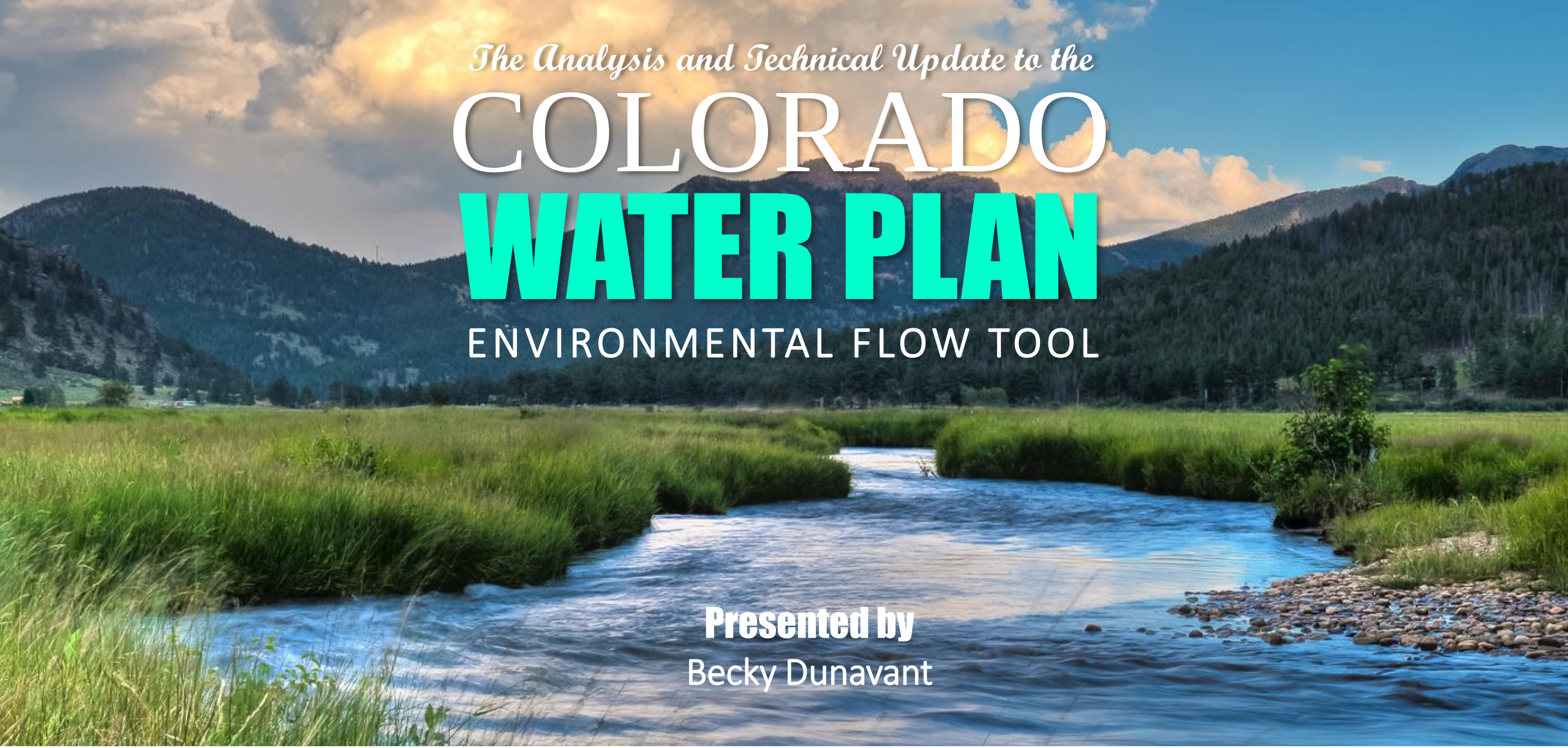

The Analysis and Technical Update to the

COLORADO WATER PLAN

ENVIRONMENTAL FLOW TOOL

Presented by

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The Nature Conservancy

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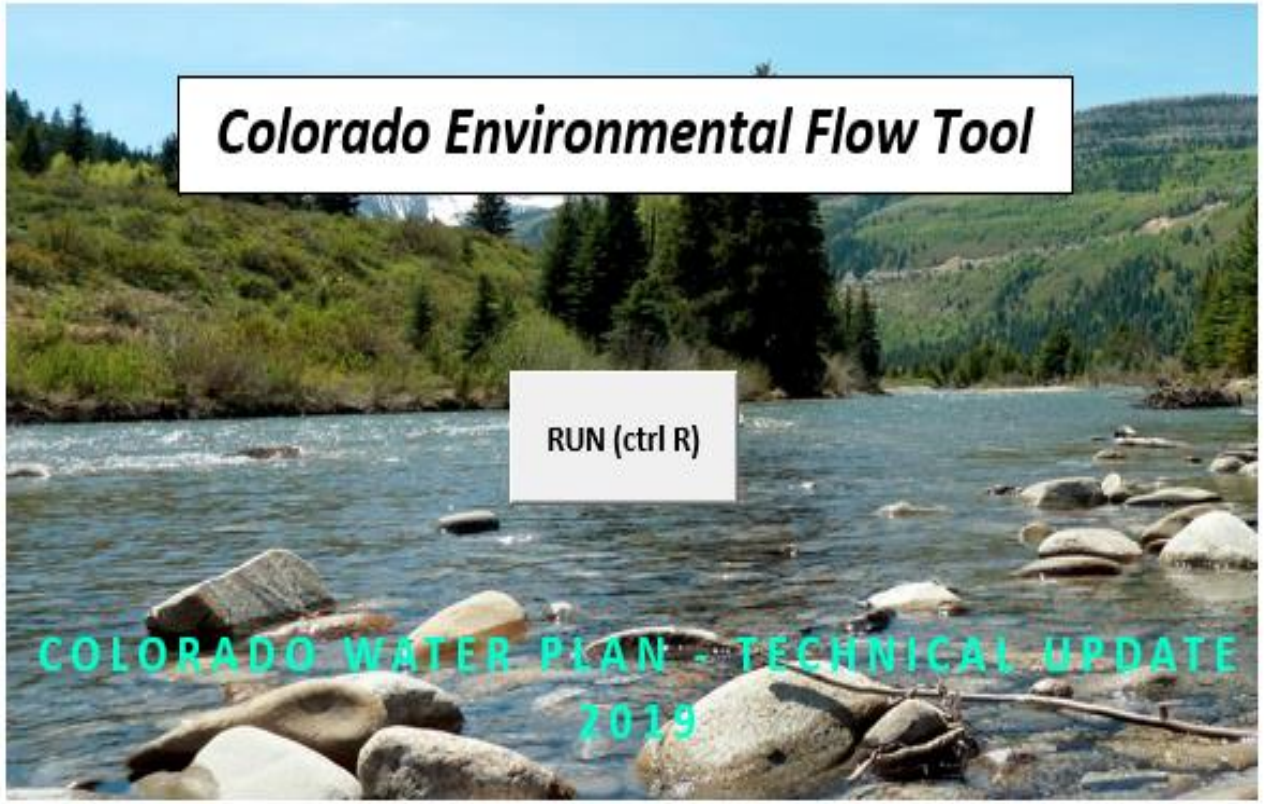
COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Agenda

Colorado Environmental Flow Tool

- What it is/is not
- Overview and Data Inputs
- Output Summaries
- Results
- Next Steps



Colorado Environmental Flow Tool

What it is

High-level tool that :

- Builds on previous efforts - Watershed Flow Evaluation Tool (WFET)
- Post-processes DSS projections to provide summaries of changes in monthly flow regime at pre-selected locations under different planning horizons
- Identifies potential risks through flow-ecology calculation projections
- Serves as a complementary tool to the DSS to refine, categorize, and prioritize projects
- Provides guidance during Stream Management Plan development and BIP development

Colorado Environmental Flow Tool

What it is not

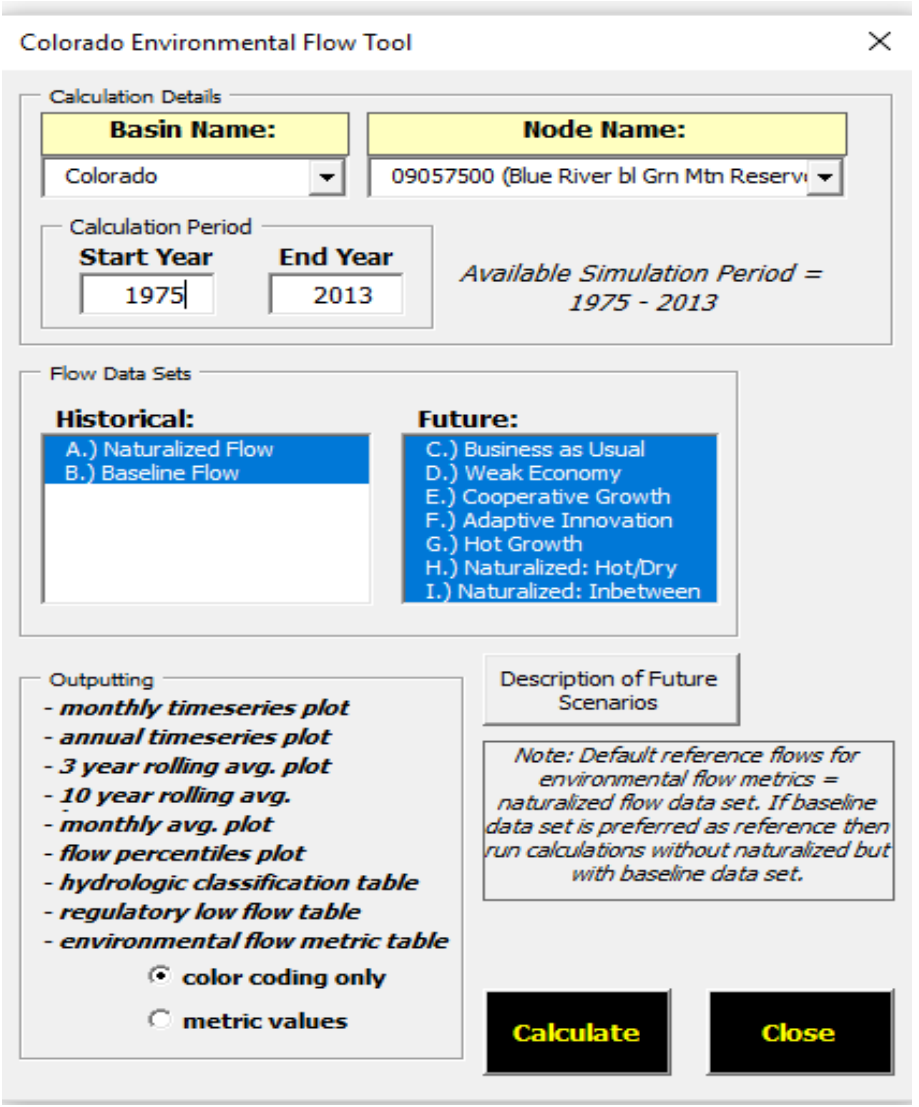
The Tool is *NOT* Prescriptive

- Does not designate any gap values
- Does not provide the basis for any regulatory actions
- Does not identify areas where ecological change may be associated with factors other than streamflow
- Does not provide results as detailed or as accurate as a site-specific analysis

Colorado Environmental Flow Tool - Overview

Software Overview

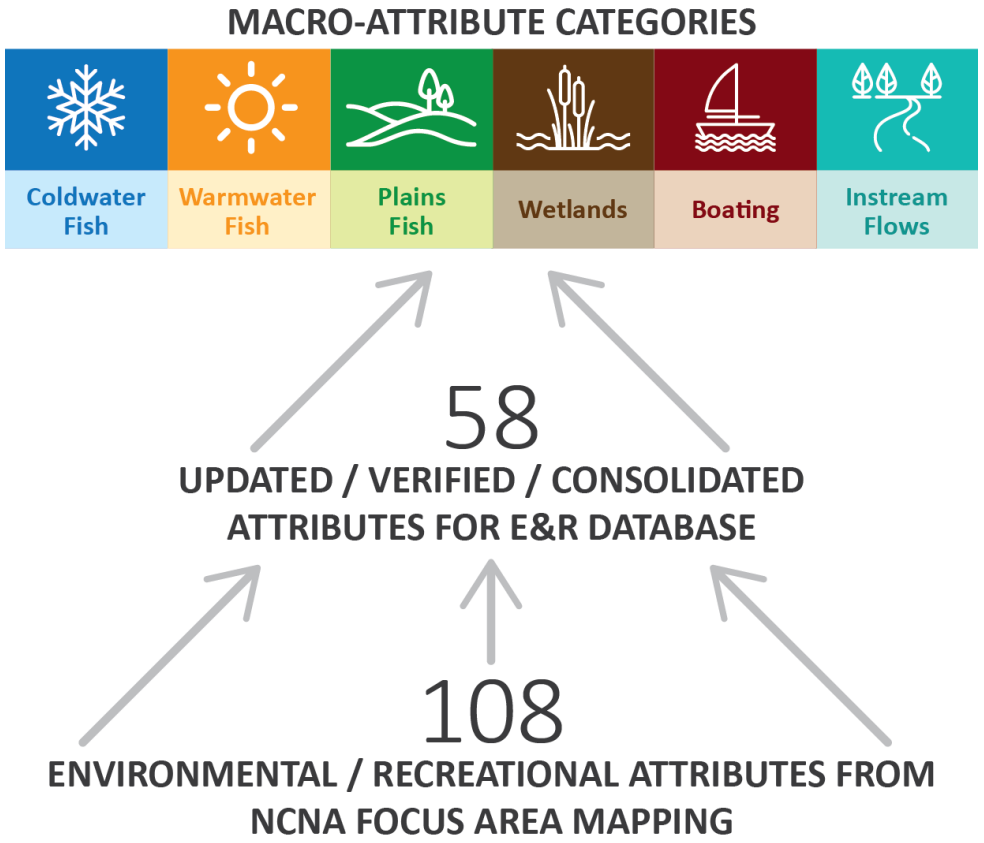
- Visual Basic for Applications, Excel workbook
- User-friendly, form-based interface functionality
- User-defined node, scenario(s), and calculation period



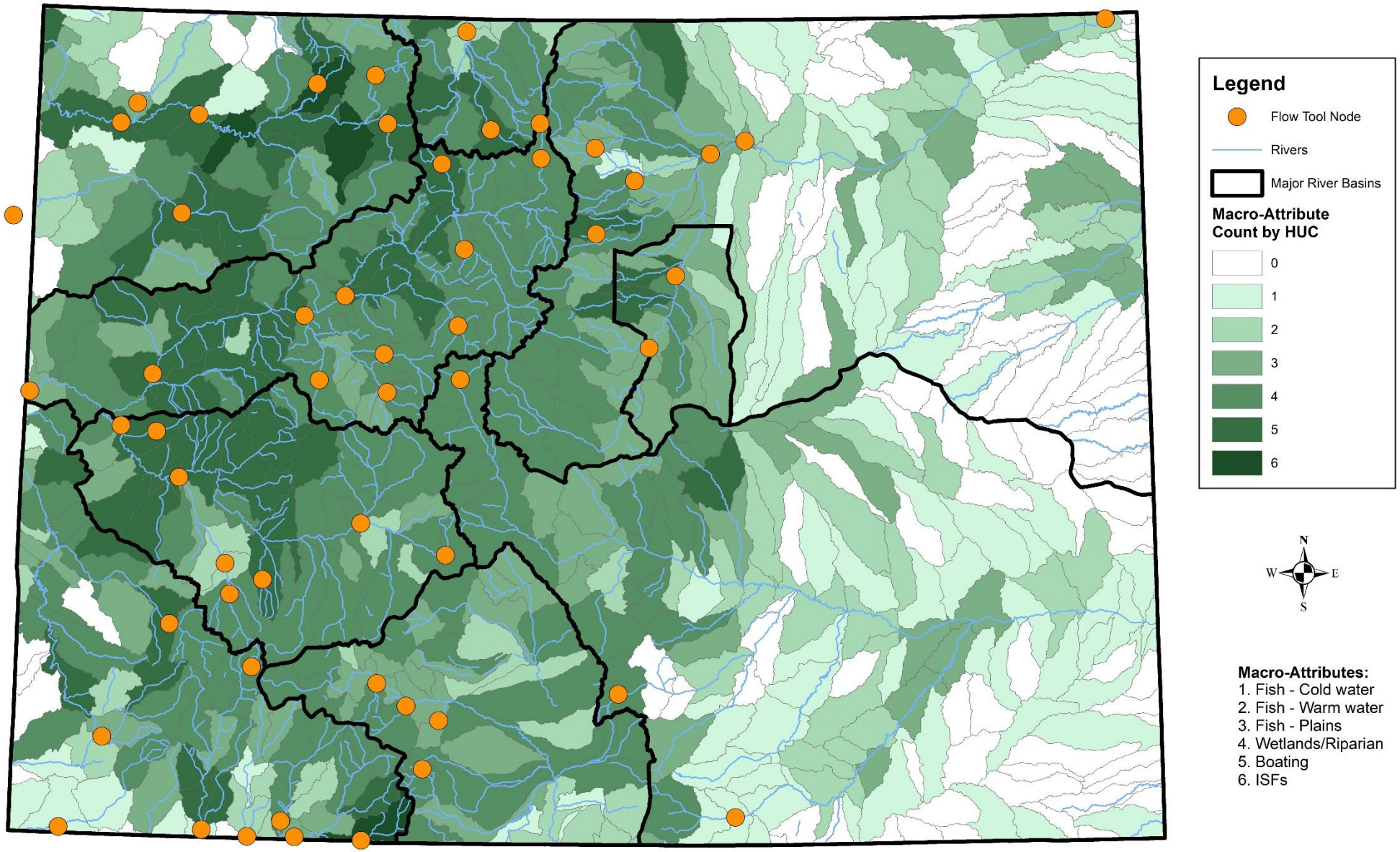
Colorado Environmental Flow Tool– Data Inputs

Flow Tool Nodes:

- Presence of E&R Attributes
- Spatial consideration by basin
- Data Availability (completeness, period of record)



Colorado Environmental Flow Tool– Data Inputs



Macro-Attributes:
1. Fish - Cold water
2. Fish - Warm water
3. Fish - Plains
4. Wetlands/Riparian
5. Boating
6. ISFs

Colorado Environmental Flow Tool– Data Inputs

Flow Data:

- CDSS - Monthly time-step
- Includes baseline, naturalized, and the modeled data for the 5 planning scenarios*
  (from the Colorado Water Plan)
- Also includes naturalized with climate change factors (in-between and hot/dry)

**Arkansas and Rio basins do not have models*

Drivers	A Business as Usual	B Weak Economy	C Cooperative Growth	D Adaptive Innovation	E Hot Growth
A. Economy/ Population					
B. Urban Land use	No change	No change	Higher density	Higher density	Lower density
C. Climate Status/ Water Supply	Same as 20th century observed	Same as 20th century observed	Between hot and dry and 20th century observed	Hot and dry	Hot and dry
D. Energy Water Needs	Low (no oil shale)	Moderate (no oil shale)	Low (no oil shale)	Low (no oil shale)	High (oil shale)
E. Agricultural Conditions	Total ag water demands slightly higher • Decrease in irrigated acres due to urbanization • Ag exports and demands lower • Ag is less able to compete with urban areas for water	Total ag water demands decrease • Decrease in irrigated acres due to urbanization • Ag exports and demands constant • Ag is less able to compete with urban areas for water	Total ag water demands slightly higher • Slight decrease in irrigated acres due to urbanization • Ag exports down and local demands up • Ag is better able to compete with urban areas for water • Increased ET due to climate change	Total ag water demands slightly higher • Slight decrease in irrigated acres due to urbanization • Ag exports down and local demands up • Ag is better able to compete with urban areas for water • Increased ET due to climate change	Total ag water demands higher • Significant decrease in irrigated acres due to urbanization • Ag exports and demands high • Ag is better able to compete with urban areas for water • Increased ET due to climate change
F. Availability of New Water Efficiency Technology	• M&I Moderate • Ag: Efficiencies are increased	• M&I Moderate • Ag: Efficiencies are increased	• M&I High • Ag: Efficiencies are increased	• M&I High • Ag: Much higher efficiencies are implimented	• M&I Moderate • Ag: Efficiencies are increased
G. Social/ Environmental Values	No change	No change	• Increased awareness • Increased willingness to protect environment and stream recreation	• Increased awareness • Increased willingness to protect environment and stream recreation	• Full use of resources • Low willingness to protect environment and stream recreation
H. Regulatory Constraints	Regulation Deregulation No change	Regulation Deregulation No change	Regulation Deregulation Increased	Regulation Deregulation Increased but expedited	Regulation Deregulation Reduced
I. M&I Water Demands	Lowest of the five scenarios	Middle of the five scenarios	Second lowest of the five scenarios	Second highest of the five scenairos	Highest of the five scnarios

Colorado Environmental Flow Tool– Data Inputs

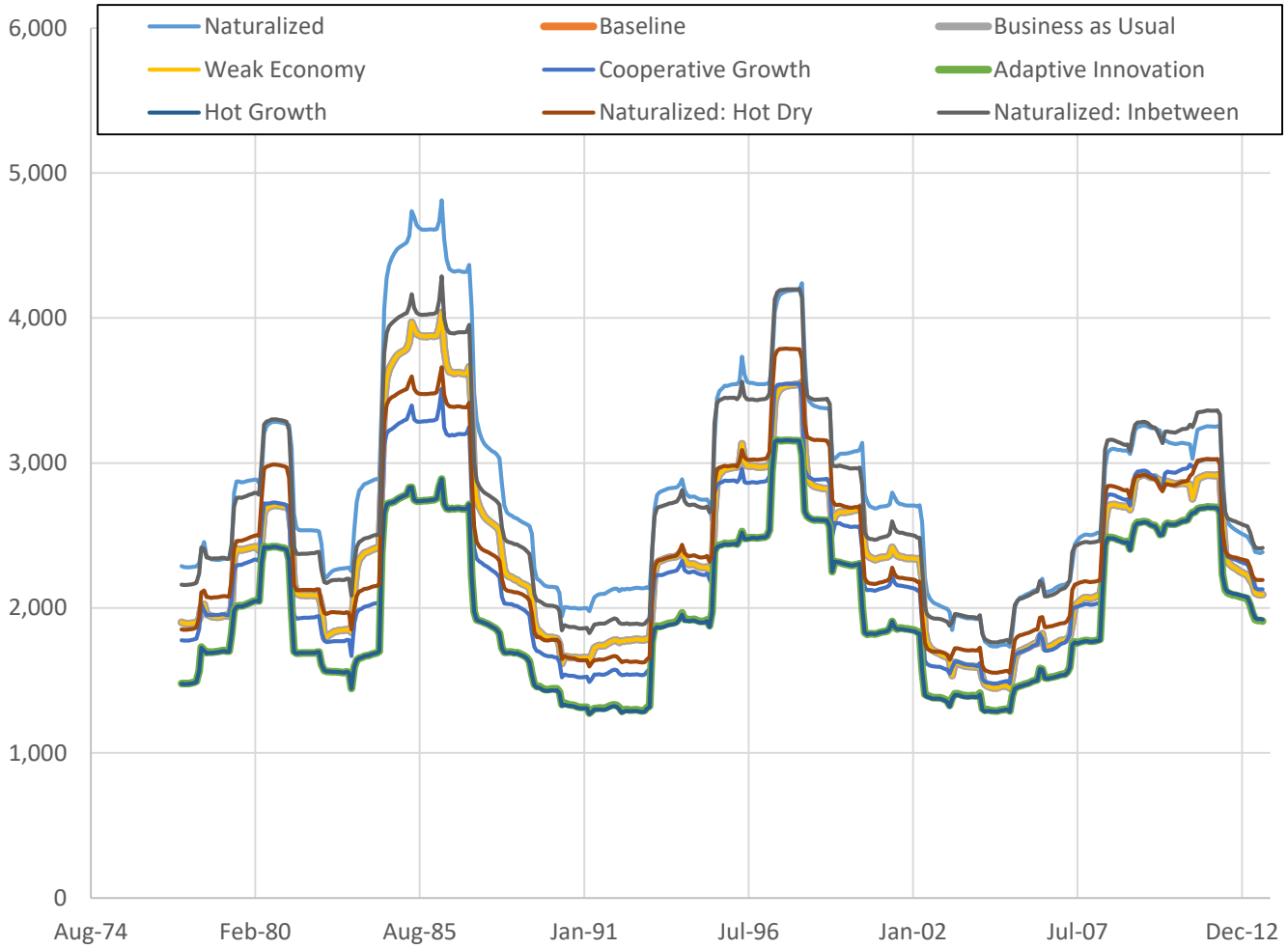
Flow-Ecology Relationships:

- Drawn from the Watershed Flow Evaluation Tool reports (developed in SWSI 2010), the Nonconsumptive Toolbox, and the Nonconsumptive sections of the Water Plan.
- Relationships reviewed and refined with TNC for Coldwater/Warmwater/Plains Fish, Riparian, Instream Flow Rights, and Boating (recreational in-channel diversions).
- Relationships include risk classes based on percent change to key metrics.

Colorado Environmental Flow Tool – Output Summaries

Flow Statistics

- Monthly and annual timeseries
- 3 and 10-year rolling average timeseries
- Monthly means
- Monthly flow percentile plots



Colorado Environmental Flow Tool – Output Summaries

Hydrologic Classification Table

Annual Flow Percentile (upper limit)	Hydrologic Category
5th	Drought
24th	Dry
75th	Average
94th	Wet
100th	Flood

Number of Modeled Years Falling into Each Category:

Percentile (max)	Threshold Volume (AF)	Hydrologic Classification	Naturalized	Gaged	Baseline	Scenario 1: Business as Usual	Scenario 2: Weak Economy	Scenario 3: Cooperative Growth	Scenario 4: Adaptive Innovation	Scenario 5: Hot Growth
0.05	14,079	Drought	2		4	4	4	4	5	5
0.24	25,077	Dry	8		13	13	13	13	19	19
0.75	42,274	Average	19		17	17	17	18	13	13
0.94	51,410	Wet	7		4	4	4	3	2	2
1.00	71,226	Flood	3		1	1	1	1	0	0

Baseline:

Modeled Water Year	Annual Flow (AFY)	Hydrologic Classification
1975	32,685	Average
1976	21,998	Dry
1977	13,704	Drought
1978	34,176	Average
1979	38,521	Average
1980	24,728	Dry
1981	11,943	Drought
1982	29,044	Average
1983	43,797	Wet
1984	59,808	Flood
1985	35,865	Average
1986	34,804	Average
1987	25,151	Average
1988	19,703	Dry
1989	20,749	Dry
1990	19,288	Dry
1991	22,583	Dry
1992	22,175	Dry
1993	39,136	Average
1994	21,592	Dry
1995	45,146	Wet
1996	40,594	Average
1997	40,918	Average
1998	21,104	Dry
1999	33,774	Average
2000	29,422	Average
2001	21,465	Dry
2002	10,741	Drought
2003	25,630	Average
2004	15,820	Dry
2005	20,094	Dry
2006	26,748	Average
2007	27,402	Average
2008	43,518	Wet
2009	34,154	Average

Colorado Environmental Flow Tool – Output Summaries

Statistical Low Flow Table

Flow Metric	*Naturalized*	*Baseline*	*Scenario 1: Business as Usual*	*Scenario 2: Weak Economy*	*Scenario 3: Cooperative Growth*	*Scenario 4: Adaptive Innovation*	*Scenario 5: Hot Growth*	*Naturalized HotDry*	*Naturalized Inbetween*
2-yr, Annual Low Flow (AFM)	522	521	521	521	497	438	437	437	498
5-yr, Annual Low Flow (AFM)	426	425	425	425	403	360	360	358	402
10-yr, Annual Low Flow (AFM)	378	379	379	379	357	323	323	322	356
25-yr, Annual Low Flow (AFM)	331	332	332	332	311	286	286	287	311
50-yr, Annual Low Flow (AFM)	303	303	303	303	283	264	264	266	284
100-yr, Annual Low Flow (AFM)	279	279	279	279	260	245	246	249	262

Colorado Environmental Flow Tool – Output Summaries

Environmental Flow Analysis

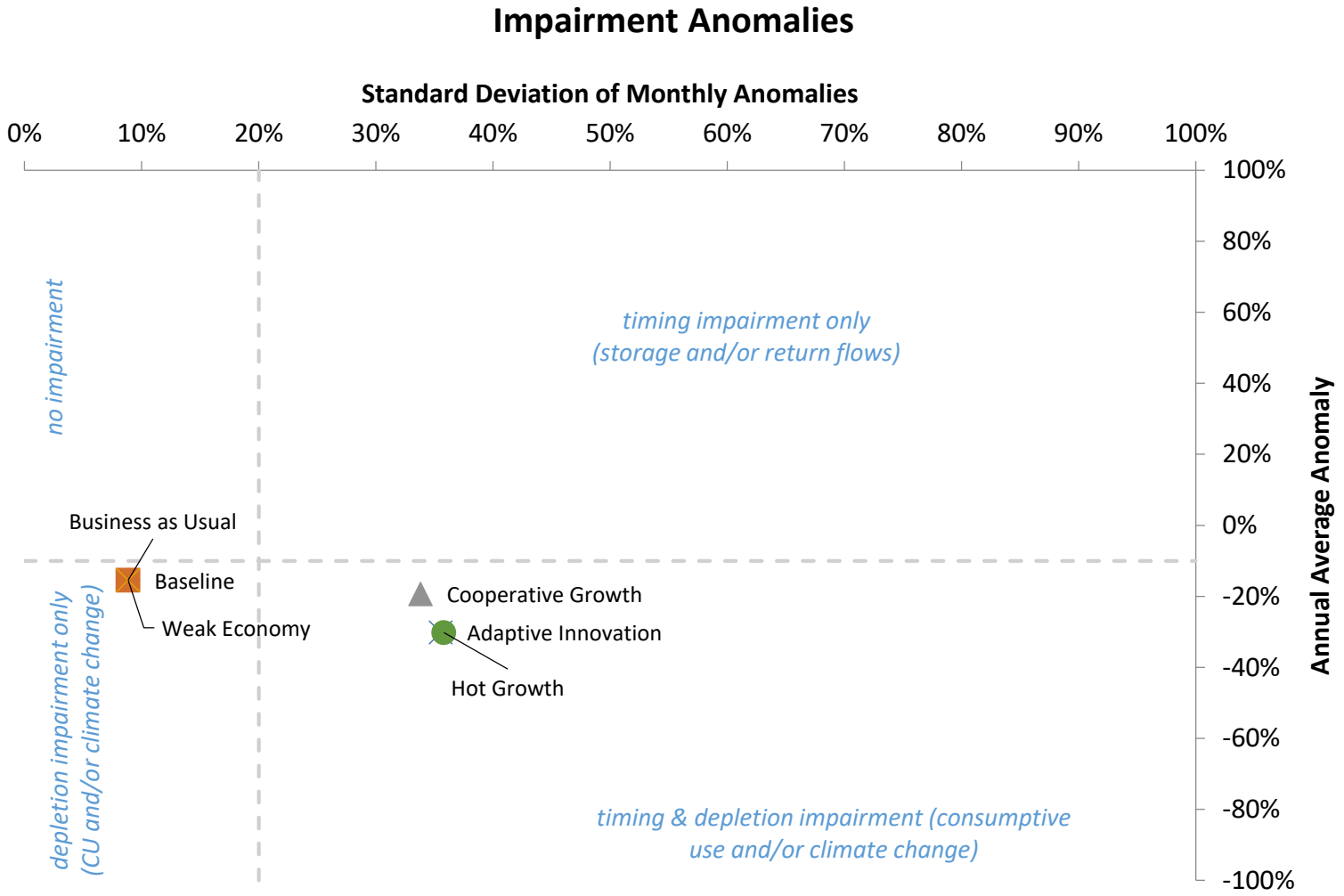
Color Key:

- = low ecological risk
- = moderate ecological risk
- = less moderate ecological risk (cold water baseflow only)
- = high ecological risk
- = very high ecological risk

Flow Metric	*Naturalized*	*Baseline*	*Scenario 1: Business as Usual*	*Scenario 2: Weak Economy*	*Scenario 3: Cooperative Growth*	*Scenario 4: Adaptive Innovation*	*Scenario 5: Hot Growth*	*Naturalized HotDry*	*Naturalized Inbetween*
Cold Water Fish Baseflow Fraction: Aug, Sep									
Change in Plains Fish Baseflow Fraction: Jul, Aug									
Change in Peak Flow, for Wetland Plants									
Change in Max Sucker Biomass									
Change in Peak Flow, for Warmwater Fish									
Change in Average Annual Flow									
Change in Average Winter Flow									
Change in Average Late Summer Flow									
Change in Average January Flow	0%	0%	0%	0%	-7%	-18%	-18%	-18%	-7%
Change in Average February Flow	0%	0%	0%	0%	0%	-11%	-11%	-11%	0%
Change in Average March Flow	0%	0%	0%	0%	18%	11%	11%	11%	18%
Change in Average April Flow	0%	-1%	-1%	-1%	48%	47%	47%	48%	49%
Change in Average May Flow	0%	-15%	-15%	-15%	28%	19%	19%	34%	43%
Change in Average June Flow	0%	-21%	-21%	-21%	-45%	-60%	-60%	-39%	-24%
Change in Average July Flow	0%	-21%	-21%	-21%	-60%	-70%	-70%	-50%	-39%
Change in Average August Flow	0%	-13%	-13%	-13%	-49%	-54%	-56%	-43%	-36%
Change in Average September Flow	0%	-6%	-6%	-6%	-31%	-35%	-36%	-31%	-25%
Change in Average October Flow	0%	-1%	-1%	-1%	-22%	-29%	-29%	-28%	-21%
Change in Average November Flow	0%	0%	0%	0%	-17%	-27%	-27%	-27%	-17%
Change in Average December Flow	0%	0%	0%	0%	-11%	-23%	-23%	-23%	-11%

Colorado Environmental Flow Tool – Output Summaries

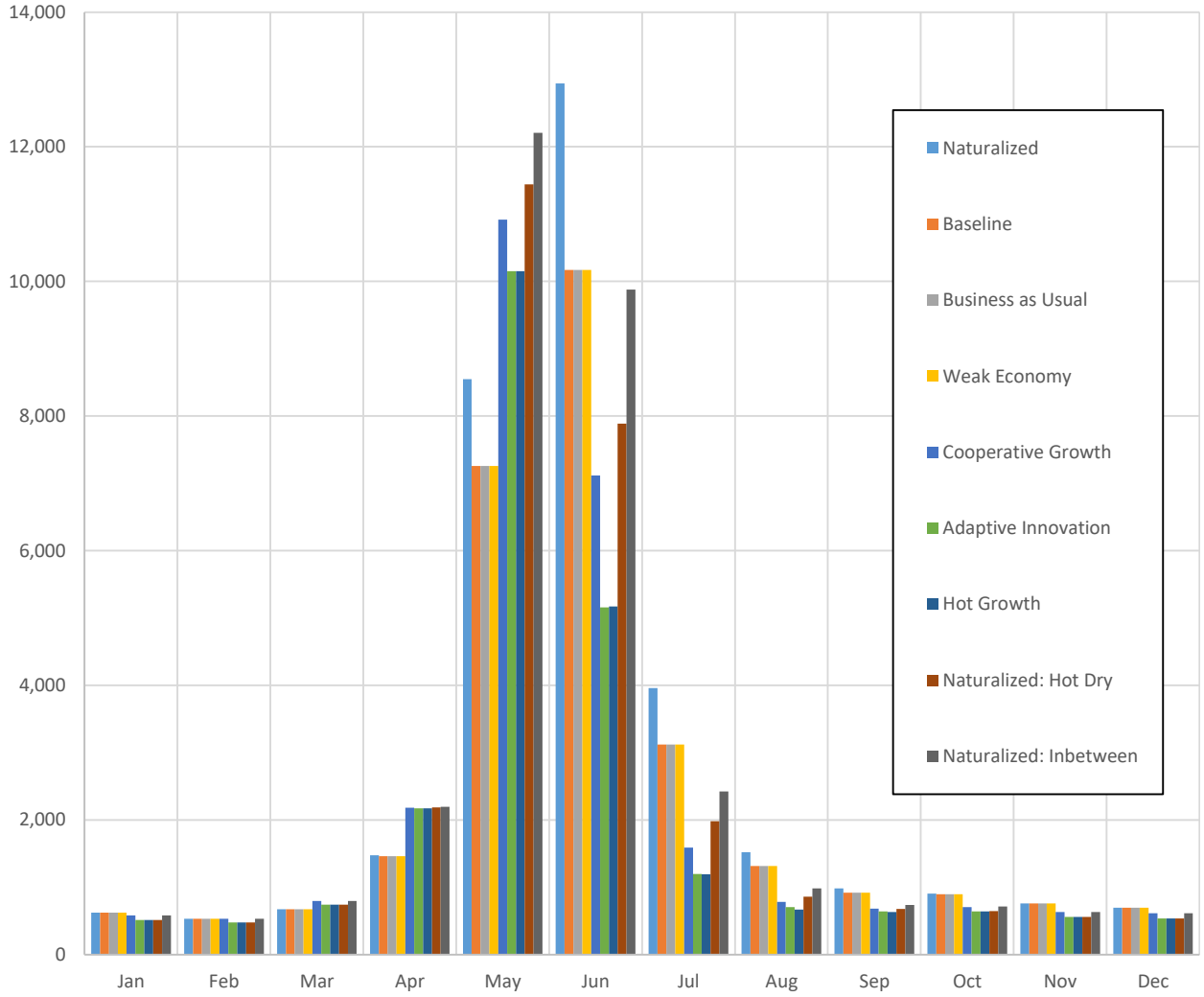
Impairment Anomolies Chart



Colorado Environmental Flow Tool – Results

Summary of Results:

- Climate change impacts on stream flow will drive risk to E&R attributes
- Future stream flow hydrographs could reflect
  - Earlier peaks
  - Drier conditions in late summer
- Earlier peak runoff might not match species' needs
- Drier late summer conditions could raise water temperatures and reduce habitat



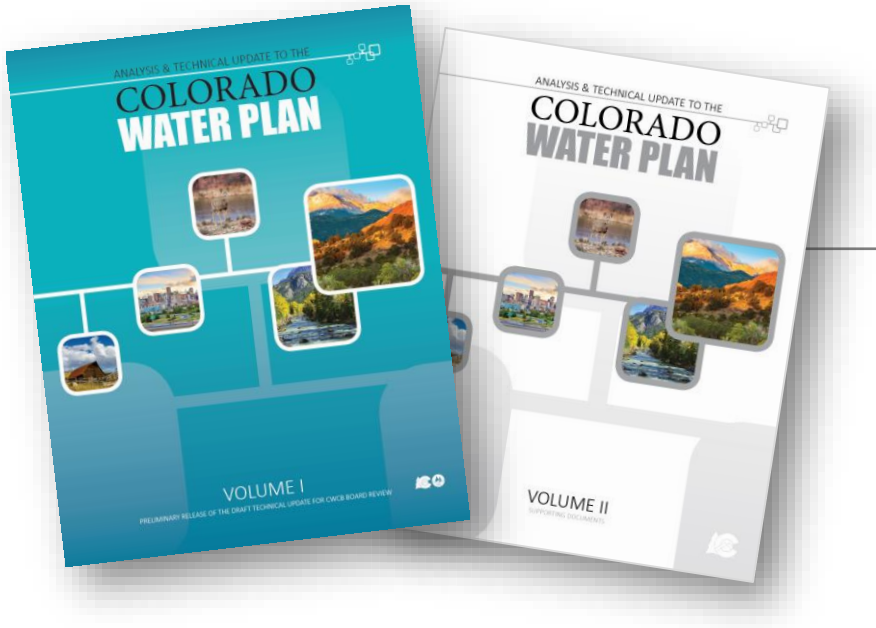
Flow Tool – Results

Summary of Results:

- Mountain streams with no infrastructure may have low to moderate risk but increasing risk to riparian plants and fish
  - Risk could increase with climate change
- Mountain streams with infrastructure could see varying risks
  - Depleted streams may see increased risks from lower flows
  - Some streams may be sustained by reservoir releases
- Instream Flow and Recreational In-Channel Diversion water rights may be met less often with climate change

Next Steps

Identify how data and tools from the Technical Update can best integrate into basin planning and, ultimately the update of the Colorado Water Plan.



BIP UPDATES

WATER PLAN UPDATE

2019

2018-2021

2019-2022


QUESTIONS ?