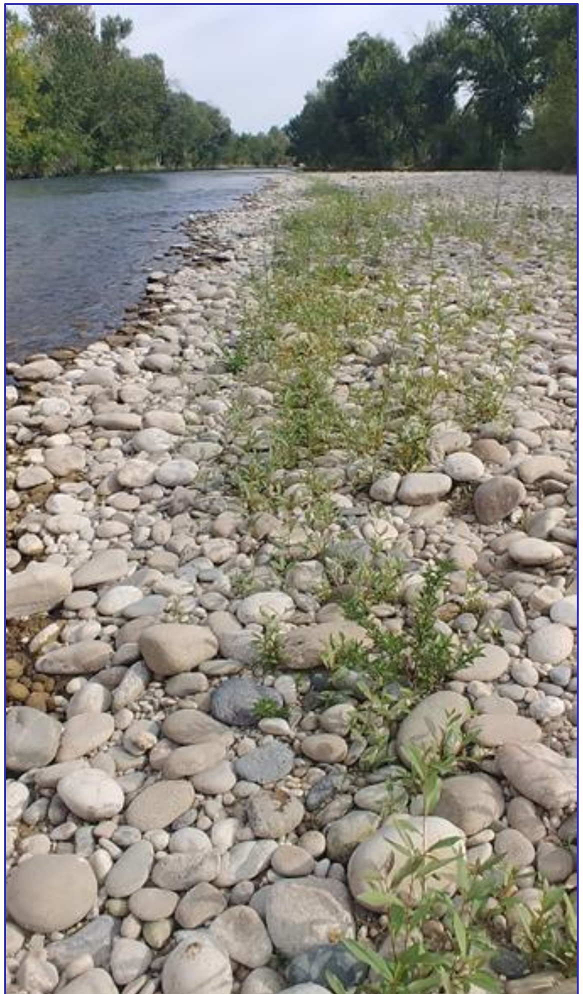
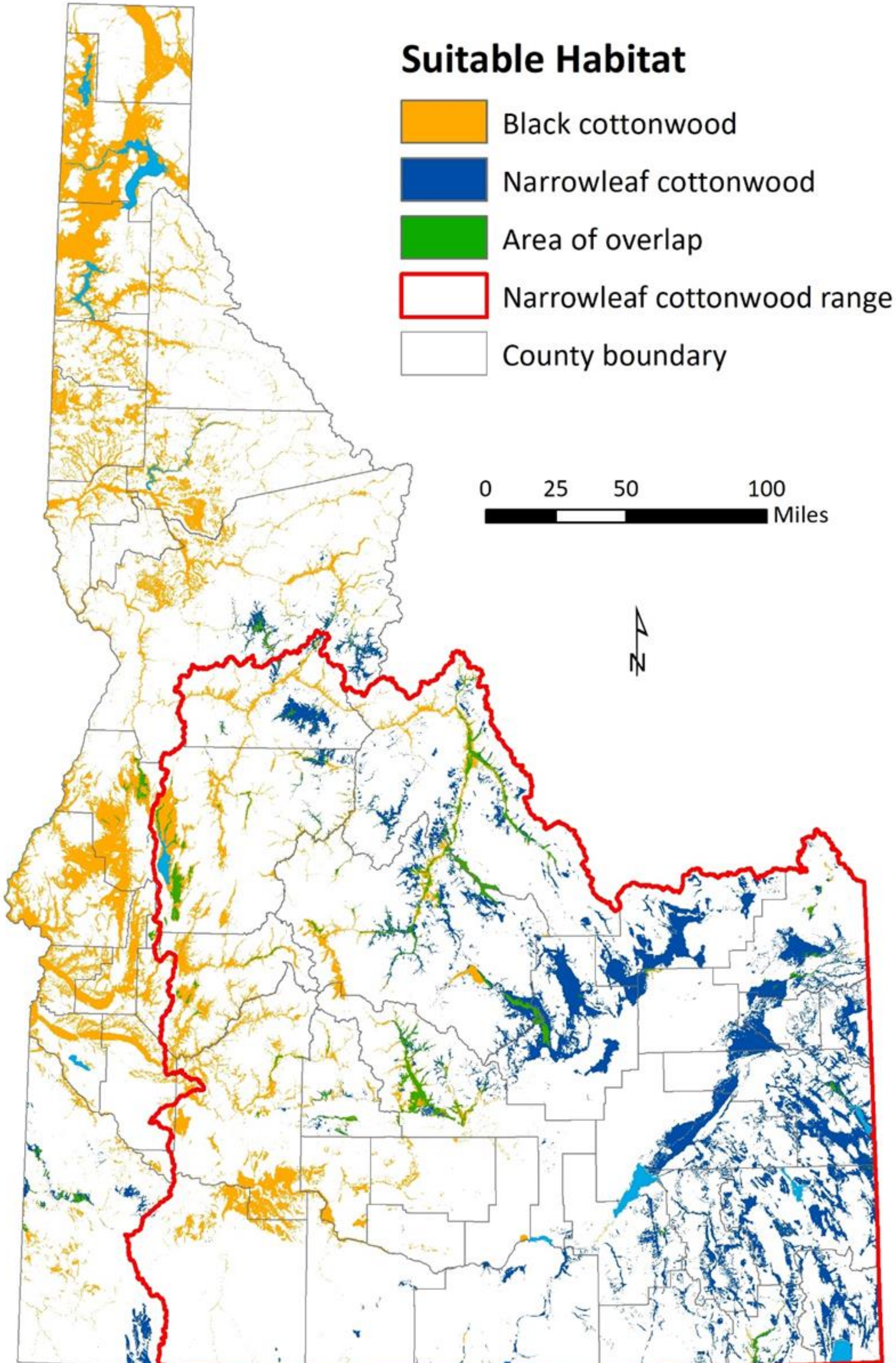
Idaho's Floodplain and Riparian Cottonwood Forests

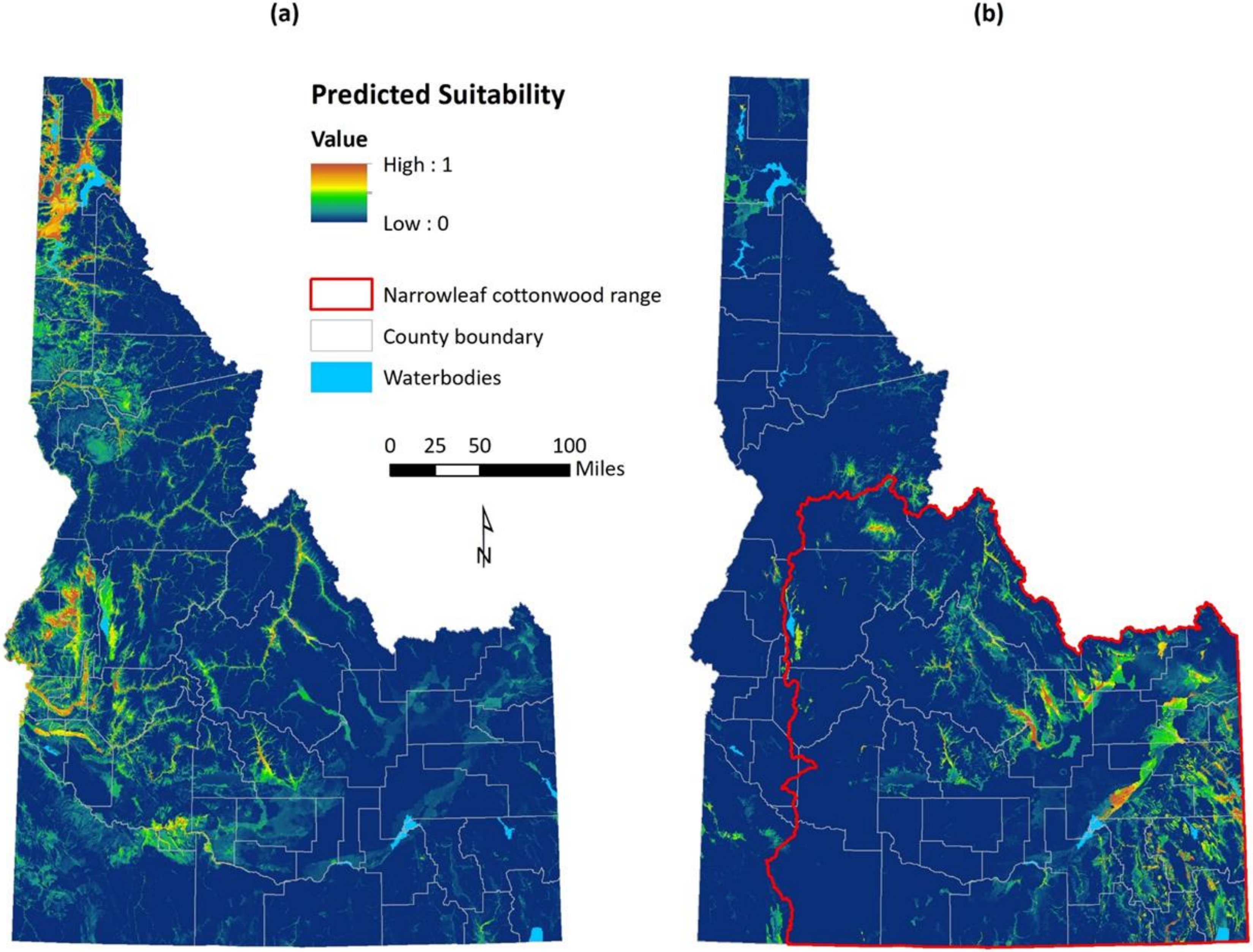


Sustaining an Imperiled Critical Habitat

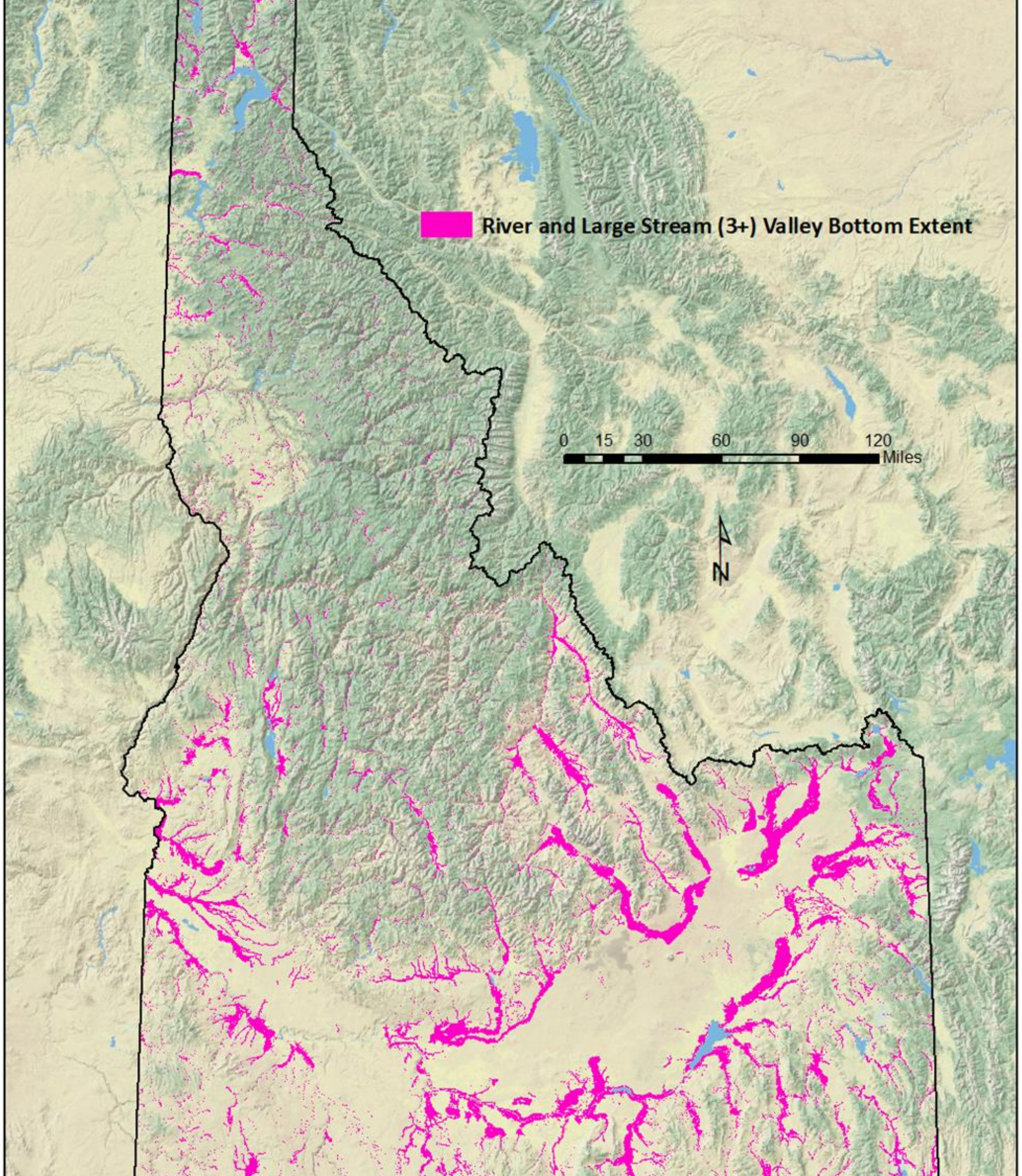
Chris Murphy
Idaho Dept. of Fish and Game Ecologist



black cottonwood (above)
narrowleaf cottonwood (below)



Predicted suitable habitat: (a) black cottonwood and (b) narrowleaf cottonwood from Maxent model using bioclimatic and soil variables


River and Large Stream (3+) Valley Bottom Extent
0 15 30 60 90 120
Miles
N

Cottonwood Forest Ecosystem

Cottonwoods reproduce on alluvial bars (Boise River)

Older stands can have a grassy understory (Snake River)

Younger forests can be diverse and productive with shrub, forb, grass layers (Snake River)

Flooding = Essential Process

South Fork Payette River

Boise River flood, April 1943,
17,300 cfs discharge,
~1 mi downstream of Boise (USACOE)

Cottonwoods are a Keystone Species of Ecologically Diverse and Dynamic River Floodplains in Idaho

- complex, dynamic, disturbance dependent
- built and shaped by annual floods
- alluvial bars, islands, backwaters
- many vegetation types and ages
- aquatic-terrestrial interface

Intact examples on rivers without large dams:
South Fork Payette River (top left), Weiser River (top right),
and Salmon River (bottom right)

Riverine Floodplain and Riparian Cottonwood Habitats

- Dynamic
- Ecosystem interface
- High productivity, diversity, value
- Range of structure and composition
- In balance with disturbance
- Reflect hydrology and geomorphology

Floodplain and Riparian Forest Functions and Values

- Hydrologic
- Habitat
- Ecosystem Support
- Ecosystem Services

Hydrologic Functions

- **small marshes interspersed**
- **backwater sloughs, re-charge local aquifer**
- **oxbows (e.g., cutoff meanders)**
- **groundwater upwellings, maintain flows**
- **important habitat, functions (e.g., surface water storage)**

Ecosystem Support Functions

- element cycling
- nutrient/element removal & transformation
- toxicant/sediment removal & retention
- primary production
- food chain support
- woody debris

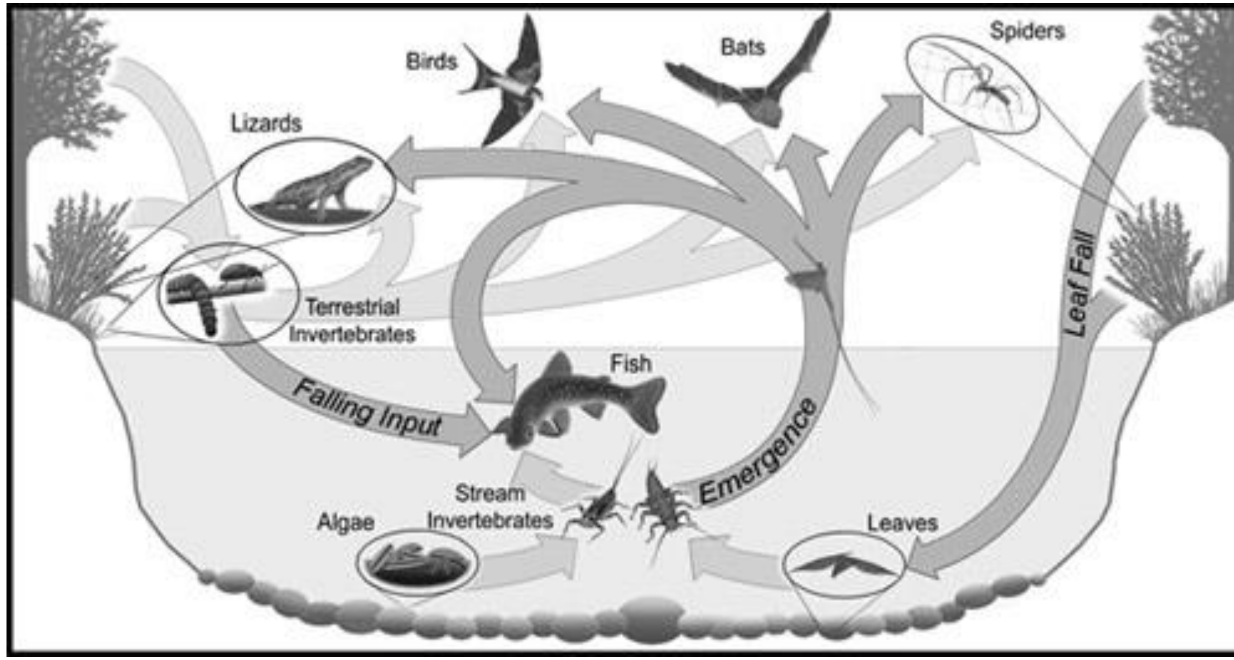


Figure by C. Baxter, Idaho State University

Critical Riparian Habitat





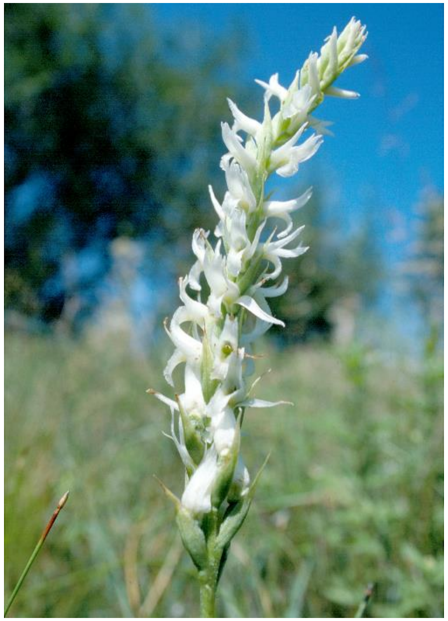

Upper Snake River Habitat

Listed Threatened Species, Endangered Species Act:

- **Ute ladies'-tresses (bottom middle)**
- **yellow-billed cuckoo (top right, Wikimedia)**

Species of Greatest Conservation Need:

- **northern leopard frog (bottom left)**
- **western toad (bottom right)**



Values to Society

- water supply
- water quality protection
- wastewater treatment

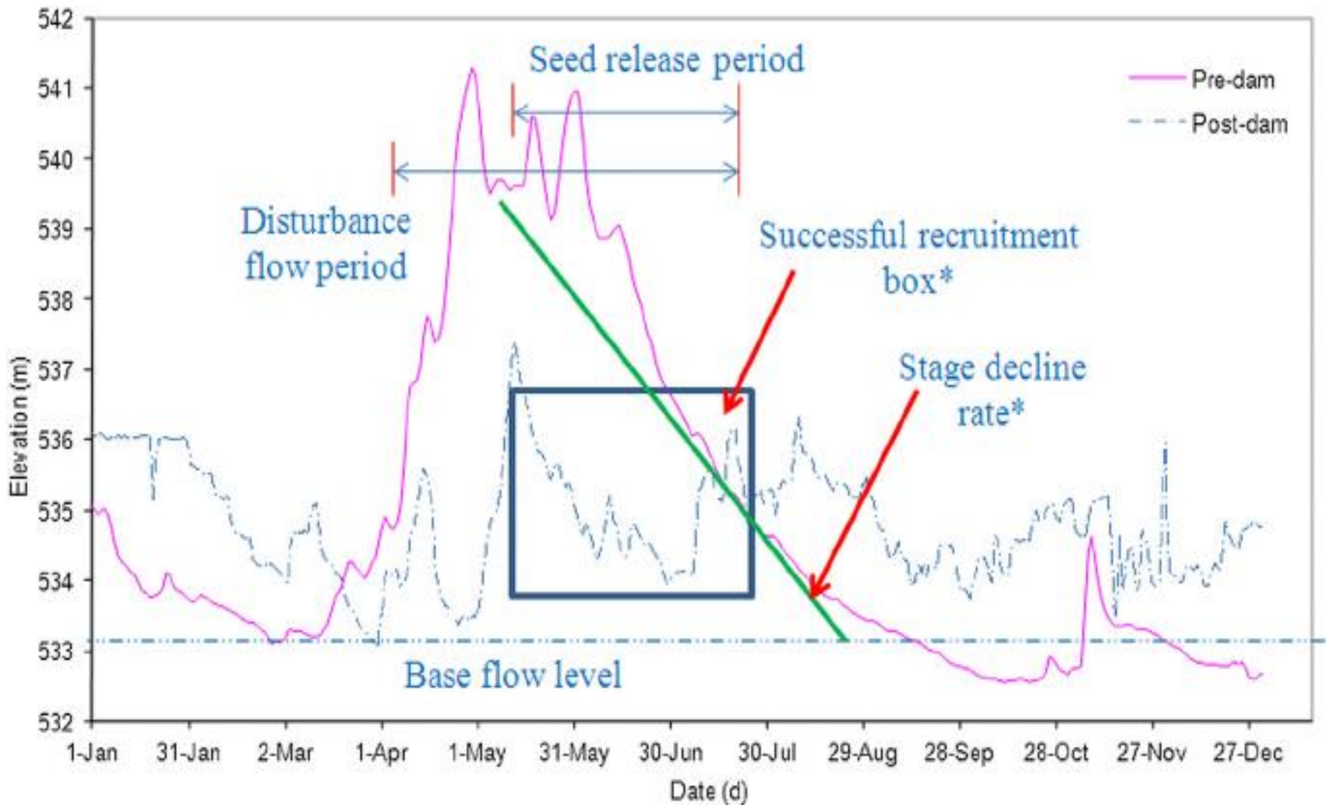
- education and research
- historical & archeological

- open space
- aesthetics
- recreation

- agricultural production
- medicinal products
- shoreline stabilization
- flood and flow alteration

Seed-based Cottonwood Reproduction

- **fluvial processes create depositional sandy-cobble alluvial bars**
- **flood disturbance maintains open, sunny environment**
- **seeds disperse in late May-June, flows decline at same time**
- **seeds germinate on exposed, moist alluvial bars**
- **moisture regime for seedling survival mirrors river stage decline (~2.5 cm/day)**

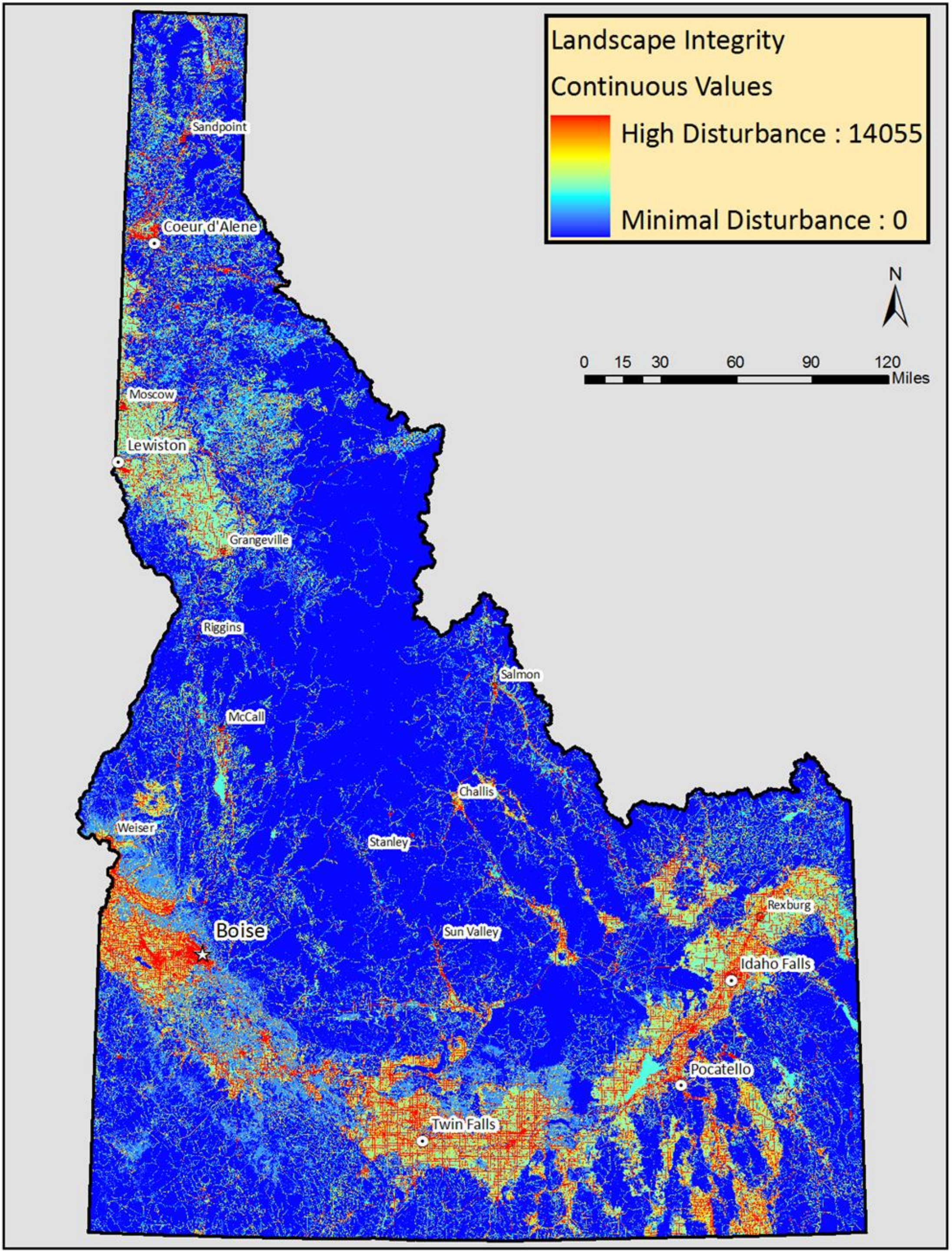


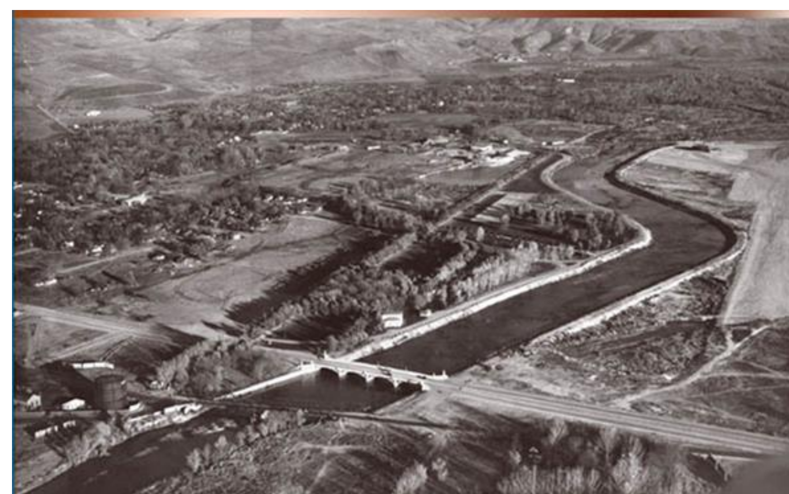
Successful cottonwood reproduction: Recruitment box and stage decline rate based on Mahoney and Rood (1998). Hydrographs are before (1934) and after (1976) Libby Dam on Kootenai River. Figure from Benjankar R, Burke M, Yager E, Tonina D, Egger G, Rood SB, Merz N. 2014. Development of a spatially-distributed hydroecological model to simulate cottonwood seedling recruitment along rivers.

Cottonwood Seedlings and Saplings

Clockwise from upper left: Weiser River, Clearwater River, Salmon River, Snake River

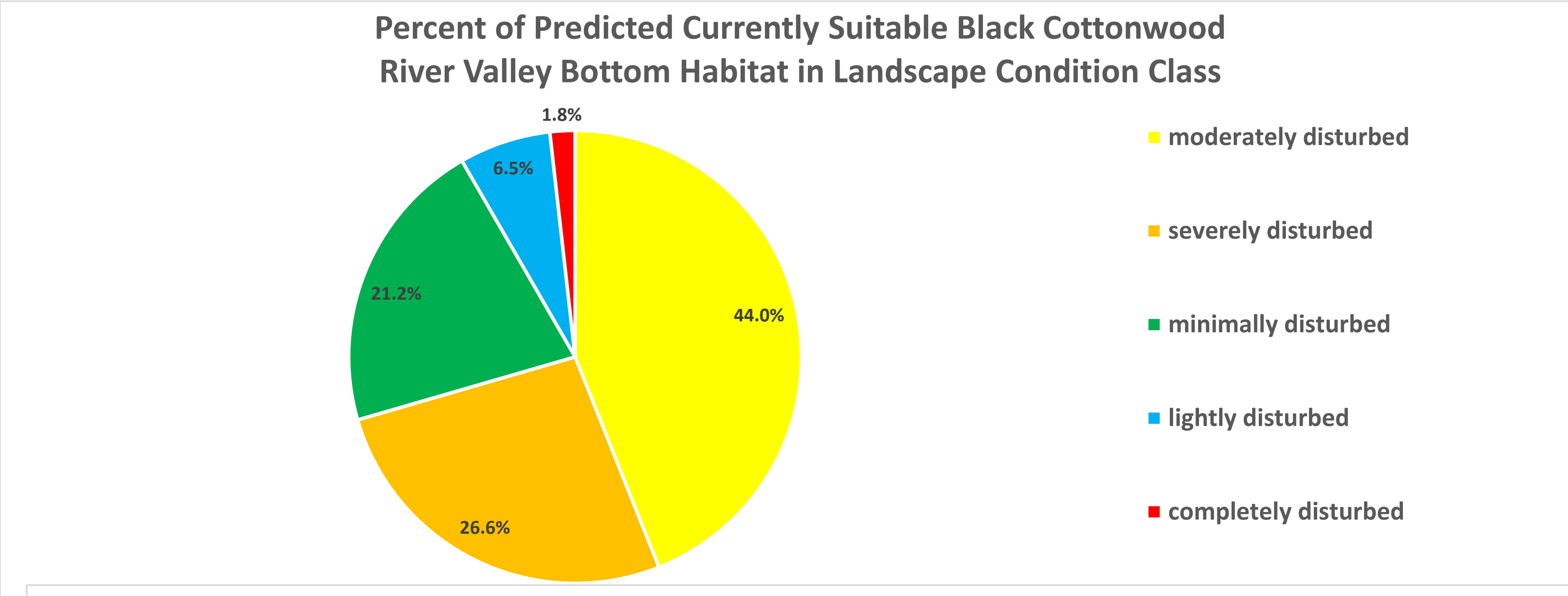
Human Footprint



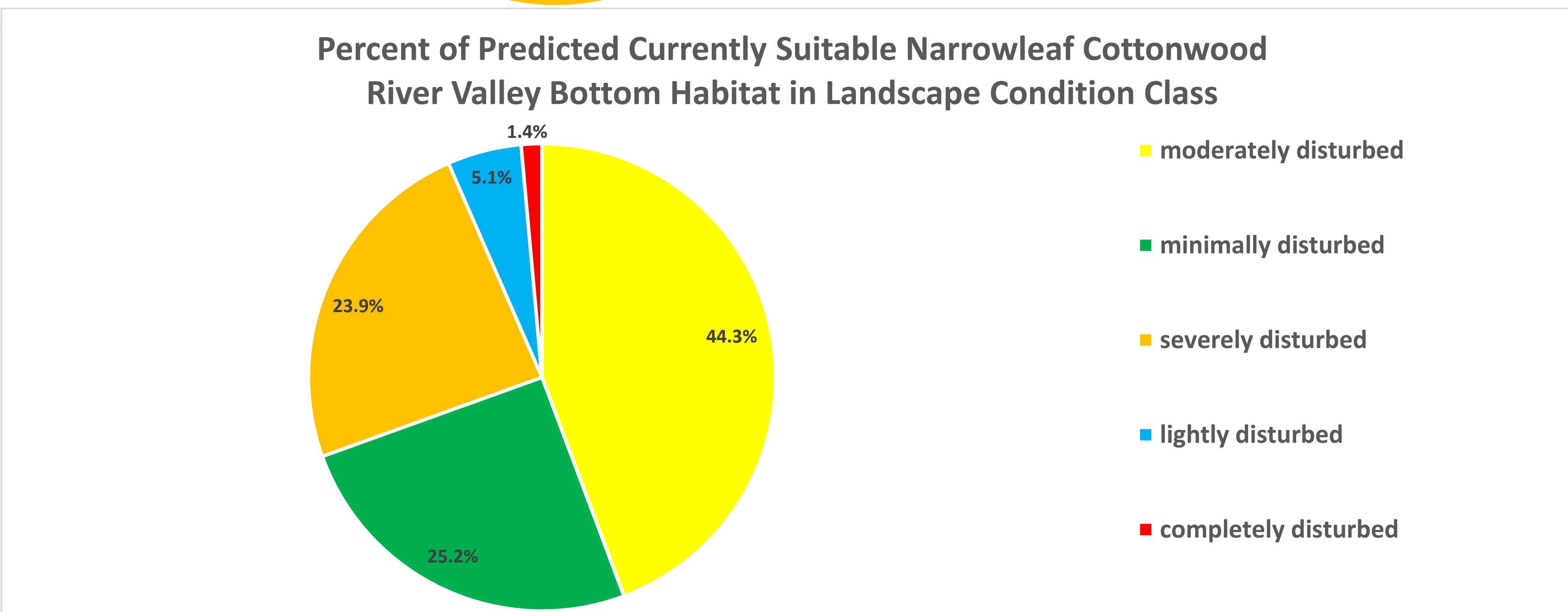


Threats and Stressors

- flow alteration (dams, diversions)
- climate, drought
- flood control (levees, dikes, channelization, bank stabilization)
- transportation (bridges, roads, railroads)
- mining
- floodplain filling, grading
- building, development
- agriculture, livestock grazing
- noxious weeds, invasive species
- logging, clearing
- recreation
- water pollution
- disease
- wildfire



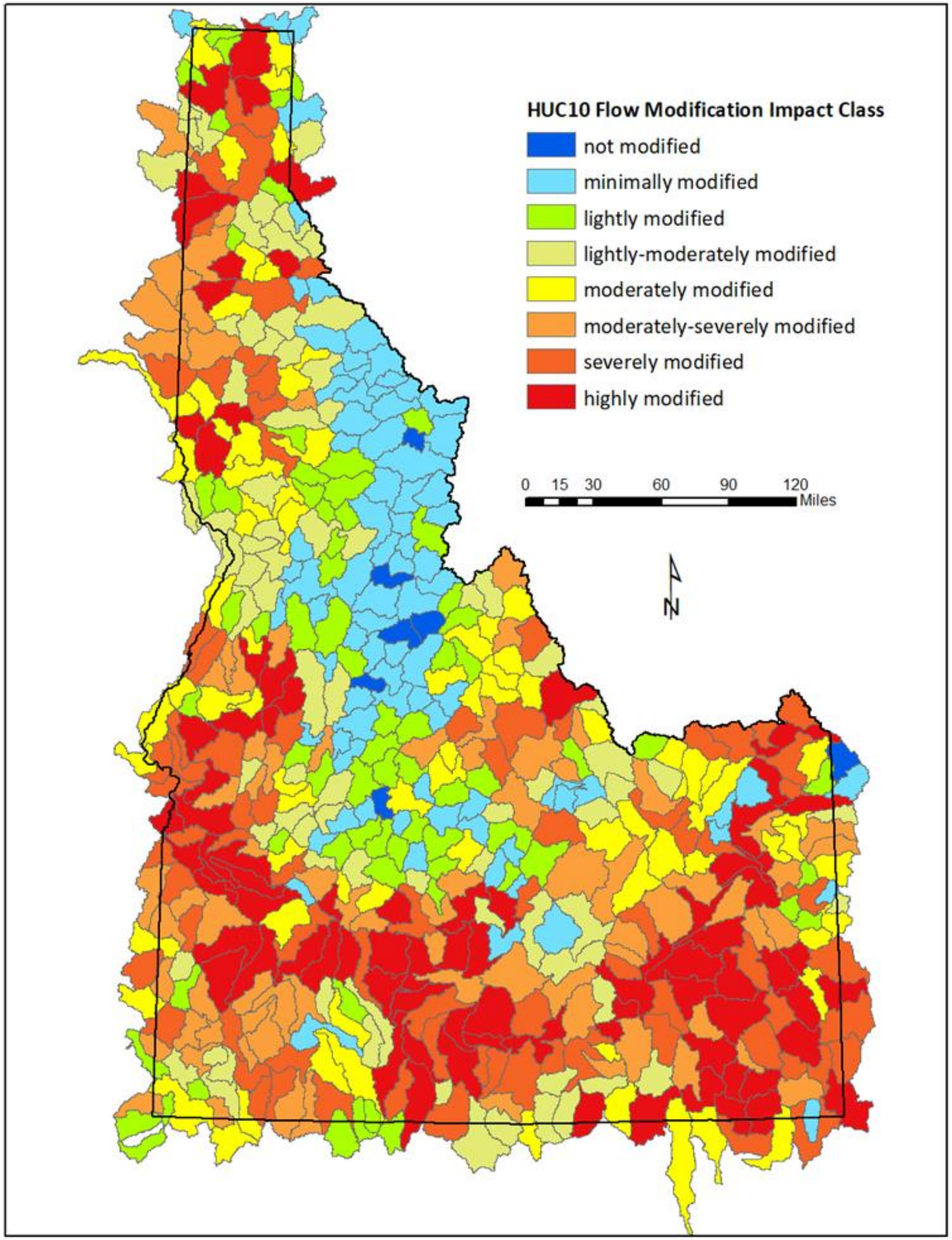
Percent of Predicted Currently Suitable Black Cottonwood River Valley Bottom Habitat in Landscape Condition Class
1.8%
6.5%
21.2%
44.0%
26.6%
moderately disturbed
severely disturbed
minimally disturbed
lightly disturbed
completely disturbed

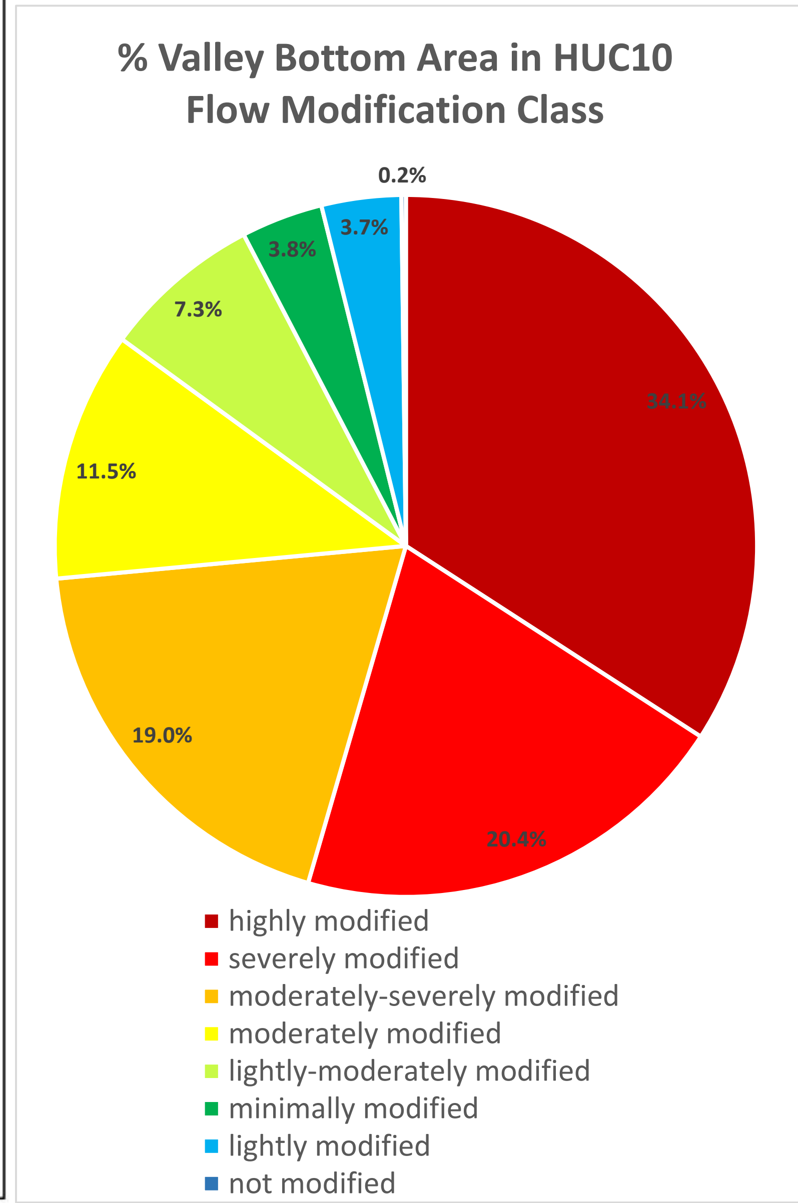


Percent of Predicted Currently Suitable Narrowleaf Cottonwood River Valley Bottom Habitat in Landscape Condition Class
1.4%
5.1%
23.9%
44.3%
25.2%
moderately disturbed
minimally disturbed
severely disturbed
lightly disturbed
completely disturbed

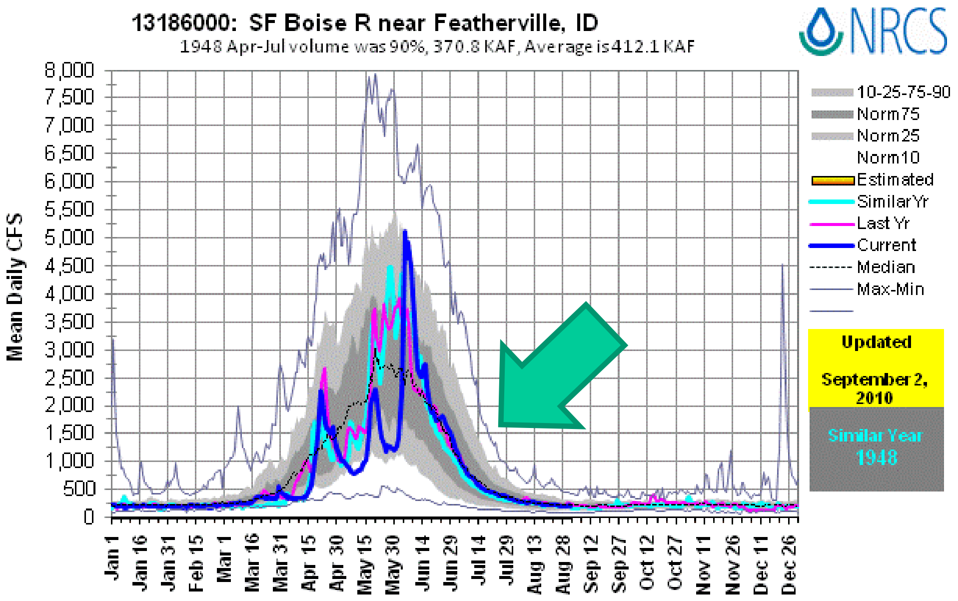
Flow Modification

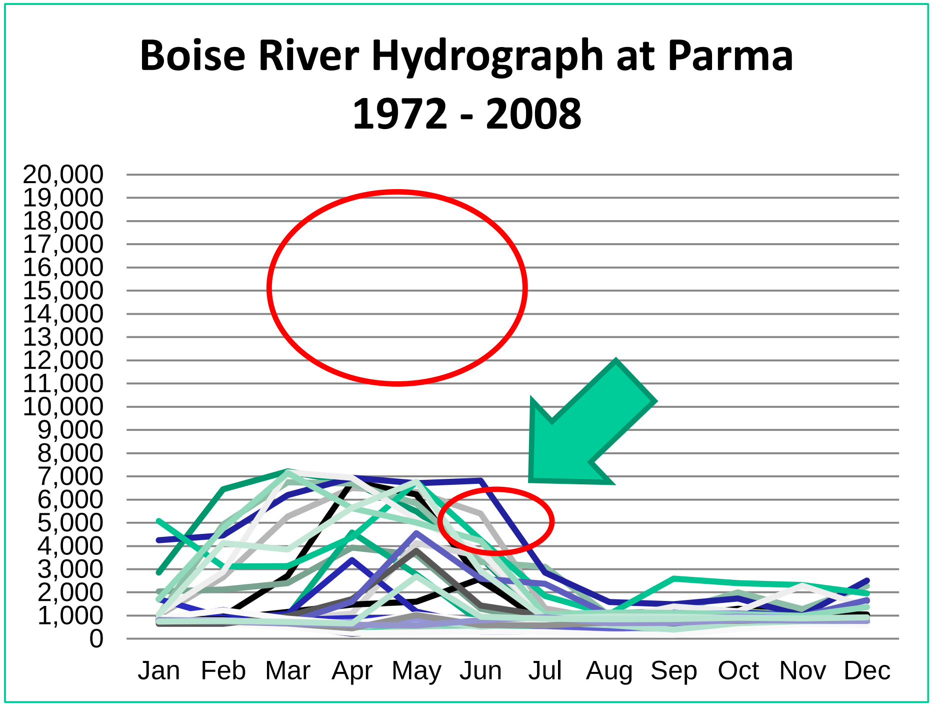
(based on dams, reservoir area, points of diversion, canals, levees, transportation disruptions)





Flow Modification





South Fork Boise River – Anderson Ranch Dam

Above Reservoir (left):
- dynamic floodplain
- large sandy-cobble bars
- woody debris
- black cottonwood reproduction
- older cottonwoods limited to high terraces

Below Dam (right):
- peak flows truncated
- base flow elevated
- sediment starved, narrow cobble bars
- limited cottonwood reproduction
- forest is older age, system stable
- shift toward willow shrubland,

Hauer, F. R., M. S. Lorang, D. Whited, and P.Matson. 2004. Ecologically Based Systems Management: the Snake River - Palisades Dam to Henrys Fork..

Snake River – Palisades Dam

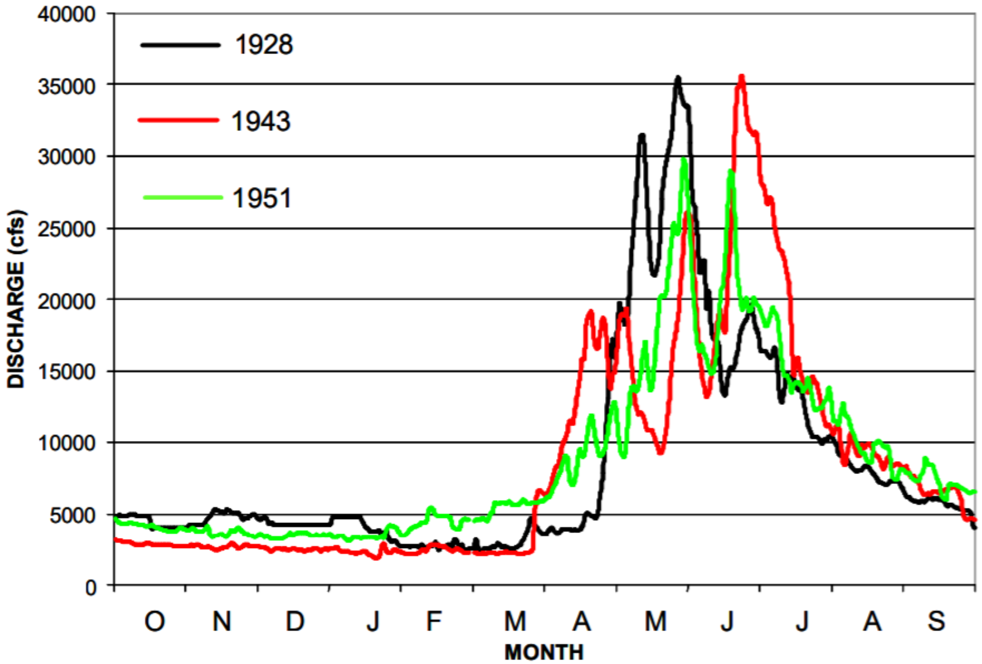


Figure 17. Historical hydrologic regimes of the Upper Snake River basin characterized by spring snowmelt as demonstrated by these pre-dam hydrographs.

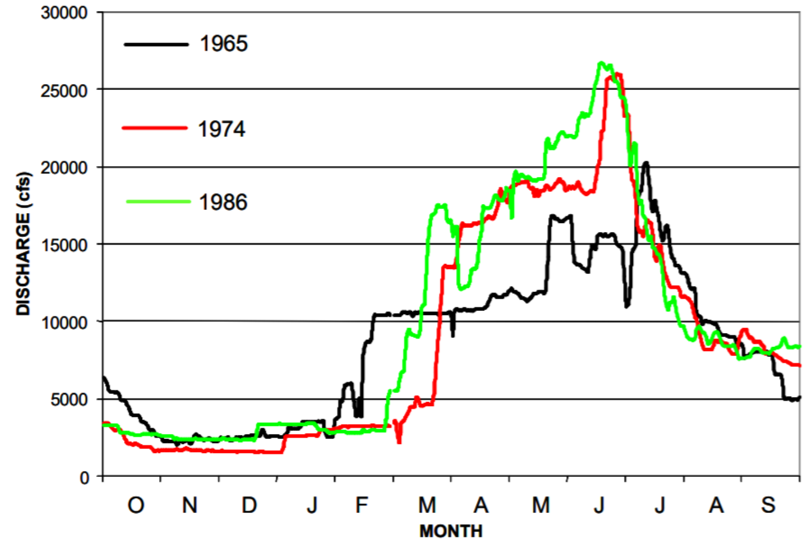


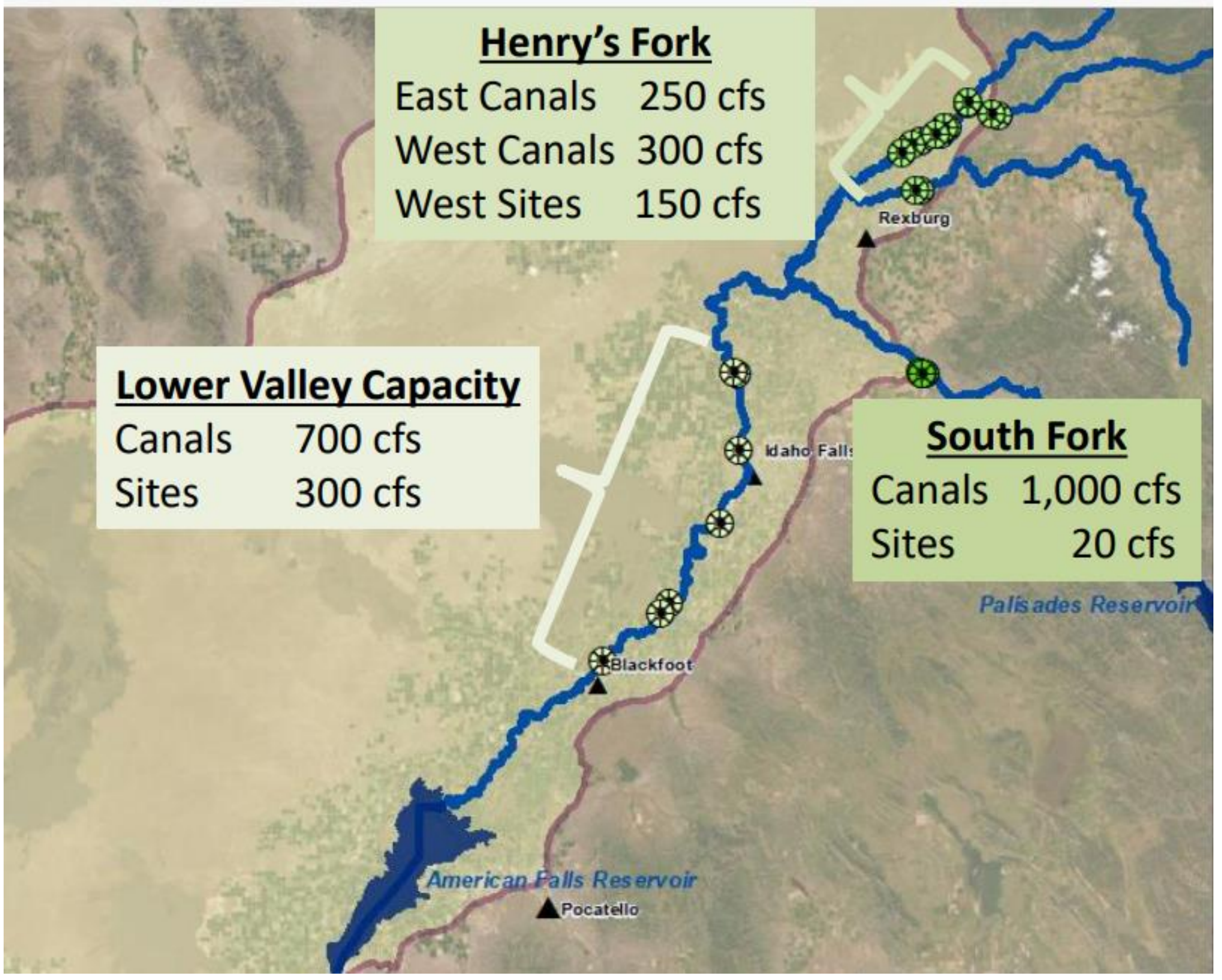
Figure 20. Hydrologic regimes during three example high volume water years of the Upper Snake River basin after dam construction. Note the high discharges during February an March and comparatively low maximum discharges during June and July.

Upper Snake River – Aquifer Recharge Diversion

Early runoff = diversion contributes to reduction of disturbance flows

Fall = lower base flow, causing drought-induced mortality of seedlings of year

Winter = least impact on dormant cottonwoods



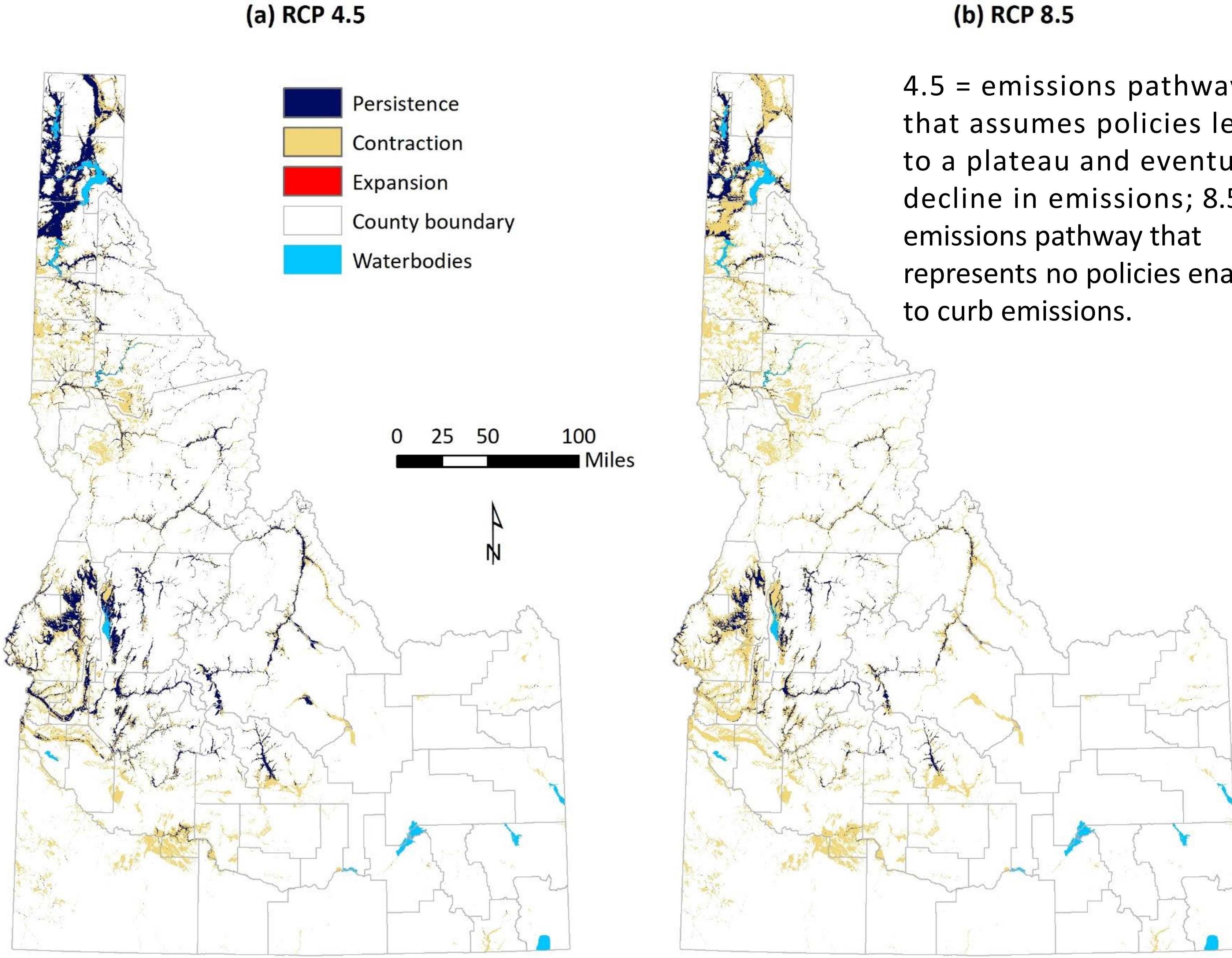
Bear River – Georgetown Summit Area

- flows kept near channel bankfull most of summer for irrigation delivery (top left)

- alluvial bars are minimally exposed during narrowleaf cottonwood seed dispersal, covered with silt (bottom left)

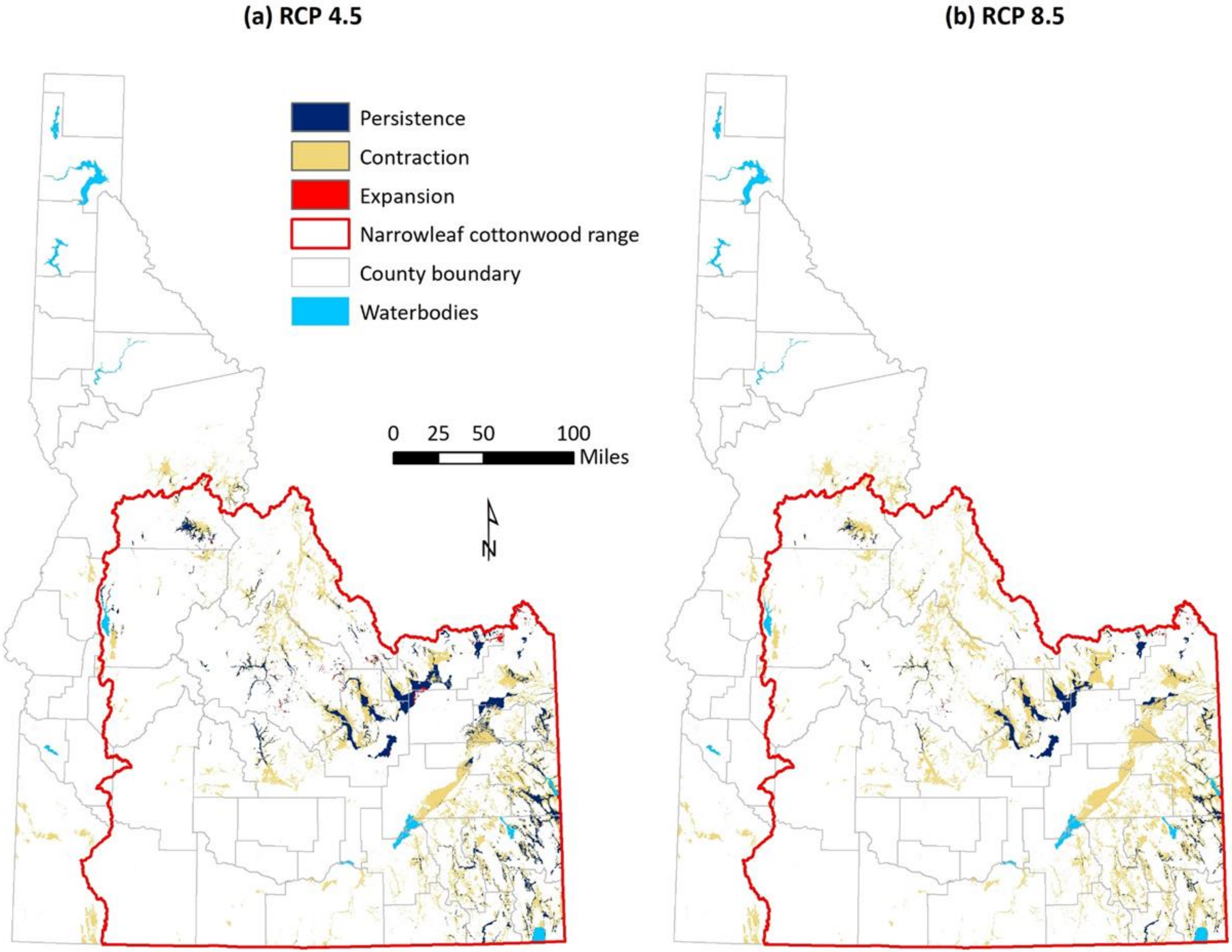
- competitive wetland plants (e.g., reed canarygrass) colonize instead of cottonwood (bottom right)

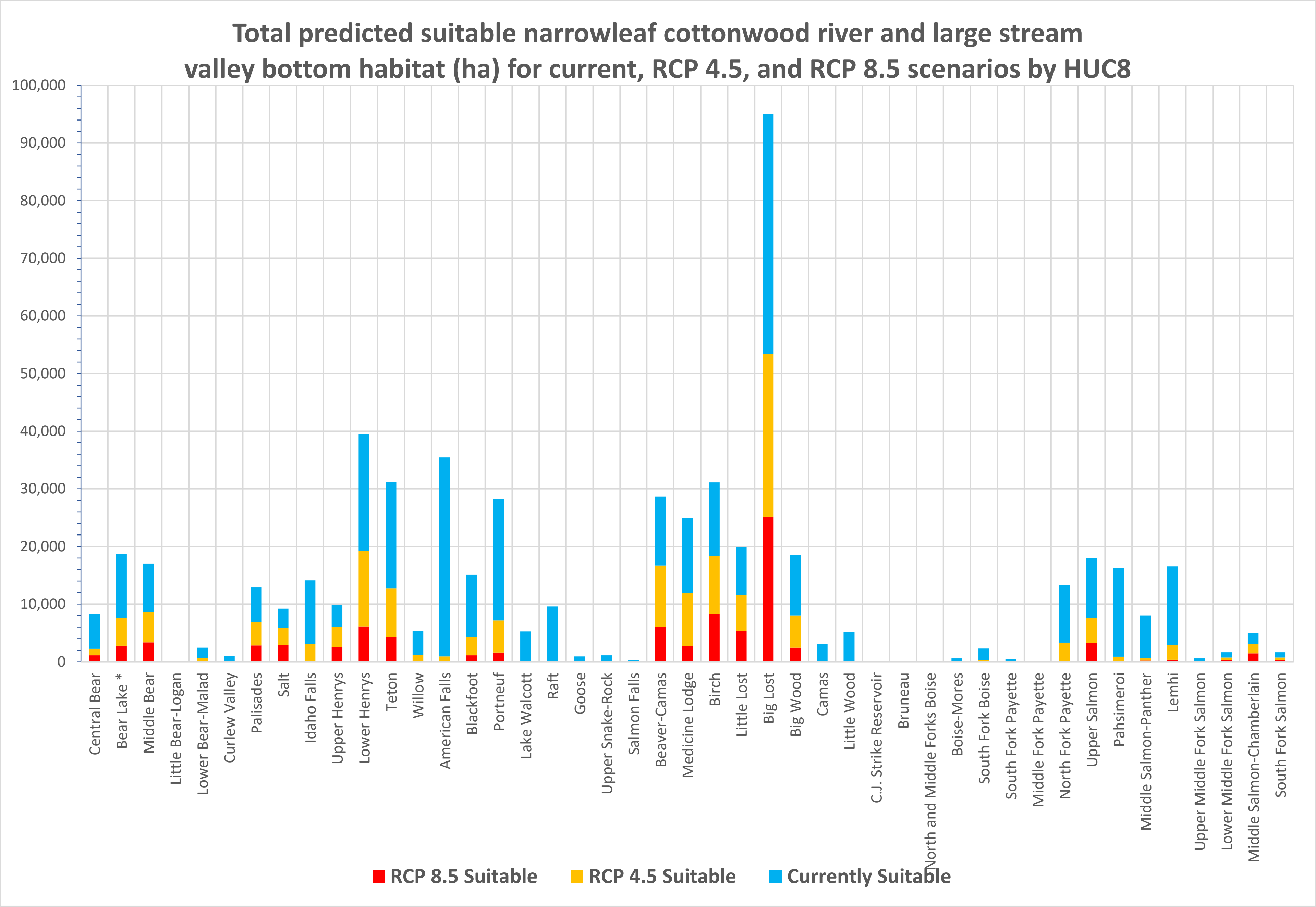
Climate Change – Black Cottonwood



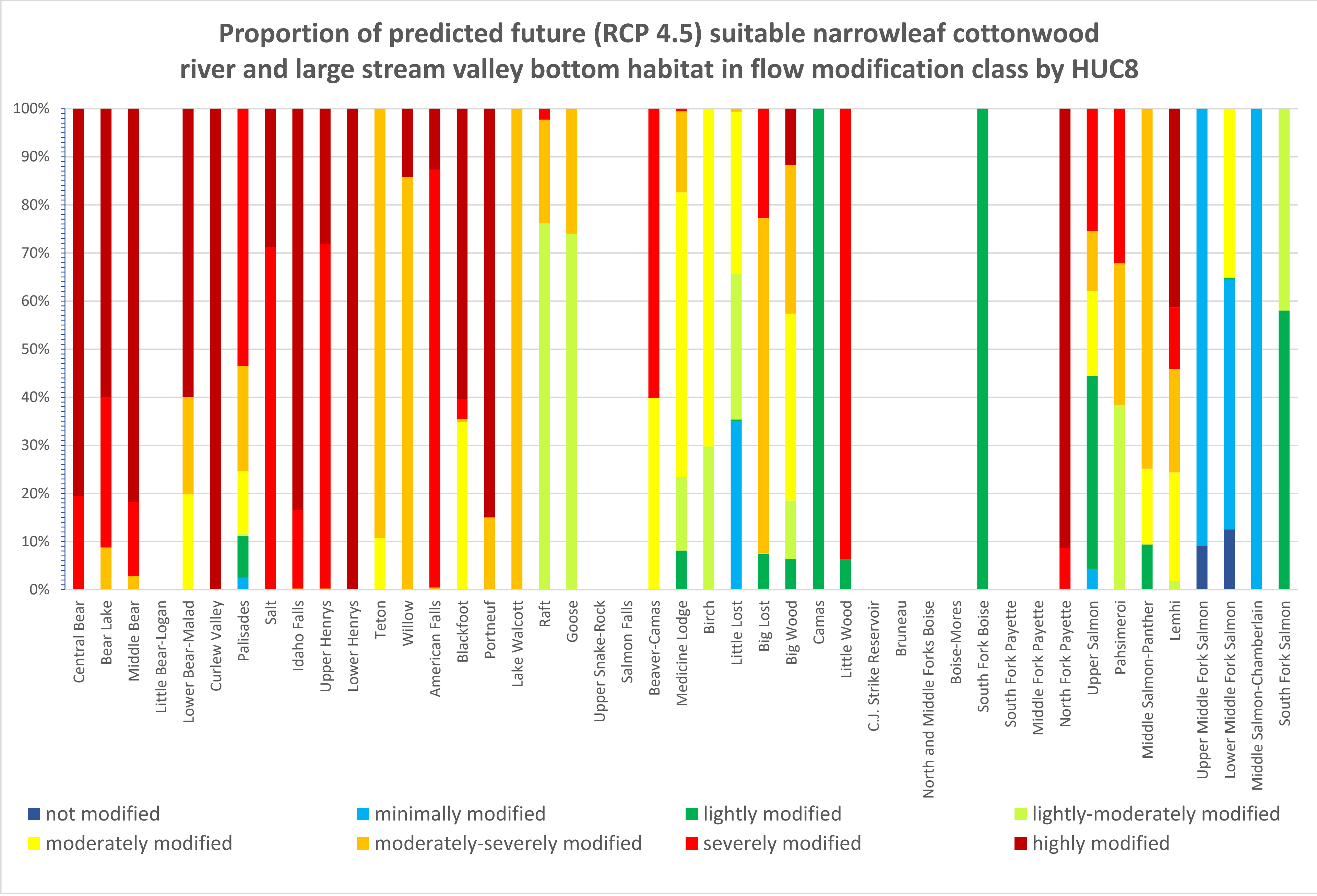
4.5 = emissions pathway that assumes policies lead to a plateau and eventual decline in emissions; 8.5 = emissions pathway that represents no policies enacted to curb emissions.

Climate Change – Narrowleaf Cottonwood





Total predicted suitable narrowleaf cottonwood river and large stream valley bottom habitat (ha) for current, RCP 4.5, and RCP 8.5 scenarios by HUC8
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Central Bear
Bear Lake *
Middle Bear
Little Bear-Logan
Lower Bear-Malad
Curlew Valley
Palisades
Salt
Idaho Falls
Upper Henrys
Lower Henrys
Teton
Willow
American Falls
Blackfoot
Portneuf
Lake Walcott
Raft
Goose
Upper Snake-Rock
Salmon Falls
Beaver-Camas
Medicine Lodge
Birch
Little Lost
Big Lost
Big Wood
Camas
Little Wood
C.J. Strike Reservoir
Bruneau
North and Middle Forks Boise
Boise-Mores
South Fork Boise
South Fork Payette
Middle Fork Payette
North Fork Payette
Upper Salmon
Pahsimeroi
Middle Salmon-Panther
Lemhi
Upper Middle Fork Salmon
Lower Middle Fork Salmon
Middle Salmon-Chamberlain
South Fork Salmon
RCP 8.5 Suitable
RCP 4.5 Suitable
Currently Suitable

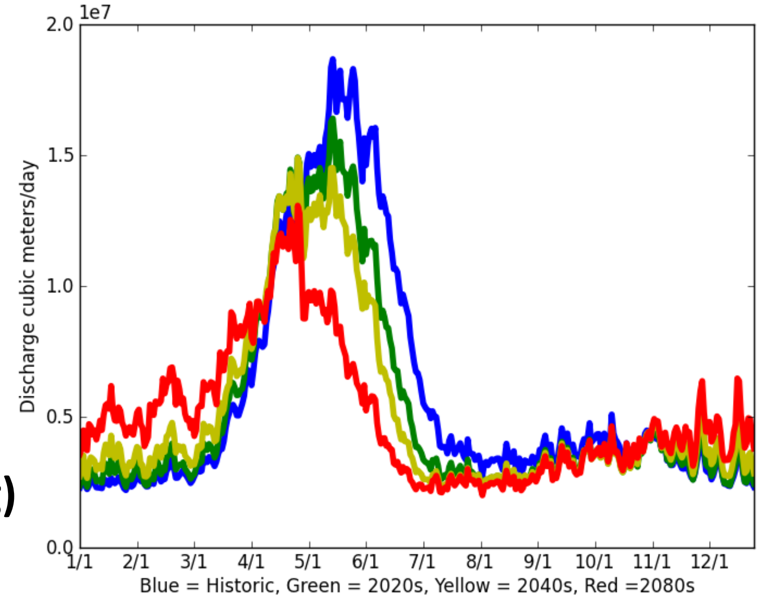


Proportion of predicted future (RCP 4.5) suitable narrowleaf cottonwood river and large stream valley bottom habitat in flow modification class by HUC8
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Central Bear
Bear Lake
Middle Bear
Little Bear-Logan
Lower Bear-Malad
Curlew Valley
Palisades
Salt
Idaho Falls
Upper Henrys
Lower Henrys
Teton
Willow
American Falls
Blackfoot
Portneuf
Lake Walcott
Raft
Goose
Upper Snake-Rock
Salmon Falls
Beaver-Camas
Medicine Lodge
Birch
Little Lost
Big Lost
Big Wood
Camas
Little Wood
C.J. Strike Reservoir
Bruneau
North and Middle Forks Boise
Boise-Mores
South Fork Boise
South Fork Payette
Middle Fork Payette
North Fork Payette
Upper Salmon
Pahsimeroi
Middle Salmon-Panther
Lemhi
Upper Middle Fork Salmon
Lower Middle Fork Salmon
Middle Salmon-Chamberlain
South Fork Salmon
not modified
minimally modified
lightly modified
lightly-moderately modified
moderately modified
moderately-severely modified
severely modified
highly modified

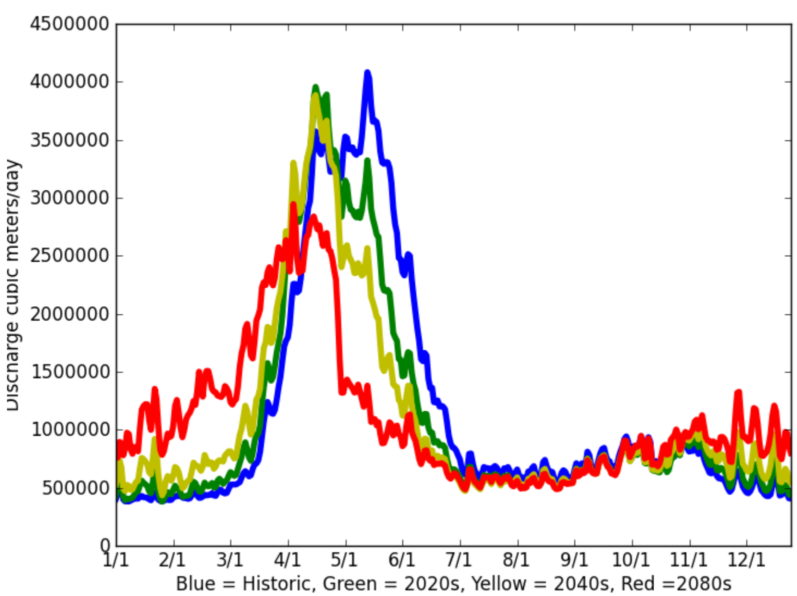
Climate Change – Projected River Flows

- Wu et al. (2012) variable infiltration capacity hydrologic models streamflow under historical & future emission scenarios
- moderate to major hydrologic shifts: earlier peak flows, less peak discharge
- decreased summer base flows
- increased winter runoff (e.g., mid-winter warming)
- falling limb of hydrograph rate varies

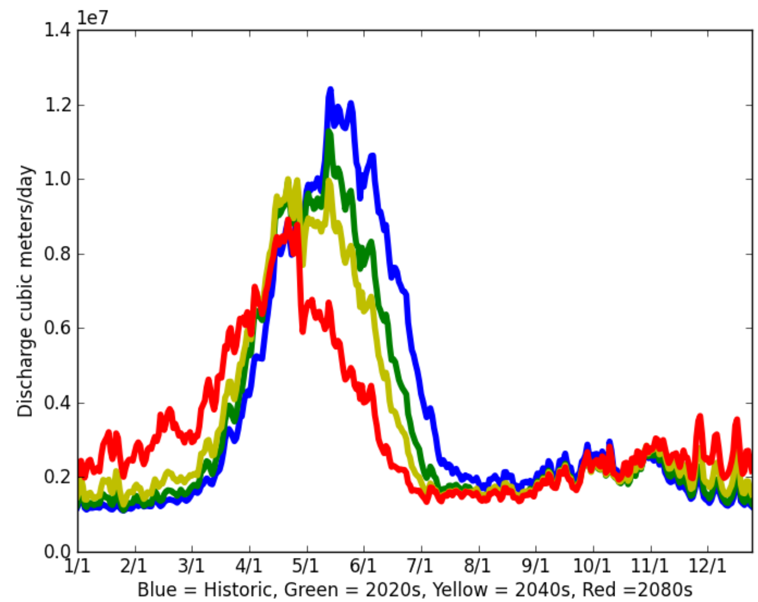
Palisades (upstream of Heise)

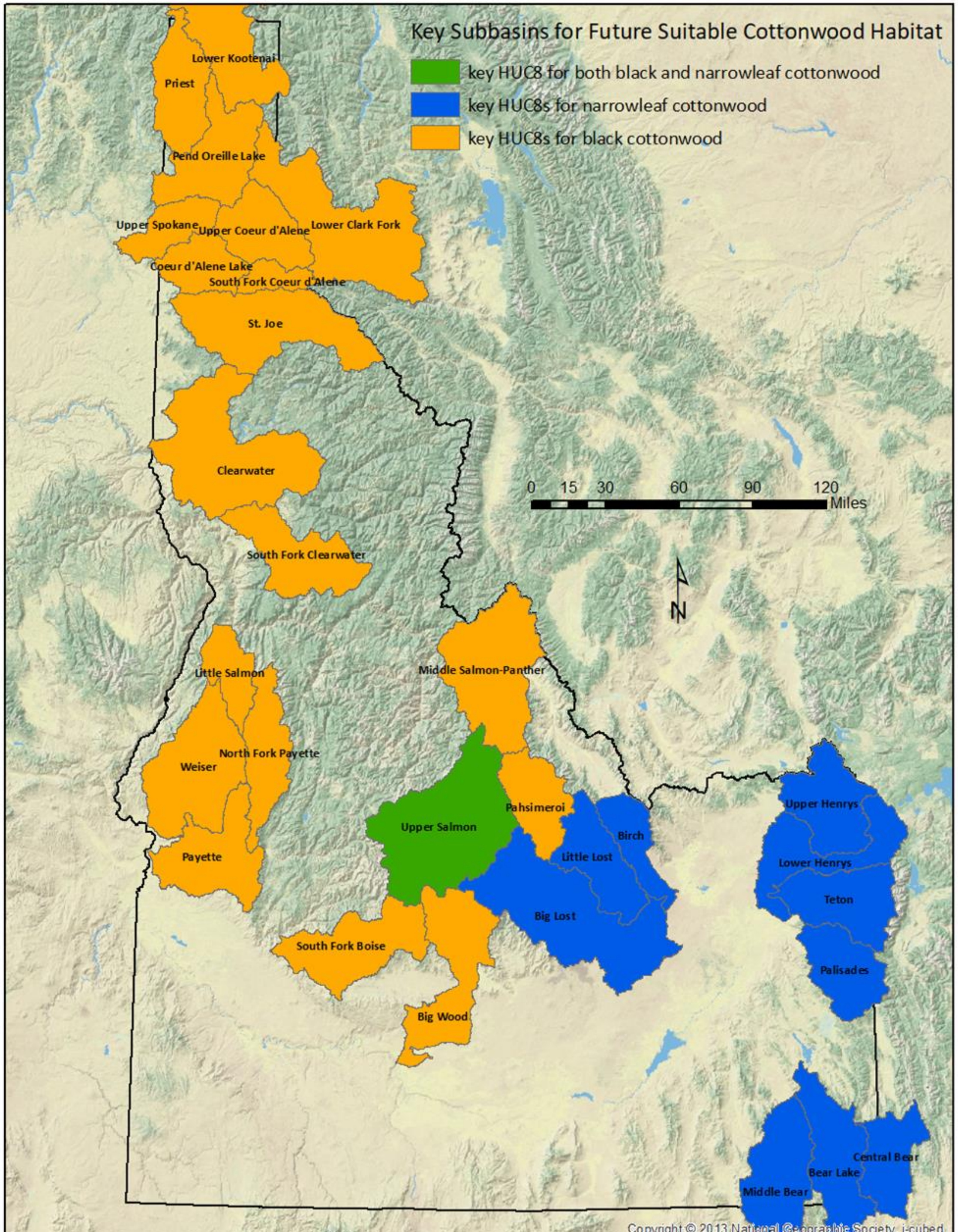


Upper Henrys (Ashton)



Lower Henrys (Cartier Slough WMA)





Conservation and Restoration Priorities

Process Based Restoration Within Constraints of Floodplain Development and Water Availability

Goals	Strategies
• increase floodplain width, complexity • allow channel migration to form alluvial surfaces for cottonwood • increase native riparian vegetation where lacking due to invasive species or land use • protect valley bottoms from development and recreational impacts • minimize consumptive water use • restore hydrologic regime conducive to cottonwood reproduction	✓ set-back hardened banks for roads and bridges ✓ buffer floodplains from development ✓ allow floodplain reconnection and widening ✓ restore meanders and side channel connection ✓ consider levee set-backs where appropriate ✓ seek opportunities for minimizing diversion ✓ convert consumptive water rights to conservation use ✓ manage water releases from dams to mimic natural magnitude, timing, and decline of peak flows ✓ seek conservation easements on restorable floodplains ✓ plant native riparian vegetation where needed