Monitoring Forest Response to Past and Future Global Change in Greater Yellowstone

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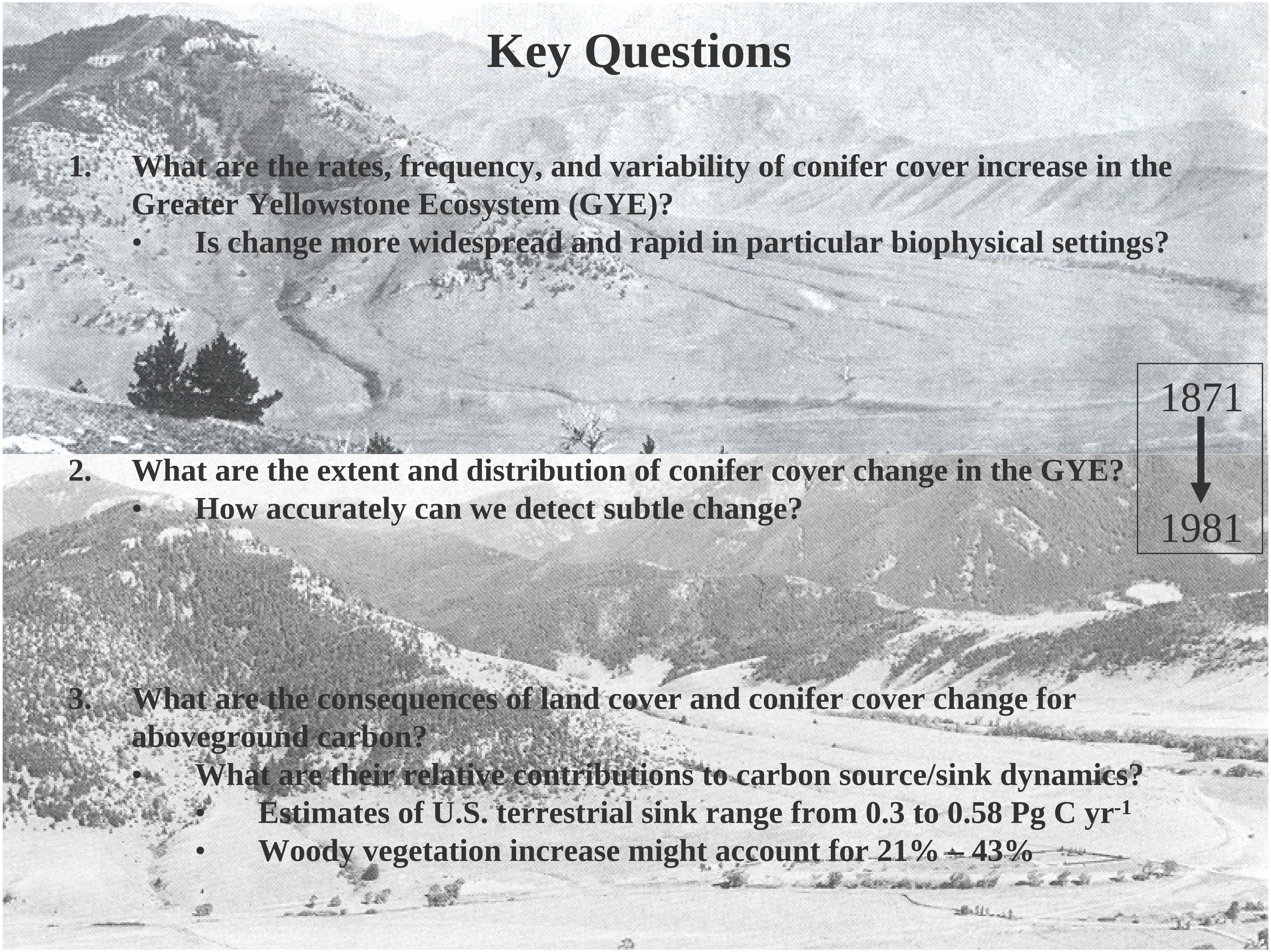
Key Questions



1. What are the rates, frequency, and variability of conifer cover increase in the Greater Yellowstone Ecosystem (GYE)?
   - Is change more widespread and rapid in particular biophysical settings?

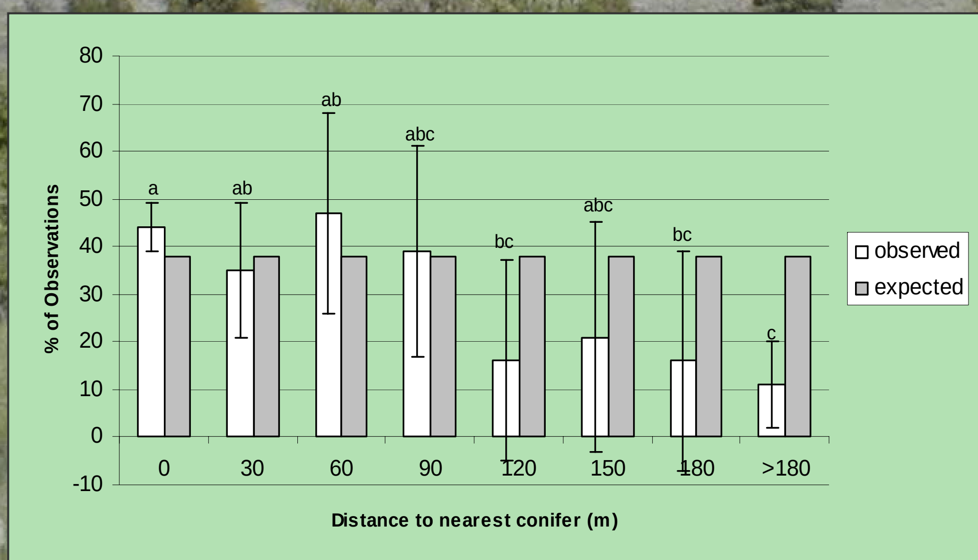
2. What are the extent and distribution of conifer cover change in the GYE?
   - How accurately can we detect subtle change?

3. What are the consequences of land cover and conifer cover change for aboveground carbon?
   - What are their relative contributions to carbon source/sink dynamics?
     - Estimates of U.S. terrestrial sink range from 0.3 to 0.58 Pg C yr^{-1}
     - Woody vegetation increase might account for 21% – 43%

Key Results 1

1. **What are the rates, frequency, and variability of conifer cover increase in the Greater Yellowstone Ecosystem (GYE)?**

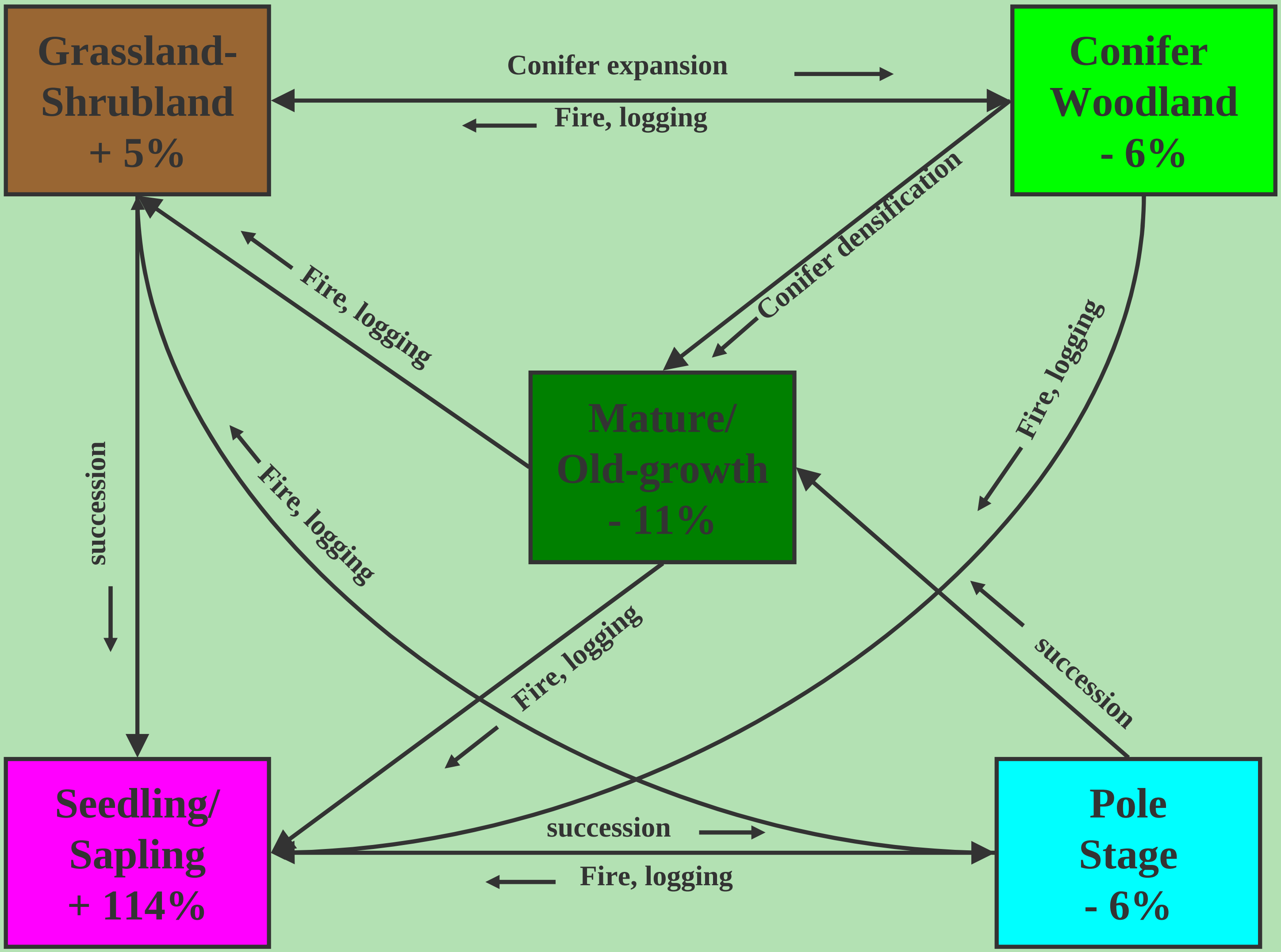
- **Between 1971 and 1999, 38% of eligible (conifer cover < 100%) samples increased in conifer cover, at an average rate of 0.22% per year.**
- **10% percent of eligible area increased in conifer cover between 1971 and 1999.**
- **Rates of change varied across sampling transects from 0% per year to 0.61% per year.**
- **Rates and frequencies of conifer cover increase varied significantly by elevation, distance to nearest conifer stand, vegetation type, and interactions between these biophysical factors, but did not vary significantly by solar aspect alone.**



Observed vs. expected frequency of conifer cover increase by distance to nearest conifer stand. Frequencies are shown with Bonferonni corrected 95% confidence intervals. Frequencies with the same letter do not differ significantly.

Key Results 2

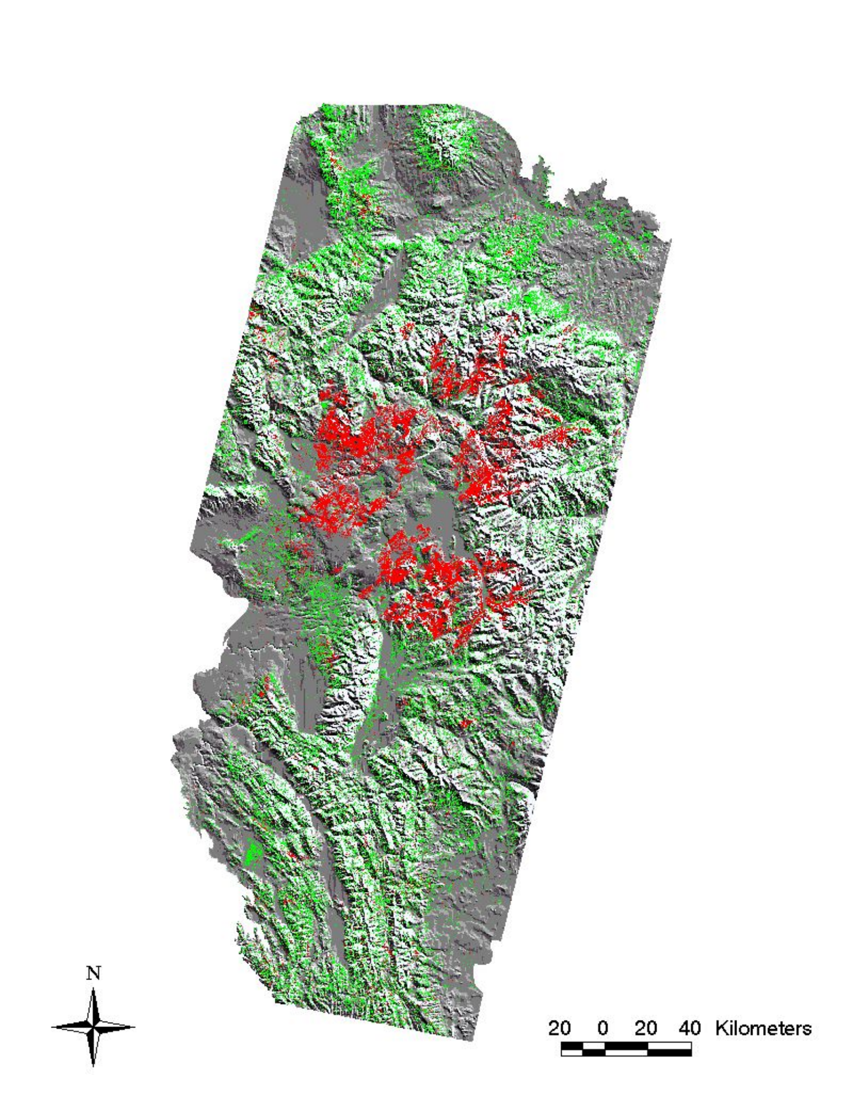
2. What are the extent and distribution of conifer cover change in the GYE?



Vegetation changes and trajectories 1985-1999

Key Results 3

3. What are the consequences of land cover and conifer cover change for aboveground carbon?



Carbon Sinks & Sources 1985-1999

Carbon sink

- expansion
  - + 274 kg C ha^{-1} yr^{-1}
  - 90,323 ha
  - **25 Gg C yr^{-1}**
- densification
  - + 579 kg C ha^{-1} yr^{-1}
  - 594,752 ha
  - **344 Gg C yr^{-1}**
- seral stage advancement
  - + 699 kg C ha^{-1} yr^{-1}
  - 59,833 ha
  - **42 Gg C yr^{-1}**

Carbon source

- seral stage regression
  - - 3,180 kg C ha^{-1} yr^{-1}
  - 337,394 ha
  - **- 1,073 Gg C yr^{-1}**

Net Carbon Change:
= Source – Sink
= **- 662** Gg C yr^{-1}

Carbon sink associated with conifer cover increase offset 34% of carbon source

Key Conclusions

- The structure and composition of conifer forests and conifer-grassland ecotones in the GYE are rapidly changing.

- Rates and frequency of change are highly variable according to biophysical setting.
  - Proximity to seed source and microsite conditions are key factors.

- Understanding of variability in conjunction with improved remote sensing techniques enable quantification of the extent of change.
  - Overall accuracy of subtle conifer cover change detection = 68%

- Conifer cover increase accounts for a significant carbon sink, though previous literature estimates for the northern Rocky Mountains are likely high.
  - Overestimated by ~18 times for expansion and ~4 times for densification.

- Temporal duration of a forest carbon sink remains in question due to the risk of fire.
  - 44% of conifer cover increase occurred in areas that were moderately or significantly departed from their historical fire regime.

- More research along these lines is necessary to document changes in conifer forests in many other regions, and improve estimates of regional/national/global carbon dynamics.

Publications

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Powell, S.L., et al. In prep. Conifer cover increase in the northern Rocky Mountains: Rates, determinants, and consequences for carbon storage and fire. BioScience.