A research framework for biodiversity insurance effects on climate change-induced phenological mismatch

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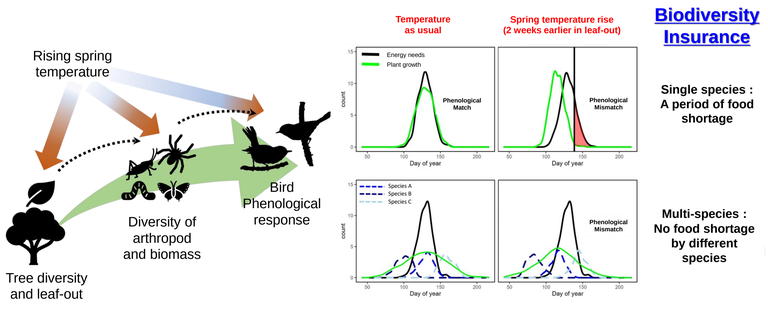
Main Conclusions

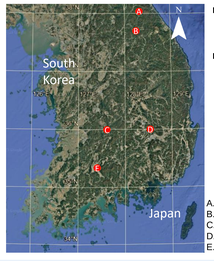
- Recently, some researchers have shown that biodiversity can alleviate climate change-induced phenological mismatch in species interactions.
- In this study, we established a research plan and conducted a pilot study to confirm the difference in the degree of phenological mismatch according to the tree species diversity by latitude and altitude.
- We confirmed that biodiversity can have a positive effect on the adaptation of species to climate change.

Objectives

- The spring temperature rise caused by climate change may accelerate the leaf-out period of plants and the emergence period of insects, but the breeding period of vertebrate birds may not advance accordingly, resulting in phenological mismatch.
- The Biodiversity Insurance Hypothesis, one of the major theories that explains the resilience and extent of damage to ecosystem disturbances, predicts that when an ecosystem has a diverse species, rather than a simple ecosystem with low diversity, the degree of response of each species to disturbances is also different, so recovery after disturbances is faster and damage caused by disturbances is less.
- This study aims to confirm how phenological mismatch at the landscape scale alters plant-arthropod-bird food web interactions within forests and how the impact of phenological mismatch is influenced by biodiversity derived from tree diversity.



Study sites



A. Inje
B. Pyeongchang
C. Muju
D. Gyeongsan
E. Gwangyang

- Total 26 study sites. They are configured by latitude, elevation and tree species diversity.
- The location of the study plots was selected in consideration of the elevation, the tree diversity, the accessibility and stability in the national forest and the academic forest.

High Latitude

Elv. \ Species	Diverse	Simple
High	A1, A2	A3
	B1	B2
Low	A4	A5, A6
	B3	B4

Medium Latitude

Elv. \ Species	Diverse	Simple
High	C1	C2
	D1	D2
Low	C3	C4
	D3	D4

Low Latitude

Elv. \ Species	Diverse	Simple
High	E1	E2
	E3	E4
Low	E5	E6
	E7	E8

Research Questions

1. When the spring temperature rises due to climate change, does **the diversity of tree species in the forests contribute to the occurrence period and diversity of the bird's prey species**?

2. Even if a phenological mismatch between the period of bird breeding and insect occurrence, can **birds use the food resources more stably if the diversity of tree species in the forests is high**?

3. Can the supply of stable food resources due to **biodiversity insurance effects alleviate the impact of phenological mismatch** caused by climate change experienced by breeding bird's populations?

Field survey

Breeding bird (Nest-box)

- Species Identification
- Nest building (stage 1 ~ 4)
- Eggs, Hatching rate
- Day for leaving the nest
- Breeding failure

Bird food

- Max larva season of occurrence of Lepidopter
  - Using Frass trap
- Diversity of bird food
  - Using Frass trap and collect the baby bird's poop

Leaf-out period

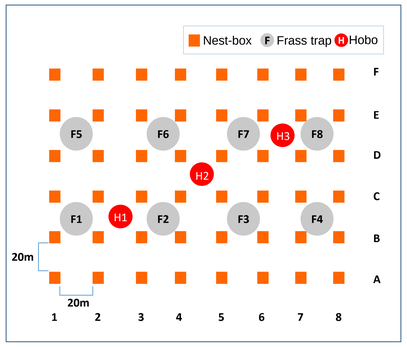
- A time-lapse sequence of canopy layer using trail camera

Air temp. in spring

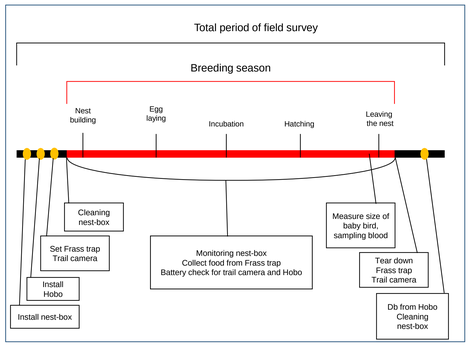
- Using Automatic Weather System (Hobo)

Space and time plan for field survey

- A total of 48 nest-box were installed in each study site, 8 wide and 6 long. Each nest-box was installed 20m apart from each other. 8 frass traps were installed in each target area, and 3 temperature measurement sensors were installed.
- The entire process of bird breeding was monitored. In particular, egg laying and hatching dates were intensively monitored to find the exact dates.



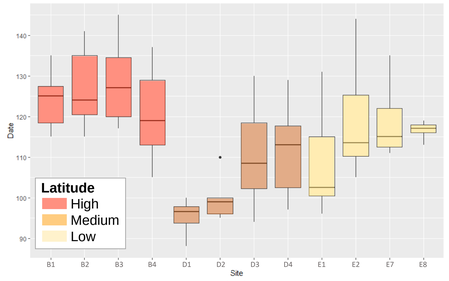
< Survey Quadrat Design >



< Time schedule for field survey>

Initial results

- Egg laying and hatching dates were found to be the latest in high latitudes (B sites). Mid-latitudes (D sites) showed earlier phenology than low latitudes (E sites). It seems to be because the study sites in the low latitudes were relatively high in altitude and the latitude difference was not large, despite being in the same low-altitude group.
- In addition to the results of this study, we're going to further evaluate the degree of phenological mismatch by comparing temperature and frass trap data.



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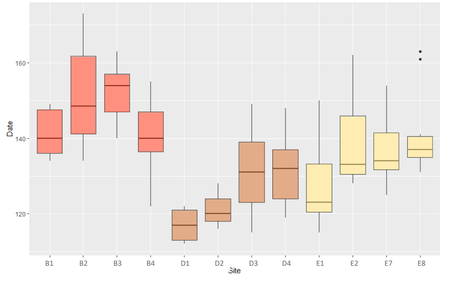

< Hatching date >

Discussions

- The initial results are not enough to answer the our research questions. However, if data is collected through field surveys for more than three years, it will be possible to confirm the impact of phenological changes due to climate change.