

Making better conservation decisions



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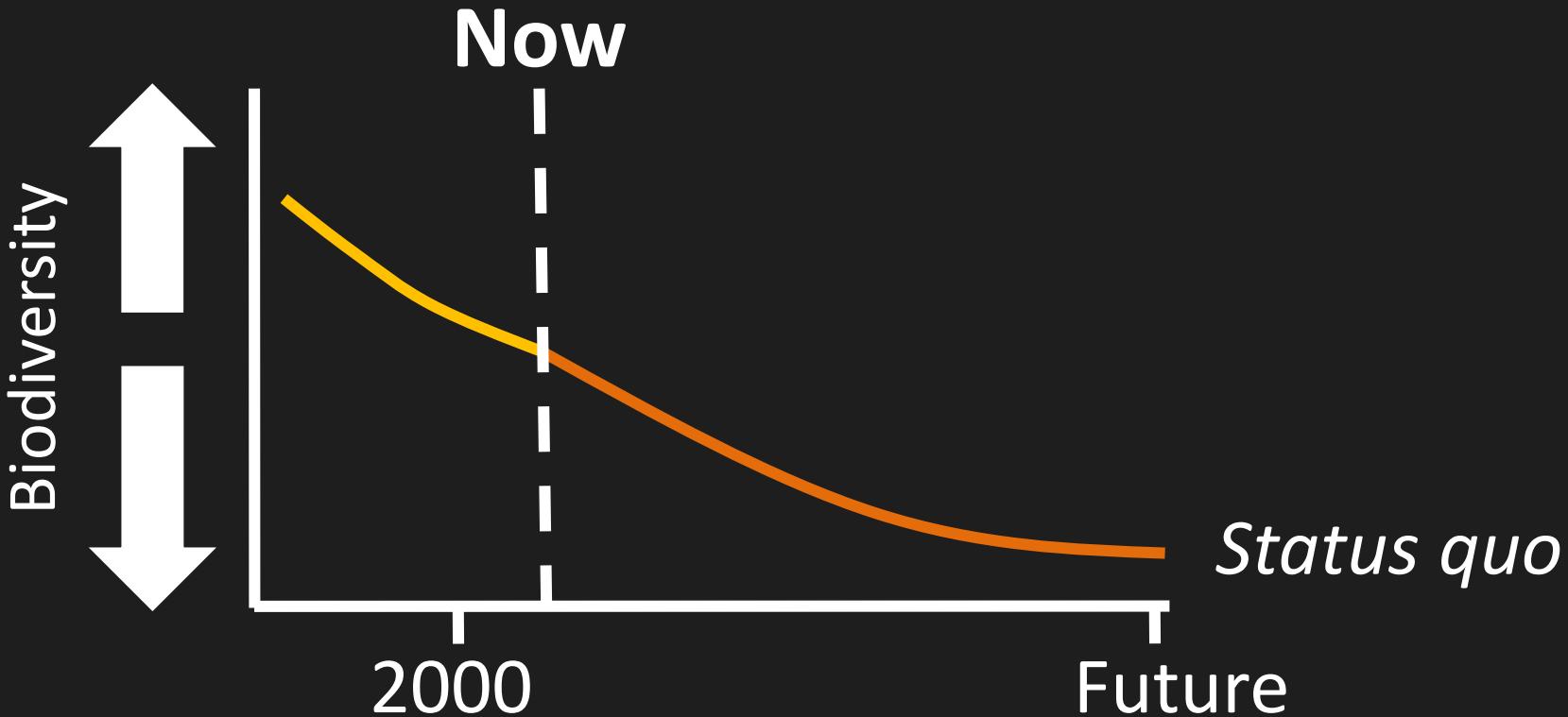


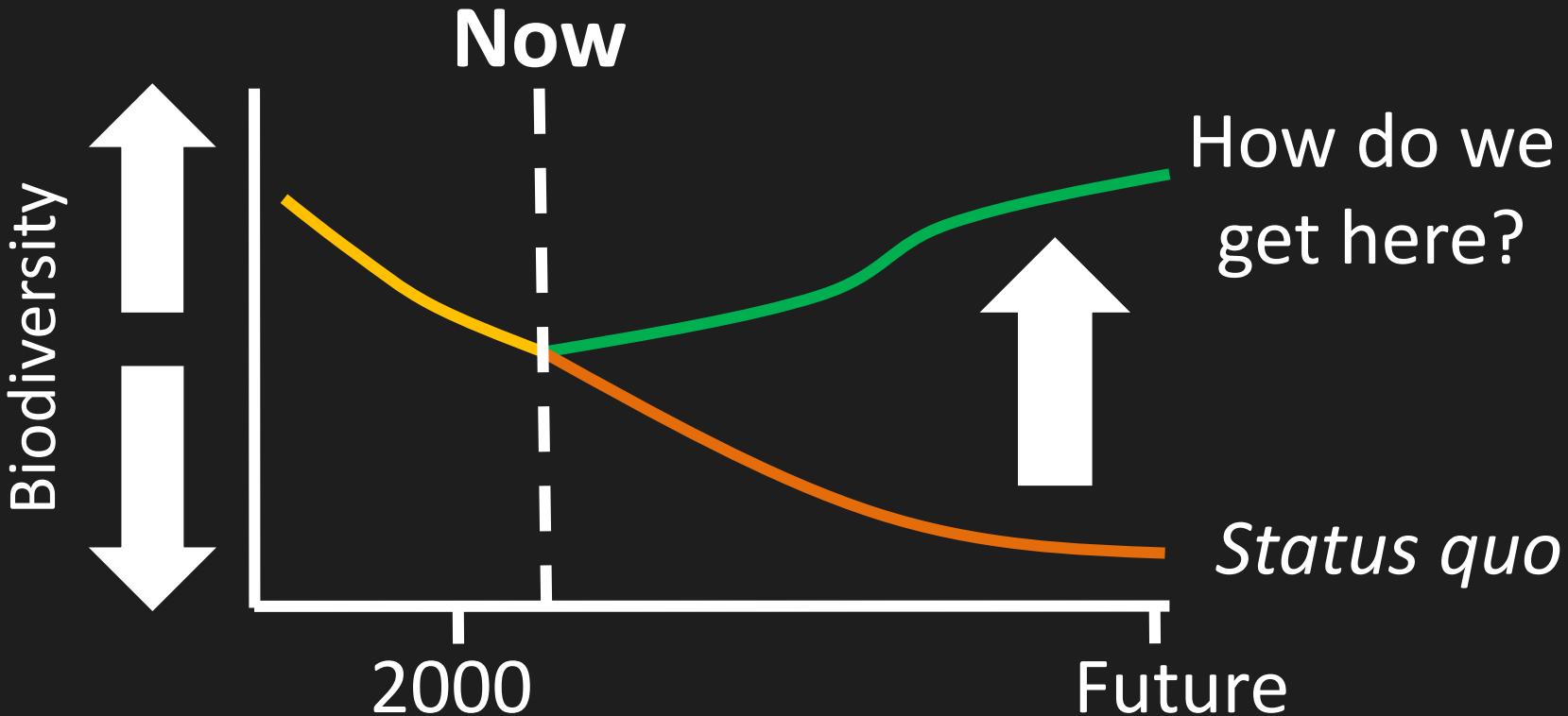
jeffrey-hanson.com

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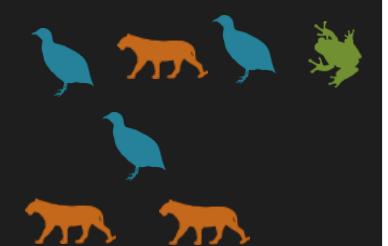
How can we get a better conservation decision?

(1) Better algorithms

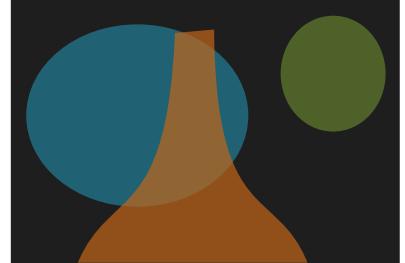
(2) Better data

(3) Better surrogates

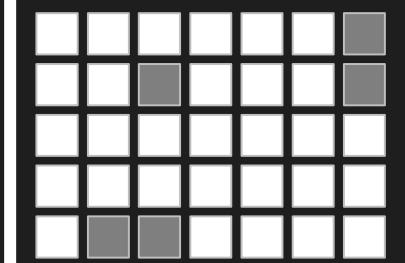
Ecological surveys



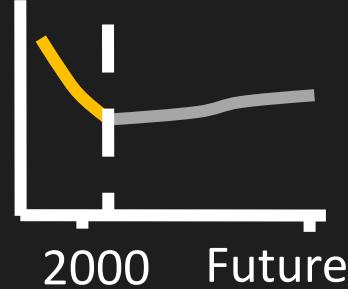
Distribution maps



Priority areas



Biodiversity



Data → Information → Plan → Outcome



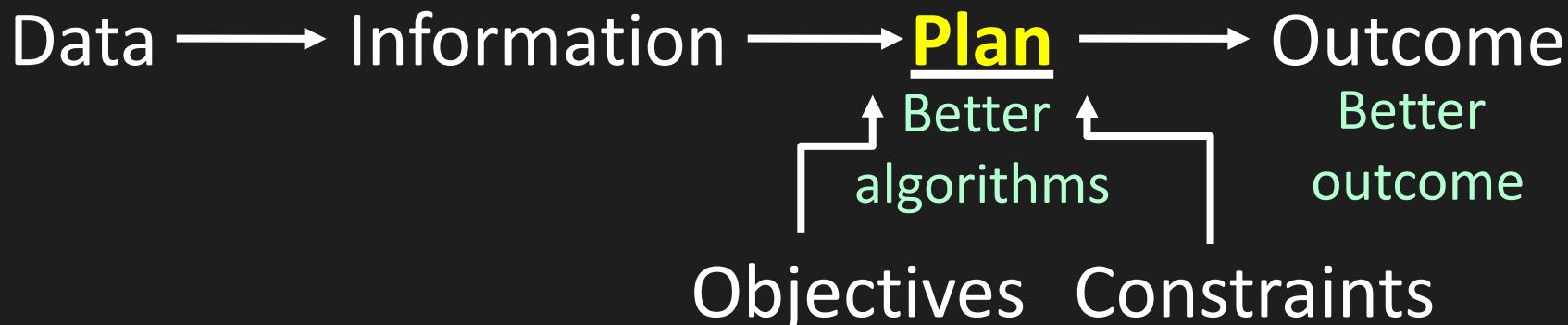
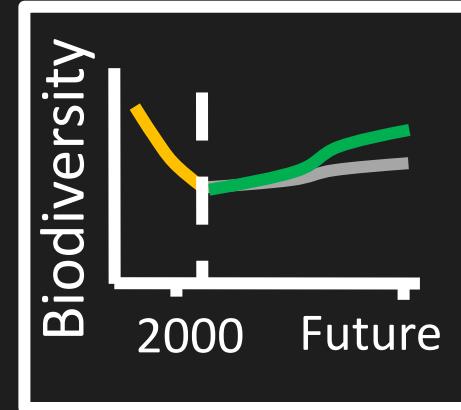
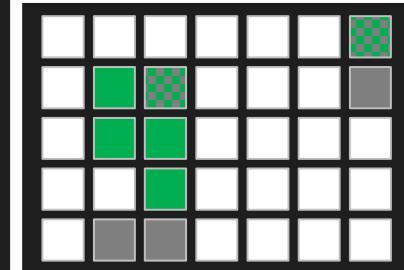
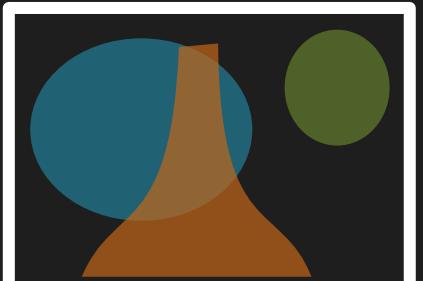
Objectives Constraints

Ecological surveys

Distribution maps

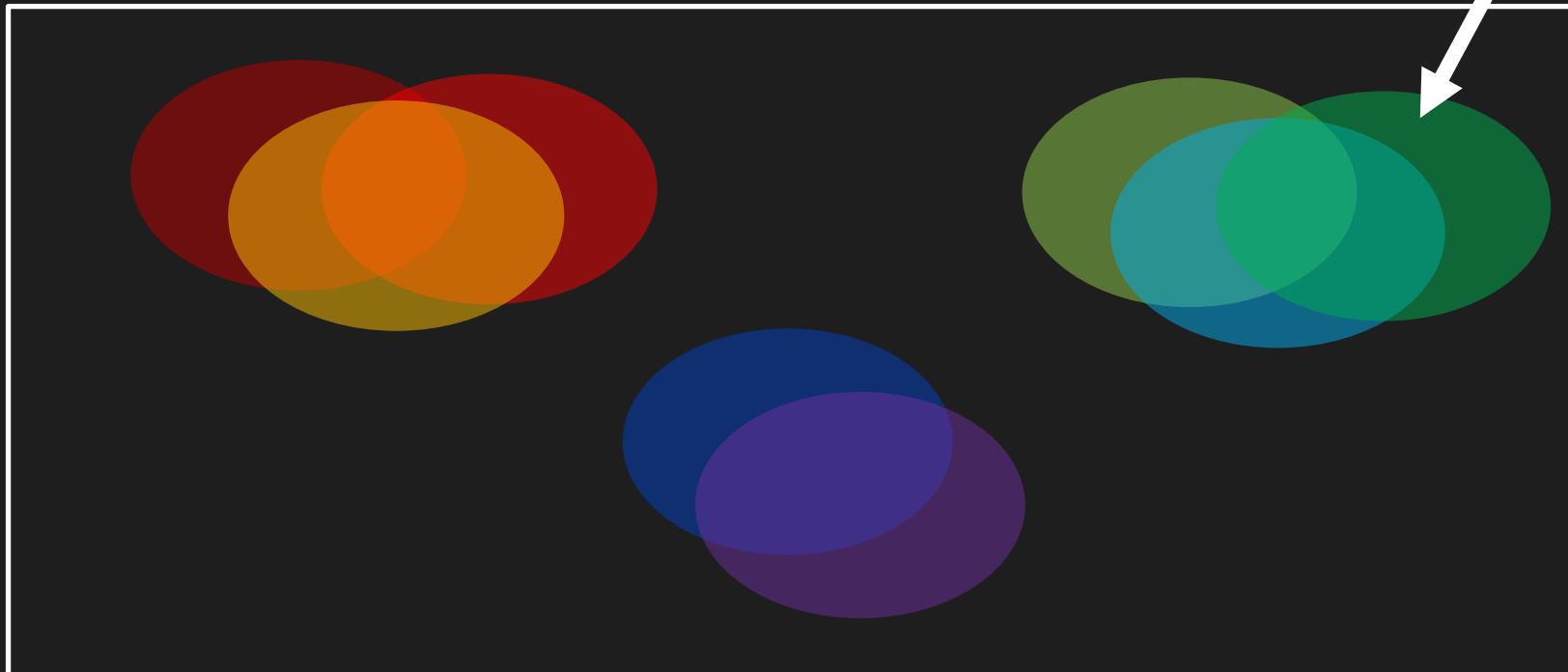
Priority areas

Biodiversity



Reserve selection

Features

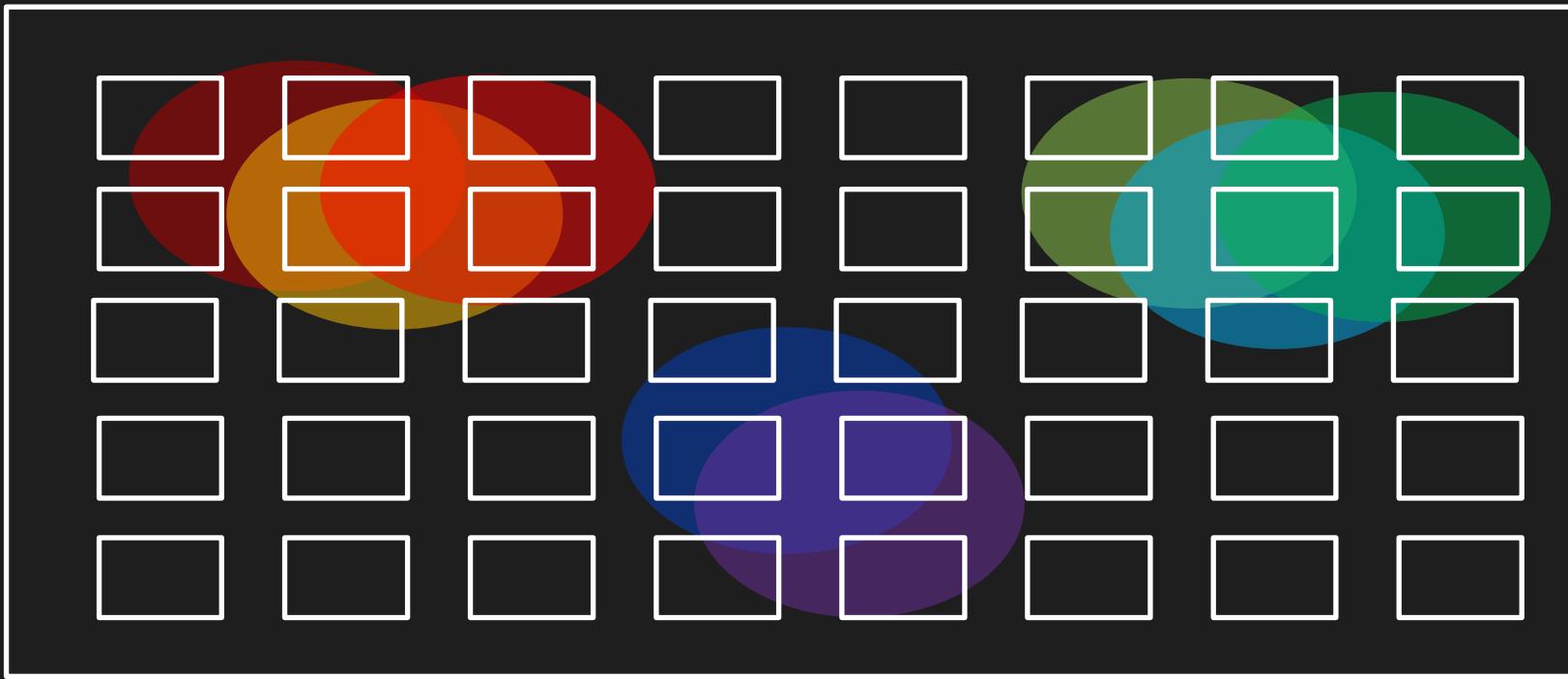


Reserve selection

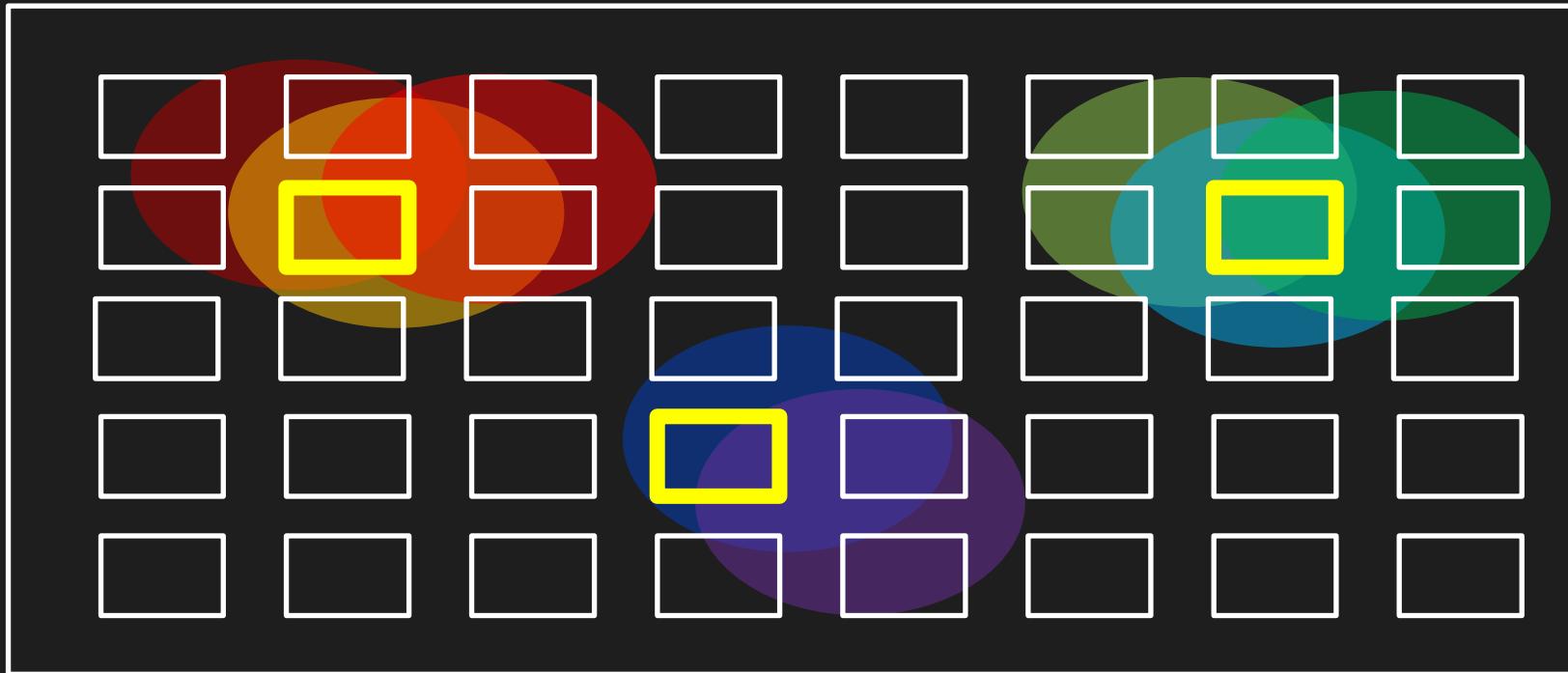
Planning units



Reserve selection



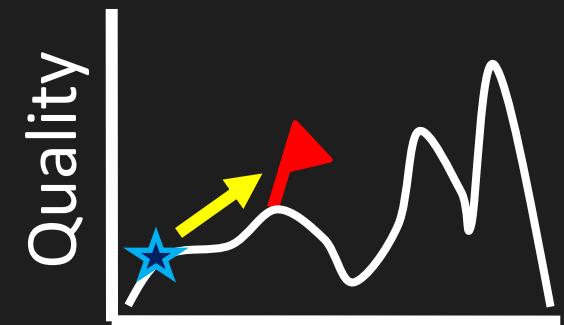
Reserve selection



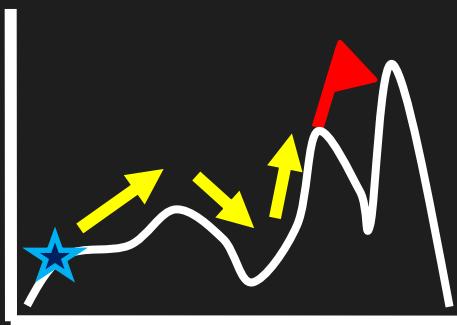
Heuristic algorithm

Meta-heuristic algorithms

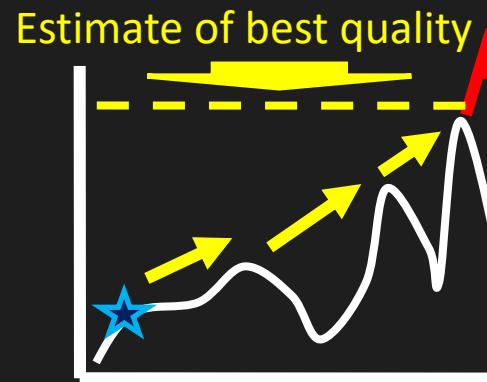
Exact algorithms



Different
solutions



Different
solutions



Different
solutions

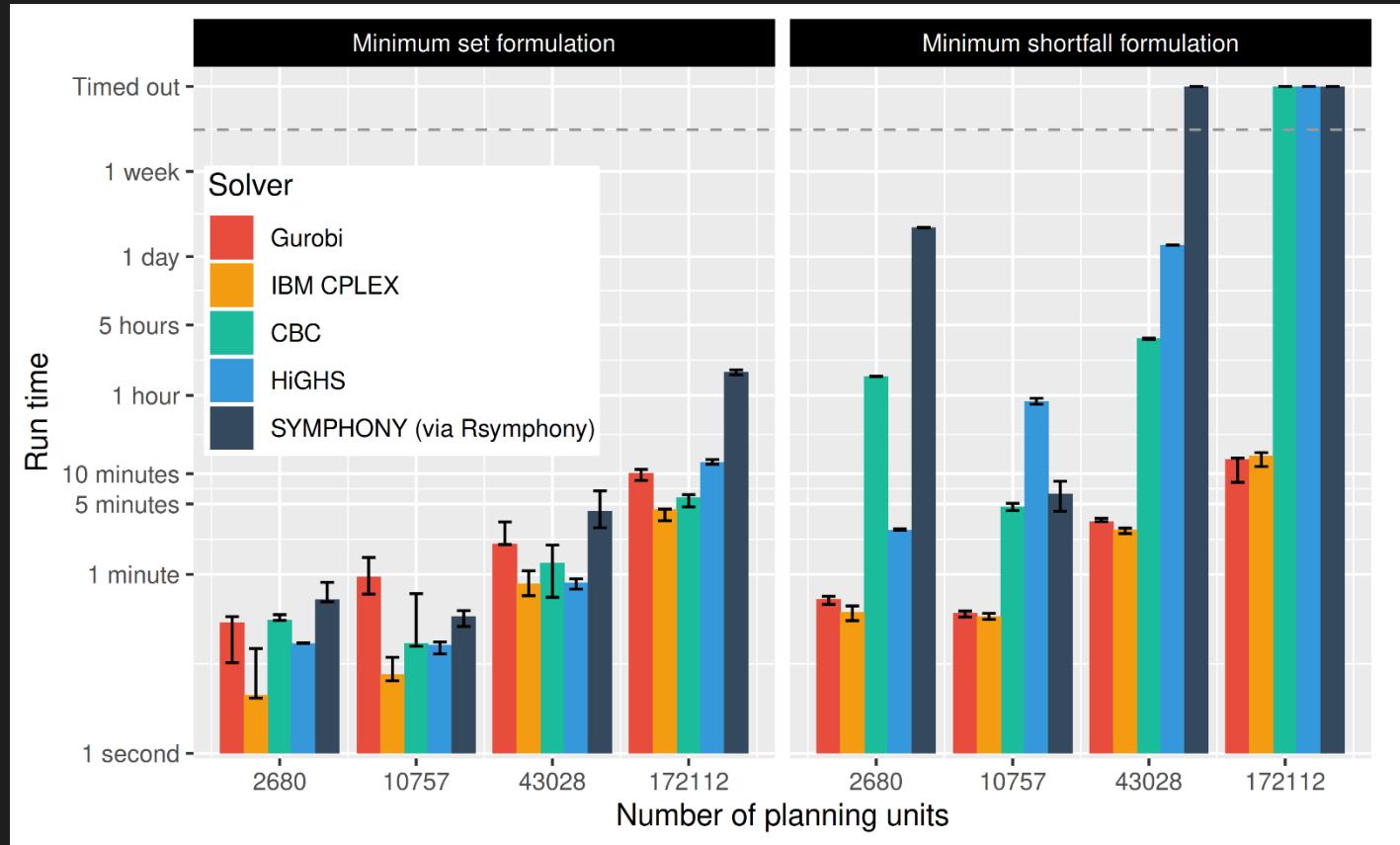


prioritizr: Systematic conservation prioritization in R

- it's an R package (yes, this is good)
- flexible interface to customize problems
- compatible with tabular and GIS data formats
- supports planning for multiple zones/actions
- powered by exact algorithm solvers



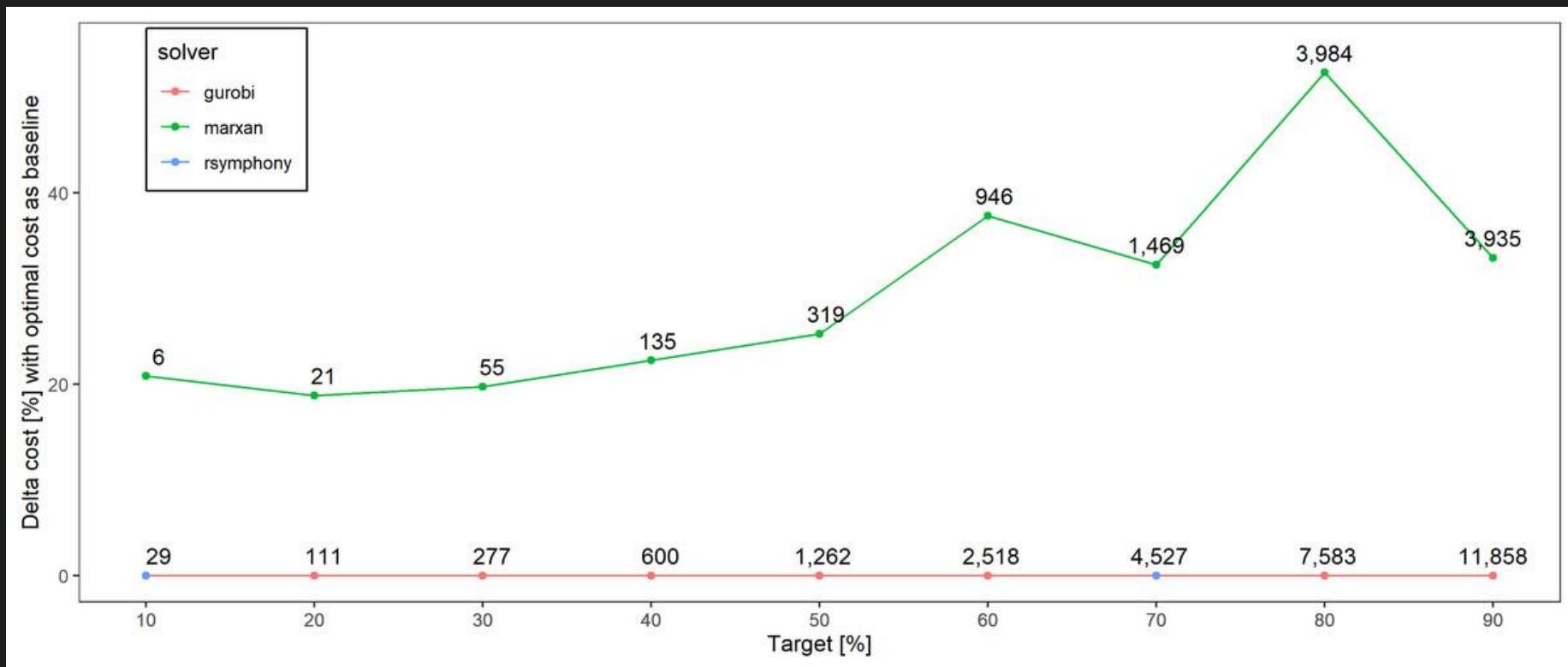
Solve problems pretty quickly!



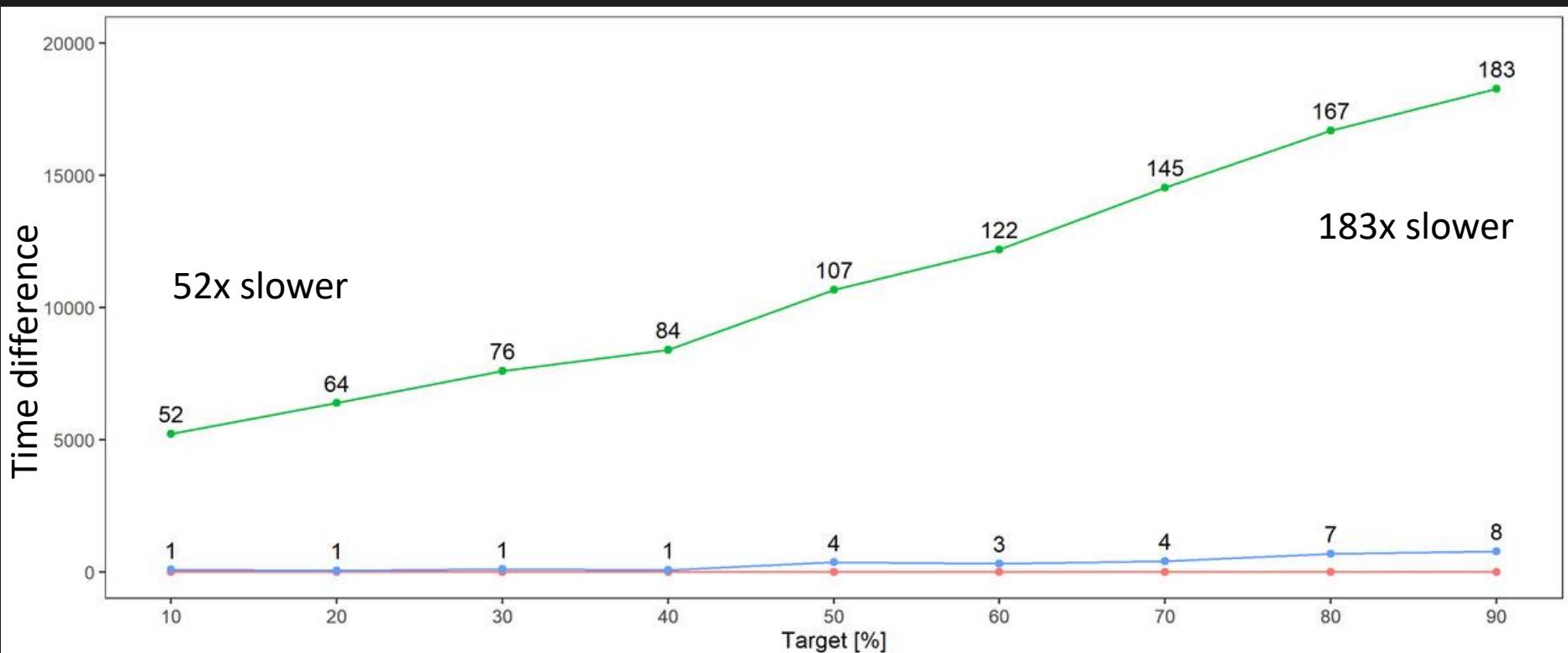
Notes: 396 features, no planning units locked in or out, prioritizations $\leq 10\%$ from optimality

??? et al. under review

Better solutions



Faster too

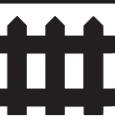


What about other
conservation
problems?

Project prioritization

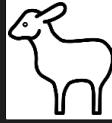
Project data

Actions



Success

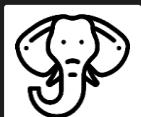
Persistence (%)



90%

95%

Recovery projects



20%

10%



50%

70%



100%

40%

9%

65%

Cost data



\$



\$\$



\$\$\$



\$0

Budget \$\$\$

Project prioritization

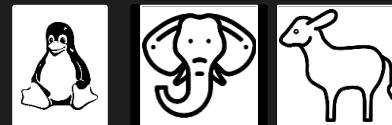
Project data

Actions

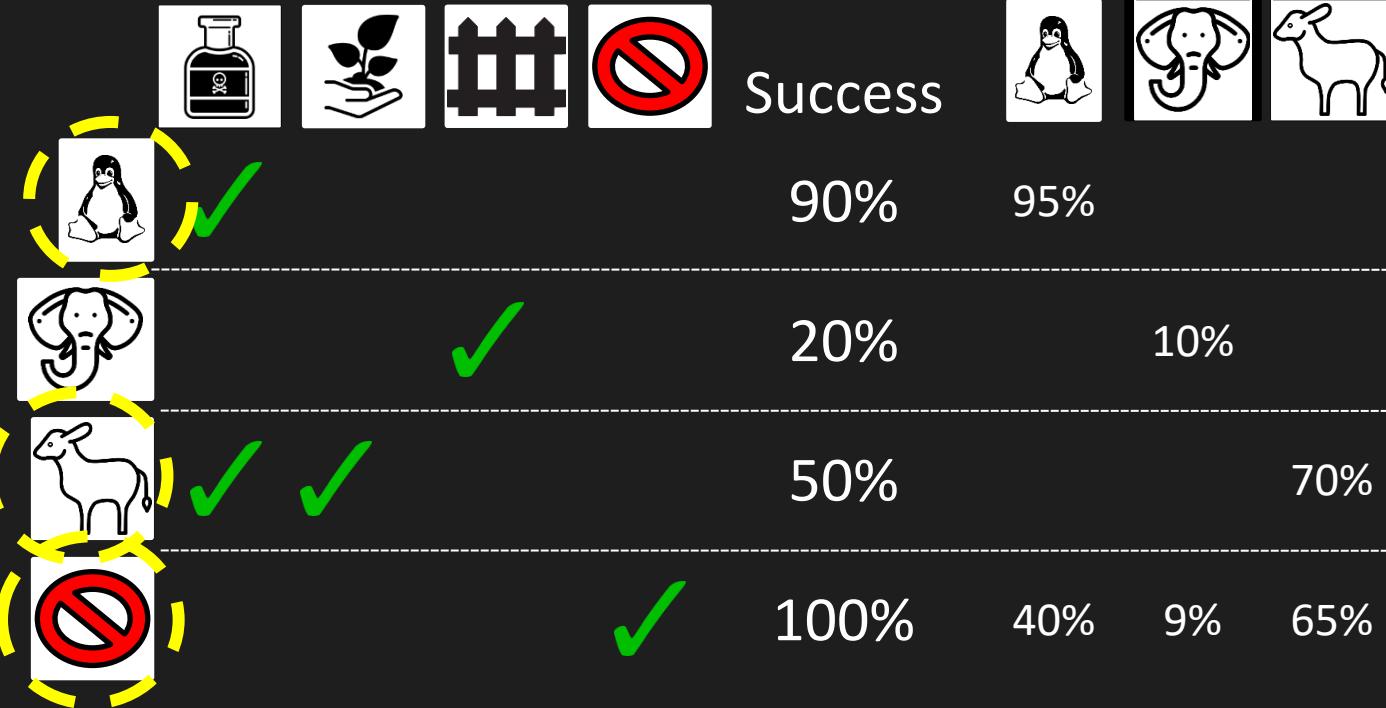


Success

Persistence (%)



Recovery projects



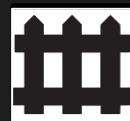
Cost data



\$



\$\$



\$\$\$

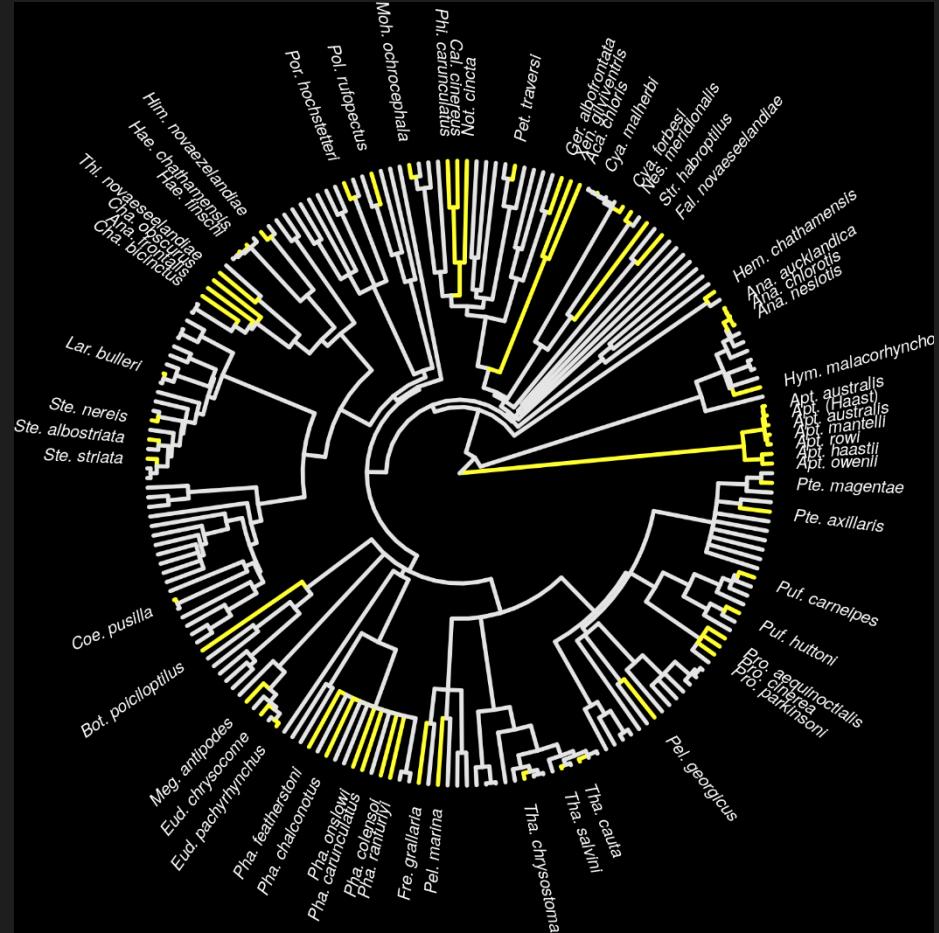


\$0

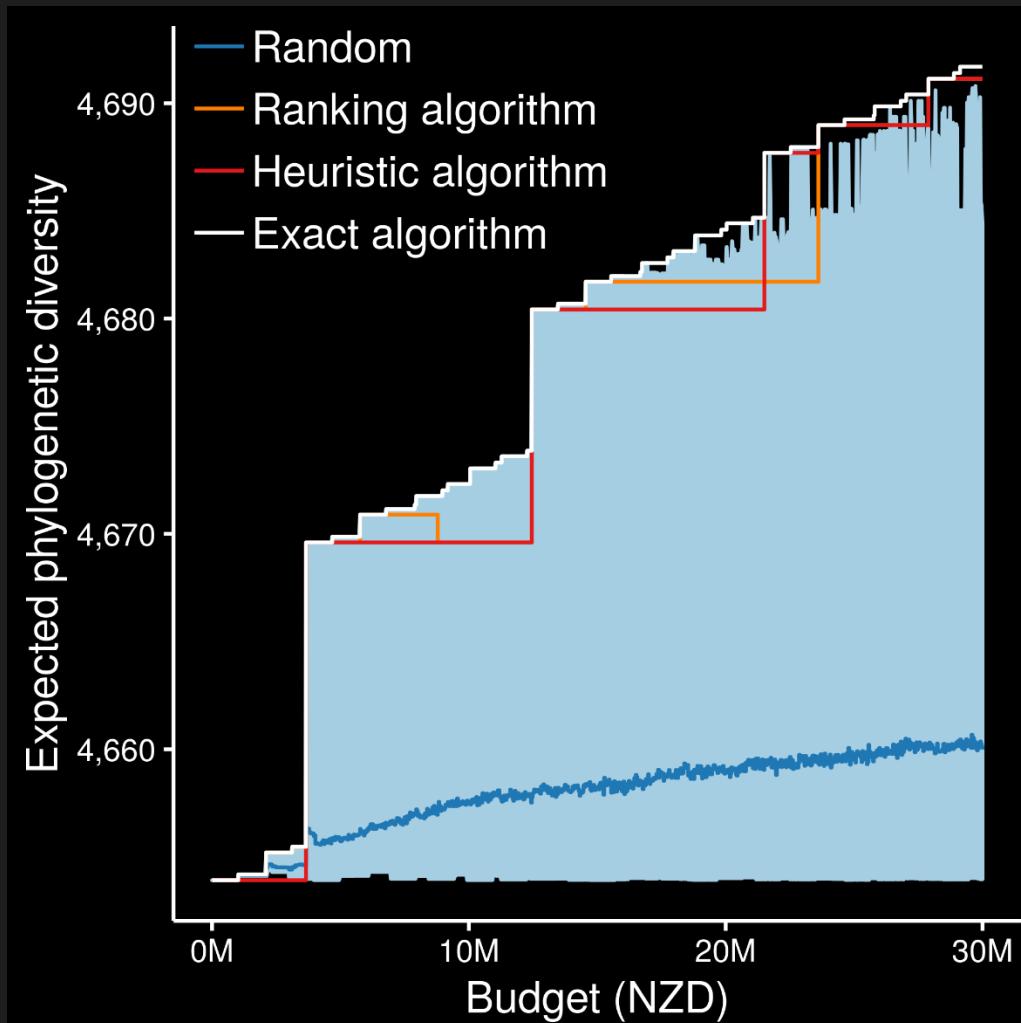
Budget \$\$\$

New Zealand case study

- Projects for 62 imperiled bird species
- 1,218 different actions
- Many actions shared between projects for different species



- Exact algorithms always best
- Ranking and heuristic algorithms sometimes produced optimal plans
- Randomly funding projects sometimes produced better plans than ranking and heuristic algorithms
- oppr R package



How can we get a better conservation decision?

- (1) Better algorithms
- (2) Better data
- (3) Better surrogates

Ecological surveys

Distribution maps

Priority areas

Biodiversity

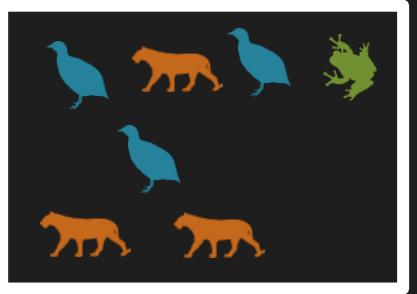
2000 Future

Data → Information → Plan → Outcome

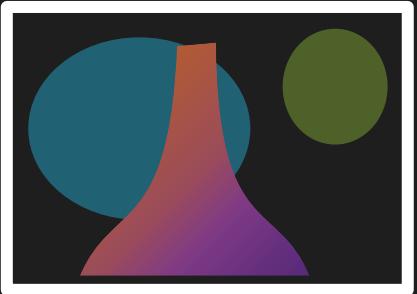


Objectives Constraints

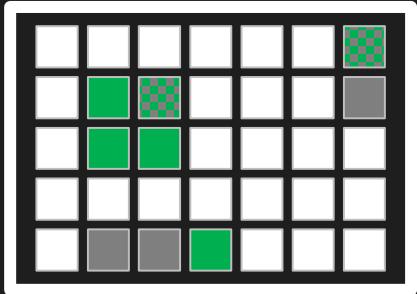
Ecological surveys



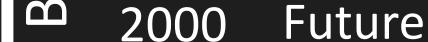
Distribution maps



Priority areas

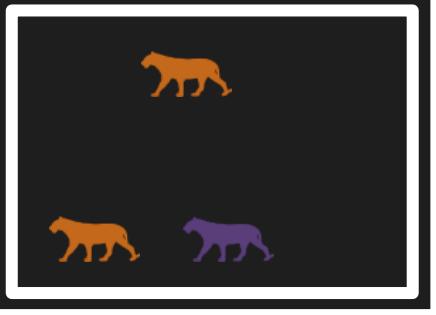


Biodiversity



Data → Information → Plan → Outcome

Genetic samples



Better
understanding
of biodiversity

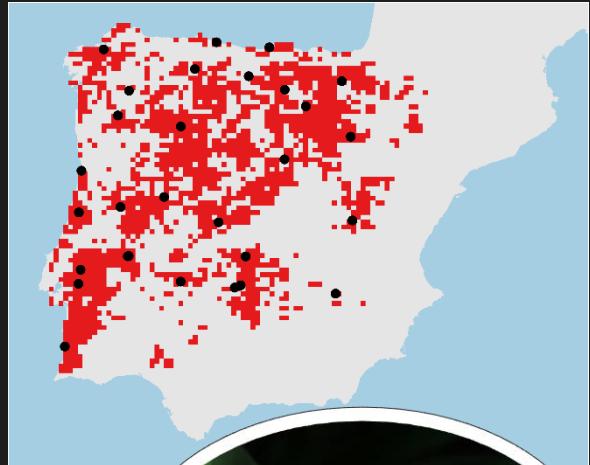
Objectives Constraints

Better
plan

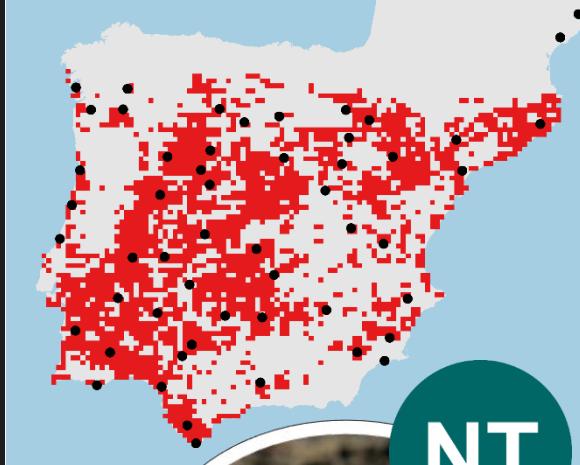
Better
outcome

Conservation planning for adaptive and neutral evolutionary processes

Hyla molleri



Pelobates cultripes



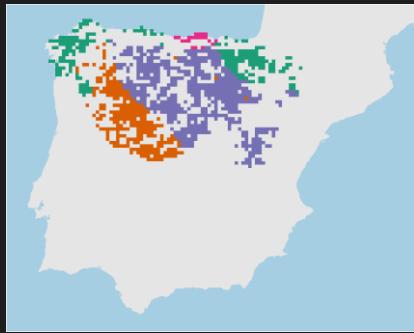
Rana iberica



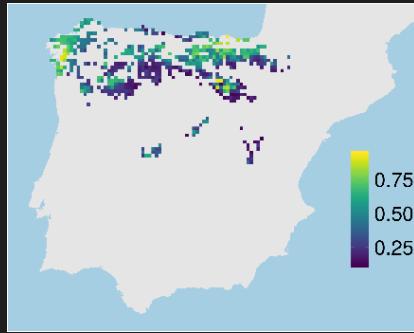


Adaptive processes

Adaptive
clusters

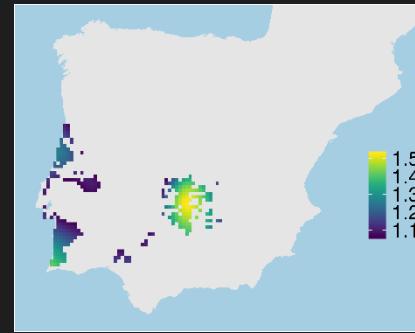


Climate
refugia

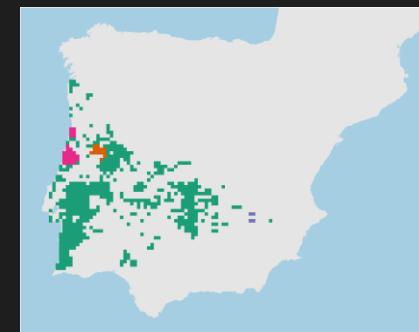
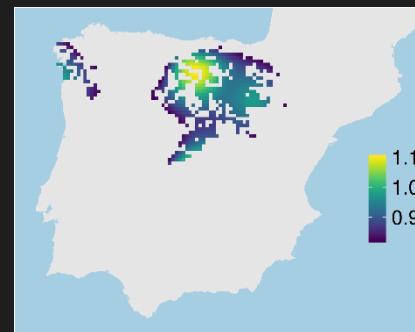
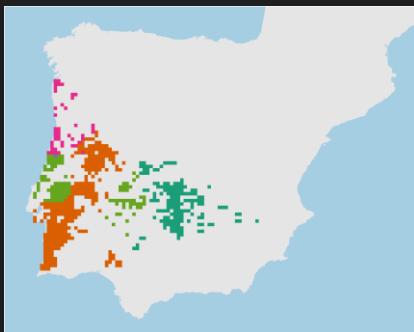
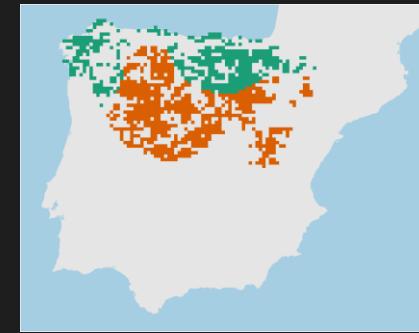


Neutral processes

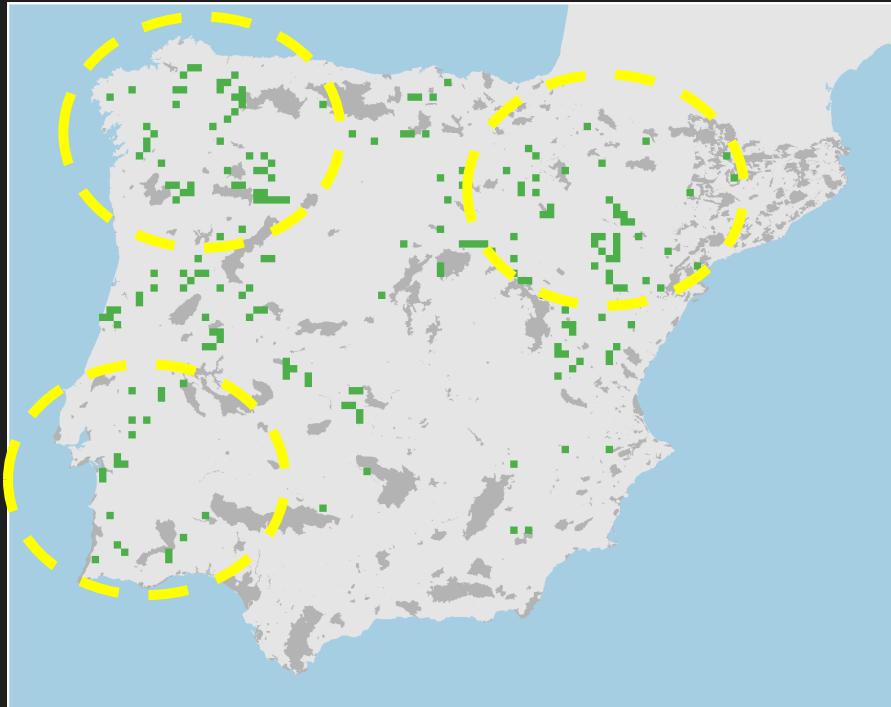
Individual
heterozygosity



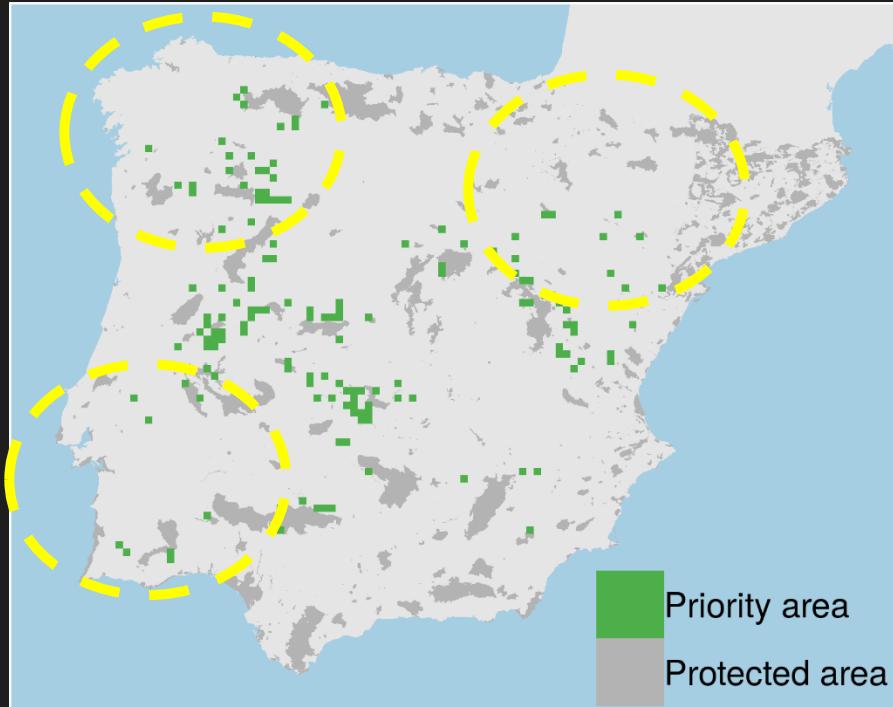
Neutral
clusters



Prioritizations



Plan with evolutionary
attributes

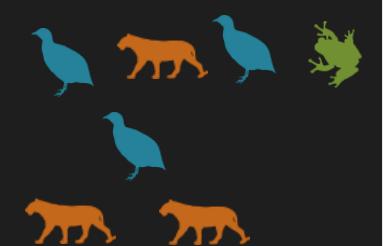


Conventional plan
Only costs 9% less

Priority area
Protected area

However, more data
isn't always better...

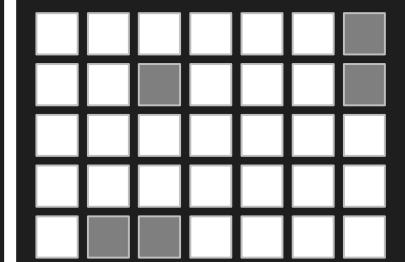
Ecological surveys



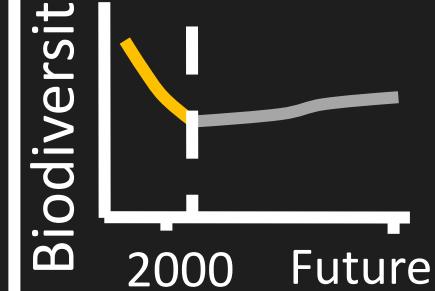
Distribution maps



Priority areas

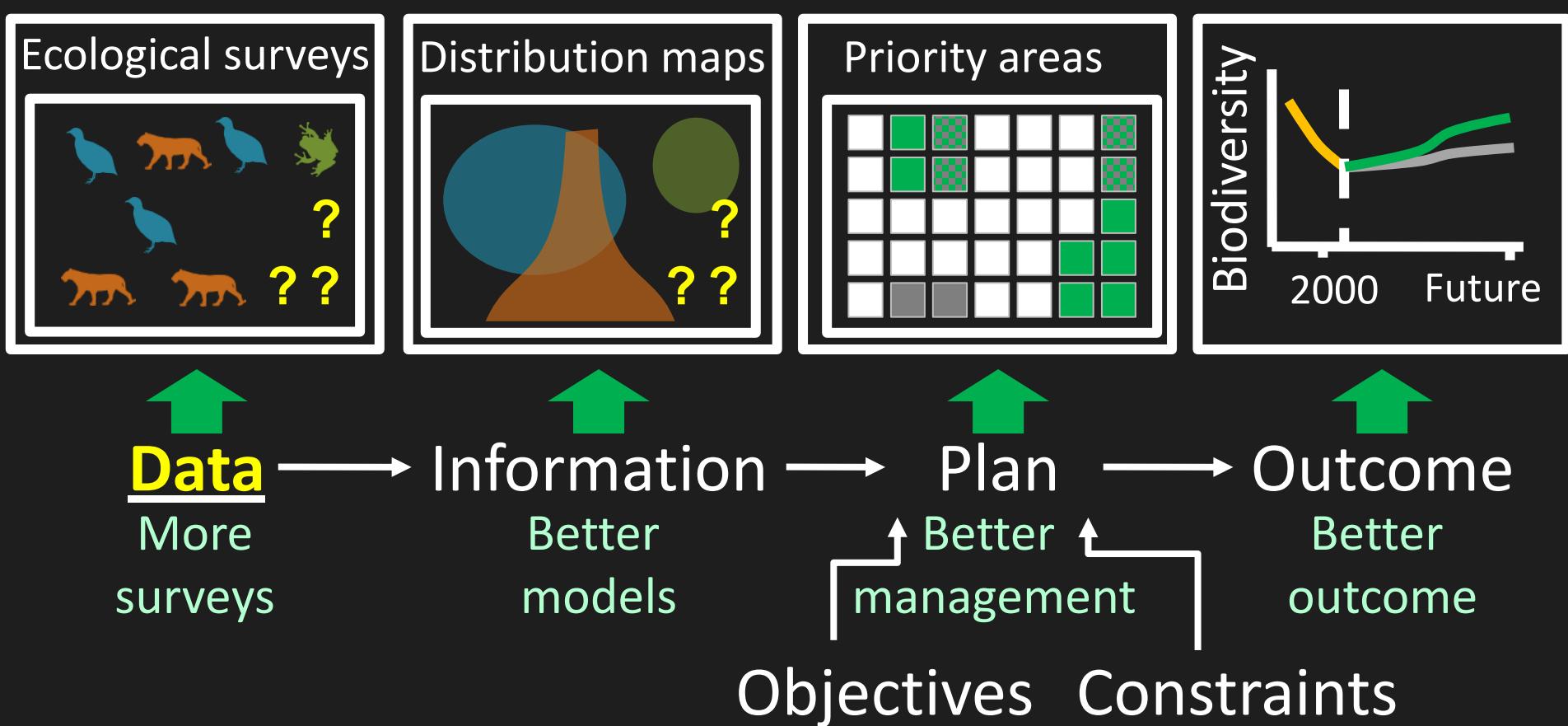


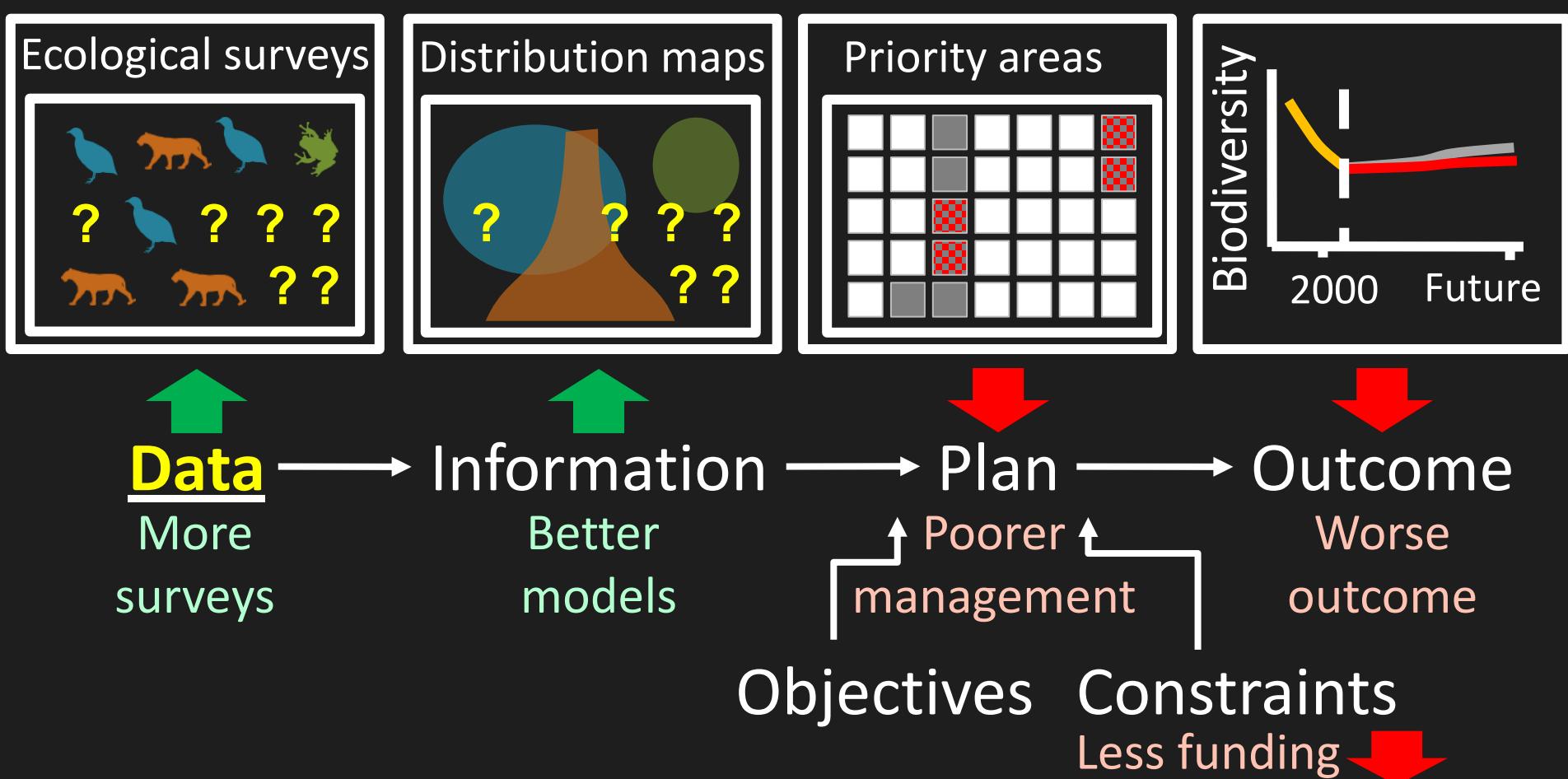
Biodiversity



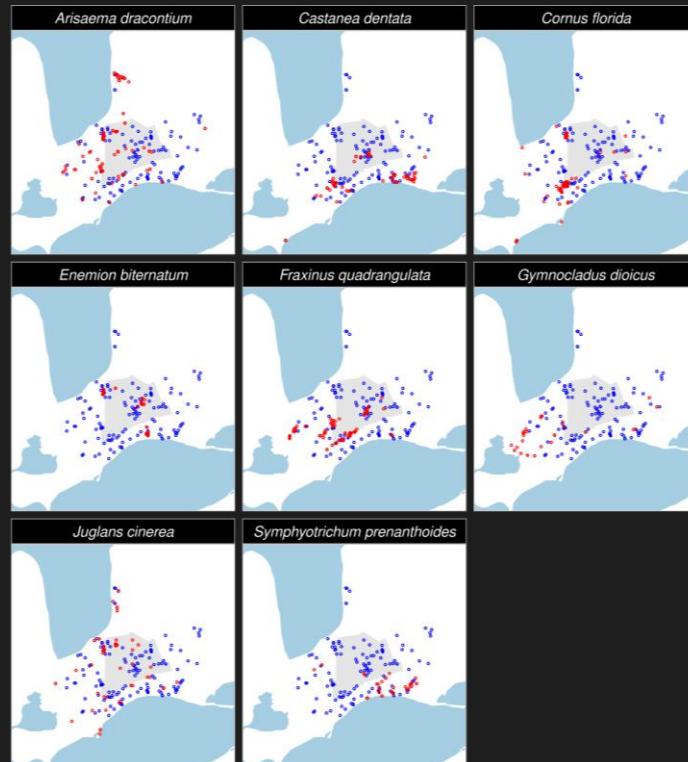
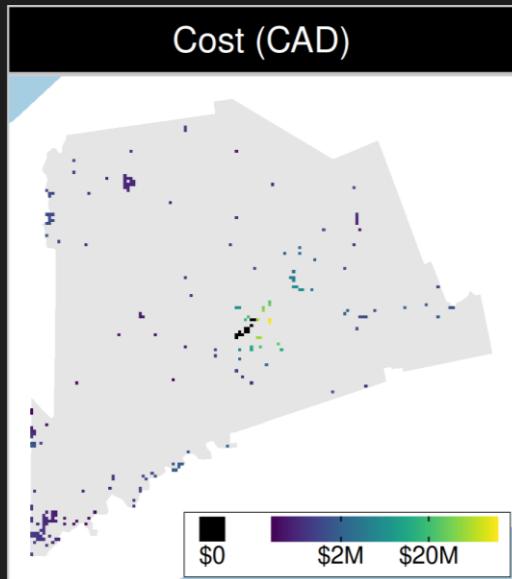
Data → Information → Plan → Outcome





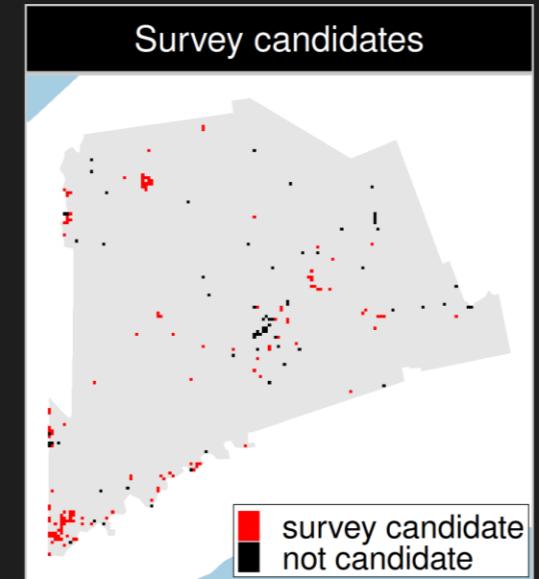


Study system: Middlesex county, Canada



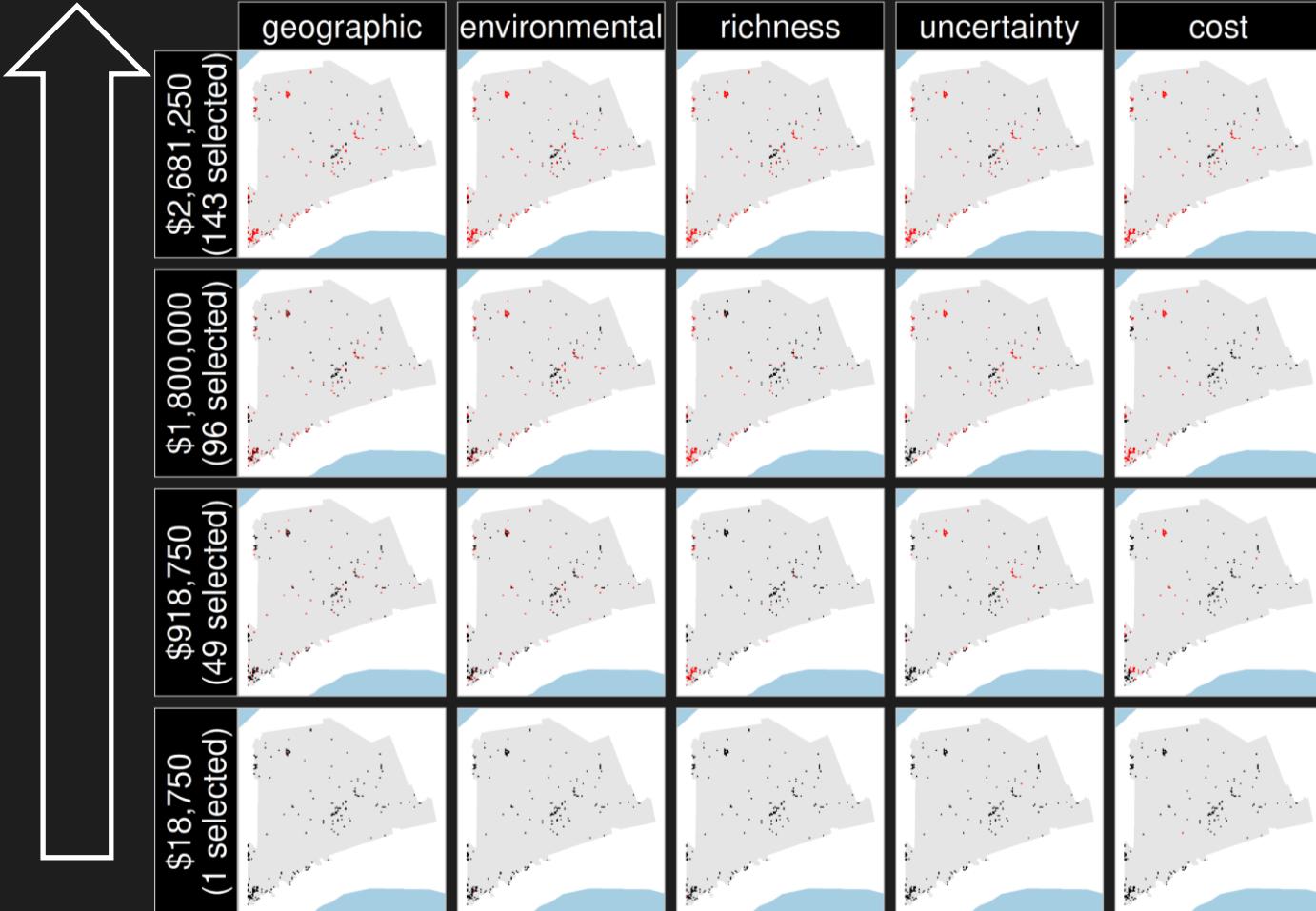
8 imperiled plant species

199 places that could potentially be acquired for protected area establishment



143 places that could potentially be surveyed to improve existing data

Number of places selected for surveys
(amount of funds allocated for collecting extra data)



Different approaches for designing survey schemes



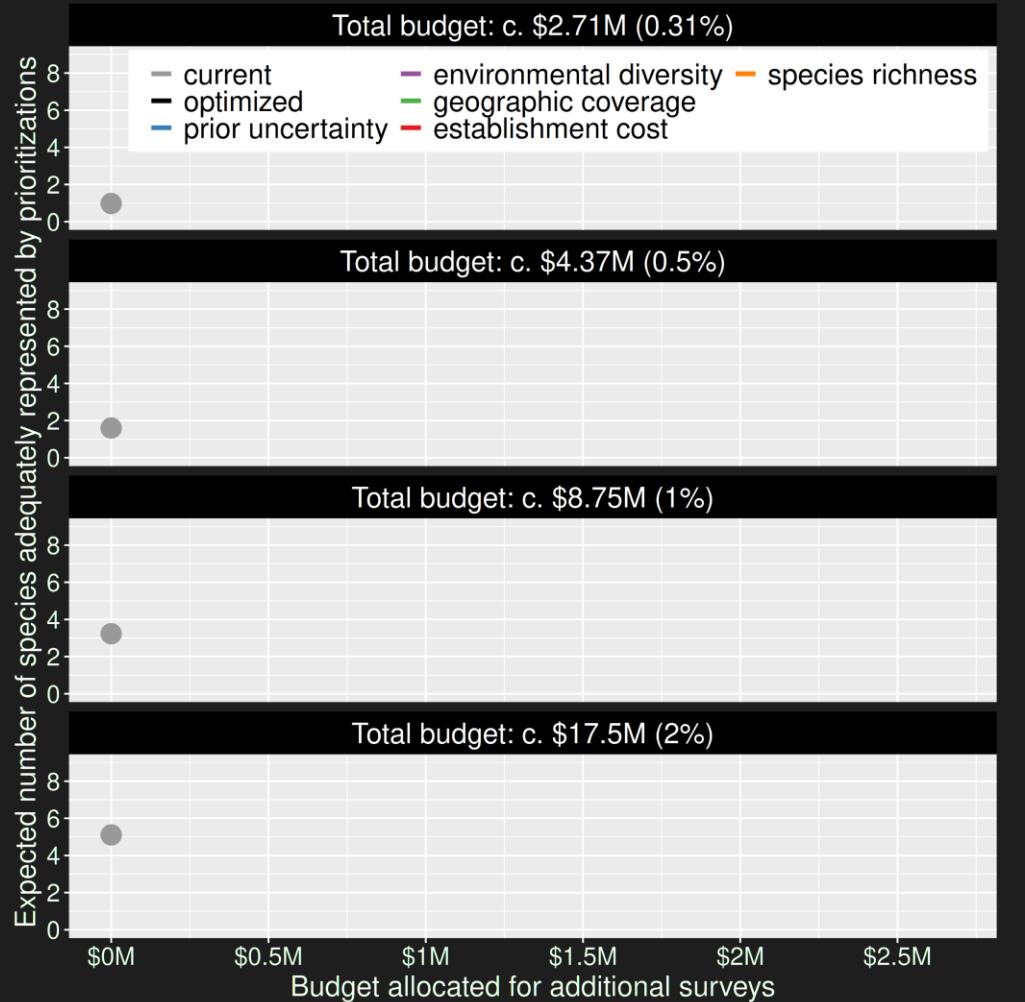
Selected
for survey



NOT selected
for survey

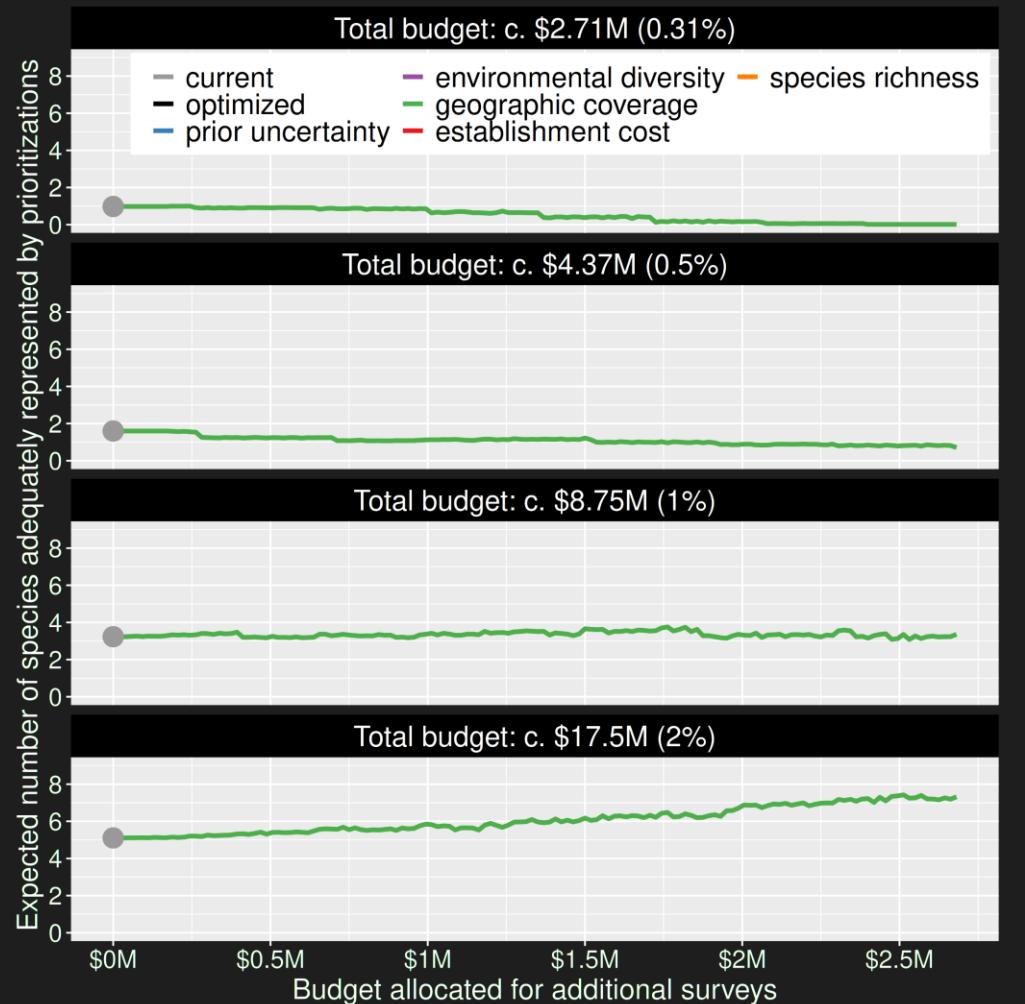
Value of information

- Existing data leads to positive outcomes
- More budget means better outcomes



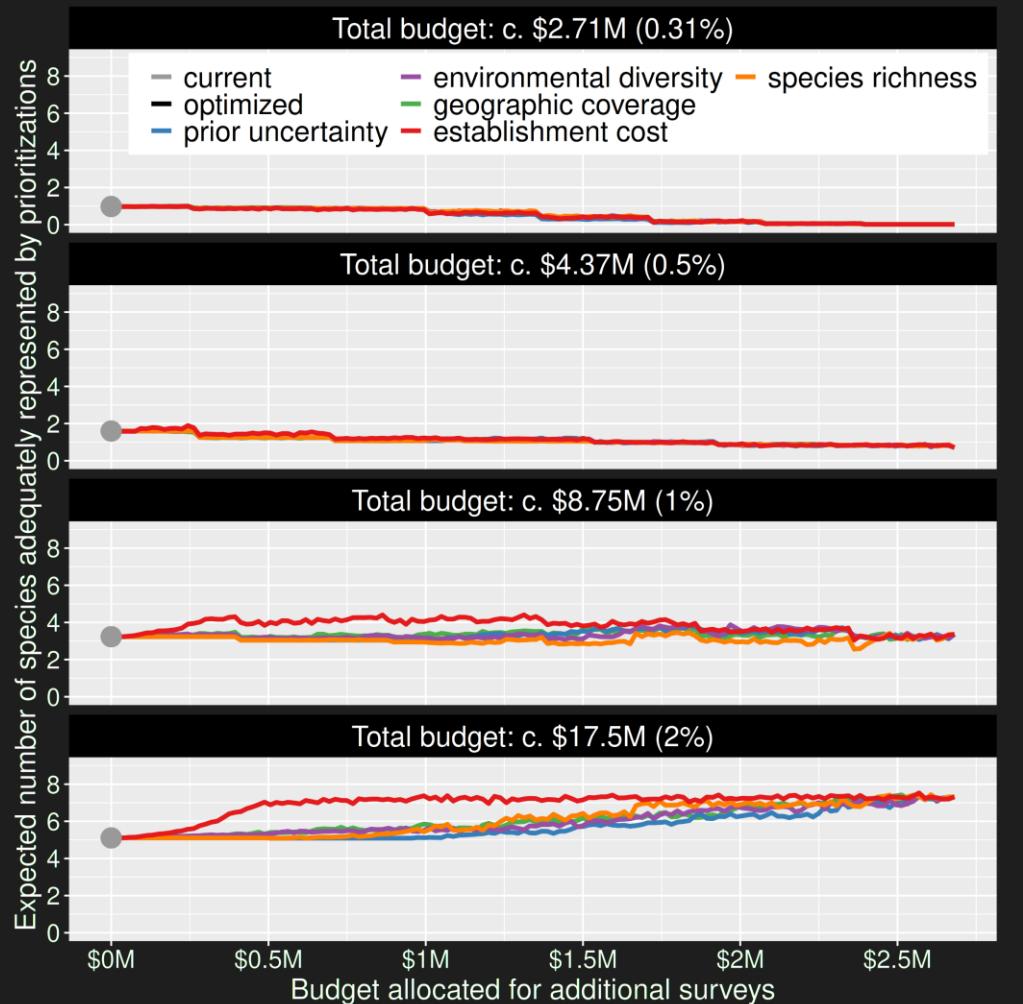
Value of information

- Allocating funds for gathering more data can mean worse outcomes
- Allocating funds for gathering more data can mean better outcomes too



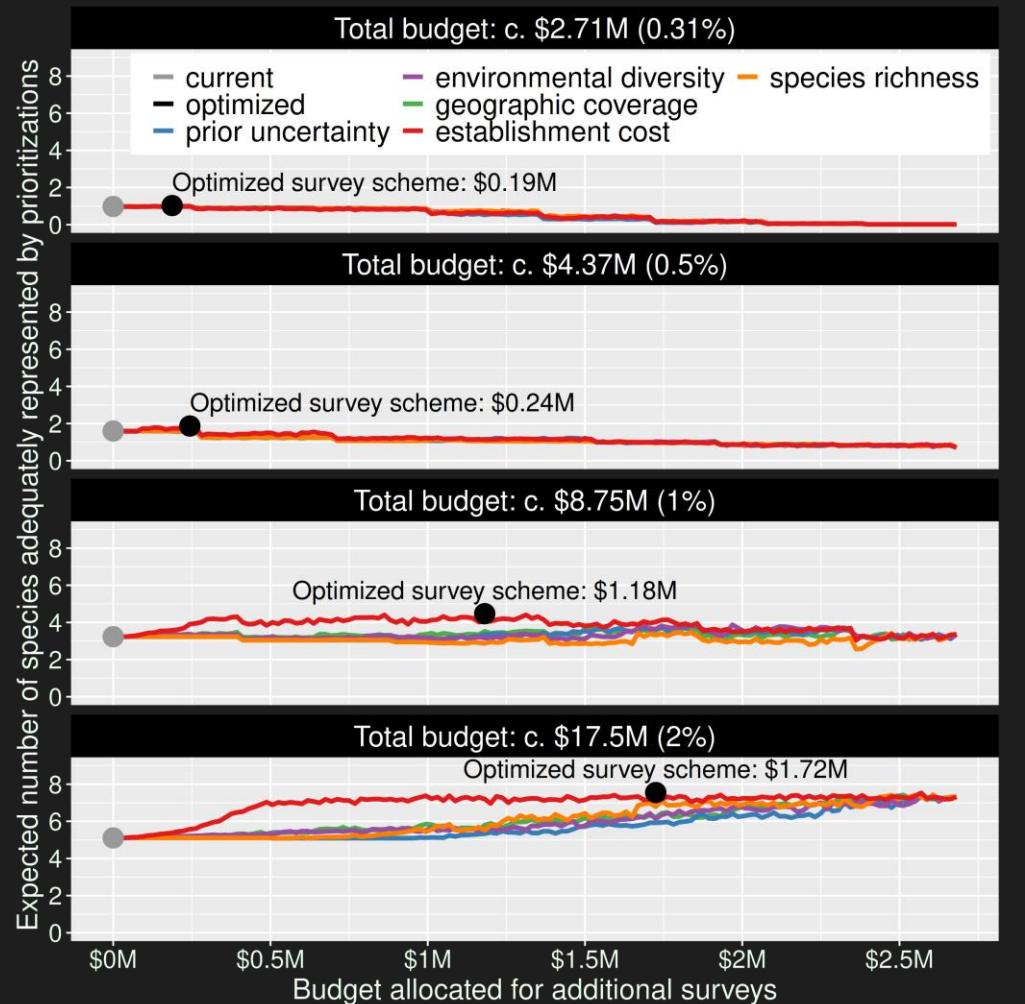
Value of information

- Conventional approaches for gathering additional evidence have different performance
- Performance of these approaches depends on available funds
- All of them could lead to worse outcomes



Value of information

- Directly maximizing return on investment is best method for additional data
- This considers objectives and constraints that underpin conservation plans and their success



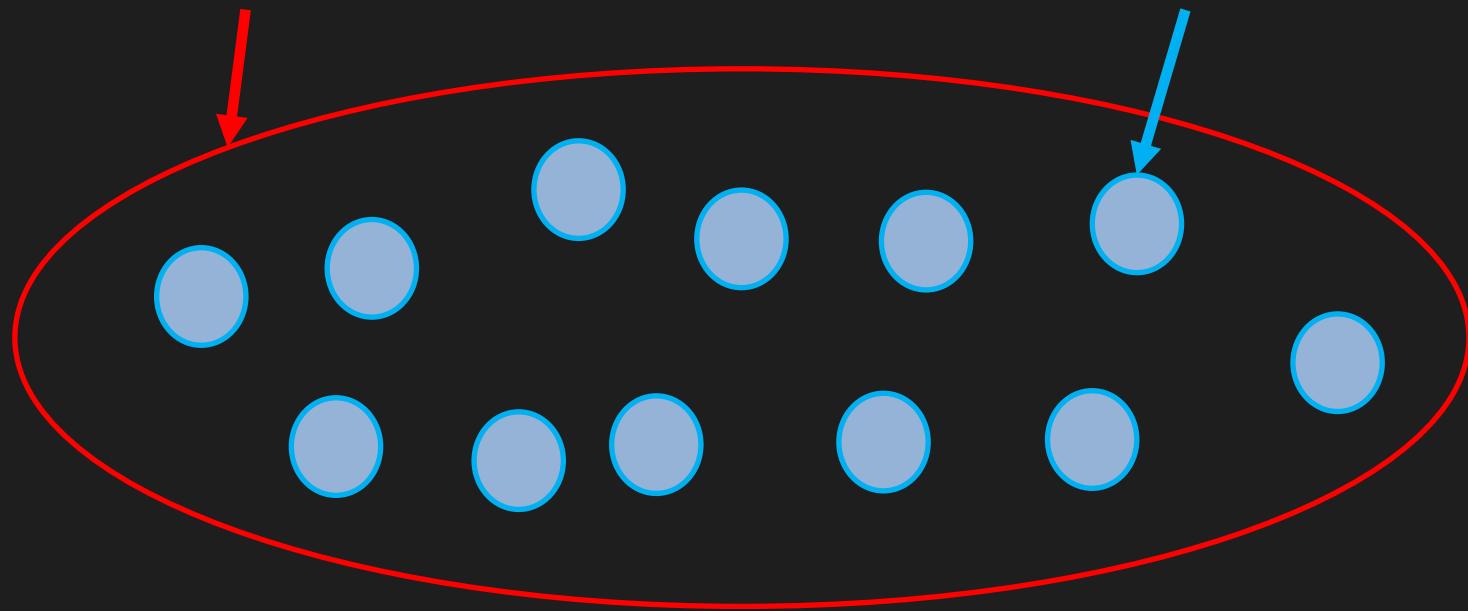
How can we get a better conservation decision?

- (1) Better algorithms
- (2) Better data
- (3) Better surrogates

Evolutionary processes

Species range

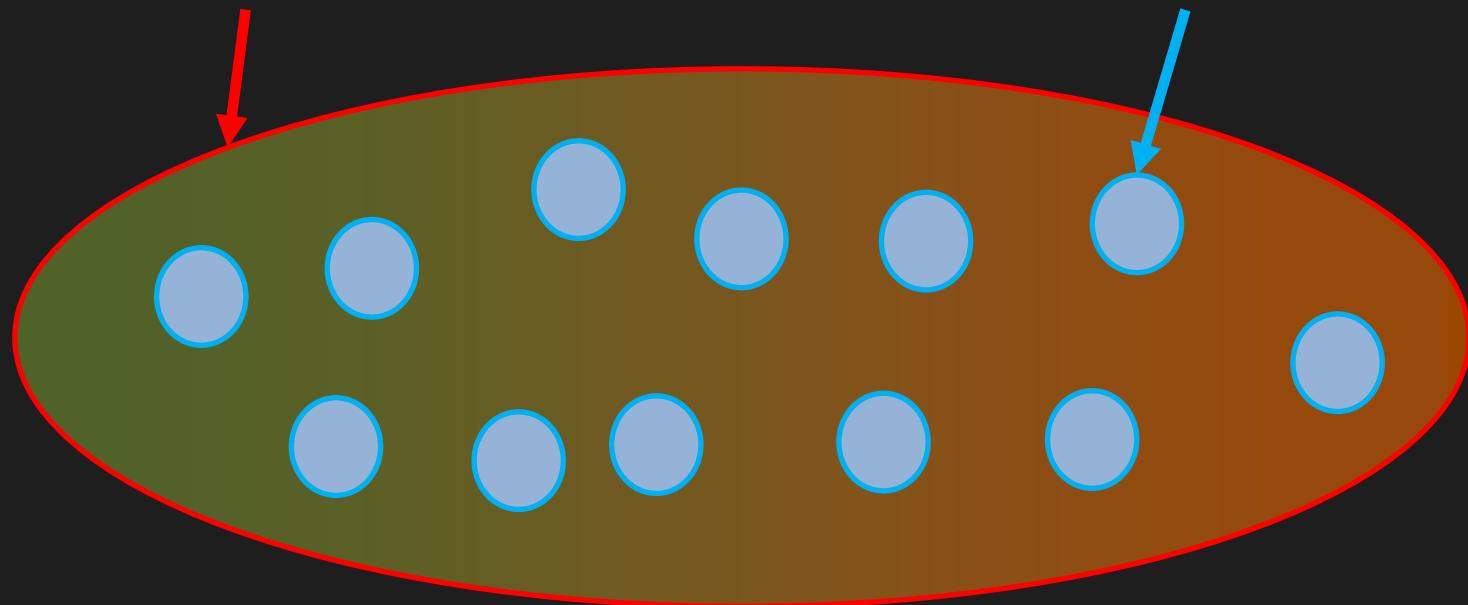
Population



Evolutionary processes

Species range

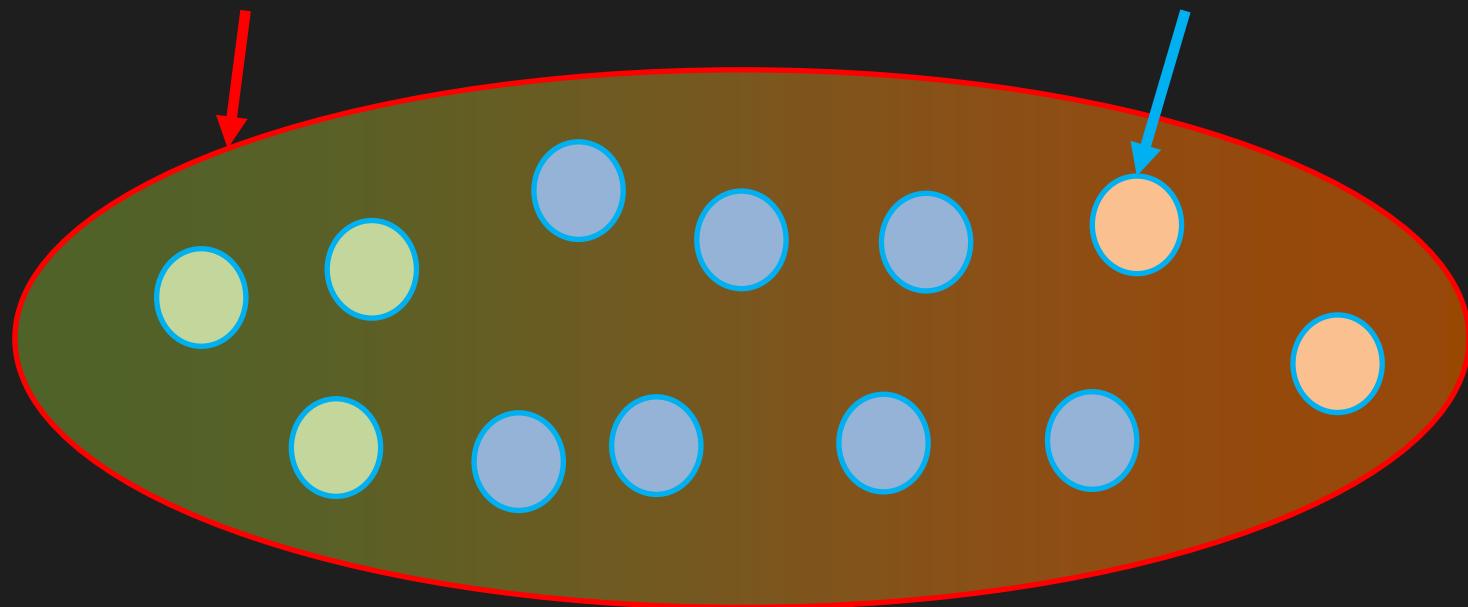
Population



Evolutionary processes

Species range

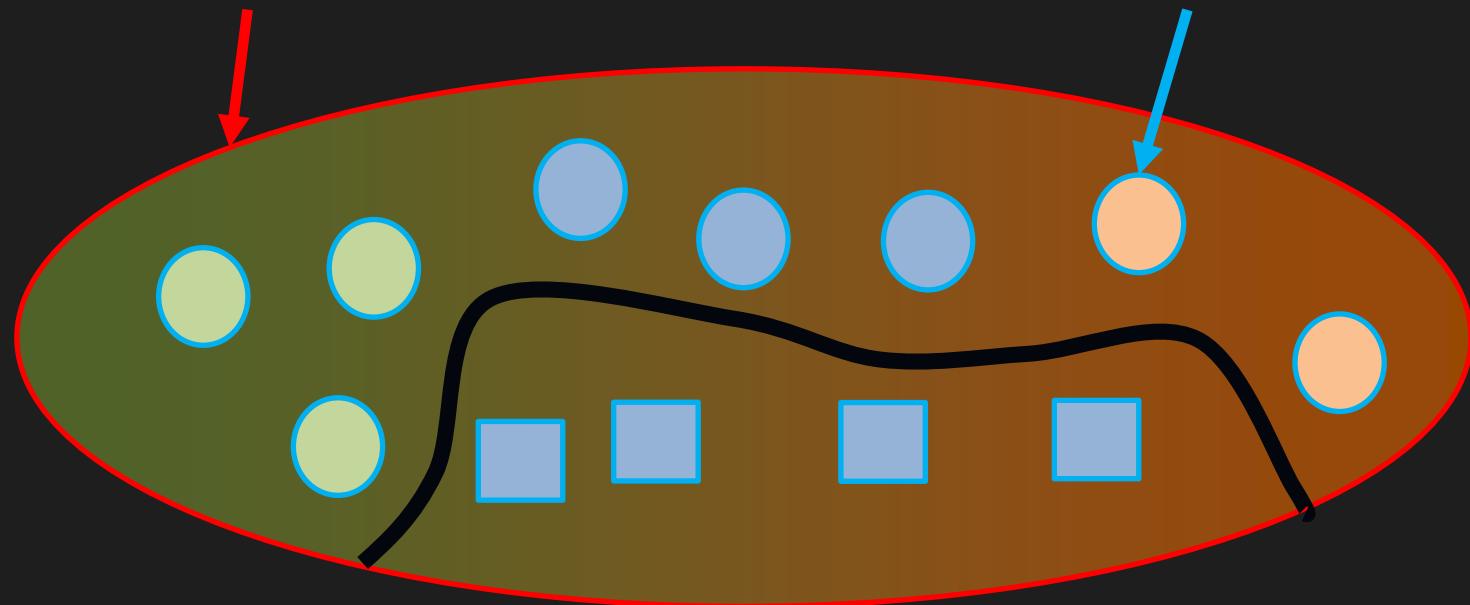
Population



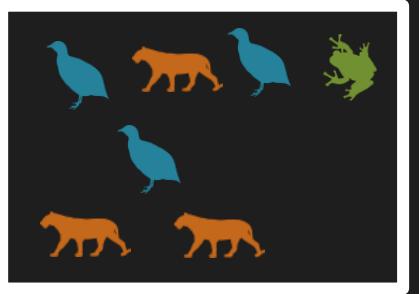
Evolutionary processes

Species range

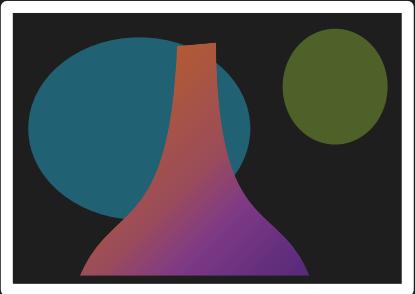
Population



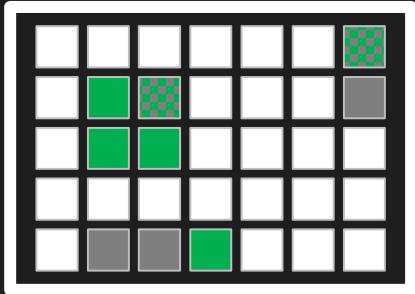
Ecological surveys



Distribution maps



Priority areas

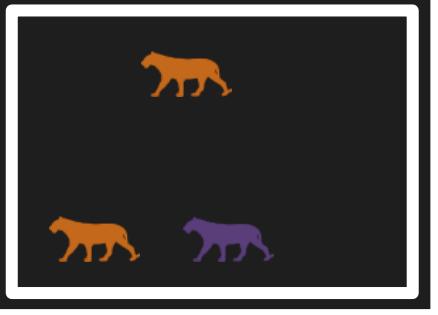


Biodiversity

2000 Future

Data → Information → Plan → Outcome

Genetic samples



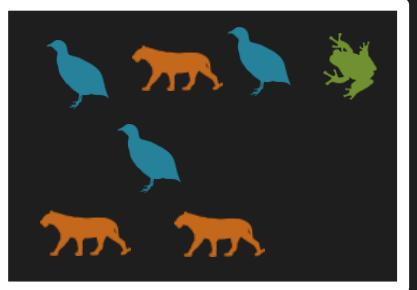
Better
understanding
of biodiversity

Objectives Constraints

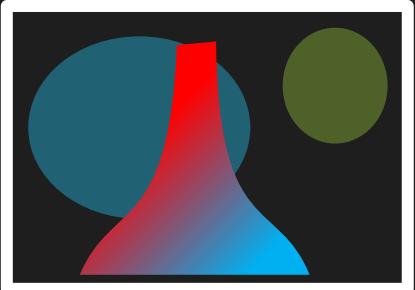
Better
plan

Better
outcome

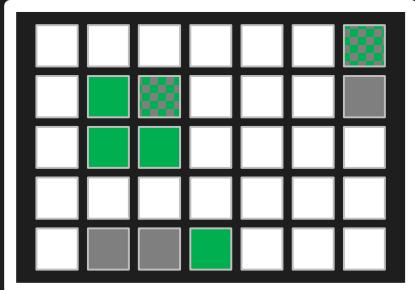
Ecological surveys



Distribution maps



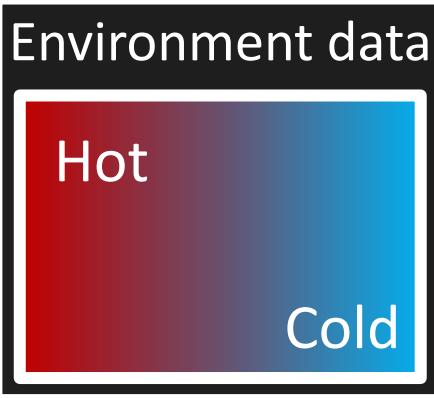
Priority areas



Biodiversity

2000 Future

Data → Information → Plan → Outcome



Good enough
understanding
of biodiversity

Objectives Constraints

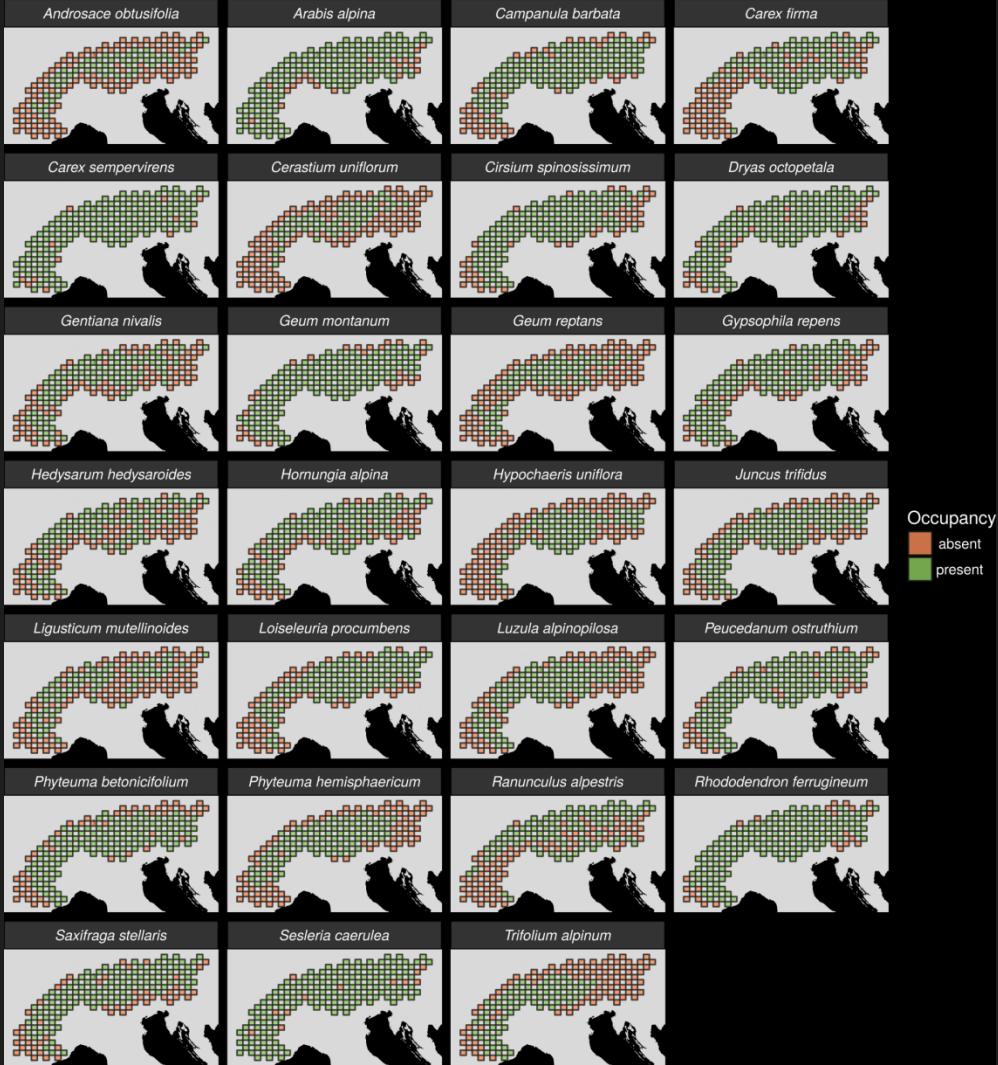
Better
plan

Better
outcome

Can we use environmental
and geographic variables
as surrogates of
genetic variation for
conservation planning?

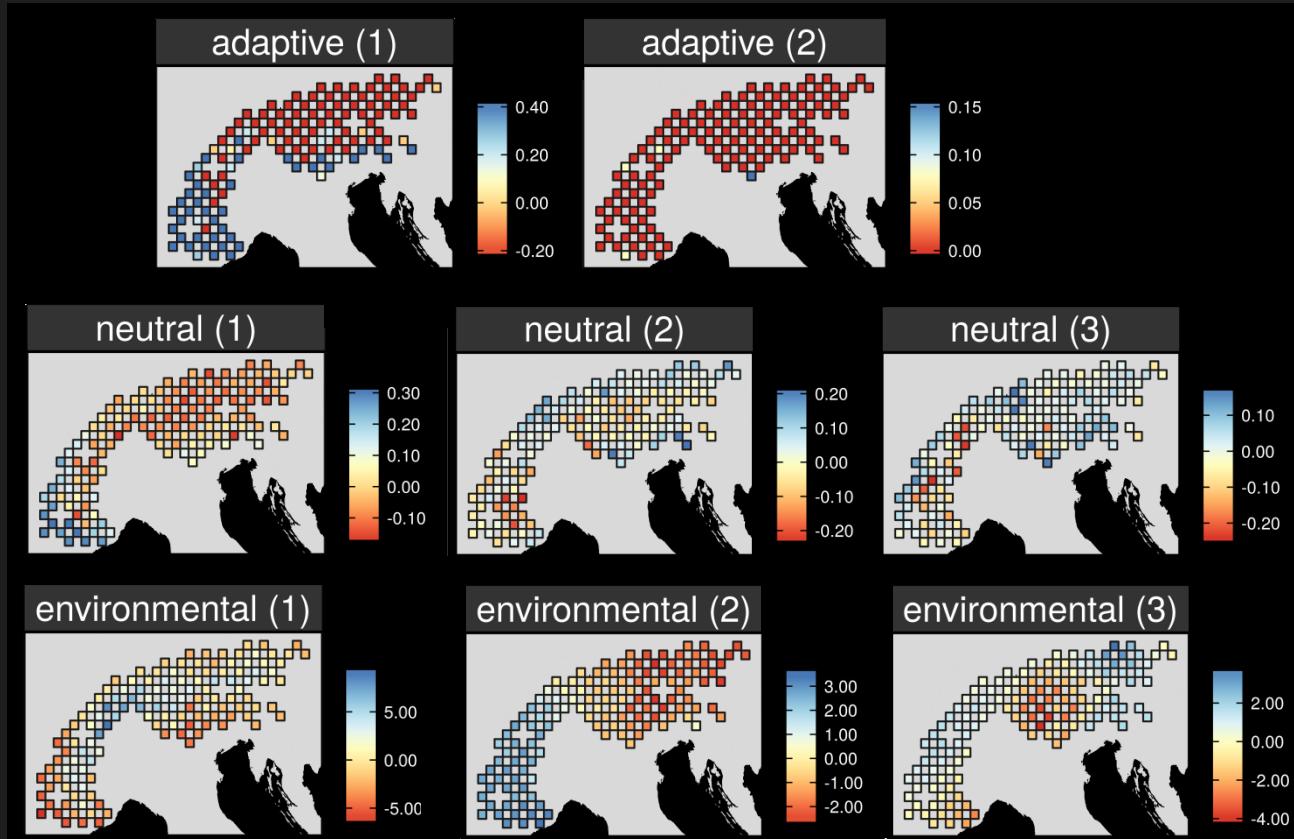
27 plant species

- Different dispersal
- Different life-histories
- Different niches
- AFLP markers



Map intra-specific variation

Arabis alpina

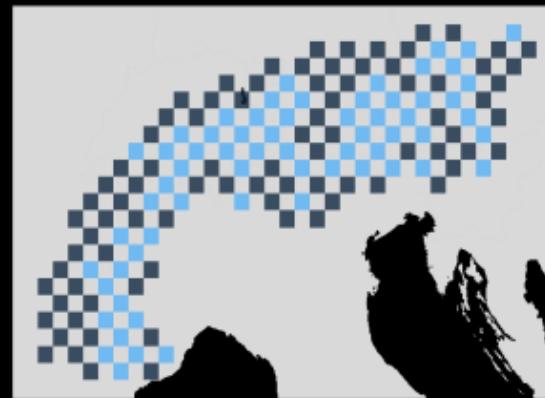
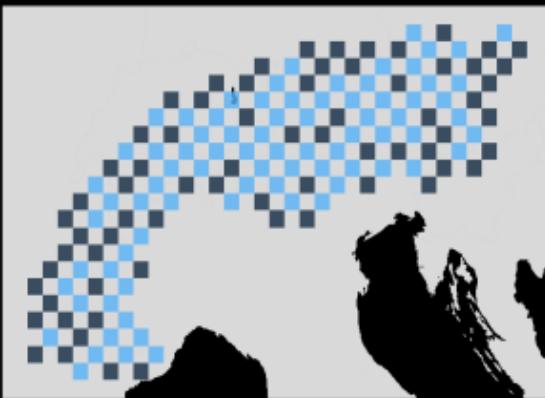
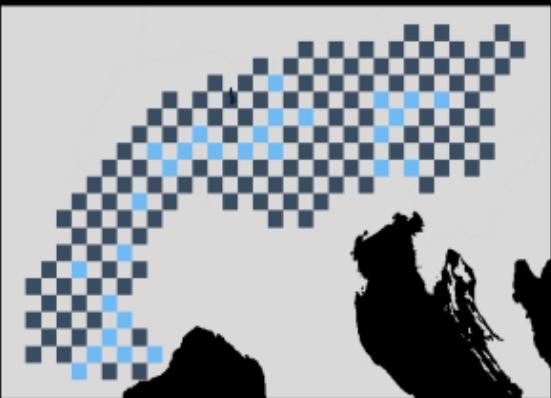


Can surrogates inform our decisions?

Amount targets

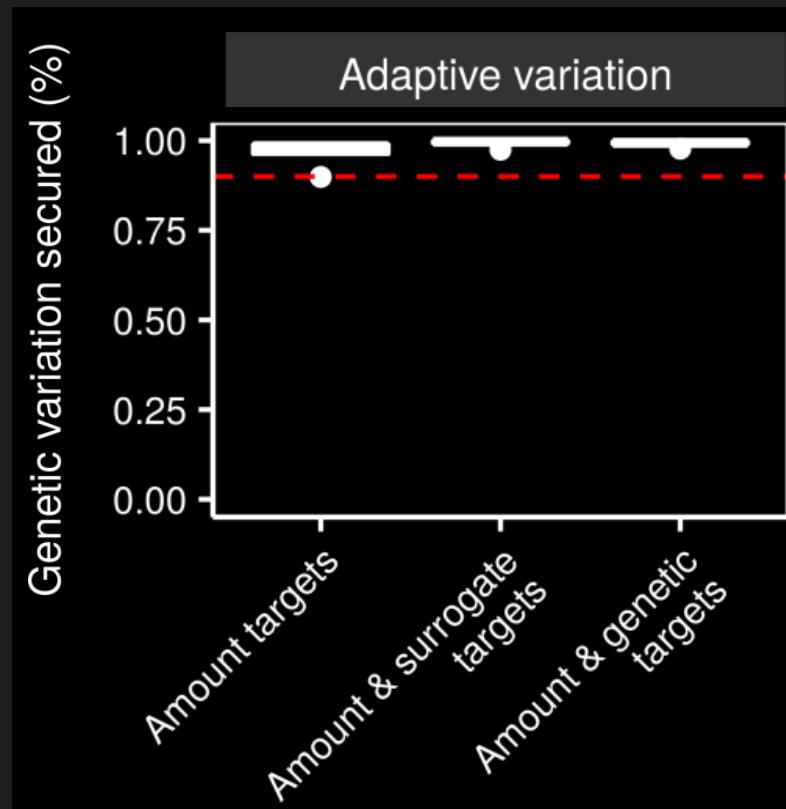
Amount & surrogate
targets

Amount & genetic
targets

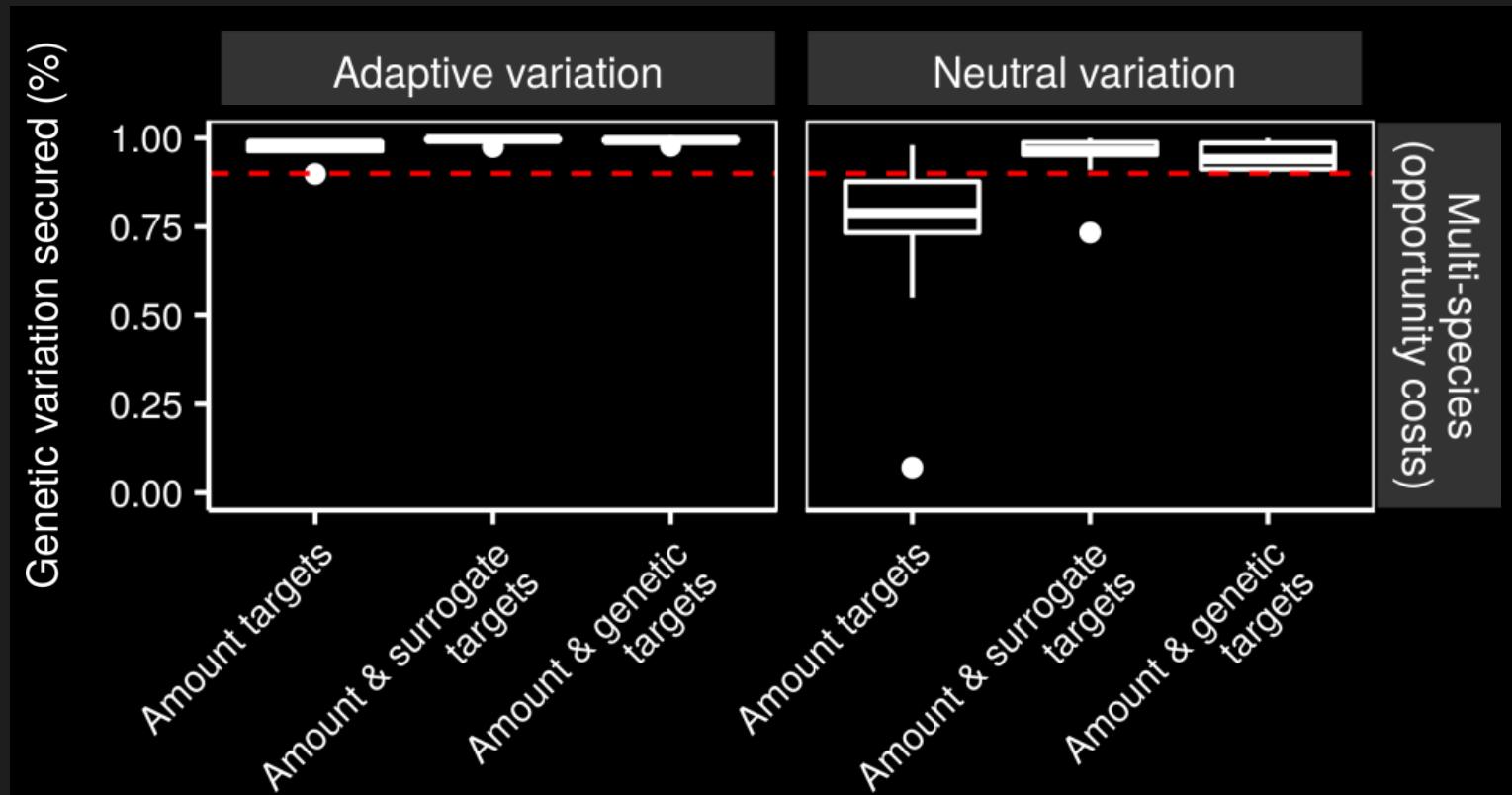


Multi-species
(opportunity costs)

Can we make better decisions using surrogates?



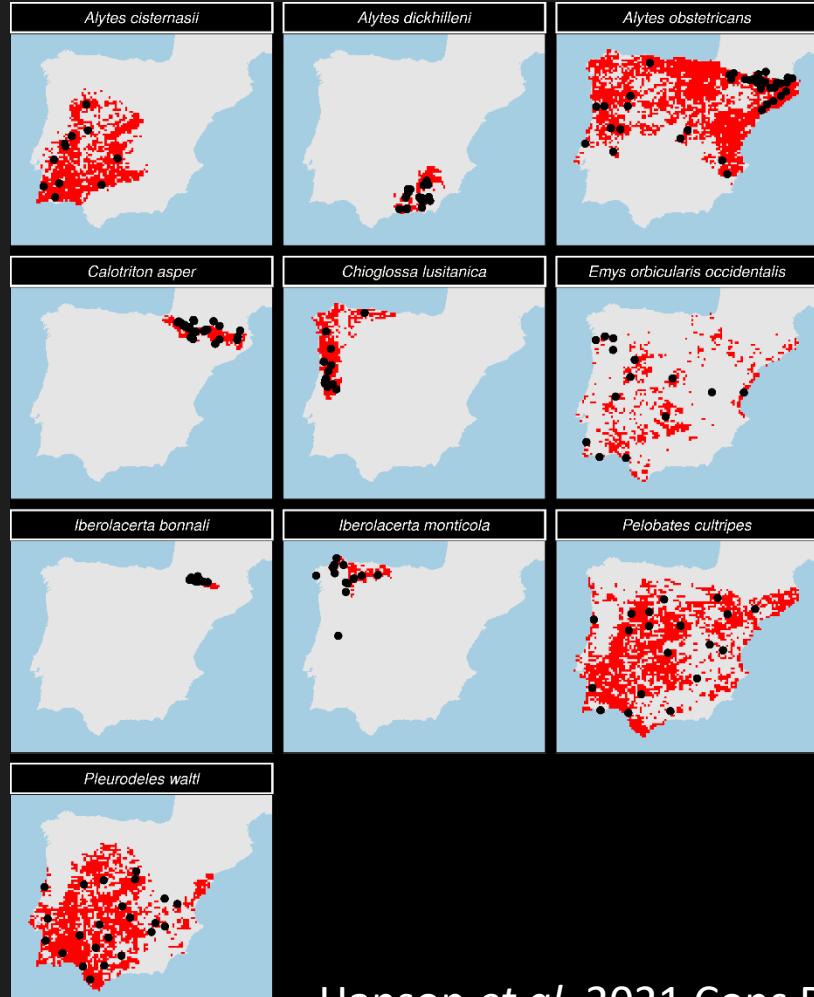
Can we make better decisions using surrogates?



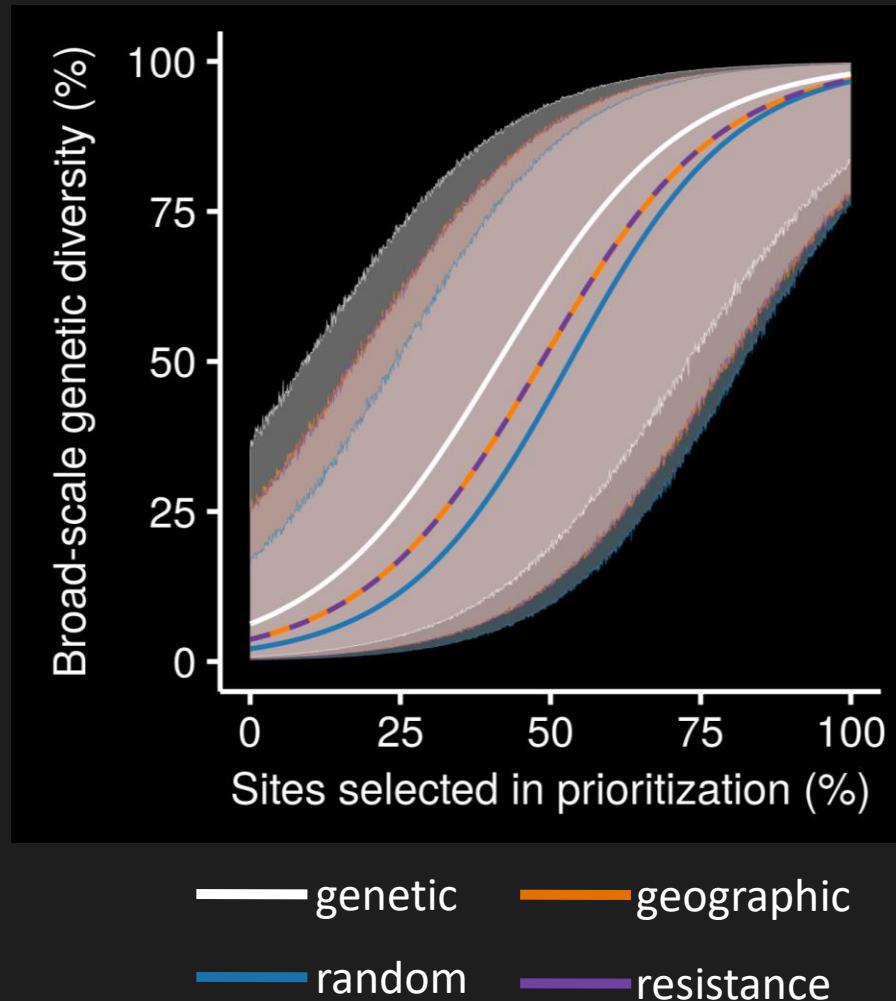
However, surrogates
may not always work

Evaluating surrogates of genetic diversity for conservation planning

- 7 amphibian species
- 3 reptile species
- Iberian Peninsula = HARD MODE
- Microsatellite markers for neutral genetic variation



- Surrogates for neutral genetic variation may not perform much better than random
- Little performance improvement with low budget

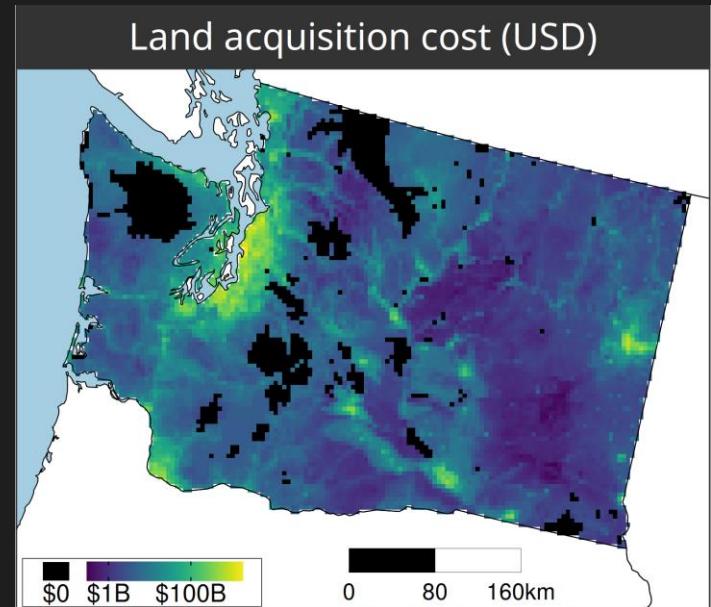


Many surrogates are
often available,
how do our choices
affect the results?

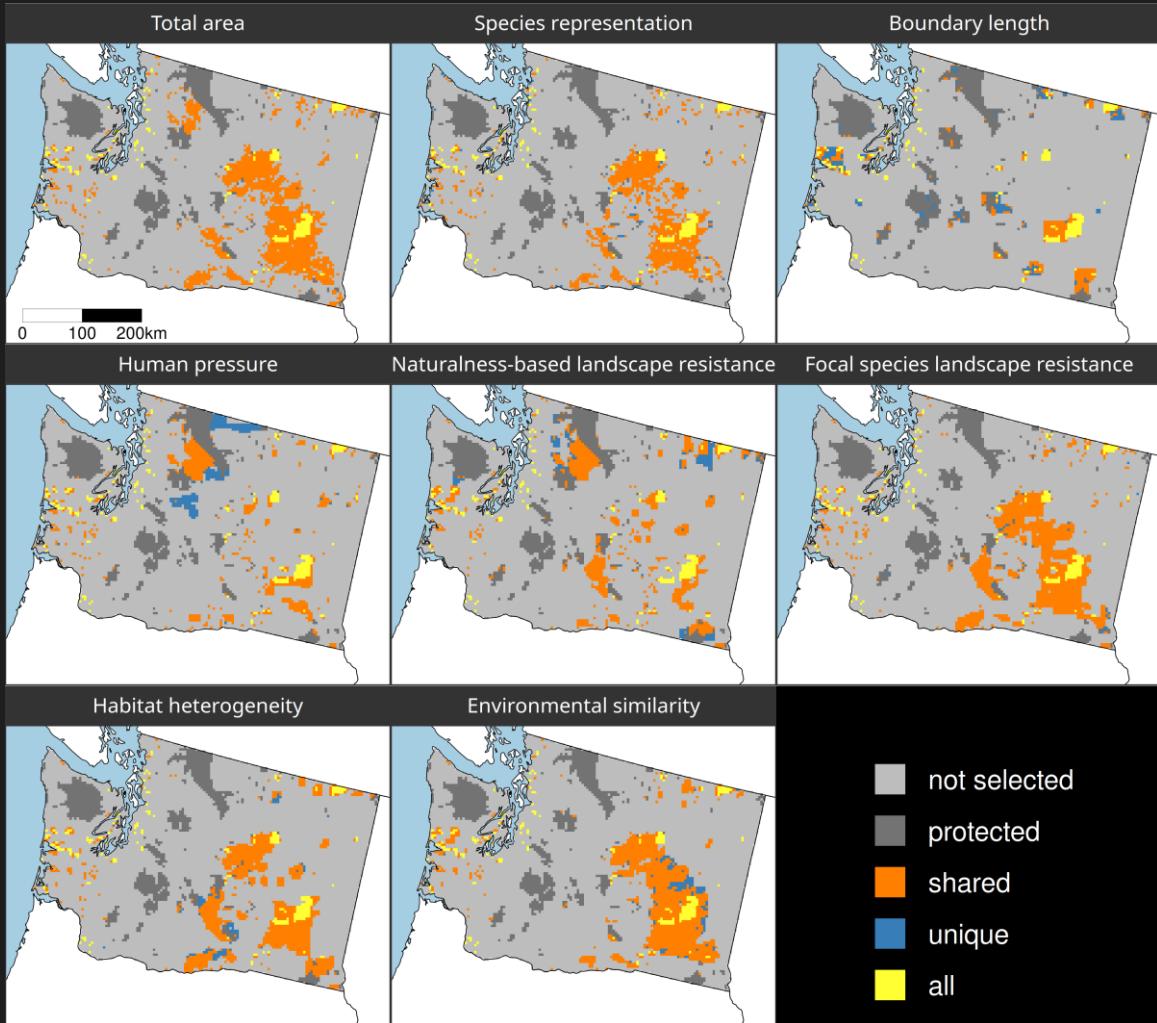
A comparison of approaches for including connectivity in systematic conservation planning

Washington State, USA

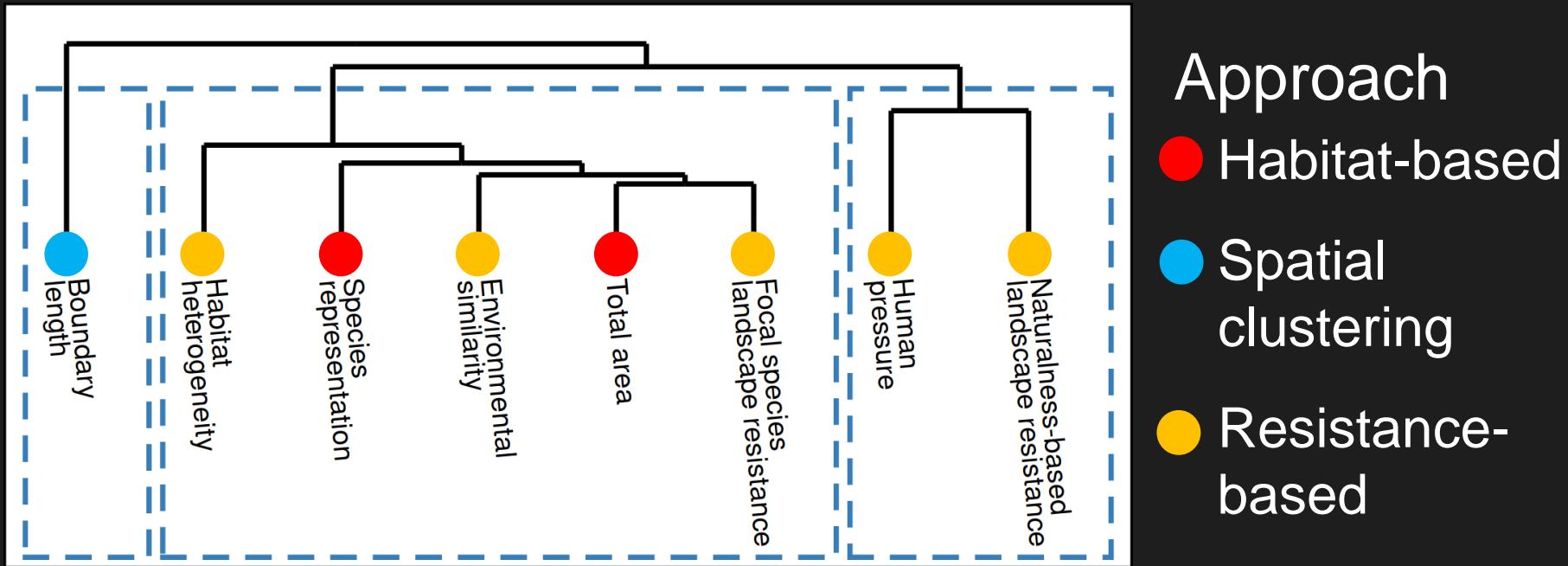
- 261 bird species
- Land acquisition costs
- Existing protected areas
- Multiple land-uses
- Multiple eco-systems



- Different connectivity approaches produce different prioritizations
- Different connectivity approaches can yield similar prioritizations



How do the prioritizations compare?



Make better conservation decisions by using...

1. Better algorithms
2. Cost-effective data
3. Reliable surrogates



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