Quarter-century monitoring of seedfall and tree growth in a forest dynamics plot, northern Japan

JaLTER

Compilation and handling of an “ecological big data”

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Forest inventory and environmental monitoring

- Inventory datasets have contributed to:
  patterns of species diversity, forest biomass, etc.
  identification of conservation hotspots

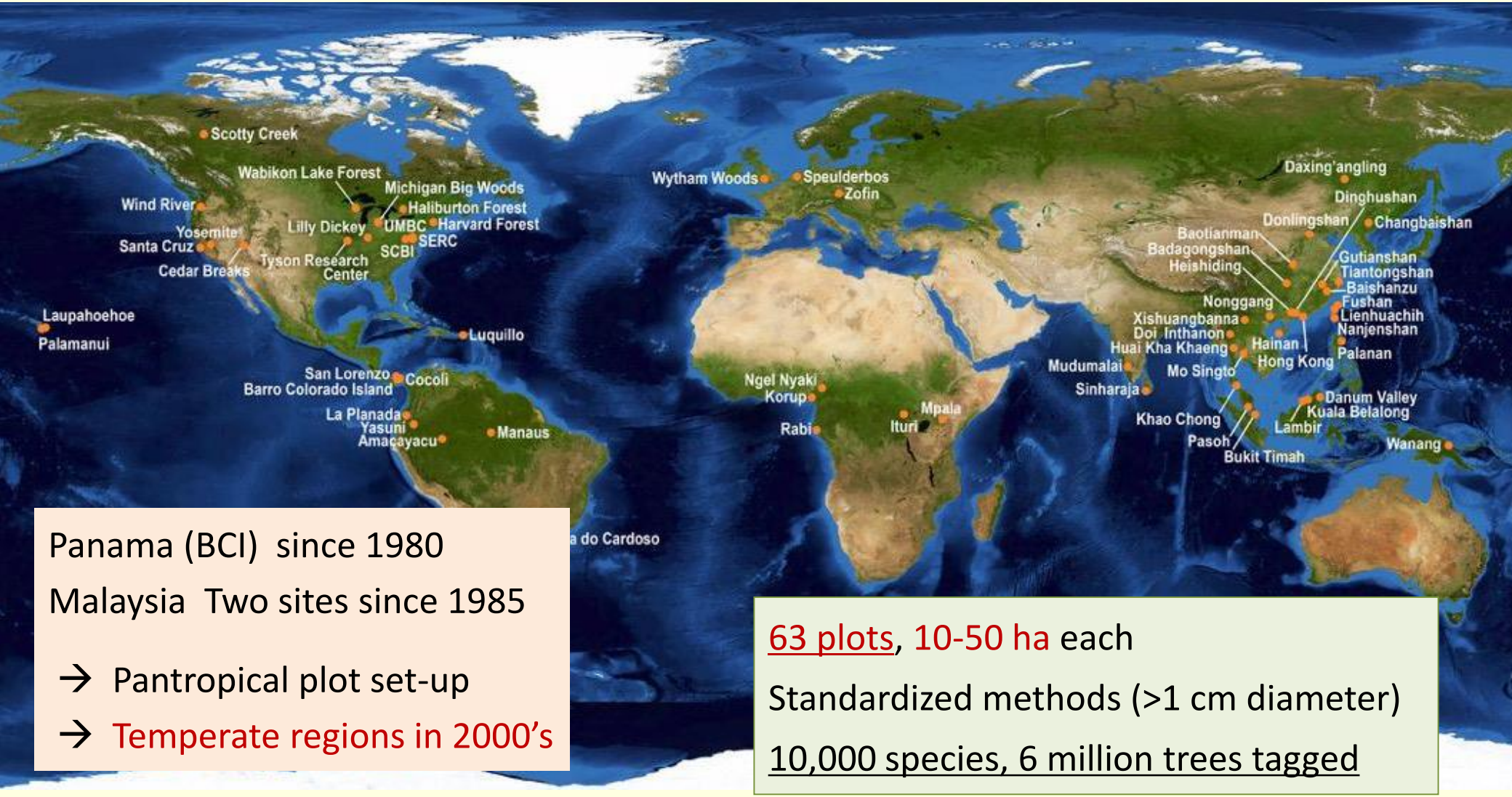
- Moreover, we need to identify/predict ecosystem responses to environmental changes;
  However, inventory is often “snapshot”

- To evaluate change along time, forest dynamics plots (FDPs) are powerful.
- So far, many FDPs have been set up over the tropics, as well as Asia-Pacific region

A network of FDPs is growing over the planet

ForestGEO

by: Center for Tropical Forest Science, Smithsonian Tropical Research Institute



Panama (BCI) since 1980

Malaysia Two sites since 1985

→ Pantropical plot set-up

→ Temperate regions in 2000's

63 plots, 10-50 ha each

Standardized methods (>1 cm diameter)

10,000 species, 6 million trees tagged

The focus of this talk

(1) To briefly summarize monitoring via FDPs in Japan

(2) To introduce our long-term datasets:
on tree diameter growth and
on flowering/fruiting records
in a temperate mixed-species forest, northern Japan

(3) With these datasets, to introduce some results showing signs of community-wide changes in recent decades under climate change

Two types of Forest Dynamics Plots (FDPs) in Japan

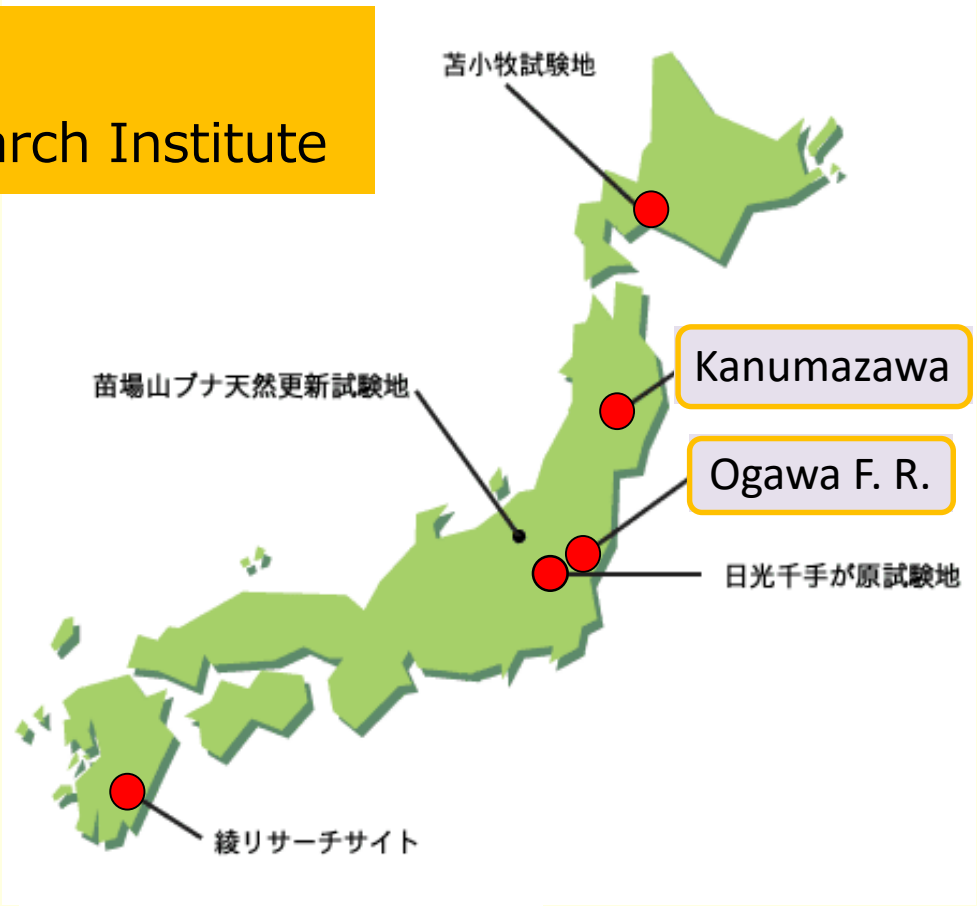
(1) FDP network by Forestry and Forest Products Research Institute

6 plots (4-6 ha each)

1987 Ogawa Forest Reserve
(eastern highlands)
→ most successful, flagship site

1988 Kanumazawa Riparian Forest
(northern mountains)

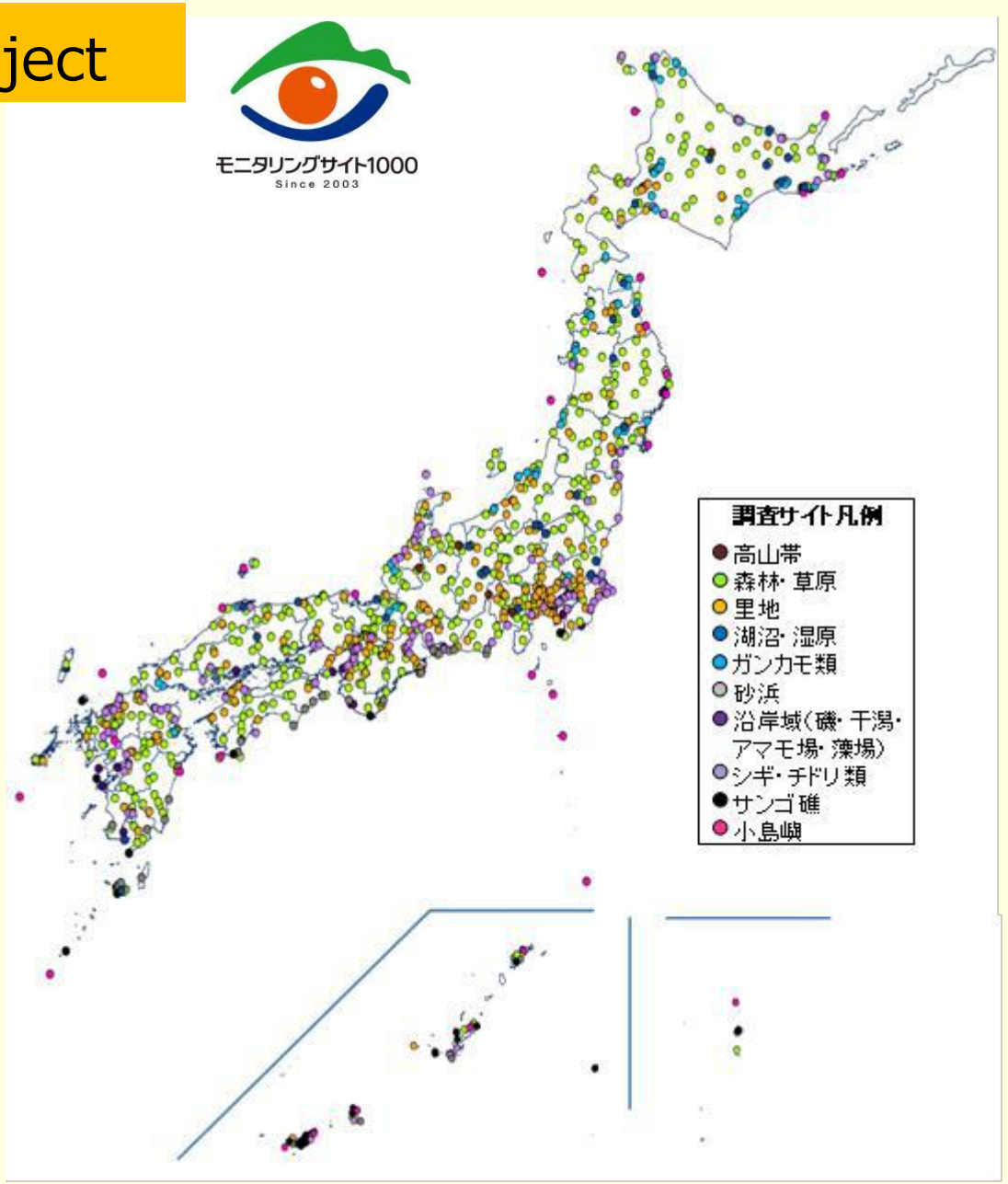
1990~ Other 3 plots



国立研究開発法人
森林総合研究所
Forestry and Forest Products Research Institute

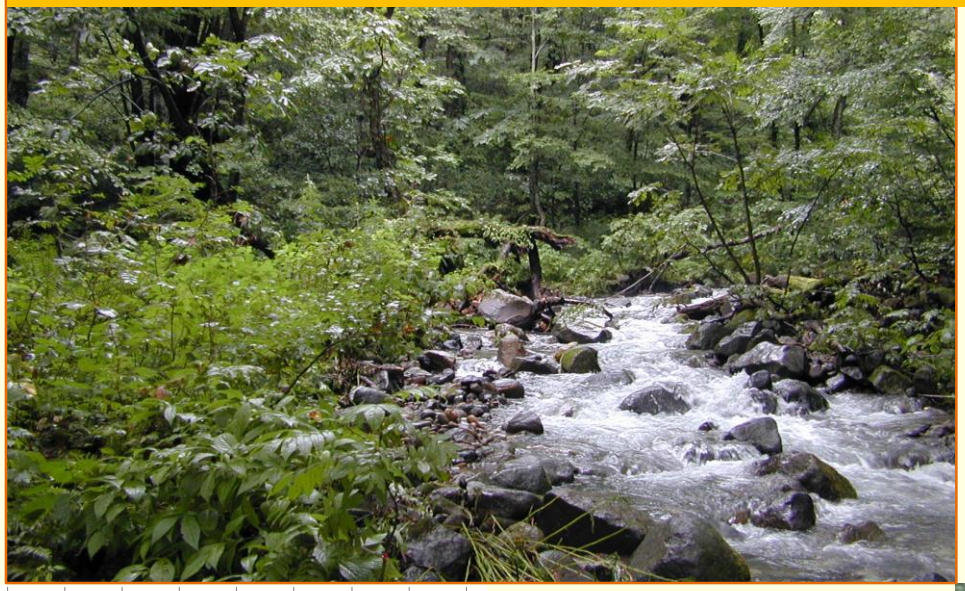
(2) Monitoring Sites 1000 project

- Founded by Ministry of the Environment, Japan
- Initiated in 2003
- Various types of ecosystems;
  alpine zones,
  grasslands,
  forests
  lakes,
  salt marshes etc.
- 21 FDPs, including FFPRI's plots, have been intensively investigated (1 ha each)

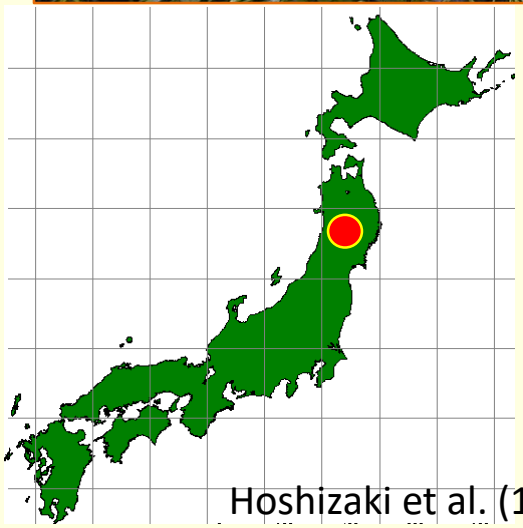


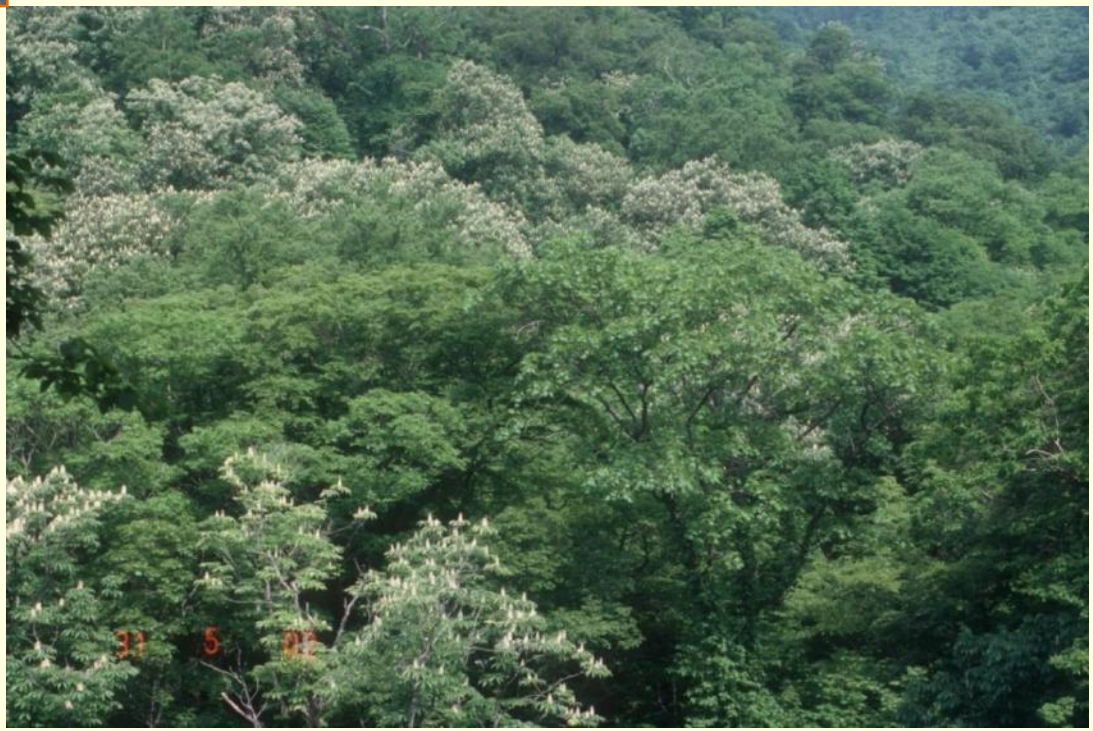
Kanumazawa Riparian Research Forest

a core site of Monitoring Sites 1000
formal site of JaLTER /ILTER



- Cool temperate climate, landscape is beech-dominated
- Along creeks, species-rich stand
- 4.71ha permanent plot since 1988
- Tree census, seed-trapping, seedling census





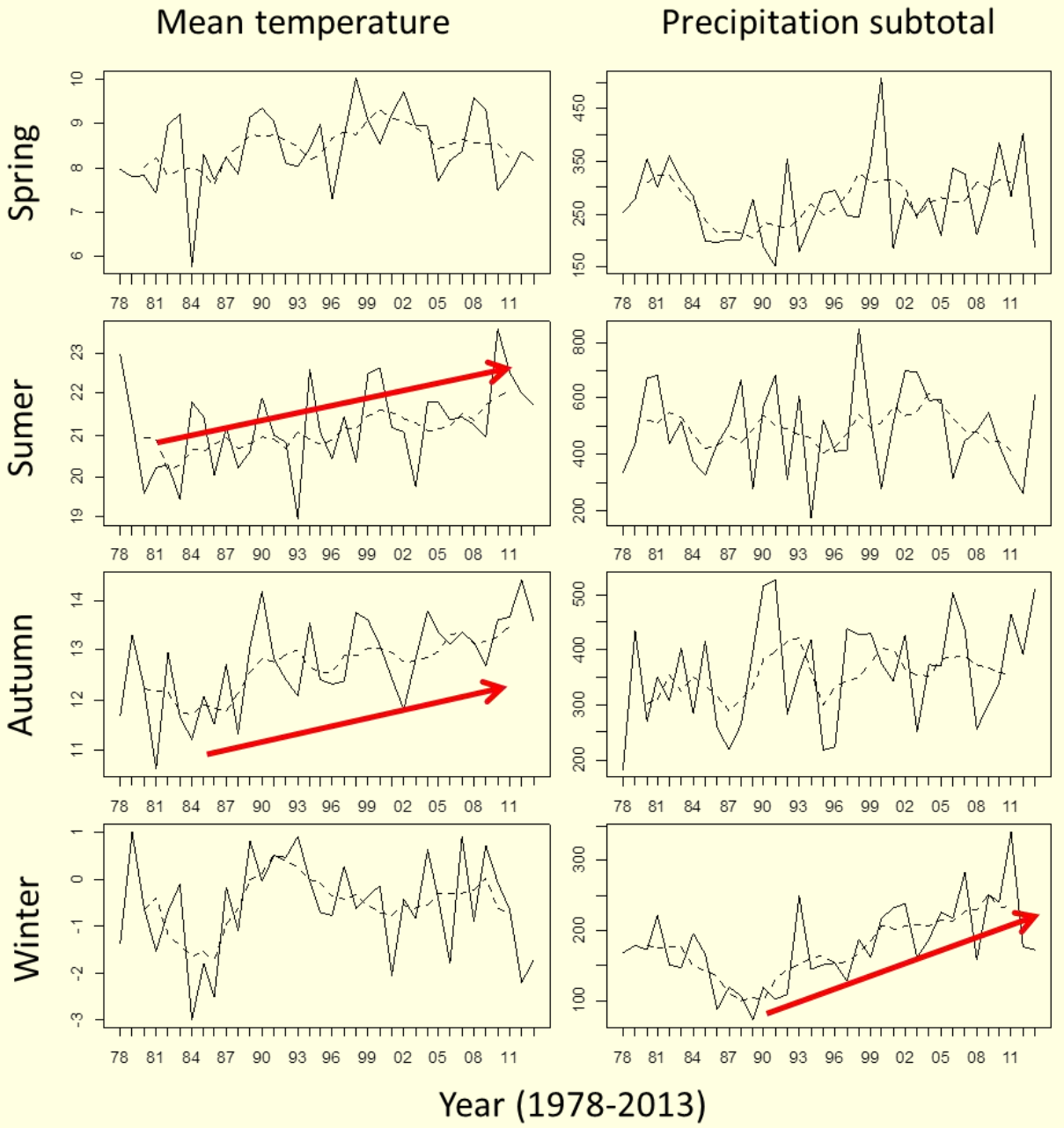
Hoshizaki et al. (1997) J Veg Sci
Suzuki et al. (2002) For Ecol Manage
Masaki et al. (2007) Ecol Res
Oki et al. (2013) Ecoscience

Climate change in the region

Meteorological data at the nearest weather station

- Summer getting hotter and longer
- More winter snow

Has tree community responded to the changing climate??

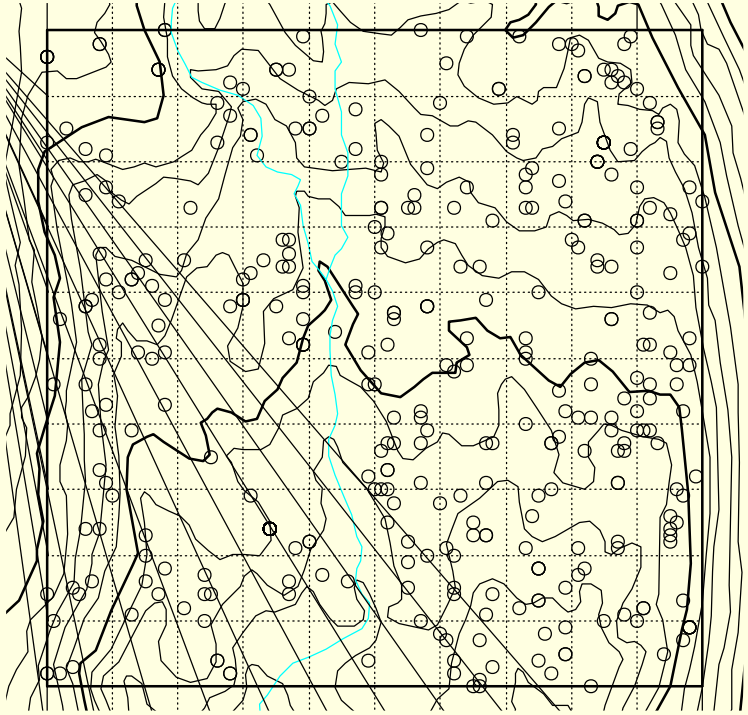



Part 1:
Tree census data

Tree census parameters

- Species composition (diversity),
  abundance (in # of stems, basal area, volume)

- Spatial distribution



Tree census parameters

- Species composition (diversity),
  abundance (in # of stems, basal area, volume)

- Spatial distribution

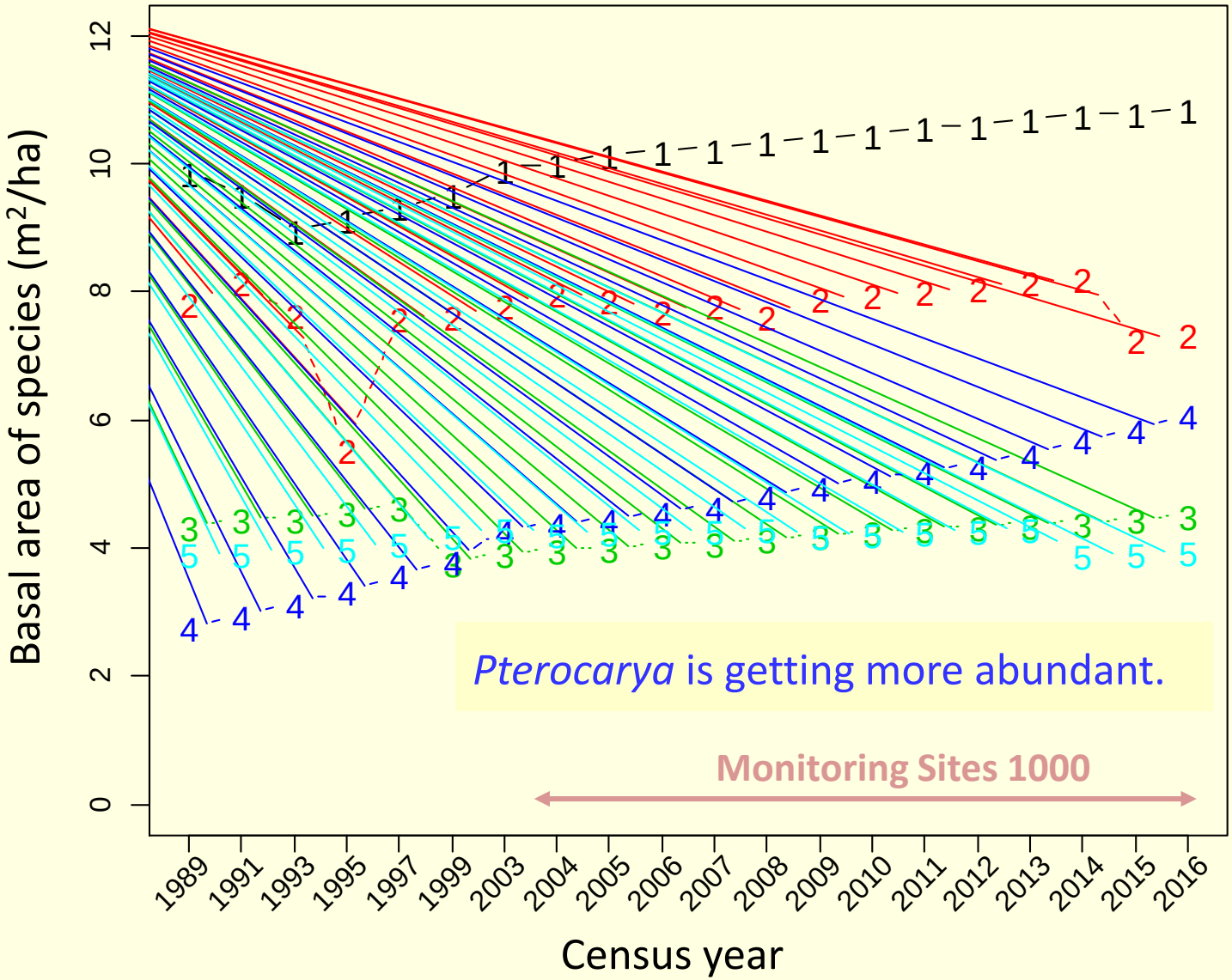
- Repeated census provides:
  - individual tree growth
  - stand growth
  - recruitment of young trees

- Long-term data is required to
  detect meaningful pattern

Our dataset covers:

22 years (1993-2015), 5132 stems in 4.71-ha whole plot; and
27 years (1989-2016), 1077 stems in 1-ha core area

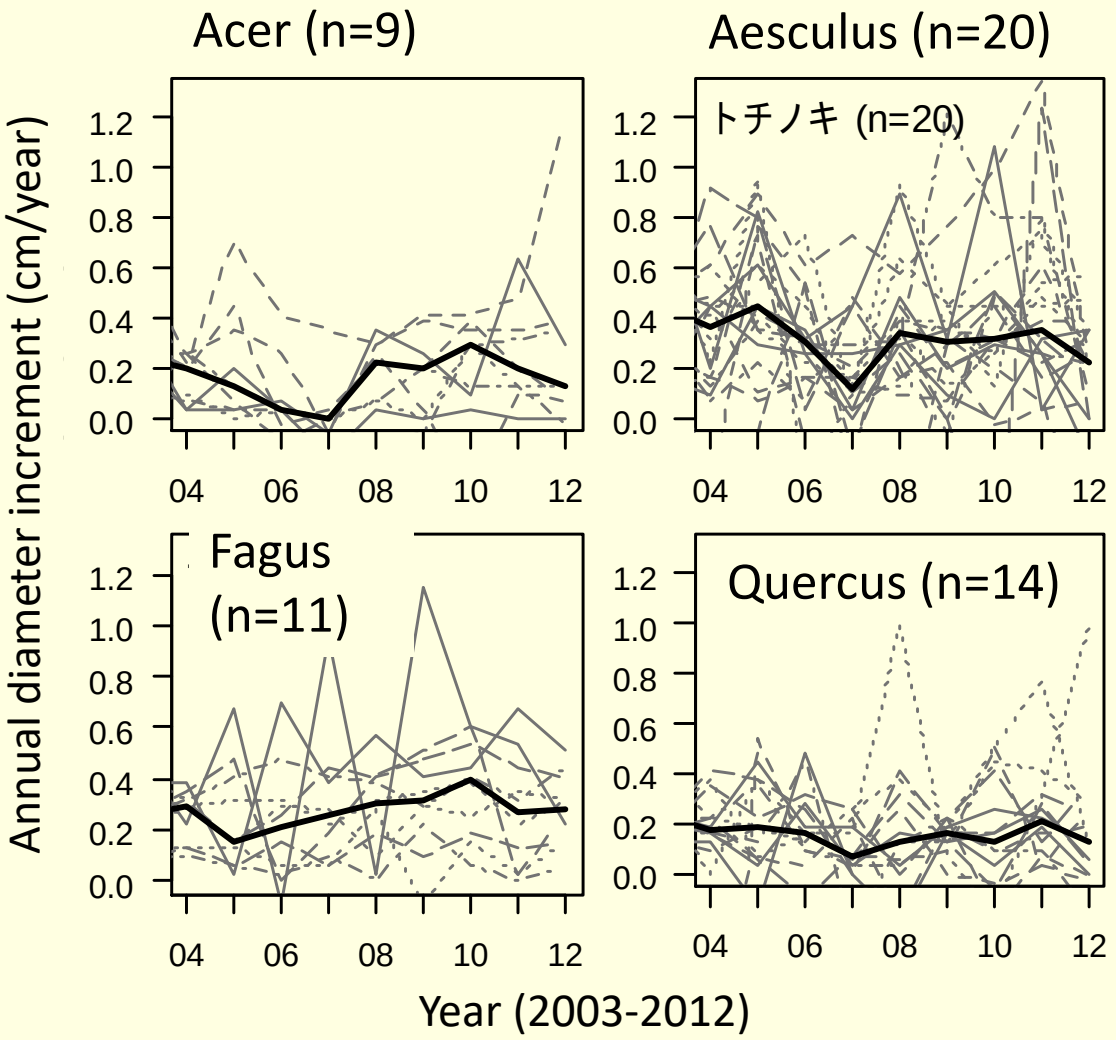
Stand growth during decades



1 *Aesculus*
2 *Cercidiphyllum*
3 *Fagus*
4 *Pterocarya*
5 *Quercus*

Noguchi, Hoshizaki et al. (unpublished data)

Individual growth and annual weather (1)

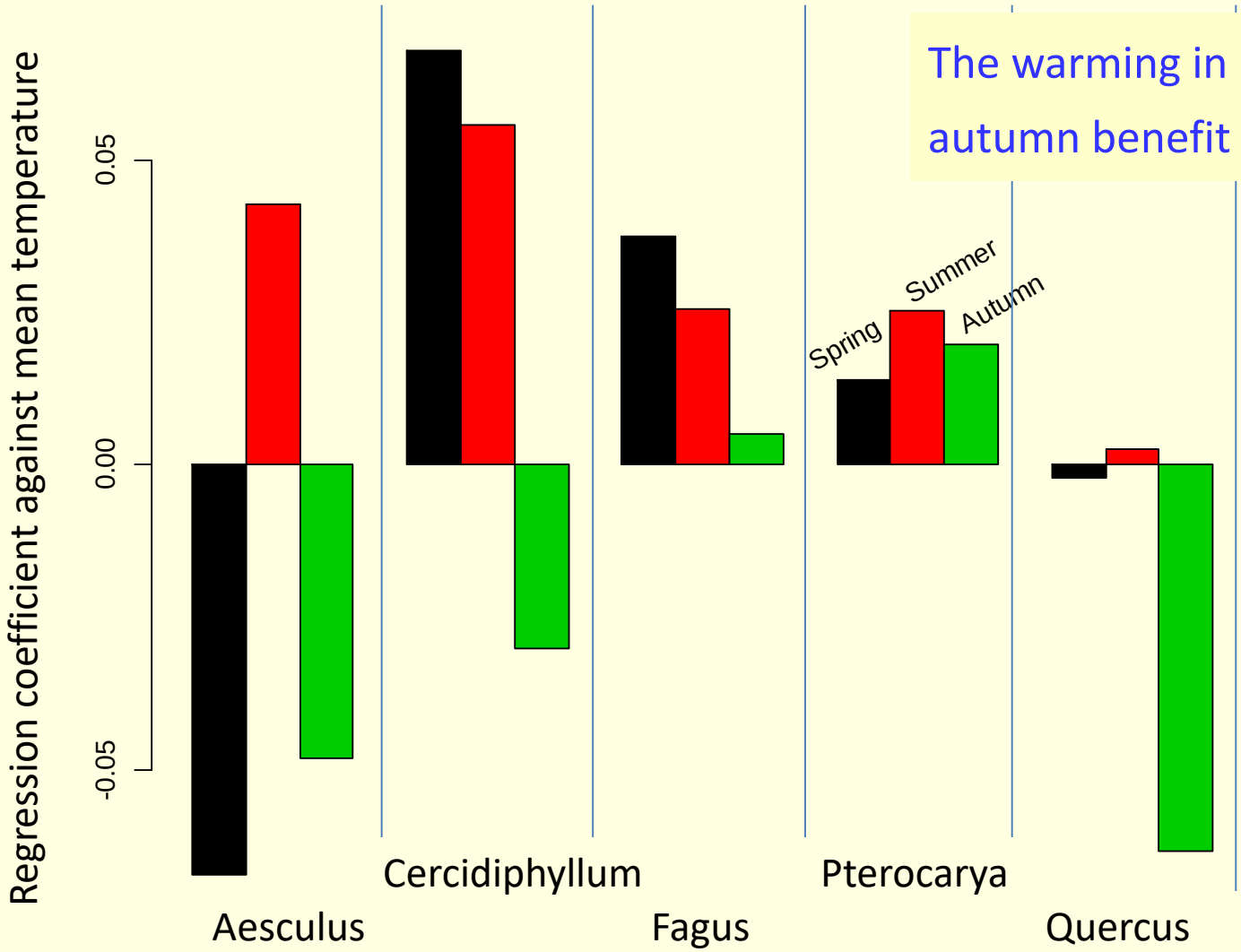


- Diameter increment varies annually
- In some species, tree growth appears to synchronize between individuals

(Matsushita, Hoshizaki et al., in prep.)

Individual growth and annual weather (2)

Sensitivity of diameter increment to annual weather



The warming in both summer and autumn benefit *Pterocarya* most

Matsushita, Hoshizaki et al. (in prep.)

Part 2: Seed trap data

- Compared with litter-trap studies, less attention has been paid to seed trapping in environmental sciences

- Annual variation in seedfall, i.e. masting, is an important phenomenon:

  Masting provides fitness benefit (regeneration) for trees

  Resource pulse/starvation influences the entire ecosystem, including human-wildlife conflicts (e.g., bears' home-range enlargement)

  Masting has been suggested to cued by weather but only evidenced in some well-studied species

- Is there any trends in flowering and/or seeding discernible in the dataset?

Spatially placed seed traps is a feature of FFPRI's FDPs

>25 year monitoring

- 60-121 traps/yr (depending on years)
- Installed in 1-ha core area
- Sample collection: biweekly or monthly

Collection of litters/seeds

Trapping efforts in Kanumazawa

- Since 1989 (starting 50 traps)
- 17,000 trap·month in total

Data summary (dataset compiled: 1990-2013)

Item	N for 23 yr	%
Flower/inflorescence	660,023	41.8%
Fruit/seed	807,626	51.2
Husk/other tissue	110,830	7.0
Total	1,578,479	100

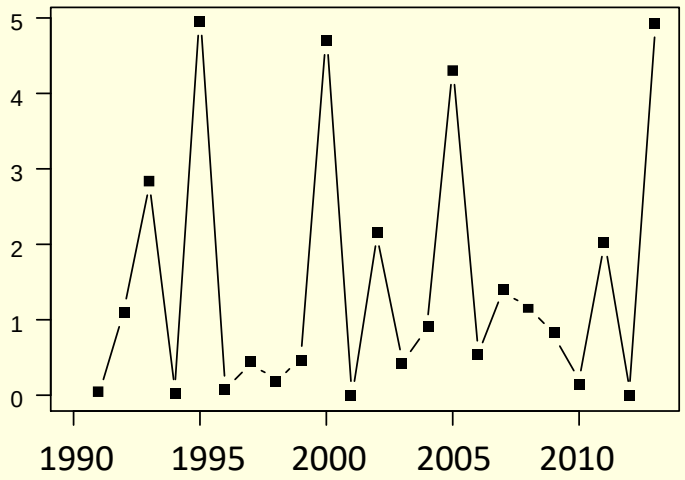
68,500 records includes:
- 1,580,000 items,
- 40 species

The dataset is growing annually

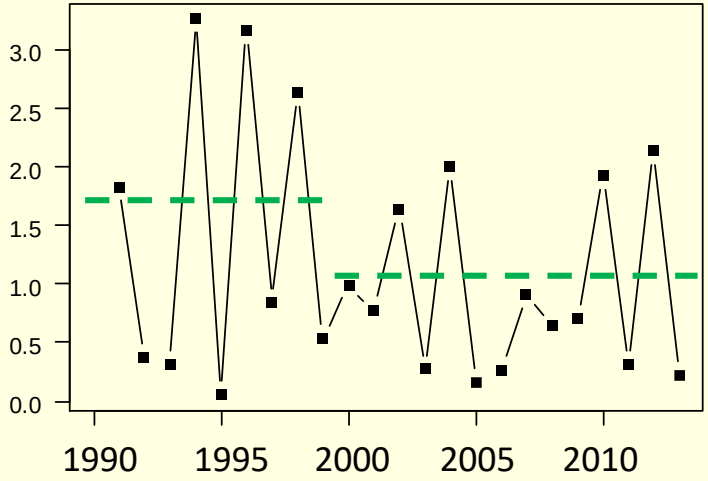
Annual values in reproductive investment = *Dry weight of flowers + seeds*

Annual female reproductive investment (per capita g/m^2)

Fagus cv 1.14

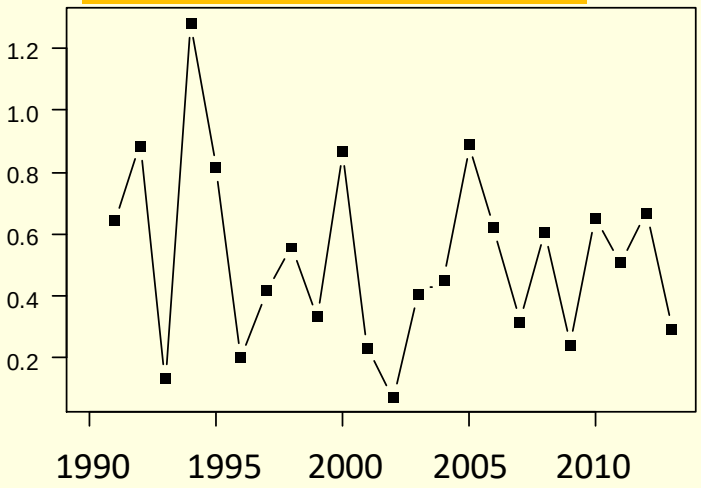


Quercus cv 0.88

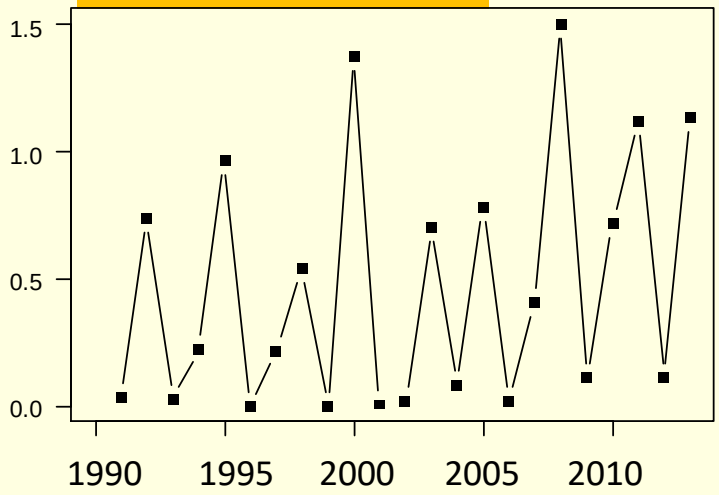


Masting discernible in many species

Cercidiphyllum cv 0.58



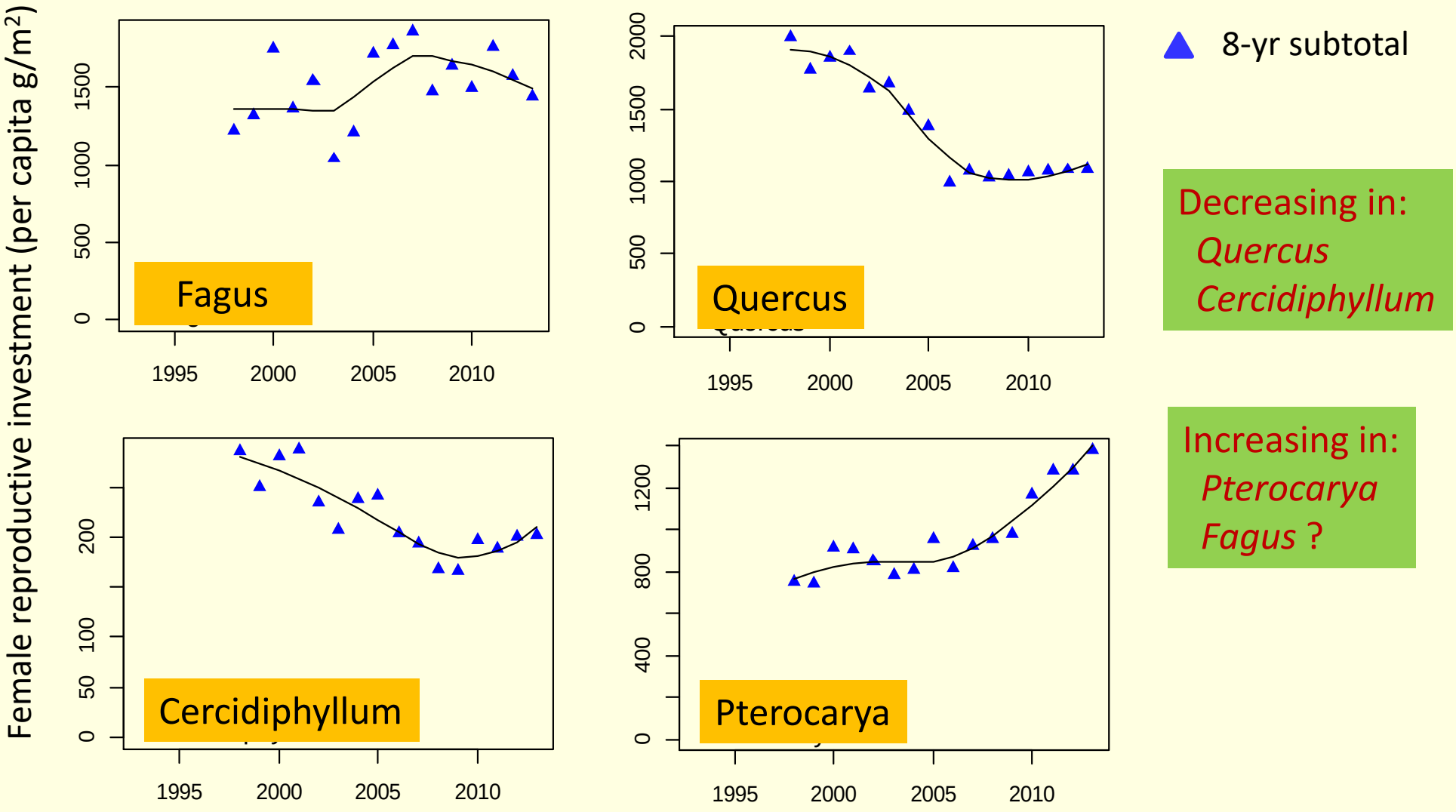
Pterocarya cv 1.03



Decreasing in *Quercus*?

Mean level & amplitude

Long-term changes in reproductive trends



Discussion

1) Trend changes detected in Kanumazawa in decades

- Contrasting changes by species;

  Dominance ranking has changed

  Reproductive investments are increasing or deceasing

- The change in masting might result in cascades through species interactions in the entire ecosystem to our daily QOL (e.g. human-wildlife conflicts), etc.

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2) Next steps to be fixed

1) These changes suggest association with the changing climate, but does not tell causality; >30 years required for time-series analysis

2) Under the current climate regime, what forest is projected? Are the changes consistent in other sites/regions/countries?

3) Potential collaboration topics and difficulties

- Geographic/phylogenetic variation; cascades across wider spatial scale or wider stakeholders
- Many FDPs in Malaysia, Thailand, China, Taiwan Is., Japan, etc.
- Optimize “big dataset” for analysis; we need not to merely continue observation but to handle the growing “big data”
- Interesting/attractive research questions called-for

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← Field sampling

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Ministry of Education, Culture, Sports, Science and Technology

← Research budgets,
Facility