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Data gaps that we see thus far

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Scarcity of minimally disturbed long-term monitoring sites

- Plus the limited spatial distribution of these sites and the relatively short durations (often <20 y) of the data sets

Discontinuities in data sets

- Samples are not collected from the same sites every year, so many data sets have discontinuities, which make analyzing and detecting trends difficult

TABLE 3. Time periods for which biological data were available at the long-term monitoring sites in Utah (UT), Maine (ME), and North Carolina (NC). Data used in these analyses were limited to autumn (September–November) kick-method samples in the Utah data set, summer (July–September) rock-basket samples in the Maine data set, and summer (July–August) standard qualitative samples in the North Carolina data set.

Site ID	Water body	Number of years of data analyzed	Years
UT-1	Weber	17	1985–1995, 1998, 2000, 2001, 2003–2005
UT-2	Virgin	14	1985–1993, 1996, 2000–2002, 2004
UT-3	Duchesne	12	1985–1993, 1995, 2000, 2001
UT-4	Beaver	9	1996–1998, 2000–2005
ME-1	Sheepscot	22	1985–2006
ME-2	West Branch Sheepscot	12	1995–2006
ME-3	Duck	9	1997–2005
NC-1	New	11	1983–1990, 1993, 1998, 2003

Quality of data

- Consistent sampling methodology
- Consistent taxonomy (genus-level operational taxonomic unit)
- Spatial distribution of sampling sites

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Critical technical elements of state bioassessment programs: a process to evaluate program rigor and comparability

Chris O. Yoder · Michael T. Barbour

Temperature data

- Lack of site-specific, continuous water-temperature data
- We used annual air-temperature data and instantaneous water temperature as surrogates, but lacked the data necessary to verify that air and water temperature were strongly correlated at all sites

•Also, now that more continuous temperature data are being collected, what is the best way to use that data, and how do you distinguish natural variability from subtle trends associated with climate change?

Hydrologic Data

Flow

- lack of site-specific, continuous flow data. We used annual precipitation data as a surrogate.

Groundwater influence

Perennial/intermittent

Traits data

We need more traits data for more taxa; as we gather this information, we need to incorporate it into an accessible database (ideally the Freshwater Biological Traits database!)

We also need to learn more about which traits are most important in the context of climate change (i.e. resistance and/or resilience traits?)

Examples of traits that we considered…

This combination of traits and trait states were used in the development of the drier-loser hydrologic indicator metrics. Organisms that possess the most number of unfavorable trait states and the least number of favorable trait states for drier conditions were categorized as 'losers.'

Traits	Favorable	Unfavorable
Voltinism	bi- or multivoltine (>1 generation/yr)	semivoltine (<1 generation/yr)
Adult ability to exit	present	absent
Ability to survive desiccation	present	absent
Dispersal ability (adult)	high	low
Adult flying strength	strong	weak
Swimming ability	strong	none
Armoring	good, heavily sclerotized	none
Occurrence in drift	abundant, common	rare
Respiration	plastron or spiracle (aerial)	tegument
Size at maturity	small	large
Rheophily	depositional	erosional
Habit (primary)	skater, swimmer	clinger
Functional feeding group (primary)	collector-gatherer, predator	scrapers, collector-filterer

Examples of taxa that had these combinations of traits…

Sensitive – will do worse?

Order	Family	FinalID	Score
Ephemeroptera	Isonychiidae	Isonychia	7
Trichoptera	Helicopsychidae	Helicopsyche	6
Trichoptera	Hydropsychidae	Hydropsyche	6
Odonata	Aeshnidae	Nasiaeschna	5
Plecoptera	Perlidae	Paragnetina	5
Trichoptera	Glossosomatidae	Agabus	5
Trichoptera	Hydropsychidae	Ceratopsyche	5
Trichoptera	Hydropsychidae	Cheumatopsyche	5
Trichoptera	Hydroptilidae	Hydroptila	5
Trichoptera	Hydropsychidae	Macrostemum	5

Order	Family	FinalID	Score
Ephemeroptera	Ephemeridae	Ephemera	-4
Ephemeroptera	Ephemeridae	Hexagenia	-4
Ephemeroptera	Heptageniidae	Rhithrogena	-4
Plecoptera	Nemouridae	Nemoura	-4
Plecoptera	Capniidae	Paracapnia	-4
Plecoptera	Nemouridae	Paranemoura	-4
Plecoptera	Nemouridae	Prostoia	-4
Plecoptera	Taeniopterygidae	Taeniopteryx	-4
Plecoptera	Capniidae	Utacapnia	-4
Plecoptera	Nemouridae	Soyedina	-5
Plecoptera	Chloroperlidae	Utaperla	-5
Ephemeroptera	Ephemeridae	Litobrancha	-6

Tolerant – will do better?

(Based on Maine warmer wetter scenario)

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Causal Assessment

Inability to completely separate biological responses to climate-induced changes from responses triggered by other confounding factors

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Natural variability

- Site to site variability
- Year to year variability
- Climate cycles
- Extreme events
- How to capture all the **complexities** and **interacting factors**
- Need to capture full range of natural variability in calibration data sets

Biological responses to extreme weather events

- Relevant studies:
  - Bêche and Resh (2007): prolonged and severe droughts in northern California;
  - Herbst and Cooper (2010): rain-on-snow flooding effects in small streams in the Sierra Nevada, California;
  - Case studies by NCDENR (2004, 2005): long-term drought and catastrophic flooding in North Carolina streams.

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Uncertainties about the Future

- Socioeconomic factors
- Land uses/land cover
- Climatic projections, challenges associated with downscaling models

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Resilience & Vulnerabilities

Which landscapes are most vulnerable?

- Groundwater influence
- Shading
- Topography
- Restoration

Which organisms are most resilient and most vulnerable?

Discussion

- What can we do to fill these gaps?
- Should we/can we collect additional types of data?
- If so, what more should we be collecting (e.g., abiotic variables, species traits information, other indicators)?
- If we are able to start collecting a set of standardized parameters across the region, what parameters should we focus on, and where would we store these data (i.e. explore the concept of a regional database?)
- What collection methods would be best suited to detecting climate change effects in stream systems?
- How can the traits database be used for some of these efforts?