USGS science for a changing world

NORTH CENTRAL Climate Adaptation Science Center

Climate Change Scenario Planning

Brian Miller, USGS, North Central Climate Adaptation Science Center

U.S. Department of the Interior
U.S. Geological Survey

Photo: Brian Miller

Key recent partners in scenario-based adaptation R&D:

Gregor Schuurman – NPS Climate Change Response Program

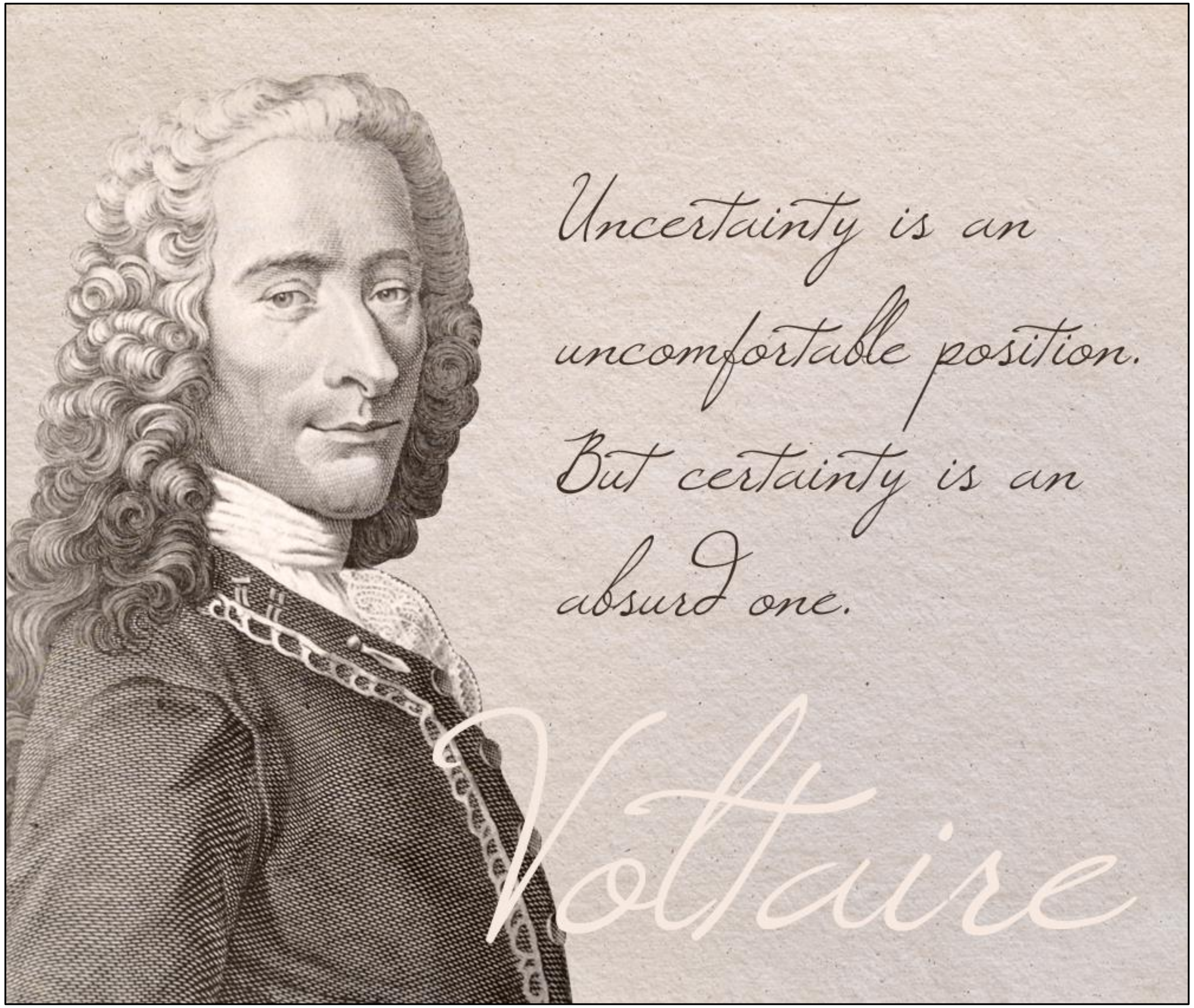
Amber Runyon – NPS Climate Change Response Program

Amy Symstad – USGS Northern Prairie Wildlife Research Center

Imtiaz Rangwala – University of Colorado, Boulder

Brecken Robb – Boise State University

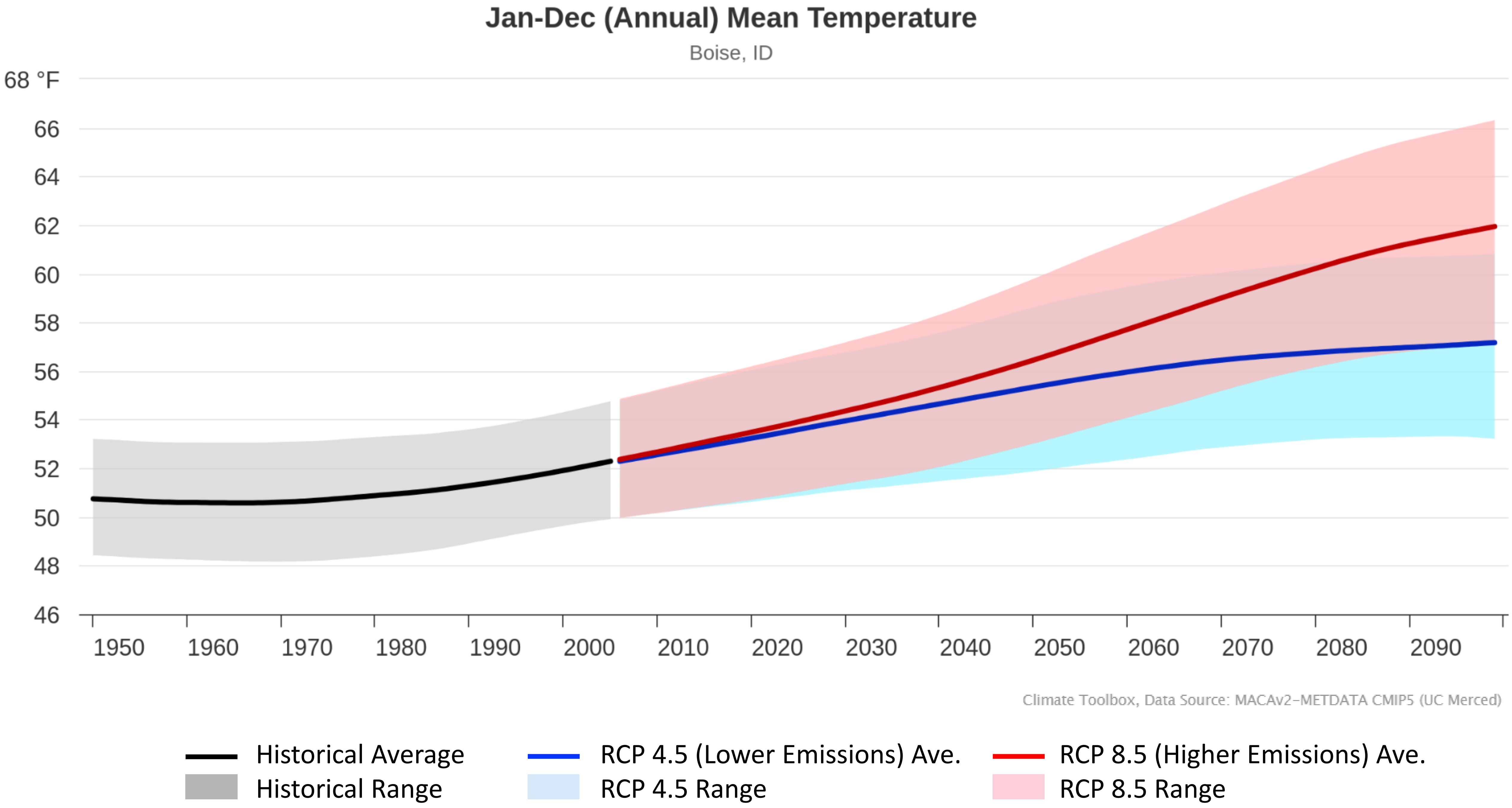
Part I

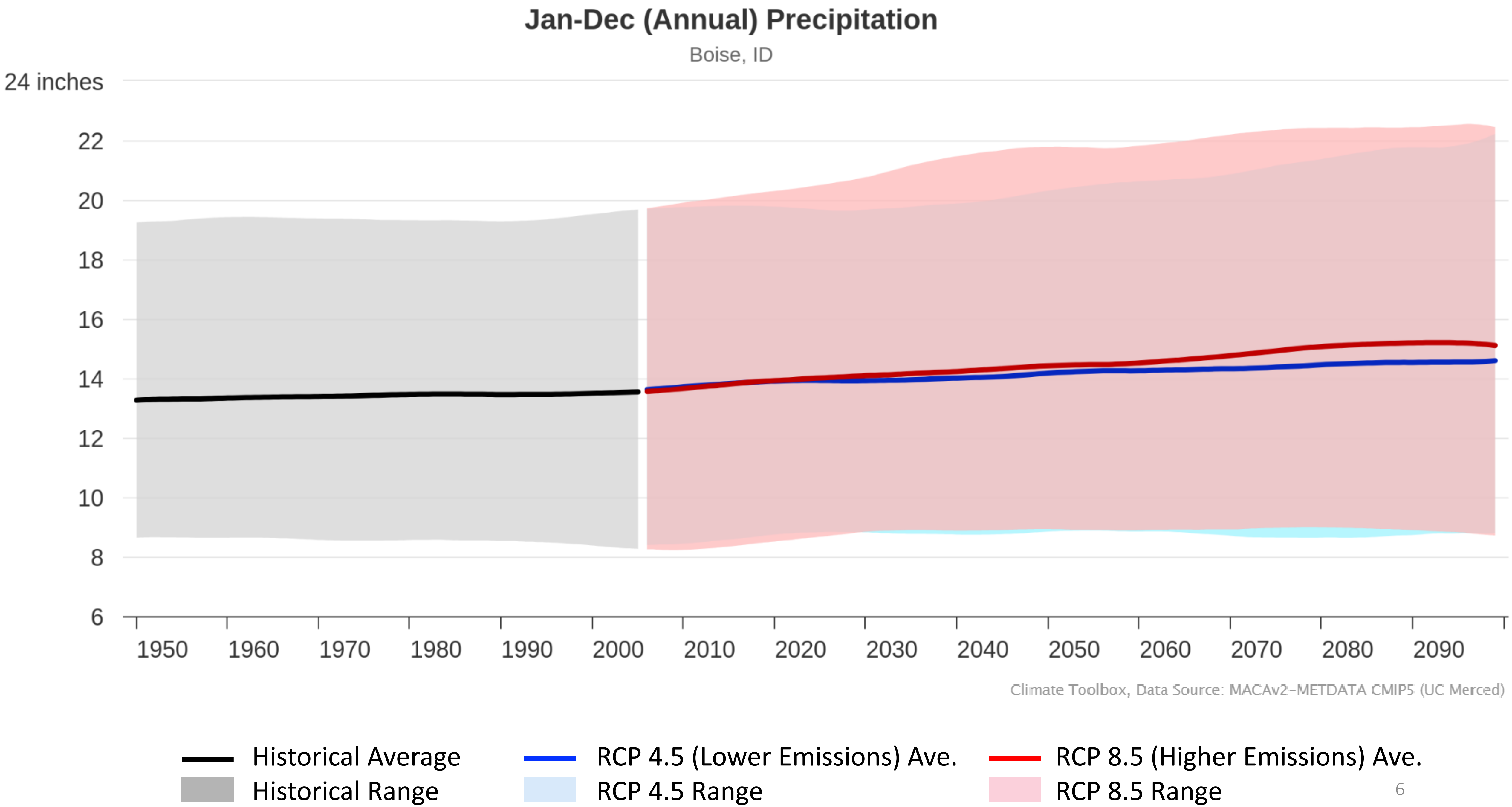

Uncertainty is an
uncomfortable position.
But certainty is an
absurd one.
Voltaire

https://www.theguardian.com/environment/2021/jul/08/heat-dome-canada-pacific-northwest-animal-deaths

https://www.nytimes.com/2022/06/15/us/yellowstone-national-park-floods.html

https://theconversation.com/rocky-mountain-forests-burning-more-now-than-any-time-in-the-past-2-000-years-162383

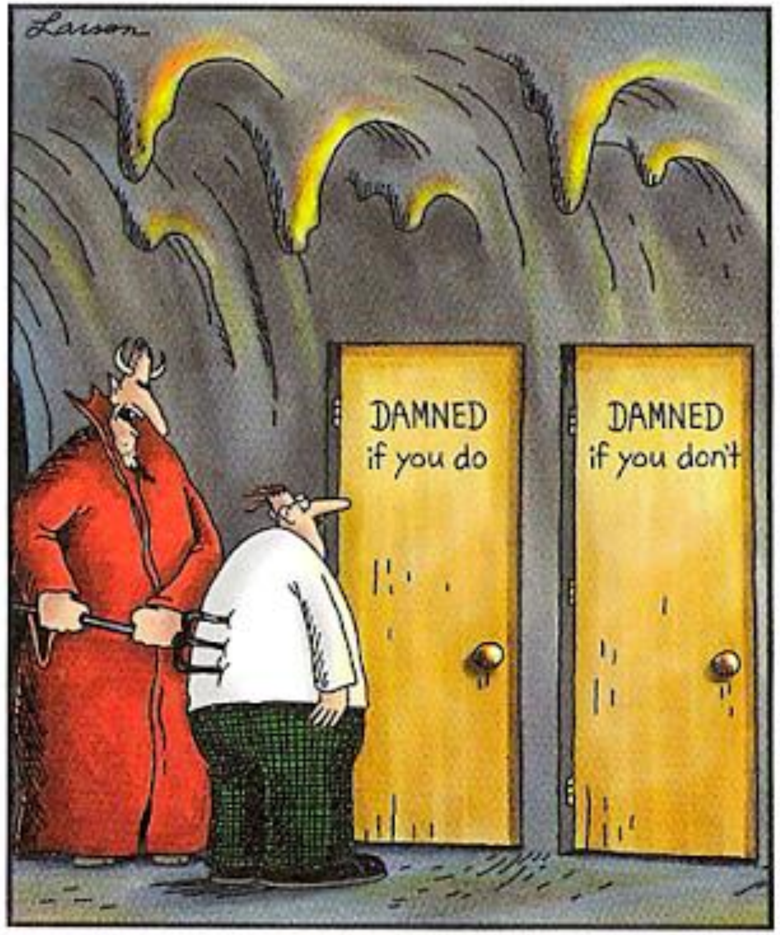

Jan-Dec (Annual) Mean Temperature
Boise, ID
68 °F
66
64
62
60
58
56
54
52
50
48
46
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
Climate Toolbox, Data Source: MACAv2-METDATA CMIP5 (UC Merced)
Historical Average
RCP 4.5 (Lower Emissions) Ave.
RCP 8.5 (Higher Emissions) Ave.
Historical Range
RCP 4.5 Range
RCP 8.5 Range



Jan-Dec (Annual) Precipitation
Boise, ID
24 inches
22
20
18
16
14
12
10
8
6
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
Climate Toolbox, Data Source: MACAv2-METDATA CMIP5 (UC Merced)
Historical Average
Historical Range
RCP 4.5 (Lower Emissions) Ave.
RCP 4.5 Range
RCP 8.5 (Higher Emissions) Ave.
RCP 8.5 Range

Despite uncertainty, resource managers need to make decisions and act to meet goals.

In a changing world with an uncertain future, how can we know what to do?



"C'mon, c'mon—it's either one or the other."

Image: Gary Larson
http://allyduncan.blogspot.com/2009/09/daily-lol-far-side-damned-if-you-do.html

Scenario planning!

Traditional planning

- Assumes the future will resemble the past
- Assumes high certainty in our ability to accurately predict the future
- Encourages a precise characterization of the future
- Leaves managers vulnerable to surprises in situations of high uncertainty

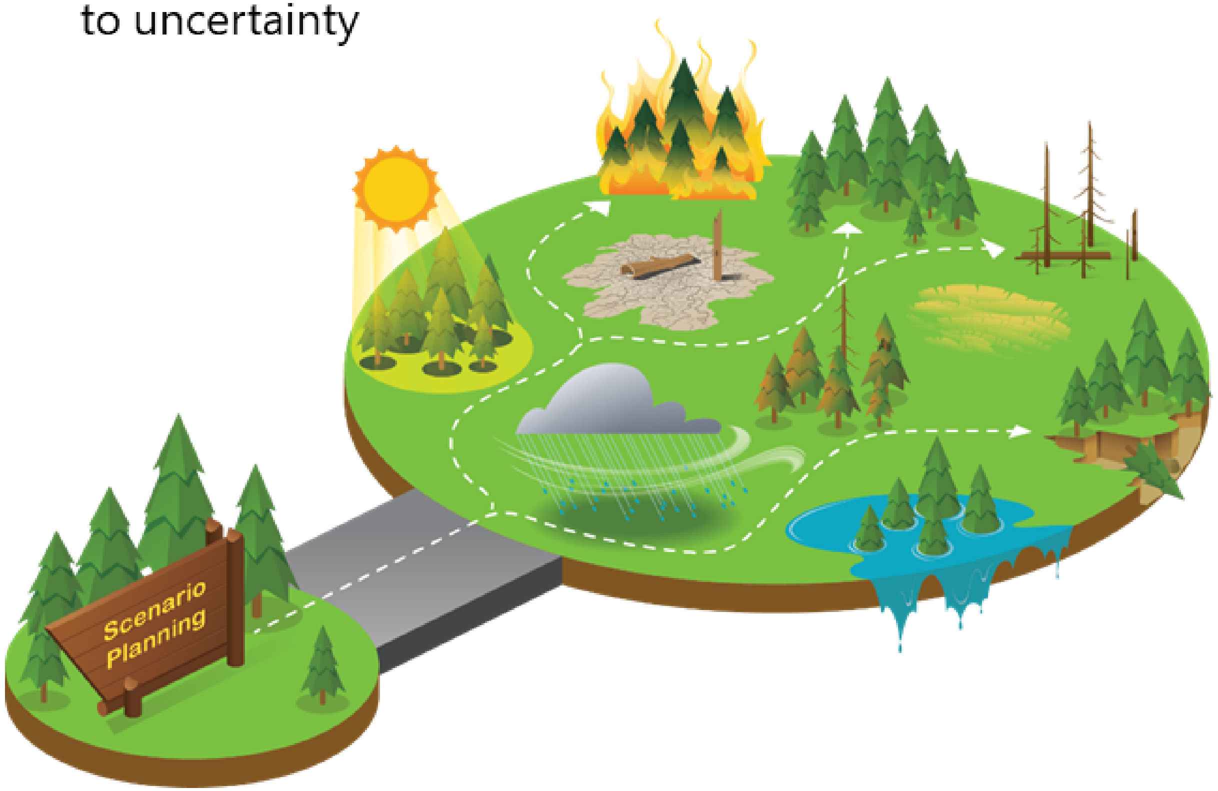
Schuurman et al. 2022 (Park Science)

Traditional planning

- Assumes the future will resemble the past
- Assumes high certainty in our ability to accurately predict the future
- Encourages a precise characterization of the future
- Leaves managers vulnerable to surprises in situations of high uncertainty

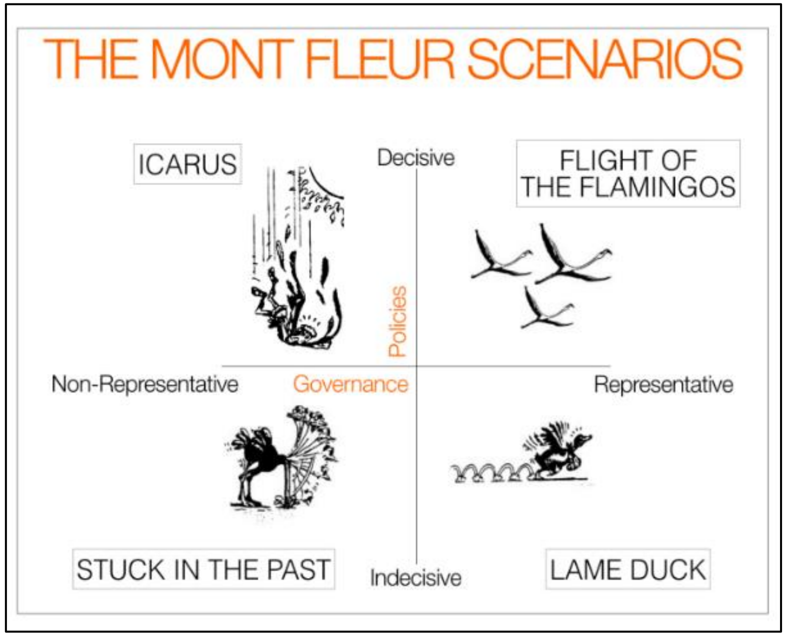
Scenario planning

- Assumes the future will likely differ from the past
- Recognizes uncertainty and asks "what might happen?" in a rigorous and structured way
- Encourages broad and open-minded exploration of future possibilities and surprises
- Helps managers identify strategies that are robust to uncertainty

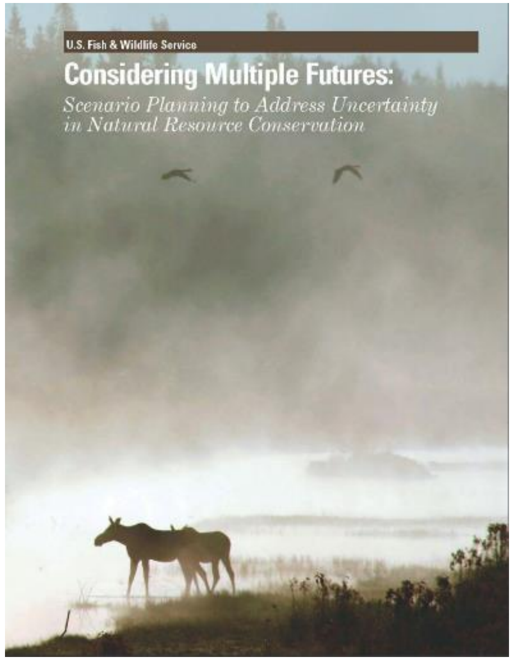


Schuurman et al. 2022 (Park Science)

Scenario Planning



By Konstantin Von Wedelstaedt [GFDL 1.2]



By Sai Saketh [CC-BY-SA-4.0]

Images: Wikimedia Commons; Scupelli, P., Wasserman, A. and Brooks, J., 2016. Dexign futures: a pedagogy for long-horizon design scenarios

Scenario Planning


Ken Teegardin

Ian Muttoo


Bart Everson

Betty Frankenfield Retirement

Images: Wikimedia Commons

Bob Krumenaker, Superintendent, Big Bend National Park

"We need to understand, *not what 'the' future will look like*, because nobody can predict that, but we do need to understand the range of possible futures"

Slide: Dave Lawrence, NPS

USGS
science for a changing world

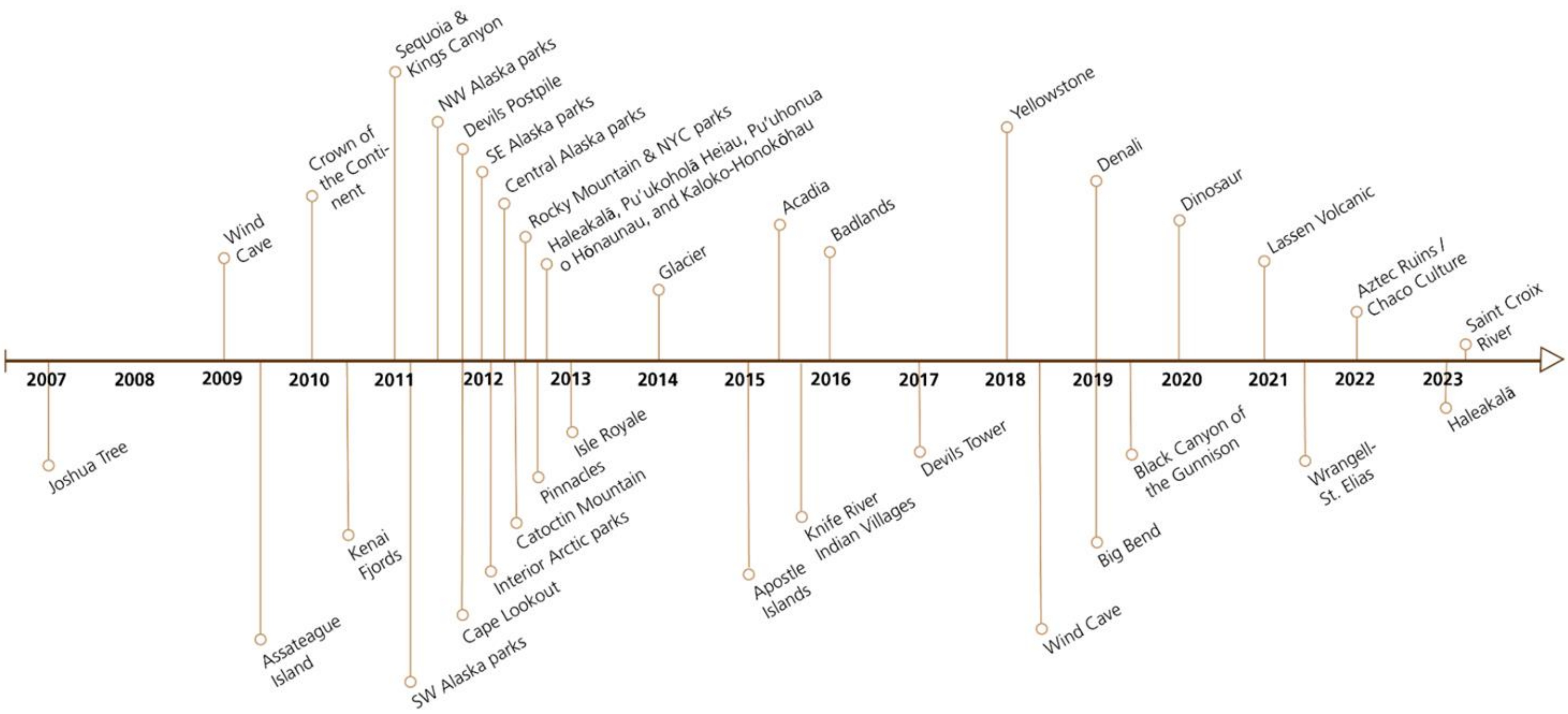
Using Information From Global Climate Models to Inform Policymaking—The Role of the U.S. Geological Survey

By Adam Terando, David Reidmiller, Steven W. Hostetler, Jeremy S. Littell, T. Douglas Beard, Jr., Sarah R. Weiskopf, Jayne Belnap, Geoffrey S. Plumlee

Open-File Report 2020–1058

“Examining a range of projected climate outcomes based on multiple scenarios is a recommended best practice…”

NPS Scenario-Based Climate Change Adaptation Timeline



NPS Scenario-Based Climate Change Adaptation Showcase: https://www.nps.gov/subjects/climatechange/scenarioplanning.htm

“We share… a robust model of streamlining and mainstreaming of CC SP in diverse decision-making processes…

[This] model…was developed in a partnership between the NPS and the USGS across more than 15years in a series of applications in dozens of park units involving hundreds of federal, tribal, state, and local-government participants, including US Forest Service field staff.”

--Reynolds et al. 2024

Reynolds, J.H., Miller, B.W., Schuurman, G.W., Carr, W.A., Symstad, A.J., Gross, J.E. and Runyon, A.N., 2024. Accurately Characterizing Climate Change Scenario Planning in the US National Park Service: Comment on Murphy et al. 2023. *Society & Natural Resources*, pp.1-6.

CONTRIBUTED PAPER

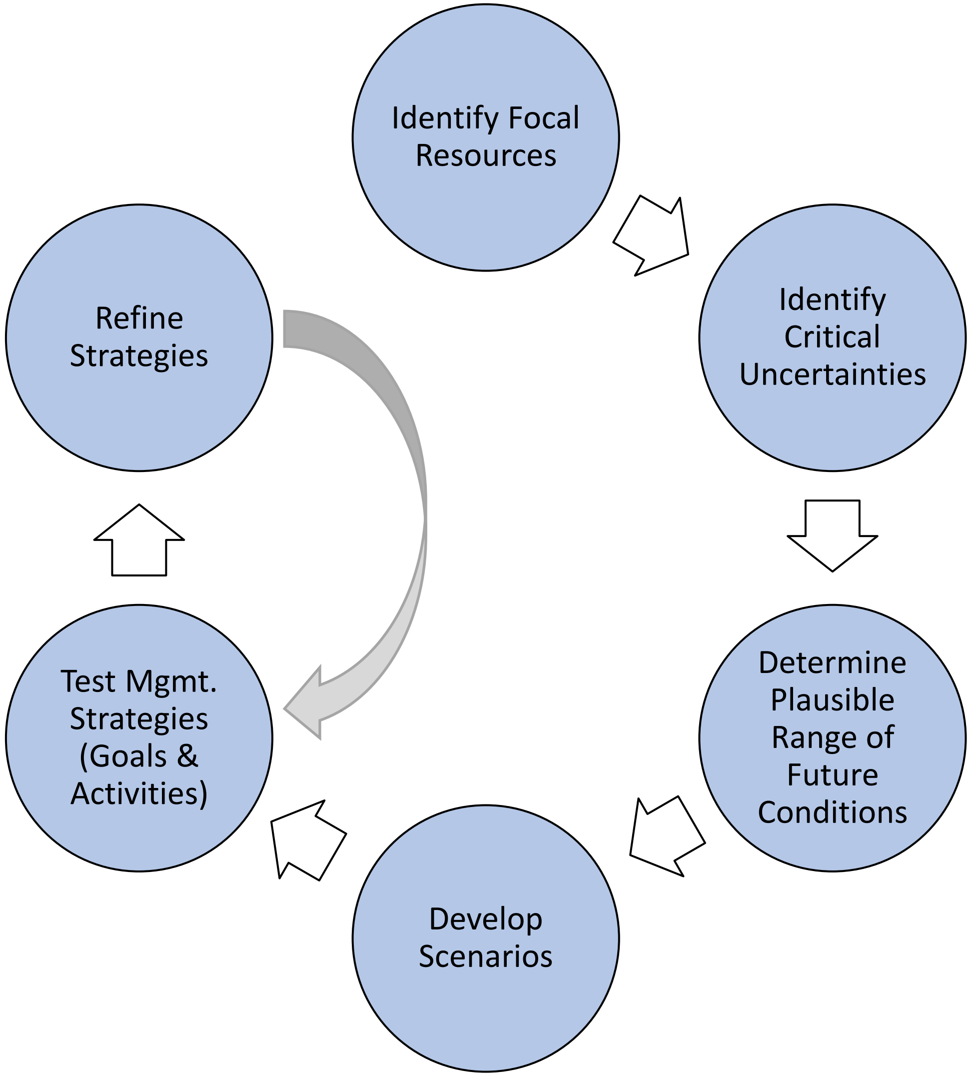
Conservation Science and Practice
A journal of the Society for Conservation Biology
Open Access
WILEY

Conservation under uncertainty: Innovations in participatory climate change scenario planning from U.S. national parks

Brian W. Miller[1] | Gregor W. Schuurman[2] | Amy J. Symstad[3] | Amber N. Runyon[2] | Brecken C. Robb[4]

Generalized CC SP Approach

Generalized CC SP Approach



Miller BW, Schuurman GW, Symstad AJ, Runyon AN, Robb BC. 2022. Conservation under uncertainty: Innovations in participatory climate change scenario planning from US national parks. *Conservation Science and Practice*: e12633.

Identify Focal Resources

Miller BW, Schuurman GW, Symstad AJ, Runyon AN, Robb BC. 2022. Conservation under uncertainty: Innovations in participatory climate change scenario planning from US national parks. *Conservation Science and Practice*: e12633.

Badlands NP


Brian Miller


Amy Symstad


Brian Miller


NPS


NPS


NPS


Amy Symstad

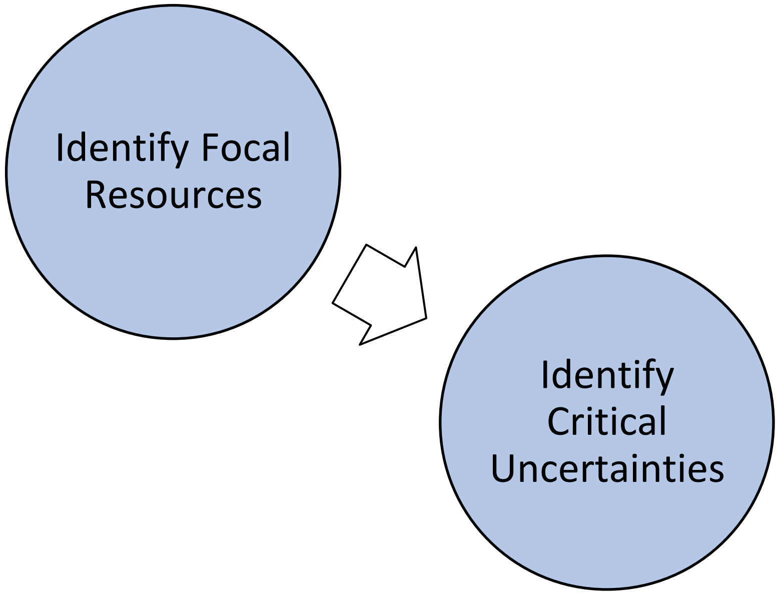

NPS


NPS

Badlands NP

Focal Resources

- Grasslands & grazing
- Infrastructure
- Paleo & archaeological resources
- Threatened and endangered species



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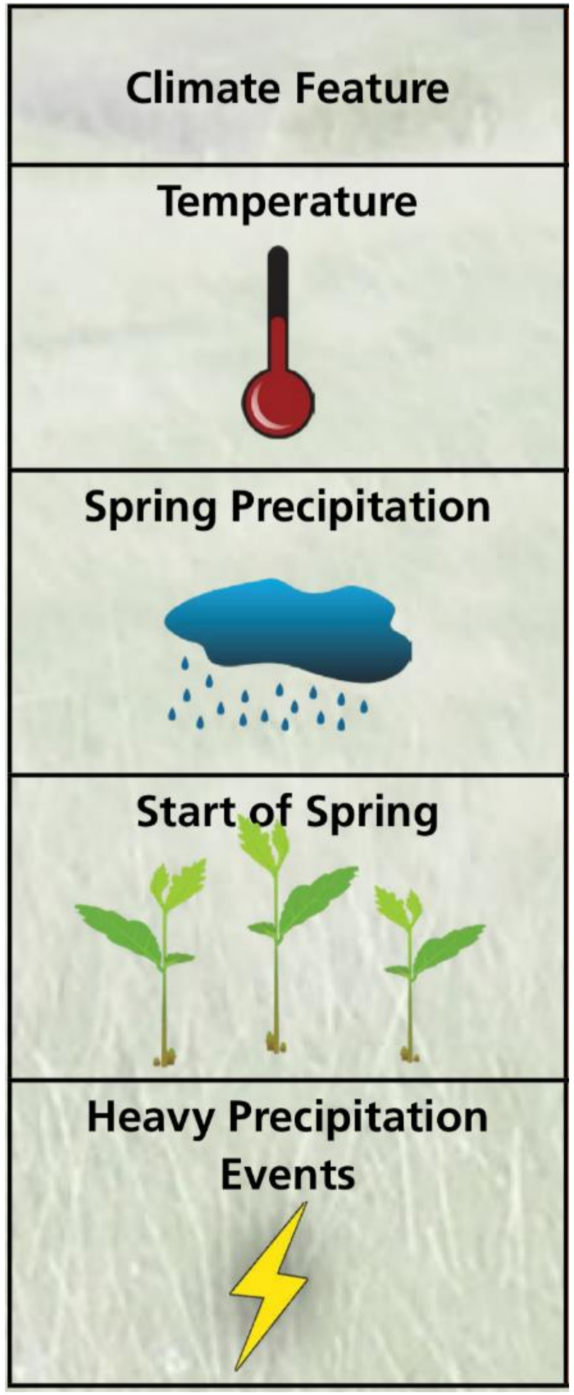
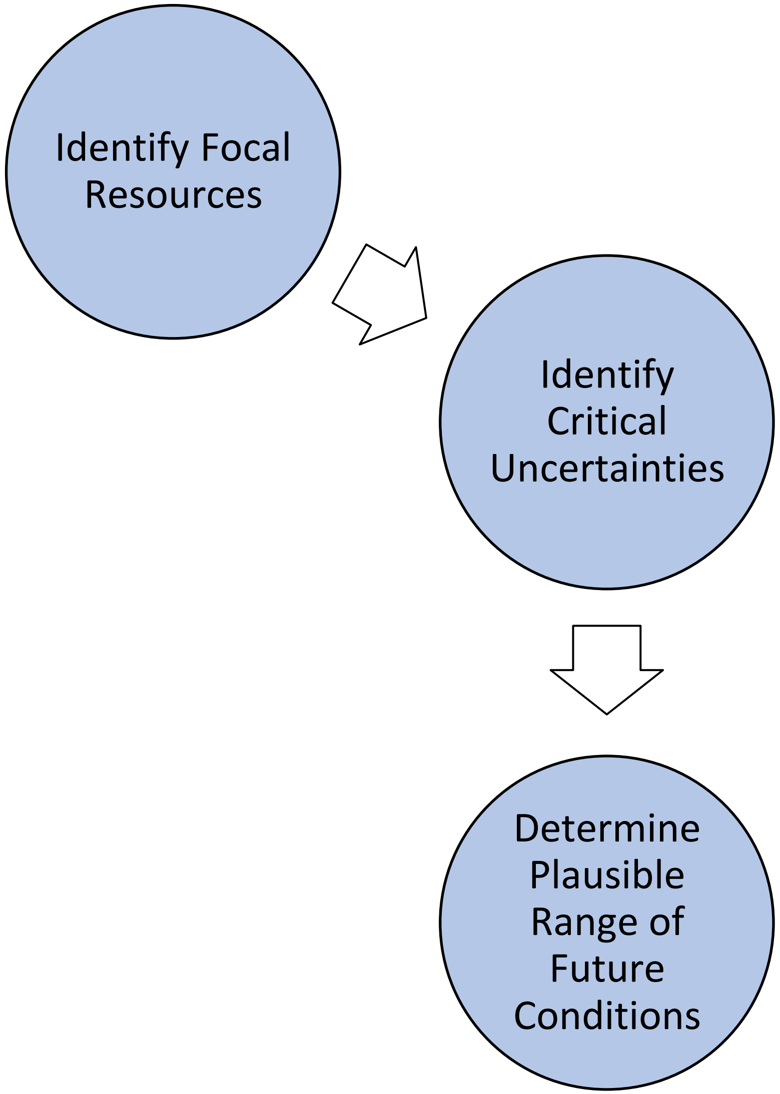


Miller BW, Symstad AJ, Schuurman GW,. 2019. Implications of Climate Change Scenarios for Badlands National Park Resource Management. Resource Brief, National Park Service Resource Brief. Fort Collins, CO.

Climate Sensitivity			Water		Vegetation					Cultural					Wildlife				Other	
Tier	Climate driver subclass	Specific climate metric	Ground water	Surface water	Prairie	Riparian vegetation	Forest complex	Rare plant species	Plants of Tribal collection interest	Archeological resources	Museum collections	Sanson ranch structures	CCC[*]-era structures	Mission 66 structures	Bison	BFF & BTPD	Elk	Bats	Air quality	Cave (micro-climate)
1	Winter temp	Winter (DJF) temps - average	m	m	m	m	m	m										H		H
2	Winter temp	Frequency/duration of temps below threshold													H		H	H		
2	Winter temp	Winter length																H		
2	Freeze-thaw	# days/year where Tmax > 34 °F & Tmin < 28 °F								m		H	H	H						
2	Freeze events	Late spring frost events							m									H		
2	Growing season	Growing season start date			H		H													
2	Growing season	Growing season end date			H		H													
2	Annual temp	Annual mean temp or Monthly mean temp	m	m		H	m													
1	Extreme precip	# days/yr that precip exceeds 99^{th}-percentile event (for 1950- 1999 historical period)	H	H		H				m			H					m		
2	Extreme precip	Size of extreme precipitation events	m	m		H				m			H							
2	Precip timing	Rain on frozen soil	H	H		H							H							
2	Precip timing	Rain on saturated soil	H	H		H							H							
2	Precip timing	Proportion of annual precip falling in fall & winter	H	H	H	m	m													
2	Precip timing	Periods of consecutive wet/dry days	m	H	H	m	H	m		H					m	m	m	m		
2	Snow	Number of snow-covered days per year					H													
1	Soil moisture	Apr-Jun Soil Moisture	H	H	H	H	H	H	m						m	H	m	m		
2	Drought	Drought frequency	m	H	H	H	H	H	m	H					H	H	H	H	H	

Runyon, A. N., G. W. Schuurman, B. W. Miller, A. J. Symstad, and A. R. Hardy. 2021. Climate change scenario planning for resource stewardship at Wind Cave National Park: Climate change scenario planning summary. Natural Resource Report NPS/NRSS/NRR—2021/2274. https://doi.org/10.36967/nrr-2286672



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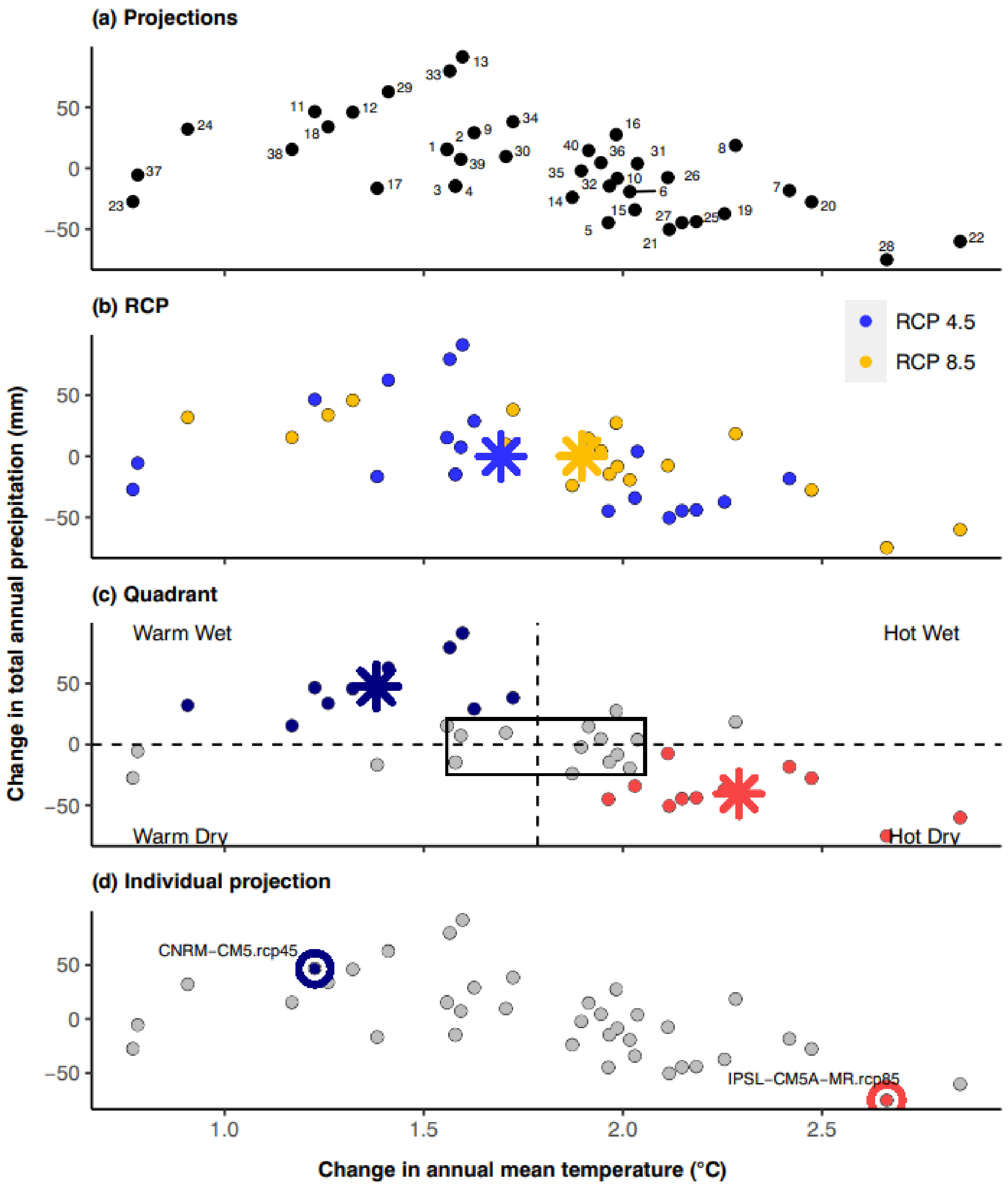
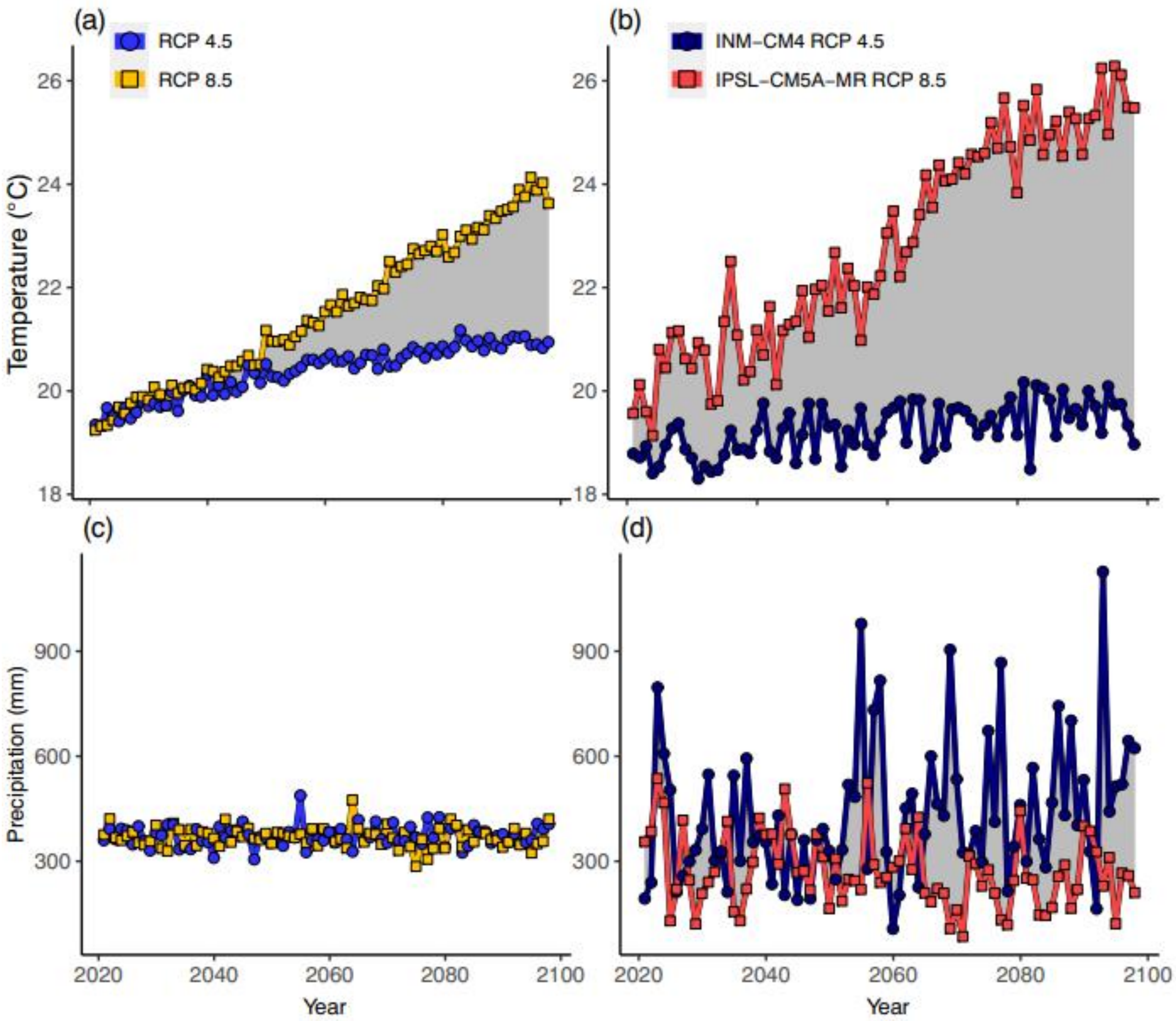
Climatic Change (2021) 167: 38
https://doi.org/10.1007/s10584-021-03169-y

Divergent, plausible, and relevant climate futures for near- and long-term resource planning

David J. Lawrence[1] • Amber N. Runyon[1] • John E. Gross[1] •
Gregor W. Schuurman[1] • Brian W. Miller[2]



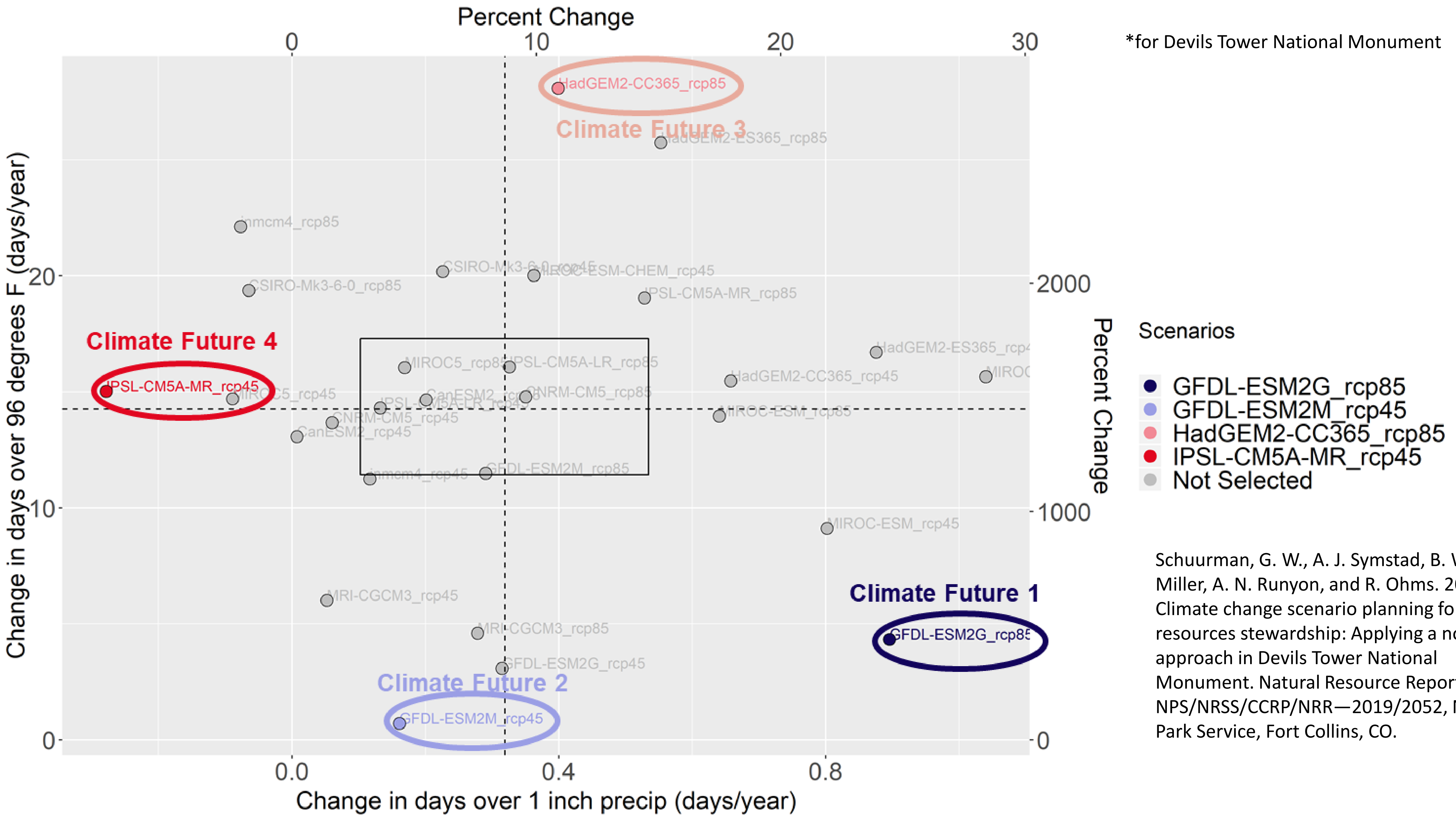
(a) Projections
(b) RCP
RCP 4.5
RCP 8.5
(c) Quadrant
Warm Wet
Hot Wet
Warm Dry
Hot Dry
(d) Individual projection
CNRM-CM5.rcp45
IPSL-CM5A-MR.rcp85
Change in total annual precipitation (mm)
Change in annual mean temperature (°C)



(a)
RCP 4.5
RCP 8.5
(b)
INM-CM4 RCP 4.5
IPSL-CM5A-MR RCP 8.5
Temperature (°C)
18
20
22
24
26
(c)
(d)
Precipitation (mm)
300
600
900
2020
2040
2060
2080
2100
Year

Changes in Extreme Precip. Events and Hot Days in 2040*

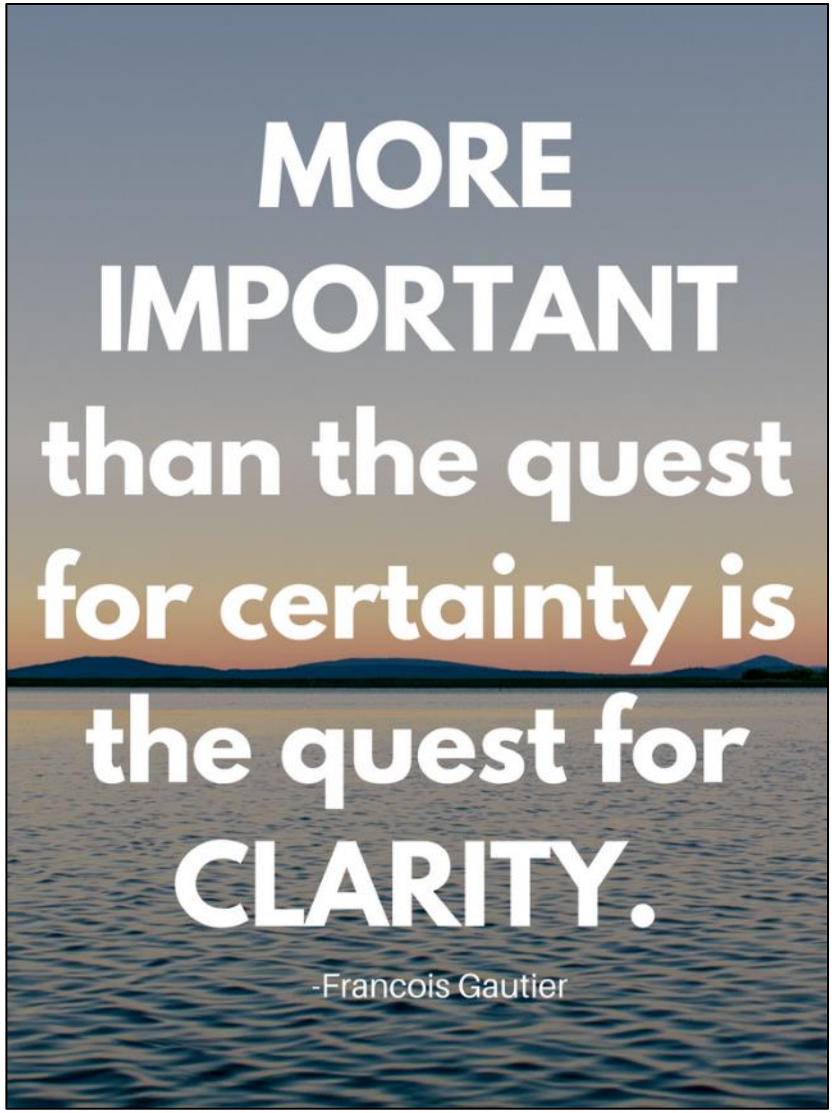
*for Devils Tower National Monument



Schuurman, G. W., A. J. Symstad, B. W. Miller, A. N. Runyon, and R. Ohms. 2019. Climate change scenario planning for resources stewardship: Applying a novel approach in Devils Tower National Monument. Natural Resource Report NPS/NRSS/CCRP/NRR—2019/2052, National Park Service, Fort Collins, CO.

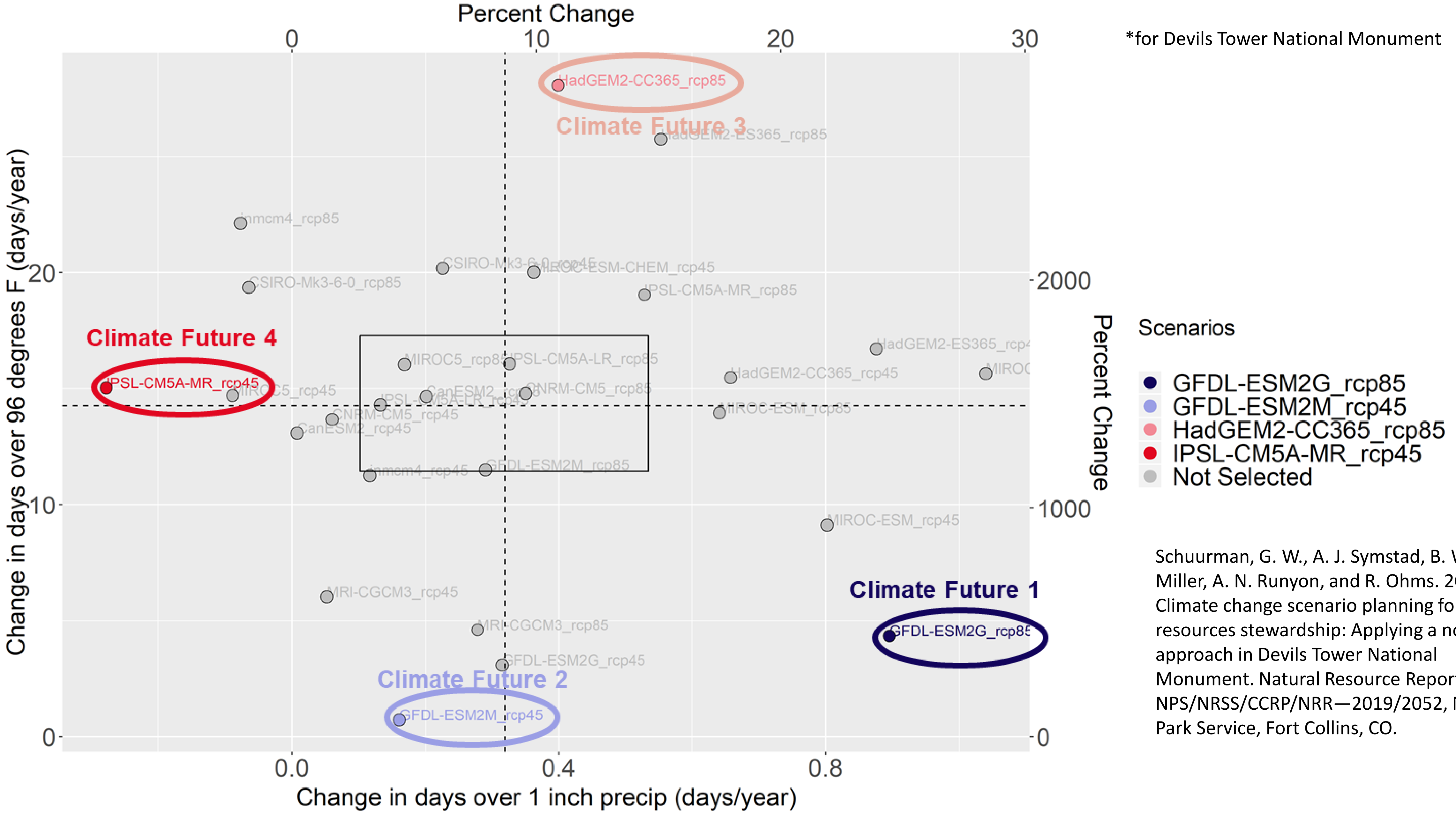
To be continued…

Part II


MORE
IMPORTANT
than the quest
for certainty is
the quest for
CLARITY.
-Francois Gautier

Changes in Extreme Precip. Events and Hot Days in 2040*

*for Devils Tower National Monument



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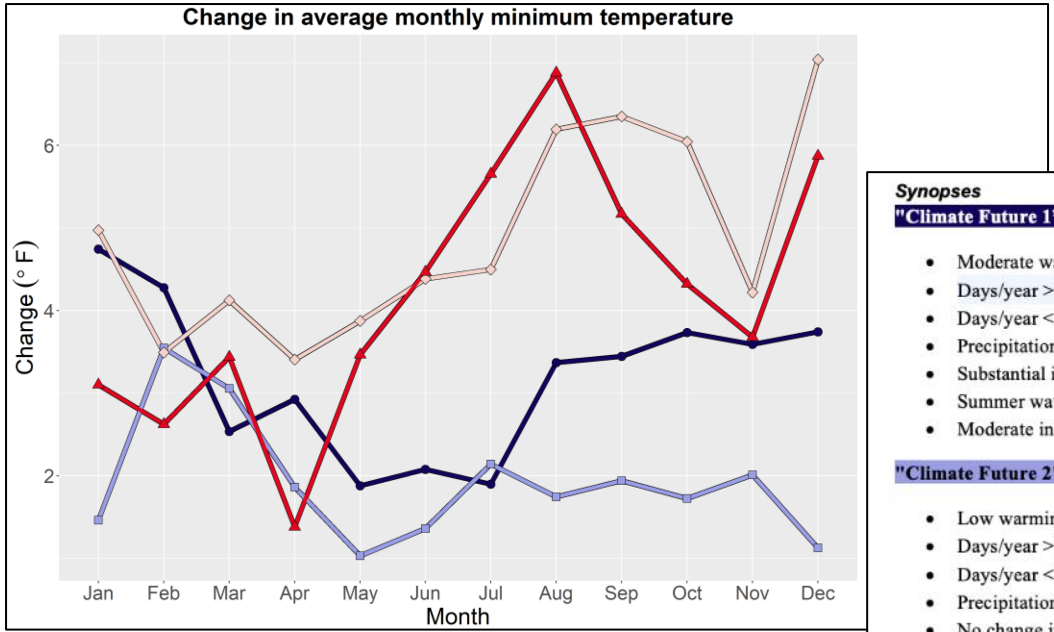
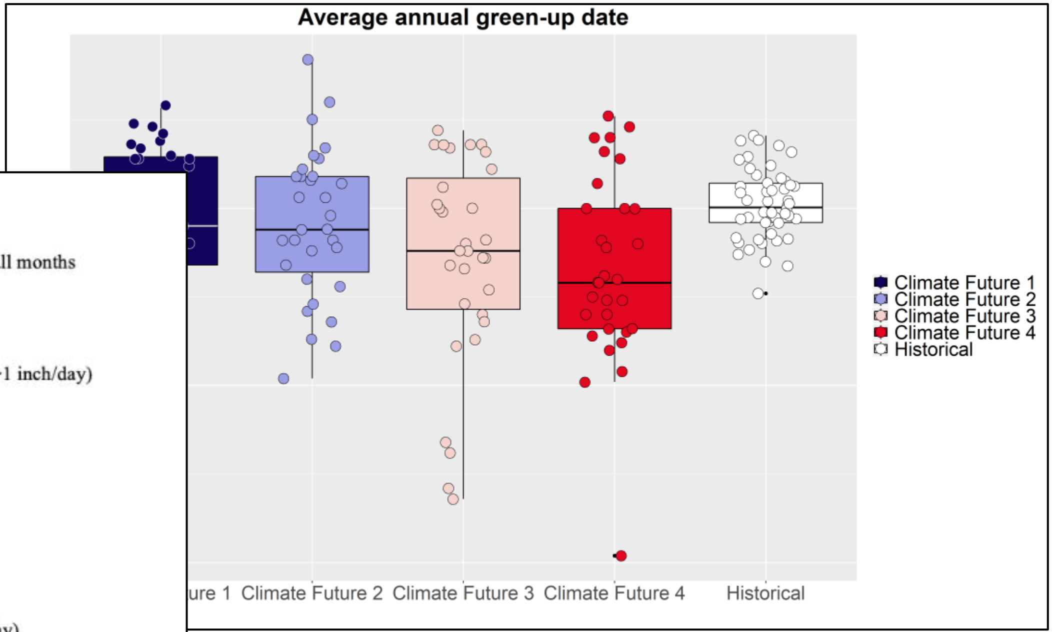




Synopses

"Climate Future 1"

- Moderate warming (+3 °F), with relatively constant change across all months
- Days/year >96 °F: 8 (4-day increase from historical)
- Days/year <32 °F: 167 (15-day decrease from historical)
- Precipitation increase in all seasons, highest in spring and summer
- Substantial increase in the frequency of large precipitation events (>1 inch/day)
- Summer water deficit decreases slightly
- Moderate increases in spring soil moisture

"Climate Future 2"

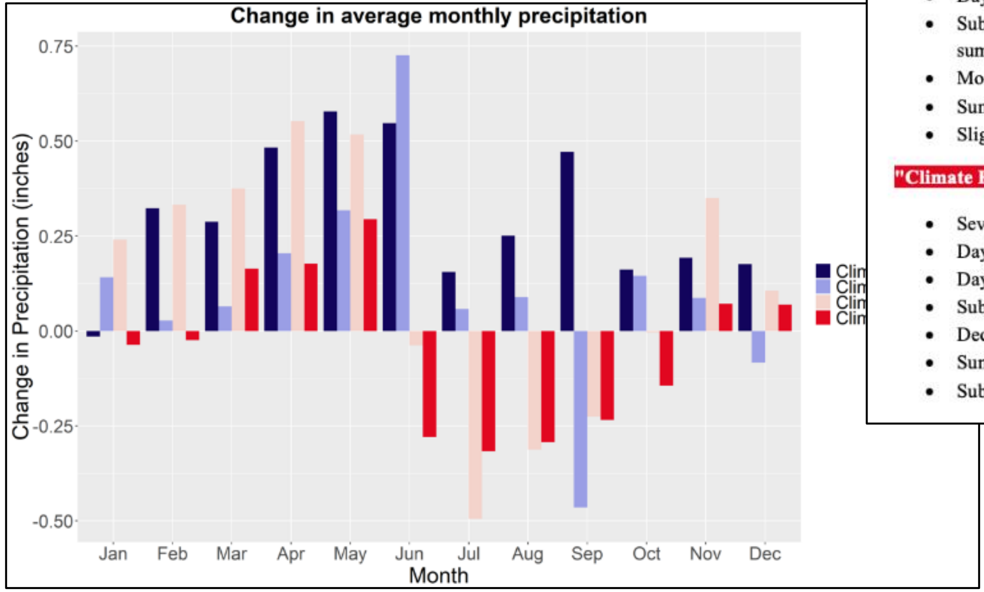
- Low warming (+2 °F), most strongly in early spring
- Days/year >96 °F: 5 (1-day increase from historical)
- Days/year <32 °F: 168 (14-day decrease from historical)
- Precipitation increases in all seasons except fall
- No change in the frequency of large precipitation events (>1 inch/day)
- No change in summer water deficit
- Slight increase in early spring soil moisture

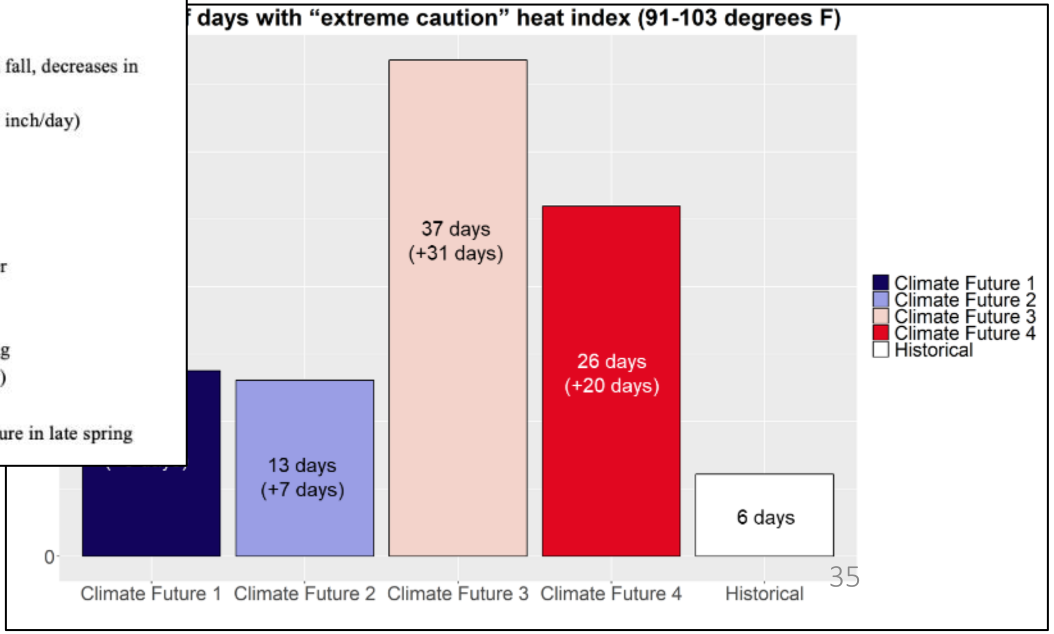
"Climate Future 3"

- Severe warming (+5 °F), most strongly in early spring
- Days/year >96 °F: 32 (28-day increase from historical)
- Days/year <32 °F: 151 (30-day decrease from historical)
- Substantial precipitation increases in spring, moderate in winter and fall, decreases in summer
- Moderate increase in the frequency of large precipitation events (>1 inch/day)
- Summer water deficit increases slightly
- Slight increase in spring soil moisture

"Climate Future 4"

- Severe warming (+4 °F), most strongly late spring and early summer
- Days/year >96 °F: 18 (15-day increase from historical)
- Days/year <32 °F: 161 (20-day decrease from historical)
- Substantial precipitation decreases in summer and increases in spring
- Decrease in the frequency of large precipitation events (>1 inch/day)
- Summer water deficit increases substantially
- Substantial decrease in late spring soil moisture with the least moisture in late spring





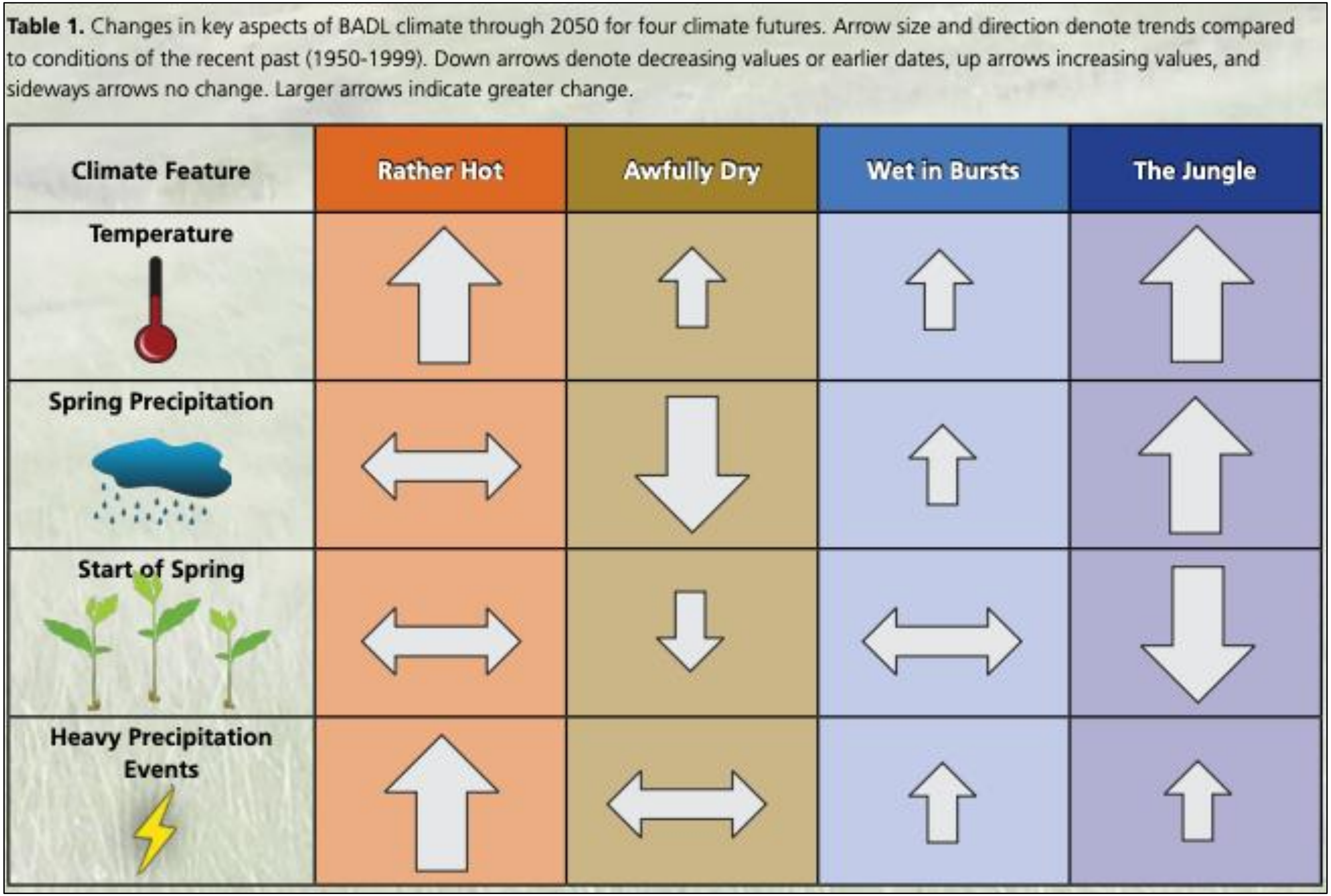
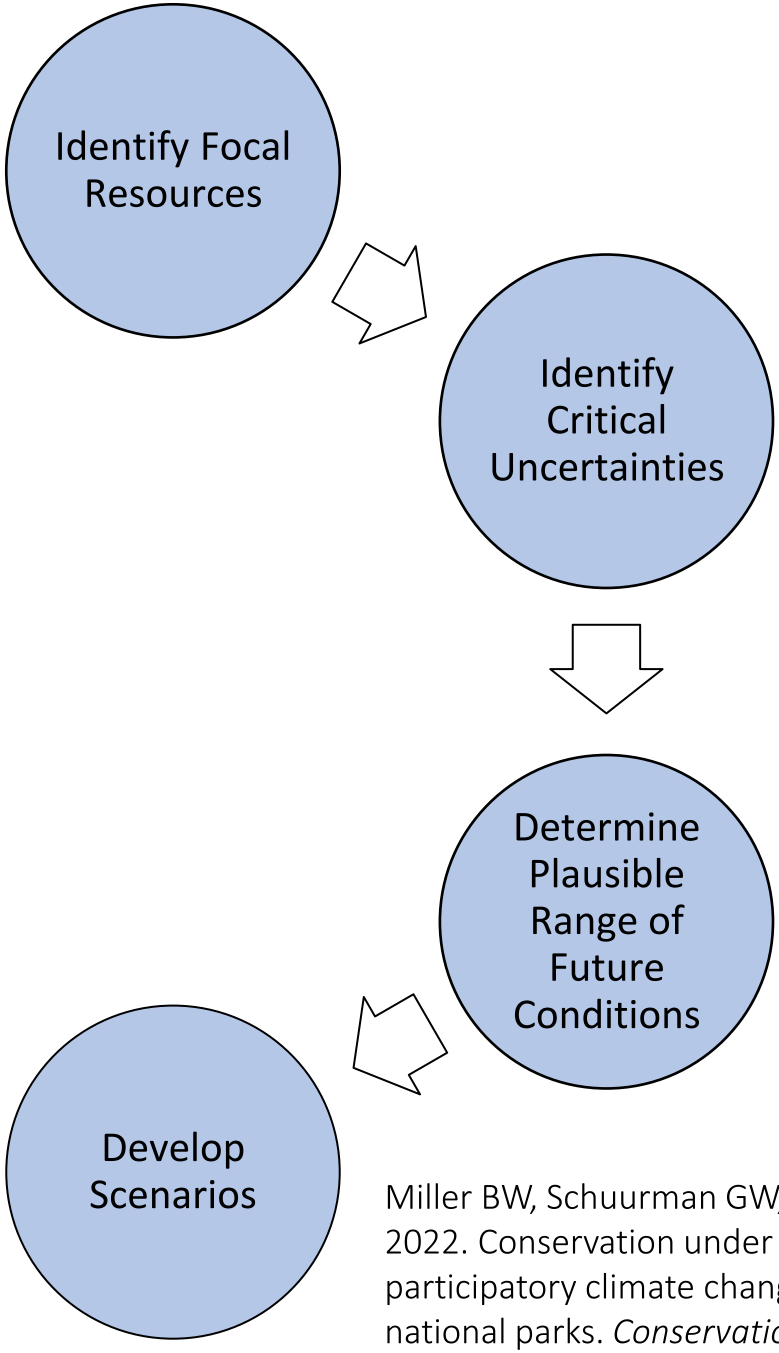


Table 1. Changes in key aspects of BADL climate through 2050 for four climate futures. Arrow size and direction denote trends compared to conditions of the recent past (1950-1999). Down arrows denote decreasing values or earlier dates, up arrows increasing values, and sideways arrows no change. Larger arrows indicate greater change.

Climate Feature	Rather Hot	Awfully Dry	Wet in Bursts	The Jungle
Temperature	↑	↑	↑	↑
Spring Precipitation	↔	↓	↑	↑
Start of Spring	↔	↓	↔	↓
Heavy Precipitation Events	↑	↔	↑	↑

Miller BW, Symstad AJ, Schuurman GW,. 2019. Implications of Climate Change Scenarios for Badlands National Park Resource Management. Resource Brief, National Park Service Resource Brief. Fort Collins, CO.



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What are scenarios?

“Scenarios are stories about the ways that the world might turn out tomorrow…

…that can help us recognize and adapt to changing aspects of our current environment”

-Peter Schwartz

Photo: Tomáš Malík (Unsplash)

Photos: B.W. Miller, G. Schuurman

Priority	Resource component	Log Ride
Vegetation	Riparian	• Warmer temperatures reduce climate suitability for birch (*Betula*) and aspen (*Populus*) • Higher GW tables (as long as withdrawal doesn't increase more) sustain riparian trees through drought periods (those reaching the GW). Decreased SW availability in the summer puts areas at risk of wildlife trampling, which, when combined with flooding from flashier precipitation, decreases bank stability and therefore habitat for wetland herbaceous species
	Forest	• Potential for episodes of high pine recruitment (seedling crops) in wet years • Prescribed fire: same as prairie • Wildfire: same as prairie, though high-recruitment episodes increase ladder fuels, and therefore fire severity • If potential increase in recruitment balances increased mortality, forest will persist largely as is now or could even increase in extent if prescribed fire does not keep up with expansion into grasslands
	Rare plant species[7]	• Orchids hang on because of occasional years with high spring soil moisture availability

Runyon, A. N., G. W. Schuurman, B. W. Miller, A. J. Symstad, and A. R. Hardy. 2021. Climate change scenario planning for resource stewardship at Wind Cave National Park: Climate change scenario planning summary. Natural Resource Report NPS/NRSS/NRR—2021/2274. https://doi.org/10.36967/nrr-2286672

Priority	Resource component	Log Ride	Hourglass	Jenga	Convection Oven	Common across all/most scenarios
Vegetation	Riparian	• Warmer temperatures reduce climate suitability for birch (*Betula*) and aspen (*Populus*) • Higher GW tables (as long as withdrawal doesn't increase more) sustain riparian trees through drought periods (those reaching the GW). Decreased SW availability in the summer puts areas at risk of wildlife trampling, which, when combined with flooding from flashier precipitation, decreases bank stability and therefore habitat for wetland herbaceous species	• Moderate increase in temperatures only slightly decreases climate suitability for birch and aspen, so they decline only slightly if at all • Riparian areas contract gradually as GW and SW both decline. Tree species already at the low end of their precip tolerance (hackberry, green ash, ironwood, bur oak, elms) decline or disappear	• Much higher temperatures, especially in latter half of future period, push birch and aspen out of their range of climate suitability, leading to their decline • More frequent, more intense, and more multi-year droughts, especially in second half of future period, reduce vigor of riparian trees and lead to severe concentration of wildlife around what remains of water sources, further damaging riparian vegetation	• Hot and dry conditions are not suitable for birch and aspen, leading to their extirpation • Perpetual drought conditions (compared to historical) leads to severe contraction or extirpation of riparian trees and shrubs	• Reduced suitability for birch and aspen • Contraction of riparian area from drought (3 of 4 scenarios)
	Forest	• Potential for episodes of high pine recruitment (seedling crops) in wet years • Prescribed fire: same as prairie • Wildfire: same as prairie, though high-recruitment episodes increase ladder fuels, and therefore fire severity • If potential increase in recruitment balances increased mortality, forest will persist largely as is now or could even increase in extent if prescribed fire does not keep up with expansion into grasslands	• Prescribed fire: same as prairie • Wildfire: same as prairie • Minor, if any, decrease in ponderosa pine forest, or potentially even increase if prescribed fire does not keep up with expansion into grasslands	• Prescribed fire: same as prairie • Wildfire: same as prairie, except fire severity higher because of lower moisture conditions in heavy fuels • Increased fire risk and greater mortality from other causes, combined with lower regeneration, causes slow (or very fast, if catastrophic fire) decline in forest extent and density	• Prescribed fire: same as prairie • Wildfire: Occurs more frequently and through much of the year, stressing fire-fighting resources and leading to larger fires that are higher in severity because of lower moisture conditions in heavy fuels • Increased fire risk and greater mortality from other causes, combined with lower regeneration, causes slow (or very fast, if catastrophic fire) decline in forest extent and density	• Increased wildfire risk and season length • Shifted timing for prescribed fires, or less opportunity
	Rare plant species[7]	• Orchids hang on because of occasional years with high spring soil moisture availability	• Orchids decline due to strong decrease in spring soil moisture availability	• Orchids decline sharply in second half of future period when droughts become more common and severe	• Orchids decline precipitously or disappear from the park	• Orchids decline (3 of 4 scenarios)

Runyon, A. N., G. W. Schuurman, B. W. Miller, A. J. Symstad, and A. R. Hardy. 2021. Climate change scenario planning for resource stewardship at Wind Cave National Park: Climate change scenario planning summary. Natural Resource Report NPS/NRSS/NRR—2021/2274. https://doi.org/10.36967/nrr-2286672

Priority	Resource component	Log Ride	Hourglass	Jenga	Convection Oven	Common across all/most scenarios
Water	Groundwater (GW)	• More winter precip and higher winter temps lead to earlier and more snow melt, adding to GW recharge • Annual, spring, and winter precip increases likely increase GW levels • Warmer late summers increase GW use by humans which may affect the	• Slow decline of GW availability • GW levels in cave lakes decline over time	• GW levels about the same as historical because very little change in annual precip and GW loss has low climate sensitivity	• Decrease in GW levels—faster than the other scenarios • Rate of GW decline dependent on external uses—greatest potential for more GW use outside of the park	–

Priority	Resource component	Log Ride	Hourglass	Jenga	Convection Oven	Common across all/mos
Vegetation		• Warmer temperatures reduce climate suitability for birch (*Betula*) and aspen (*Populus*)	• Moderate increase in temperatures	• Much higher temperatures, especially in latter half of future period, push		
	Forest					
	Rare plant species[7]					

Priority	Resource component					
Cultural	Archaeological	• Potential Black-tailed prairie dog town			• More extreme than Hourglass—more	
	Museum collection					

Priority	Resource component	Log Ride	Hourglass	Jenga	Convection Oven	Common across all/most scenarios
Wildlife	Black-footed ferret (BFF) & Black-tailed prairie dog (BTPD)	• BTPD: Increase in fleas in wet years so colonies more likely to contract plague in very wet years but could rebound in intervening years • BFF: Potential increase in flea species (two flea species that peak in different times) may increase plague risk to BTPD which could indirectly impact BFF obligate prey base of BTPD and reduce BFF populations	• BTPD: Expansion of prairie dog colonies and potential slight decrease in plague due to fewer fleas in drier years • BFF: Potential decrease in plague in BTPD due to fewer fleas in drier years could increase prey availability of BTPD to black-footed ferrets leads to slight increase in ferrets	• BTPD: Slightly positive effects, at least in first half—potentially higher forage while with pups; then dries out so colonies can expand. Can take advantage of late season green-ups • BFF: Expansion of BTPD colonies leads to potentially slightly more ferrets, but BTPD habitat limited to 3300 acres, that will support an estimated maximum of ~30 ferrets	• BTPD: Colony area expands and density will decrease. Inconclusive as to what happens to disease rates, although initial thoughts are less chance of disease transmission? • BTPD: Might see drops in pup production after severe droughts • BFF: Drier conditions thought to be less likely for plague due to fewer fleas leads to potential increase in BFF populations	• BTPD: Prairie dog populations maintained within target colony acreage • BTPD: Colonies will have potential to expand because of drier conditions (3 of 4 scenarios) • BFF: Ferret populations maintained within targets
	Elk	• More food in some years but slightly less in most • Potentially higher reproductive rates in some years because of better forage in some years • High tick numbers • Slight potential, if elk are more spread out when better forage is available, that there is less transmission of chronic wasting disease (CWD)	• Slight decrease in productivity of prairie, but because grazing is below capacity it won't impact elk numbers • Elk slightly more concentrated, particularly around water resources when drier, with more potential for transmission of CWD • Potentially fewer ticks, because of less moisture in spring	• Decrease in growing season moisture availability leads to decreased productivity of prairie, but because grazing is below capacity it won't impact elk numbers • Late summer decrease in precipitation, with increased fire risk that could decrease forage • Animals may be more concentrated in the late summer; might be a short season of being concentrated in riparian areas. Concentration leads to higher possibility for CWD transmission • High tick numbers • Unknown if novel diseases such as Bluetongue may arrive in WICA with implications for elk	• May have increase in CWD transmission because they will be concentrated on limited water resource • Vegetation should be adequate for current (2019) population of elk, although there will be more pressure from grazing on prairie vegetation • Potential loss of forage with fire risk going up may lead to constraint on numbers of elk • Higher tick numbers • Water might be a constraining factor. During severe droughts, slight potential for elk to try to leave park for water sources	• Lower forage quantity and possibly quality (due to increase in exotics, increased fire risk) in drought years (periodic in Scenario 1) may impact elk • Higher potential for CWD transmission (3 of 4 scenarios) • Tick numbers increase (3 of 4 scenarios)
	Bats	• More insects for bats during wet years. Potentially the highest positive effect on bats with the most water available. Distance to water is less; food availability is greater • Might have issues with forest fire in dry years	• Potential slight decrease in bat populations, although not as much as under Scenario 4 • Decreasing bat populations from loss of water sources, and increased distance required to travel for water • Drier conditions reduce insect populations, decreasing food availability and fitness, resulting in fewer bats	• Able to reproduce. Good foraging in the spring because of high moisture; counteracted by dry August. If there's a wet September, they might be able to recover • When pups are young, there will be good forage. Tough month in August, but there could be a bump in September if we get more precip	• Worst scenario for bats • Decreasing bat populations from loss of water sources and increased distance required to travel for water • Forest fire leads to potential loss of forest and less roosting habitat, decreasing bat numbers • Drier conditions reduce insect populations, decreasing food availability and fitness, resulting in fewer bats	• Drought years result in (periodic in Scenario 1) lower water availability and/or insects during those periods • Might have issues with forest fire in dry years leading to loss of roosting habitat • Uncertainty about how white nose syndrome may affect bats in light of climate change

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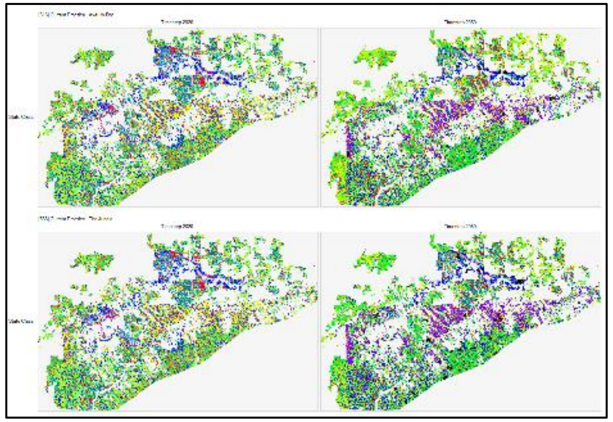
Quantitative Scenarios

- Consider incorporating quantitative resource response information



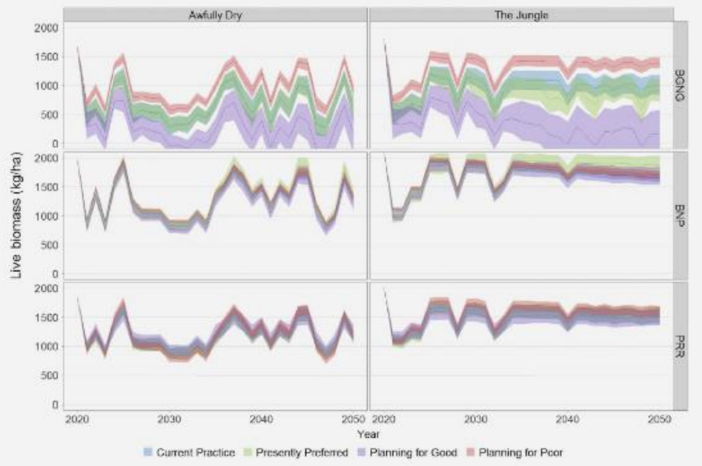
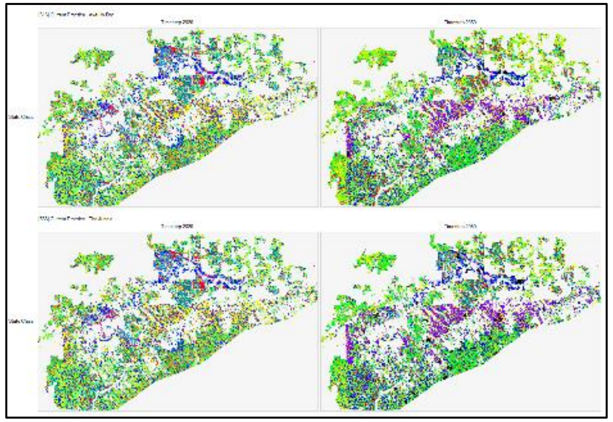


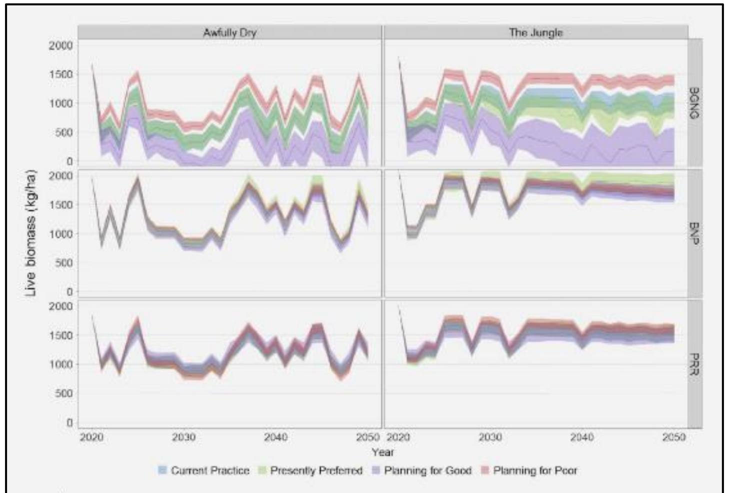
Fig. 5. Peak live biomass (kg/ha) for each management jurisdiction (rows) under two climate scenarios (Awfully Dry [left] and The Jungle [right]) and four management alternatives (colored lines). Lines represent the means of 100 Monte Carlo simulations, and shaded regions represent the 95th percentile range.

Miller, BW, AJ Symstad, L Frid, NA Fisichelli, GW Schuurman. 2017. Co-producing simulation models to inform resource management: a case study from southwest South Dakota. *Ecosphere* 8(12).

Quantitative Scenarios



- Consider incorporating quantitative resource response information
- E.g., modeled veg. biomass & composition & mgmt. costs as a function of:
  – 4 climate futures
  – 4 management alternatives
    - Grazing rates/seasons
    - Rx fire
    - Invasive inventory & treatment
    - Vary by jurisdiction



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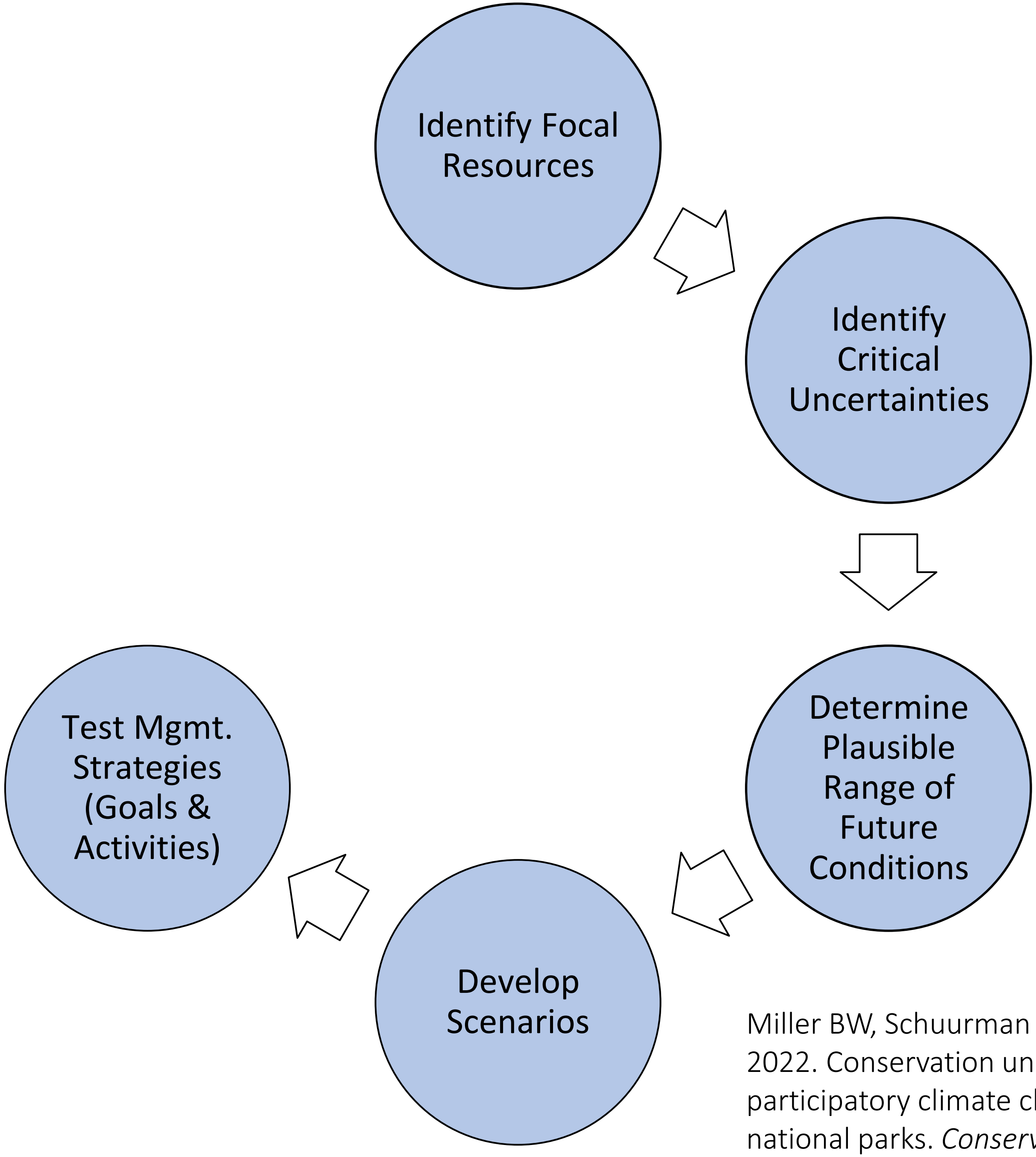
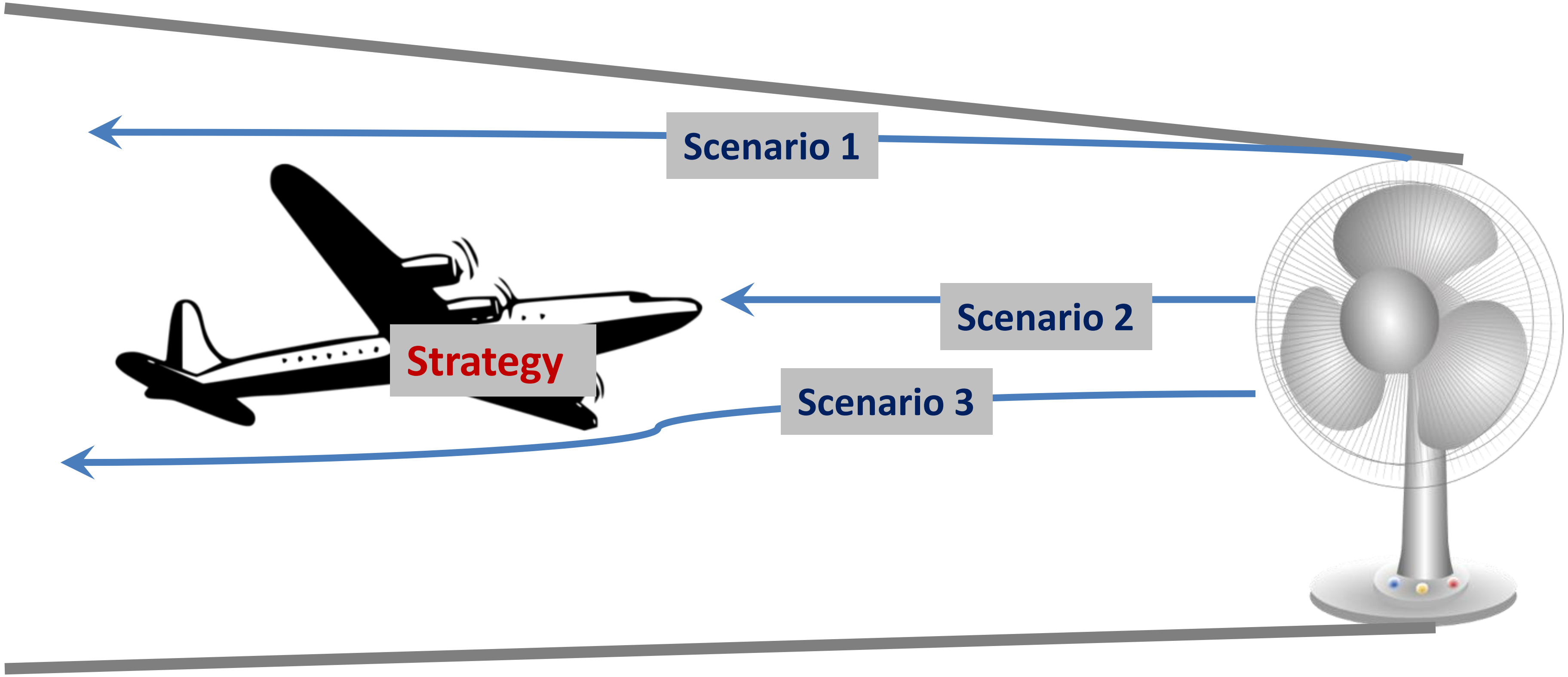


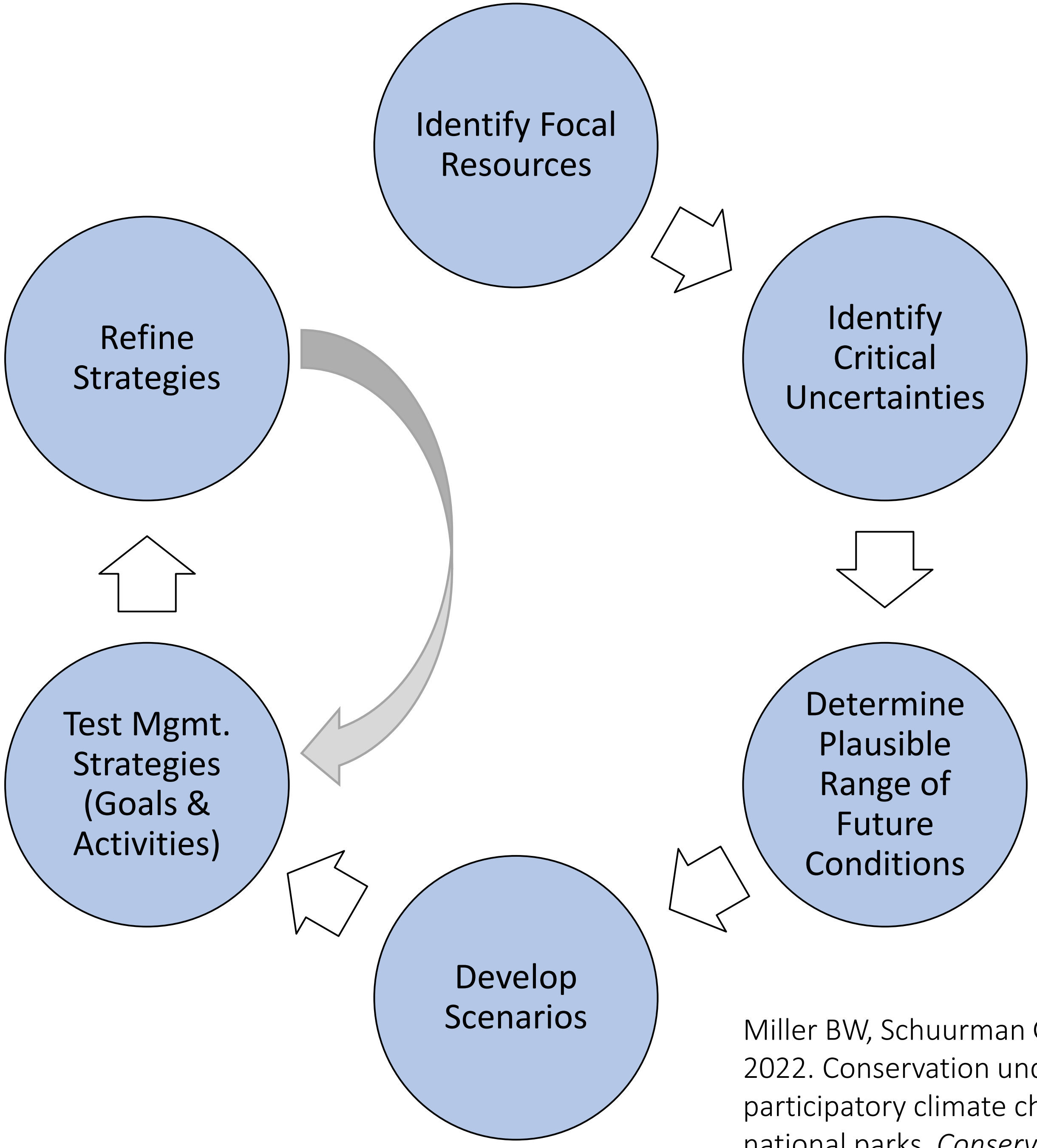
Miller BW, Schuurman GW, Symstad AJ, Runyon AN, Robb BC. 2022. Conservation under uncertainty: Innovations in participatory climate change scenario planning from US national parks. *Conservation Science and Practice*: e12633.

Scenario Planning: Testing Strategies



"If the world turns out as described in scenario X, am I going to succeed in achieving my goals?"

Graphic: modified from NPS Climate Change Response Program



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Scenario Planning

We cannot know what *will* happen, but we can prepare for what *might* happen.

Scenario Planning

We cannot know what *will* happen, but we can prepare for what *might* happen.

When we ask what might happen, we need to guard against

OPTIMISM BIAS

- A common human tendency to underestimate the probability and consequences of negative outcomes.

Slide: G. Schuurman
Scenario planning training aid on Optimism Bias: [Training Aid: What might happen? How to make the most of scenario planning. (nps.gov)]

Climate Change Response Program

Natural Resources Stewardship & Science

National Park Service
U.S. Department of the Interior

"Optimism is like red wine. A glass a day is good for you, but a bottle a day can be hazardous."

-Manju Puri & David Robinson in *Optimism & Economic Choice*

National Park Service (NPS) has been using scenario planning since 2007 to help parks prepare for what might happen as a result of climate change.

Since then, the NPS Climate Change Response Program developed improved methods to provide park-specific climate projections to support scenario planning. Faciliated discussions with scientists, park staff, and other subject matter experts produce scenarios that are plausible (based on best available science), relevant (focused on a management question), and divergent (characterize a broad range of future conditions).

As an unfortunate testament to their plausibility and relevance, a number of imagined, worst-case scenarios were "scooped by reality" in recent years. As our world changes rapidly in new and novel ways, we must increasingly be ready for such events. Doing so requires that we work through mental barriers that might prevent us from properly considering high-risk scenarios.

Our rational minds are often hijacked by myriad fallacies, biases, and mental shortcuts. Among them is **optimism bias**, wherein people often overestimate the probability of positive events, and/or underestimate the probability of negative outcomes. In moderation, optimism bias fortifies us against depression and despair. But left unchecked, optimism bias can promote risky behaviors or disincentivize taking proper precautions.

"Optimism is like red wine. A glass a day is good for you, but a bottle a day can be hazardous."
-Manju Puri & David Robinson in *Optimism & Economic Choice*

Optimism bias transcends education, experience, and background—it seems we all like to hope for the best! But when we recognize and account for optimism bias, we are better able to anticipate challenges and avoid risk. In the context of scenario planning, tempering optimistic tendencies prepares us to better envision a full range of plausible futures, and consider management options with greater urgency. The following case studies may be helpful as you begin to envision your future scenarios.

Pearmam, O, L Perez, W Carr. 2022. What might happen? How to make the most of scenario planning. Training Aid. NPS. https://www.nps.gov/subjects/climatechange/scenarioplanning.htm

Unfortunately, a number of imagined, worst-case scenarios have played out on NPS lands in recent years…

Unprecedented wildfire

Lassen Volcanic NP

Extreme rain+flooding

Acadia NP

Permafrost thaw+landslides

Denali NP

Slide: G. Schuurman

Scenario planning training aid on Optimism Bias: [Training Aid: What might happen? How to make the most of scenario planning. (nps.gov)]

Strategies for tempering OPTIMISM BIAS

- *Think about the unthinkable:* We are better prepared to act when we proactively confront the possibility of worst-case realities.
- *Think bigger:* Don't downplay the severity or magnitude of extreme scenarios. Anticipating extremes boosts our capacity regardless of what happens.
- *Plan for sooner rather than later:* It's better to imagine difficult futures happening sooner than anticipated, and recognize signs of extreme change.
- *Give fair attention to the improbable:* Strive for objectivity in interpreting the best available information for scenarios to help prepare for extreme, complex events.

Slide: G. Schuurman
Scenario planning training aid on Optimism Bias: Training Aid: What might happen? How to make the most of scenario planning. (nps.gov)

USGS
science for a changing world

NORTH CENTRAL
Climate Adaptation
Science Center

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Photo: Brian Miller