Monitoring Grass Lake Research Natural Area with Bryophyte Cover Correlated with Climatic Change

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Peatlands

- Cover 3% of the Earth's surface[1]
  - Make up 0.1% of the mountain landscape
- Wetlands with thick organic soil[1]
  - Perennially saturated soils
  - Low oxygen subsurface conditions
- Provide island habitat diverse flora and fauna
- Help regulate stream flow and temperatures
  - Peat is a thermal insulator
  - Acts as a sponge
- Sierra Nevada peatlands are thought to be sustained groundwater (fens[2])
  - High evapotranspiration
  - Low summer precipitation

[1]Clymo 2004; [2]Cooper et al. 1998

Sierra Nevada Fens

- Often the only source perennial moisture
- Support ecosystems with high biodiversity
- Sensitive plant communities
- CA National Forests are directed to maintain, restore, and/or enhance fens

Grass Lake

- Largest peatland in Sierra Nevada (93 ha)
- South Lake Tahoe, Luther Pass, CA
- Designated as a Research Natural Area in 1991
- Tahoe Regional Planning Agency uncommon plant community

Fens are climatically sensitive ecosystems[1]

- Climate change may increase impacts to fens[3]
  - Increase evapotranspiration
  - Decrease water table
  - Decrease peat volume due to increased decomposition
  - Change in the plant community
- Climate change predictions for Tahoe Basin include[2]:
  - Increased air temperature
  - Shift from a snow to a rain dominated regime
  - Earlier snowmelt
  - Increased interannual variability
- We hypothesize that hydrologic changes are one of the largest threats to Grass Lake (and peatlands in general)

[1]Gignac 2001; [2]Coats 2010; [3]Cooper et al. 1998

Bryophytes

- Form the foundation for peatland plant communities[2]
- More sensitive to climatic changes than vascular plants[2]
- Good ecological indicator species:
  - Monitored with simple[1] repeatable field methods
  - Responds relatively quickly to changes[1]
  - Has a link to societal values[1]

[1]McCune 2000; [2]Vile et al. 2001

Meesia triquetra

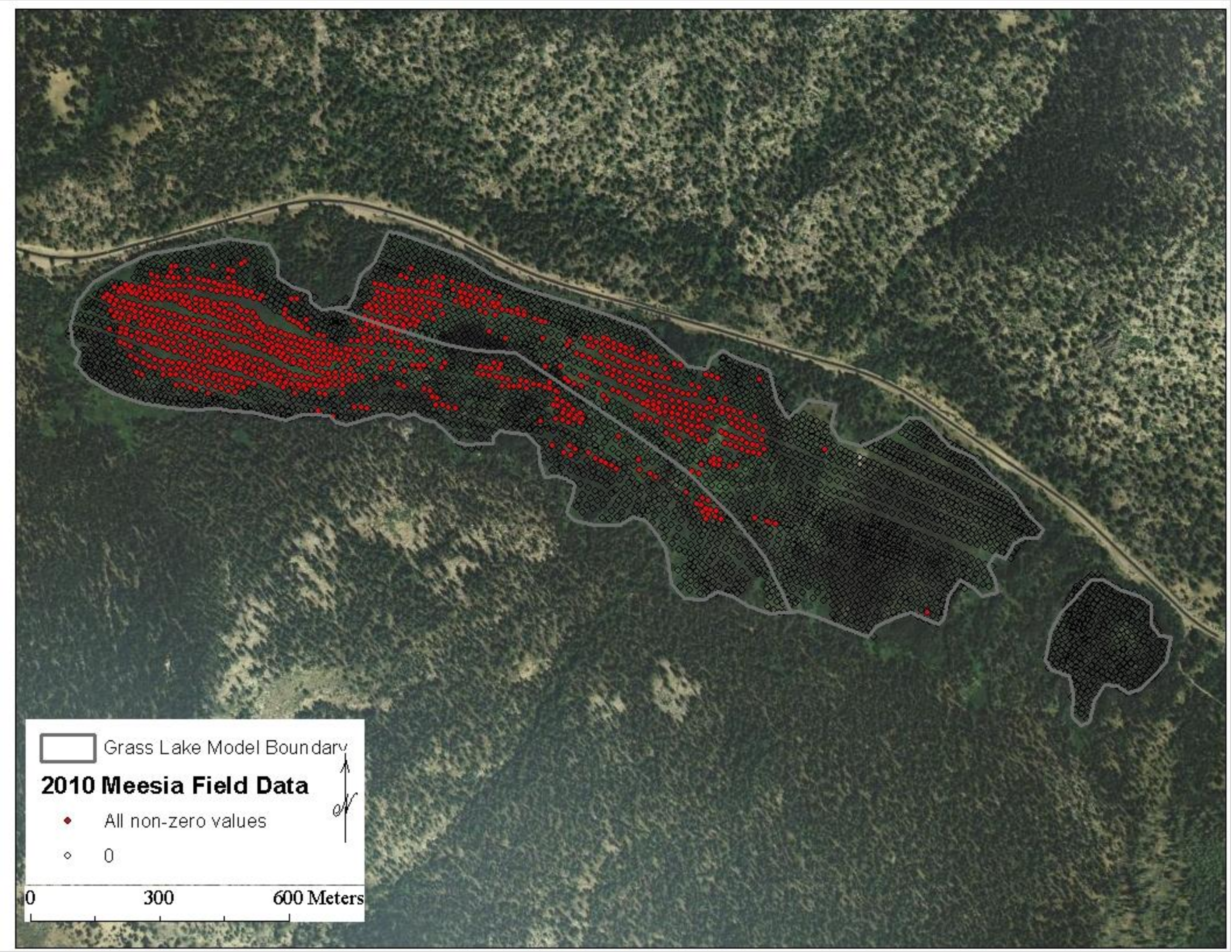
- CA Forest Service FS Sensitive Species
- Uncommon due to limited distribution habitat[1]

Sphagnum spp.

- GL largest Sphagnum "bog" in CA
- Indictor climate change[2]
- Intimately tied to hydrology[3]

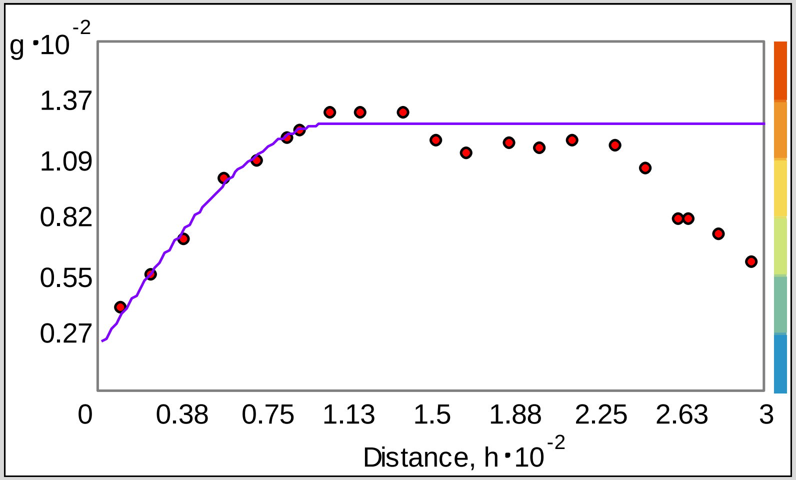
[1]Montagnes 1990; [2]Gignac 2001; [3]Andrus 1986

Field Methods

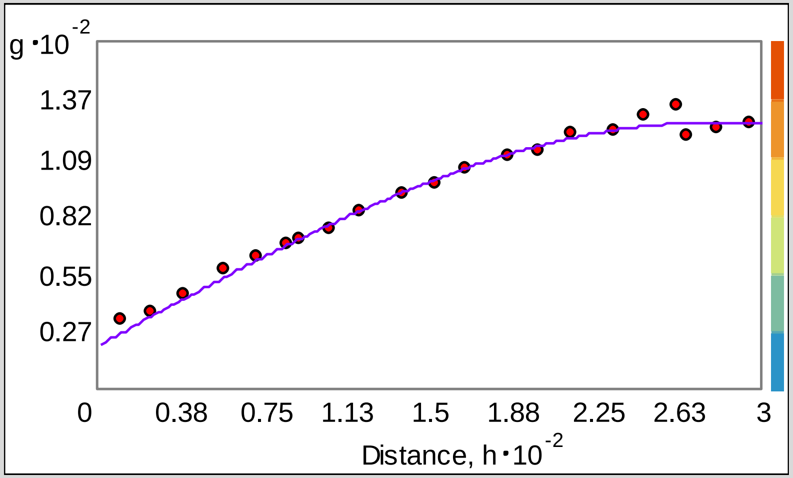


Geostatistics

- ArcMap 9.3 Geostatistical Analysist
- Ordinary krigging
  - Spherical model
  - Lag of 15 meters
- Visually fit semivariograms:
  - Nugget = variance at small distances
  - Sill = variance at large distances
  - Range = distance with constant variance
- Anisotropy – major axis 110^0
- One sector neighborhood 1:20 neighbors



Meesia triquetra 2010 semivariogram, minor axis 20^0



Meesia triquetra 2010 semivariogram, major axis 110^0

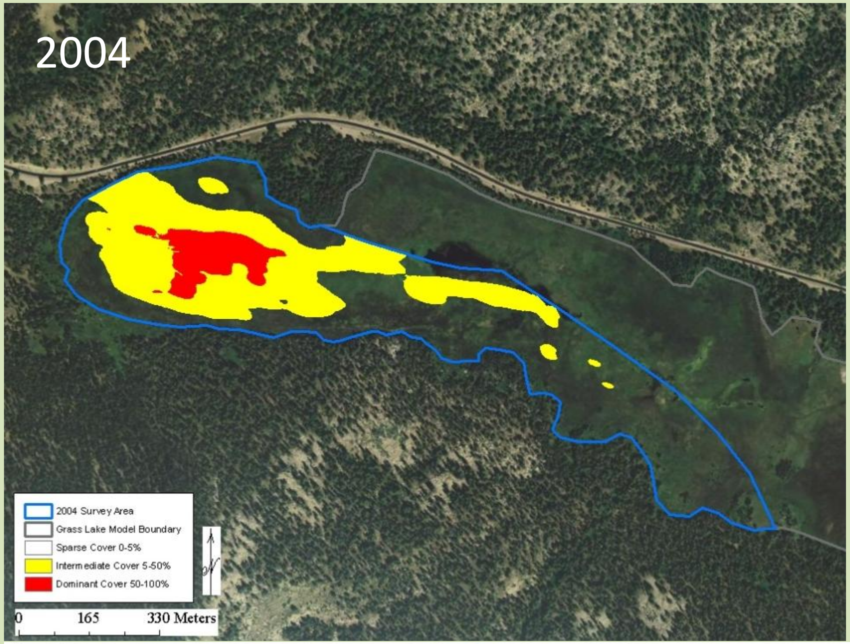
Cover Categories

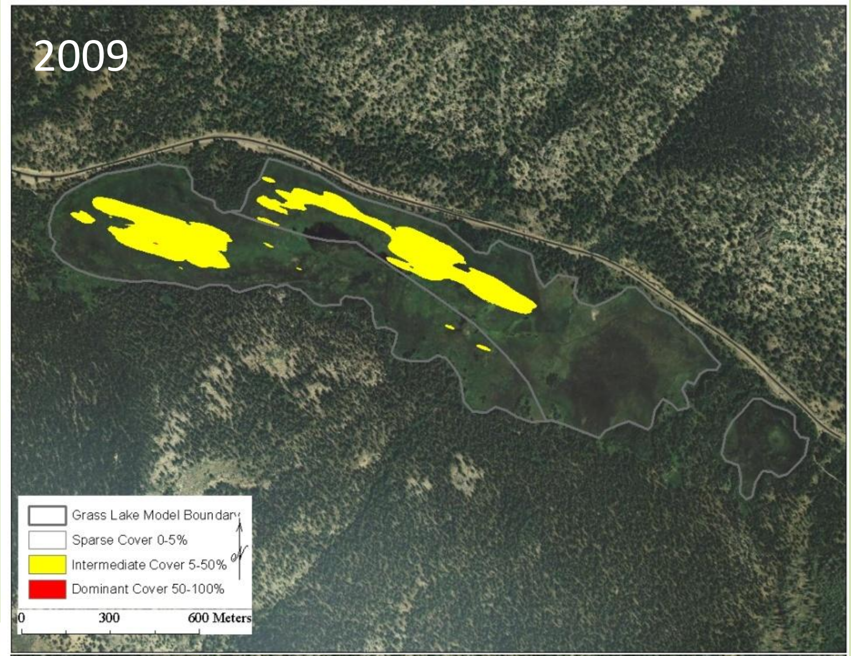
- **Sparse cover: 0-5%**
- **Intermediate cover: 5-50%**
- **Dominant cover: 50-100%**

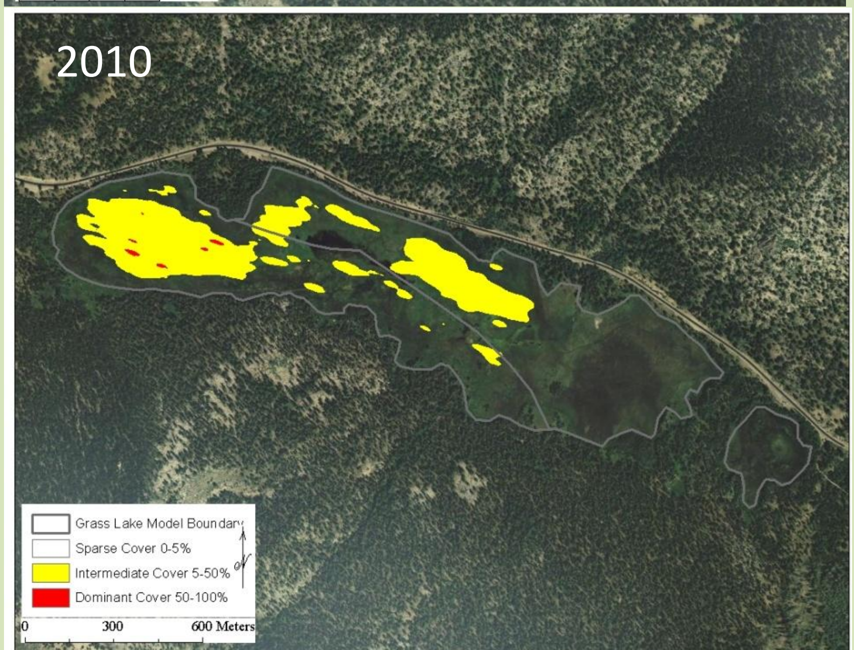
Validation

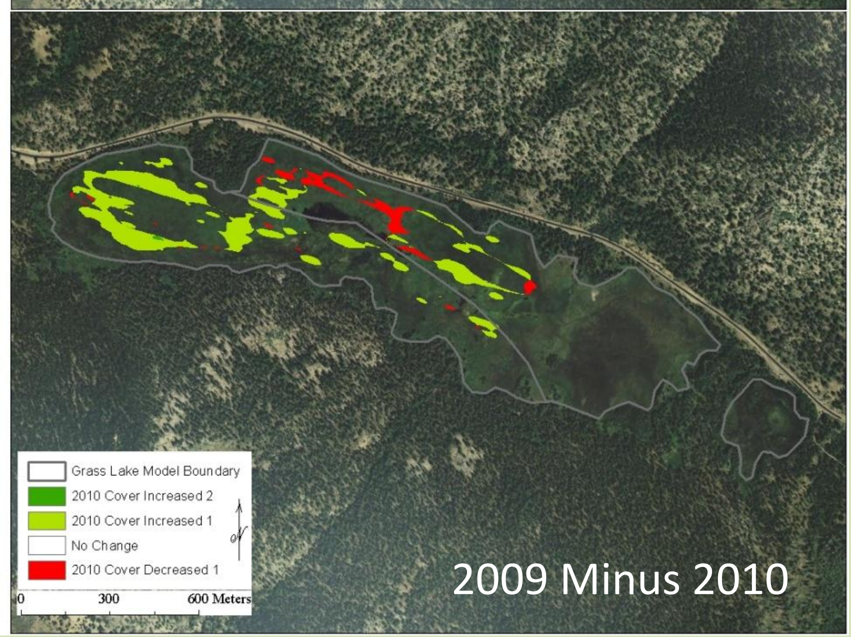
Year	2010	2009	2004	2010	2009	2004
Correct Prediction	91%	91%	86%	87%	78%	84%
Over Predicting	6%	8%	6%	8%	12%	13%
Under Predicting	3%	1%	8%	5%	10%	3%

Meesia triquetra

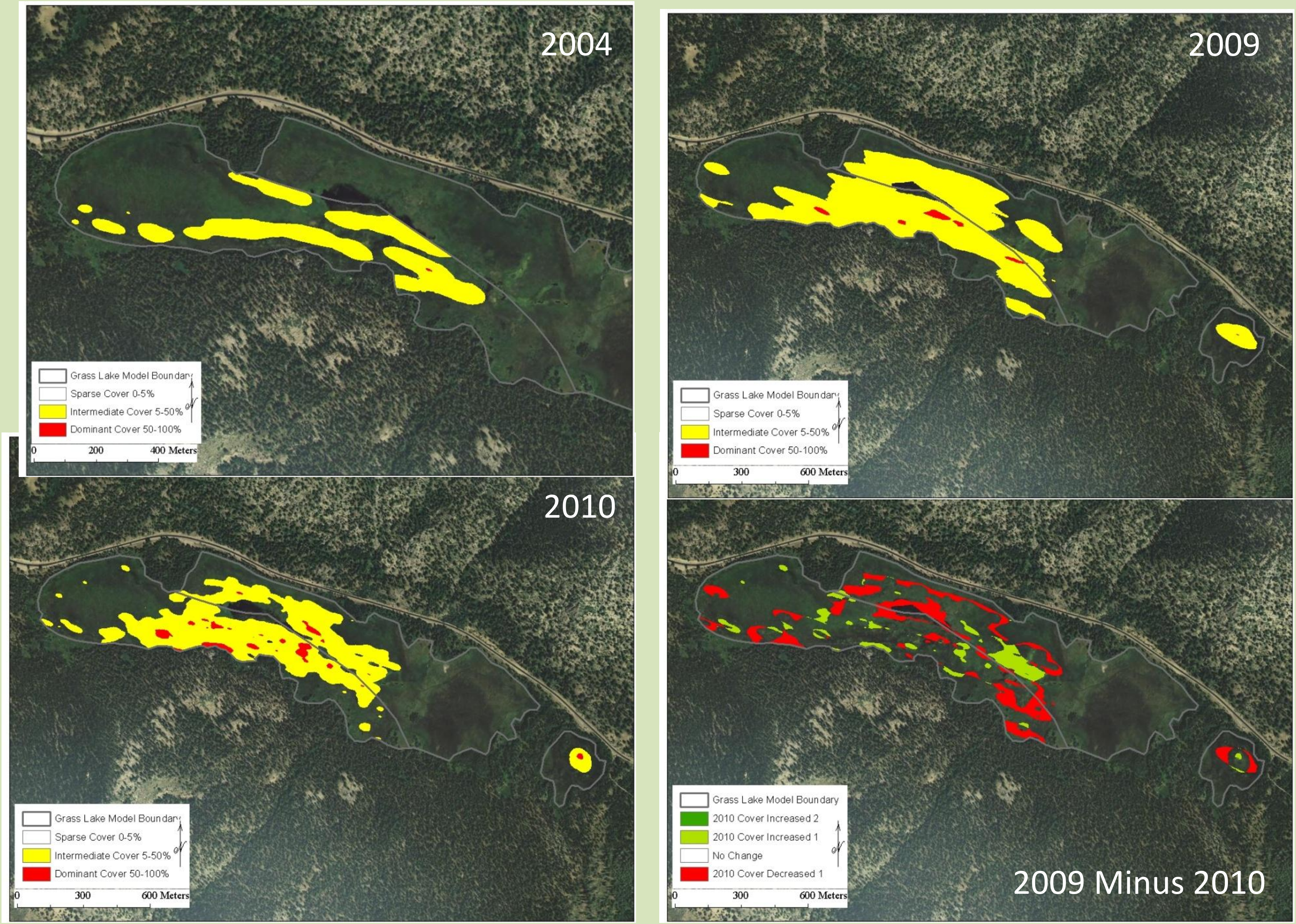








Sphagnum spp.: *Sphagnum inundatum*, *S. lescurii*, and *S. squarrosum*

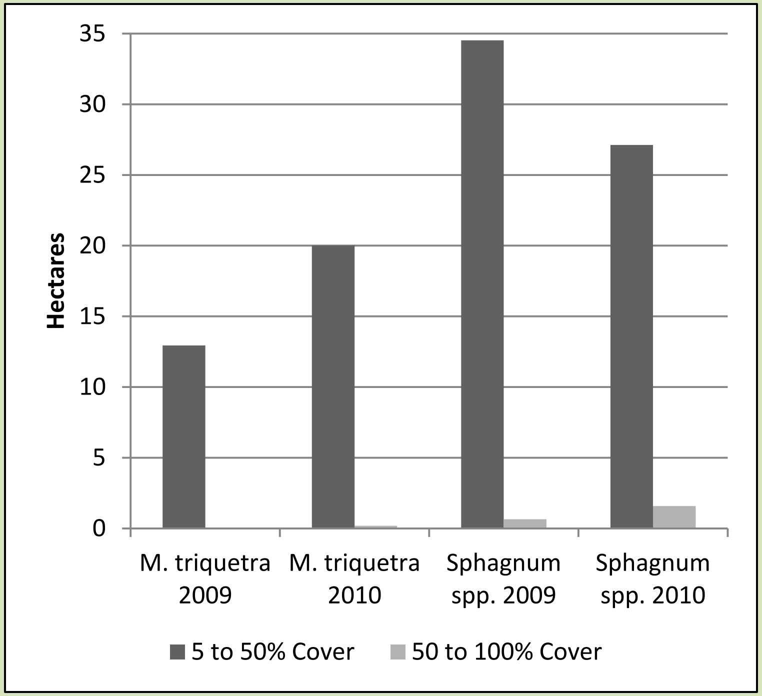


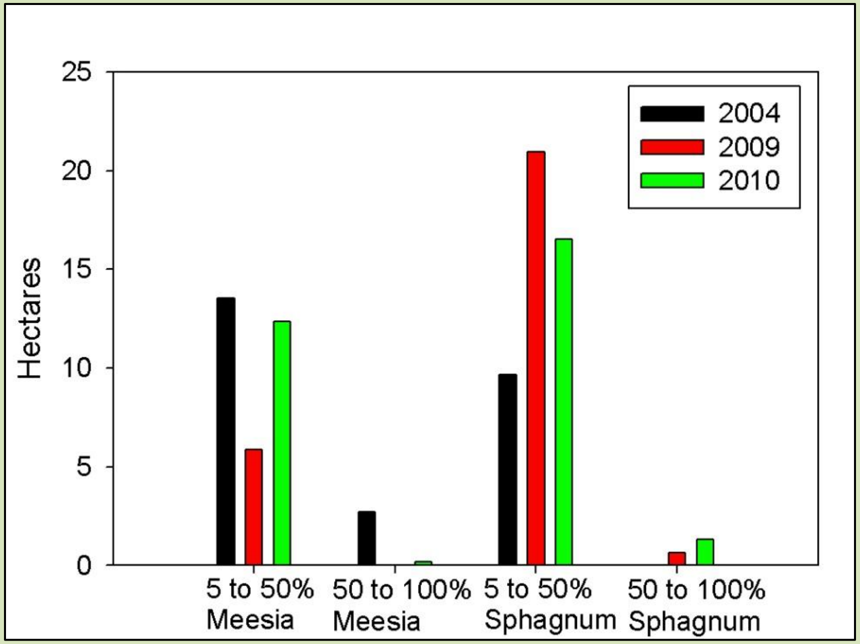
Climate Data

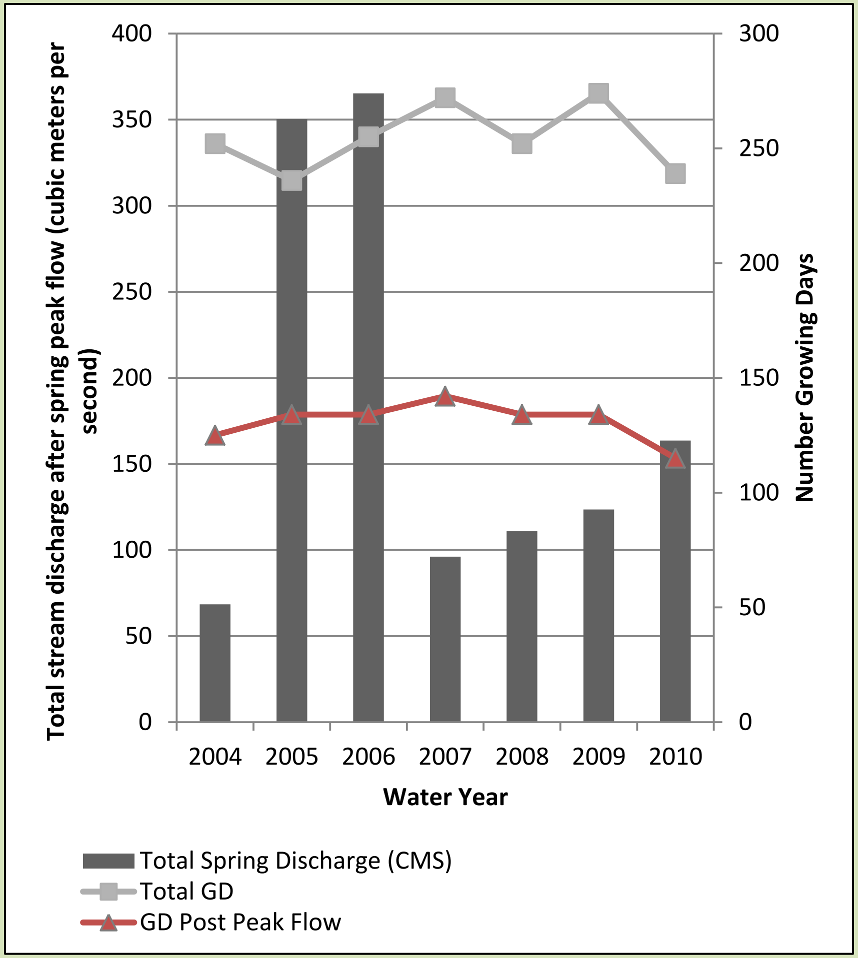
- Water Year
- Total Growing Days
  - Echo Peak SNOTEL[1]
  - >2^0 C[2] ave daily temperature
- Growing days since peak spring flow
  - Echo Peak SNOTEL[1]; USGS Meyers gauge[3]
  - >2^0 C ave daily temperature post peak stream flow
- Total stream discharge after peak stream flow
  - USGS Meyers gauge[3]

[1] http://www.wcc.nrcs.usda.gov/snow/snotel-precip-data.html; [2]Gignac et al. 1991; [3] http://waterdata.usgs.gov/nwis/rt

Bryophyte Area and Climate







1 ha = 2.47 acres

Summary

- Since 2004
  - Rapid contraction and expansions of bryophyte cover
  - Decrease of *Meesia triquetra*
  - Increase of *Sphagnum* spp.
  - Increase total spring discharge (magnitude varies year)
  - Number Growing Days vary by year
- Look to other potential climate variables explain trend
- Continue Monitoring

Acknowledgements

- **Field Personnel**
  - Blake Engelhardt
  - Alison Stanton
  - Beth Brenneman
  - Cristina McKernan
  - Emily Millar
  - Erik Frenzel
  - Eva Olin
  - Jody Fraser
  - Justina Fedorchuk
  - Katie Heard
  - Kim Gorman
  - Stu Osbrack
- **Funding**
  - Southern Nevada Public Lands Management Act