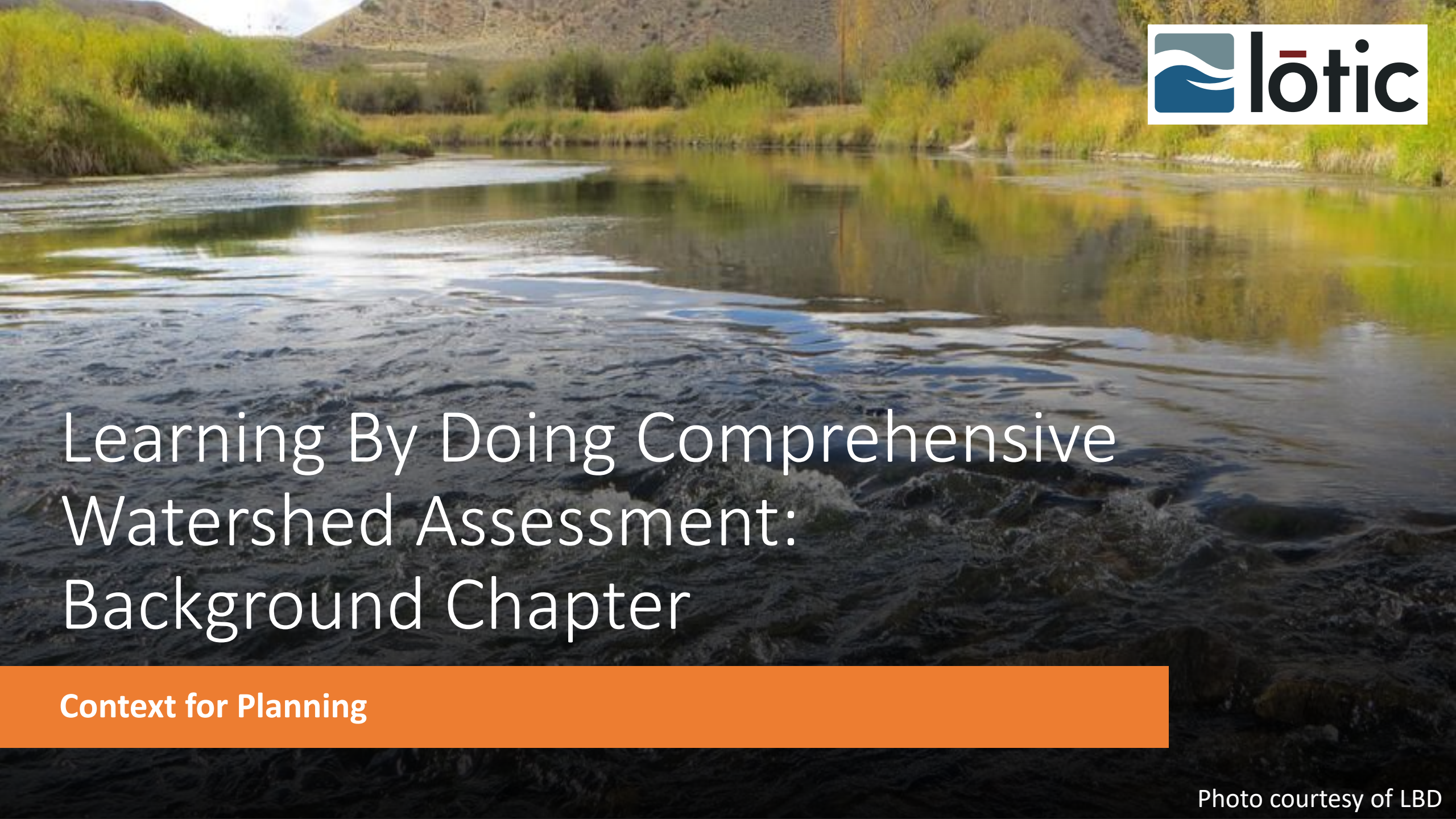


Learning By Doing Comprehensive Watershed Assessment: Background Chapter

Context for Planning

Photo courtesy of LBD

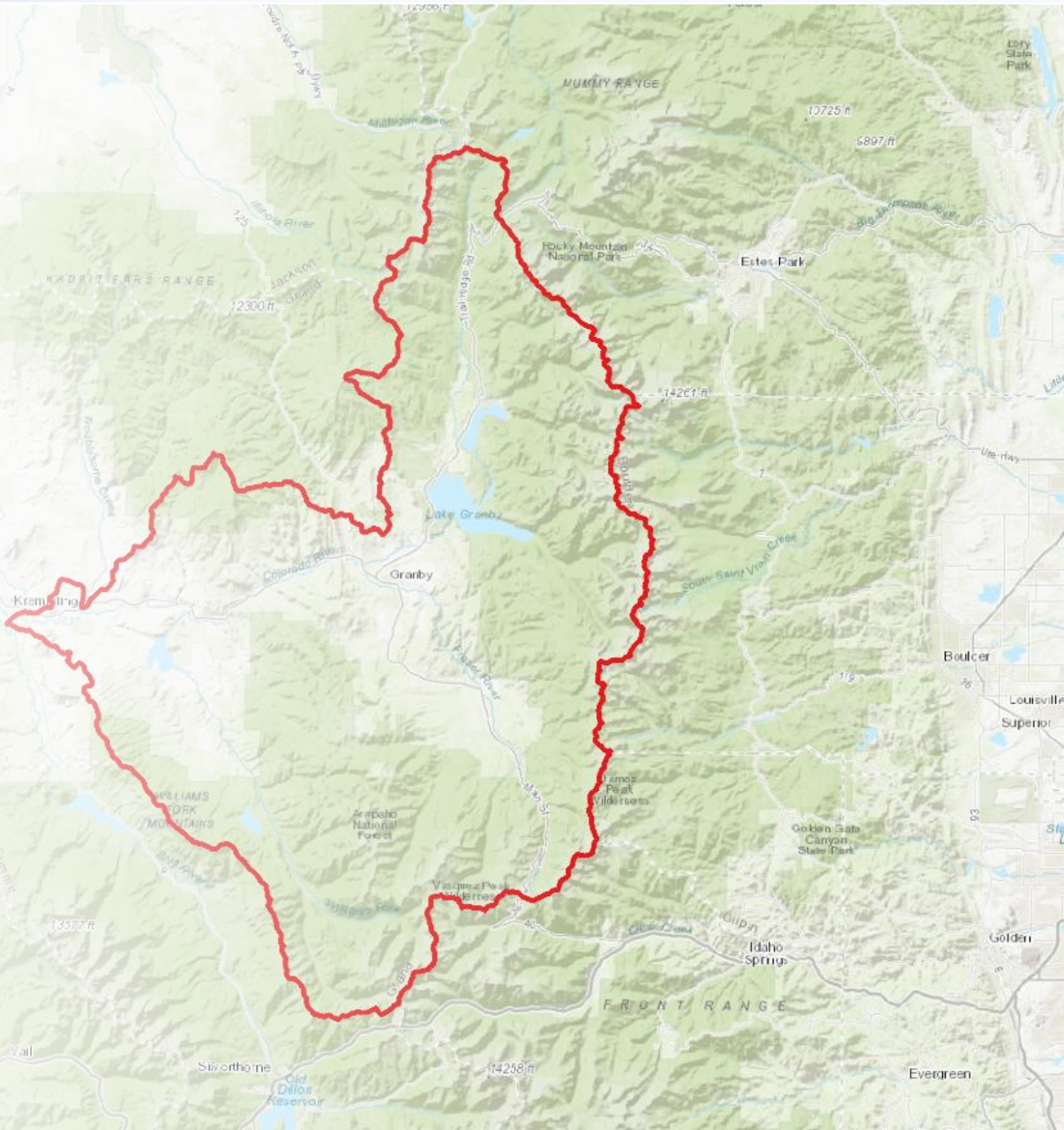
Presentation Topics

- Watershed Assessment Goals & Approach
- Key Aquatic Resource Concerns Identified in the 2010 GC SMP
- Recent Changes in the CEA
  - Landcover
  - Land Use and Population Growth
  - Trends in Streamflow
  - Water Development and Operations
  - Climate and Snowmelt
- Recent and Ongoing Monitoring & Mitigation Efforts
- Watershed Assessment Expected Outcomes

Watershed Assessment Scope and Objectives

Watershed Assessment Goal: Assess hydrological regime characteristics, water rights, water quality, geomorphic, riparian, and biological data relevant to focus streams in the CEA for the purpose of understanding the condition of streams and aquatic habitat within the CEA and the factors that affect their preservation and, where possible, their improvement.

Geographic Scale: >100 miles of rivers and streams in the Colorado, Fraser, and Williams Fork River Basins upstream of the Colorado River's confluence with the Blue River in Grand County



Scoped Tasks

Task 1	Task 2	Task 3	Task 4
Background Chapter	**Data Analysis and Interpretation**	**Report Generation**	**Maps and Data Visualizations**
Conduct Literature Review	Analyze Hydrology Characteristics & Trends	Draft Report	Create Interactive Mapping Layers
Inventory Streamflow Data and Summarize Hydrological Change	Analyze Water Temperature Trends	Finalize Report	Generate Interactive Data Visualizations
Summarize Past Water Development and Current Water Use and Management	Assess Geomorphic Function	Provide LBD Presentation	Develop Decision Support Tools
Inventory Notable Landscape Events	Assess Aquatic Ecosystem Conditions & Trends	Provide Stakeholder Presentation	
Characterize Demographic and Land Use/Cover Change	Characterize Water Quality Conditions & Trends		
Inventory Existing Environmental Data	Perform Integrative Assessment		
	Provide Recommendations for Monitoring & Studies		

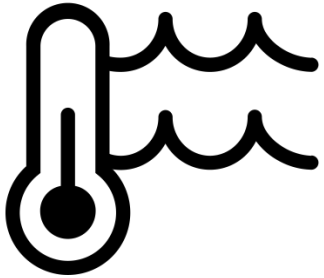
Key Concerns identified in 2010 GC SMP

Setting the context for the wider planning effort

2010 Grand County Stream Management Plan

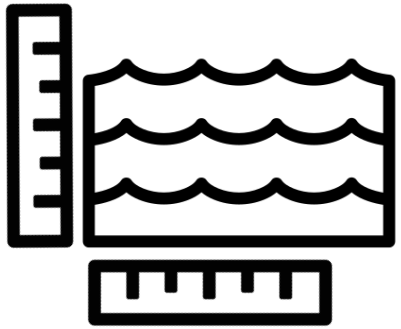
- Assessed a broad array of aquatic resource factors
- Identified key concerns across the CEA (Tetra Tech, 2010)

Environmental Streamflows

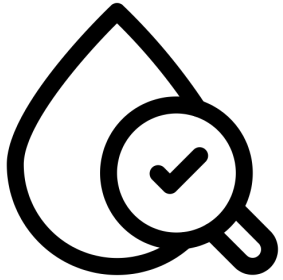


Water Temperature

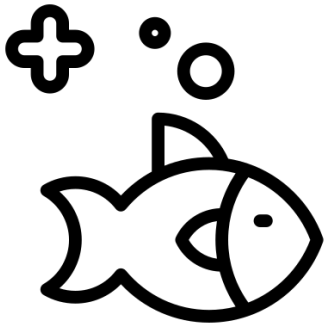
Water Uses



Geomorphic Conditions



Water Quality



Ecosystem Health

2010 GC SMP Findings: Environmental Streamflows

- **Streamflow highly altered** on reaches throughout the CEA
- Recommended **April-July environmental flow** targets generally met
- Environmental flow targets ranges met less often during **low flow periods**.
- **Rapid streamflow changes** were identified as a possible issue below reservoirs

Environmental Streamflows

2010 GC SMP Findings: Water Temperature

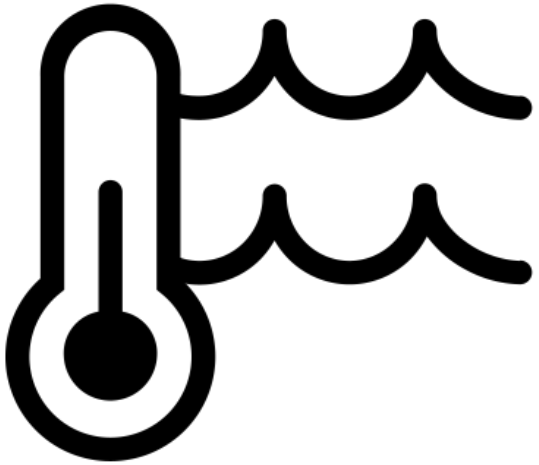
Temperatures above state standards observed at some locations in July and August.

Fraser River Basin

- Lower Fraser: **summertime chronic** exceedances
- Lower Ranch Creek: **late summer acute** exceedances

Colorado River:

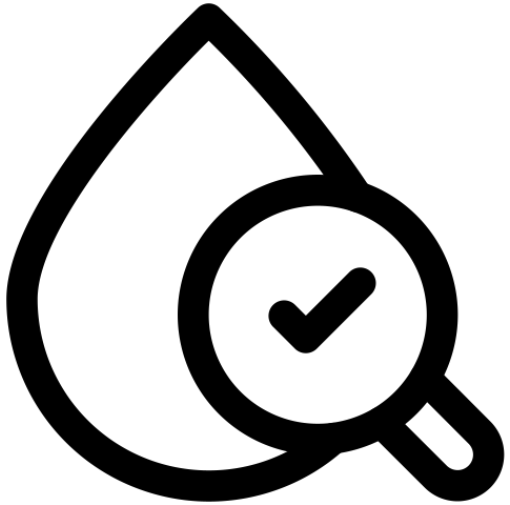
- North Fork of Colorado: **summertime chronic** exceedances when diversions are active
- Windy Gap to confluence with Williams Fork: **summertime chronic** exceedances



Water Temperature

2010 GC SMP Findings: Water Quality

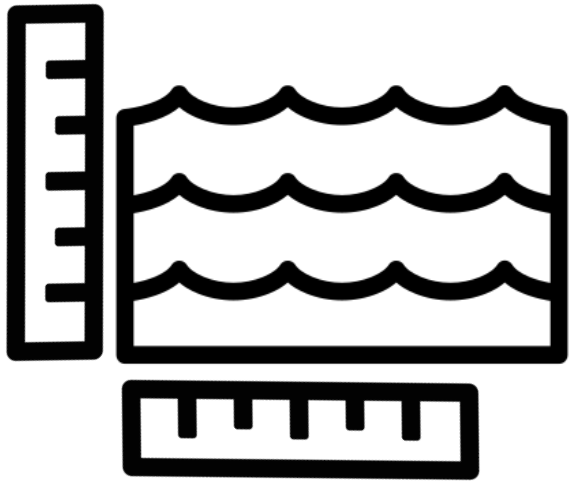
- Generally, **good water quality conditions**
- Concerns include:
  - **Nutrients** on Colorado River above Windy Gap.
  - **Filamentous algae** and Didymosphenia geminata
  - **Metals** including discharges by Union Pacific Railroad's at Moffat Tunnel



Water Quality

2010 GC SMP Findings: Geomorphology

- Variable morphology across the CEA.
- Location of channels in the poorest condition:
  - **low gradients**
  - **further downstream**
  - more **intensive land use**
- Impaired channel characteristics:
  - extensive **bank erosion**
  - fine **sediment deposition**



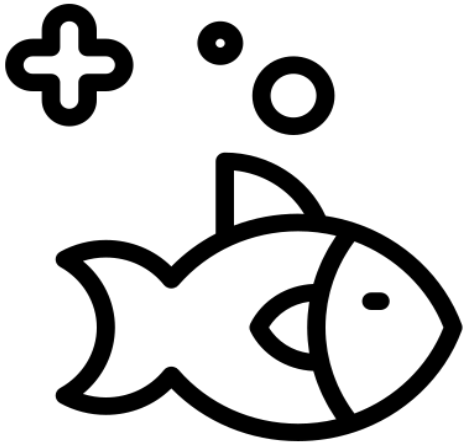
Geomorphic Conditions

2010 GC SMP Findings: Ecosystem Health

- Multiple stressors identified:
  - **habitat and water quality**
  - **angling** pressures
  - inter-annual **hydrological variability**
  - **disease**
  - inter-species **competition**

- Dramatic declines in rainbow trout fishery since the mid-1980s → **Whirling disease**.

- Colorado River cutthroat trout **range reduced** to ~6% of historic habitat in the upper Colorado River drainage.



Ecosystem Health

Recent Changes in the CEA

Recognizing a dynamic landscape

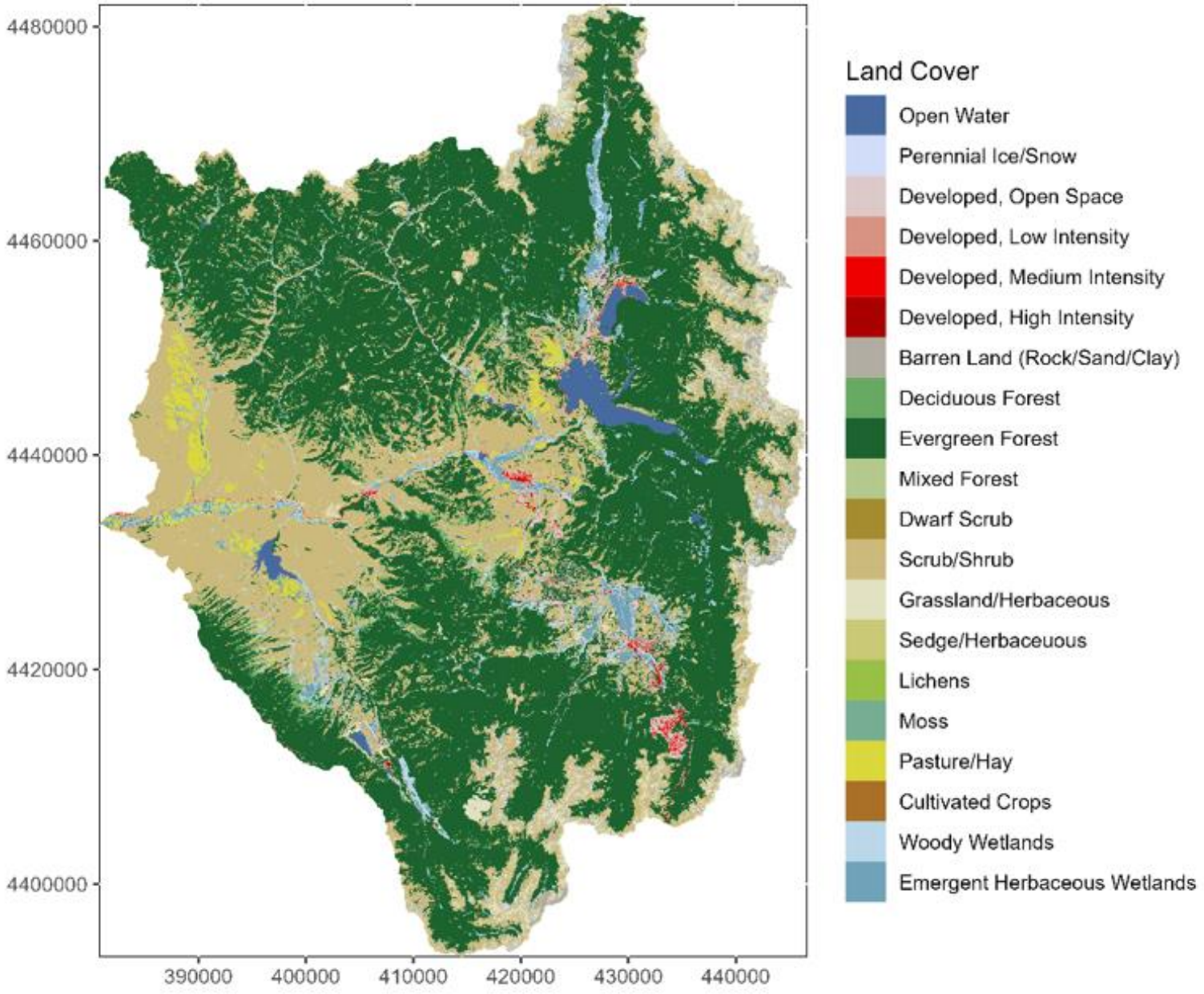
Assessed Changes

- Landcover
- Population & Housing
- Hydrology & Water Development
- Climate

Current Landcover

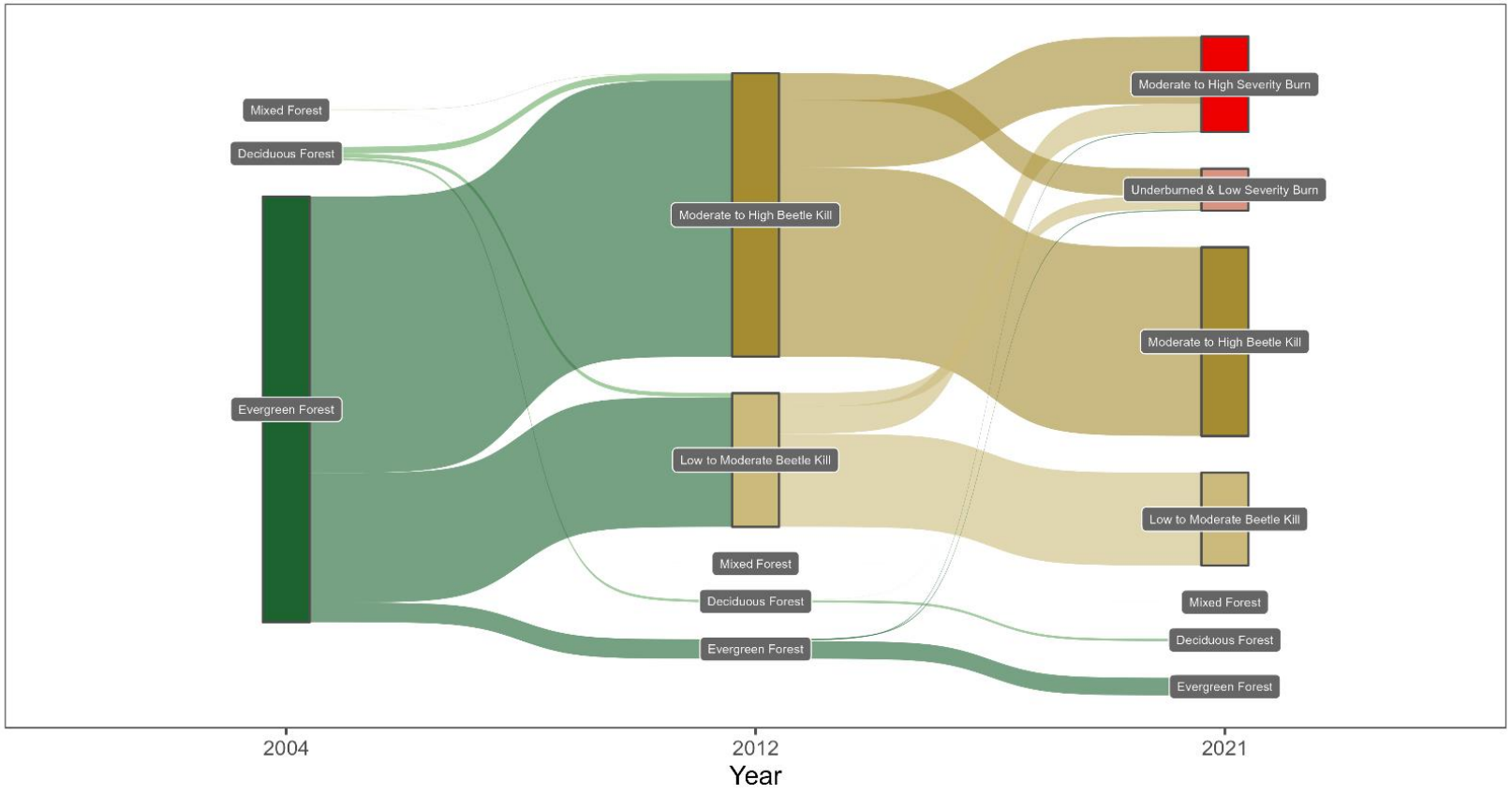
Mapped in 2019:

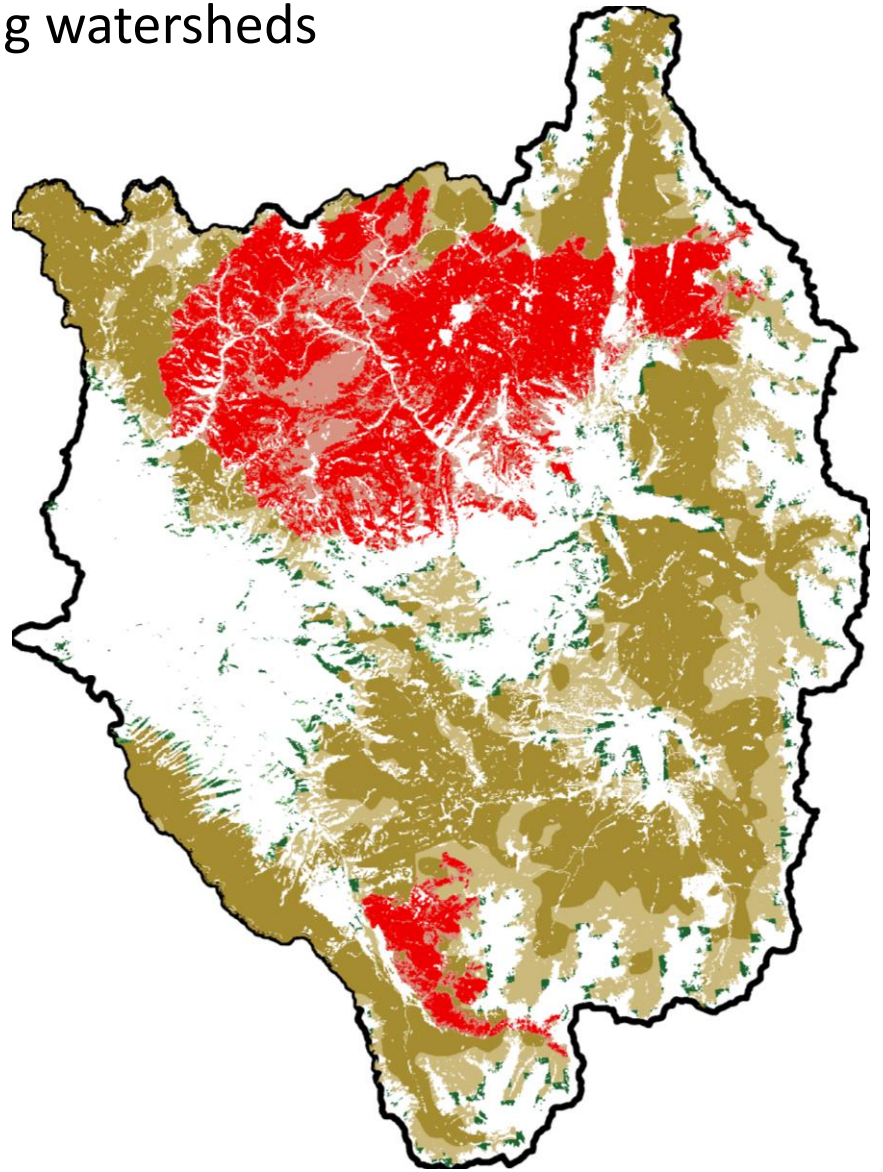
- Evergreen Forests (55%)
- Shrublands (26.9%)
- Wetlands (4.7%)
- Agriculture (3.2%)
- Developed Lands (1.6%)
- Open Water (1.4%)



Forest Disturbance

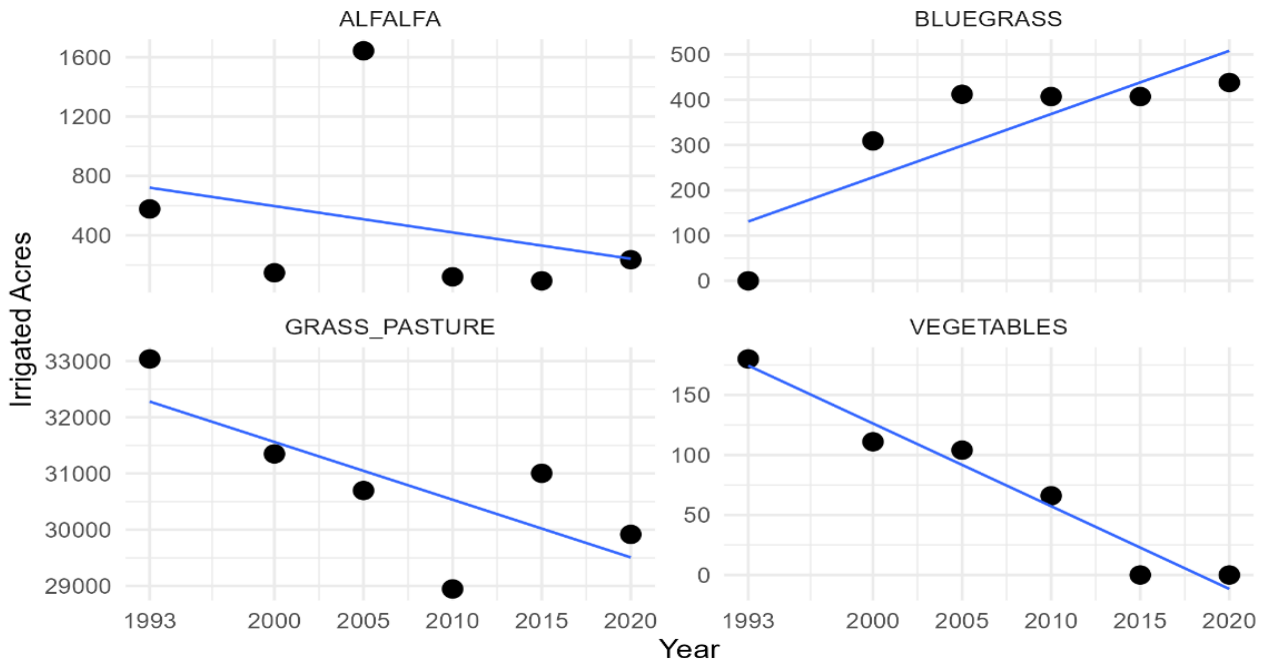
- Evergreen forests constitute ~55% of landcover in CEA-contributing watersheds
- 95% of forest impacted by **pine beetle** between 2003-2012.
- 31.4% of forested area **burned** between 2018-2020

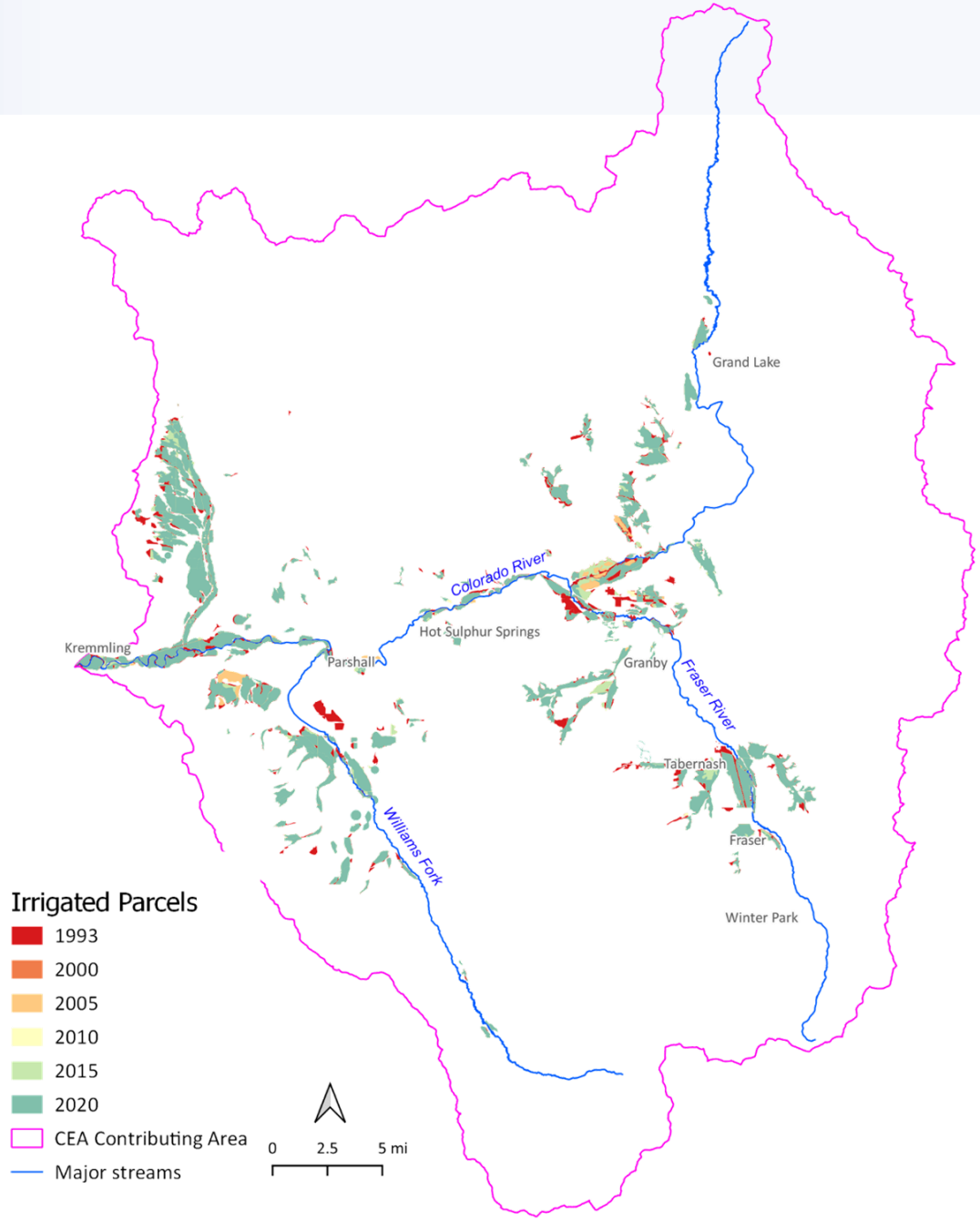




Agricultural Change

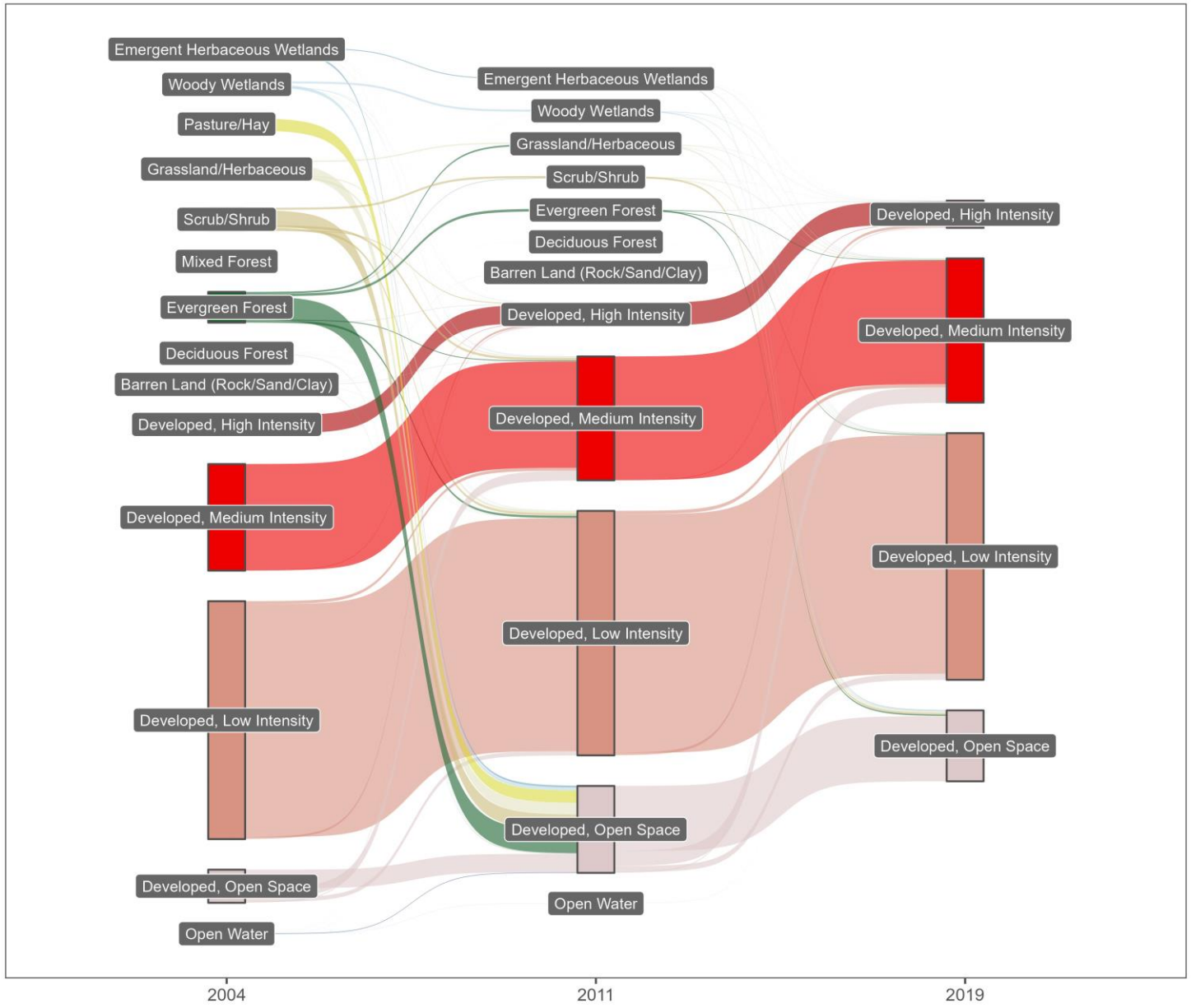
- Agricultural lands ~3% of landcover in CEA-contributing watersheds in 2019
- **Reduction of ~3000 irrigated acres** from early 1993 to 2020





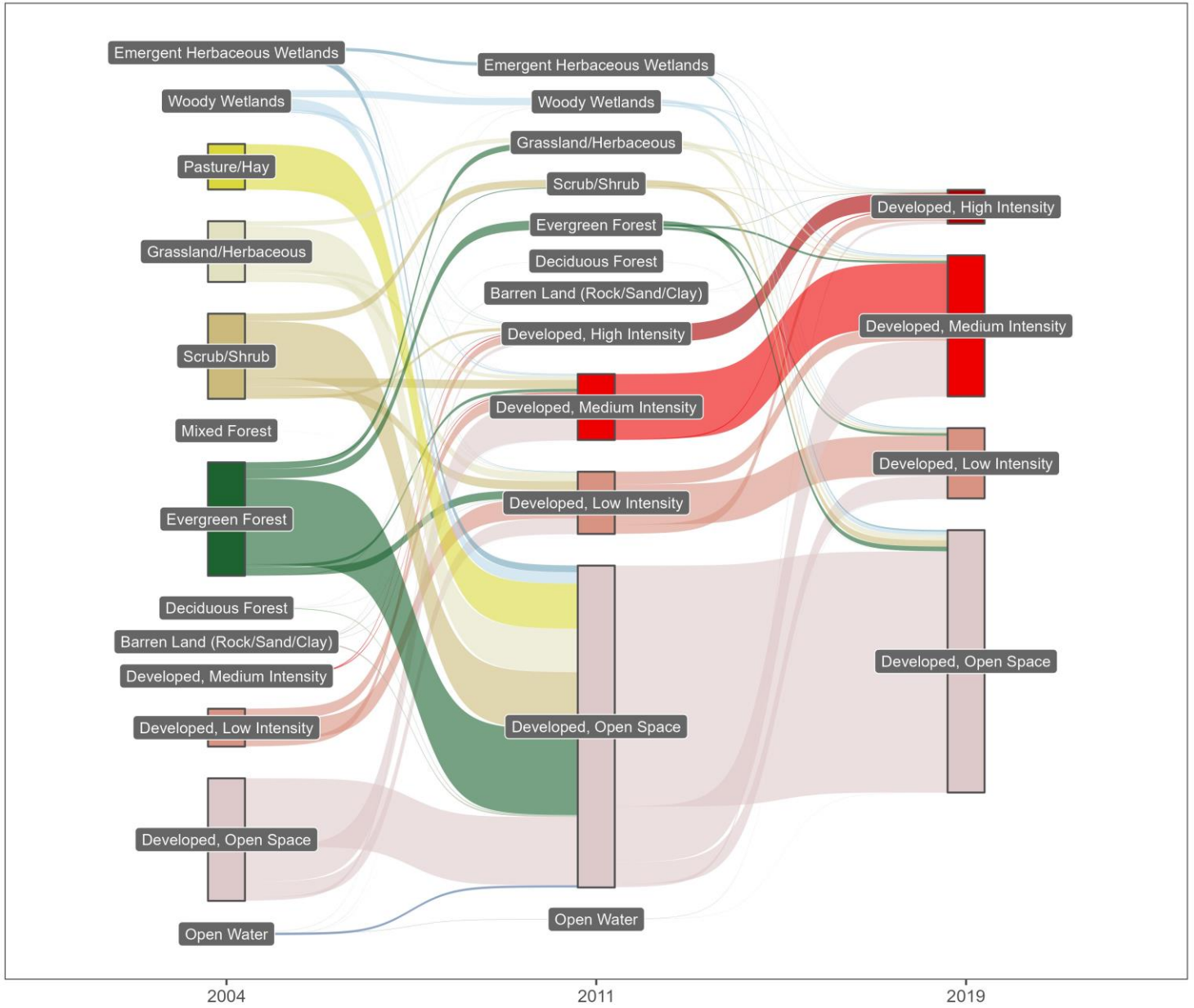
Land Use Changes in Developed Areas

- Developed Lands ~1.6% total area in 2019
- ~10% increase in developed lands since 2004
- Most developed areas classified as low- or medium-intensity
- Majority of mapped change since 2004: conversion of wildland to developed open space



Land Use Changes in Developed Areas

- Results filtered to only show areas where some change occurred since 2004
- 2004-2011 transitions from wildland to open space
- 2011-2019 transitions from developed open space to higher-intensity development patterns



A Growing Population

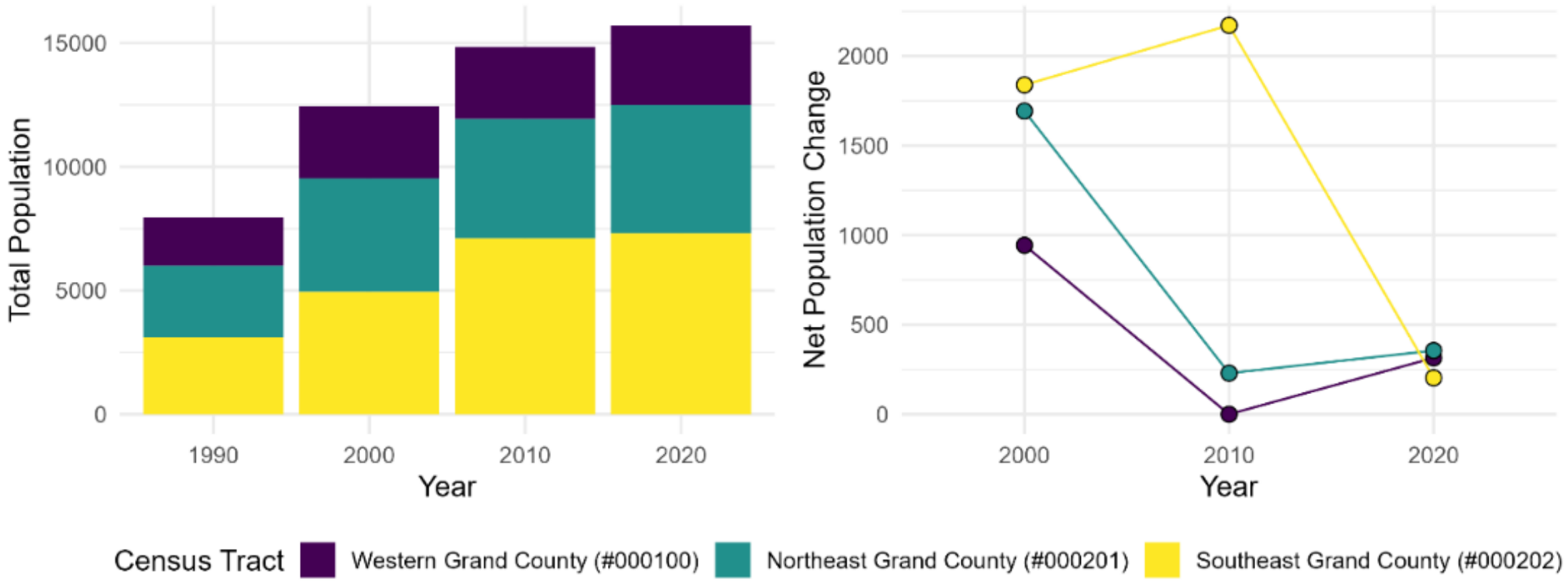


FIGURE 15: TOTAL POPULATION AND NET POPULATION GROWTH IN GRAND COUNTY GROUPED BY CENSUS TRACT. THE WESTERN GRAND COUNTY TRACT INCLUDES AREAS OUTSIDE OF THE CEA WATERSHEDS.

Housing Boom in the 2000's

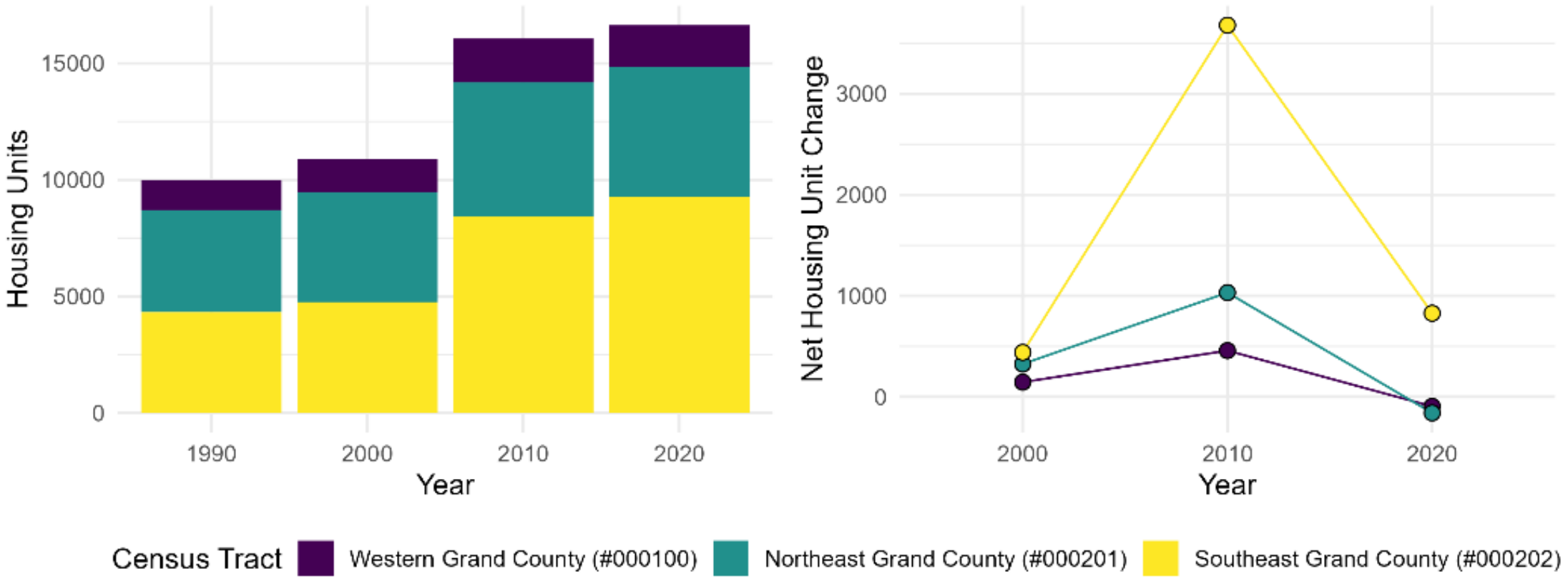
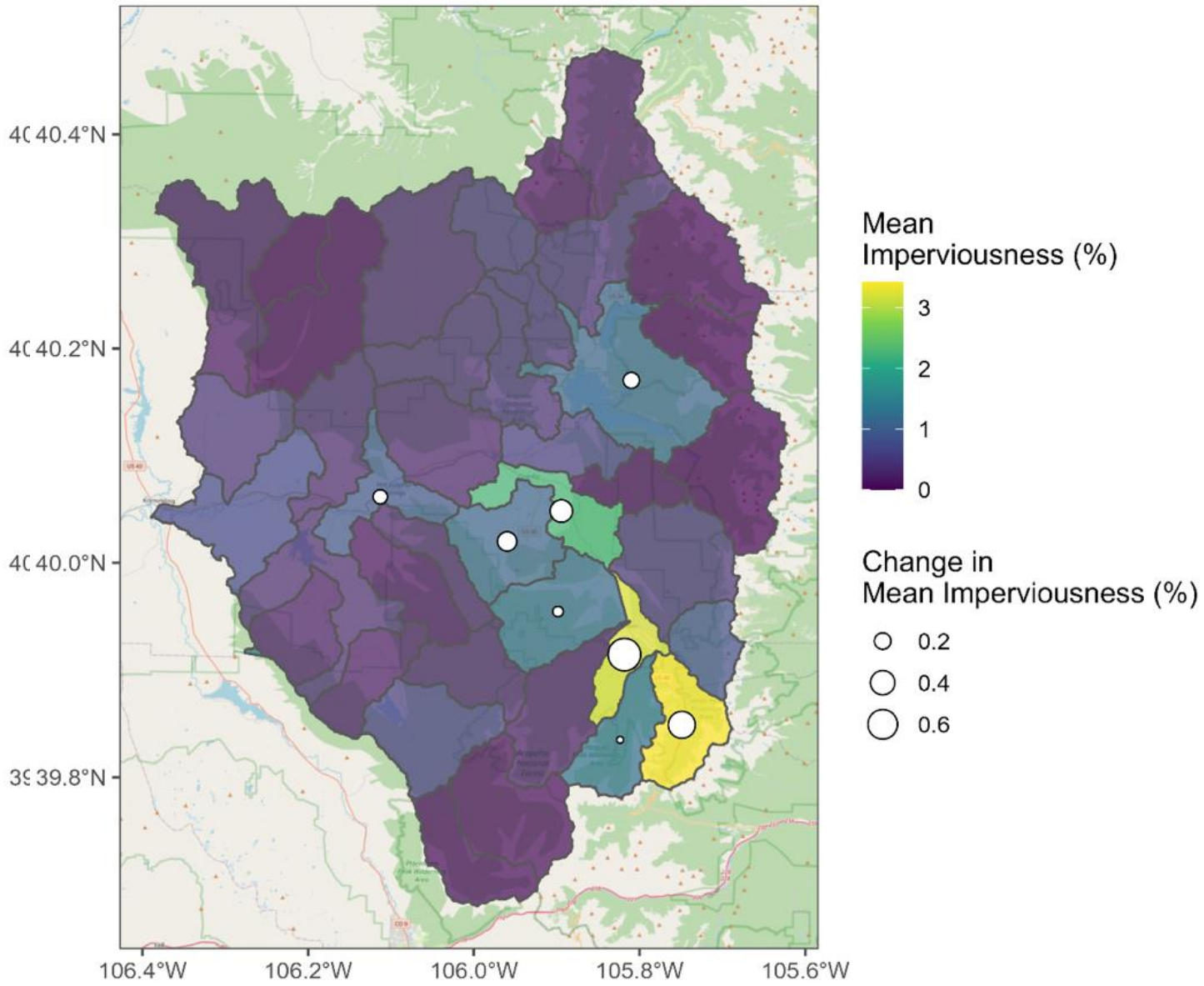


FIGURE 16: TOTAL HOUSING UNITS AND NET HOUSING UNITS IN GRAND COUNTY GROUPED BY CENSUS TRACT. THE WESTERN GRAND COUNTY TRACT INCLUDES AREAS OUTSIDE OF THE CEA WATERSHEDS.

Development Patterns

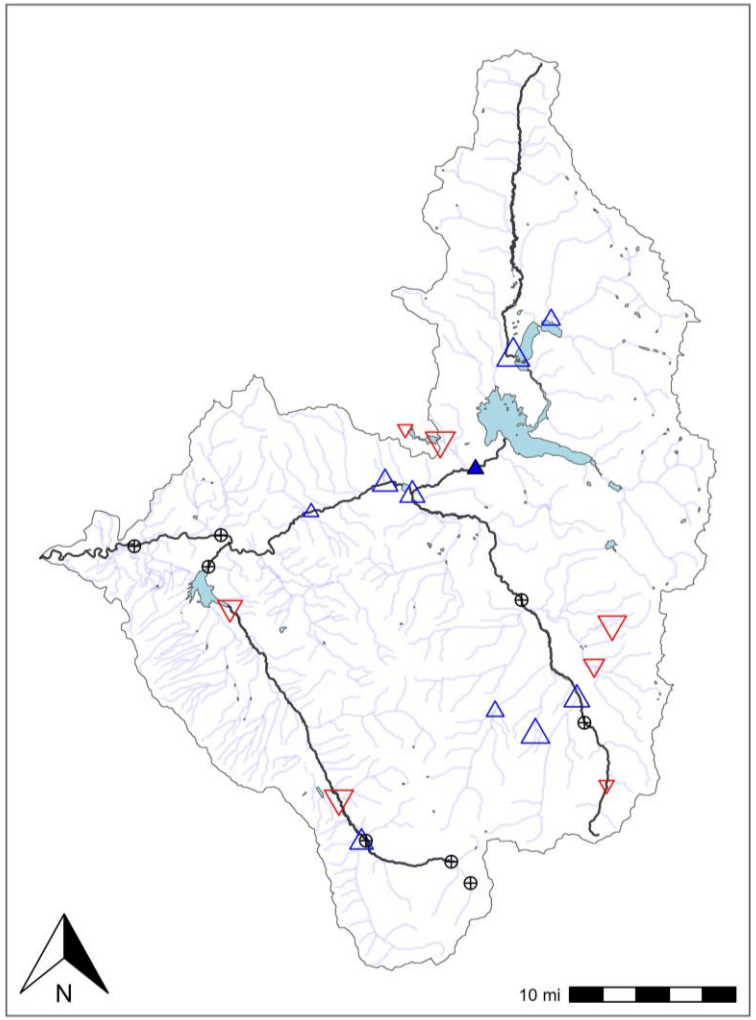
- Most development exists in the Fraser River valley and in the vicinity of Granby. This is reflected by relatively high levels of mapped impervious cover

- Small increases in developed areas/impervious surfaces can have outsized impacts on downstream aquatic systems

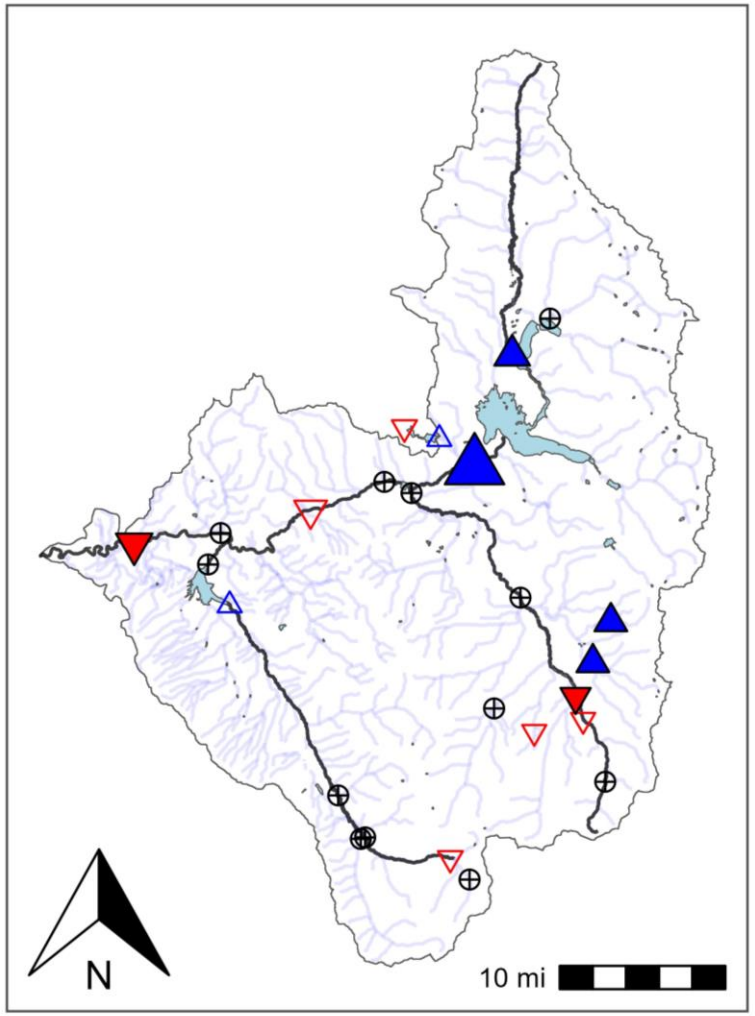


Peak Streamflow Trends (2003-2021)

Spring Peak Flow



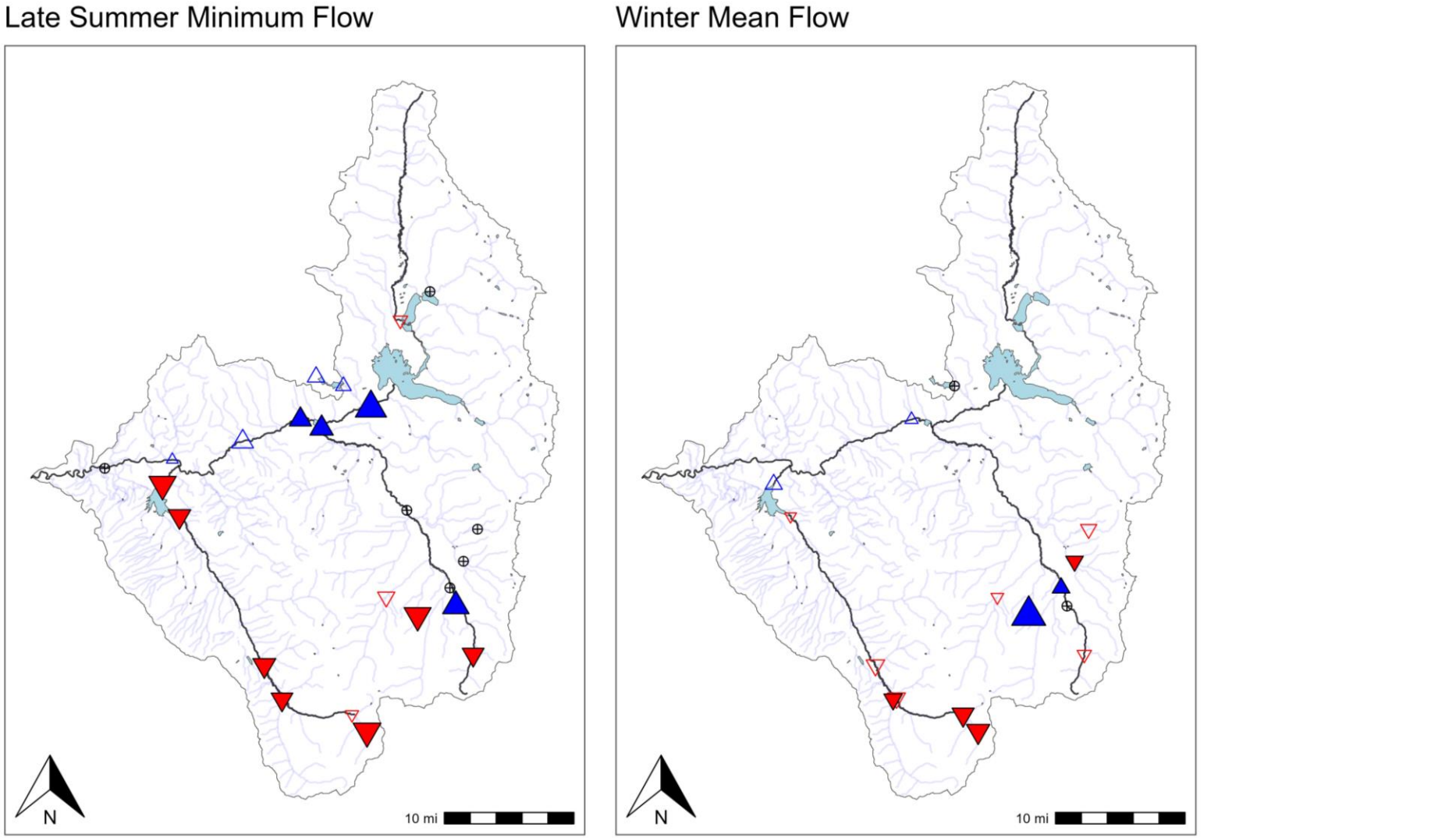
Spring Peak Timing



Median Change Per Year (%) <0.5 1 2 3 4 >5

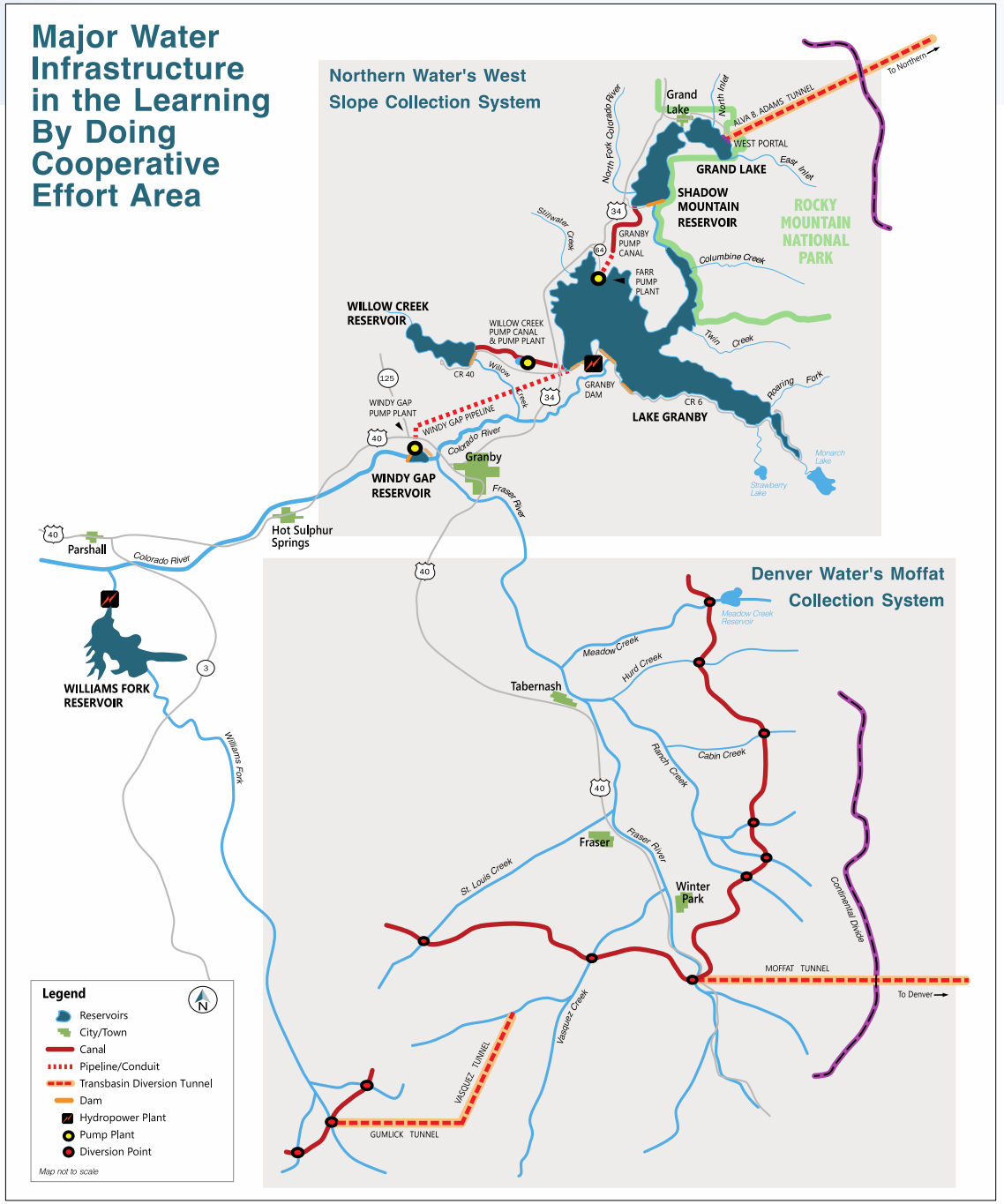
Trend Explanation: Likely Positive; Somewhat Likely Positive; As Likely Positive as Negative; Somewhat Likely Negative; Likely Negative

Minimum Streamflow Trends (2003-2021)



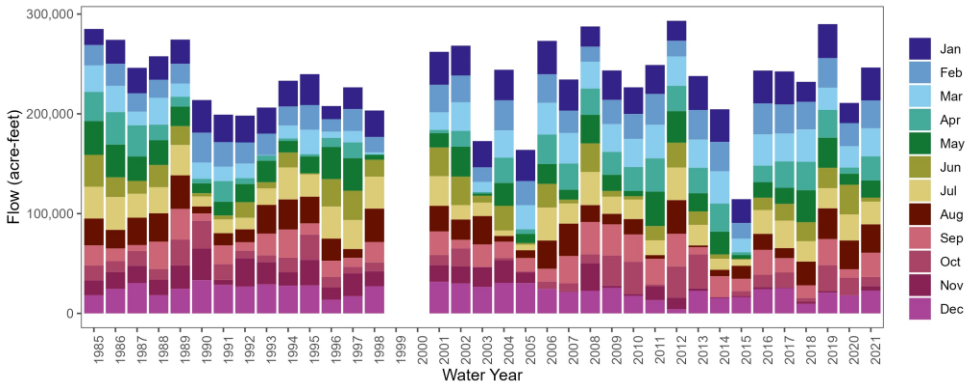
Water Agreements & Infrastructure

- **1992** — Clinton Reservoir – Fraser River Water Agreement
- **1995** — Denver Water - GCILC agreement on Meadow Creek Collection System
- **2011** — Windy Gap Firming Project (WGFP) Fish & Wildlife Mitigation Plan
  - Fish & Wildlife
- **2012** — Grand County 1041 Permit for WGFP
  - Northern Water IGA
- **2013** — 5,412.5 Endangered Fish Recovery Program Agreement
  - Colorado River Cooperative Agreement (CRCA)
  - WGFP IGA
- **2014** — Bureau of Reclamation FEIS Record of Decision for WGFP
  - WGFP Carriage Contract
- **2015** — Big Lake Ditch
- **2016** — WGFP 401 Certification
- **2022** — Gross Reservoir Expansion

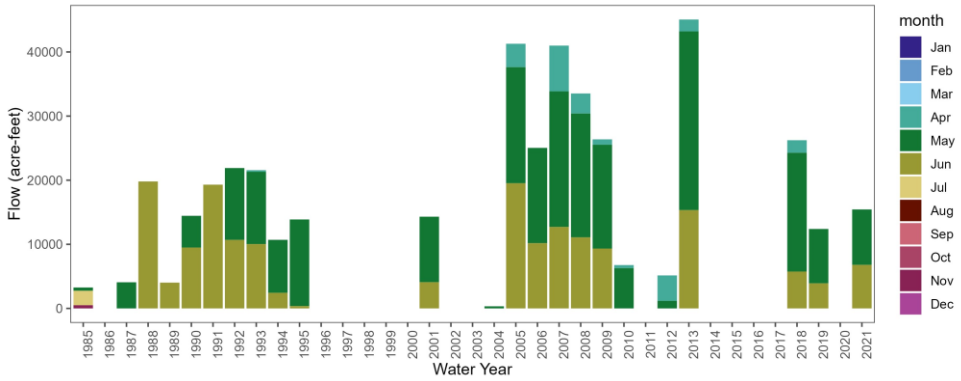


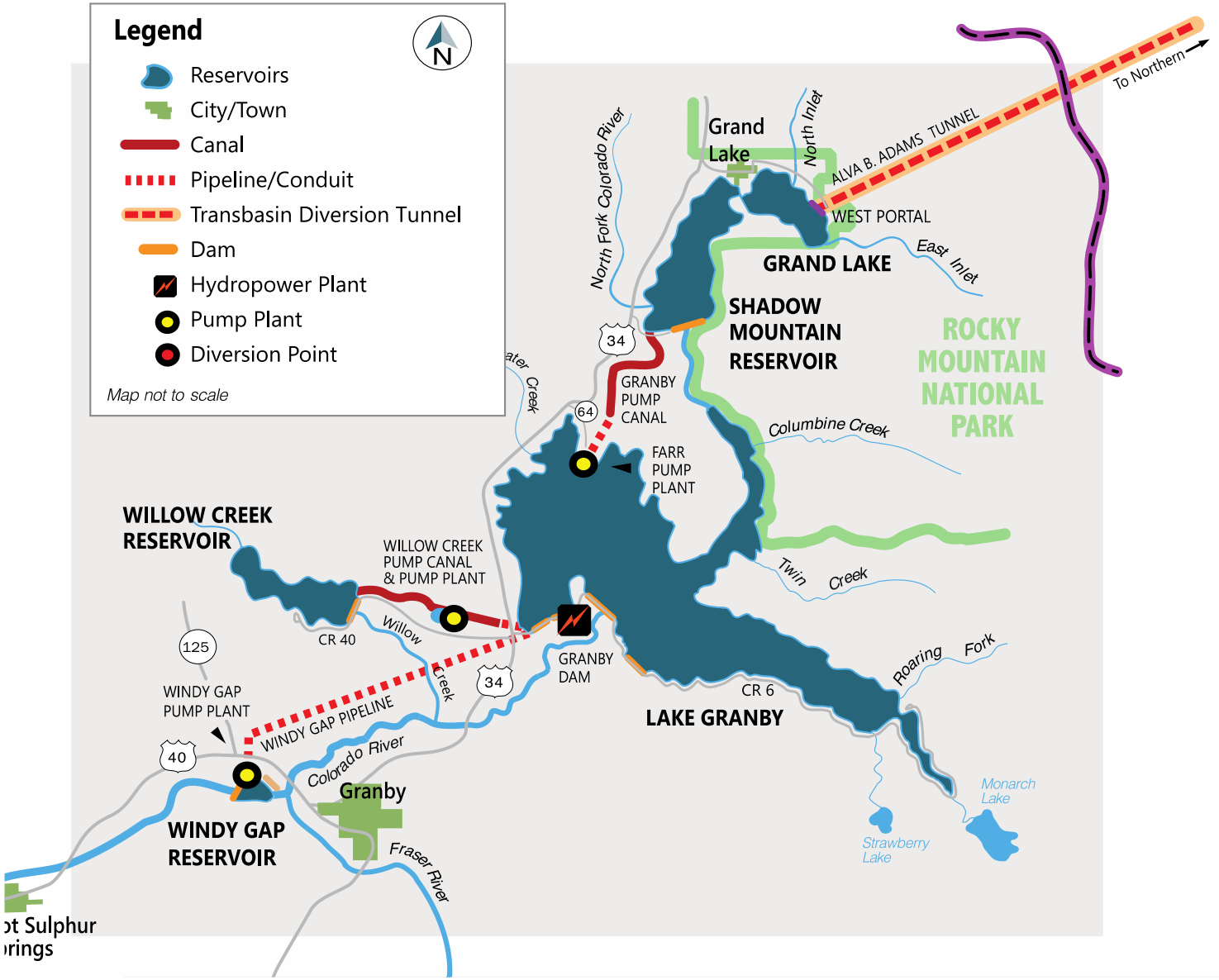
Norther Water's Infrastructure & Operations

ADAMS TUNNEL AVERAGE ANNUAL DIVERSIONS (~230,000 AF)



WINDY GAP AVERAGE ANNUAL DIVERSIONS (~13,000 AF)



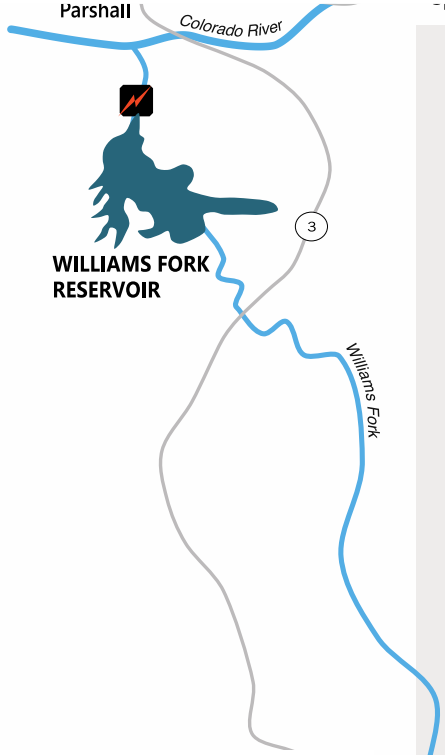


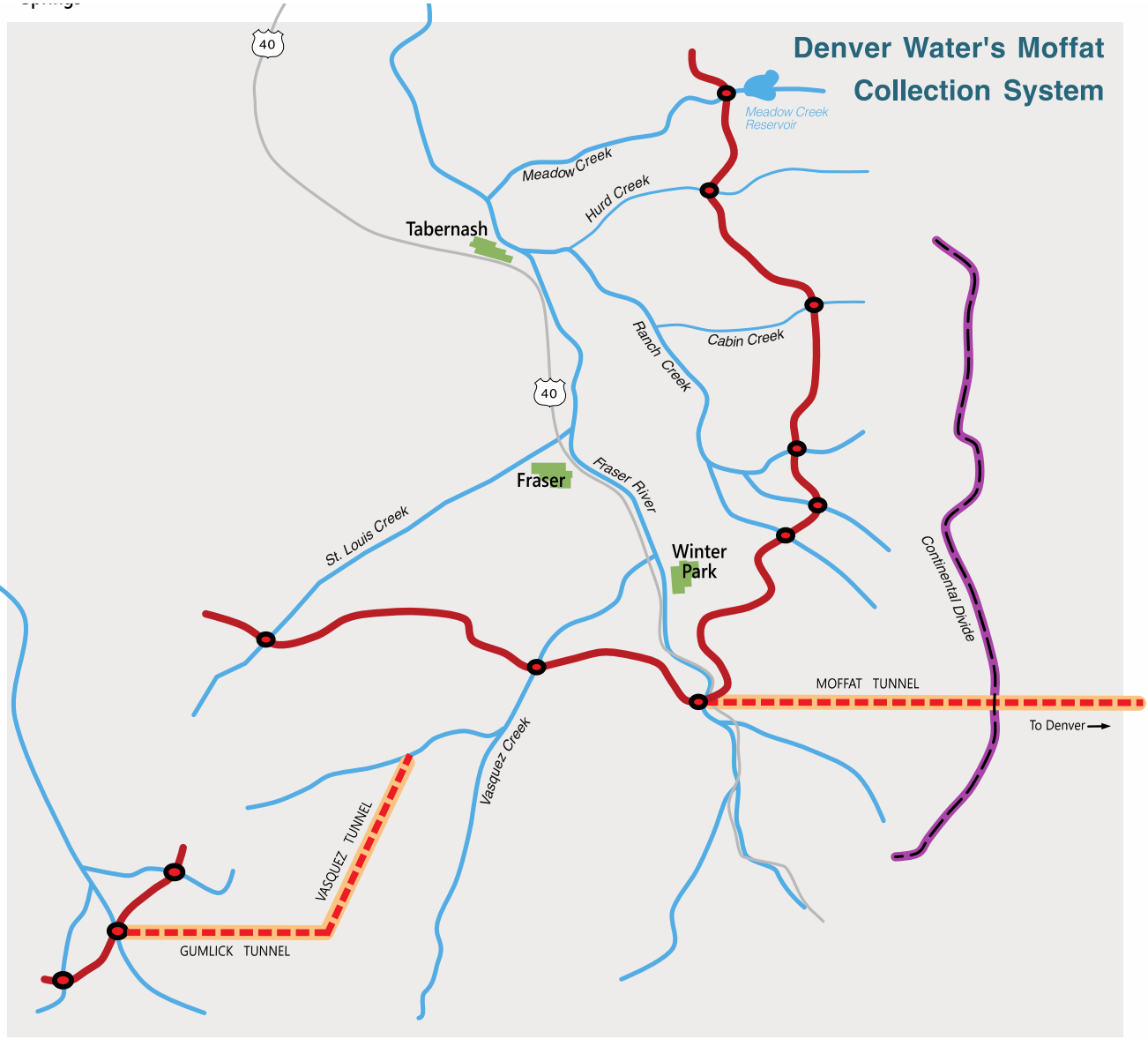
Denver Water's Infrastructure & Operations

Legend

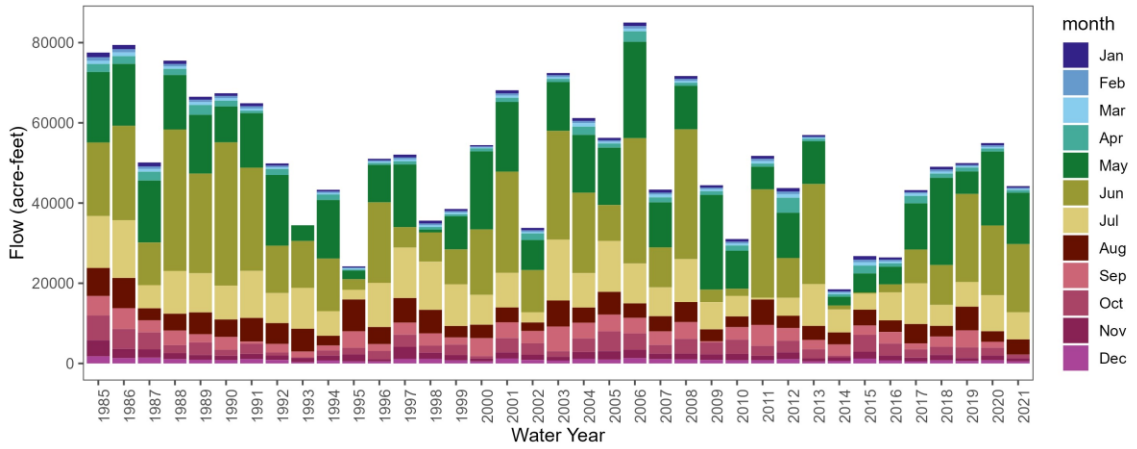
- Reservoirs
- City/Town
- Canal
- Pipeline/Conduit
- Transbasin Diversion Tunnel
- Dam
- Hydropower Plant
- Pump Plant
- Diversion Point

Map not to scale





MOFFAT TUNNEL AVERAGE ANNUAL DIVERSIONS (~50,000 AF)



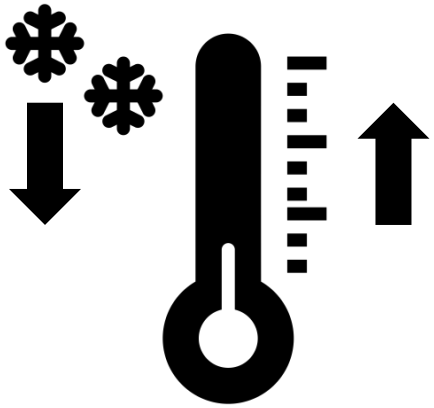
Rising Temperatures Decrease Regional Snowpack

- **30-50% of snow stations** across Rocky Mountain region experienced a significant declining trend in snow water equivalent (SWE) [1,2]
- Mean losses across sites in peak SWE of **1.6 in to 2.2 inches per decade** [1,2]
- At least some of these losses relate to **increased sublimation** driven by increasing winter and spring temperatures [3,4]
- No evident regional trends for declining winter precipitation [3,4]

[1] Elias et al., 2021
[2] Sexstone et al., 2020
[3] Xiao et al., 2018
[4] Milly & Dunne 2020

Evidence of Local Snowpack Impacts

Study of SNOTEL stations in Rocky Mountain National Park[1]



Temperature ↑ **0.54** ˚F per decade

SWE ↓ **0.4-0.8** inches per decade

Snowfall ↓ **0.16** inches per decade

[1] Fassnacht et al., 2018

Impacts of Recent Wildfires

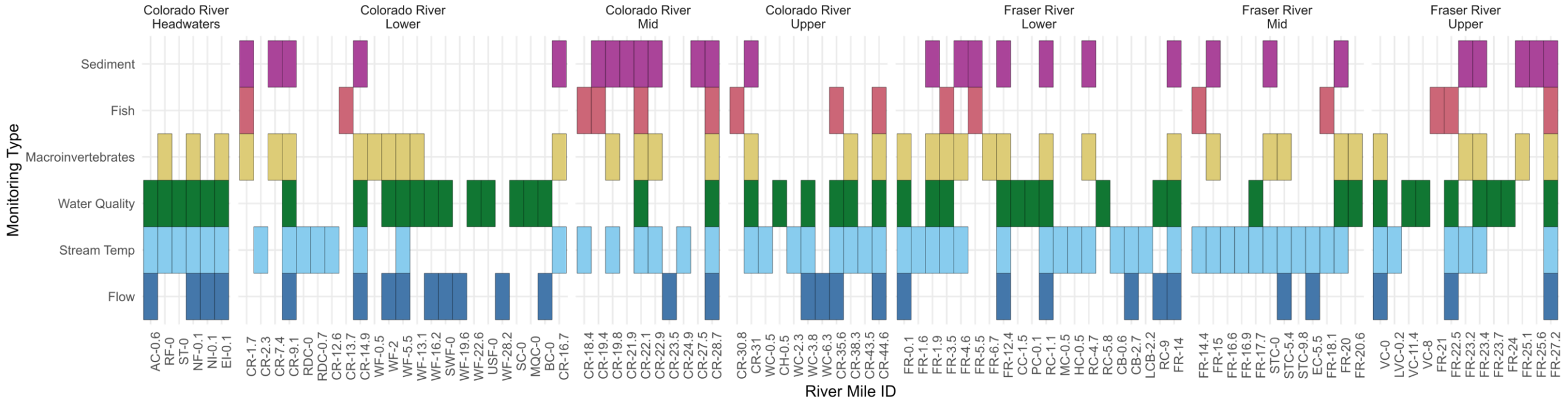
- Preliminary evidence → **earlier snowmelt** in burned areas
- Change in total yield is uncertain

Ongoing Monitoring and Mitigation

Efforts to identify and address existing and emergent conditions

Regular LBD Monitoring Activities

- Coordination and evaluation of current ***water quality*** sampling and development monitoring plans.
- Annual review of ***flushing flows target*** achievement as recommended in 2010 GC SMP
- ***Stream temperature*** monitoring network (67 sites in 2021)
- ***Sediment, substrate and algae*** monitoring (~15 sites per year as of 2021)
- Coordinated ***Benthic Macroinvertebrate*** sampling (29 sites collectively in 2021)
- CPW actively monitors **fish populations** (approx. 7-9 sites monitored each year)



Recent and Ongoing Mitigation Projects

- Fraser Sediment Pond (2011)
- Irrigators of Lands in the Vicinity of Kremmling (2012 – Present)
- Fraser Flats Aquatic Habitat Restoration Project (2016-2018)
- Williams Fork River Restoration (2018-2019):
- Ranch Creek Riparian Habitat Restoration (2018-2019):
- Granby/Kaibeb Park Fish Passage (2020):
- Cabin Creek Fish Passage (2021):
- Kemp-Breeze SWA Aquatic Habitat Improvement (2022- Ongoing)
- Colorado River Connectivity Channel (Completion expected in 2024)

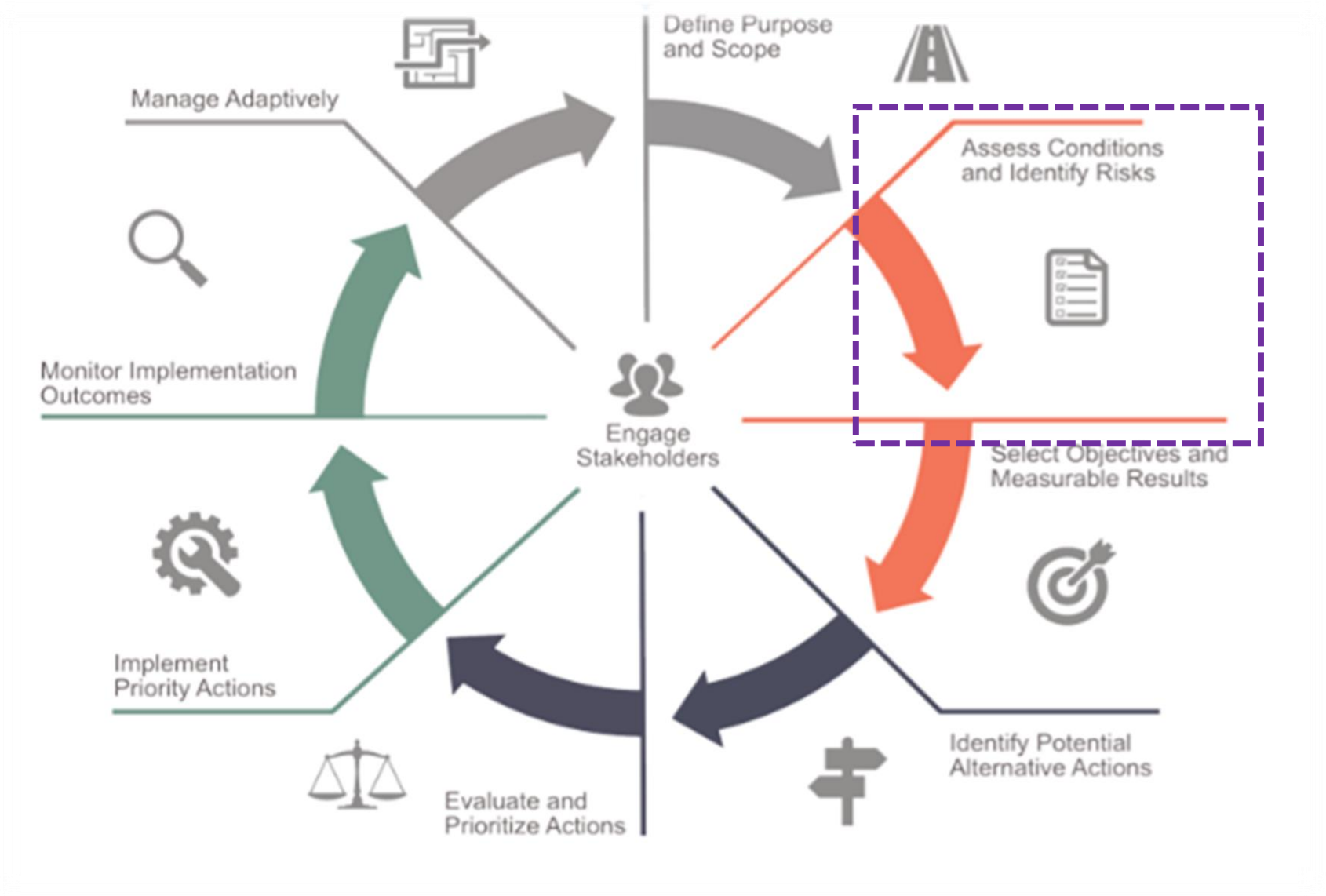
Photo courtesy of LBD

***list does not include all projects on private lands**

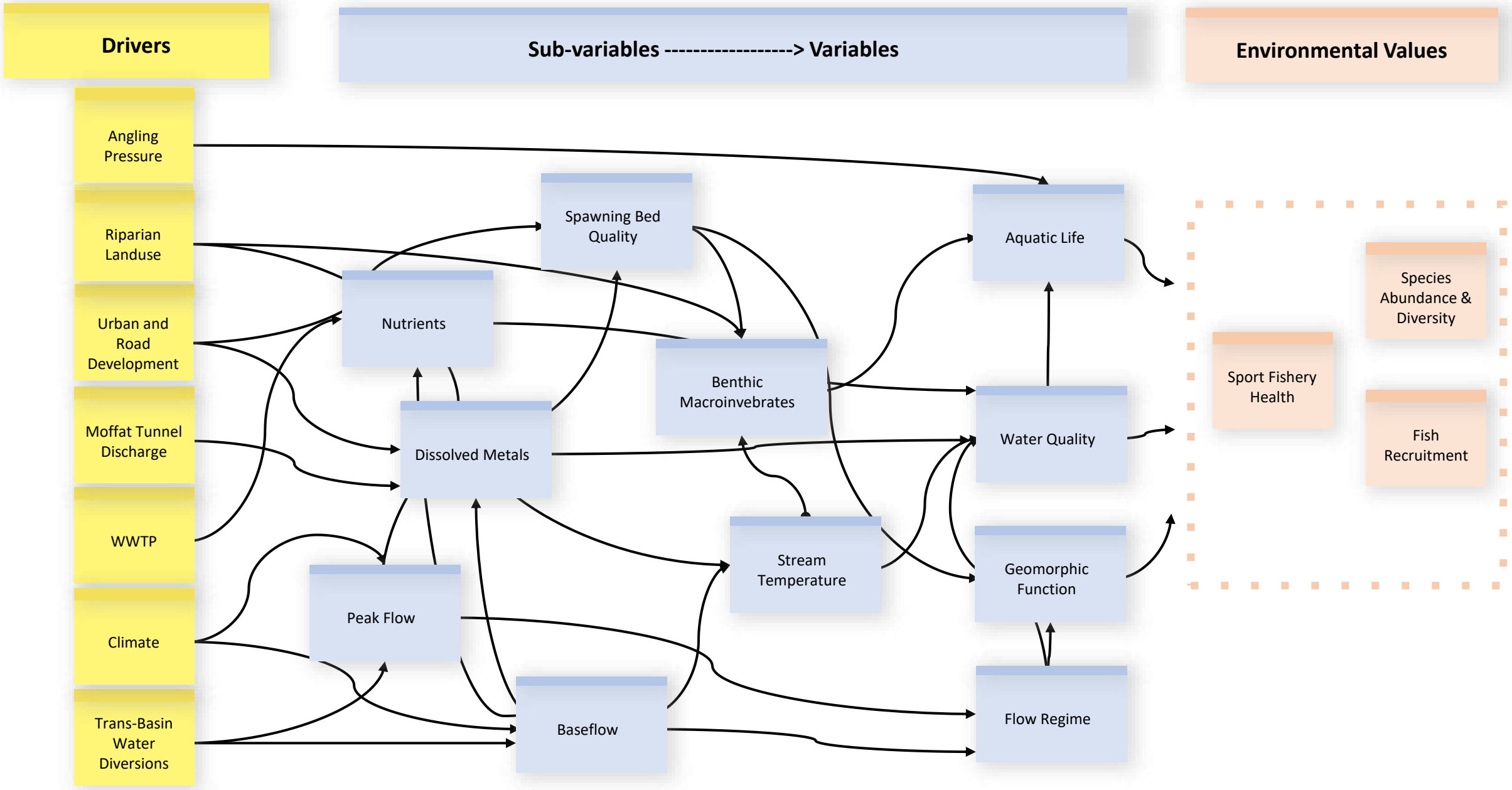
Comprehensive Watershed Assessment

Providing a robust foundation for a new round of planning

Watershed Assessment in SMP Process



Support for Phase II



Questions?

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