

# Making better conservation decisions



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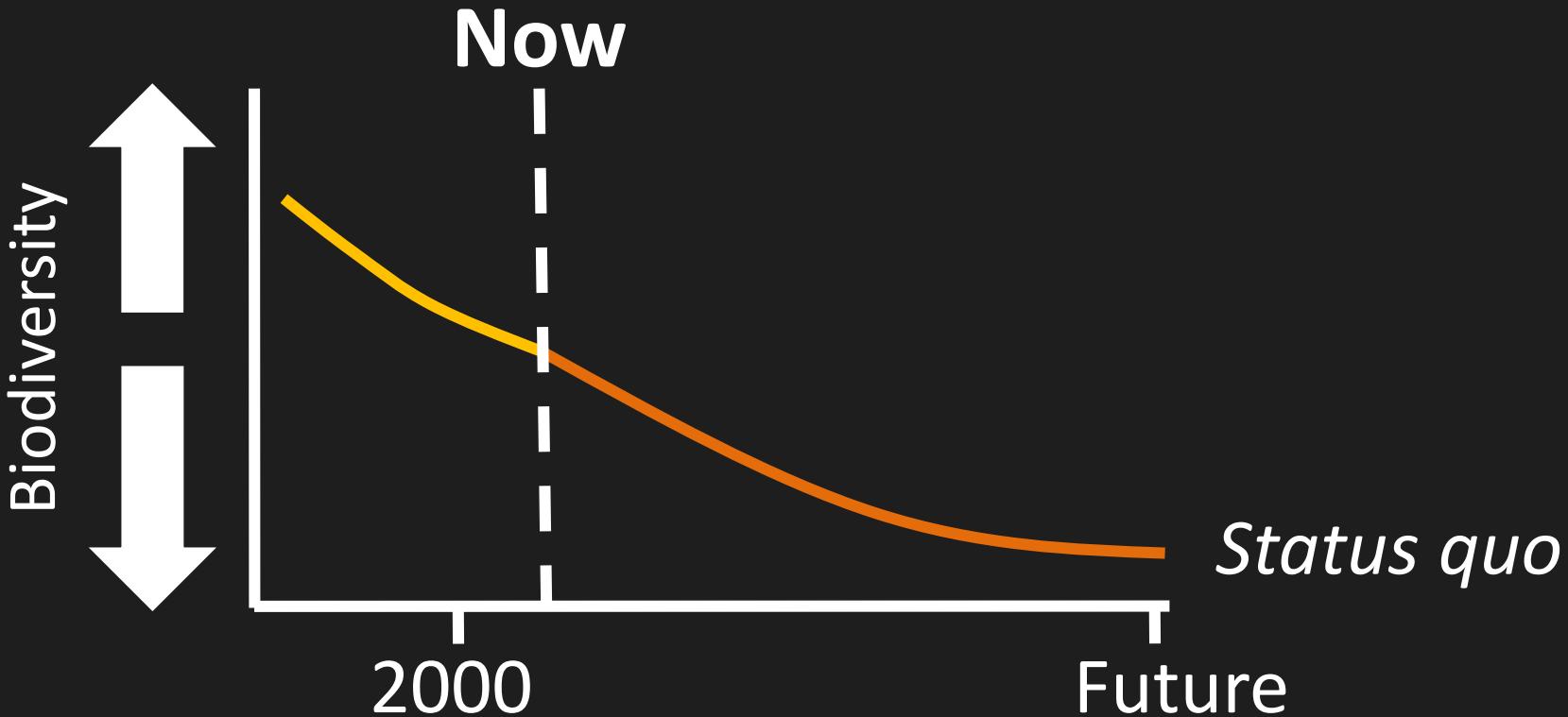


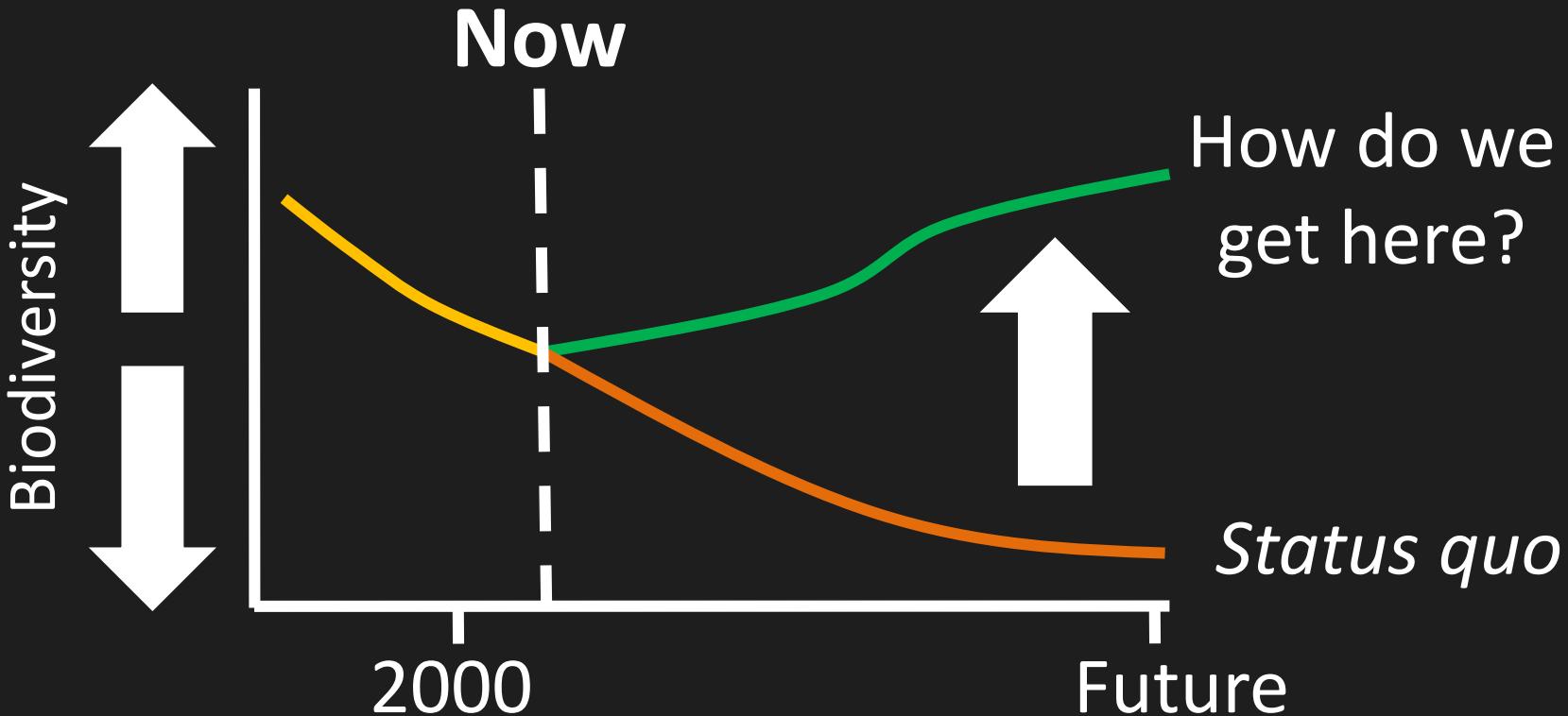
jeffrey-hanson.com

# Acknowledgements

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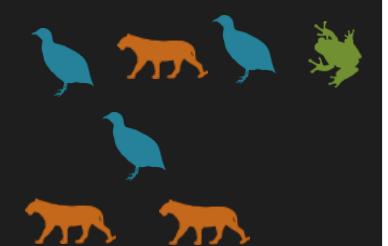




# How can we get a better conservation decision?

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

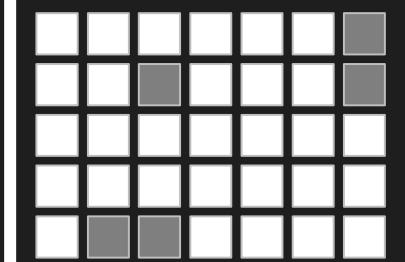
Ecological surveys



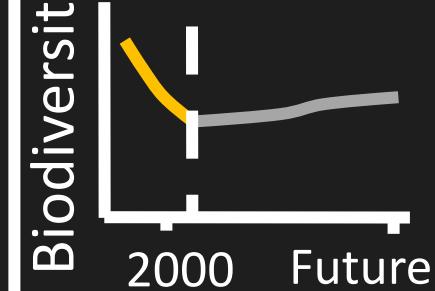
Distribution maps



Priority areas



Biodiversity



Data → Information → Plan → Outcome



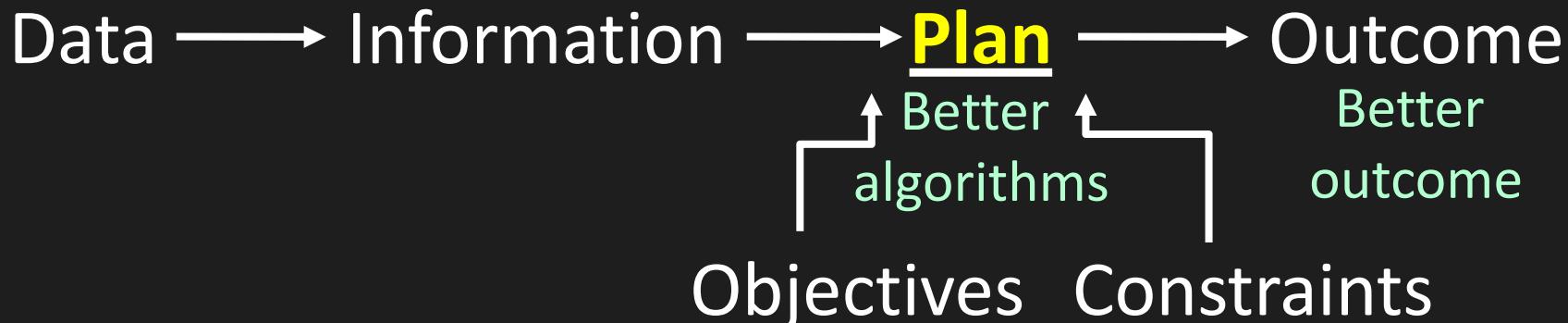
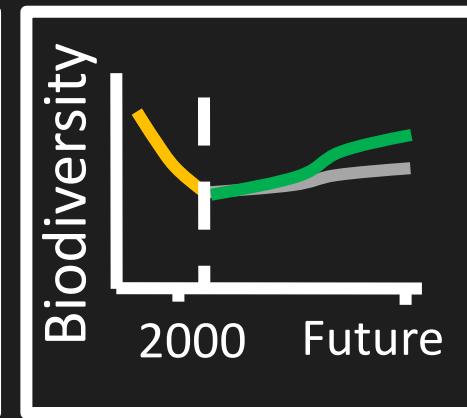
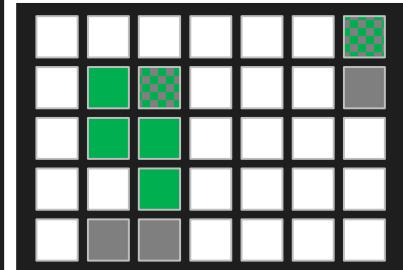
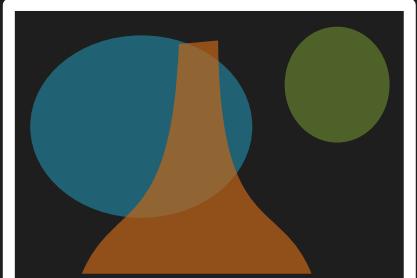
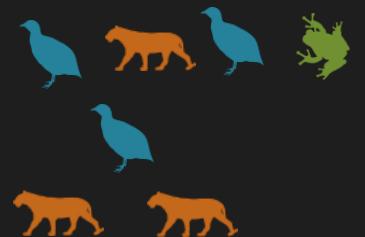
Objectives   Constraints

Ecological surveys

Distribution maps

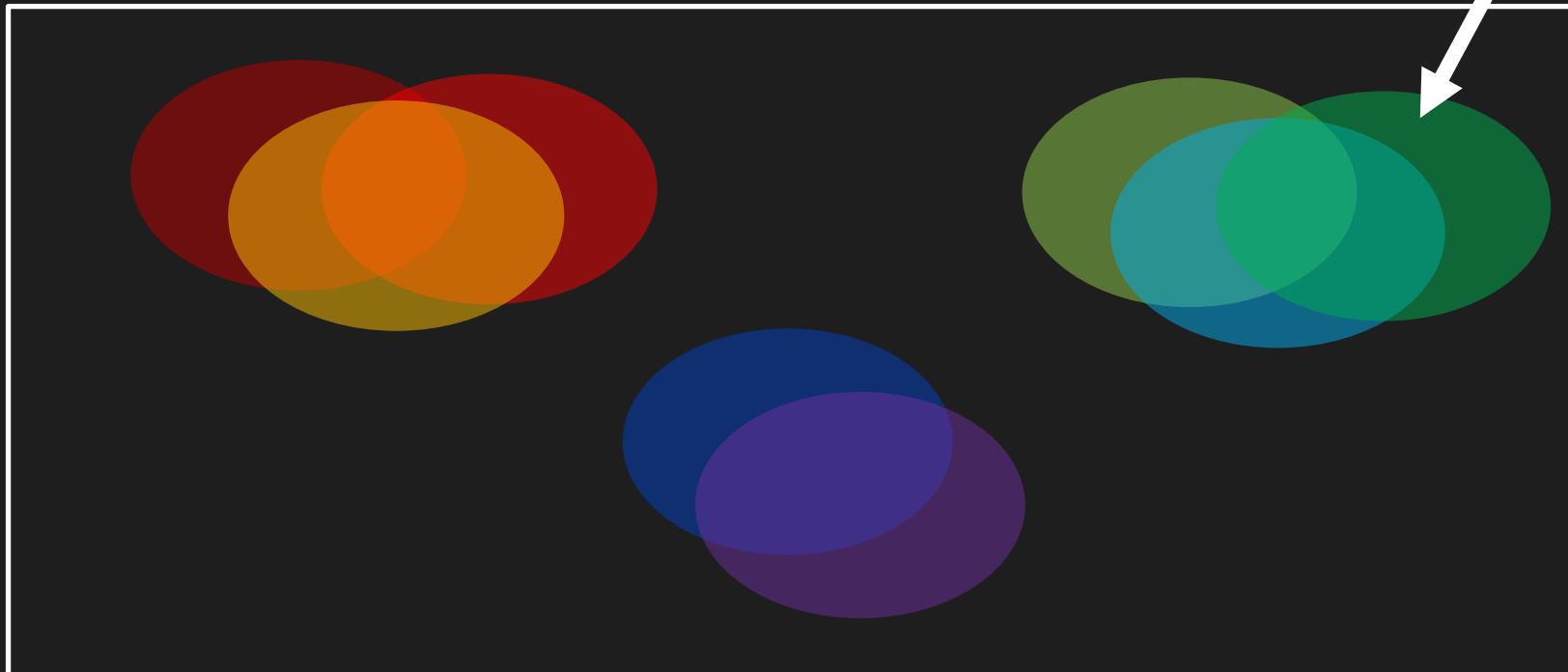
Priority areas

Biodiversity



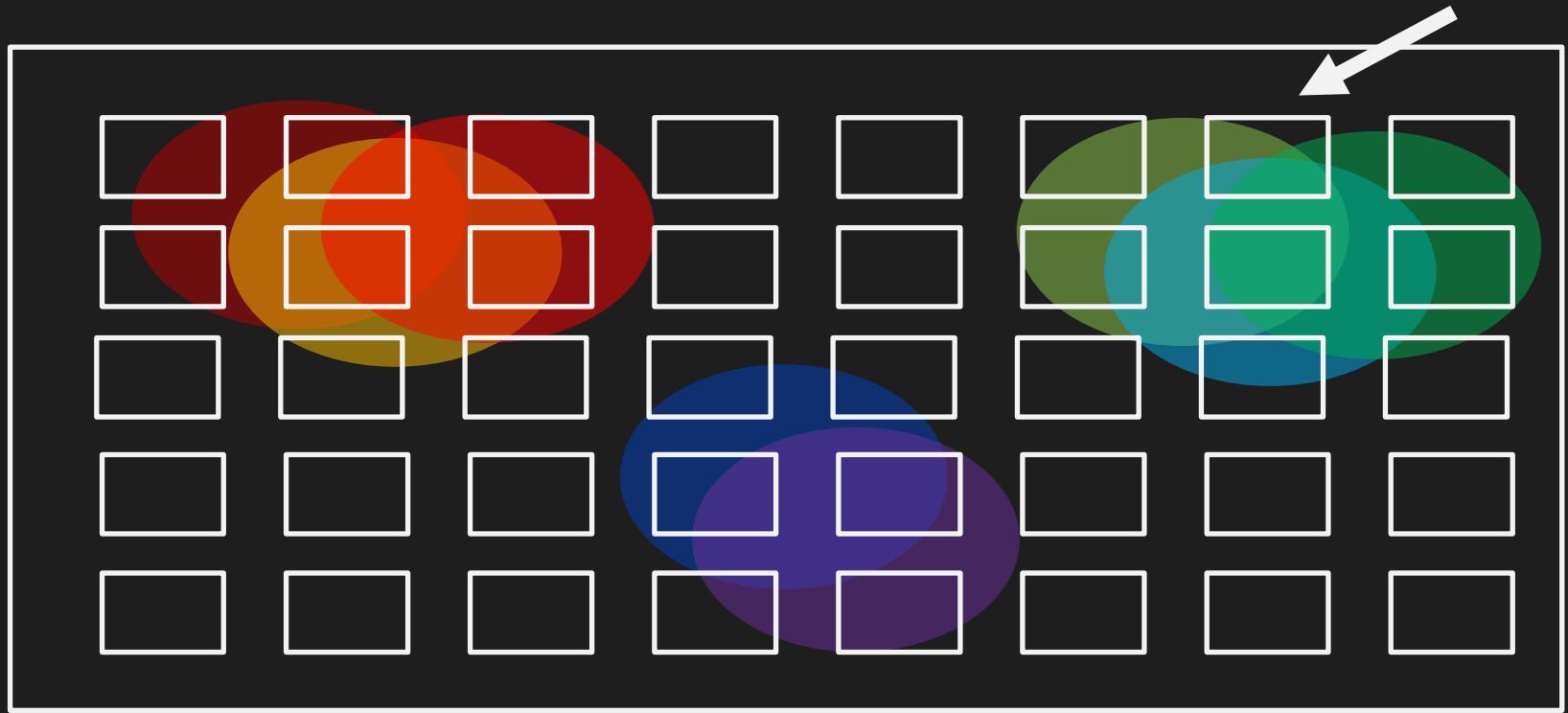
# Reserve selection

Features

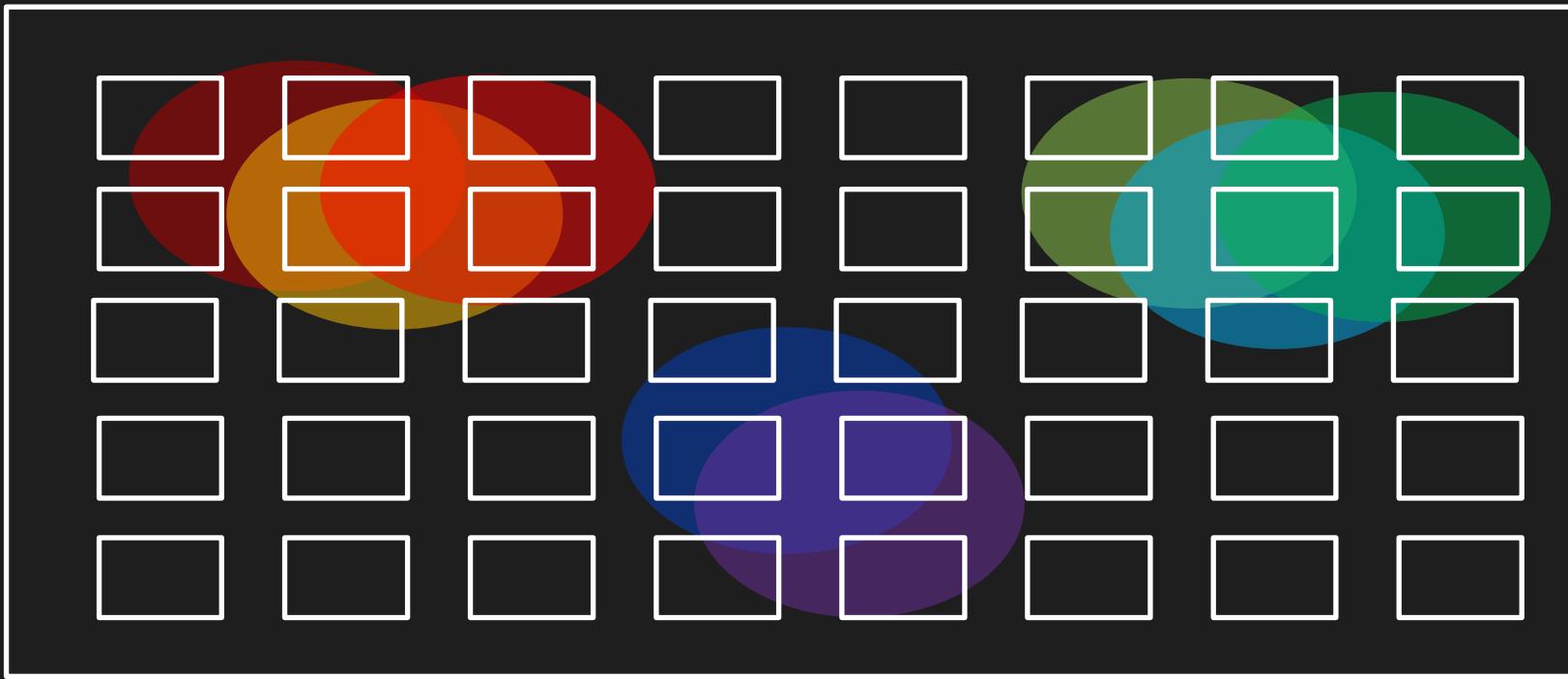


# Reserve selection

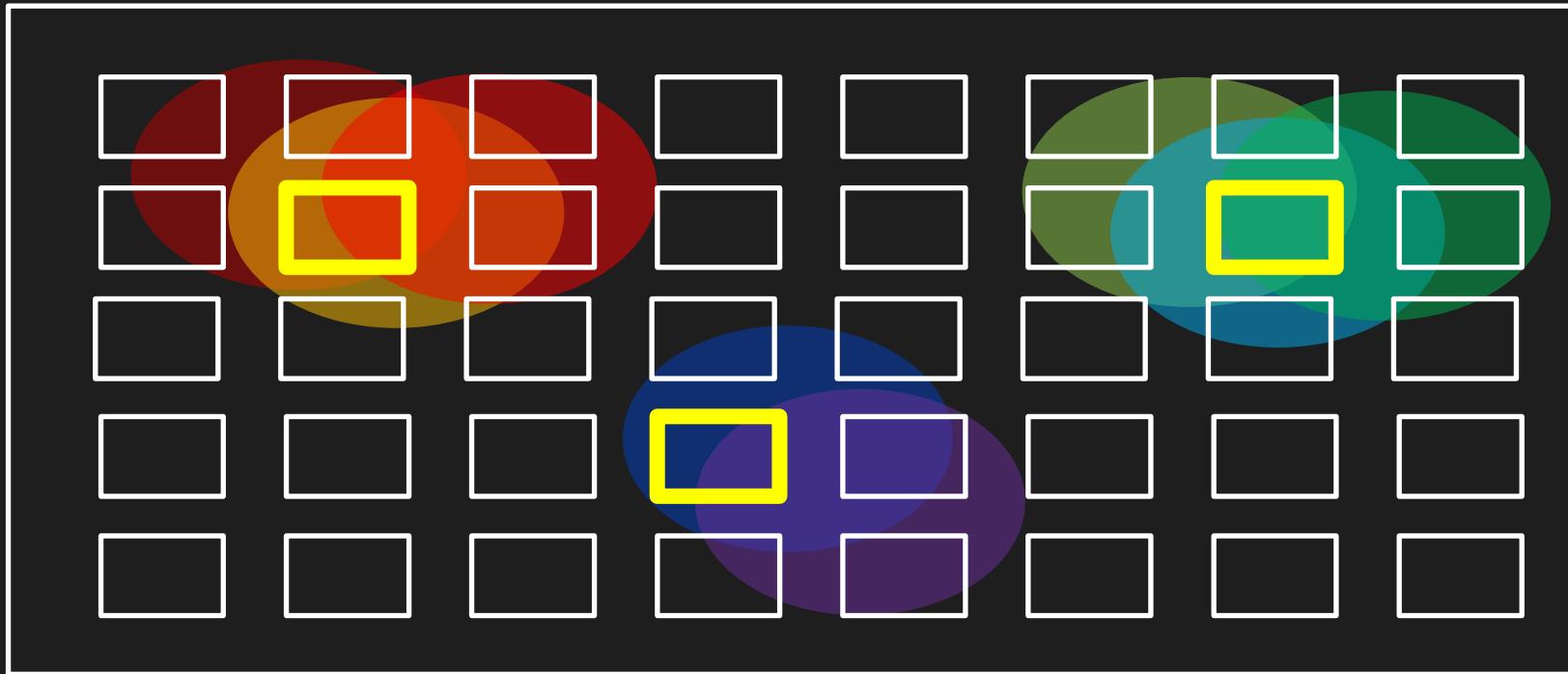
Planning units



# Reserve selection



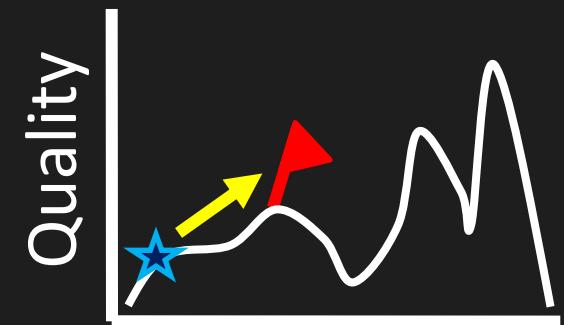
# Reserve selection



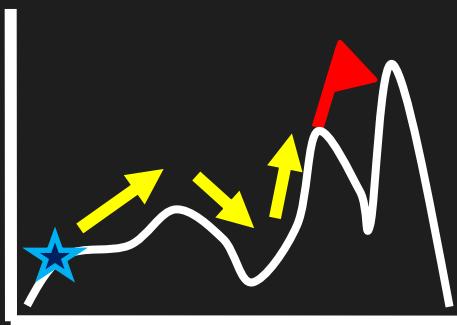
## Heuristic algorithm

## Meta-heuristic algorithms

## Exact algorithms



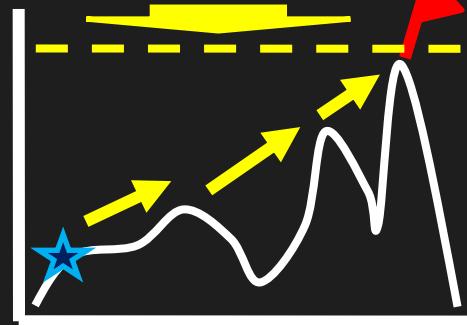
Different  
solutions



Different  
solutions



Estimate of best quality



Different  
solutions

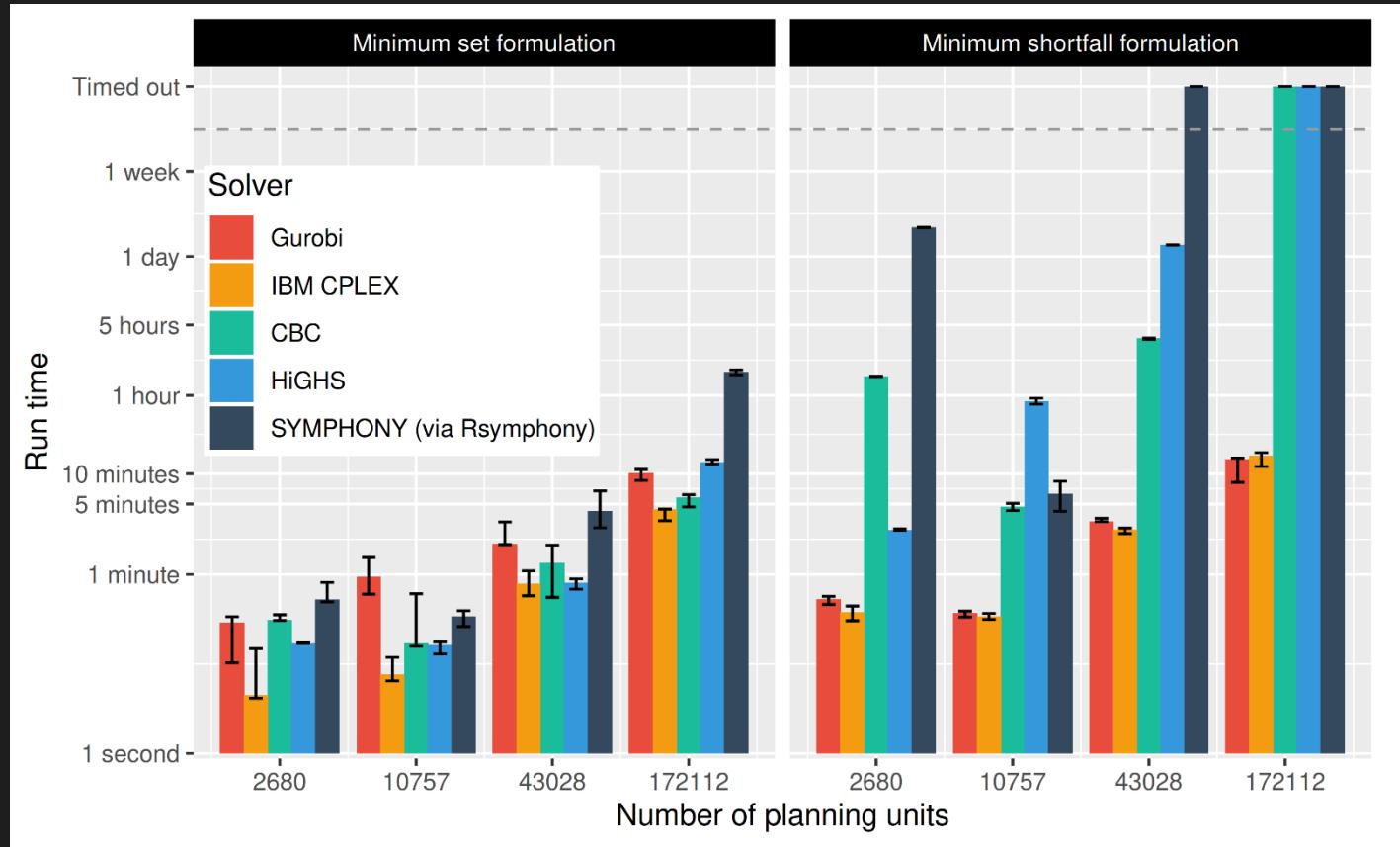


# prioritizr: Systematic conservation prioritization in R

- 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 (commercial + free)



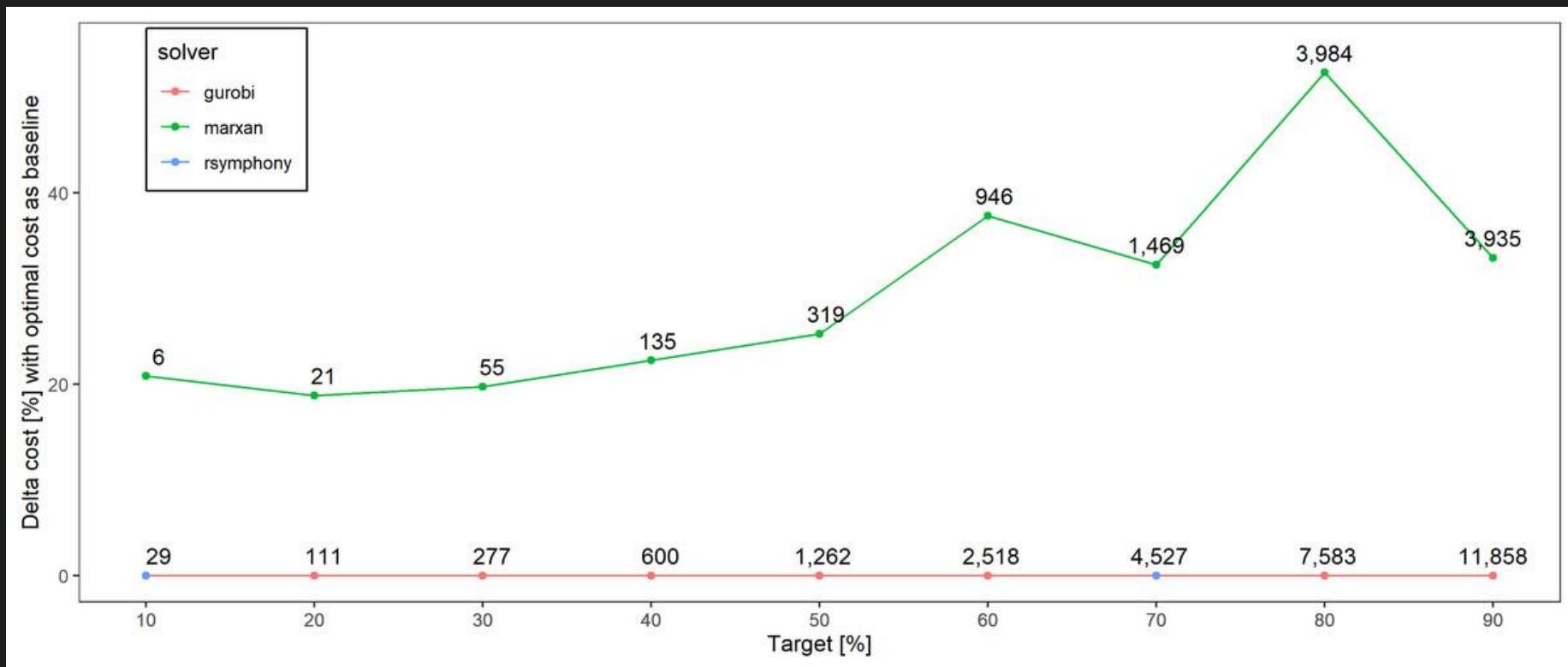
# Solve problems pretty quickly!



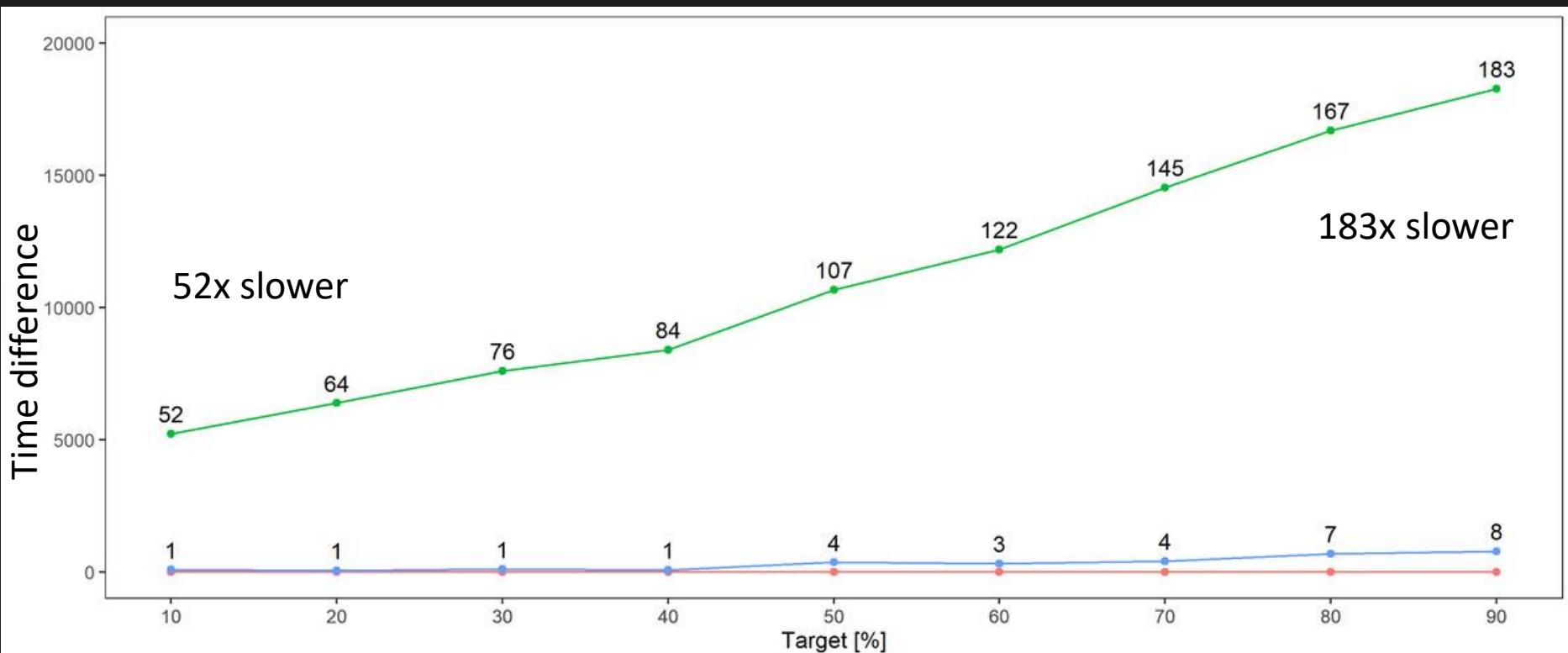
Notes: 396 features, no planning units locked in or out, prioritizations  $\leq 10\%$  from optimality

Hanson *et al.* under review

# Better solutions



# Faster too



What about other  
conservation  
problems?

# Project prioritization

## Project data

Actions



Recovery projects



# Project prioritization

## Project data

### Actions



Success



90%



20%



50%



100%

Recovery projects

# Project prioritization

## Project data

Recovery projects	Actions				Success	Persistence (%)
					90%	95%
					20%	10%
					50%	70%
				100%	40%	9% 65%

# Project prioritization

## Project data

Recovery projects	Actions				Success	Persistence (%)	Cost data	
					90%	95%	\$	
					20%	10%	\$\$	\$\$\$
					50%	70%		\$0
					100%	40%	\$\$\$	

# Project prioritization

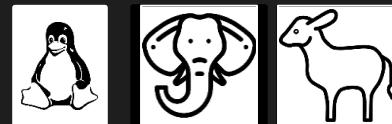
## Project data

### Actions

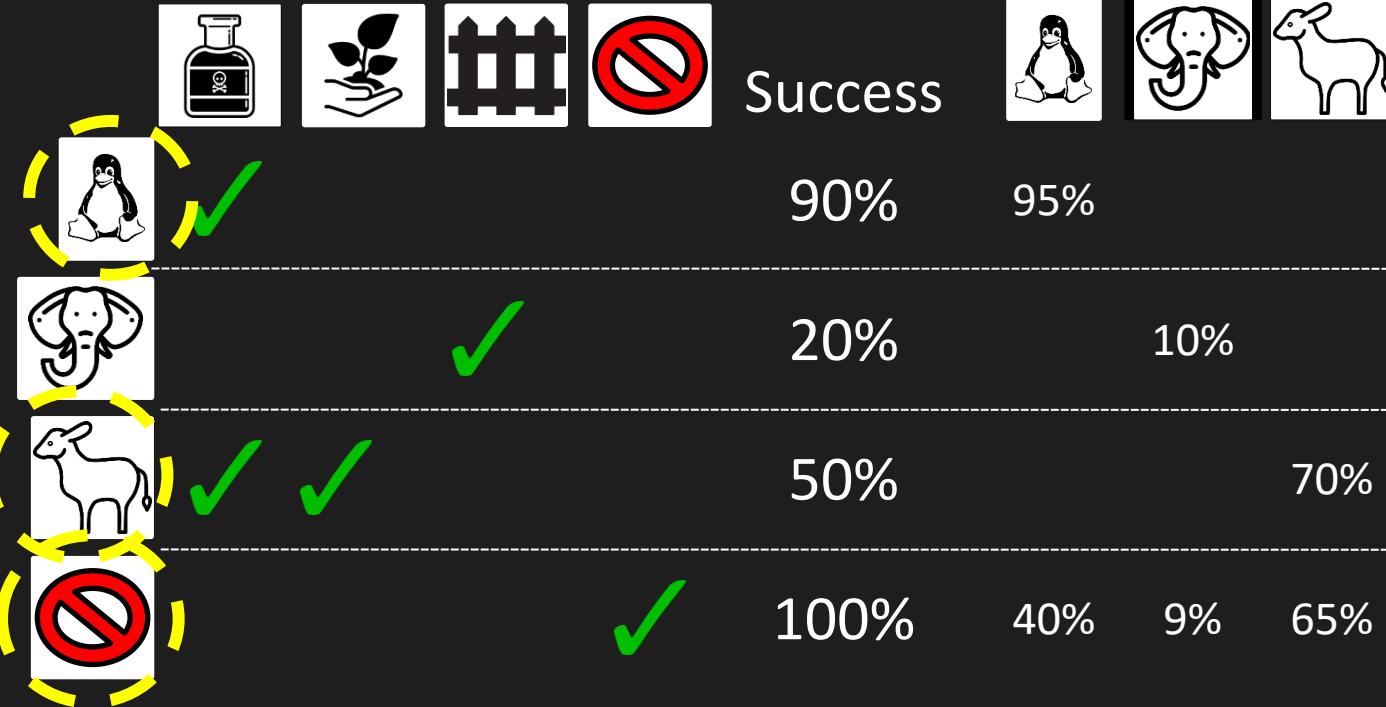


### Success

### Persistence (%)



Recovery projects



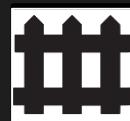
## Cost data



\$



\$\$



\$\$\$

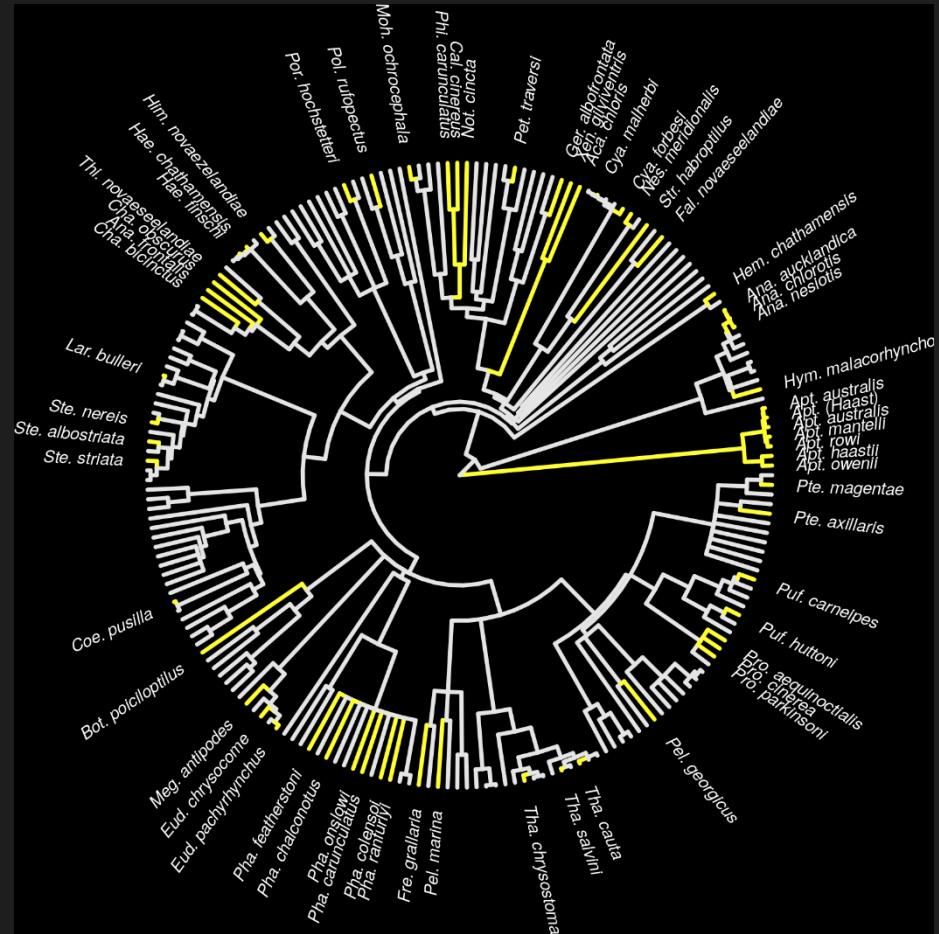


\$0

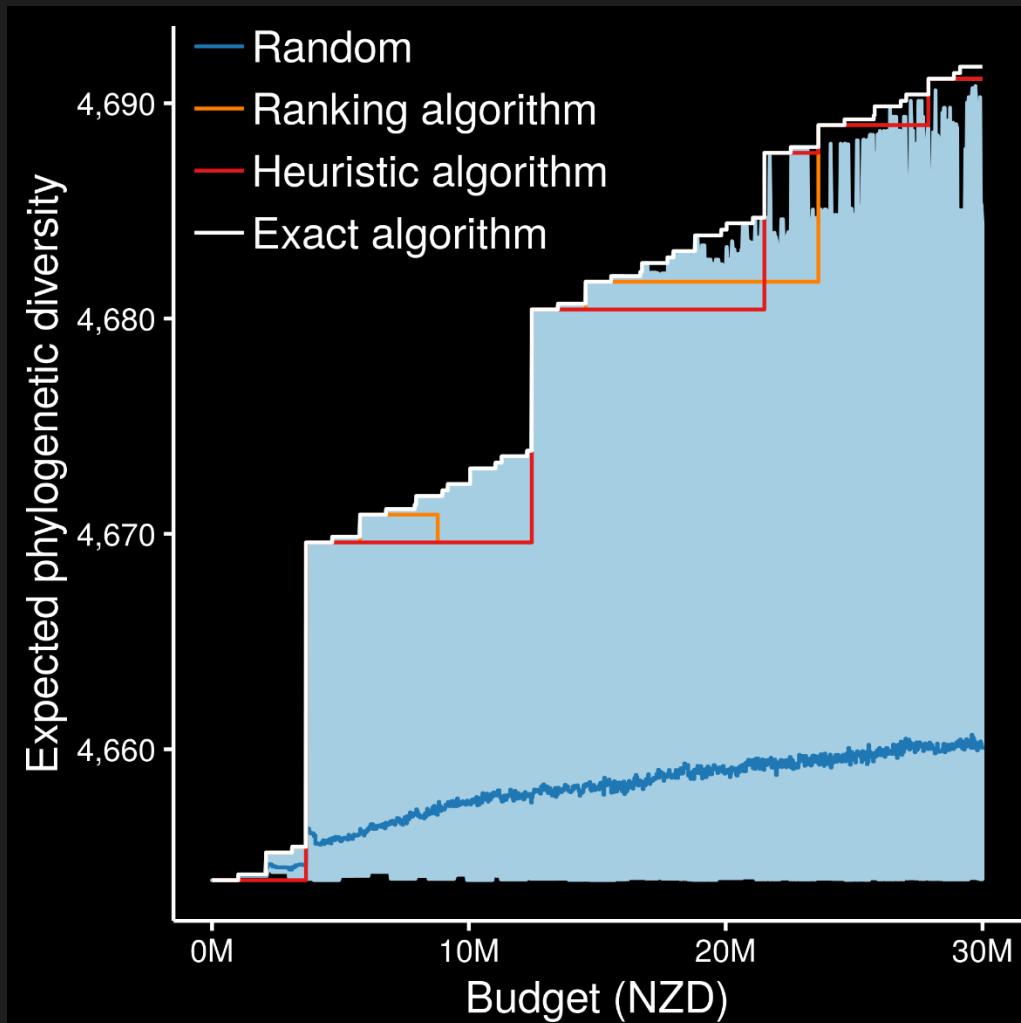
Budget \$\$\$

# 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

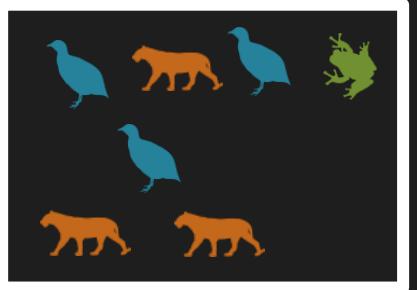
2000 Future

Data → Information → Plan → Outcome

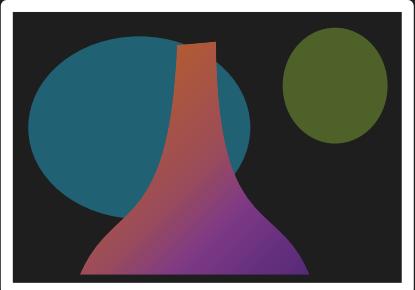


Objectives Constraints

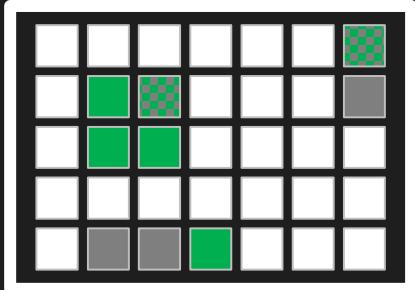
## Ecological surveys



## Distribution maps



## Priority areas

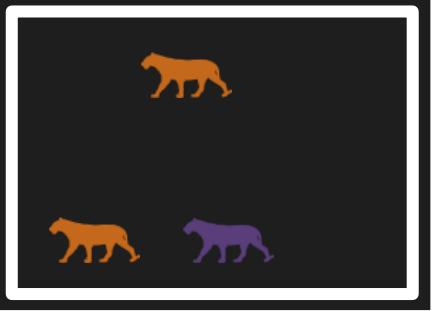


Biodiversity

2000 Future

Data → Information → Plan → Outcome

## Genetic samples



Better  
understanding  
of biodiversity

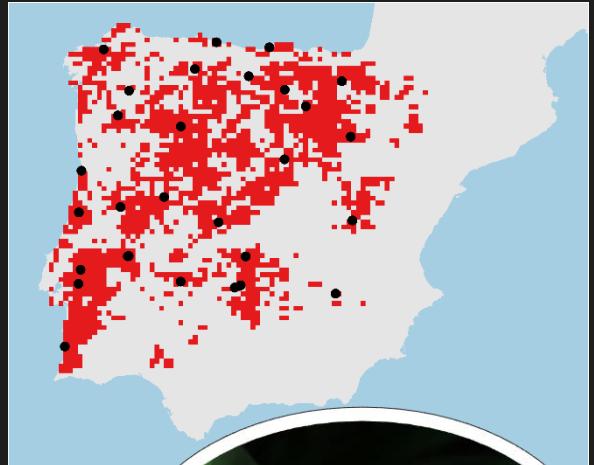
Objectives Constraints

Better  
plan

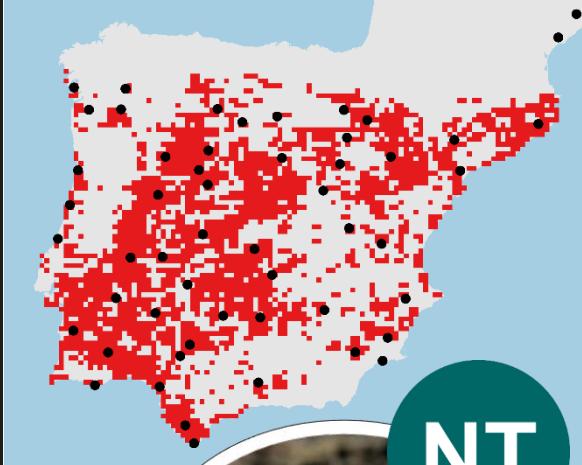
Better  
outcome

# Conservation planning for adaptive and neutral evolutionary processes

*Hyla molleri*



*Pelobates cultripes*



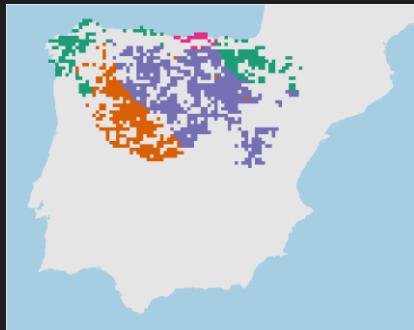
*Rana iberica*



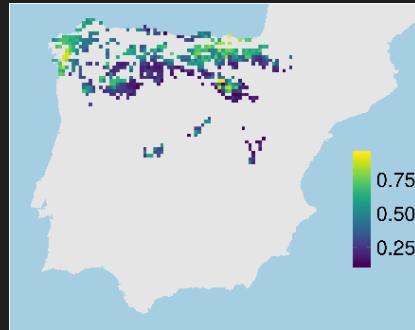
NT

## Adaptive processes

Adaptive  
clusters

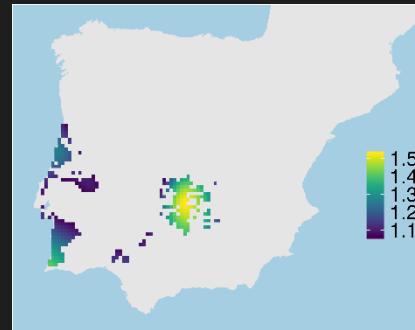


Climate  
refugia

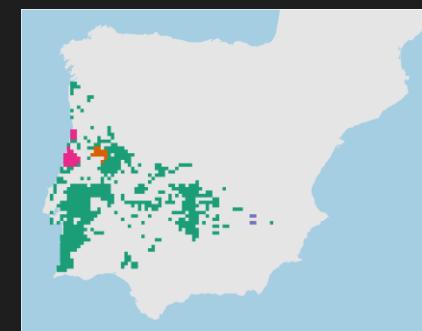
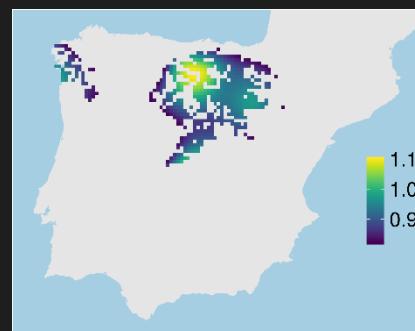
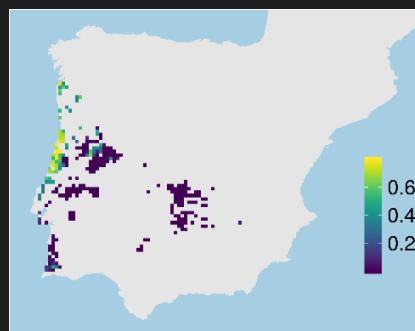
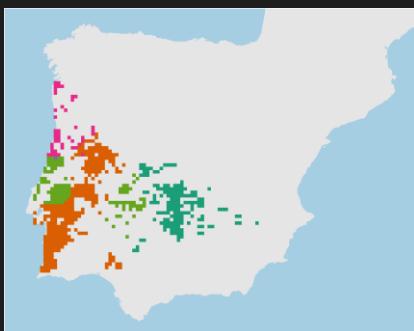
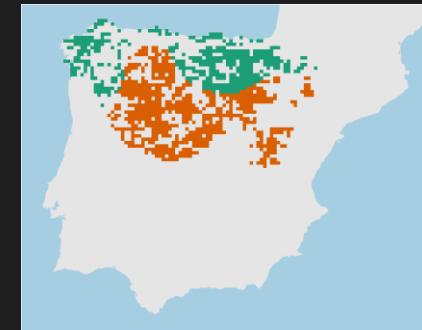


## Neutral processes

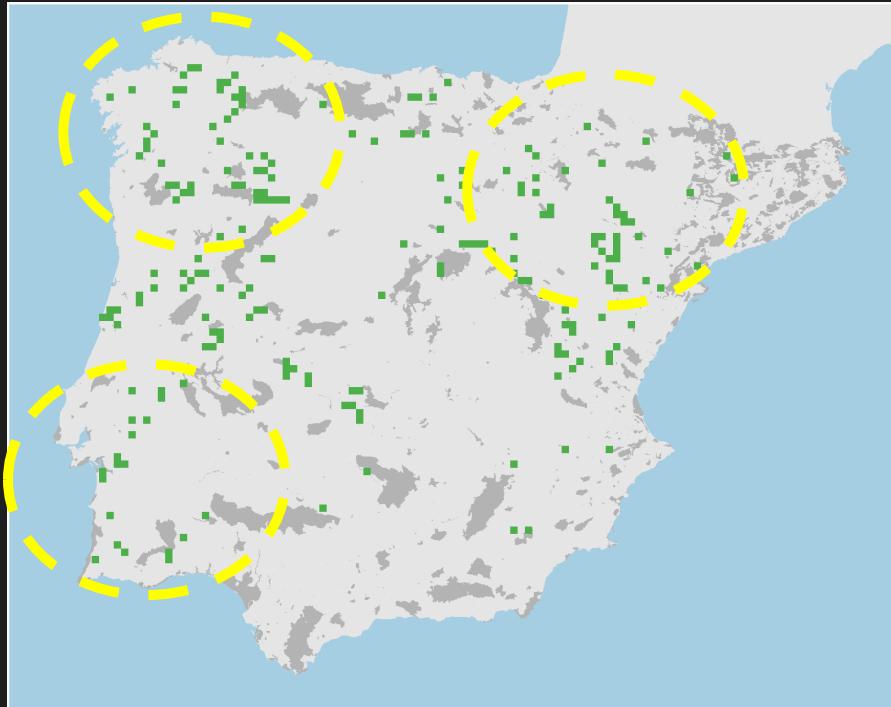
Individual  
heterozygosity



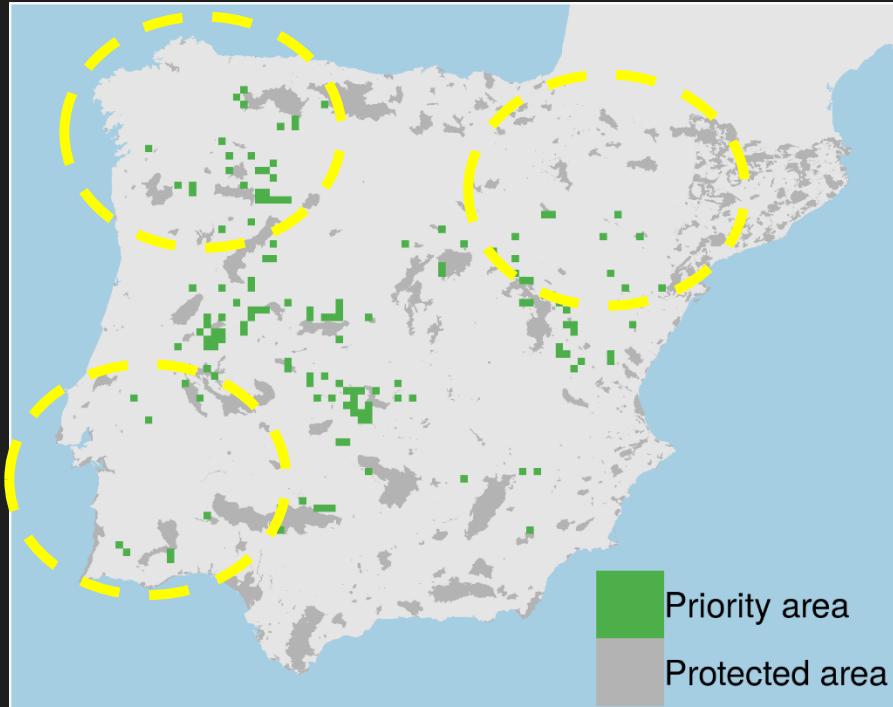
Neutral  
clusters



# Prioritizations



Plan with evolutionary  
attributes

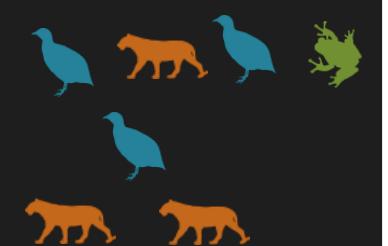


Conventional plan  
**Only costs 9% less**

Priority area  
Protected area

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

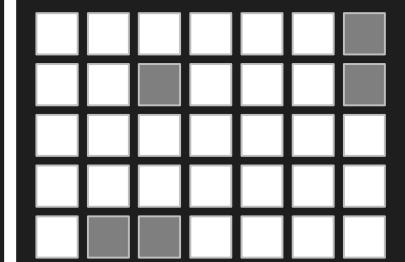
Ecological surveys



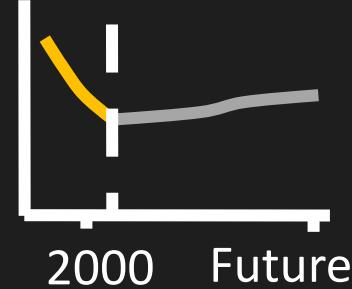
Distribution maps



Priority areas



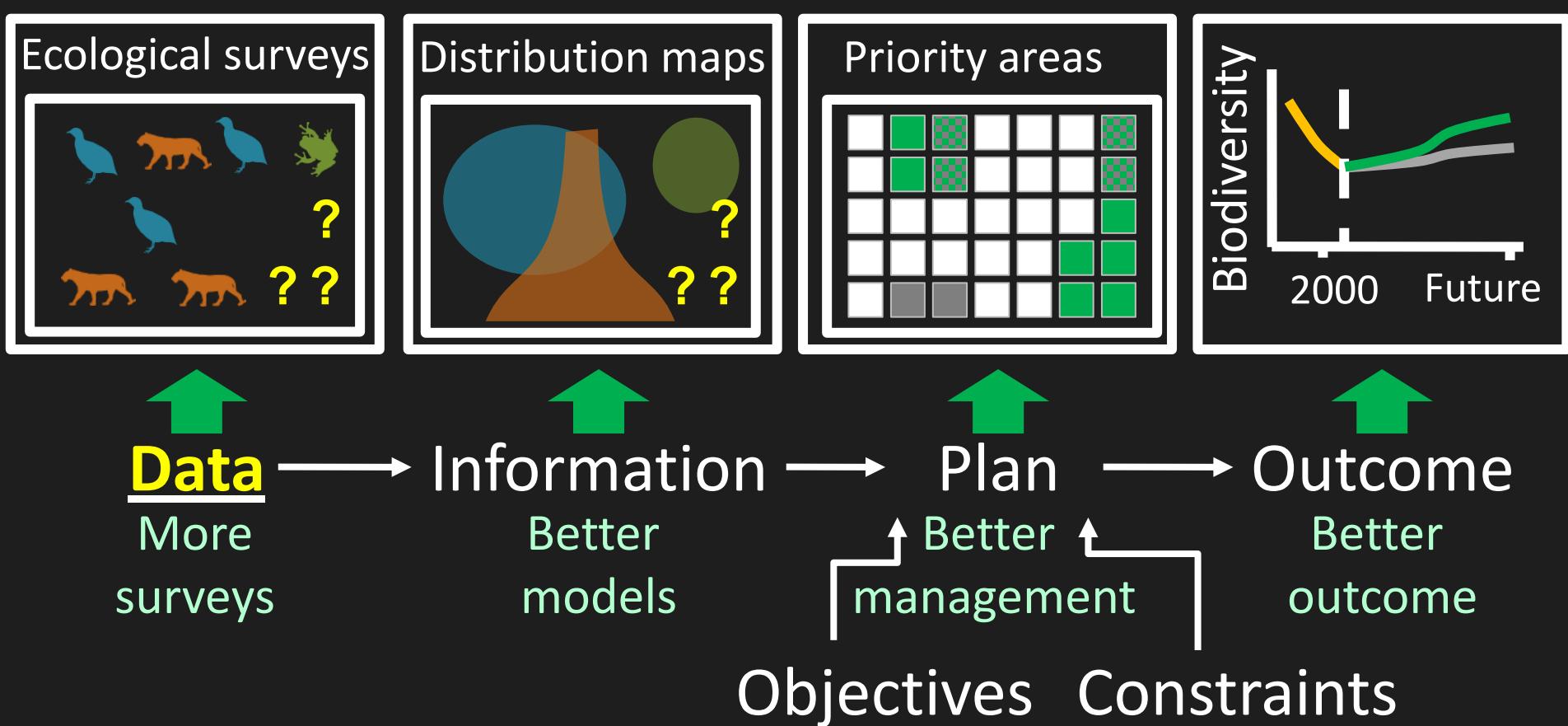
Biodiversity

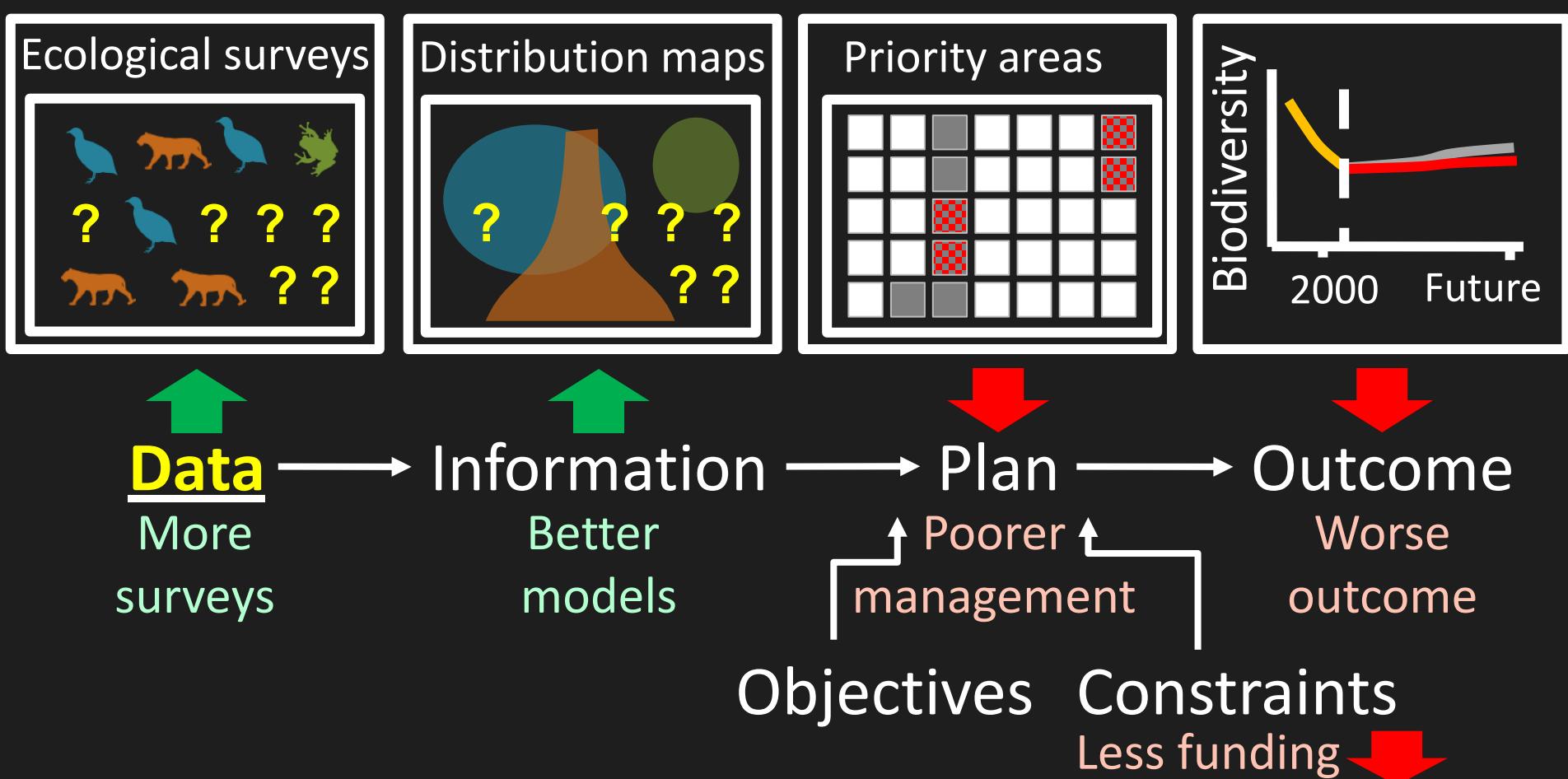


Data → Information → Plan → Outcome

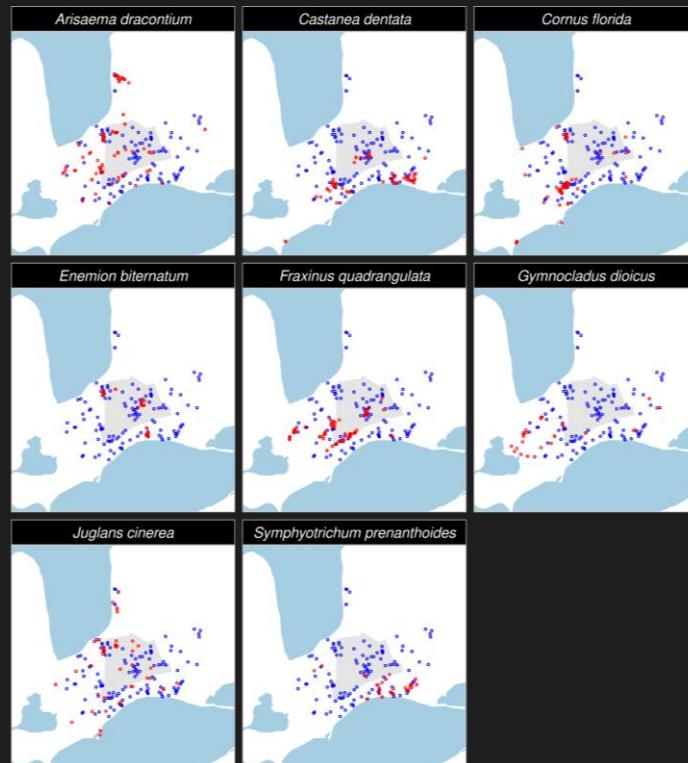
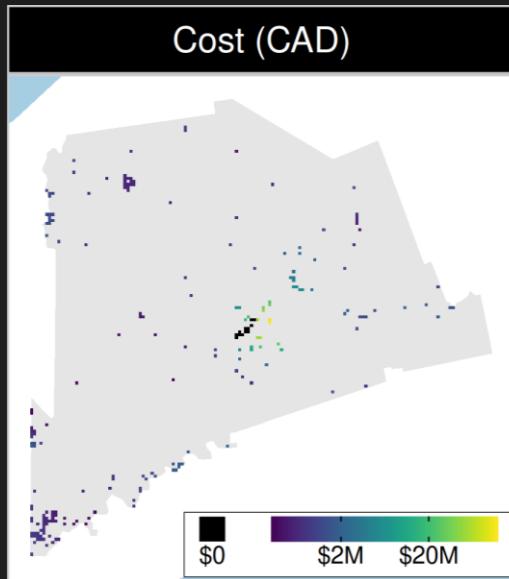


Objectives   Constraints



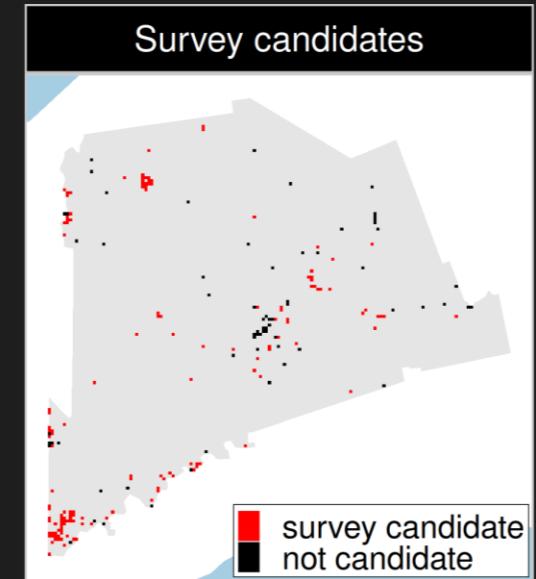


# Study system: Middlesex county, Canada



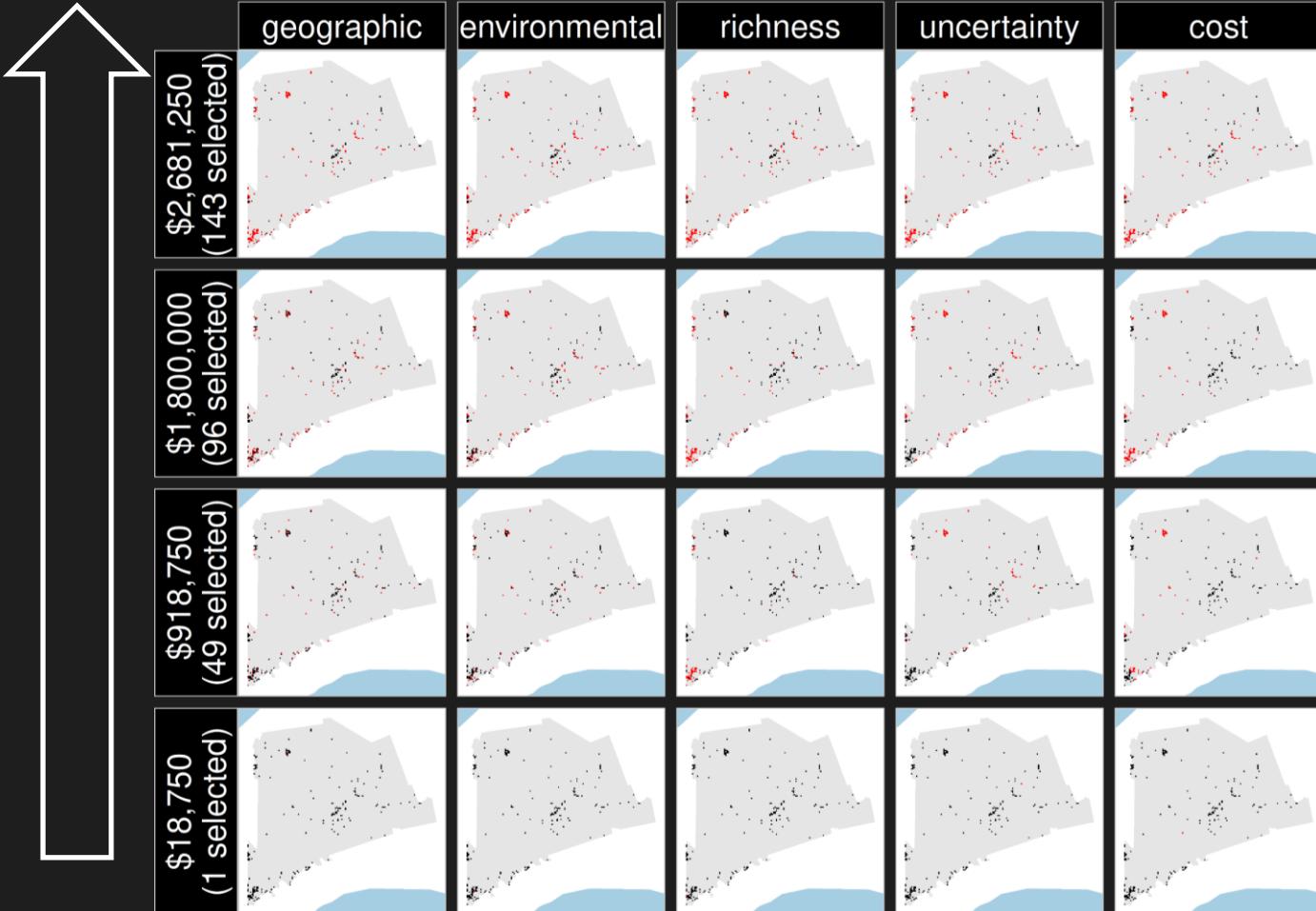
8 imperiled plant species

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



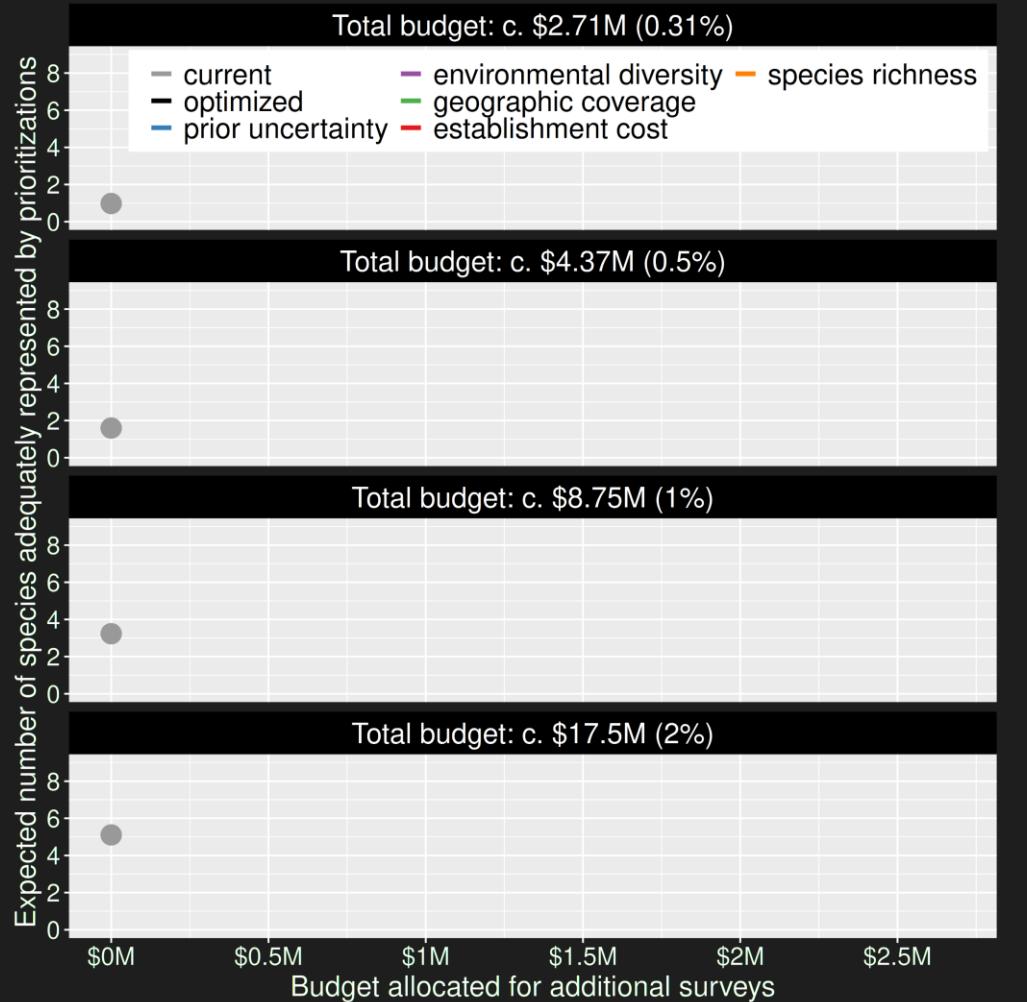
Selected  
for survey



NOT selected  
for survey

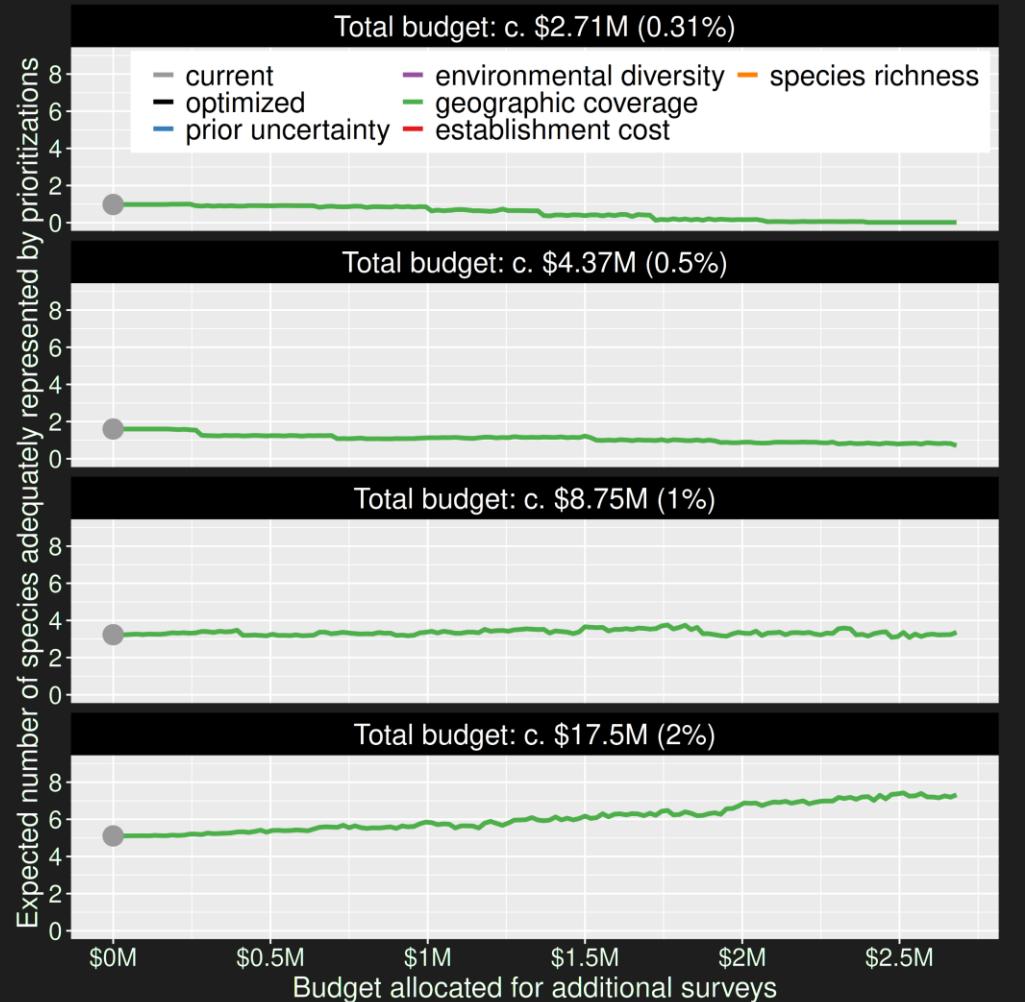
# Value of information

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



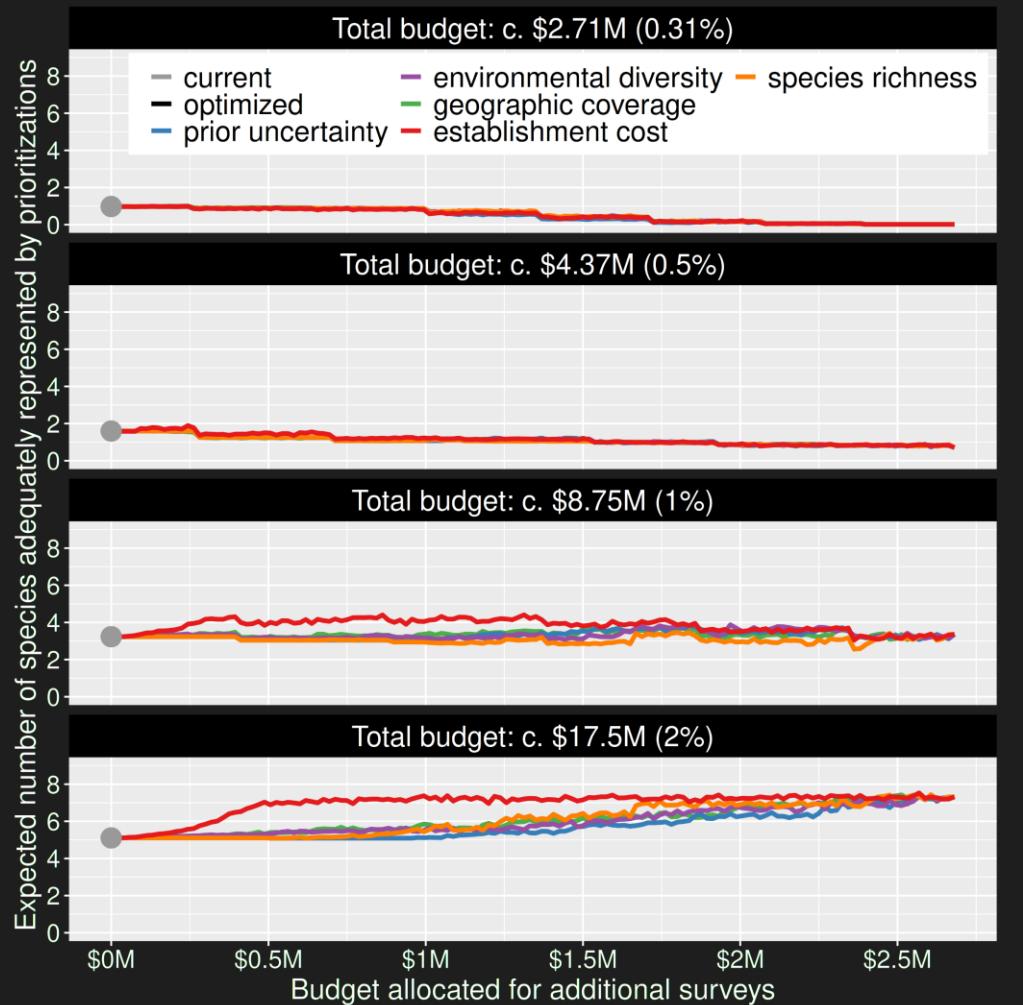
# Value of information

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



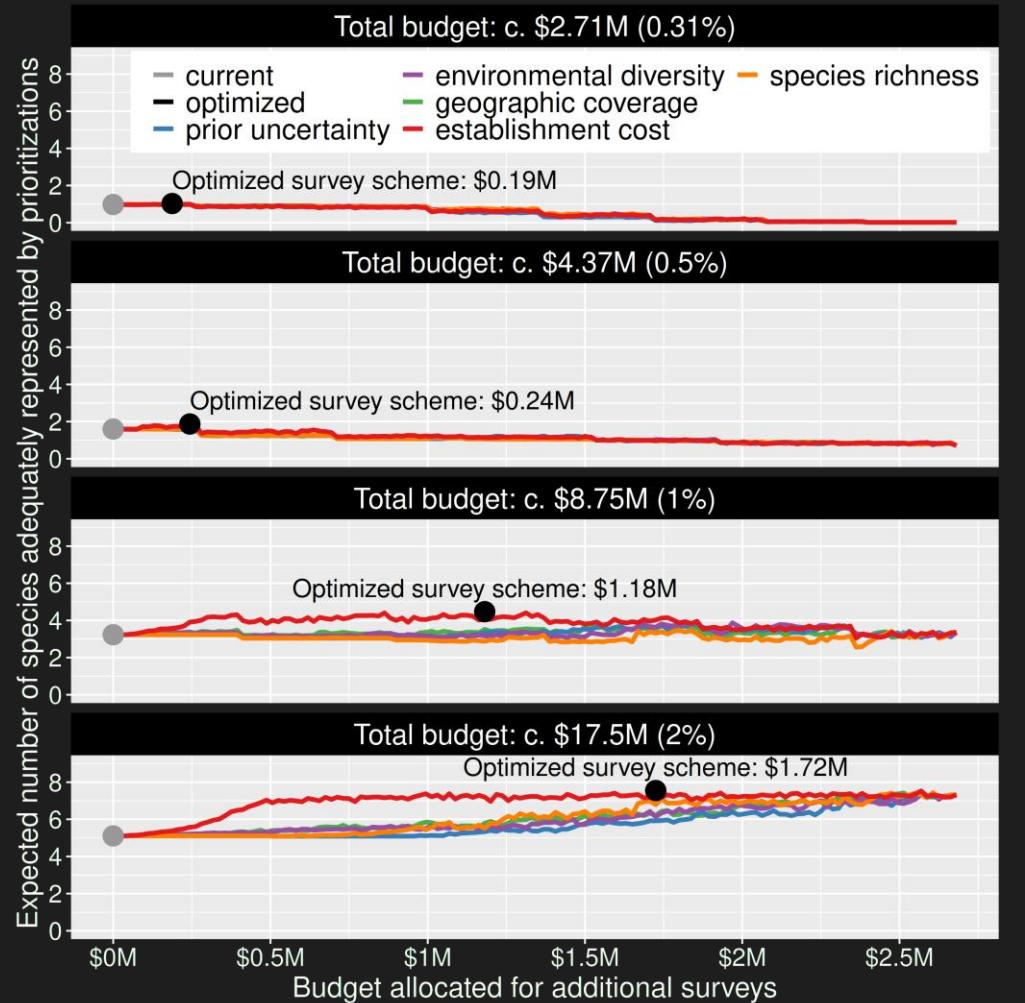
# Value of information

- 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



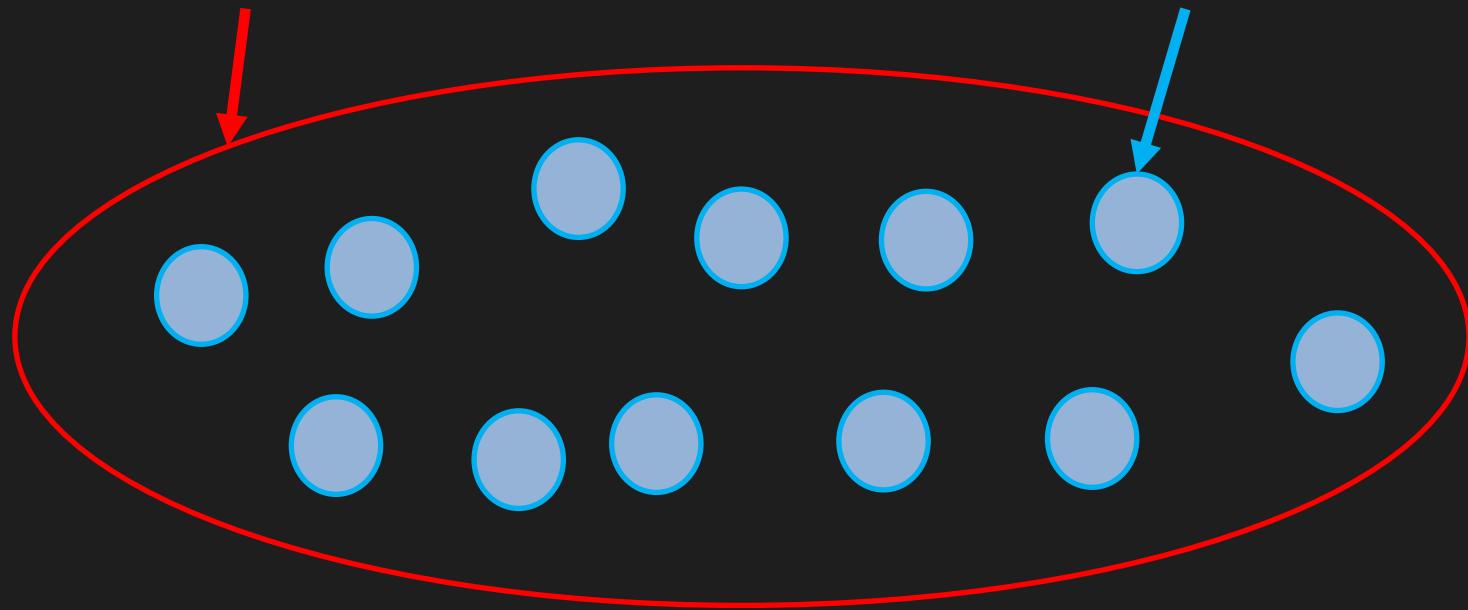
# How can we get a better conservation decision?

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

# Evolutionary processes

Species range

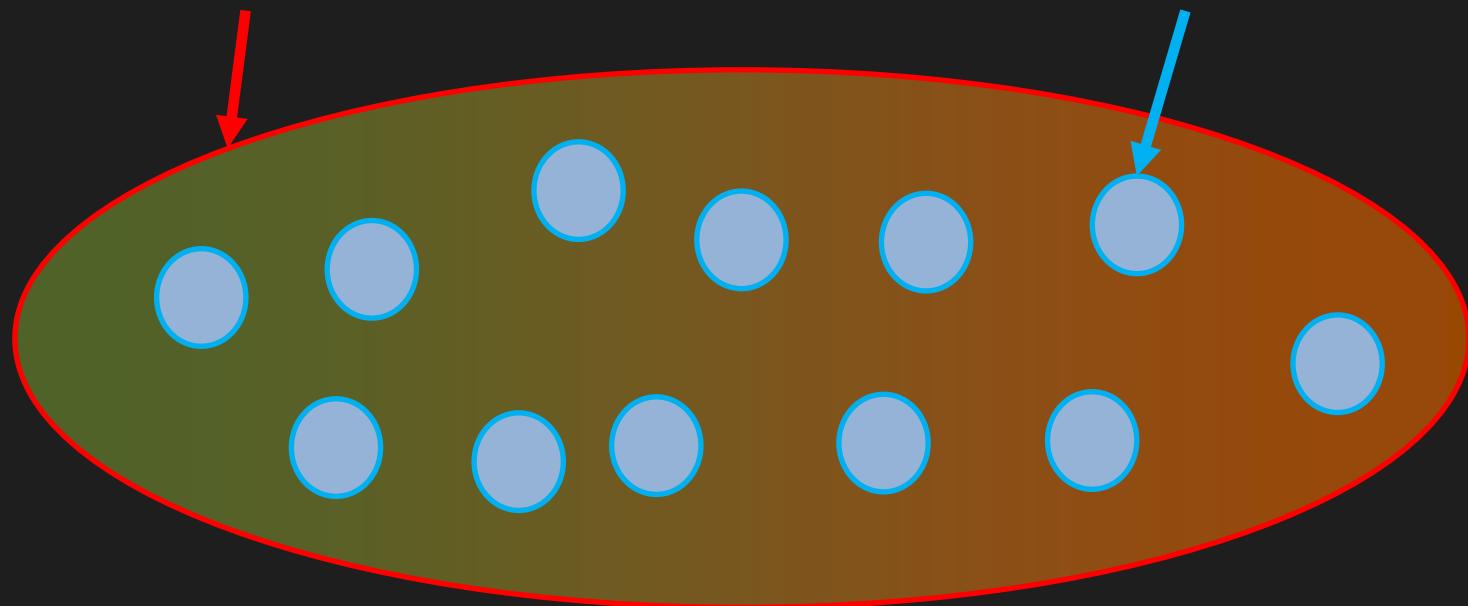
Population



# Evolutionary processes

Species range

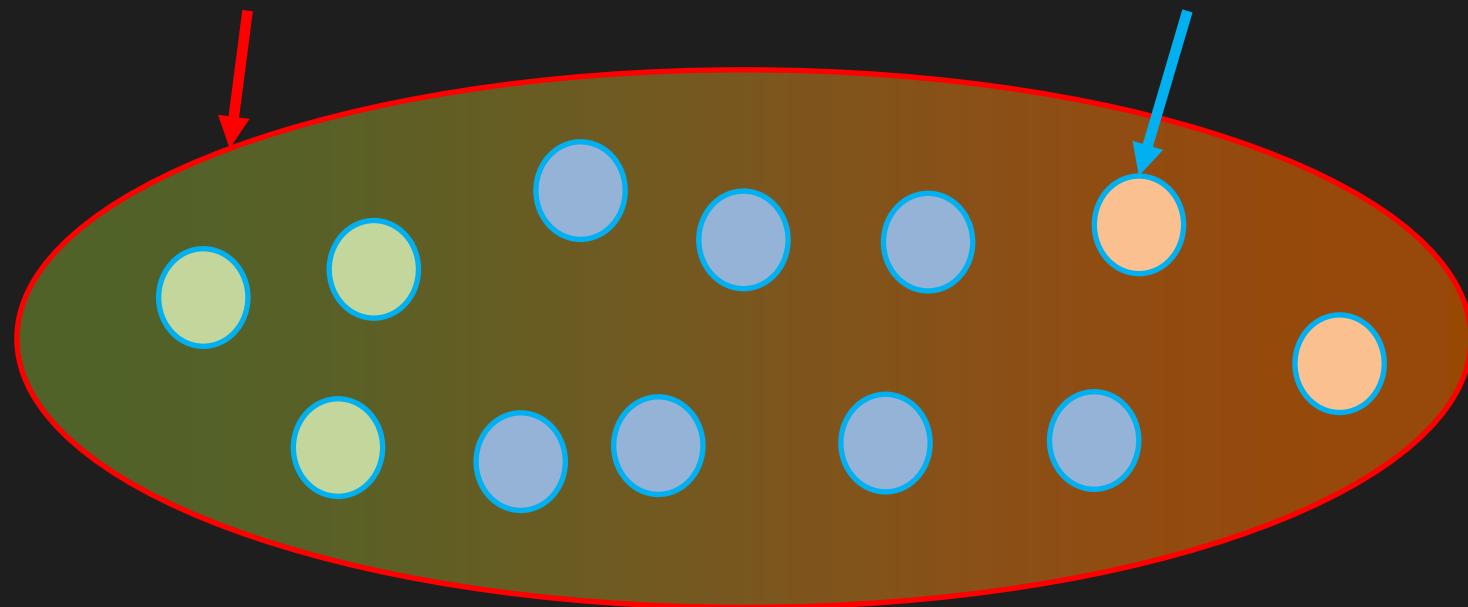
Population



# Evolutionary processes

Species range

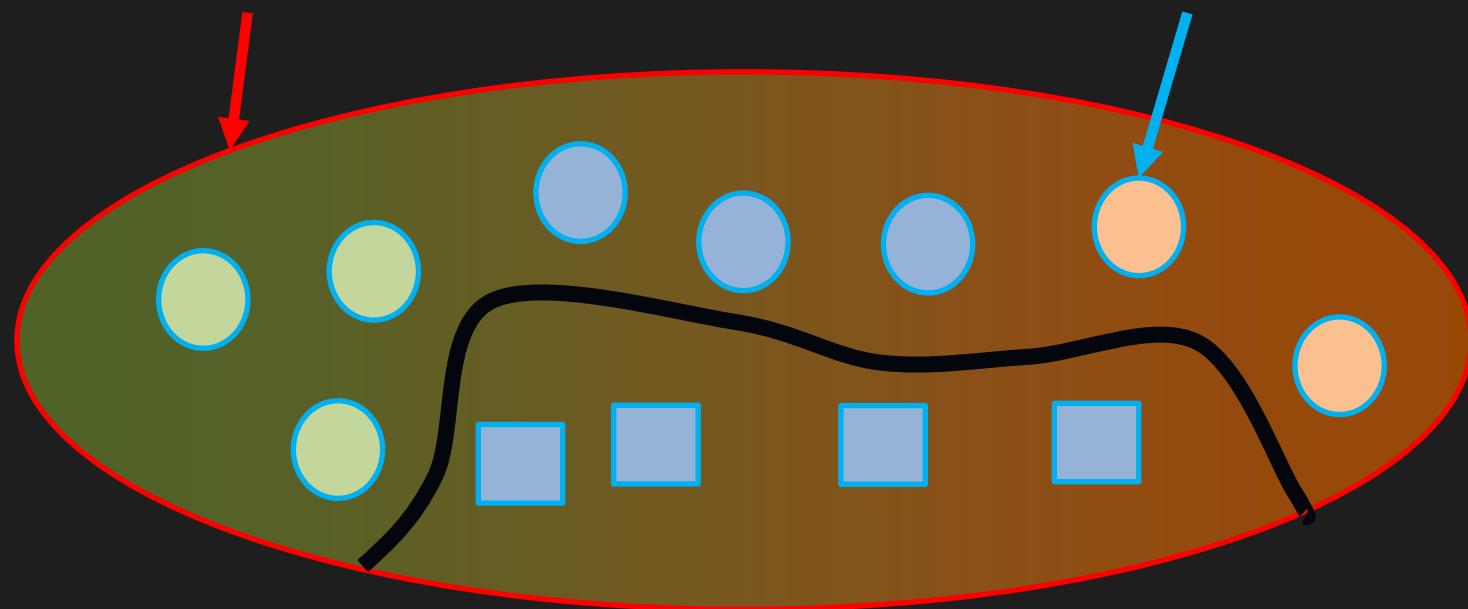
Population



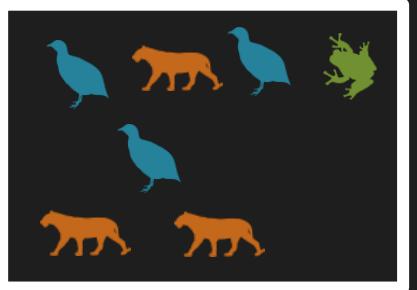
# Evolutionary processes

Species range

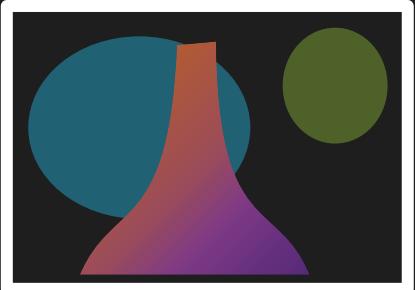
Population



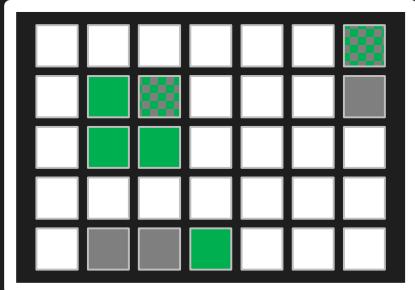
## Ecological surveys



## Distribution maps



## Priority areas

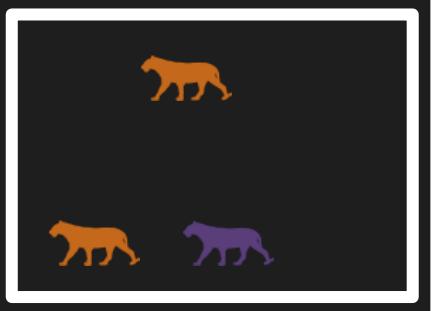


Biodiversity

2000 Future

Data → Information → Plan → Outcome

## Genetic samples



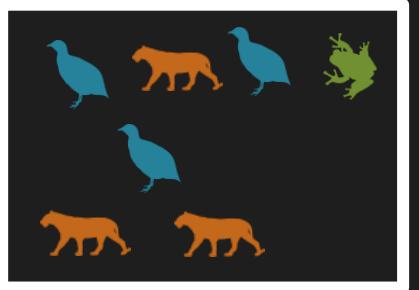
Better  
understanding  
of biodiversity

Objectives Constraints

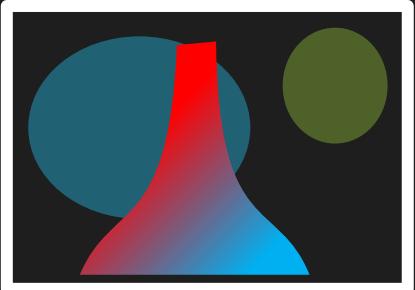
Better  
plan

Better  
outcome

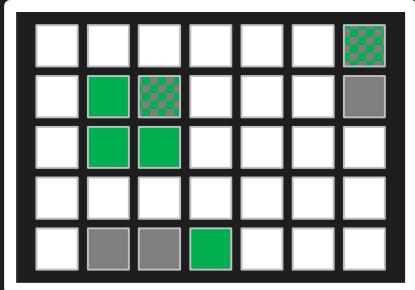
## Ecological surveys



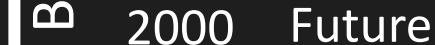
## Distribution maps



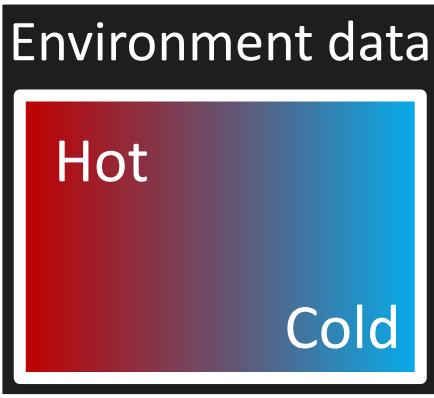
## Priority areas



Biodiversity



**Data** → Information → Plan → Outcome



Good enough  
understanding  
of biodiversity

Better  
plan

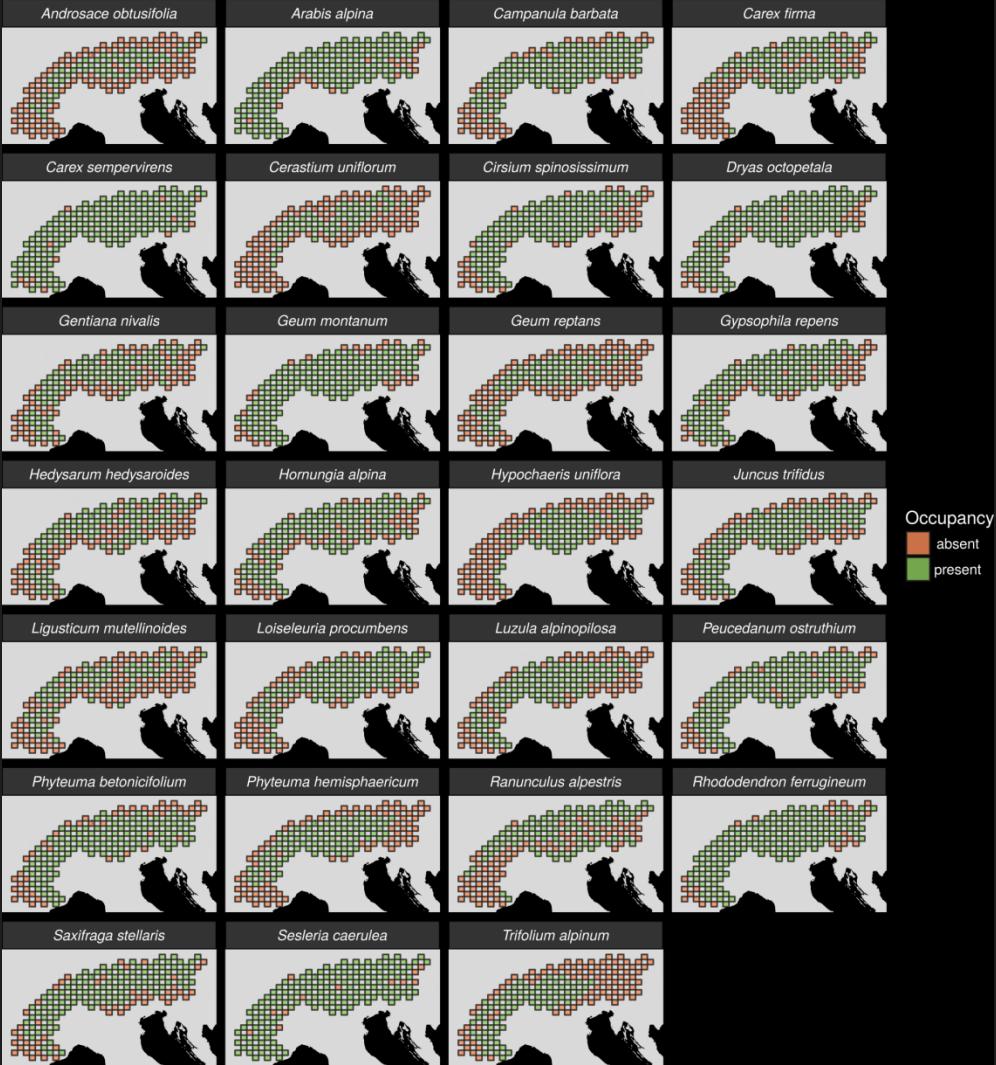
Objectives   Constraints

Better  
outcome

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

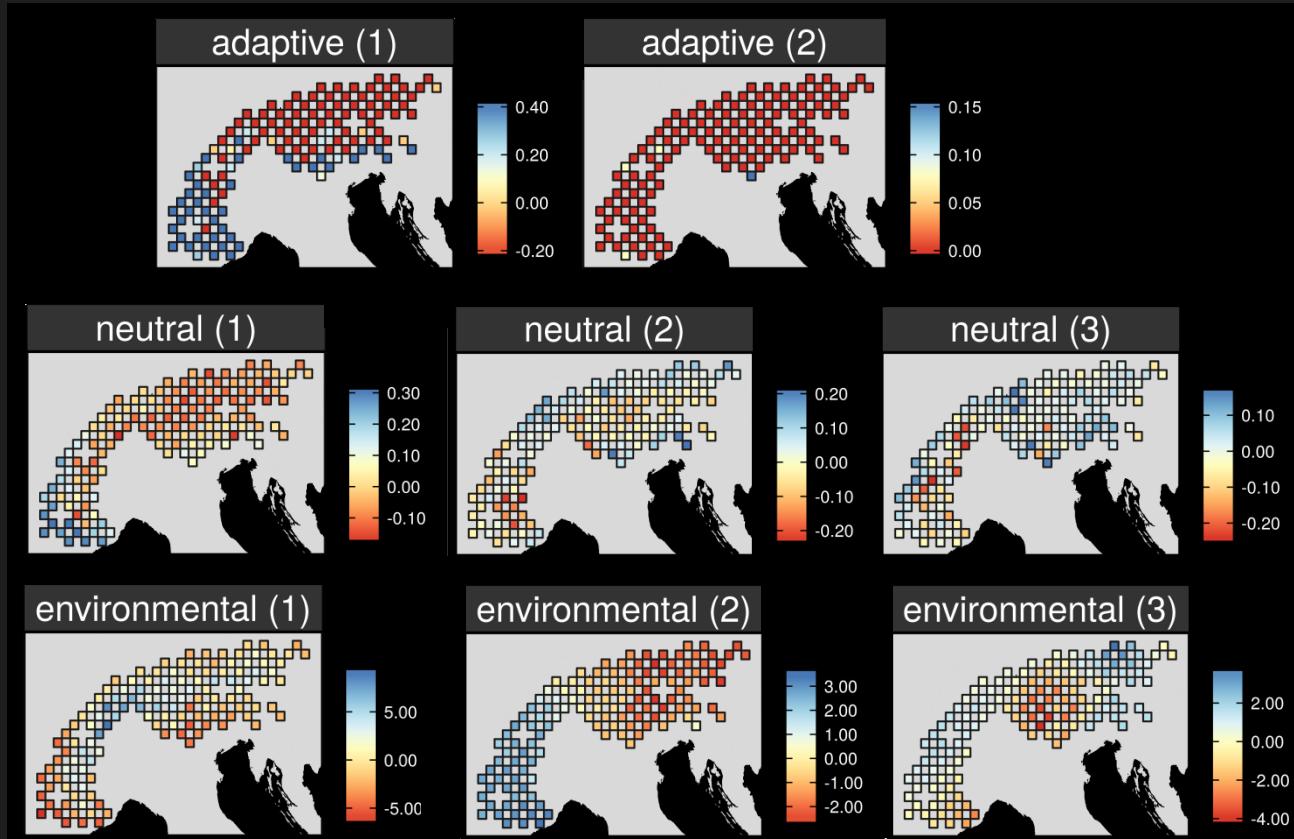
# 27 plant species

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



# Map intra-specific variation

*Arabis alpina*

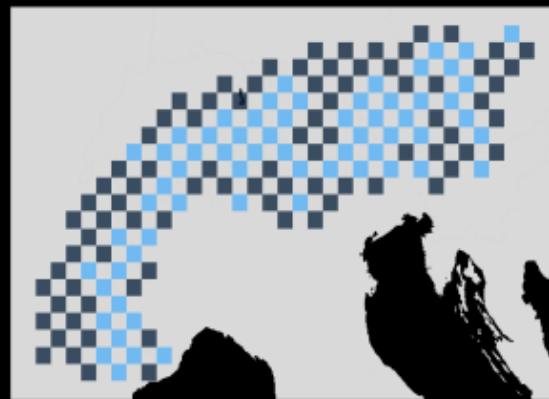
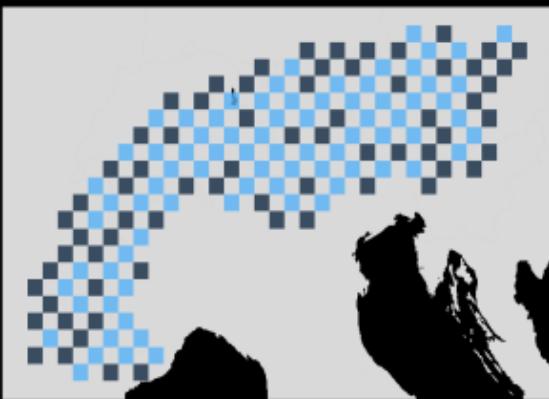
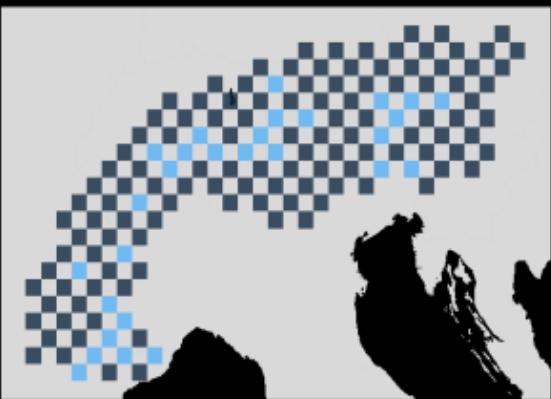


# Can surrogates inform our decisions?

Amount targets

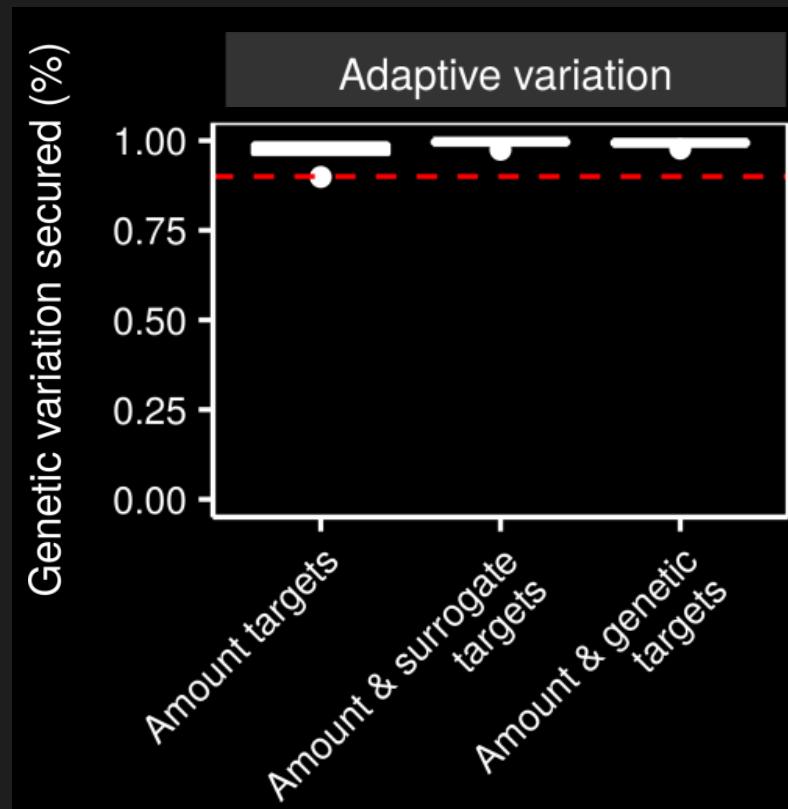
Amount & surrogate  
targets

Amount & genetic  
targets

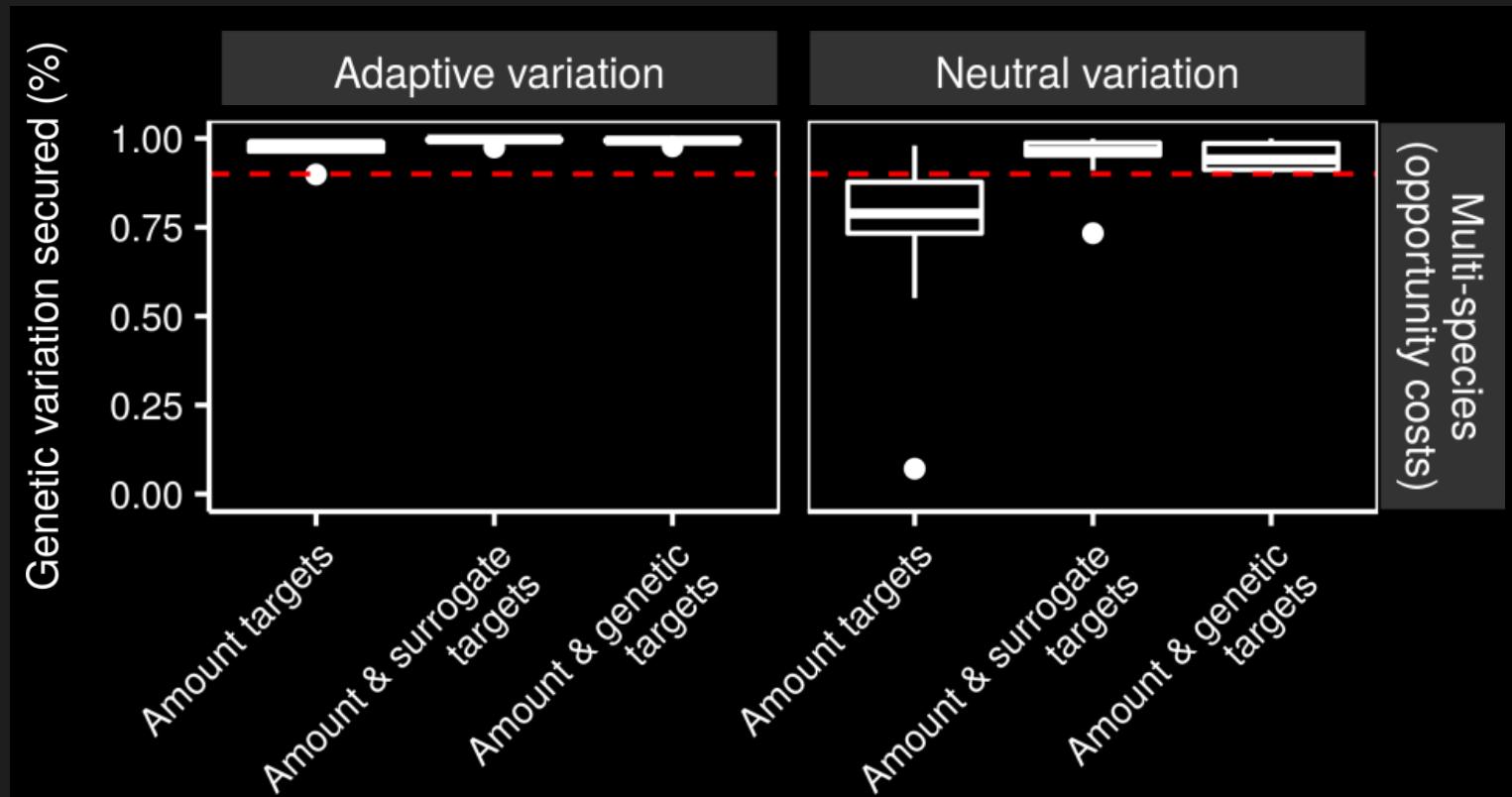


Multi-species  
(opportunity costs)

# Can we make better decisions using surrogates?



# Can we make better decisions using surrogates?

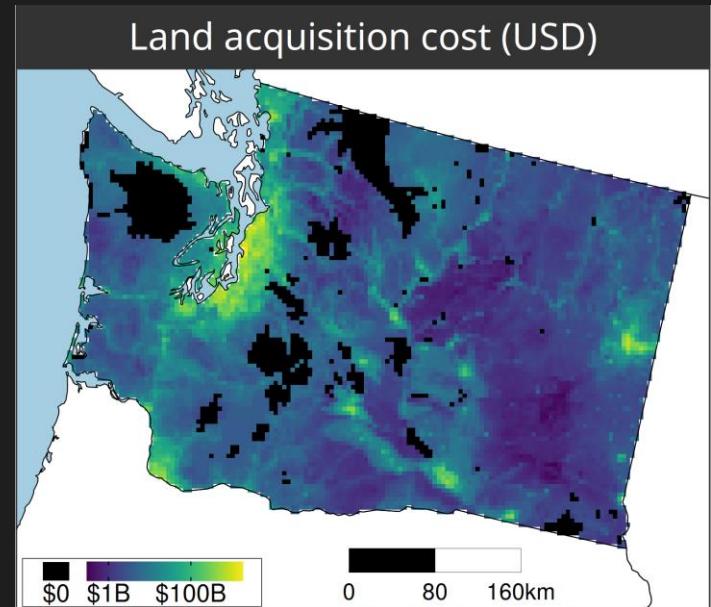


Many surrogates are  
often available,  
how do our choices  
affect the results?

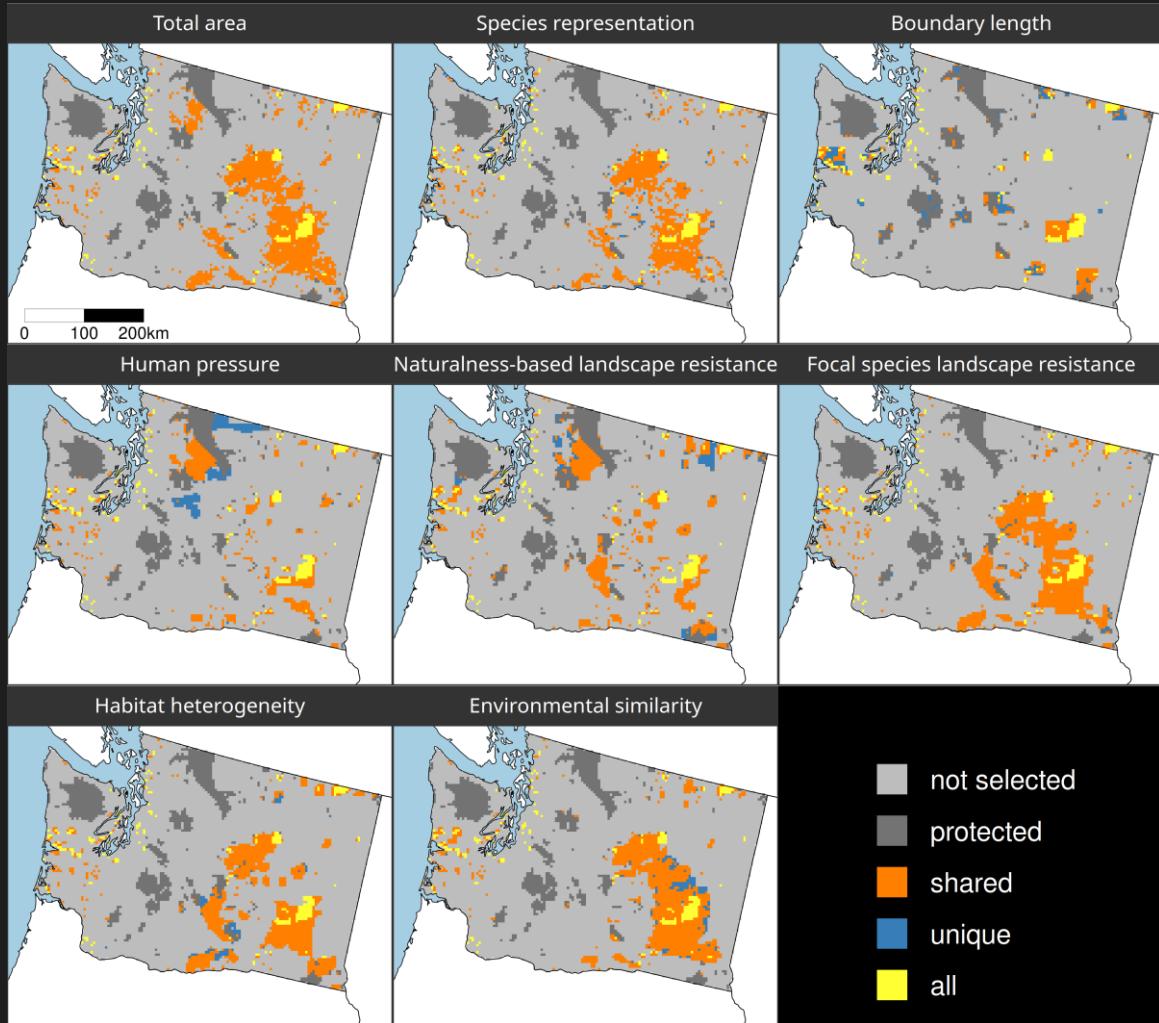
# A comparison of approaches for including connectivity in systematic conservation planning

Washington State, USA

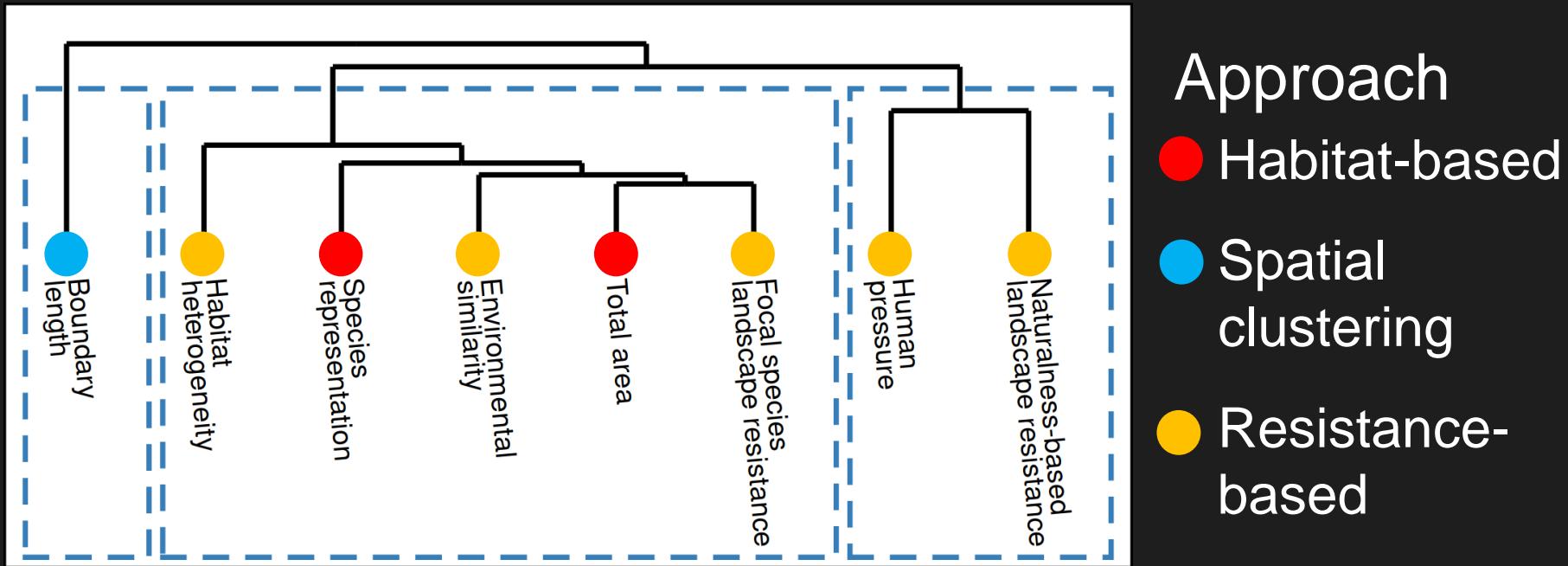
- 261 bird species
- Land acquisition costs
- Existing protected areas
- Multiple land-uses
- Multiple eco-systems



- 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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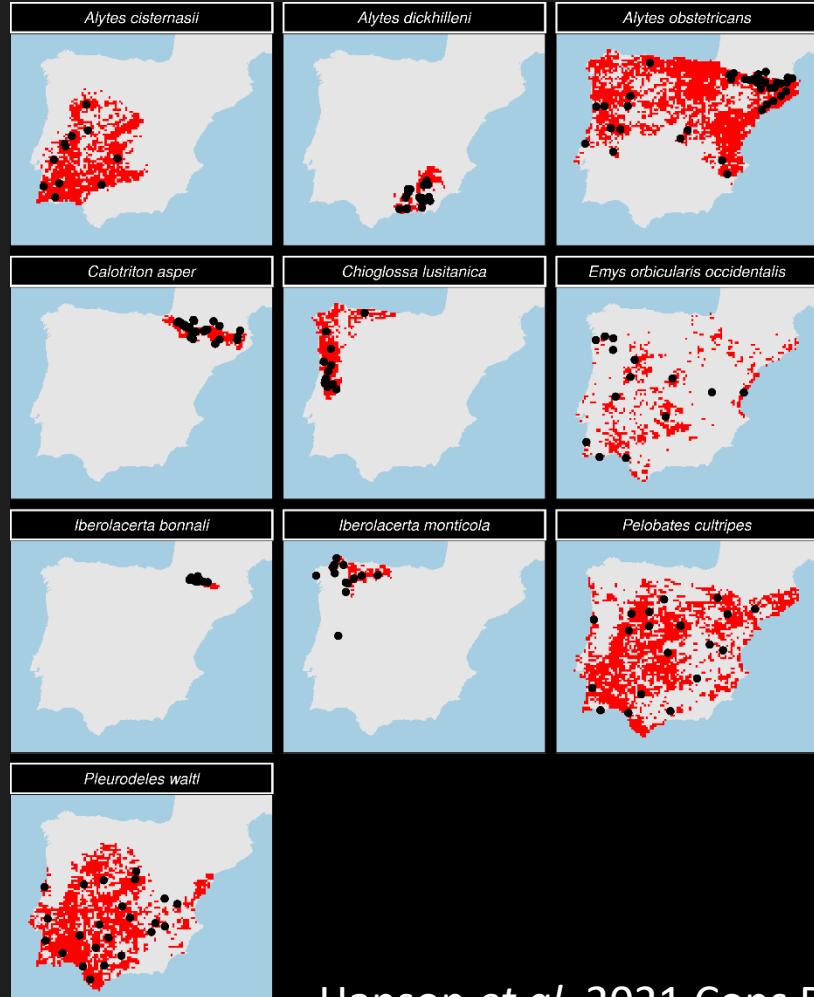
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However, surrogates  
may not always work

# 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

