ECOLOGY AT THE INTERFACE
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Bio-monitoring: lessons from the past, challenges for the future

Plant strategies as biological indicators of ecosystem services

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Types of ecosystem services

Provisioning

the supply of ecosystem products (affecting food, fuel and water)

Supporting

such as nutrient cycles, photosynthesis and ecosystem processes that allow other services to proceed

Regulating

controlling the extent of environmental processes, including climate change

Cultural

spiritual, recreational and scientific benefits

Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Synthesis.* Island Press, Washington (DC), USA.

Methods: trait-based ecosystem service indices for 60 herbaceous communities

Provisioning

Index of 'biomass' based on:

Community above-ground dry weight (AGDW)
and community-weighted mean (CWM):
Canopy height (CH) $_{CWM}$
Leaf dry weight (LDW) $_{CWM}$

=SQRT((AGDW/10)*CH*LDW)/1000

Supporting

Index of 'flowering nitrogen use period' (potential extent and period of support for flowering from leaf nitrogen):

Leaf nitrogen content (LNC) $_{CWM}$
Flowering start (FS) $_{CWM}$
Flowering period (FP) $_{CWM}$

=SQRT(LNC*(6-FS)*FP)*2

Regulating

Index of 'carbon sequestration' based on:

Community below-ground dry weight (BGDW)

Leaf carbon content (LCC)$_{CWM}$

=(BGDW*LCC)/20000

Cultural

Index of 'botanical quality' based on relative abundance, within the plant community, of:

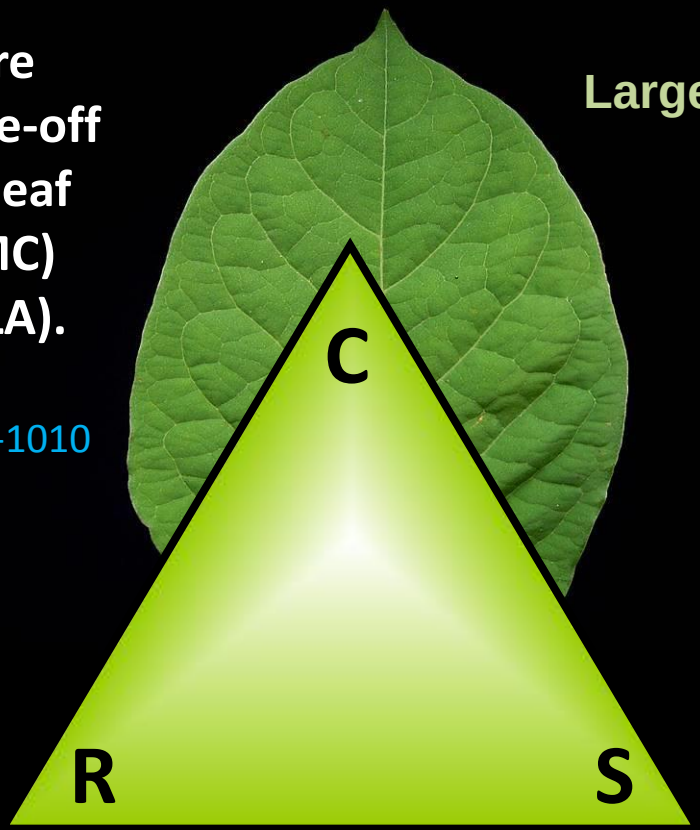
Protected species (PS)
Black list species (BL)
Species with evident/aesthetic flowers (SF)

=(PS+(100-BL)+SF)/20

Methods: CSR analysis

Grime's CSR strategies are calculated from the trade-off between leaf area (LA), leaf dry matter content (LDMC) and specific leaf area (SLA).

Pierce *et al.* (2013)
Functional Ecology 27(4): 1002-1010



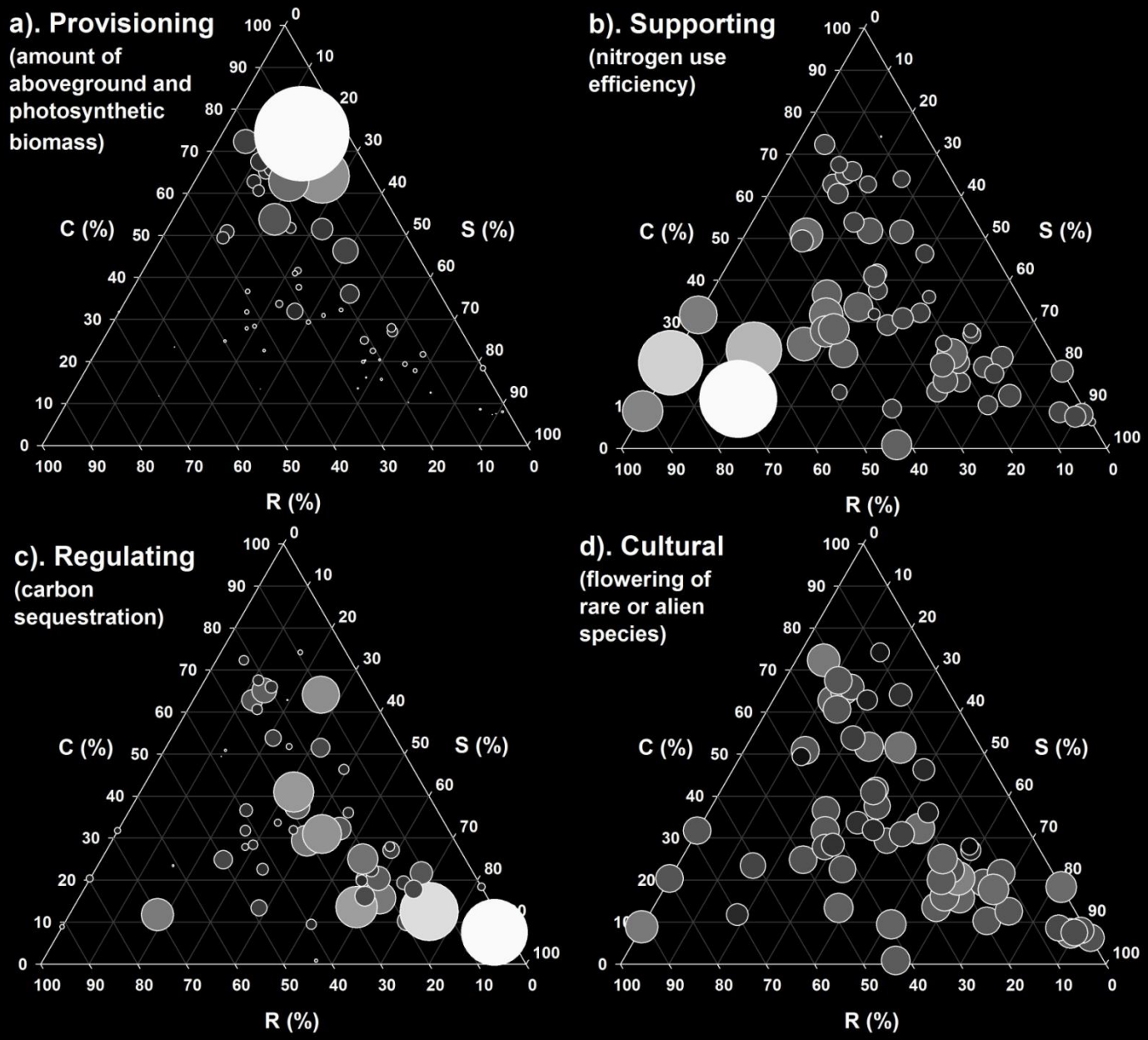
Competitors:
Large (high LA), intermediate economics

These traits are NOT used in the calculation of the four ecosystem service indices

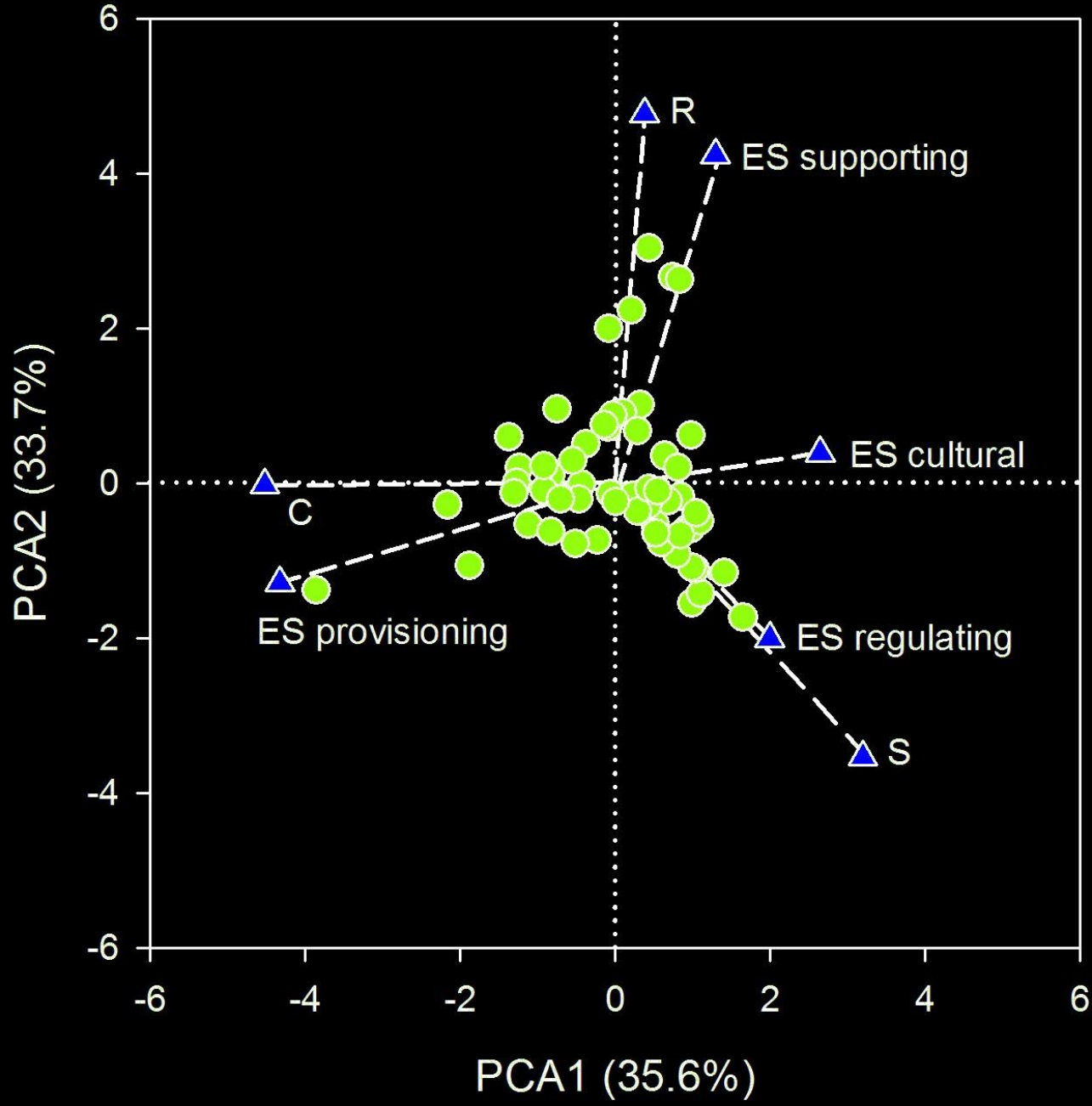
Ruderals:
Small, soft, acquisitive economics (high SLA)

Stress-tolerators:
Small, tough, conservative economics (high LDMC)

CSR as a framework for ecosystem service assessment

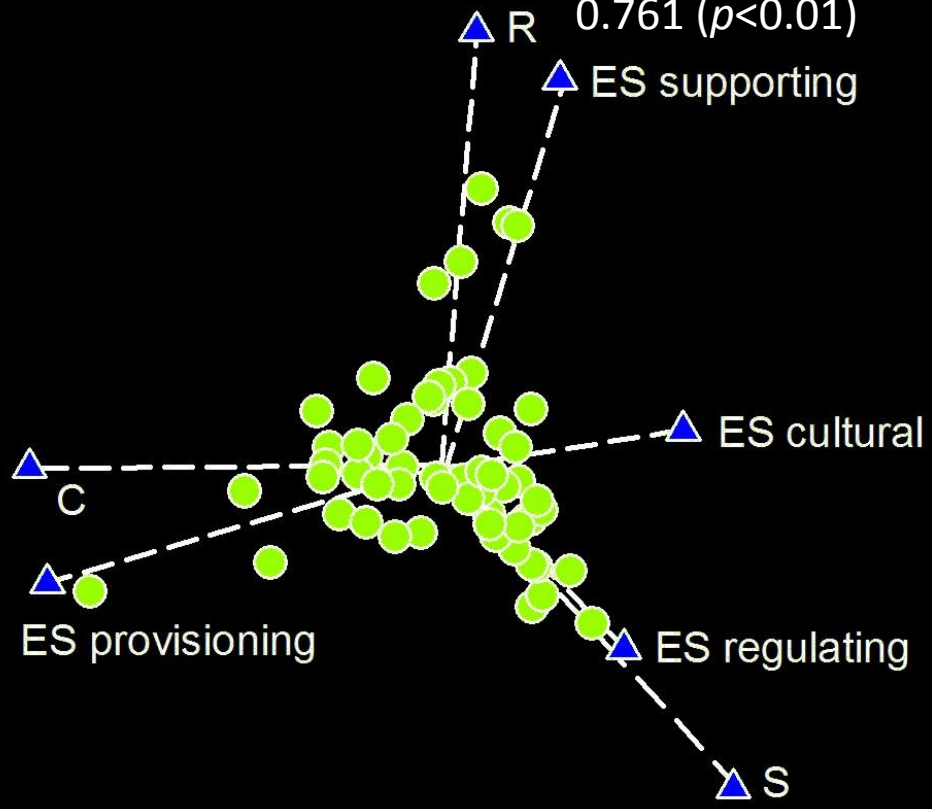


Relationship between community types, plant strategies and ecosystem services



Relationship between community types, plant strategies and ecosystem services

Pearson's correlation coefficient between R and Supporting ES index = 0.761 (p<0.01)

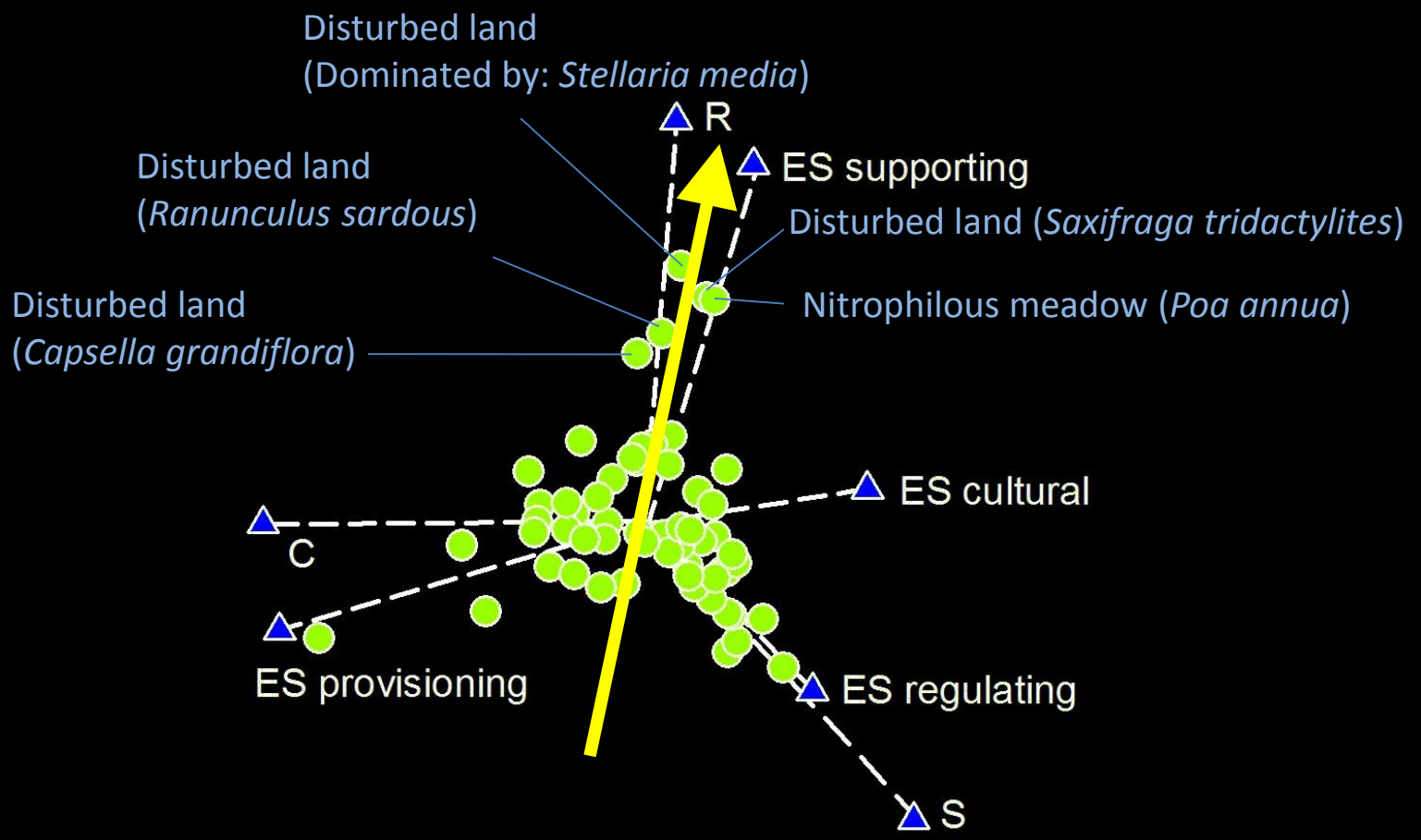


Pearson's correlation coefficient between C and Provisioning ES index = 0.713 (p<0.01)

∴ C, S and R are strong indicators of physical/chemical ecosystem services.

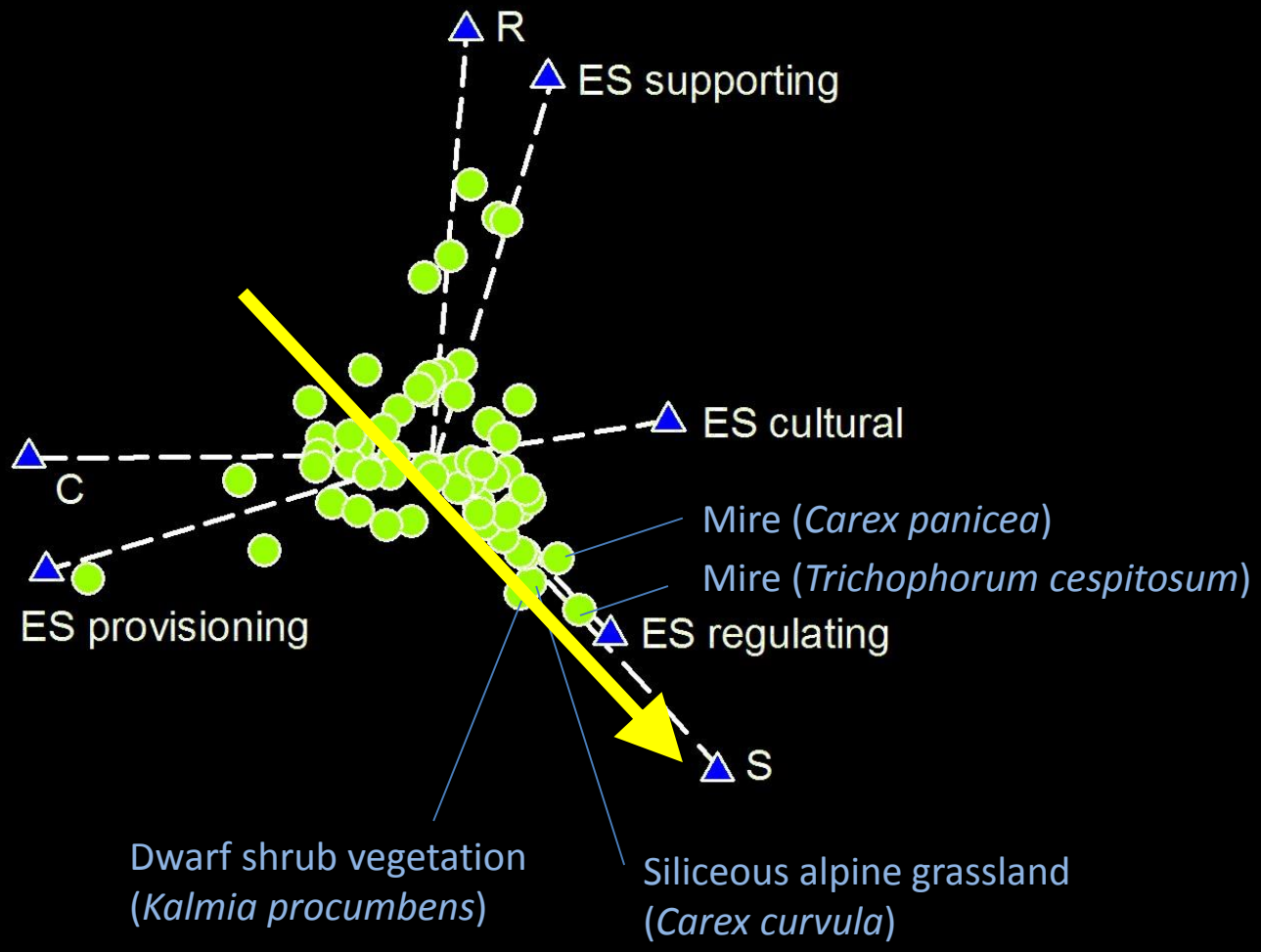
Pearson's correlation coefficient between S and Regulating ES index = 0.384 (p<0.01)

Relationship between community types, plant strategies and ecosystem services



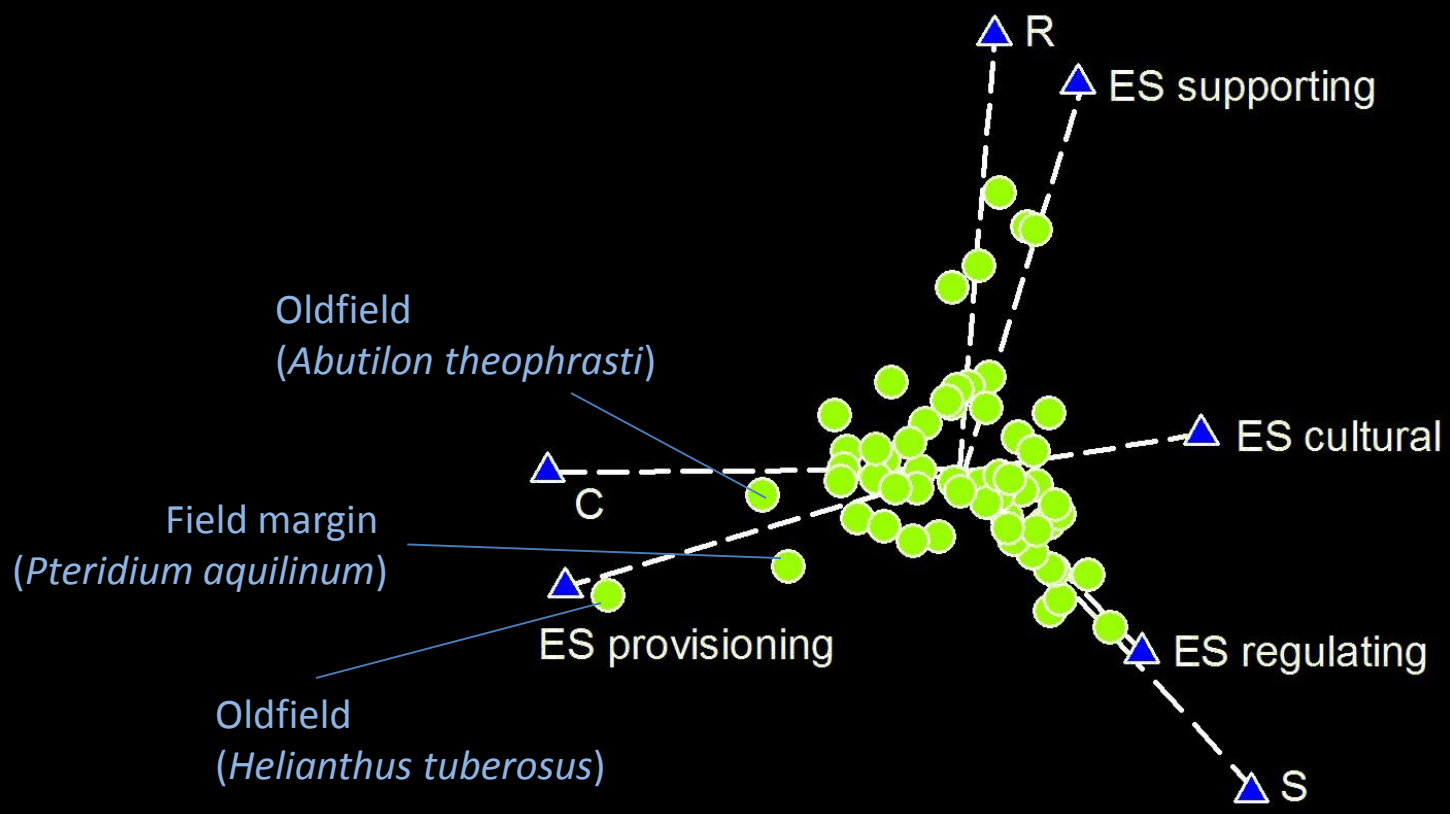
Greater 'flowering nitrogen use period' is associated with R-selection, disturbed ecosystems and actually indicates **ecosystem instability** and the degree of *inconsistency* of supporting services.

Relationship between community types, plant strategies and ecosystem services



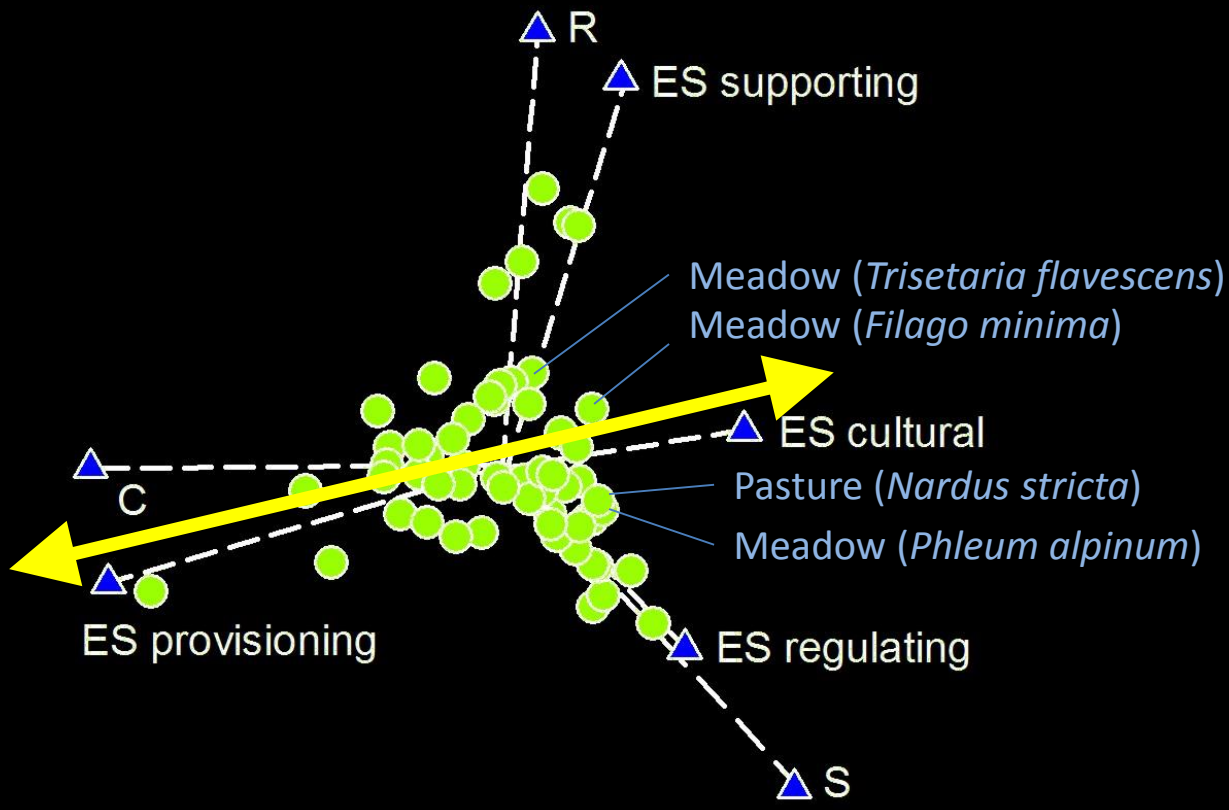
A high degree of S-selection is an indicator of **sequestration** of organic matter in ecosystems with slow dynamics.

Relationship between community types, plant strategies and ecosystem services



C-selection is associated with greater ‘biomass’ provisioning in less disturbed ecosystems.

Relationship between community types, plant strategies and ecosystem services



Our ‘provisioning’ index and C-selection actually represent the *potential* biomass provision.
Our ‘botanical quality’ cultural index represents where ecosystems *actually do* provide biomass regularly, following mowing (meadows) or grazing (pastures).
This is indicated by a low degree of C-selection at one end of a ‘**provisioning gradient**’.

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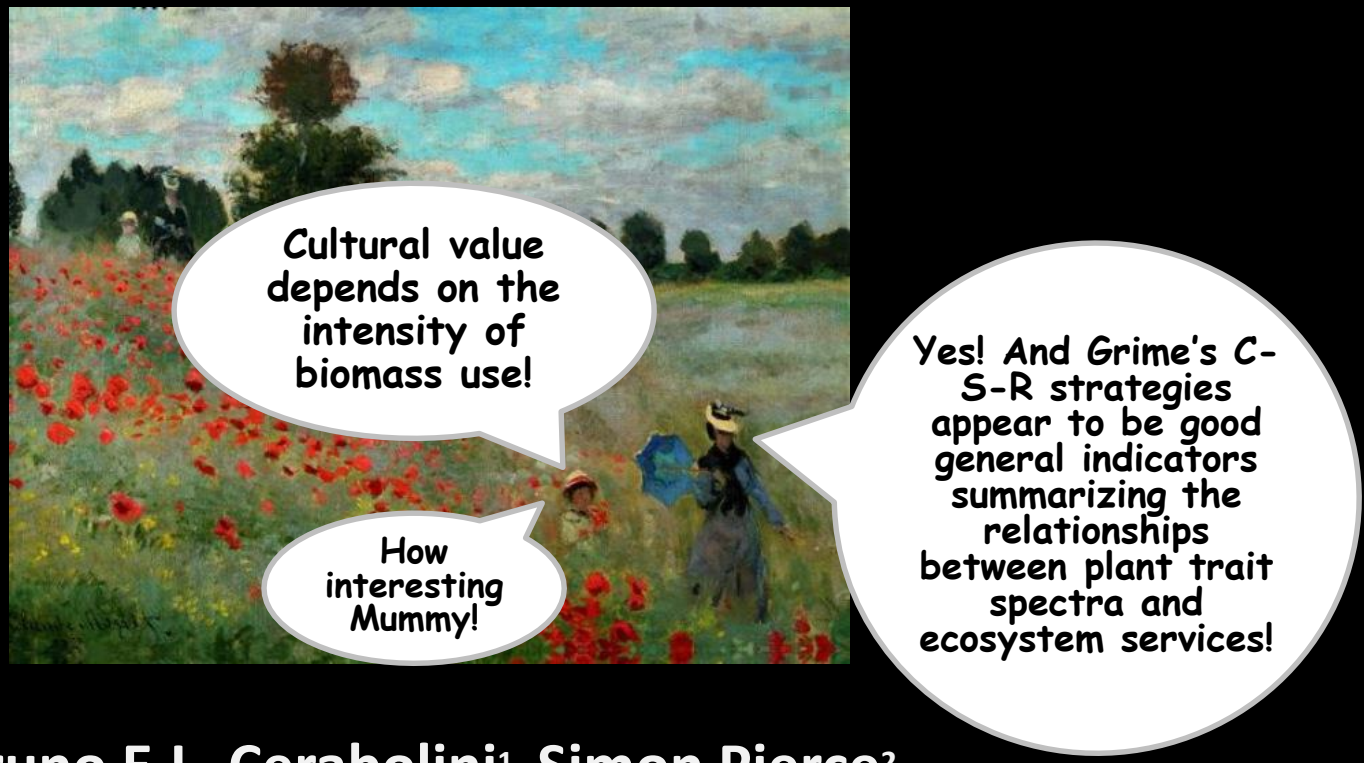

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