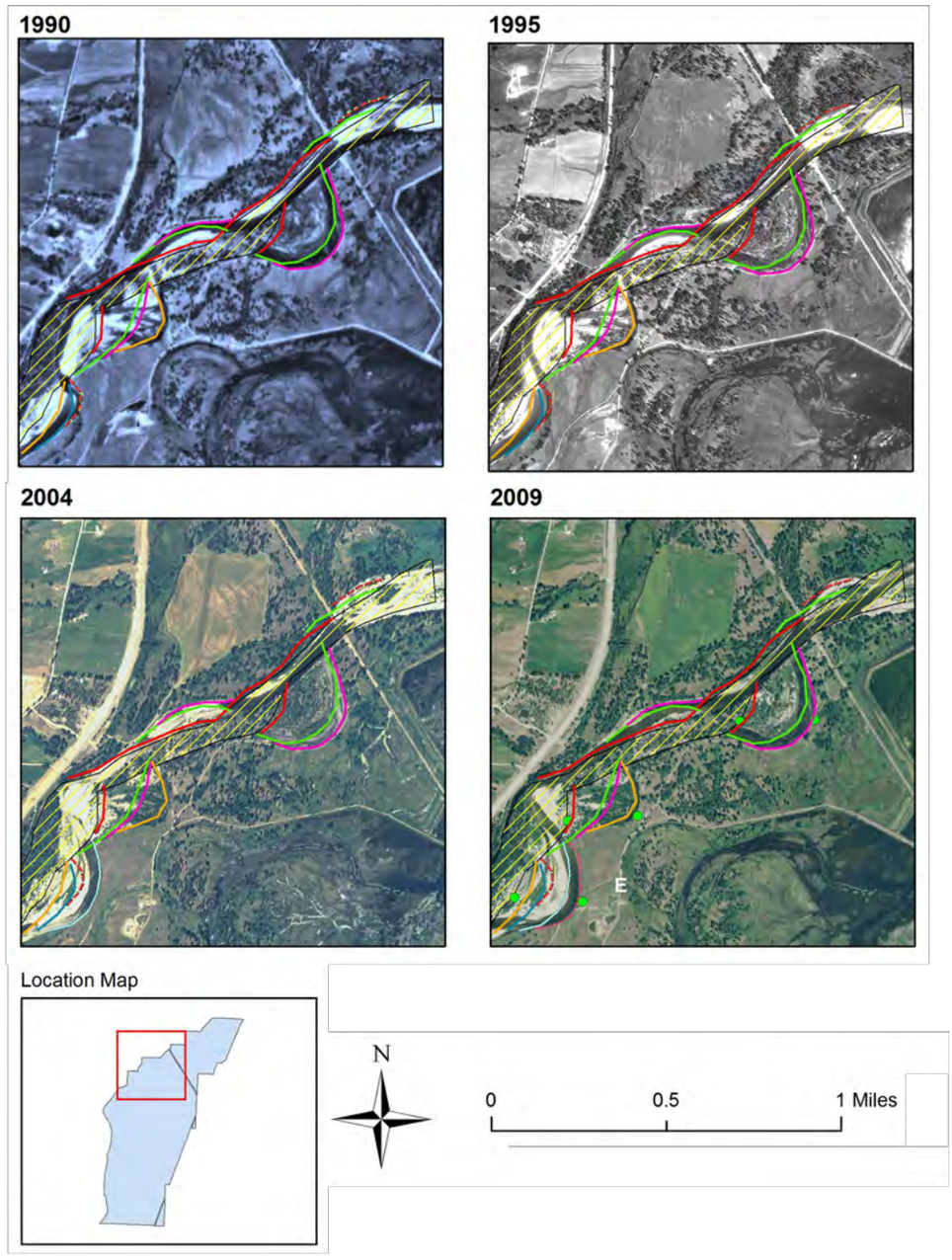


Figure 20. Changes in the location of the main channel of the Bitterroot River over a 2.5 km stretch along the north boundary of Lee Metcalf National Wildlife Refuge, 1937 to 2009. Historical photographs were acquired from a variety of sources including the National Archives and Records Administration, U. S. Fish and Wildlife Service files, U.S. Department of Agriculture, Natural Resources Conservation Service, and U.S. Geological Survey. Each time frame is presented at the same scale and extent, and the color of the lines representing the river location for a particular year is maintained throughout the series of maps for ease of comparison.

those adjacent to Lee Metcalf NWR. The Main Supply Canal facilitates a net transfer of about 75,000 acre-feet/year of water from the west side of the valley to the eastern benches/terraces. During summer, irrigation withdrawals significantly reduce flow in the Bitterroot River and some of its tributaries. Part of the diverted flow eventually drains back into the river system; this irrigation return flow is about 280,000 acre-feet/year in normal precipitation years. Average discharge of the Bitterroot River near Florence is 1,540,000 acre-feet/year, and indicates about 13% current loss of discharge at this point from irrigation use, evapotranspiration and other consumptive uses. Over 10,000 wells now occur in the valley and the extraction of water from these wells, coupled with irrigation diversion, may be affecting groundwater levels, recharge to floodplain wetlands, ground and surface water quality, and anastomosis of the Bitterroot River (e.g., Briar and Dutton 2000).

ACQUISITION AND DEVELOPMENT OF LEE METCALF NWR

Lee Metcalf NWR was authorized/established in 1963. Originally named the Ravalli NWR, the refuge name was changed in 1978 in honor of long-time U.S. Senator Lee Metcalf who grew up in Stevensville and was involved with its establishment and many other conservation initiatives. The primary purpose of the refuge is to provide habitat for migratory birds and federally-listed endangered and threatened species.

The USFWS began physical developments on floodplain lands on Lee Metcalf NWR in 1965-66. By the late 1980s over 1,000 acres had been partly or completely impounded in 14 "ponds" for managed wetland units (Table 3; Figs. 21, 22). These wetland ponds typically were impounded by levees or dams to back water up drainages and depression areas. Currently, the Lee Metcalf NWR impoundments and other naturally flooded depressions and drainage corridors comprise > 20% of all palustrine wetlands present in the Bitterroot Valley (Kudray and Schemm 2008). Dams or weirs that significantly alter direction and amount of surface water flow in natural drainages have been constructed on Three-Mile Creek, Rogmans Creek, Barn Slough, and Francois Slough/North Burnt Fork Creek (Fig. 22). Wetland impoundments have been managed by diverting irrigation and tile drain water, flows in minor channels and tributaries, and Three Mile Creek water into and through the impoundments. Lee Metcalf NWR has 24 water rights claims and one permit totaling 50,495 acre-feet/year (Appendix E, USFWS, unpublished water rights files). Some of these claims were originally based on decreed rights that had been adjudicated during the early 1900s when landowners (that owned what is now Lee Metcalf NWR) petitioned district courts for adjudications of individual streams. Other claims were based on filed rights made by former land owners. Some claims were submitted for use rights that were vested with Migratory Bird Conservation Commission approval for acquisition of the NWR. All NWR water rights are "supplemental", meaning the water sources are comingled to supply water to the refuge for past desired management of wetland impoundments. Water rights submissions made by the USFWS for the refuge in 1982 stated a need for consumptive volume of 7,386 acre-feet/yr and an additional 10,840 acre-feet for non-consumptive flow through. Consumptive volume is 2,190 acre-feet for natural sub irrigation of 730 acres, 717.5 acre-feet for flood and sprinkler irrigation of fields, 3,349.6 acre-feet for 632 acres of wetland impoundment surface area, and 1,129 acre-feet for timber, brush and grass areas that receive return-flow and runoff. Non-consumptive use is for conveyance, filling, and freshening of impoundments. The refuge also receives up to 2,600 acre-feet/yr, at a diversion rate of 8.57 cfs from the Bitterroot Irrigation District Supply Ditch.

Water that enters, or can be diverted to, Lee Metcalf NWR comes from multiple points of diversion (POD). Certain sources, such as the South and Middle Drain supply private property in addition to the NWR and often the private property has "priority" of use in limited water periods. Tile drain water also enters the refuge from "open" tile drain or irrigation recovery, ditches from surrounding private lands. One specific tile drain originates from the privately owned "Bison Field" and contributes organic contaminants to Ponds 3 and 4 and commonly causes algal blooms in these and other ponds that receive gravity flow water from Ponds 3 and 4. Most water enters managed wetland impoundments from the south end of the refuge and sequentially is routed via gravity flow through Ponds 1 to 10. However, the various sources of water often results in variable amounts and timing of water being available for individual ponds. For example, water originating from the South Drain can be moved via gravity flow into most ponds on the refuge, whereas water from Rogmans Creek can only be used for Ponds 6-13. Spring Creek POD is only siphoned from Pond 10 to Otter Pond, where it then flows to Ponds 12 and 13. Three Mile Creek POD water is available for Ponds 11-13 and the North Slough. Currently, Three Mile Creek contains high sediment loading and is not diverted to ponds, and instead flows to the Bitterroot River.

Since establishment, most wetland impoundments have been managed to promote waterfowl production by holding water through summer or year round; and occasionally draining areas for vegetation management using tillage, grazing, and burning (Lee Metcalf NWR, unpublished annual narratives). Otter Pond was stocked with warm-water fish in 1989 to provide prey for nesting osprey and limited public fishing opportunity. Other wetland/ hydrological developments included construction of siphons to move water, level-ditching in Ponds 3, 4, 11, and 12; mitigation construction near the Potato Cellar Pond, and sediment removal in Three-Mile Creek (Table 3, Fig. 22). Over 25 miles of roads are present on the refuge and many buildings, trails, and berms also have been constructed on the refuge. Certain upland areas were converted to warm-season grasses for dense nesting cover for waterfowl and predator-exclusion fences were built around some fields (Fig. 23). In the 1960s and early 1970s some higher elevation fields on the refuge were used for small grain production.

In 1971, the refuge contracted the placement of rip-rap material along 1,250 feet of the east bank of the Bitterroot River west of McPherson Ditch (Lee Metcalf NWR, unpublished annual narratives). This rip-rap subsequently was eroded and moved by high river flows and by 1984 the rip-rap was no longer present and the bank at this location was moving eastward. Since the mid 2000's, levees built along the Bitterroot River, including the area where the rip-rap was placed in 1971, have eroded, and been at least partly breached in places as the Bitterroot River is attempting to move laterally (Figs. 19, 20). Also, the Bitterroot River appears to be moving more discharge through the North Slough area immediately north of Otter Pond on the north side of the refuge. These river movements potentially could impact the north Otter Pond levee and cause water movement across other floodplain areas on the refuge that might impact other structures, roads, and the railroad bed.

Table 3. Summary of wetland development/management activities on Lee Metcalf National Wildlife Refuge (from refuge annual narratives and aerial imagery

Refuge authorized by Migratory Bird Conservation Commission on December 10, 1963.
First parcel purchased in February 1964, refuge officially established.
Pools 1 thru 4 completed the summer of 1966.
Pool 5 - The mid 1960s photos show the stream channels coming through the present pool, but no clear pond area is visible. By June 1970, water control structures in place and impoundment completed.
Pools 6, 8, and 10 were constructed sometime between 1967 and 1970 based on the imagery.
Ponds 11-13 were built between 1970 and 1973. Flood photos from 1974 show impoundments in place. Pond E, which was a small impoundment on Rogman's Creek, near pool 11, likely built around the same time frame. Pond E was ultimately expanded by the creation of Otter Pond in 1989.
Ditch Leveling done in Pools 3, 4, 11, 12 in 1990, clearly visible in the 1995 photos, but not in 1990.
Otter Pond built in 1989, which expanded the existing pond E to about 65 surface areas. 18" PVC siphon brings water over 3-mile bypass to pool 11.
Pair ponds by July 1988 – designs completed, 10 acres, up to 3 feet deep.
Montana Power Company – channel ponds. Mitigation work conducted in Section 2, near Potato Cellar ponds. Originally built in the late 2960s or early 1970s, then washed out in floods during mid 1970's. Dry from the mid 1970s until a rehab project in 1988. About 3 acres in size.
Early 1980s focus on 3-mile creek sedimentation issues. This creek flowed into pool 11 and out through pool 13 to the river. Three sediment ponds constructed in 1984, two supply ditches cleaned out in 1985 (from annual water management plan 1986/1987 RO). Ultimately, the bypass channel takes 3-mile creek directly to the river.
Pool levels maintained at high levels for several reasons, cattail control, fishery for osprey, and to prevent waterfowl access to lead shot. 1987 – pools 1 drawdown entire year, and pool 6 in drawdown in spring, refilled in July for cattail control. At end of july, pool 6 drained again for remainder of year. 1987-1988 water management plan RO
Francios Slough – no dikes or structures on it in mid 1960s, North Burnt Fork creek unimpeded on refuge. By 1970, 3 water control structures constructed. These remain in place today.
Barn Slough area – Evidence that a diversion structure sending water through the Mcpherson and Nickerson Ditch was present pre-refuge (see below). Image from mid-1960s.

VEGETATION COMMUNITIES

Collectively, the many landscape and hydrological changes in the Bitterroot Valley since the Presettlement period have dramatically altered the physical nature, hydrology, and vegetation communities of the Lee Metcalf NWR. Prior to European settlement, the relatively dry climate of the Valley

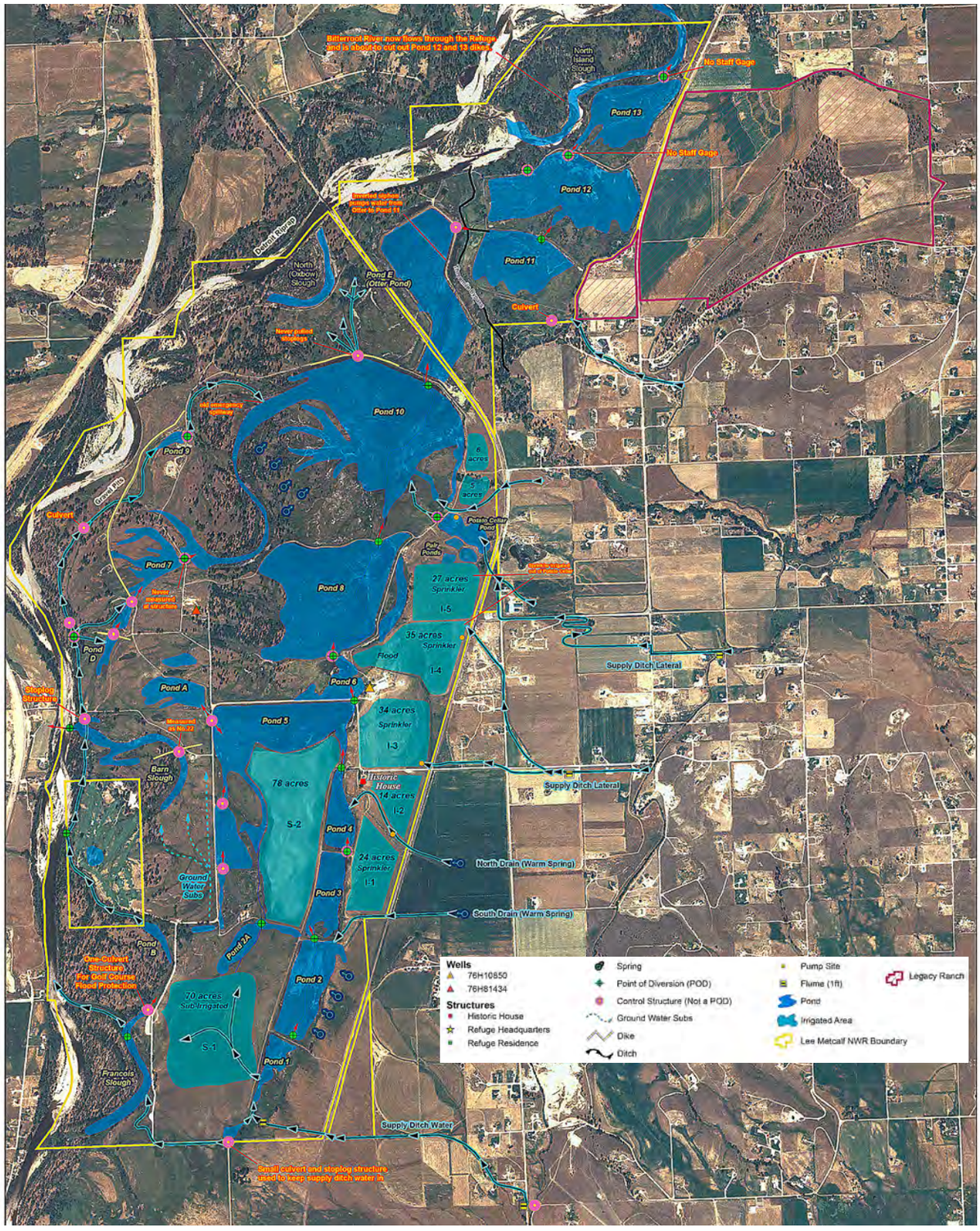


Figure 21. Contemporary water, drainage, and water-control features on Lee Metcalf National Wildlife Refuge.

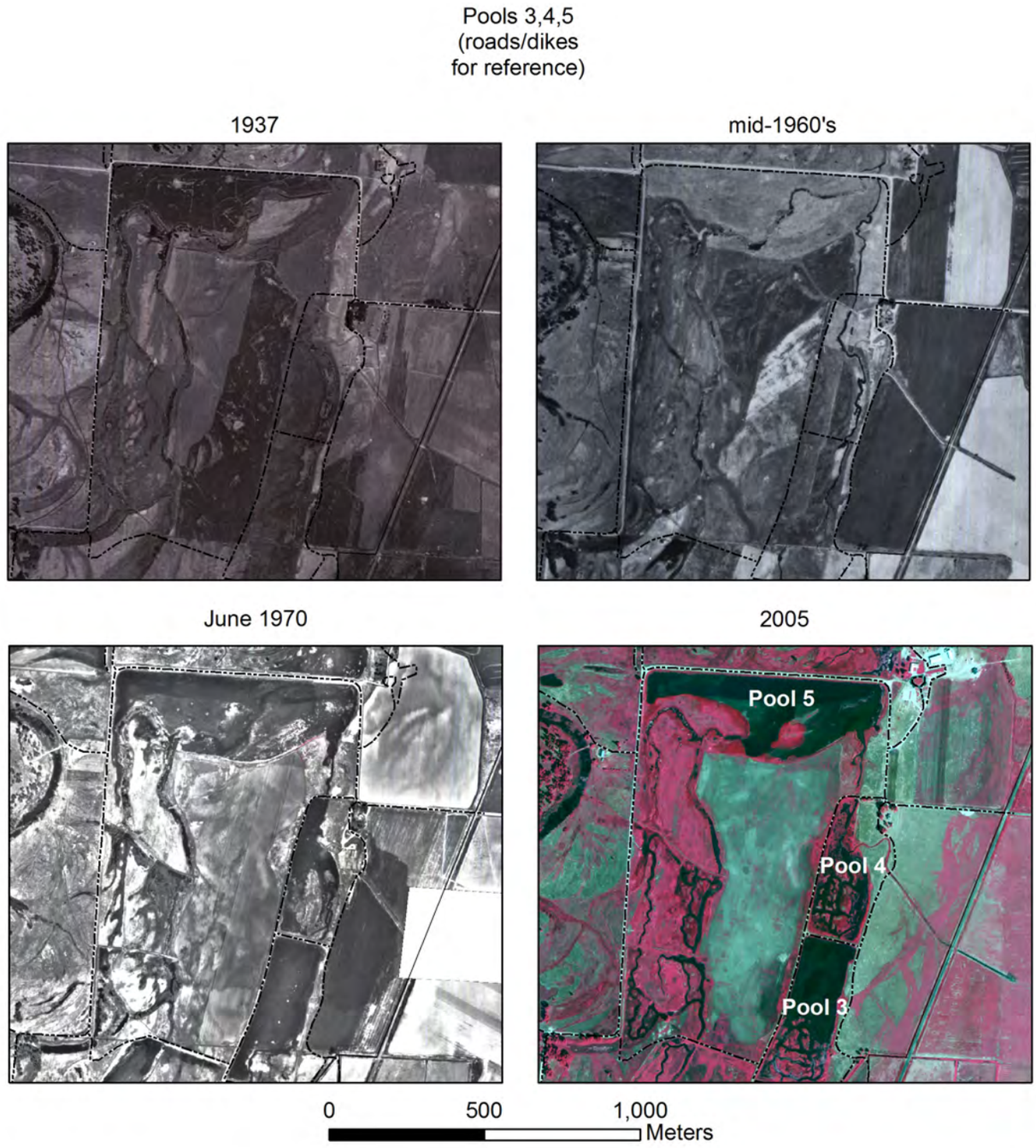


Figure 22. Aerial photographs of wetland pond and management developments on Lee Metcalf National Wildlife Refuge before (1960s and 1970s) and after (2005) construction. (cont'd on next page)

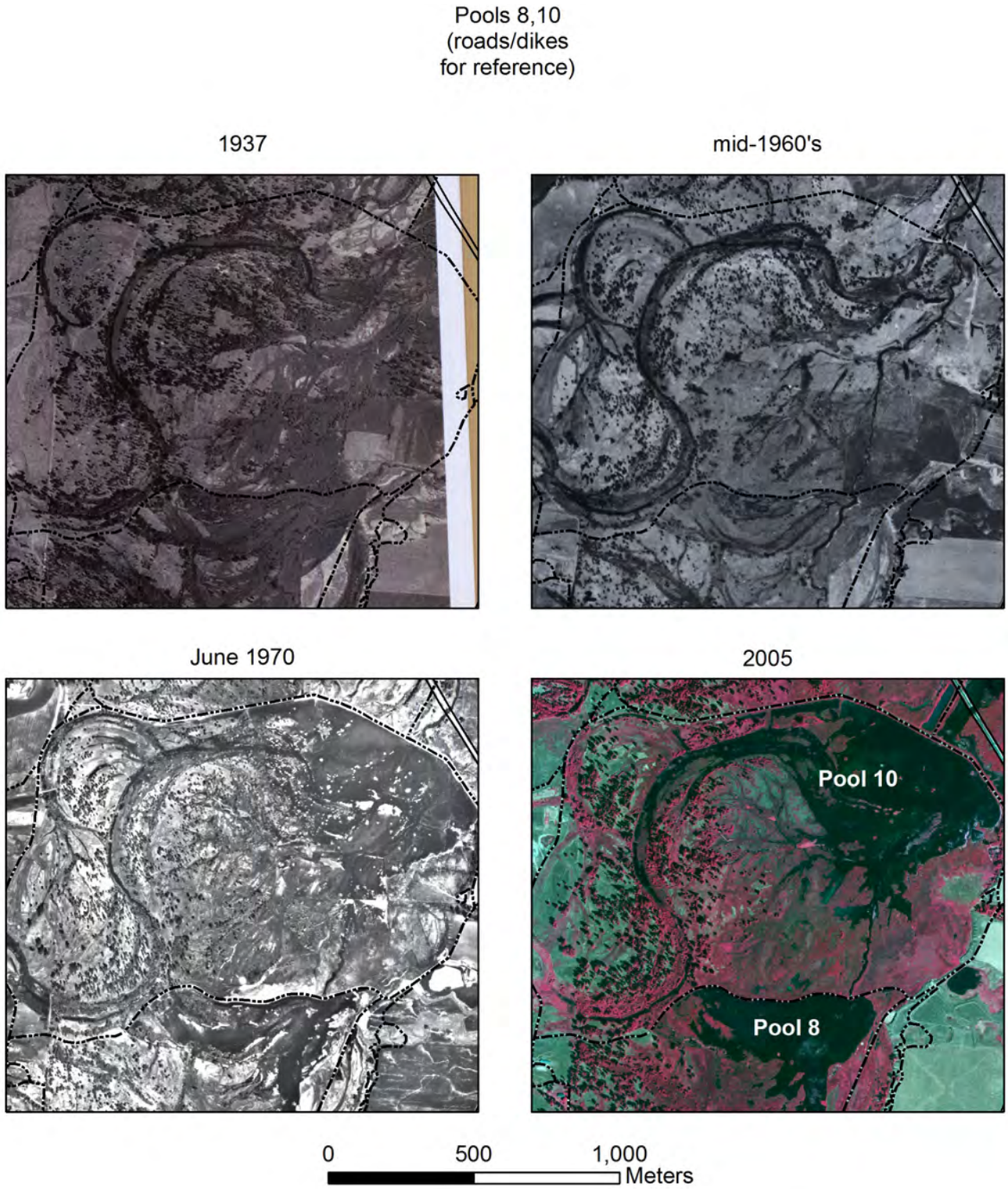


Figure 22 (cont'd). Aerial photographs of wetland pond and management developments on Lee Metcalf National Wildlife Refuge before (1960s and 1970s) and after (2005) construction.

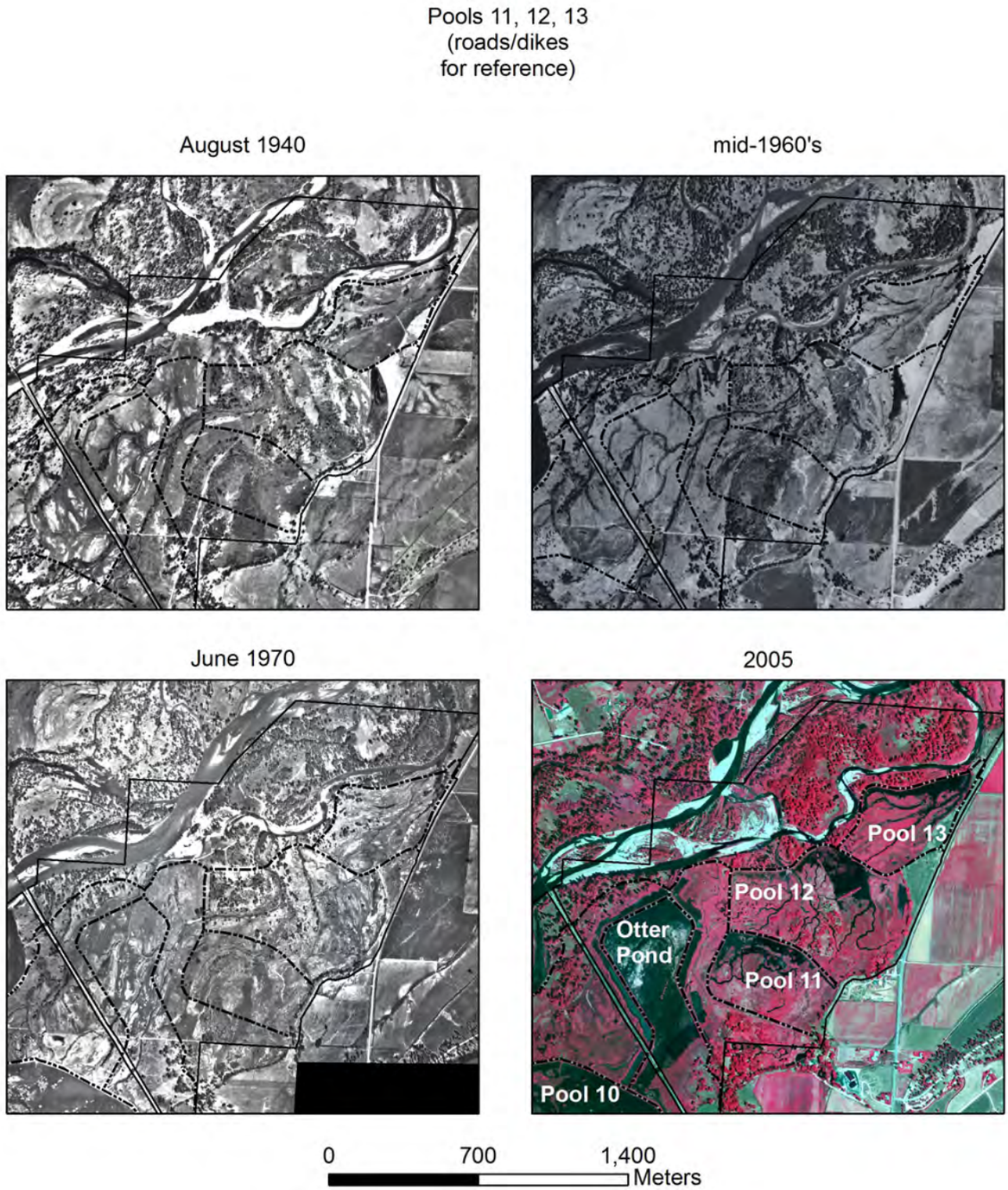


Figure 22 (cont'd). Aerial photographs of wetland pond and management developments on Lee Metcalf National Wildlife Refuge before (1960s and 1970s) and after (2005) construction.

Figure 23. Photograph of a field planted as waterfowl dense nesting cover on Lee Metcalf National Wildlife Refuge.

and the anastomosing nature of the Bitterroot Valley created a heterogeneous mix of communities including Riverfront and Gallery Forest adjacent to the Bitterroot River and floodplain drainages, Persistent Emergent wetland communities along floodplain drainages and fluvial-created depressions, Wet Meadow habitats, and Grassland/Sagebrush communities on higher elevation terraces and alluvial fans (Fig. 13). This community matrix was maintained by:

1) Periodic overbank flooding of the Bitterroot River that inundated much of the floodplain for relatively short periods in spring.

2) Regular backwater flooding of the Bitterroot River up tributaries and floodplain secondary channels into floodplain wetland depressions.

3) Annual spring discharge of water from tributaries, sheetwater flow across terraces and alluvial fans, and seep/spring discharge from mountain slopes and terraces.

4) Occasional fire and grazing that recycled nutrients and established germination and regeneration sites for specific plant species

Each of these primary ecological processes at the Lee Metcalf NWR has been systemically altered so that:

1) Water diversions, channel constriction, and river channel modification have reduced overbank flooding and restricted floodplain connectivity. Fewer extensive overbank events now occur, but lateral movement and bank erosion of the Bitterroot River have been accelerated in this river stretch.

2) The above changes have restricted backwater flow from the Bitterroot River into its floodplain and tributaries and floodplain secondary channels have been ditched, diverted, dammed, and impounded.

3) Water flow across the floodplain has been altered by extraction and diversion of water from drainages prior to reaching the floodplain. Sheetflow across terraces and alluvial fans is almost completely eliminated and groundwater aquifers and discharge from seeps/springs are changed, usually by reduction, from Presettlement times.

4) Fire and grazing by native ungulates have been eliminated or greatly reduced in occurrence.

In addition to changes in the primary ecological processes of the Bitterroot Valley ecosystem at Lee Metcalf NWR, the local and regional landforms and vegetation communities have been negatively affected by numerous alterations to topography, drainages, clearing, conversion to various agricultural crops or livestock forage, extensive grazing by cattle and sheep, sedimentation, expansion of nonnative plants, and recently urban expansion (e.g., Fig. 17). Vegetation changes at Lee Metcalf are documented in aerial photographs from the 1940s to the present (Figs. 4, 15, 24). Collectively, the system now has:

1) Reduced area of Riparian and Gallery Forest
2) Increased Persistent Emergent and Open Water habitat
3) Increased Herbaceous Wetland vegetation
4) Decreased native Grassland communities
5) Increased agricultural and tame grass fields
6) Increased presence of invasive and exotic plant species

Invasions of sulphur cinquefoil, Dalmation toadflax, leafy spurge, spotted knapweed, Canada and musk thistle, Hound's tongue, St. John's wort, and yellow flag iris are present in many areas on the refuge (Kudray and Schemm 2008, U.S. Fish and Wildlife Service, Lee Metcalf NWR unpublished data). Of 34 currently considered noxious weeds in Montana, 15 species are present on the refuge.

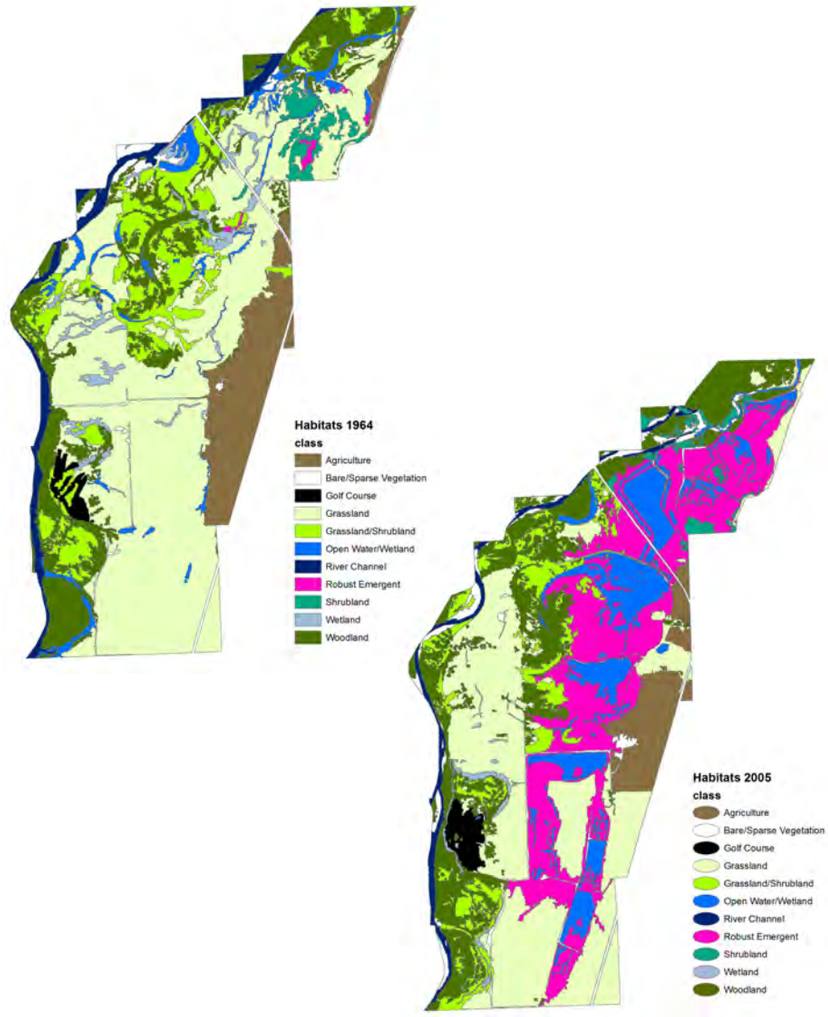


Figure 24. Composite vegetation community model for Lee Metcalf National Wildlife Refuge 1964 compared to 2005.

FISH AND WILDLIFE POPULATIONS

The many ecological and community changes to the Lee Metcalf NWR ecosystem have caused corresponding affects on fish and wildlife populations using the area. Unfortunately, little quantitative data are available on animal use of the area during historic times, but correlations of species occurrence with specific habitat types can infer relative abundance for at least some groups. Apparently, waterbirds and other wetland associated birds increased in number and seasonal occurrence on Lee Metcalf NWR, at least during the 1970s and 1980s after wetland impoundments were built and managed for more prolonged water regimes during summer and fall (e.g., Hess 1978). Peak numbers of dabbling and diving ducks, shorebirds, and wading birds exceeded 20,000 birds on Lee Metcalf NWR, especially in spring and fall migration during some years in the 1970s and 1980s, but now seldom exceed 5,000 (Lee Metcalf NWR, unpublished annual narratives). Production of ducks on the refuge also reached 10,000 in some years during the 1970s and 1980s, but now annual production typically is < 1,000 ducklings. Other birds associated with more permanently flooded wetlands including osprey and certain passerines also apparently increased after wetland impoundments were initially built, but now are declining. For example, Osprey production on Lee Metcalf reached a peak of 40 young in 1988, but has declined since (Fig. 25). Concerns about mercury contamination of osprey eggs and young relate to the consumption of warm-water fish stocked in Otter Pond and high mercury levels in other refuge impoundments and regional waters. Mercury concentration in fish (mainly large-mouth bass) on Lee Metcalf average > 0.1 mg/kg wet weight for 14-22 inch size classes (Fig. 26). Wetland bird species of concern present on the refuge include common loon, Clark's grebe, white pelican, American bittern, black-crowned night heron, white-faced ibis, trumpeter swan, bald eagle, long-billed curlew, Franklin's gull,

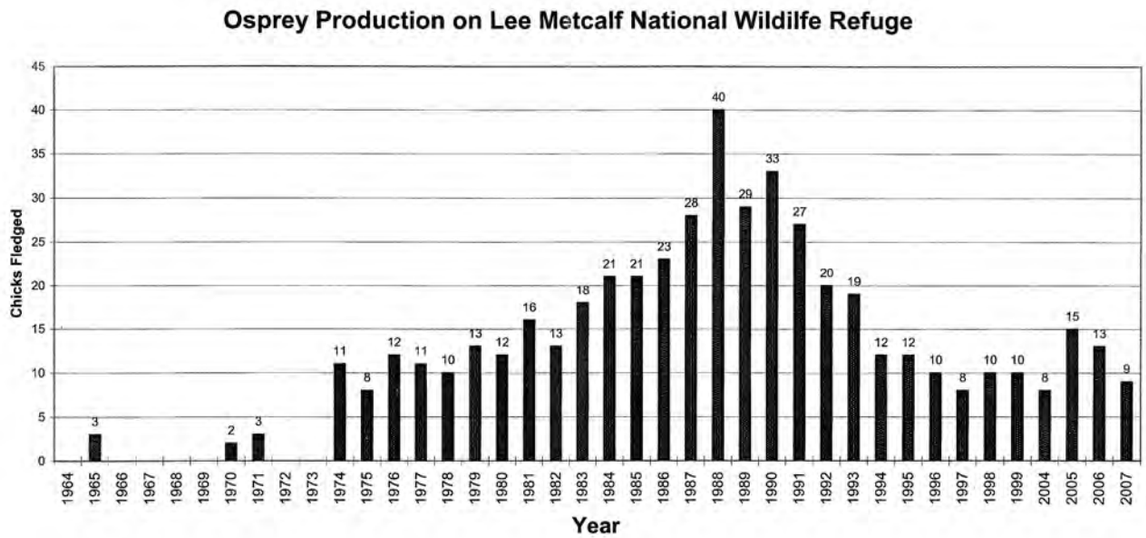


Figure 25. Number of osprey produced on Lee Metcalf National Wildlife Refuge 1964 to 2007.

Black tern, common tern, Caspian tern, and Forster's tern (Appendix C).

Limited data suggest declines in animals using floodplain channels and tributaries to the Bitterroot River, Riparian forest, and Grassland/Sagebrush communities over time (e.g., U.S. Fish and Wildlife Service, unpublished NWR inventories, Brandt 2000, USFWS 2005). Reduced area of Riparian Forest habitat causes less foraging, nesting, loafing, and stopover habitat for numerous passerine birds, raptors, and native resident species. Conversion of native Grassland to pasture, hay land, and agricultural crops also has reduced resources for many birds, mammals, and amphibians. Forest and Grassland bird species of concern documented on Lee Metcalf NWR include peregrine falcon, black swift, burrowing owl, Great gray owl, Flammulated owl, Lewis' woodpecker, olive-sided flycatcher, Clark's nutcracker, loggerhead shrike, black-and-white warbler LeConte's sparrow, and bobolink. Further, four mammals, the boreal toad, two dragonflies, and two plants also are listed as species of concern on the refuge. Most large mammals that historically used the Bitterroot Valley floodplain near Lee Metcalf NWR are extirpated or rarely present, including bison, elk, cougar, and grizzly bear.

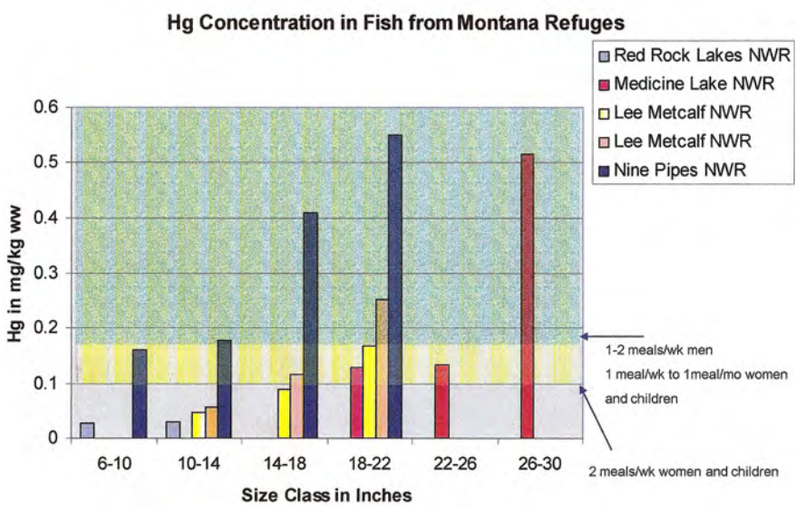
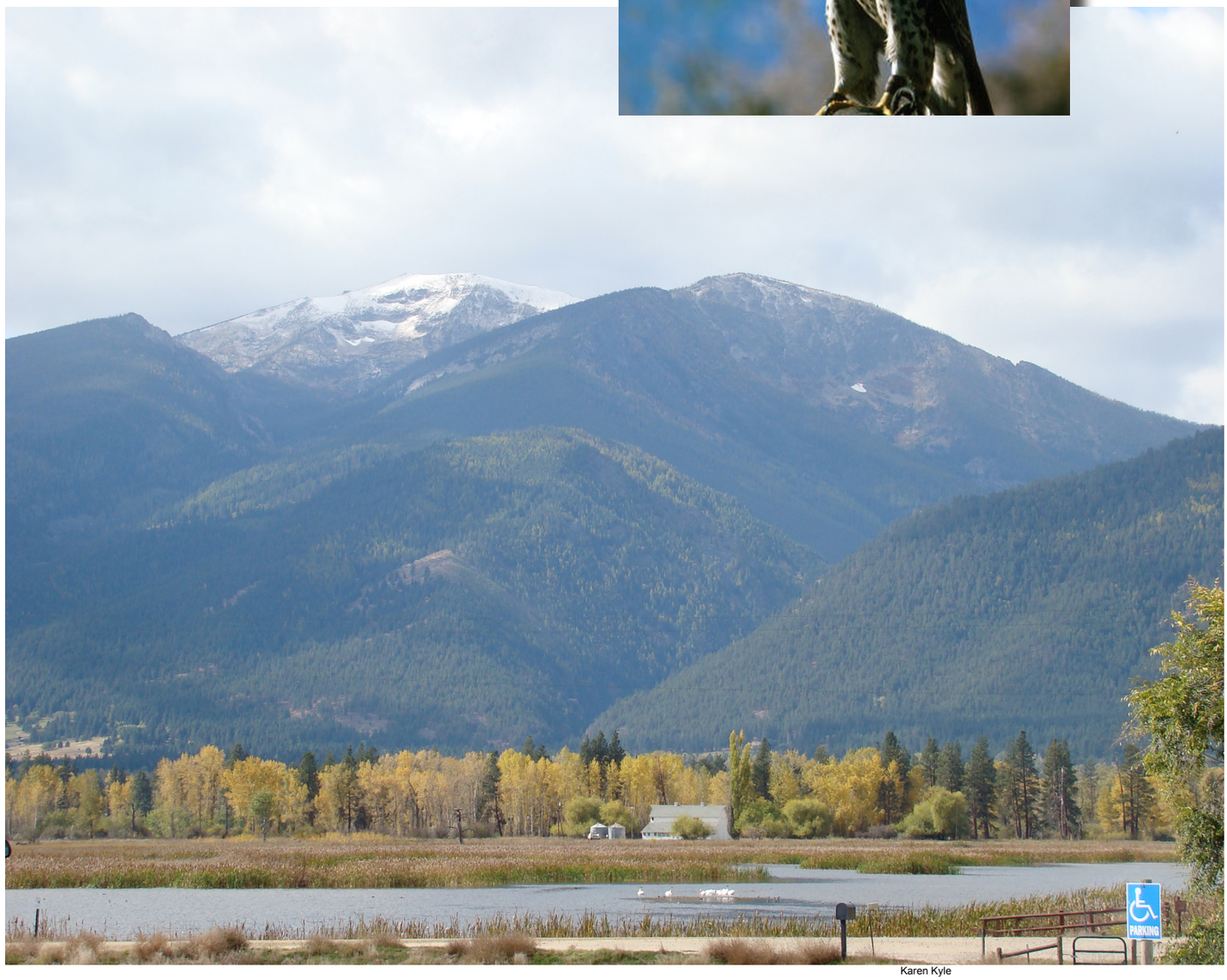


Figure 26. Mercury (Hg) concentration in fish from National Wildlife Refuges in Montana, 2005 (U.S. Fish and Wildlife Service, unpublished data).

While the Bitterroot River and its floodplain did not support a large diversity of native fish, many species were highly abundant and widely distributed, especially when overbank and backwater floods occurred. Currently, fish diversity is reduced, comprised mainly of non-native species, and

distribution is restricted to primary channels of the Bitterroot River and man-made impoundments/ponds (Brandt 2000). The native bull trout, that historically was present in North Burnt Fork Creek, now has reduced and restricted abundance largely because of dammed and diverted water flow, sedimentation, and increased water temperature in the creek and the impounded Francois Slough area (Stringer 2009).

Phil Million, USFWS



Karen Kyle

Ronald L. Bell, USFWS

Karen Kyle