

APPENDIX III

SUMMARY OF PAST IMPACTS TO THE MISSOURI RIVER ECOSYSTEM

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Summary of effects of river channelization (c), including snag removal, and construction of dikes, revetments, and levees; construction and operation of mainstream dams (d), and both types of alterations (cd) on the lower Missouri River ecosystem (Adopted from Galat et al. 1994).

Physical

- C Changes in channel geomorphology:
 - 8 percent reduction in channel length
 - 27 percent reduction in bank-to-bank channel area
 - 50 percent reduction in original surface area of river
 - 98 percent reduction in surface area of islands
 - 89 percent reduction in number of islands
 - 97 percent reduction in area of sandbars

resulting in reduction in channel diversity through loss of side channels, backwaters, islands, and meandering (Funk and Robinson 1974, Hesse et al. 1988).
- C Change in physical substrate from dominance of silt, sand, and wood to rock riprap.
- C Increased water depth and velocity in main channel.
- D Pre- versus postimpoundment declines in suspended sediment loads at Omaha, Nebraska, and St. Louis, Missouri, respectively, of 175 to 25 and 250 to 125 million tons per year (Schmulbach et al. 1992).
- D Reduction in river sediment load resulting in channel bed degradation including channel deepening, increased bank erosion, and drainage of remnant backwaters downstream from dams (Hesse et al. 1988, 1989a, b).
- D Silt-clay fraction of suspended sediment load reduced by 50 percent, but sand fraction increased 260 percent, following closure of Gavins Point Dam in 1954 (Slizeski et al. 1982).
- D Reduction in turbidity resulting in increased light penetration (Morris et al. 1968, Pflieger and Grace 1987).
- D Modification of natural flow regime by evening maximum and minimum discharges and eliminating periodic flood pulse.
- D Reduction in annual temperature range.
- CD Loss of periodic flooding and floodplain connectivity.

Chemical

- C Higher water velocities reduce travel time for dissolved ions, nutrients and contaminants.
- D Increase in dissolved oxygen concentrations below main stem dams (Morris et al. 1968).
- D Higher postimpoundment summer flows for navigation dilute impacts of point source discharged pollutants (Ford 1982).
- D Reductions in nitrogen and phosphorus concentrations downstream from reservoirs and changes in spiraling patterns (Ward and Stanford 1983, Schmulbach et al. 1992).

Biological

- C Decline in habitat richness resulted in presumed decrease in diversity of periphytic algae (Farrell and Tesar 1982).
- C Elimination of plankton and invertebrates produced in standing water chutes and sloughs with loss of these habitats (Whitley and Campbell 1974).
- C Loss of instream snag habitat and functions of organic matter retention and substrate for invertebrates and fishes (Benke et al. 1985).
- C Greater standing crop of benthic invertebrates in main stream of unchannelized versus channelized river sections (Berner 1951, Morris et al. 1968, Nord and Schmulbach 1973).
- C Smaller standing crops of benthic invertebrates in chutes and mud banks of unchannelized versus channelized sections (Morris et al. 1968).
- C Larger standing crop of drift in unchannelized than channelized sections of river and little similarity between drift and benthos (Morris et al. 1968, Modde and Schmulbach 1973).
- C 67 percent reduction in benthic area suitable for invertebrate colonization (Morris et al. 1968).
- C 54 percent decline in benthic invertebrate production from all unchannelized habitats of Missouri River downstream from main stem dams between 1963 and 1980 and 74 percent decrease in production in chute/backwater habitats (Mestl and Hesse 1992).

- C Loss of river-floodplain connection for fish migration, spawning and rearing.
- C Reduction in microhabitats resulting in decreased abundance of fish species in channelized versus unchannelized section of river in Nebraska (Schmulbach et al. 1975).
- C Higher standing crop of sportfishes in unchannelized sections of river in Nebraska compared with channelized sections attributed to more backwater habitat and greater habitat diversity (Groen and Schmulbach 1978).
- C Loss of nesting habitat for sandbar/sand island birds leading to drastic population declines (e.g., *Sterna albifrons*, *Charadrius melodus*).
- D Elimination of riparian forests and stream channels in areas flooded by reservoirs, totaling over one-third entire length of Missouri River (Hesse et al. 1988).
- D Entrainment of fluvial particulate organic matter in reservoirs.
- D Temperature induced shifts in periphyton and phytoplankton community structure, particularly below dams (Farrell and Tesar 1982, Reetz 1982).
- D Increase in periphyton primary production below dams (Ward and Stanford 1983).
- D Increased relative importance of phytoplankton biomass and primary production compared with upstream allochthonous inputs.
- D Increase in diversity and density of zooplankton community in river downstream from reservoirs (Repsys and Rogers 1982).
- D Changes in standing crop and diversity, and shifts in functional feeding groups of benthic macroinvertebrates in river downstream from reservoirs (Ward and Stanford 1979).
- D Alteration of emergence cues, egg-hatching, diapause-breaking, and maturation of aquatic insects due to thermal modifications below reservoirs (Ward and Stanford 1979, Petts 1984).
- D Blockage of riverine fish migration.
- D Inundation of floodplain fish spawning and nursery habitats.
- D Development of extensive sportfisheries in reservoirs and tailwaters (Hesse et al. 1989a).

- CD Near elimination of natural riparian community (Hesse et al. 1988, 1989a, b).
Changes reported:
- 41 percent deciduous vegetation
 - 12 percent grasslands
 - 39 percent wetlands
- CD 25 percent decrease in post-dam tree growth in North Dakota floodplain compared with pre-dam period related to absence of annual soil profile saturation, lowering of water table in spring to reduce downstream flooding (Reiley and Johnson 1982), and lack of nutrient silt deposition (Burgess et al. 1973).
- CD Increasing proportion of mature forest to other successional stages in remaining floodplain (Bragg and Tatschl 1977).
- CD 80 percent decline in organic carbon load of post-control Missouri River to Mississippi River compared with pre-control (Hesse et al. 1988).
- CD Loss of major floodplain habitat types reduced populations of associated flora and fauna (Clapp 1977).
- CD Decreases in endemic large river fishes (e.g., *Scaphirhynchus albus*, *Polydon spathula*, *Cycleptus elongatus*, *Hybopsis gracilis*, and increases in pelagic planktivores (e.g., *Dorosoma cepedianum*, *Alosa chrysochloris*) and sight-feeding carnivores (e.g. *Morone chrysops*, *Lepomis macrochirus*) (Pflieger and Grace 1987, Hesse et al. 1992).
- CD Population declines of 11 native Missouri River Basin biota leading to listing as federally threatened or endangered (Table 7).
- CD As much as an 80 percent decline in commercial fishery in Nebraska and 97 percent decline in tailwater recreational fishery below Gavins Point Dam (Hesse and Mestl 1992).
- CD Decline in legal sized catfishes in Missouri River, Missouri, attributed in part to increased susceptibility to exploitation due to lost habitat diversity (Funk and Robinson 1974, Robinson 1992).
- CD Introduction and establishment of non-native fishes and invertebrates (e.g., *Oncorhynchus* spp., *Osmerus mordax*, *Mysis relicta*). See Table 6 for list of introduced fishes.

Social

- D Hydroelectric power generation of over 2.2 Gw, sales totaling \$1.5 billion from 1943-86 (Sveum 1988).
 - D Development of major reservoir based recreation and associated commercial services, supported spending of \$65 million in 1988 (General Accounting Office 1992).
 - CD Commercial navigation industry transports about 2 million tons of goods, producing gross revenues of \$17 million in 1988 (General Accounting Office 1992).
 - CD Water supply provided to 40 cities (3.2 million people), 21 power plants, and 2 chemical manufacturers in lower Missouri River (General Accounting Office 1992).
 - CD 4,000+ increase in area of agricultural land use (Hesse et al. 1988).
 - CD 95 percent of protected floodplain now in agricultural, urban, and industrial uses (Hesse et al. 1989b).
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