ECOSYSTEM RESTORATION AND MANAGEMENT OPTIONS

A SUMMARY OF CONDITIONS

Information obtained and analyzed during this study were sufficient to conduct a HGM-based evaluation of historic and contemporary physical and biotic conditions on Lee Metcalf NWR and the surrounding region. Lee Metcalf NWR is a small refuge situated almost entirely within the recent, and active, floodplain of the Bitterroot River. The formation of land surfaces, soils, and drainages on and adjacent to the Lee Metcalf NWR floodplain were primarily created by active fluvial dynamics of the Bitterroot River. The historic floodplain system of seasonal patterns of surface water flow and inundation, overbank and backwater flooding of the Bitterroot River, and interactions of ground and surface water dictated the types and distribution of floodplain vegetation communities. The floodplain at Lee Metcalf NWR is bounded by higher elevation late Pleistocene terraces and alluvial fan complexes that created striking transitions in communities and ecological processes between the terraces and floodplain. Collectively, the complexity of river movements, floodplain drainages, topography, soils, and geomorphic surfaces created a heterogeneous mosaic of vegetation communities on the site ranging from Grassland-Sagebrush habitat on high elevation terraces to Persistent Emergent wetland habitats in low elevation depressions and drainage corridors in the floodplain (Fig. 13).

Apparently, the first major changes to the physical and biotic characteristics of lands now in Lee Metcalf NWR were made in 1871, when Peter Whaley began farming and modifying topography to qualify to receive lands under the Homestead Act. Larger changes to the historic Lee Metcalf NWR ecosystem occurred in the early 1900s when irrigation systems were constructed in the Bitterroot Valley and many lands in the Lee Metcalf NWR region were converted from Gallery Forest or Grassland to orchards, small grain crop fields, and pature-haylands (Eckmann and Harrington 1917). On specific Lee Metcalf NWR areas, former landowners converted many sites to agricultural uses and began constructing infrastructure to bring Bitterroot Irrigation Water to their properties and to divert and/or partly impound floodplain and regional drainages. Levees and berms were constructed along the Bitterroot River and floodplain drainages to protect low-lying areas from overbank and backwater flooding (Fig. 14). Other alterations included construction of numerous roads, levees, railroad beds and bridges, buildings, and a golf course on site. Parts of the Bitterroot River channel were straightened and sections of river banks have been stabilized with various rip-rap materials. Collectively, these ecosystem changes, prior to USFWS acquisition of the site in 1963, greatly disconnected the Bitterroot River from its floodplain and altered the basic hydrological features of the site including water flow pathways; depth, duration, and extent of flooding; and river migration tendencies. Further, native vegetation communities have become altered by decreases in Gallery Forest and native Grassland and increases in introduced grasses, orchards, and various agricultural crops.

After the USFWS acquired Lee Metcalf NWR, additional changes occurred to the Bitterroot River ecosystem. A major alteration to the site was the construction of 14 water impoundments or "ponds" to create more permanent water areas to enhance waterfowl production on the site. These ponds further altered water flow across the Bitterroot River floodplain, impounded and dammed drainages, drastically altered topographic features of the site, changed water regimes from seasonal flood pulses and spring runoff regimes to more permanent water sites, and caused additional diversion of water in the system. In addition to construction of levees, dikes, and water-control structures for these impoundments, level-ditching and islands were constructed in some sites that caused further disruption of topography and within-impoundment water movement. Some upland grassland and agricultural areas were planted to dense nesting cover and fields were fenced to inhibit mammalian predators from entering the nesting cover fields. Agricultural crops were grown in some areas to increase food availability for some waterfowl species. Additional roads, buildings and complexes, public access facilities, and structures have been constructed on the refuge in the last three decades. Collectively, these post-USFWS acquisition, changes attempted to convert this semi-arid and highly active western river floodplain-terrace ecosystem into more of a Northern Great Plains wetland "basin" system that supported consistent and higher waterfowl production. In essence, management and development of Lee Metcalf NWR since the 1960s has not been consistent with the naturally occurring physical, biotic, and basic formation and sustaining ecological features of the site.

The information provided in this report identifies the "mismatch" of management on Lee Metcalf NWR to historic conditions and the significant influence of off-site land uses to current and future management and restoration activities. The HGM-based data in this study identify what communities and ecological processes belong on the site, and also identify the many constraints to being able to restore them. The obvious challenge for future restoration and management of Lee Metcalf NWR is to understand what management actions are potentially possible, will be most effective/efficient to restore basic ecological attributes of this ecosystem, and if restored system processes and communities can be sustainable given the many competing and influential physical and biotic changes to the region.

Key summary data and observation obtained in this study are:

1. The Bitterroot River Valley, where Lee Metcalf NWR sets, is a structural trough formed during the late Cretaceous emplacement of the Idaho batholiths and is bounded by the Bitterroot Mountains on the west and the Sapphire Mountains on the east.

2. Four general geomorphologic zones occur in the Bitterroot Valley including: 1) the Holocene floodplain of the Bitterroot River, 2) low elevation alluvial fans that extend into the floodplain, 3) high elevation, mostly Quaternary-derived, terraces adjacent to the floodplain on the west side of the valley, and 4) high-elevation Tertiary-derived terraces adjacent to the floodplain on the east side of the valley.

3. At Lee Metcalf NWR, most geomorphic surfaces are "Qal" floodplain alluvium, with minor "Qaty" younger alluvial outwash terrace at the far north end of the refuge, and a large "Qafy" terrace and alluvial fan present on the east side of the refuge and floodplain.

4. The Bitterroot River has inherent unstable hydraulic configuration and high channel instability in, and immediately upstream from, the Lee Metcalf NWR area. This unique river stretch reflects the geology and slope form of the Bitterroot Valley at this position and has a complex multi-strand channel pattern that is characterized by numerous braided or anastomosing channels that spread laterally over a wide area of the valley floor.

5. Numerous abandoned channels, cut-off chutes, and minor or "secondary" channels are present in the Lee Metcalf floodplain; minor channels appear to have their genesis from groundwater discharge from surrounding mountain slopes.

6. Nearly 25 soil types/groups are present on or adjacent to Lee Metcalf and reflect the complex geomorphic and topographic configuration of the site. Most soils are shallow, with thin veneers of loam and sandy-loam overlying deeper sands and gravel deposited by the historic Bitterroot River.

7. Elevations on Lee Metcalf range from about 3,230 feet amsl on the north end of the refuge to about 3,260 feet on the south end. Terraces adjacent to the floodplain rise to 3,300 feet. Much topographic heterogeneity exists within the floodplain related to historic Bitterroot River and tributary channel migrations, floodplain scouring, and alluvial deposition.

8. The climate of the Bitterroot Valley is characterized by cool summers, low precipitation in the Valley floor, little wind, and relatively

mild winters. Annual average precipitation at the refuge is about 13 inches and the growing season averages about 103 days.

9. Precipitation is highest in spring, and this water coupled with runoff from snow melt in the region, creates a strong unimodal pulse of discharge in the Bitterroot River in May and June.

10. Overbank flooding of the Bitterroot River that covers much of the Lee Metcalf NWR area is infrequent (> 20-year recurrence interval), but spring backwater flooding into the floodplain occurs regularly (about a 2-5 year recurrence interval).

11. Historic water regimes in the Lee Metcalf NWR region were mostly seasonal "flow-through" inundations, rather than extended flooding regimes.

12. Alluvial aquifers in the Bitterroot Valley are generally unconfined and interconnected and contribute substantial subsurface water inputs to the floodplain at Lee Metcalf.

13. Historic (pre-European settlement) vegetation in the Bitterroot Valley near Lee Metcalf included seven relatively distinct communities/habitat types: 1) Riparian/Riverfront Forest, 2) Gallery Forest, 3) Persistent Emergent, 4) Wet Meadow, 5) Floodplain Grassland, 6) Saline Grassland where saline seeps occurred, and 7) Grassland-Sagebrush communities.

14. HGM-based mapping of potential distribution of communities indicates a complex mosaic of habitats based primarily on soil, hydrology, and geomorphic surface characteristics (Fig. 13).

15. The Bitterroot River ecosystem at Lee Metcalf NWR supported a wide diversity of animal species associated with the interspersed riverine, riparian/gallery forest, wetland, and grassland habitats. Most species were seasonal visitors utilizing resources provided by spring and early summer pulses of water into the system. During wet years, more prolonged flooding into summer and fall increased the availability of wetland-type habitats and probably supported more waterbird breeding and fall migration habitat in those years.

16. The Bitterroot Valley was inhabited by native people in the last 12,000 years, European settlement did not occur until the 1800s; St. Mary's Mission (the current site of Stevensville) was the first Anglo-American settlement in Montana, established by catholic priests in 1841.

17. Increased settlement of the Bitterroot Valley occurred in the mid to late 1800s and following a short surge in limited gold exploration, the Lee Metcalf NWR area was used primarily for cattle production and some agricultural cropping.

18. The relatively dry climate in the Bitterroot Valley created annual variation in water availability and therefore variable success in growing agricultural crops; consequently settlers began attempting to divert water from rivers and streams to crop and pasture areas in the late 1800s.

19. Beginning in 1905, the Bitterroot Valley Irrigation Company began construction on a major water infrastructure project to deliver surface irrigation water to lands on the east side of the Bitterroot Valley. This project included water storage in Lake Como, a diversion dam on Rock Creek, over 70 miles of canals, siphons under the Bitterroot River, and multiple water-control structures and delivery ditches.

20. Irrigation water from the Bitterroot Irrigation Company was originally planned for orchard development and production on lands now in the Lee Metcalf NWR. In the early 1900s some grassland and Gallery Forest was converted to orchards and former landowners constructed extensive ditch and water diversion infrastructure in the floodplain and adjacent terraces.

21. Limited water and other economic considerations caused this orchard "boom" to collapse and eventually the Bitterroot Irrigation Company went bankrupt in the early 1900s. In 1930, the U.S. Bureau of Reclamation secured past financial liabilities and rehabilitated the

system, now known as the Bitterroot Irrigation District. Subsequent irrigation flows and diversions have sustained cattle production and small grain farming in the Bitterroot Valley.

22. A railroad bed and bridge was built across the Bitterroot River and some floodplain areas in the late 1800s. Other rail and road bridges also were built across the river through the mid 1900s.

23. In the 1950s, attempts were made to stabilize the banks of the Bitterroot River with various rip-rap materials and also to straighten and effectively channelize portions of the river. Levees were constructed along the Bitterroot River by landowners in many areas. These channel projects attempted to mitigate or reduce the lateral migration of the Bitterroot River near Lee Metcalf NWR to protect rail and road beds and bridges, urban developments, and agricultural fields.

24. By the l970s, extensive agricultural production in the Bitterroot Valley had peaked and landowners began subdividing holdings for housing developments. Ravalli County had the most rapid population and residential expansion in Montana by the mid 1990s and many lands close to Lee Metcalf NWR now are residential.

25. The combination of irrigation development and land use changes significantly altered the hydrology and river channel morphology and movement in the Bitterroot Valley in the 1900s.

26. Lee Metcalf NWR, containing 2,800 acres, was authorized and established in 1963. Originally named Ravalli NWR, the refuge name was changed in 1978 in honor of long-time U.S. Senator Lee Metcalf.

27. The USFWS began physical developments on the refuge in 1965-66 and by the late 1980s, over 1,000 acres in 14 wetland pools had been partly or completely impounded with levees, dams, and water-control structures.

28. Wetland impoundments have been managed by diverting irrigation drain water, flows in floodplain channels, and Three Mile Creek into and through the impoundments. Most water enters the area from ditches and drainages in the south part of the refuge and is moved via gravity flow sequentially through pools.

29. The refuge has 24 water rights claims and one permit for water to manage wetland impoundments and other areas such as irrigation for agricultural fields, etc.

30. Since establishment, most wetland impoundments on the refuge have been managed to promote waterfowl production by holding water through summer or year round, and occasionally draining areas for vegetation management. Islands and level-ditching were built in some ponds in the 1980s to improve pair seclusion and nesting sites. Otter Pond was stocked with warmwater fish in 1989 to provide prey for nesting osprey and limited public fishing opportunity. This fish stocking has contributed to nonnative fish moving into other refuge impoundments and drainages and also into the Bitterroot River.

31. Collectively, the many landscape and hydrological changes at Lee Metcalf NWR have degraded basic ecological processes of the historic ecosystem system and shifted plant communities to: 1) reduced area of Gallery Forest and native grassland and 2) increased area of Persistent Emergent wetlands, agricultural fields, tame grassland, and invasive plant species.

32. Fish and wildlife populations on Lee Metcalf NWR apparently have changed over time coincident with changes in vegetation communities and hydrology of the system. Waterbirds and species associated with wetland impoundments apparently increased in occurrence and abundance at the sites in the first 20+ years after impoundment, but subsequently have declined. Native species of fish and wildlife associated with reduced area and condition of riverine, Riparian and Gallery Forest and Grassland habitats have declined throughout the Bitterroot Valley ecosystem

GENERAL RECOMMENDATIONS FOR RESTORATION AND MANAGEMENT OPTIONS

This study is an attempt to evaluate restoration and management options that will protect, restore, and sustain natural ecosystem processes, functions, and values at Lee Metcalf NWR. Lee Metcalf NWR provides key resources to meet annual cycle requirements of many plant and animal species in the Rocky Mountain region of the western U.S., and is an important area that provides opportunities for outdoor experiences, recreation, and education for large numbers of people. These public uses are important values of the refuge that hopefully can be sustained within the context of more holistic regional landscape- and system-based management. This study does not address where, or if, the many sometimes competing uses of the refuge can be accommodated, but rather this report provides information to support The National Wildlife Refuge System Improvement Act of 1997, which seeks to ensure that the biological integrity, diversity, and environmental health of the (eco)system (in which a refuge sets) are maintained (USFWS 1999,Meretsky et al. 2006). Administrative policy that guides NWR goals includes mandates for: 1) comprehensive documentation of ecosystem attributes associated with biodiversity conservation, 2) assessment of each refuge's importance across landscape scales, and 3) recognition that restoration of historical processes is critical to achieve goals (Mertetsky et al. 2006). Most of the CCP's completed for NWR's to date have highlighted ecological restoration as a primary goal, and choose historic conditions (those prior to substantial human related changes to the landscape) as the benchmark condition (Meretsky et al. 2006). General USFWS policy, under the Improvement Act of 1997, directs managers to assess not only historic conditions, but also "opportunities and limitations to maintaining and restoring" such conditions. Furthermore, USFWS guidance documents for NWR management "favor management that restores or mimics natural ecosystem processes or functions to achieve refuge purpose(s)" (USFWS 2001) and to improve biological integrity (USFWS 201:601.FW3).

Given the above USFWS policies and mandates for management of NWR's, the basis for developing recommendations for Lee Metcalf NWR is the HGM-approach used in this study. The HGM approach objectively seeks to understand: 1) how this ecosystem was created, 2) the fundamental processes that historically "drove" and "sustained" the structure and functions of the system and its communities, and 3) what changes have occurred that have caused ecosystem degradations and that might be reversed and restored to historic and functional conditions within a "new desired" environment. This HGM approach also evaluates the NWR within the context of appropriate regional and continental landscapes, and helps identify its "role" in meeting larger conservation goals and needs at different geographical scales. In many cases, restoration of functional ecosystems on NWR lands can help an individual refuge serve as a "core" of critical, sometimes limiting, resources than can complement and encourage restoration and management on adjacent and regional private and public lands.

Generally, comprehensive restoration of native ecosystems and their sustaining ecological processes at Lee Metcalf NWR will be difficult because of: 1) the small size of the refuge, 2) the "insular" nature of the refuge that increasingly is surrounded by urban/residential expansion and development (Fig. 17), 3) highly modified landforms and communities on and adjacent to the refuge, 4) constraints on sustaining the inherent morphology and basic hydrology attributes of the Bitterroot River, and 5) high public use and competing demands for refuge management and access. Despite these substantial challenges, based on the HGM context of information obtained and analyzed in this study, we believe that future management of Lee Metcalf NWR should seek to restore ecological communities and processes to the least degraded state possible, including attempts to:

1. Maintain the physical and hydrological character of the Bitterroot River and its floodplain on Lee Metcalf NWR.

2. Restore the natural topography, water regimes, and physical integrity of surface water flow patterns in and across the Bitterroot River floodplain and adjacent terraces and alluvial fans.

3. Restore and maintain the diversity, composition, distribution, and regenerating mechanisms of native vegetation communities in relationship to topographic and geomorphic landscape position.

The following general recommendations are suggested to meet these ecosystem restoration and management goals for Lee Metcalf NWR.

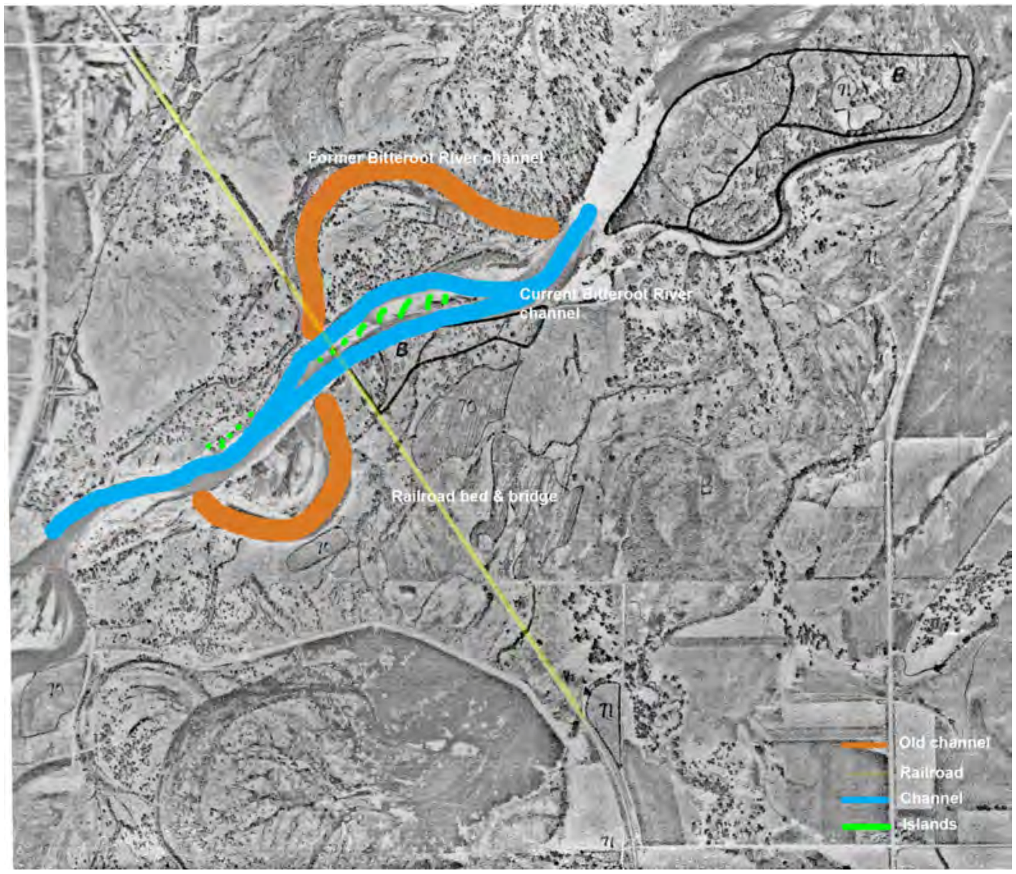
1. *Maintain the physical and hydrological character of the Bitterroot River and its floodplain on Lee Metcalf NWR.*

The Bitterroot River has an inherently unstable hydraulic configuration and high channel instability in the stretch immediately upstream from, and at, the Lee Metcalf NWR. The river in this area has a complex multi-strand channel patterns that is characterized by numerous braided, anastomosing, channels that spread over a wide area of the Bitterroot Valley floodplain. Complex networks of minor floodplain drainages and tributaries to the Bitterroot River are present on Lee Metcalf NWR and represent historic drainage patterns from adjacent mountain slopes and from groundwater discharge. Evidence of many historic abandoned channels of the Bitterroot River are evident on Lee Metcalf, some apparently quite recent in origin (Fig. 4).

Since the 1930s, lateral migration of the Bitterroot River channel has apparently accelerated and the river is actively attempting to cross the floodplain at Lee Metcalf NWR in new pathways, including shifting primary discharge through the North Slough (Fig. 20). Lateral migration of the river has been discouraged to date by land interests along the river, including the Lee Metcalf NWR, to protect existing roads, the railroad bed and bridge on the north end of Lee Metcalf NWR, and residential/farm owners. Control of river migration has been attempted by channelization and armoring channel banks with rip rap and other materials. Eventually, more channel stabilization will be needed to keep the Bitterroot River channel "in place" because hydraulic dynamics from future high flow events will continue to destabilize the current river channel configuration and destroy or damage existing physical structures. Current river stabilization structures on Lee Metcalf NWR including frontline levees and rip rap placed along the Bitterroot River in the 1970s and 1980s seem contradictory to the physical and hydraulic dynamics and character of the Bitterroot River and may ultimately be contributing to potential damage on other stretches or non-refuge lands along the river, both up and downstream from the refuge. Allowing the Bitterroot River to move more freely across the Lee Metcalf NWR floodplain seems desirable where it is possible and not detrimental to structures or interests that the USFWS has no control over. One of these structures is the railroad bridge and rail bed on the north end of the refuge. Unfortunately, this rail bed is located in an area of recently active river movement caused by the geological underlay of the site and the physical configuration of the river where the river has frequently moved and created recent abandoned channels and a braided river/island system (Fig. 27). Even with increasing attempts to stabilize the Bitterroot River at this point, ultimately this rail bed will be in jeopardy of river damage. Removal or relocation of the rail bed is outside of USFWS purview, but interest groups should be advised and aware of its precarious position and the ultimate consequences of its continued use and maintenance pending future alterations to the Bitterroot River channel and discharges. Furthermore, continued maintenance of this rail bed will limit and complicate future ecological restoration actions on Lee Metcalf NWR.

2. *Restore the natural topography, water regimes, and physical integrity of surface water flow patterns in and across the Bitterroot River floodplain.*

The diversity and productivity of the Bitterroot Valley ecosystem at and near Lee Metcalf NWR was created and sustained by a diverse floodplain geomorphic/topographic surface that was seasonally "hydrated" by a strong pulse of water input to the system each spring from Bitterroot River flooding and drainage/seepage from surrounding mountain slopes. Occasional overbank, and more regular backwater, flooding from the Bitterroot River into its floodplain at Lee Metcalf NWR historically helped create and sustain communities and basic ecological functions and values of the site. These flooding processes now are restricted by levees along the river, levees and dams on constructed wetland ponds and impoundments, roads, the railroad bed, and dams or other obstructions on tributary channels. Restoring the capability of the Bitterroot River to overflow its banks, and to back water up tributaries and into other floodplain channels is desirable to restore the floodplain ecosystem at Lee Metcalf NWR. This seasonal "pulsed" flooding regime provided uninhibited movement of water, nutrients, sediments, and animals between the river and the floodplain and supported critical life cycle events and needs of both plant and animal communities (Junk et al. 1989). Periodic long-term flood events also are important flood plain processes that help maintain community dynamics and productivity (e.g., Whited et al. 2007) For example, overbank flooding deposits silts and nutrients in floodplains that enhance soil development and productivity. Overbank flooding creates scouring and deposition surfaces critical for germination and regeneration of Gallery Forest species, especially cottonwood. Backwater flooding provides foraging habitat for pre-spawning native river fish and entrainment and development/growth habitat for larval and juvenile fishes. Annual backwater flooding recharges water regimes in depressions and shallow floodplain wetlands that serve as productive



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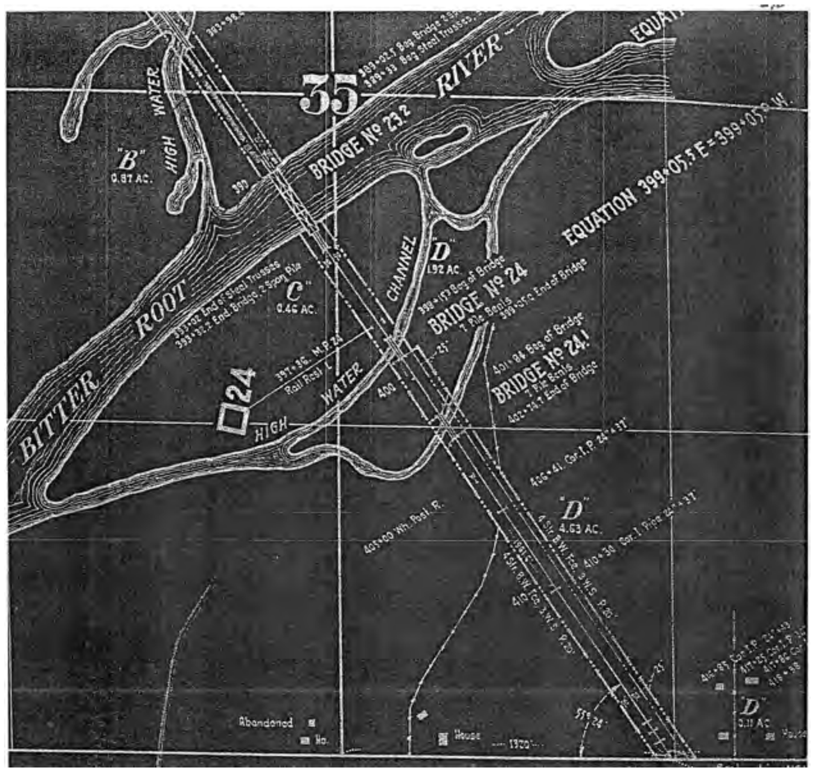

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Figure 27. Location of the railroad bridge and bed across the Bitterroot River and its floodplain on Lee Metcalf National Wildlife Refuge showing: a) its position relative to current and former river channels and the braided channel-island geomorphology and b) the historical blueprint of the railroad corridor and its crossing of multiple active and abandoned channels of the Bitterroot River.

breeding habitat for amphibians and reptiles, waterbirds, and certain mammals. Subsequent drying of floodplains concentrates aquatic prey for fledgling waterbirds. Collectively, the body of scientific evidence suggests that restoring the hydrologic connectivity between the Bitterroot River and its floodplain at Lee Metcalf is desirable.

Topographic and soil/geomorphology variation created a heterogeneous mosaic of elevations and site-specific hydrology that supported many vegetation communities on Lee Metcalf NWR and provided diverse resources that supported many animal groups. Unfortunately, the topography and flow of water across the Lee Metcalf NWR area has been altered dramatically; initially from land conversion and physical developments and diversion of water for irrigating crop and pastureland and then by construction of water-control infrastructure by the USFWS in an attempt to create more permanent wetland areas (ponds) for breeding waterfowl. Both early 1900s and more recent physical developments on Lee Metcalf NWR have been detrimental to sustaining the natural ecosystem of the area/region, and do not match historic ecosystem structure or function.

Restoration of the physical and biotic diversity and productivity of the Lee Metcalf NWR ecosystem will require at least some restoration of natural topography, especially reconnecting water flow pathways or corridors, in the floodplain. Restoration of topography and water flow pathways is important to allow water, nutrients, and animals to move through the system in more natural patterns. Additionally, restoring water pathways can improve both flooding and drainage capabilities, more closely emulate natural hydroperiods that sustained native plant communities, and reduce prolonged flooding in ponds and other depressions during the growing season. Restoration and emulation of natural water regimes, and floodplain communities, on Lee Metcalf NWR will require a fundamental change in the philosophy of water management in wetland impoundments on the area. Past management of impoundments has sought to provide more annually predictable, and permanently flooded, water regimes to enhance waterfowl production. Impoundment infrastructure and more frequent and permanent growing season inundation has caused highly altered topography, disconnected natural flow patterns and corridors, conversion of native plant communities wetter types, and general degradation of historic Bitterroot Valley ecosystem processes. Future water and impoundment (if they are retained) management of Lee Metcalf NWR should seek to manage surface water with seasonal water regimes, driven by spring runoff and Bitterroot River backwater flooding, and by restoring drying periods in late summer and fall in most years.

3. *Restore and maintain the diversity, composition, distribution, and regenerating mechanisms of native vegetation communities in relationship to topographic and geomorphic landscape position.*

The diversity of vegetation communities historically present at Lee Metcalf NWR was distributed along geomorphic surface, soil, topographic, and flood frequency gradients. In this active river migration floodplain setting, the dominant factors determining distribution of vegetation was soil/geomorphology surfaces and topography as it was related to the seasonal flooding regime caused by interannual and intraannual dynamics of water flows and levels of the Bitterroot River and its tributaries. Major disturbance factors that sustained communities included seasonal and long-term flooding (Hansen et al. 1995), herbivory (Burkhardt 1996), and fire (Arno 1976, Fischer and Bradley 1987). Many factors have changed the presence, extent, and distribution of habitat types at Lee Metcalf NWR including land clearing and conversion to orchards and agricultural crops, construction of extensive irrigation systems, drainage, levee and water-control infrastructure, and altered hydrology and movement capability of the Bitterroot River. Certain of these land and water changes (e.g., floodplain drainage infrastructure) may be reversed, but others (e.g., residential developments, railroad beds) are not likely to change in the foreseeable future, or are not under the control of the USFWS.

Generally, ecosystem restoration strategies seek to restore elements of the diversity and natural distribution patterns of habitats in a region, where they have been highly altered (e.g. Heitmeyer 2007). This restoration is important to sustain plant and animal communities and to provide ecosystem functions and values such as nutrient flow, carbon sequestration, water filtration, groundwater recharge, flood water storage, etc. Restoration projects at Lee Metcalf NWR should attempt to restore at least some functional patches of all native habitat types that were present in the late 1800s (e.g., Porter 2008) and be integrated with Montana's Comprehensive Fish and Wildlife Conservation Strategy (Montana Fish and Wildlife Comprehensive Conservation Steering Committee 2006). The challenge at Lee Metcalf NWR will be to develop site-specific strategies to restore natural topography, river migration, and seasonal water flow regimes in areas that have had extensive alteration. Basically, restoration works that seek to restore some components and distribution of native plant communities (Knopf et al. 1988) will require "deconstruction" of many past infrastructure developments that may be controversial amidst the current expectations, uses, and competing demands of user groups and neighboring lands. Certain changes may not be possible (e.g., changing Bitterroot Irrigation District ditch and drain systems) or desirable, however other USFWS controlled changes can be conducted (e.g., removing impoundment levees, islands, and level-ditch spoil/dredge sites). Undoubtedly, some conflicts will occur among user groups, but priorities and management ultimately must be based on restoring sustainable communities to the site to meet resource/ecosystem goals.

SPECIFIC RECOMMENDATIONS FOR RESTORATION AND MANAGEMENT OPTIONS

Restore the Physical and Hydrological Character of the Bitterroot River System

As previously stated, the inherently unstable and dynamic physical and hydrological character of the Bitterroot River ecosystem at Lee Metcalf NWR was created by geological and hydrological processes that still exist in their general physical/hydraulic form. The presence of large mountains bounding the Bitterroot Valley that contribute sediment and water to the Bitterroot River and its floodplain exert basic physics to the system that must be understood and accommodated in management of specific sites in the Valley, including Lee Metcalf NWR. Clearly, many changes have occurred to this riverine-floodplain system and many changes may be irreversible or are unlikely to change in the near future (e.g., the Bitterroot Irrigation District infrastructure). Nonetheless, the USFWS has the opportunity to manage Lee Metcalf NWR in an exemplary way that contributes to the overall sustainability and restoration of the Bitterroot Valley, albeit in a small somewhat isolated scale. The following restoration opportunities seem possible:

1. *Allow the Bitterroot River to undergo natural anastomosing migration patterns across Lee Metcalf NWR, where possible.*

- Remove, or place wide carefully engineered spillways in, main stem levees along the Bitterroot River. Where old or existing levees have been breached or destroyed, do not rebuild them.

- Remove or do not replace hard points or rip rap along the channel banks of the Bitterroot River on Lee Metcalf NWR properties unless they protect non-USFWS property or structures.

- Do not inhibit tendencies for the Bitterroot River to move primary discharge through the North Island Slough.

- Evaluate removal of levees along the north sides of Otter Pond and Ponds 12 and 13 to allow the Bitterroot River to move into, and seasonally flood, these areas.

2. *Reconnect floodplain habitats with the Bitterroot River to allow natural overbank and backwater flooding into and out of the floodplain.*

- Remove, or construct wide spillways in, levees, berms, dams roads, and ditches that prohibit overbank and backwater flooding from the Bitterroot River into the floodplain on Lee Metcalf NWR property.

- Allow, or restore, seasonal flows of the Bitterroot River into and through North Island and Francois sloughs, respectively.

3. *Reconnect unimpeded flow from Valley/Mountain channels and tributaries into the Bitterroot River.*

- Remove dams and obstructions in tributary and floodplain channels to allow water to move freely into the Bitterroot River and allow fish and other aquatic animals to use this flowage corridor.

- Reconnect the North Burnt Fork Creek with flow pathways through Francois Slough and into the Bitterroot River to reduce creek water temperatures, improve water and nutrient flow, and help restore native populations of bull trout.

Restore Floodplain Topography, Water Regimes, and Water Flow Patterns

Restoration of ecological communities and processes at Lee Metcalf NWR will require at least some restoration of natural topography, water flow, and flooding/drainage regimes. Unfortunately, some past infrastructure developments and management of Lee Metcalf NWR lands and water have been contradictory, not complementary, to these restoration needs. In general, the Bitterroot River floodplain at Lee Metcalf NWR is semi-arid and water regimes are dominated by early spring flooding and surface water runoff followed by drying through summer and fall to low more stable levels in winter. Superimposed on this strongly seasonal pattern are occasional long-term punctuations (> 20-year recurrences) of more extreme flooding of the Bitterroot River that caused prolonged inundation of the floodplain and its drainages/depressions throughout summer/fall and across a few consecutive years. Past management and development of wetland impoundments on Lee Metcalf NWR have not emulated seasonal or long-term dynamics of flooding or maintained floodplain water flow corridors. A return to more natural dynamics may require significant changes to current landforms and management strategies. Possible changes include:

1. *Restore natural topography and reconnect natural water flow patterns and corridors where possible.*

- Remove and/or breach spoil material berms and levees along major drainages.

- Improve water flow into and through historic slough and swale channels by removing obstructions, levees, and dams in and across these drainages.

- Restore at least some natural topography in all wetland impoundments, fields, and terraces and remove islands and level-ditch dredge and spoil sites.

- Evaluate all levees and roads to determine if they are necessary, or are detrimental, to water management on the area. Remove unnecessary levees and roads and construct spillway breaches in some pond levees to allow water to move among units during high water flow or flood events.

- Do not construct additional wetland impoundments, roads, levees, or other structures that altered water flow into or across the floodplain.

- Remove roads, berms, and ditches etc. that disrupt natural “sheetflow” of water across mountain slope alluvial fans into the floodplain.

2. Manage wetland impoundments/ponds for natural seasonal and long-term water regimes.

- Manage water regimes in all ponds for a more seasonally and annually dynamic water regime that emulates natural increases in distribution and depth in spring, followed by drying in summer and fall.

- Emulate long-term patterns of drier conditions in floodplain wetlands in most years including periodic complete drying in some years and occasional prolonged flooding in a few years.

Restore Natural Vegetation Communities

The native vegetation communities present on Lee Metcalf NWR provided critical resources to many animal species and populations and contributed to the many functions and values of the Bitterroot Valley. Degradation of these native communities began in earnest in the early 1900s and subsequent changes in land form, hydrology, and management have continued alterations. Despite these alterations, some restoration of communities is possible by:

1. *Restore distribution of plant communities to appropriate sites based on HGM-documented geomorphology, soils, topography, and hydrologic features identified in Table 2, Fig. 13).*

- Sustain Riverfront Forest along the margins of the Bitterroot River on newly deposited/scoured coarse material surfaces.

- Sustain and expand Gallery Forest on higher elevation floodplain areas with sandy-loam soils, on natural levees, and other floodplain ridges that have 2-5 year flood recurrence intervals.

- Restrict Persistent Emergent habitats to deeper depressions, poorly drained Slocum muck soils, and more permanent water regimes.

- Sustain Wet Meadow communities adjacent to Persistent Emergent communities with 2-5 year flood frequencies.

- Restore native Grassland in silt loam soils on higher floodplain elevations and on terraces.

- Restore Saline Grassland to terrace areas with saline soils.

- Sustain Grassland-Sagebrush communities on alluvial fans.

2. *Improve conditions to increase the distribution and composition of native Grassland in higher floodplain elevations and on terraces/alluvial fans.*

- Remove introduced and tame grassland from locations where native Grassland communities historically were present and restore native species where possible.

- Restore intermittent and seasonal water regimes to higher elevation sites and restore patterns of "sheetflow" surface water movement across the sites by removing unnecessary roads, ditches, levees, etc.

- Convert higher elevations of current impounded wetlands back to Grassland, where it was historically present, by removing levees and water-control structures, and restoring seasonal water regimes.

- Providing occasional disturbance from fire or grazing to recycle nutrients and regenerate grass and forb species.

3. *Restore regenerating mechanisms for Gallery Forest communities on well drained floodplain natural levees and benches.*

Gallery Forests in the Bitterroot Valley were sustained by fertile floodplain soils and seasonal inundation for generally short periods at about 2-5 year intervals. Further, occasional disturbance mechanisms provided suitable substrates for regenerating tree species and shrubs. Cottonwood Gallery Forests in Montana generally are in poor condition if the shrub components are not present, most commonly due to overgrazing (Hansen et al. 1995). Gallery Forest on Lee Metcalf NWR is in better condition (i.e., more shrub component) in the north end of the refuge compared to the middle and south end of the refuge along the Bitterroot River. Regenerating mechanisms, that need to be reinstated into the management of Lee Metcalf NWR include:

- Occasional large flood events to occur in the floodplain to scour surfaces, deposit sands, and create regeneration sites for cottonwood.

- Occasional fire and perhaps some grazing during dry periods to sustain occurrence of grasses and forbs and to scarify pine cones and permit germination of ponderosa pine (e.g., Fischer and Bradley 1987).

4. *Reduce the area of more permanently flooded wetland impoundments and Persistent Emergent vegetation.*

- Change water management of impounded areas that might be maintained, to seasonal water regimes and periodic dry conditions.

- Remove levees, ditches, and water-control structures from all higher elevation areas within the floodplain and on terraces.

- Eliminate the warm-water fishery in Otter Pond.

5. *Actively control invasive and exotic plant species.*

- Actively control invasive and exotic plant species using appropriate chemical, mechanical, and biological methods.

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