Implementing a Framework for Adaptation Planning: Future Climate Scenarios, Goals & Logistics

Southwest Climate Change Initiative (SWCCI)

Bear River Climate Change Adaptation Workshop

26-27 May 2010 – Salt Lake City, Utah

Gregg Garfin

Institute of the Environment

CLIMAS Climate Assessment for the Southwest

Main Scenario: Climate

NCAR

- Annual temperature: +3.5ºC (+6.3 ºF)
- Annual precipitation: +1.6%

Season	Precip %	Temp °C	Temp °F
Winter	+13	+2.5	+4.5
Spring	-6	+3.5	+6.3
Summer	-15	+4.5	+8.1
Fall	0	+3.5	+6.3

Main Scenario: Hydrology

NCAR

Parameter	Impacts
Runoff Amount	5-18% decrease
Snowpack Accumulation and Melt	• later fall accumulation • 10-15% lower peak accumulation • earlier spring melt – 2-4 weeks
Runoff Timing	earlier by 1-3 weeks
Summer Flows Winter Flows	• low flows -10% • high flows -25% • 30-50% increase, due to more rain events

Alternative: Climate

– Annual temperature: +2.7ºC (+4.9ºF)
– Annual precipitation: –3%

Season	Precip %	Temp °C	Temp °F
Winter	-5	+2.7	+4.9
Spring	+10	+2.0	+3.6
Summer	-20	+3.0	+5.4
Fall	+3	+3.0	+5.4

Alternative: Hydrology

NCAR

Parameter	Impacts
Runoff Amount	5-13% decrease
Snowpack Accumulation and Melt	• later fall accumulation • 15-20% lower peak accumulation • earlier spring melt – 2-4 weeks
Runoff Timing	earlier by 1-2 weeks
Summer Flows Winter Flows	• low flows -15% • high flows -50% • 30-50% increase, due to more rain events

Refine Management Objectives
Refine Conceptual Model
Assess Impacts: Scenarios
Complete Table 1: Impacts

12:45-4:30 **Breakout Groups** Refine objectives Develop model Assess impacts Table 1	**Bonneville Cuttroat Trout** (“trout”) – this room **Bear River Wetlands** (“Wetlands”) – breakout room to west	McCarthy & Garfin Cross & Gori

8:30-12:00 **Breakout Groups** Identify Actions Opportunities Needs	Trout Wetlands	

Identify Strategic Actions
Complete Table 2
Review Management Objectives
Evaluate Priority/ID Opportunities
Research & Monitoring Needs

Conservation Features – Tab 3

Gunnison Climate Change Adaptation Workshop
Summary of Conservation Features

At the Gunnison Basin Climate Change Adaptation Workshop, we will apply an adaptation planning framework to develop strategic actions for three different types of conservation features (species, ecosystem, and ecological process). Based on participant input, we selected the Gunnison sage-grouse, alpine ecosystem and Gunnison headwaters to be the focus of adaptation planning exercises conducted during breakout sessions.

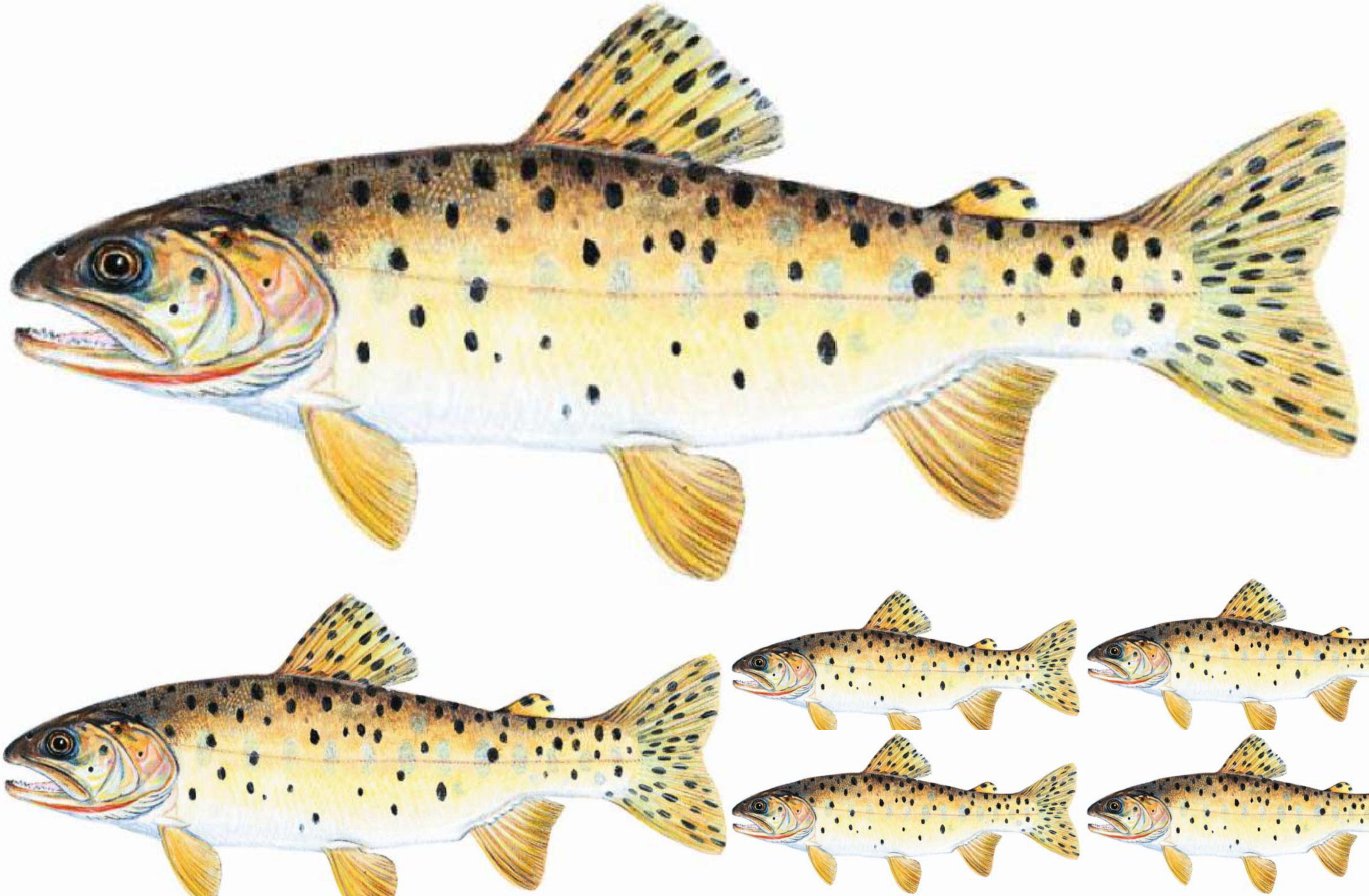
Criteria for selecting features to focus on at the workshop include: species, ecosystems or processes of ecological significance within the watershed; rare, imperiled or Colorado Division of Wildlife Tier I species; species of concern; availability of information; particular vulnerability to climate change; and potential for development of adaptation strategies. A short description of each of these features is below.

Gunnison sage-grouse:
The largest known population of the Gunnison sage-grouse, only known from southwestern Colorado and southeastern Utah, occurs in the Gunnison Basin. The grouse's priority habitats include montane sagebrush shrublands and riparian meadows. The Gunnison sage-grouse is ranked as critically imperiled by NatureServe/Colorado Natural Heritage Program, and is a Colorado Division of Wildlife Tier I species. Other imperiled species and/or species of concern inhabiting the sagebrush shrublands include Gunnison's prairie dog, Brewer's sparrow, Green-tailed towhee, Vesper's sparrow, Sage thrasher, Rollin's twinpod, skiff milkvetch and Gunnison milkvetch.

Gunnison headwaters:
The Gunnison headwaters include the upper watershed of the Gunnison River above the junction with Beaver Creek. Primary tributaries include East River, Ohio Creek, Taylor River, Tomichi Creek, Los Pinos Creek, and South Beaver Creek. These rivers and streams support riparian woody riparian vegetation. Associated imperiled species and/or species of concern inhabiting the headwaters include Colorado River cutthroat trout, boreal toad, Black Swift, and the Gunnison sage-grouse. The group will consider these "nested" species and ecosystems of conservation concern and the characteristics of the headwaters hydrologic regime that are important for maintaining them.

Alpine ecosystem:
The alpine ecosystem occurs above approximately 11,500 feet (timberline) and includes the highest peaks of the West Elk, Elk, Sawatch, and San Juan Mountains. Alpine habitats include dry alpine tundra, moist to wet alpine meadows, dwarf shrublands, fell-fields, talus slopes, snow and ice fields, and krummholz. These are cold wind-swept environments much of the year and receive intense ultraviolet radiation. For the purposes of this workshop, we will also include the transition zone between the alpine and subalpine zone (e.g., subalpine meadow/tree-line interface) because of potential shifts in plant and animal species. Associated imperiled species and/or species of concern include American pika, yellow-bellied marmot, Uncompahgre fritillary, Colorado tansy-aster, White-tailed Ptarmigan, Brown-capped Rosy Finch, and Rocky Mountain bighorn sheep. Wolverines were historically present.

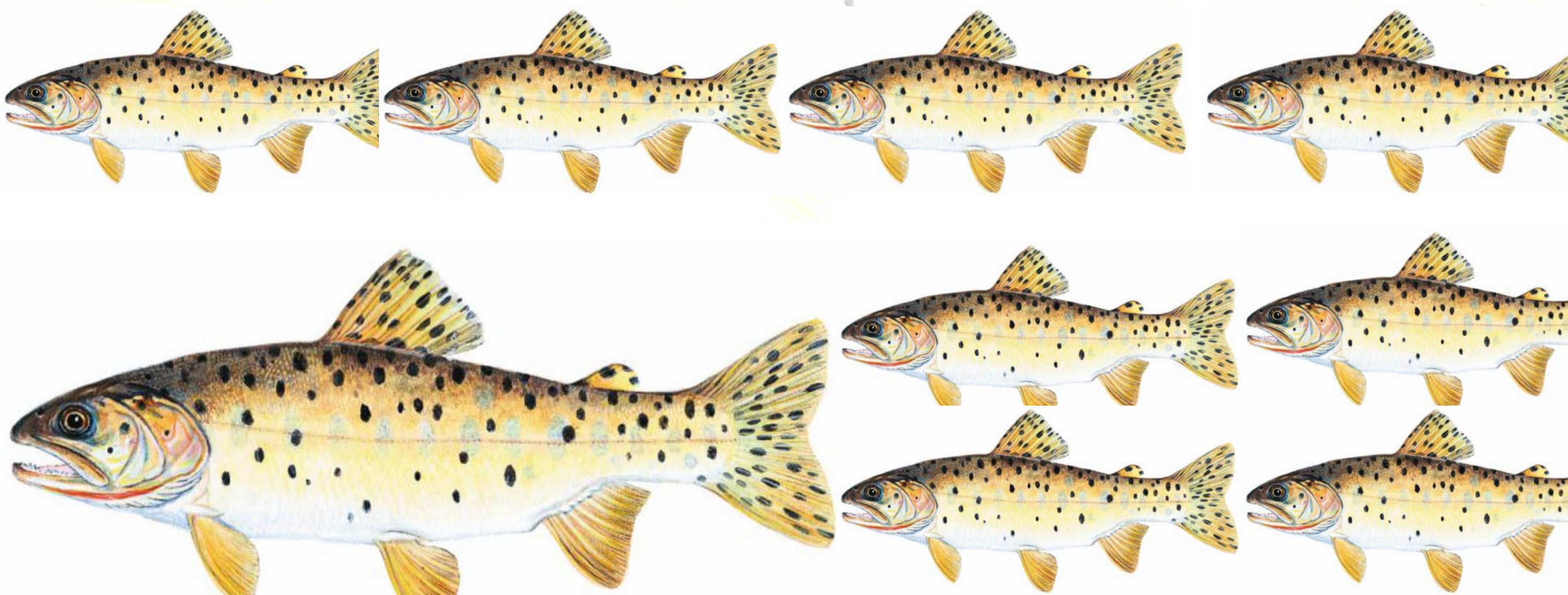
Oncorhynchus clarki utah



Oncorhynchus clarki utah

Bonneville Cutthroat Trout

Facilitators: Patrick McCarthy and Gregg Garfin

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Bear River Wetlands

Facilitators: Molly Cross, Dave Gori

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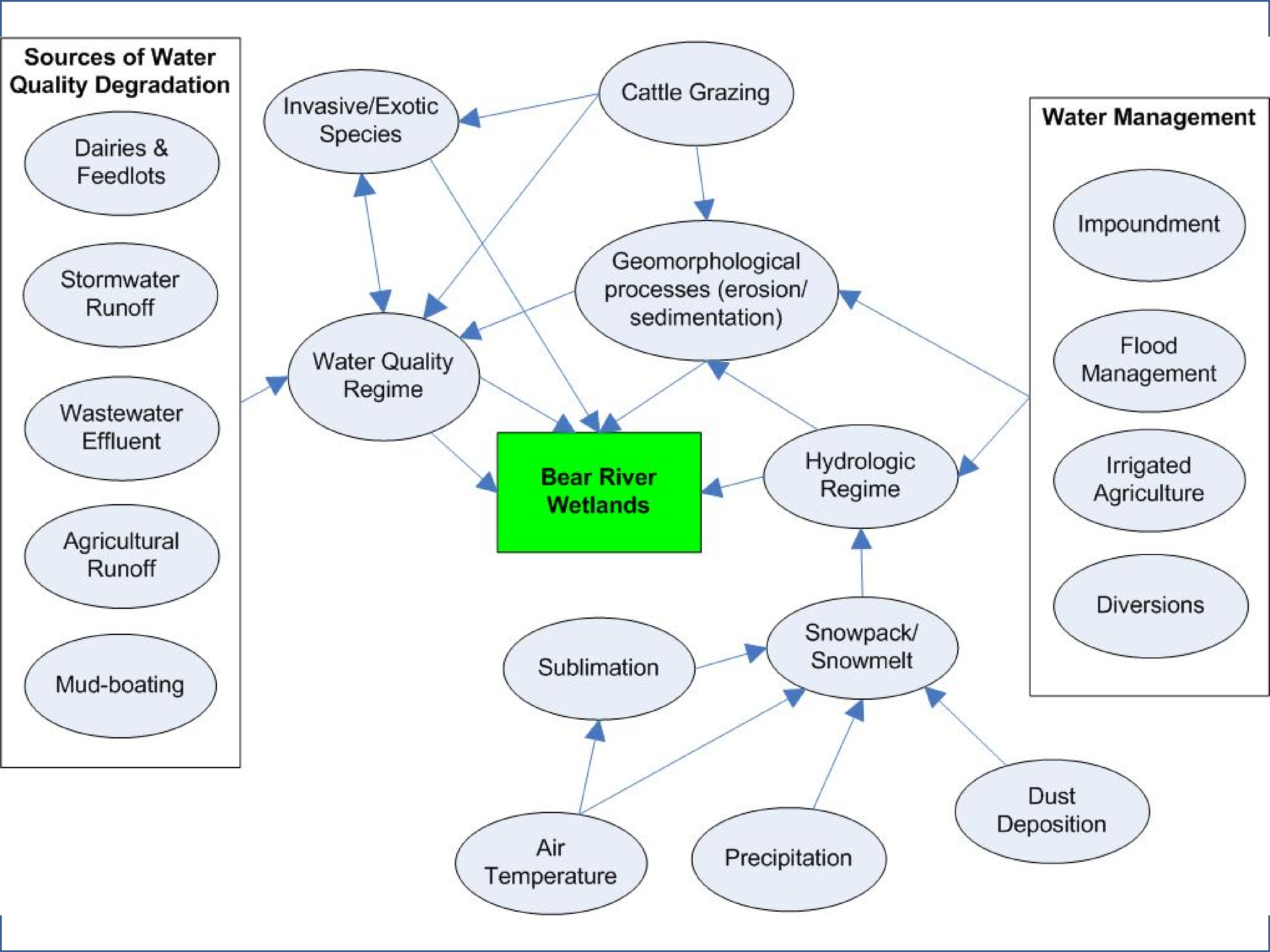

Sources of Water Quality Degradation
Dairies & Feedlots
Stormwater Runoff
Wastewater Effluent
Agricultural Runoff
Mud-boating
Invasive/Exotic Species
Cattle Grazing
Water Quality Regime
Geomorphological processes (erosion/ sedimentation)
Bear River Wetlands
Hydrologic Regime
Snowpack/ Snowmelt
Sublimation
Air Temperature
Precipitation
Dust Deposition
Water Management
Impoundment
Flood Management
Irrigated Agriculture
Diversions

Table 1 – Notebook Tab 5

Table 1. Climate Change Impacts (Hypotheses of Change): Bear River Climate Change Adaptation Workshop
Conservation Feature (circle): Bonneville Cutthroat Trout or Wetlands

Key Climate-Influenced Drivers/Effects (e.g., Physical, Ecological, Social, Economic)	Observed & Projected Climate Change Impact[1] (i.e., Hypotheses of Change)	Comments, Notes, Sources
Example: snowpack (for watershed function)	Warmer winter temperatures and decreased precipitation lead to significantly reduced snow pack and reduced summer base flows.(S1 & S2)	

S1, S2, S1+S2

[1] Indicate Scenario (see description in heading) the impact applies to: "S1" = Scenario #1 only, "S2" = Scenario #2 only, or "S1+S2" = both.

Table 2 – Notebook Tab 5

Table 2. Identification of Strategic Actions to Address Climate Change Impacts for Scenarios #1 and #2: Bear River Workshop
Conservation Feature (circle): Bonneville Cutthroat Trout or Wetlands
Management Objective: ______________________________

Observed & Projected Climate Change Impact[1] (Hypotheses of Change)	Intervention Point[1]	Scenario #1 Strategic Action (Planning Horizon: 2040-2060)	Scenario #2 Strategic Action (Planning Horizon: 2040-2060)	Level of Urgency / Priority	Opportunities to Implement
Warmer winter temperatures and decreased precipitation lead to significantly reduced snow pack and reduced summer baseflows.(S1 & S2)	Snowpack management	Manage forests as natural snow fences to slow snow melt and protect from sublimation caused by prevailing winds	Conduct selective thinning and planting to create a living snow fence for shade and snow accumulation, protection from wind	Medium to high	

[1]See list of Definitions in participants' packet.

10-15 year for actions to prepare for the 2040-2060 time frame

Climate and Hydro Scenarios – Notebook Tab 4

Climate Change Scenarios
Linda Mearns, National Center for Atmospheric Research & NARCCAP

Time frame: 2041-2070 compared to 1971-2000
Region: Bear River Basin (40°-44°N, 110°-114°W)
IPCC SRES Emissions Scenario: A2 ("medium-high emissions")

Background and Method
The climate change scenarios were constructed using a variety of information, including: regional probabilistic information generated using the CMIP3 (CMIP: Coupled Model Intercomparison Project) suite of over 20 global climate model results used in the IPCC Fourth Assessment Report (based on methods explained in Tebaldi et al. 2004, and 2005), results from Chapter 11 of the IPCC Working Group 1 Report (Christensen et al., 2007), and some results from the NARCCAP (North American Regional Climate Change Assessment Program) regional climate model simulations (Mearns et al., 2009). The emissions scenario considered for the probabilistic information and for NARCCAP is the A2, a medium high scenario. However, for Chapter 11 of IPCC the A1B scenario, a lower (middle) emissions scenarios, was emphasized. The time period for the future is roughly 2041-2070, compared to 30 years in the current period (1971-2000) for NARCCAP but further out in the century for the CMIP3 climate model results in the IPCC Chapter. For the regional probabilistic information the time periods are similar to those used in NARCCAP. The quatniles the probability distributions for temperature change and precipitation change are presented later in this document.

The quantiles of the probability distributions for temperature change and precipitation change (%) for annual and seasonal values for an area covering all of the Bear River Basin, for the A2 emissions scenario for around 2060, are used as the basis for choosing the Main Scenario. It is important to note that the distributions are based on multiple models, and other sources cited above are also taken into consideration. Thus, the same percentile is not chosen for all seasons for both temperature and precipitation. Below, key quantiles are presented from these distributions to give the reader a sense of the spread across the model simulations.

Hydrologic Impacts of Climate Change Scenarios
Joseph Barsugli, Western Water Assessment & NOAA Earth System Research Laboratory

Background
The hydrologic scenarios are created from the temperature and precipitation changes chosen by Linda Mearns, by running these changes through a hydrology model to produce climate-altered flows and snowpacks for the Bear River. We consider only "natural" flows –unaltered by diversions and reservoir storage and are not able to address reaches of the river where groundwater interactions are important. Scenarios are referred to as "Main Scenario or Scenario 1" and "Alternative Scenario or Scenario 2."

Method ("delta method")
Historical temperature and precipitation data for 1915-2003 from the Hamlet and Lettenmaier (2005) gridded 1/8 degree (approx. 12 km or 7.5 mi.) dataset are input to the VIC (Variable Infiltration Capacity) hydrologic model to produce the baseline hydrology. The overall method simply adds the average projected change to data in the historic record. Historic temperatures are adjusted by adding the *difference* in temperature specified in the climate scenarios. Historic precipitation values are adjusted by the *percent change* specified in the climate scenarios. These adjusted meteorological sequences are then run through the hydrology model, producing climate-altered hydrologic sequences. The runoff and base (soil) flow were routed down the river network producing modeled streamflow. We will look at three tributary inflows and at the river basin as a whole.

Annual Natural Streamflow
The long term average "natural" flow in the basin decreases in both scenarios. The effect of warming alone would be to reduce flows by about 15-25%. However, the increases in the Winter (Main Scenario) and Spring (Alternative Scenario) precipitation somewhat compensates for the increases in evapotranspiration due to warmer temperatures.

Table 1. Streamflow changes in thousands of acre-feet

Streamflow Location	Base (Historic)	Main Scenario	Alternative
Uinta Headwaters (BEARH)	187	153 (-18.2%)	162 (-13.4%)
Smith Fork (SMITH)	130	124 (-4.6%)	120 (-7.7%)
Logan River (LOGAN)	411	384 (-6.6%)	392 (-4.6%)
Bear River cumulative (BEARC)	1810	1659 (-8.3%)	1691 (-6.6%)

Cheat Sheet – Tab 5

- Annual temperature: +3.5ºC (+6.3 ºF)
- Annual precipitation: +1.6%

Season	Precip %	Temp °C	Temp °F
Winter	+13	+2.5	+4.5
Spring	-6	+3.5	+6.3
Summer	-15	+4.5	+8.1
Fall	0	+3.5	+6.3

Climate Change Adaptation Framework – Tab 5

Climate Change Adaptation Framework

Gunnison Climate Change Workshop
Southwest Climate Change Initiative
December 2-3, 2009

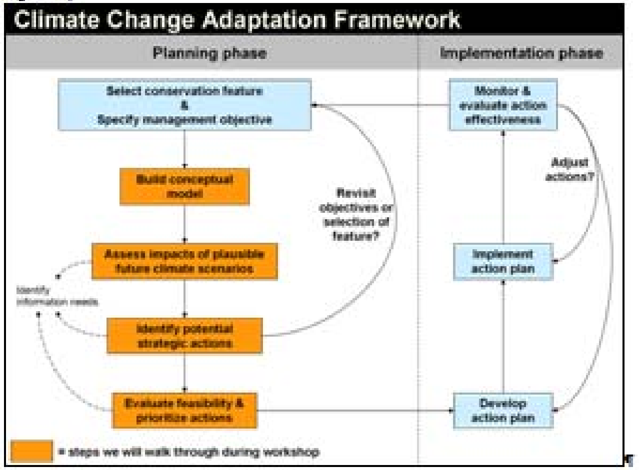
At the workshop, we will present an iterative framework for developing strategic actions for climate change adaptation*. The climate change adaptation framework is designed for collaborative application in a given landscape by a multidisciplinary group of managers, conservation practitioners and scientists, and includes the following steps (Figure 1):

1) **Select feature targeted for conservation** (e.g., species, ecological processes, or ecosystems) and **specify an explicit, measurable management objective** for that feature;
2) **Build a conceptual model** that illustrates the climatic, physical, ecological, and socio-economic drivers that affect the selected feature;
3) **Assess impacts of plausible future climate scenarios:**
    a. Use the conceptual model to assess climate change impacts (i.e., develop hypotheses of change) by examining how specific changes in climate variables might directly or indirectly influence the selected feature, for each scenario of future climate conditions being considered.
    b. Consider how human responses to climate change (e.g., solar and wind power development, construction of dams for increased water storage, etc.) may influence the selected feature.
    c. Assess the likely impact of climate change relative to other known impacts or threats, and identify which climate-induced impacts are most critical to address to achieve the stated management objective.
4) **Identify potential strategic actions in light of climate change:**
    a. Identify intervention points—those places in the system that we can influence through management and conservation actions.
    b. Brainstorm potential strategic actions that can be taken at those intervention points to achieve the stated objective under each climate scenario.
    c. Determine whether the management objective or the selection of the feature needs to be revisited: Does climate change fundamentally change the landscape? Do the management objectives for that feature need to change? Will the feature even be found in the same location in the future? Does our view of the landscape and boundaries need to change?

* The Climate Change Adaptation Framework presented here is adapted from Cross et al. (in prep.) (contact mcross@wcs.org *for a copy of the manuscript*) and The Nature Conservancy's "Conservation Action Planning Guidelines for Developing Strategies in the Face of Climate Change" (October 2009) *(included in workshop folders).*

5) **Evaluate feasibility of potential strategic actions and prioritize** according to factors such as: cost; social and political feasibility; potential for positive effects or risk of unintended negative consequences for other features or objectives; and robustness to uncertainty in future climate.
6) **Develop action plan** outlining priority strategic actions to be implemented.
7) **Implement action plan;**
8) **Monitor and evaluate action effectiveness** and progress toward objectives—adjust or reevaluate actions if needed to address system changes or ineffective actions.

Figure 1



Definitions – Notebook Tab 5

Gunnison Climate Workshop Definitions

1. **Adaptation to climate change:** An adjustment in natural systems in response to a changing climate in order to moderate adverse impacts or capitalize on novel opportunities (IPCC 2007). Adaptation involves anticipating the influence of climate change and using this information to make proactive choices to achieve objectives.

2. **Adaptive capacity:** The ability of a system to adjust, to moderate, to take advantage of, or cope with novel conditions (IPCC 2000). Enhancing an ecosystems adaptive capacity is an effort to reduce the systems vulnerability and/or strengthen its ecological resilience through management or mitigation.

3. **Adaptive strategies:** Three approaches to adaptive strategies are resistance, resilience, and enabling natural resources to respond to changes, e.g., improving habitat connectivity to enable species movement (the latter is the most proactive approach).

4. **Climate change impacts (hypotheses of change):** How climate change will specifically impact conservation features and their ecological attributes. Vulnerability of the systems-the combination or exposure and sensitivity of the ecology of the species or ecosystem (e.g., *significantly reduced snow pack will alter the spring and summer hydrologic flow regime for a riparian ecosystem*).

5. **Conceptual ecological model:** Illustration of the climatic, ecological, social and economic drivers that affect a selected species or ecosystem. A box and arrow diagram representing ecological relationships to help understand and communicate potential ecological impacts of climate change on conservation features.

6. **Driver:** An ecological element that causes a change in an organism, community, ecosystem, or other ecological component of the landscape.

7. **Exposure:** The degree, duration, and/or extent to which a system is in contact with a perturbation, often depicted by analysis of historic climate and future climate projection data (such as changes in

Participation & Interaction

Ground Rules

- Participate
- Don’t Dominate
- “Boss-Free Zone”
- Everyone advocates
  - but the team decides
- Cell phones off
- No email or side conversations
- Have Fun

Questions?

Climate Change Adaptation Framework