# SUMMARY OF KEY FINDINGS FROM THE VULNERABILITY ASSESSMENTS

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Climate Change Adaptation Strategy Workshop
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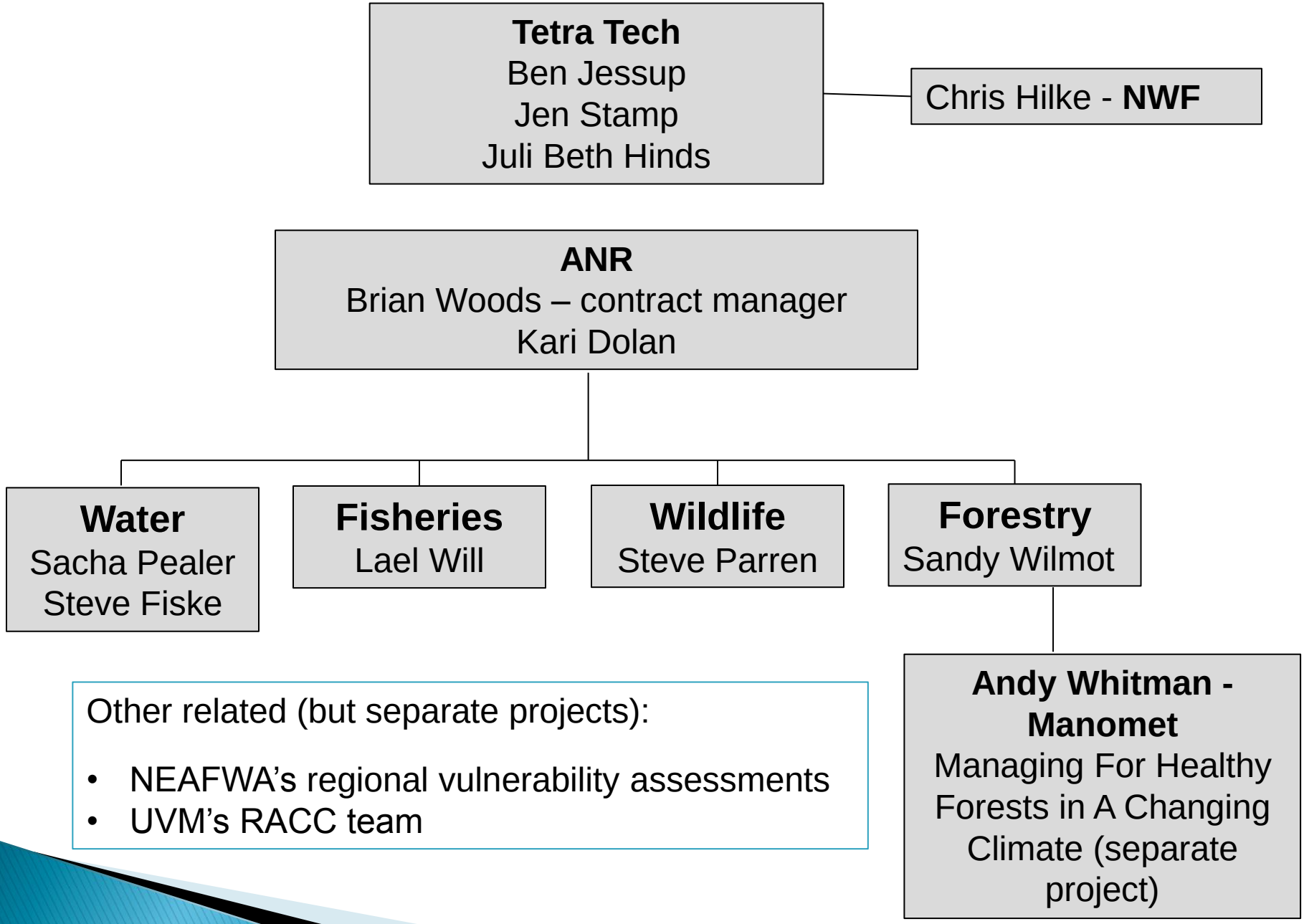
*The views expressed in this talk are those of the author and they do not necessarily reflect the views or policies of the Vermont Agency of Natural Resources*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Andy Whitman - Manomet
Managing For Healthy Forests in A Changing Climate (separate project)
Other related (but separate projects):
• NEAFWA's regional vulnerability assessments
• UVM's RACC team

# Major Tasks

**Write Report**

- Summarize **historic climatic trends & future projections**
- Summarize information from climate change **vulnerability assessments**
- Identify **information gaps**
- Develop a State climate change **adaptation strategy framework**

**Held 2 workshops in 2012**

1. Vulnerability assessments (July)

2. Adaptation strategies (December)

**Main objectives:**

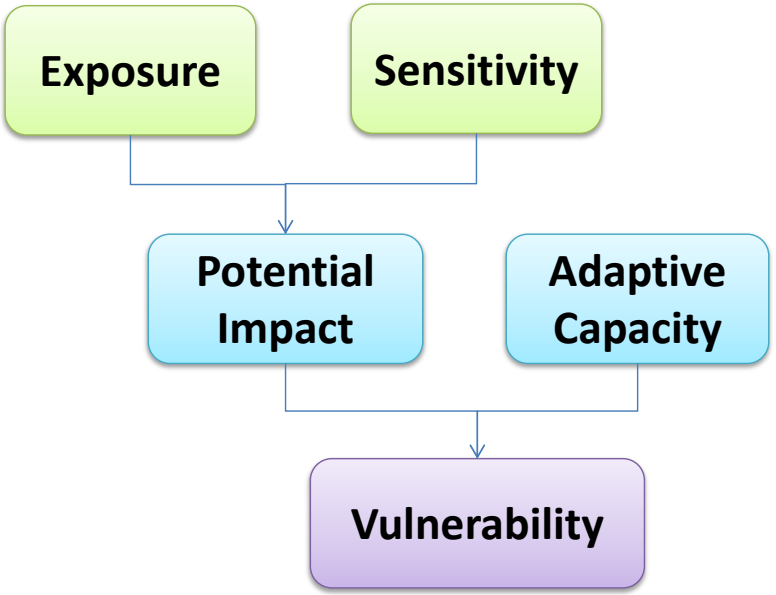
- ***Educate*** participants on what other states have done/are doing with natural resource-based vulnerability assessments and adaptation strategies.
- ***Elicit expert opinion***
- ***Find points of coordination among VANR departments and actions***

# What is vulnerability?

A function of the ***sensitivity*** of a particular system to climate changes, its ***exposure*** to those changes, and its ***capacity to adapt*** to those changes *(Intergovernmental Panel on Climate Change)*

***Exposure*** –how much of a change in climate and associated problems a species or system is likely to experience

***Sensitivity*** –measure of whether and how much a species or system is likely to be affected by a given change in climate



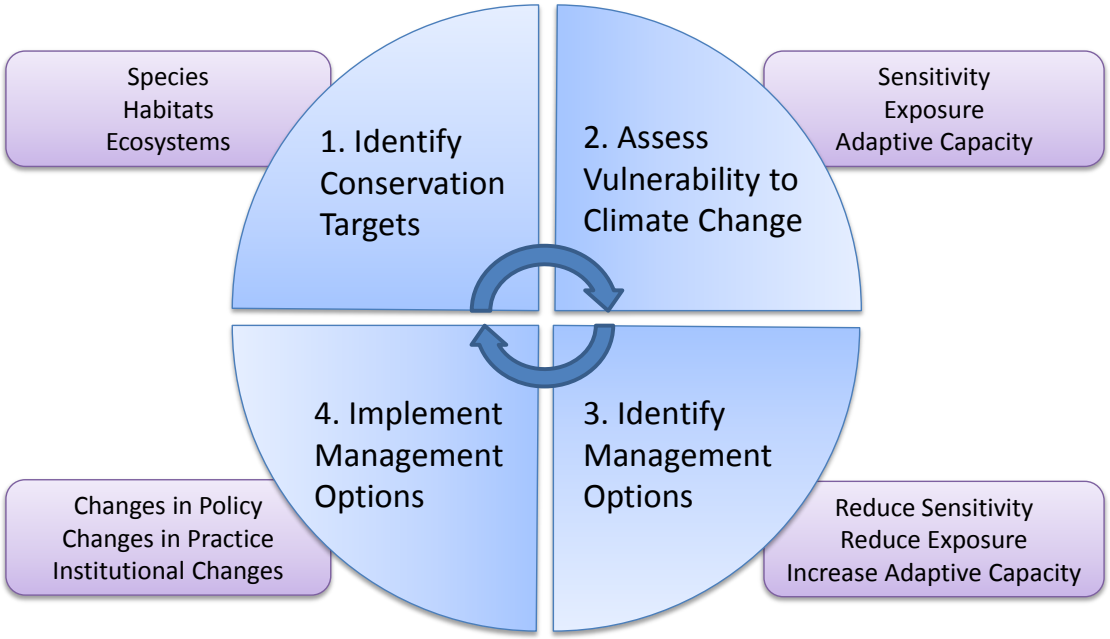

*Glick et al. 2011*

# **Why do vulnerability assessments**?

- To identify ***which*** species or habitats are likely to be most strongly affected by projected changes
- To understand ***why*** these resources are likely to be vulnerable, including the interaction between climate shifts and existing stressors

*Glick et al. 2011*

# Framework for developing climate change adaptation strategies

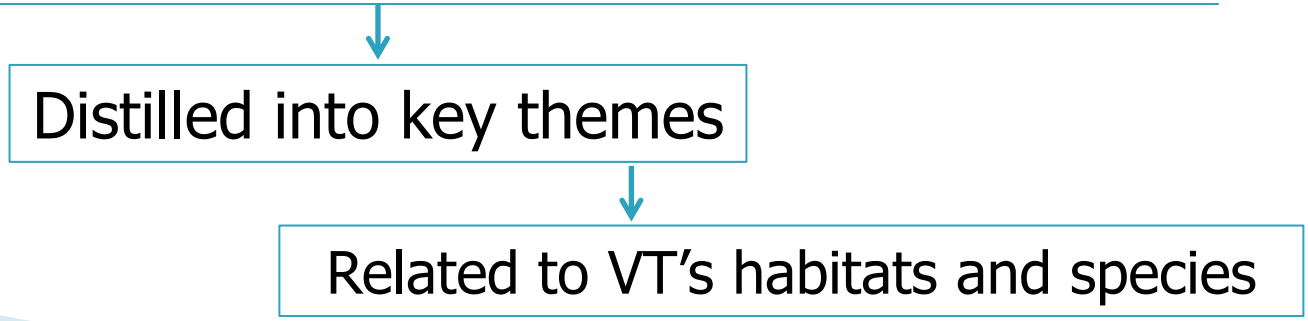



*Glick P, Stein BA, and Edelson N. 2011. Scanning the conservation horizon: a guide to climate change vulnerability assessment. Washington, DC: National Wildlife Federation. Available at: www.nwf.org/vulnerabilityguide*

# Methodology

Compiled information from the following **data sources**:

- **July 9th Workshop** & **Follow-up**
  - Habitat & species-level: expert elicitation
- **NEAFWA** Reports
  - Habitat-level: expert elicitation (Excel-based model)
- Reports from **Other States**
  - Habitat-level:  expert elicitation
  - Species-level: expert elicitation and/or Nature Serve Climate Change Vulnerability Index (CCVI))
- **Literature**



# Methodology
## How Did We Define the Habitats We Were Assessing?

- Upland forests & wetlands
  - Formations (i.e. Northern Hardwood forest) and natural community types (i.e. Mesic Red Oak-Northern Hardwood forest) per Thompson and Sorenson 2000
- Rivers
  - Crosswalk of the geomorphic classification scheme/s used by the Rivers program with the biological classification scheme/s used by the Biomonitoring program
- Lakes
  - Stratified vs. unstratified

# Methodology
## Species-level Assessments

Main considerations:

- Habitat specificity
- Range
- Environmental or physiological tolerance
- Interspecific or phenological dependence
- Mobility
- Vulnerability to exotic pathogens or invasive species

We focused more on habitats than species -

- Species are being assessed in **greater detail** as part of the **2015 SWAP updates** (currently underway)
- A **comprehensive report** by Whitman et al. with results for **442 species** is soon to be released

# Results - ratings

Ratings were applied to habitat and species

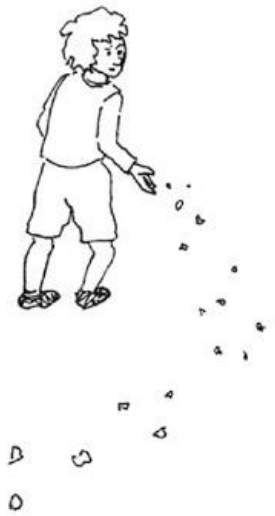
## Vulnerability

**Extreme (likely to be eradicated)**
**High**
→ **Moderate** ←
**Relatively unaffected**
**Likely to benefit**

## Confidence

**Low**
→ **Medium** ←
**High**

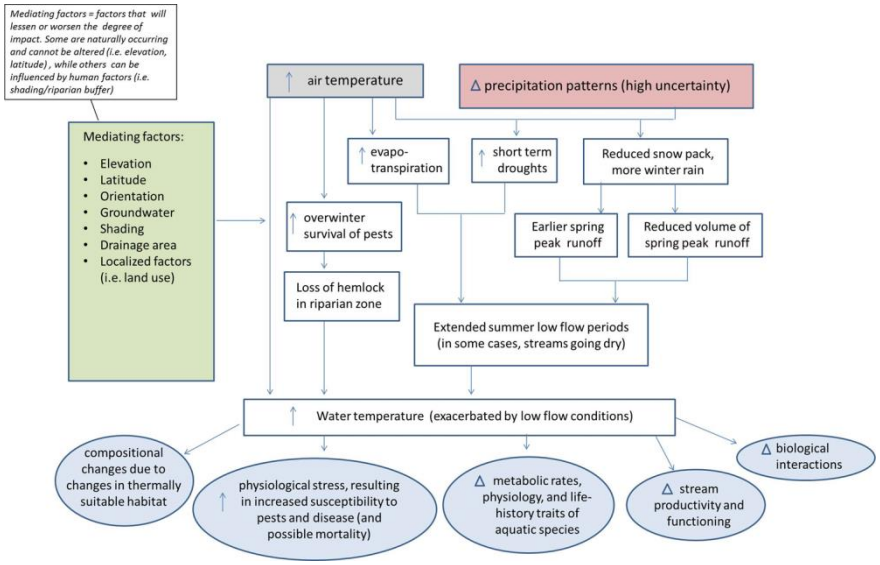
Important to "leave a trail of bread crumbs" (Hector Galbraith); other people might draw different conclusions from similar lines of evidence



# Results – summary tables

- **Summary tables** for each major habitat group (upland forests, wetlands, rivers and lakes)
  - **Ecological effects** (direct and indirect)
  - **Timeframe**
  - **Mediating factors**

- **Conceptual diagrams**
  - Can identify places in the causal pathways where you can apply management strategies



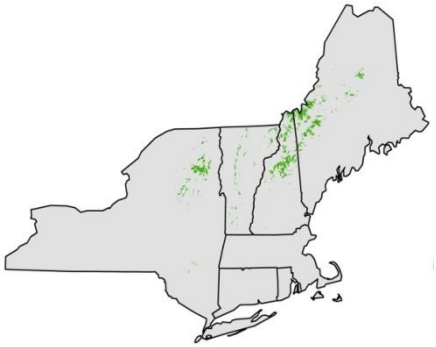
# Results - Common themes across habitat groups (high certainty)

- **Compositional changes** associated with changing climatic conditions (***long-term***, *localized effects could occur on shorter timescale*)
  - **loss of cold-adapted species**
  - **increase in warm-adapted species**
- Increase in **physiological stress** (***immediate***)
  - particularly concerned about **summer heat** and/or **water limitation** (potential hot spot = **Champlain Valley**, which is naturally hotter and drier than other parts of VT)
- Increase in susceptibility to **disease** and **pests** (***immediate***)
- Increase in **disturbance** (i.e. from extreme storm events) (***immediate***)
  - facilitates the spread of **invasives**

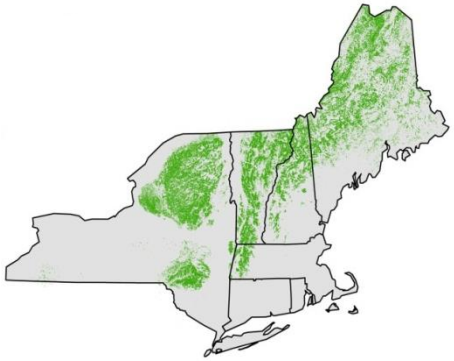
# Results – Upland forests (formation-level)

**Most vulnerable**

**Montane/high elevation spruce-fir** forests in **southern VT** & **associated species** (i.e. Bicknell's thrush)



**Northern hardwood forests** will experience **compositional changes**; these are likely to be most evident in **southern VT**



**Most likely to benefit**

**Oak-pine forests -** likely to expand northward

# Results – Upland forests

- **Forest health** and **productivity** are likely to be compromised
  - Decrease in **soil moisture**, increase in **thermal stress**
  - Increase in spread of **invasives & pests**
    - Hemlock and balsam **woolly adelgid** no longer limited by winter temperatures
  - Early **spring thaws/late frosts** can damage buds, blossoms & roots, which affects **regeneration**
    - Apples, sugar maples

Additional results for individual tree species (30+) will soon be available:

- Modeling/expert elicitation exercise by Vermont Forest & Parks (contact: Sandy Wilmot)

# Results – Wetlands

**Most likely to be negatively impacted**:

Precipitation-dependent peatlands (particularly those in southern Vermont)

- Increased **decomposition** rates
- **Specialized habitat** requirements (cold climate, short growing season, organic matter that accumulates faster than it decays)
- Could eventually be **replaced** by forested wetlands or non-wetland habitats

**Other negative impacts:**

- **Woolly adelgid** will impact hemlocks
- Increased **disturbance** facilitates the spread of **invasives**

# Results – Wetlands


## Lots of uncertainties due to limitations with precipitation models

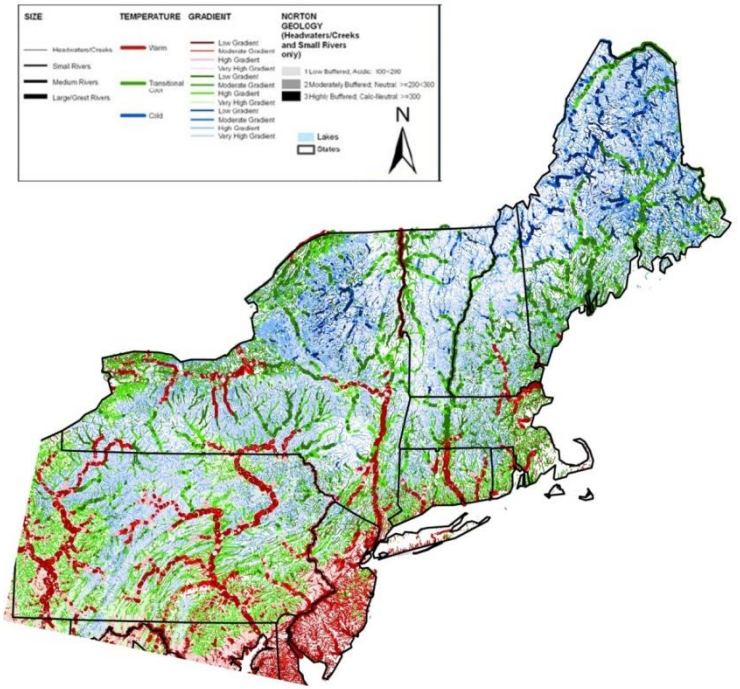
Source water will be very important:

- If source water is from **ground water seepage**, the seepage will **moderate fluctuations in precipitation**
- If source water is derived from **precipitation/local watershed runoff**, the wetlands will be **susceptible to changes in volume & seasonality of precipitation & snow melt**.

Other important considerations:

- Understanding **local hydrologic processes** at individual wetlands
- **Soil type** (organic vs. mineral)
- **Non-climatic factors**

# Results – Rivers




**Loss of coldwater habitat** is of great concern

Coldwater streams with the following characteristics are likely to be particularly vulnerable:

- Poor shading
- South-facing
- Little or no groundwater influence
- Low to mid-elevation
- Southern part of the state

Riparian shading from hemlock and ash will be impacted by pests

Cold water species like brook trout and eastern pearlshell mussel are going to be negatively impacted

# Results – Rivers

**Increase in extreme/heavy precipitation events** could potentially lead to **more flooding**

Important mediating factors:

- Catchment **slope**
- Watershed **size**
- Capacity to **absorb water**
  - % Open water & wetlands
  - Floodplain

Other important considerations:

- **Land use**
- **Human response**

**Species most likely to be negatively impacted**

- long-lived species that are slow to recolonize (i.e. mussels, mosses)

**Species most likely to be positively impacted**

- Invasives like Japanese knotweed (*Fallopia japonica*)
- Species that have a high capacity to adapt to high levels of disturbance

# Results – Rivers

Extended **summer low flow** periods + increase in **temperature** = double whammy effect

- Physiological stress
- Fish kills
- Algal blooms
- Decrease in water quality

Important mediating factors:

- **Groundwater** influence
- Watershed **size**
- Underlying **geology**
- **Effluent** inputs

Photo credits: Bio-West

# Results – Lakes

**Loss of coldwater habitat** is of great concern

Coldwater lakes with the following characteristics are likely to be particularly vulnerable:

- Little or no groundwater influence
- Low to mid-elevation
- Southern part of the state

Warming temperatures + earlier stratification may mean

- **loss of cold, deep water hypolimnetic habitat** and associated **species** (i.e. lake trout)
- greater chance of late summer **hypolimnetic hypoxia**
- **greater phosphorus release**

# Results – Lakes

Increase in **extreme/heavy precipitation events**

Increased **intensity** and **seasonality** of **runoff**

**Exacerbates** existing problems related to **nutrient** and **sediment loading**, as well as **shoreline erosion**

Photo credit: Emily McManamy

Other important considerations:

- **Land use**
- **Human response**

# This is a first step, not a final product

- By necessity, these are oversimplifications of incredibly complex processes
  - Biological interactions
  - Interactions with non-climatic stressors (i.e. atmospheric deposition, invasives, habitat alteration and fragmentation)
- More work needs to be done
  - Some will be done as part of the SWAP updates; other cross-sector follow-up?
  - Data gaps/research needs

**We welcome your comments**

Draft write-ups are posted on our FTP site, as are other relevant publications

# Acknowledgments

**Sector leads**

- Sacha Pealer
- Steve Fiske
- Sandy Wilmot
- Steve Parren
- Eric Smeltzer

**Facilitators**

- Andy Whitman (Manomet)
- Chris Hilke (NWF)

- Eric Sorenson
- Art Brooks
- Hector Galbraith
- Brian Woods

All of the participants at the July 9th workshop!

# QUESTIONS? COMMENTS?

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