The Upper Snake River's Climate Future: Scenario Planning for Uncertainty

The interaction of both biophysical and social forces will drive climate-related change in the watershed

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Our changing climate, and the way society responds to those changes, will have long-term impacts on the health of the Upper Snake River ecosystem and to the human communities who rely on it.

To better understand how the linked social and ecological system might change, a group of 42 local experts, planners, researchers and practitioners in natural resource management and conservation gathered for an Exploratory Scenario Planning (XSP) workshop in April 2023. The aim was to collectively build a set of future scenarios about how the watershed might change under climate change, and to develop strategies that might be used to anticipate and adapt to those futures.

While we don't know which future scenario might prevail, planning for a range of probable futures can help mitigate the uncertainties posed by climate change to the linked social and biophysical processes.

The group participating in the Upper Snake River XSP workshop came from municipal, county, state and federal government agencies, non-profit organizations, and academia. Areas of specialization were also broad, including national park and national forest management, forest hydrology, fisheries biology, landscape ecology, wildfire response and management, urban and regional planning, emergency response, social science, public outreach, climate change, conservation, youth outreach and place-based education.

Detrimentally, the participants did not include several groups whose livelihoods are closely tied to the Snake River's health. This includes tribal nations who were dispossessed from the lands of the Upper Snake River, as well as ranchers and farmers, and immigrant communities.

What is driving changes to the Upper Snake River watershed and ecosystem?

The group began by looking at a set of variables that could drive change in the watershed. *Driving forces* are defined as things outside of one's control, that are uncertain, and that can affect the future. The list was built through a previous workshop with University of Wyoming researchers and a smaller group of stakeholders a few months earlier. Participants were asked to rank the driving forces in order of "importance," a term that was left up to individual interpretation.

While many biophysical variables, such as water flow, wildfire, and invasive species, were of significant concern to the group of local experts, *three of the top-ranked drivers are related to human and social processes.*

Table 1: Drivers of Change on the Upper Snake River, ranked by degree of importance

Rank *(votes)*	*Driving force* *(Ranking in 2nd exercise, see Table 2)*
1 (12)	• **Bureaucratic processes (7)**
2 (11)	• **Infrastructure** • **Land use and development** • **Water flow (1)**
5 (9)	• **Invasive/non-native species (2 and 8)** • **Wildfire (4 and 4)**
7 (7)	• **Snowpack (2)**
8 (6)	• **Population (4)**
9 (5)	• **Water temperature**
10 (3)	• **Drought**
12 (0)	• **Earthquakes** • **Floods** • **Jackson Lake management** • **Transportation** • **Visitation to national parks** • **Water pollution** • **Wildfire smoke**

Biophysical processes (black), Social processes (blue)

The group was particularly concerned with how

- **bureaucratic processes,**
- **infrastructure,**
- **land use/development** and
- **water flow**

will impact the Upper Snake River in the future.

It is also insightful to see the set of driving forces that did not receive any votes (left side of Table 1).

Next, the local expert group brainstormed specific ways that each driving force would impact their lives, the community, or the future of the Upper Snake River. The group collectively brainstormed more than 350 of these *future outcomes*. Again, they voted to select the future outcomes they saw as "most important."

Through a round voting, the group reached a high degree of consensus around the top three most important future outcomes:

- **Decreased ecological function, terrestrial and aquatic**
- **Changes in snowpack resulting in decreased water availability**
- **Shifting baseline for invasive/non-native species, creating management challenges**

A second tier of important future outcomes (lighter shading in Table 2) also garnered a fair degree of agreement among the workshop participants.[1]

Once the group started to think in tangible ways about the specific future outcomes that could result from each driving force, a different set of "most important" driving forces rose to the top, compared with the first exercise.

Two *new drivers* rose in importance:

- **Population,** not highly ranked in the first exercise, was linked to two top-ranked future outcomes in the second exercise.
- **Snowpack**, also not highly ranked in the first exercise, was tied to a top-ranked future outcome in the second exercise.

Table 2: The most important future outcomes of climate change to consider for the health of the Upper Snake River, ranked by participants

Rank *(votes)*	*Future outcome*	*Linked driving force* *(ranking in 1st exercise)*
1 (22)	**Decreased ecological function, terrestrial and aquatic**	**Water flow** (2)
2 (13)	▪ **Changes in snowpack, resulting in decreased water availability** ▪ **Shifting baseline, creating management challenges**	**Snowpack** (7) **Invasive/non-native species** (5)
4 (6)	▪ Increased prevalence of wildfire leads to dramatic vegetation changes ▪ Increased population pressure increases impacts to public land (intensity and seasonality) ▪ Reduced water quality and quantity	Wildfire (5) Population (8) Population (8)
7 (5)	Watershed coordination council formation	Bureaucratic processes (1)
8 (4)	Aquatic invasives impact native fish populations, decrease jobs	Invasive/non-native species (5)

Biophysical processes (black), social processes (blue)

[1] Voting was done with sticky dots in a group setting, not individually and privately. Therefore, some group think was likely involved, and we should not read too much into the exact number of votes.

Three drivers *remained clear top concerns*:

- **Water flow** was the first or second-ranking driver in both exercises.
- **Invasive/non-native species** remained an important concern, leading to two out of the 8 top-ranked future outcomes.
- **Bureaucratic processes** remained an issue of concern, although falling from top rank to a middle rank.

Two social drivers *fell in terms of importance:*

- **Infrastructure** and **land use/development**, social factors that were ranked highly in the first exercise, did not give rise to any top-ranked future outcomes.

Building future scenarios for the watershed

On day 2 of the workshop, WyACT[2] presented the group with a revised set of five future outcomes from which to build a set of scenario narratives. These five future outcomes that were selected aimed to build on local experiences and knowledge about the region's past, and to push the group to consider a wider range of possible futures than those that arose in the initial exercise. They were:

1. Frequent March rain-on-snow events cause regular flooding including three 500-yr floods and road damage by 2040. The early runoff causes summer flows to occasionally become intermittent in major tributaries.
2. In 2031, several 1988-style wildfires burn 600,000 acres including Jackson, JH Mountain Resort and transform the vegetation in a large portion of Grand Teton National Park.
3. Increased water temperatures lead to harmful cyanobacteria blooms and a dramatic cutthroat trout population crash.
4. In 2027, the State of Wyoming obtains ownership of National Forest lands, ultimately leading to 80% of the watershed becoming privately owned and increasing recreation pressure on remaining public lands.
5. New State and Federal budgets reduce flexibility to respond to new resource management needs, particularly in the context of existing infrastructure commitments and costs.

Some participants reported that they found the scenarios derived from the more extreme future outcomes so dire that it became difficult to engage in strategic thinking.

After another round of brainstorming and voting, scenario narratives were built from top-ranked combinations of these five future outcomes.[3] The narratives served as the basis for brainstorming strategies to address the future.

In total, the group came up with **more than 170 strategies**, ranging from strategies to address public education to new laws and regulations, building infrastructure, specific interventions onto the landscape, protecting particularly vulnerable areas, recommendations for further study or planning, new zoning and jurisdictional changes, suggestions for fundraising and financing, political and leadership strategies, and changing natural resource management practices.

Possible next steps could include:

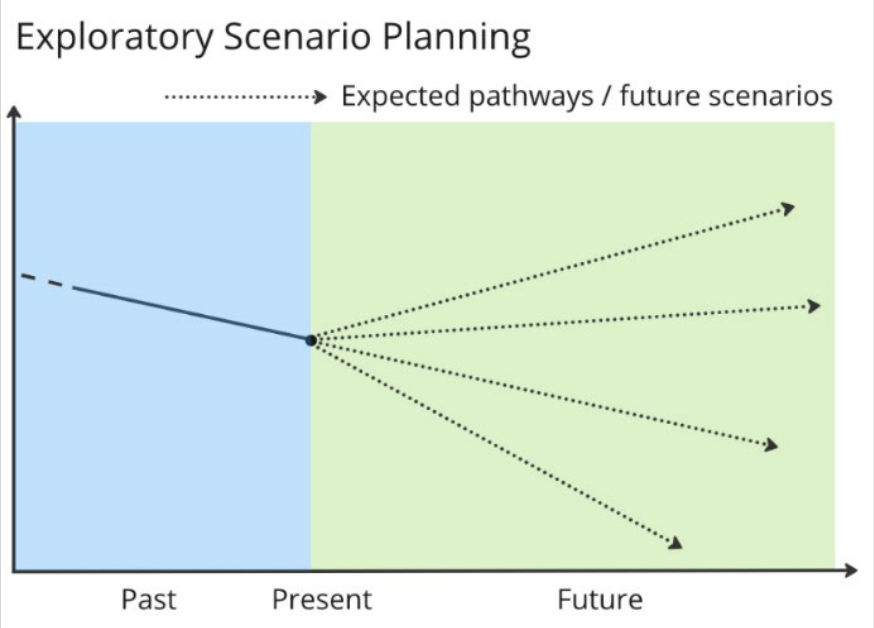
- Consider the specific **interactions and feedbacks** between each combination of top-ranking **biophysical and social driver**. Ultimately, these linkages will be key for understanding the socio-ecological system's resilience and building our adaptive capacity
- **Evaluate the 170+ strategies**. A common approach in XSP is to search for strategies that are robust (e.g. taking the action could be useful in preparing for more than one future), contingent (actions that only address one possible future), as well as those that may be low cost, no-regrets and "business as usual."
- **Clarify the sources of uncertainty about the future**. While climate change has some clear historic trends and future projections, there are many linkages and interactions in socio-ecological systems that introduce uncertainty about the future. Another futures-oriented exercise could consider the sources of uncertainty about the future from climate science, as well perceptions about uncertainty, to build scenario narratives and to develop strategies.

[2] WyACT: Wyoming Anticipating the Climate-Water Transition

[3] WyACT also introduced a final scenario narrative not related to the future outcomes: Jackson Hole becomes a climate refuge for those fleeing faster-warming temperatures in other places.

What is Exploratory Scenario Planning?

Exploratory Scenario Planning (XSP) is a medium- and long-term strategic planning tool in which stakeholders consider a range of futures that might plausibly occur, desirable or not, and come up with actions or strategies to anticipate and respond. The XSP process is particularly useful when the future is uncertain or difficult to predict. While we can't be sure which future will prevail, by anticipating a range of plausible futures, we can build greater resilience and capacity to adapt.



XSP is most useful at timescales of 30-50 years out, a typical planning horizon and also sweet spot for heightened uncertainty about the future under climate change. At this timescale, current climate trends may no longer hold, but long-term climate forecasting and modeling are most accurate at timescales of 100 years or more.

"Scenarios" are narratives about a possible future that represent external uncertainties beyond the control of the public or decision-makers. The XSP process is at its best when it involves a diverse group of participants who are able to bring a wide variety of experiences, knowledge systems and expertise into a group's thinking about the particular challenges associated with different futures, as well as the kinds of preemptory actions (strategies) that might be taken to mitigate and respond to those challenges.

Photos: Nichole Lumadue, at the XSP workshop, April 2023

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