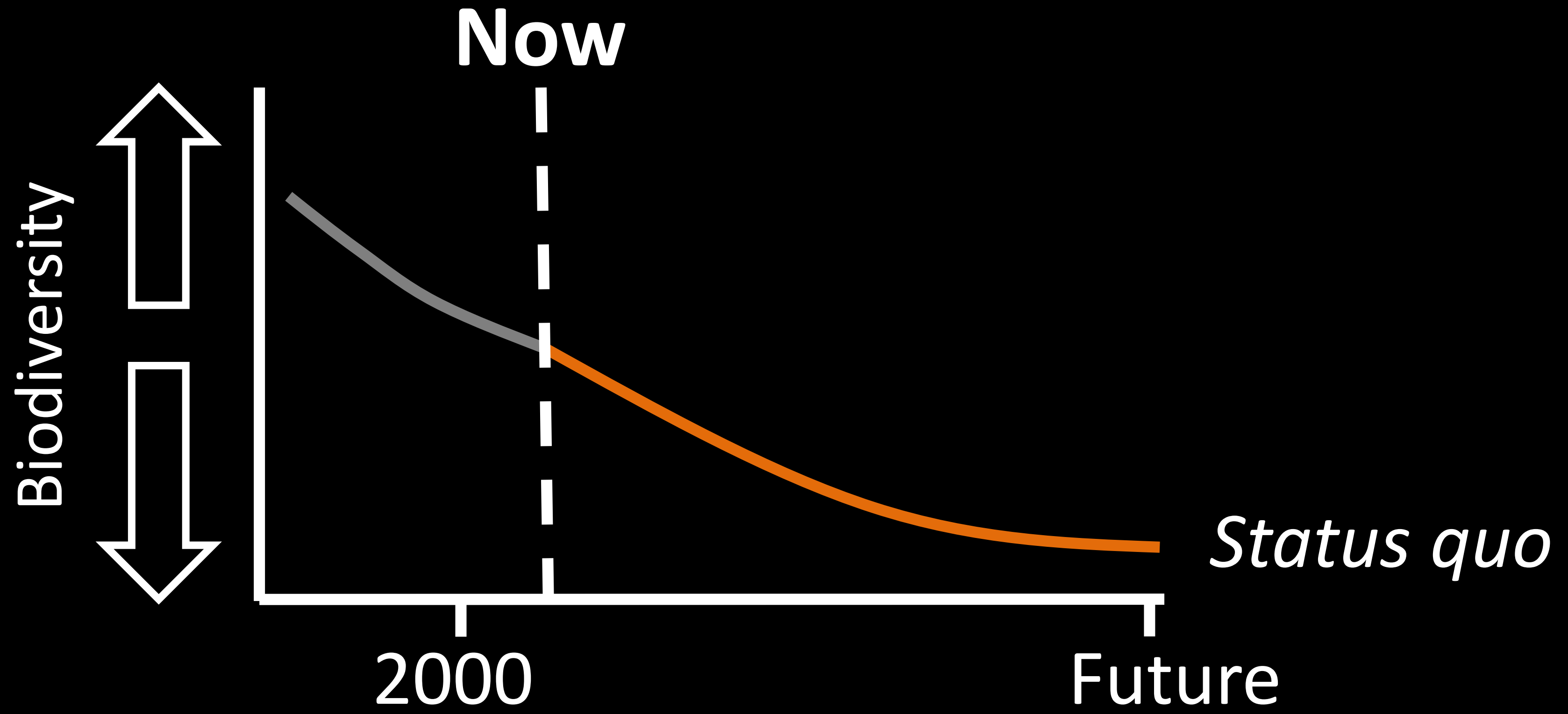
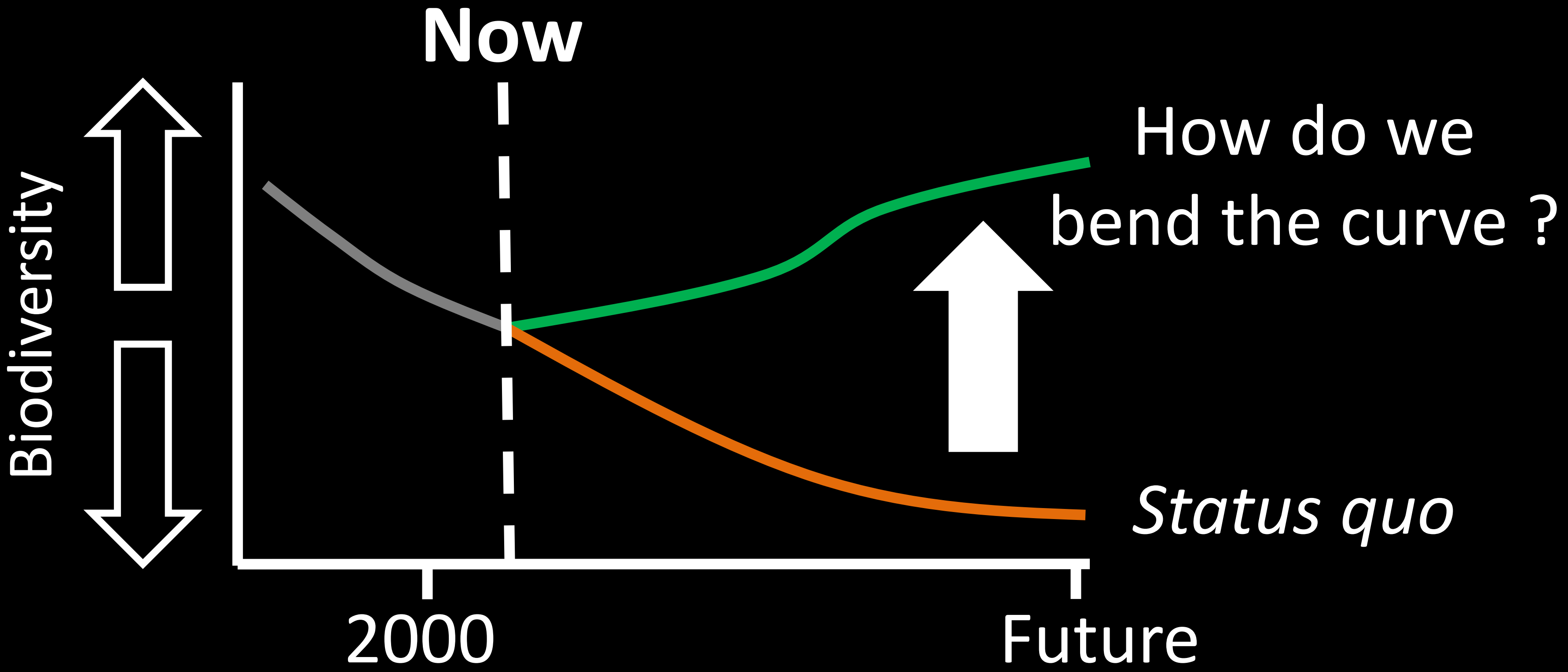
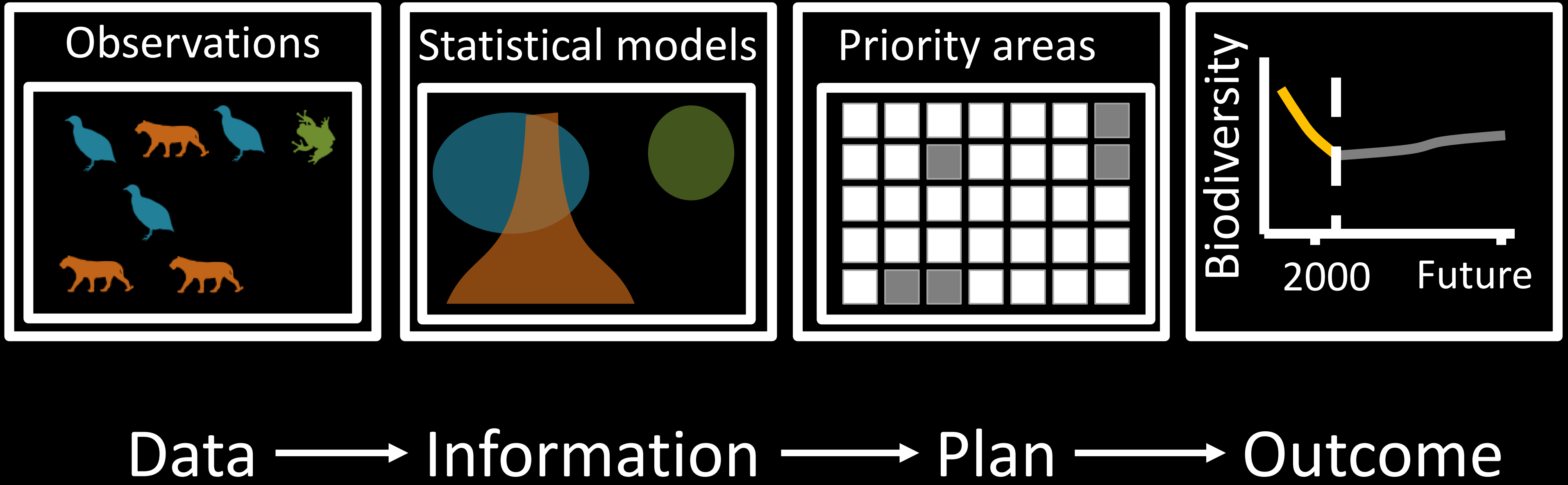
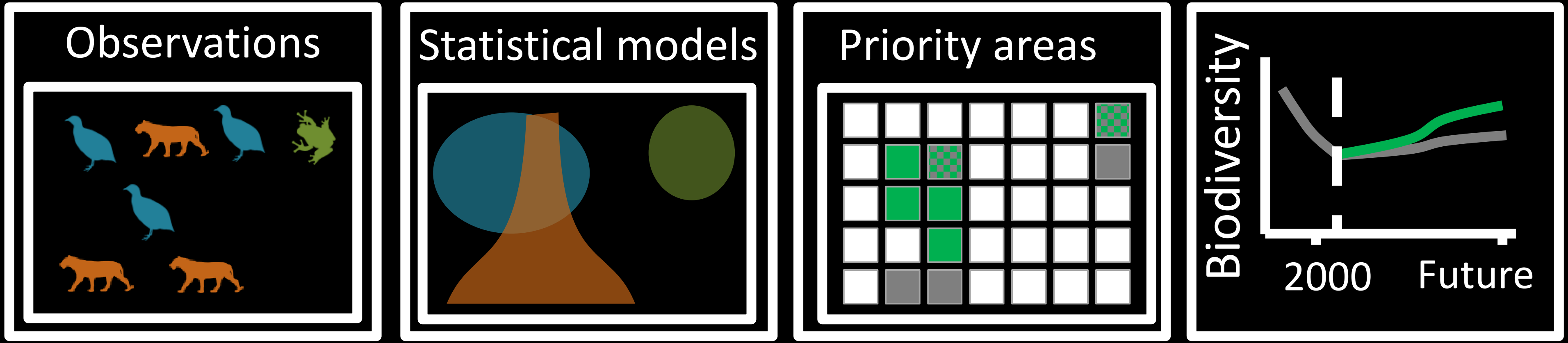
Conservation science (196.315)
Project Prioritization

Jeffrey Hanson


Now
Biodiversity
Status quo
2000
Future


Now
Biodiversity
How do we
bend the curve ?
Status quo
2000
Future


Observations
Statistical models
Priority areas
Biodiversity
2000
Future
Data → Information → Plan → Outcome



Data → Information → **Plan** → Outcome

Better plan

Better outcome

Prioritization

Systematic conservation planning

"Systematic conservation planning aims to provide a rigorous, repeatable, and structured approach for designing new protected areas that efficiently meet conservation objectives"

Schuster et al. (2020) PeerJ, DOI:10.7717/peerj.9258

Project prioritization

Project data

Recovery projects

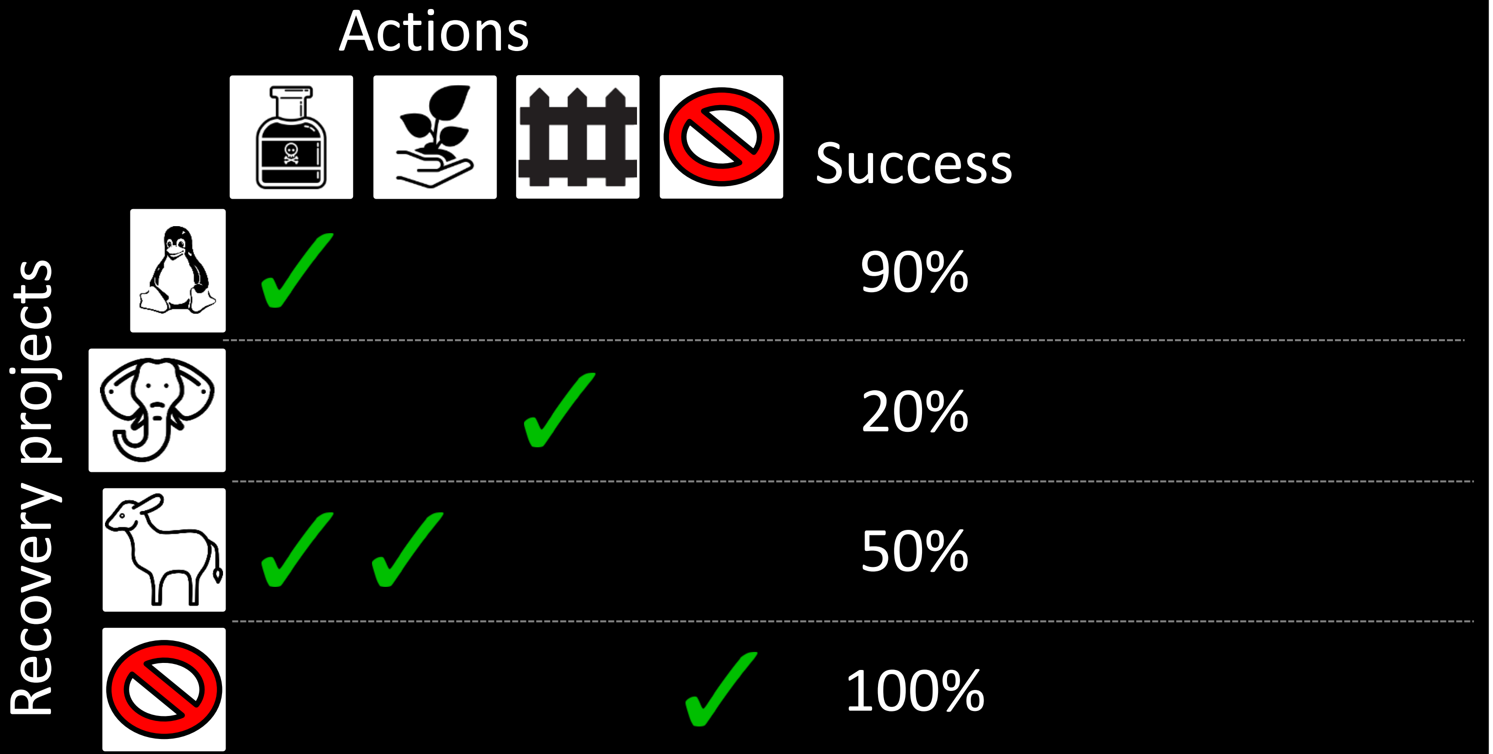
Project prioritization

Project data

Cost data

Project prioritization

Project data



Cost data

Project prioritization

Project data

Recovery projects

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

Cost data

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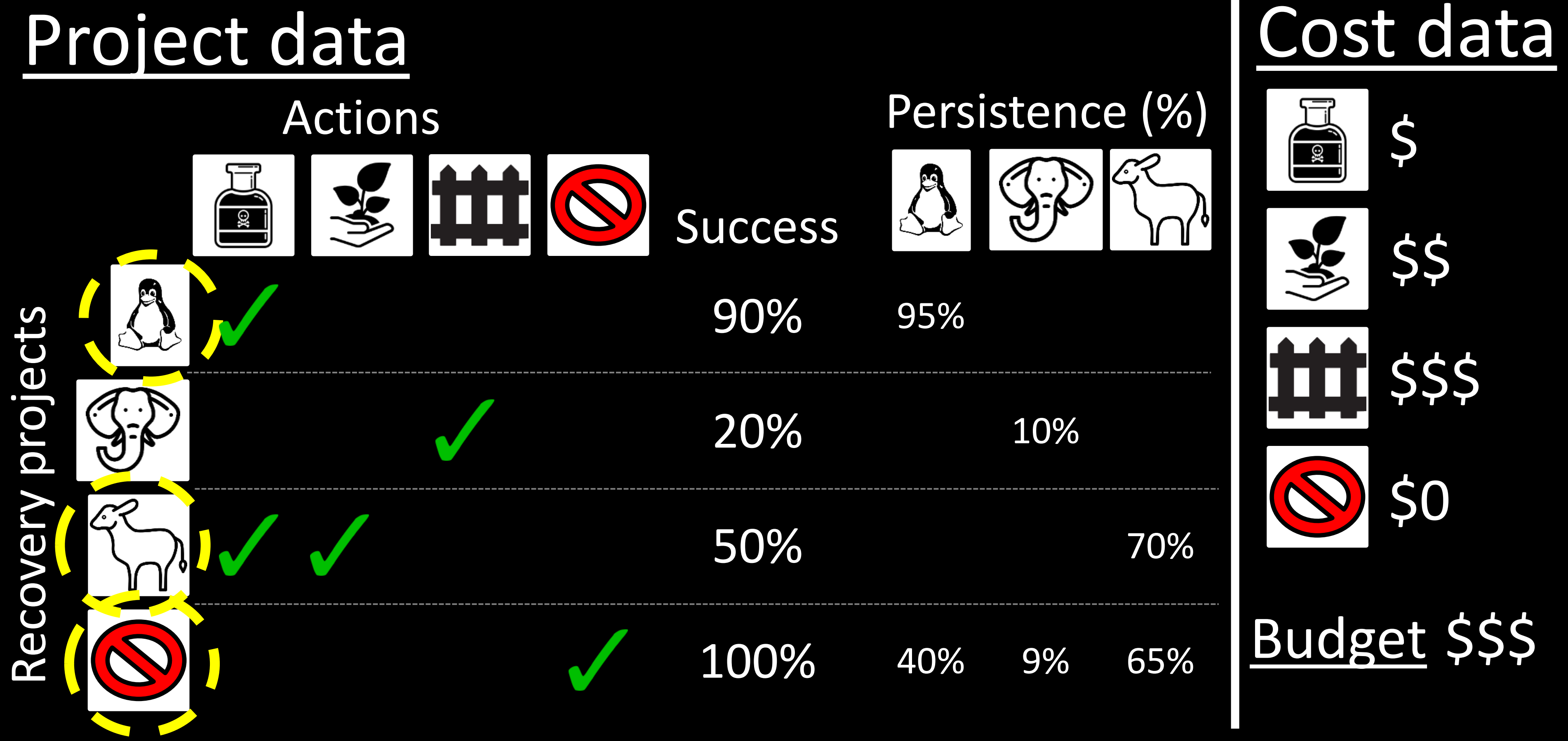
Project prioritization



Project Prioritization vs. Reserve Selection

Project prioritization

- Management actions are organized into projects
- Specific data requirements (i.e. detailed information on costs, budgets, species' persistence)
- Typically uses data from expert elicitation
- Typically used for planning management of a small number of sites

Reserve selection

- Typically, only one action is considered (i.e., protect or not)
- Wide variety of data can be used (e.g., surrogate data for costs [human pop. density], general budget rules [≤30% of land selected], maps describing species' presence/absence or abundance across study area)
- Typically used for landscape, national, or global-level planning

Project prioritization protocol

- “The PPP [… involved…] combine information on costs, values, benefits and likelihood of success to **rank** projects according to benefits per unit dollar and choose set of projects.”

Joseph *et al.* (2009) Cons Biol, DOI:10.1111/j.1523-1739.2008.01124.x

Project prioritization protocol

- “The PPP [… involved…] combine information on costs, values, benefits and likelihood of success to **<u>rank</u>** projects according to benefits per unit dollar and choose set of projects.”

Better methods available now

Joseph *et al.* (2009) Cons Biol, DOI:10.1111/j.1523-1739.2008.01124.x

Ranking things based on overall efficiency gives very different results to cost, taxonomic distinctiveness, or threat status

Table 2. Species projects ranked with the weighted project efficiency (columns 1 & 2) and priority ranks obtained with the 4 other priority-setting methods: unweighted project efficiency, cost, taxonomic distinctiveness, and threat status.

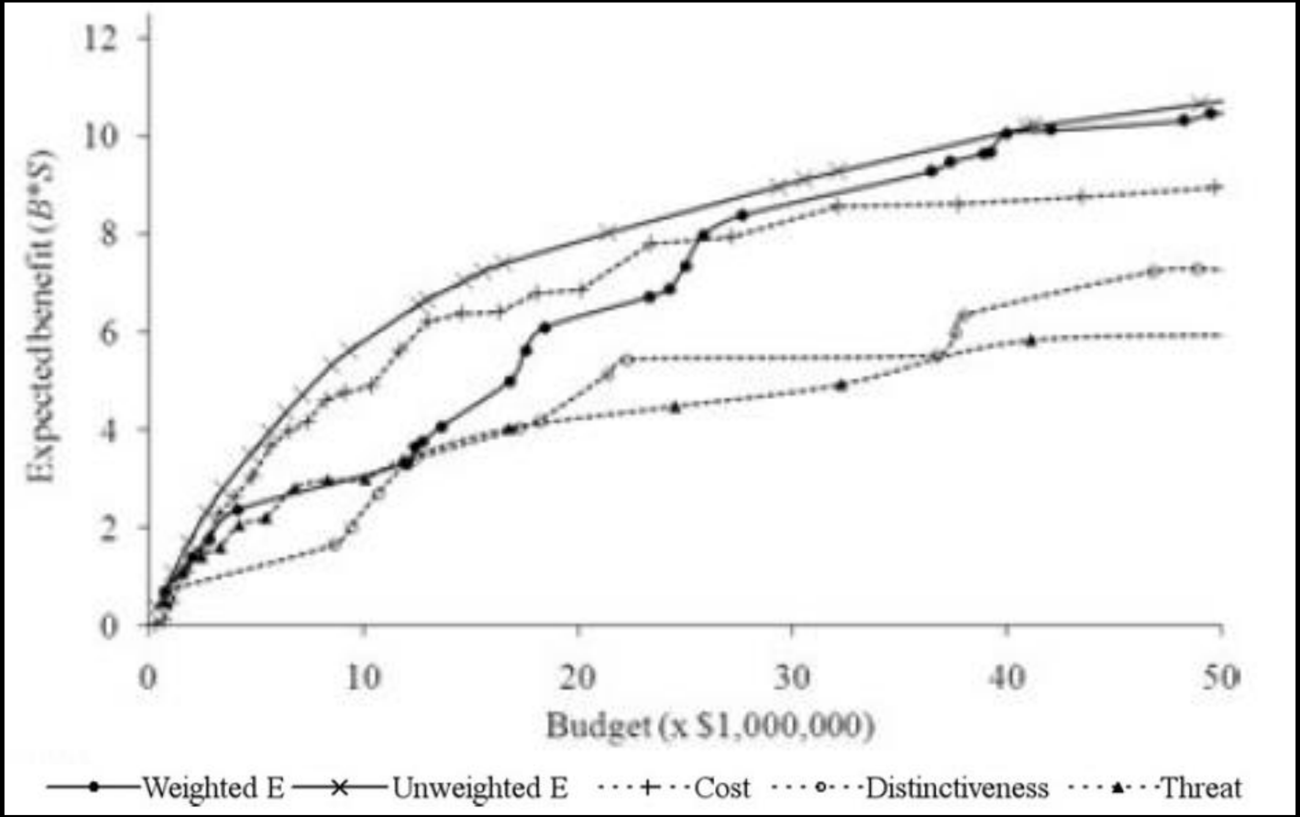
Species	*Weighted efficiency rank*	*Unweighted efficiency rank*	*Cost rank*	*Distinctiveness rank*	*Threat status rank*
Dactylanthus	1*	2*	6*	1	27
Maud Island frog	2*	6*	15*	4	20
Shrubby tororaro	3*	9*	7*	3	26
Hamilton's frog	4*	10*	16*	5	7*
North Island Brown Kiwi	5*	18	30	2	28
Climbing everlasting daisy	6*	1*	3*	13	17
Hochstetter's frog	7*	13*	2*	6	31
New Zealand Shore Plover	8*	11*	10*	10	3*
Pittosporum patulum	9*	12*	21	9	21
Oreomyrrhis sp. *nov* (= *O. aff rigida*)	10*	3*	4*	17	18
Pachycladon exilis	11*	7*	12*	12	5*
Archey's frog	12	17	23	7*	11*
Canterbury mudfish	13	16*	13*	8*	19
Carmichaelia hollowayi	14	5*	5*	24	1*
Poa spania	15	4*	9*	25	2*
Chatham Island Oystercatcher	16	14*	19*	18	10*
Kaki	17	21	31	14	14
Cardamine cf. *bilobata*	18	15*	11*	22	4*
Black Robin	19	20	17*	19	8*
Pygmy button daisy	20	22	1*	21	16
Cook Strait giant weta	21	8*	8*	32	32
Big-nose galaxias	22	27	20*	15	29
Long-tailed bat	23	26	26	20	24
Carabid beetle	24	19	14*	26	6*
Lowland long jaw galaxid	25	29	18*	16	9*
Orange-fronted Parakeet	26	32	32	11	15
Mohua	27	28	25	23	23
Grand skink	28	23	27	27	12
Otago skink	29	24	28	28	13
Short-horned grasshopper	30	25	22	31	30
Chevron skink	31	30	29	29	25
Robust grasshopper	32	31	24	30	22

*Species selected with a fixed budget of $20,269,096.

Joseph *et al.* (2009) Cons Biol

Different ranks → different biodiversity outcomes

- More funding means greater benefit
- Ranking by overall cost-efficiency gives better outcomes than other criteria



Joseph *et al.* (2009) Cons Biol, DOI:10.1111/j.1523-1739.2008.01124.x

Ok sure, but people often have very strong opinions on what species “deserve” funding – so why bother using prioritization?

Private sponsorship for flagship species

- Flagship species raise lots of $$$ for conservation
- Donors want $$$ spent on projects for flagship species
- If we can only spend this $$$ on flagship species, what's the point of prioritization?

species	annual sponsorship from private sector partner ($NZD)	annual cost for full funding of conservation actions ($NZD)
kiwis (seven species; *Apteryx* spp.)	538 500	1 741 100
Kākāpō (*Strigops habroptilus*)	200 000	2 265 800
Whio (*Hymenolaimus malachorhynchos*)	500 000	1 867 000
Takahē (*Porphyrio hochstetteri*)	62 500	1 172 700
total	1301000	7046600

Bennett *et al.* (2015) Proc B, DOI:10.1098/rspb.2014.2693

Explored different funding scenarios

Baseline scenario: Baseline scenario: prioritization protocol assuming that no flagship species received private funding, and that flagship species were considered alongside other threatened species in the prioritization protocol.

Flagship scenario: Flagship sponsorship without considering synergies for non-flagship species. Randomly allocate funding to actions for flagship species according to funding level.

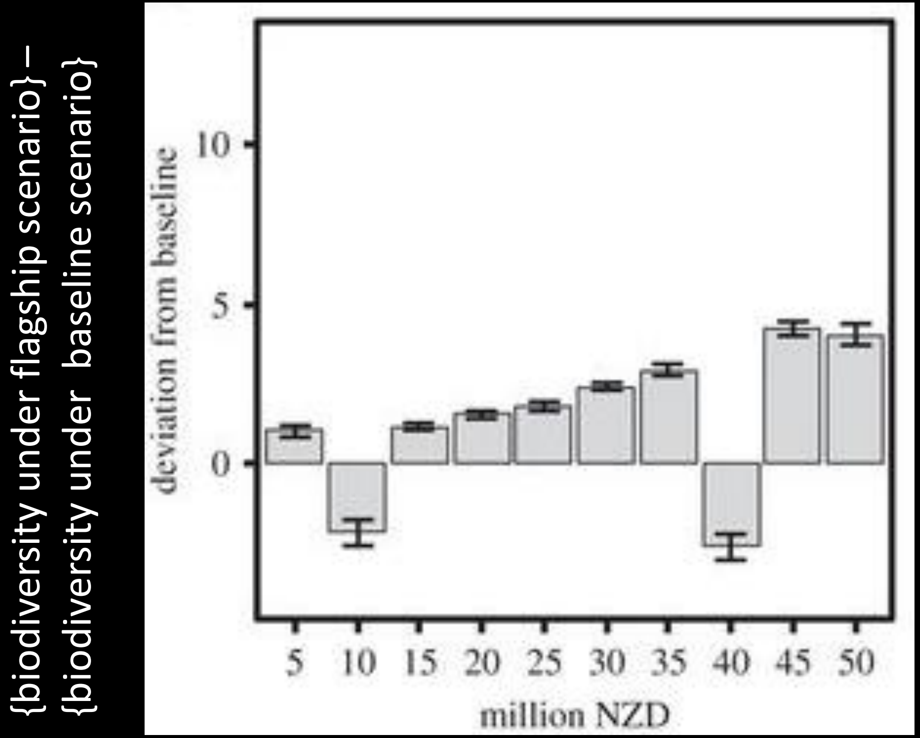
Synergistic flagship scenario: Flagship species sponsorship to maximize synergies with other non-flagship species. Allocate funding for the flagship species to the conservation actions that maximize the ratio of shared costs with other species

Bennett *et al.* (2015) Proc B, DOI:10.1098/rspb.2014.2693

Biodiversity gains from private sponsorship for flagship species

- In most cases: funding for flagship species improves overall biodiversity, even if the additional funding is focussed purely on flagship species

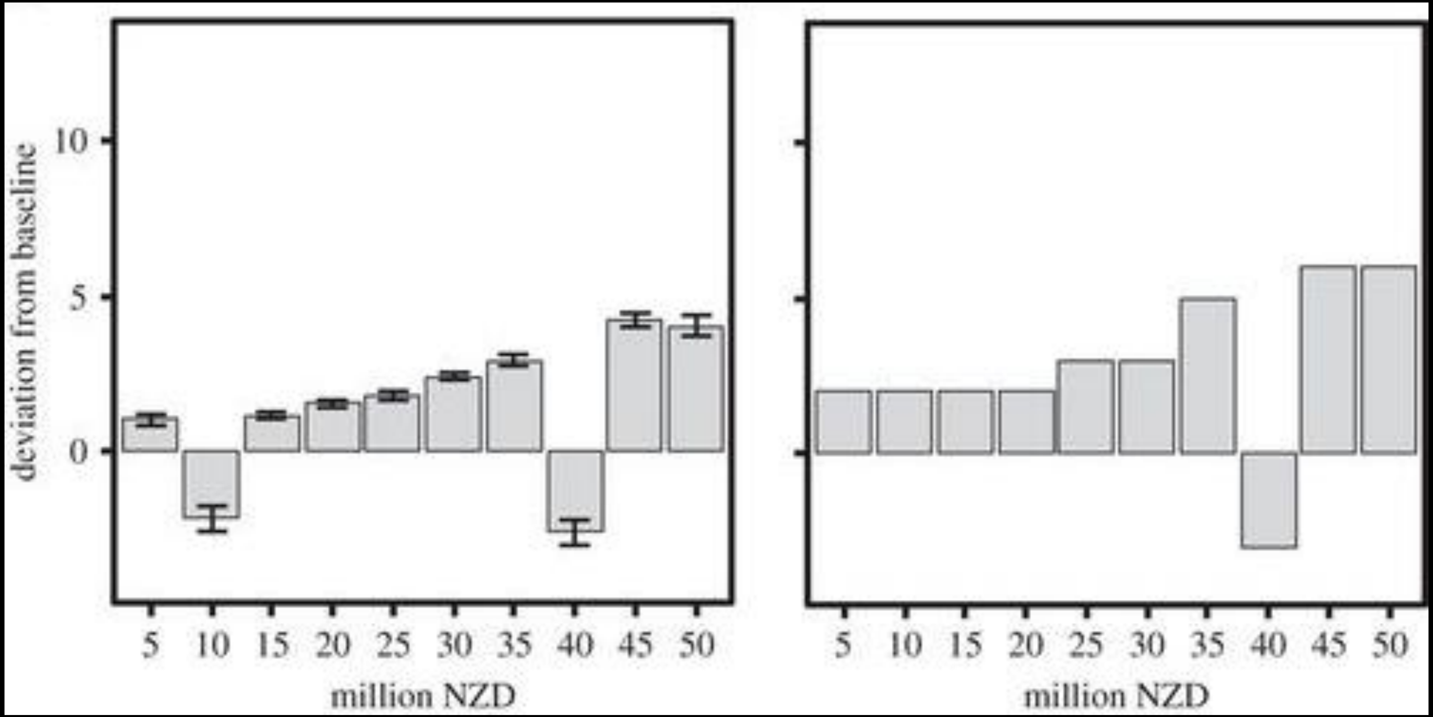
- Increases in funding for flagship species also means greater overall benefits to biodiversity



Bennett *et al.* (2015) Proc B, DOI:10.1098/rspb.2014.2693

Prioritizations can help optimize funding allocation for flagship species by finding synergies with other species

{biodiversity under scenario} –
{biodiversity under baseline scenario}



Flagship scenario

Synergistic flagship scenario

Bennett *et al.* (2015) Proc B, DOI:10.1098/rspb.2014.2693

There’s important trade-offs to think about when collecting data for project prioritization

Remember this?

Project data

Recovery projects

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

Cost data

	$
	$$
	$$$$$
	$0

Remember this?

Project data

Recovery projects

	Actions				Success	Persistence (%)		
	✓				90%	95%		
			✓		20%		10%	
1	✓	✓			50%			70%
				✓	100%	40%	9%	65%

Cost data

	$
	$$
	$$$$$
	$0

What if we had multiple options?

Project data

Recovery projects

	Actions				Success	Persistence (%)		
1	✓	✓			50%	95%		
2	✓				90%		80%	
3		✓			56%			45%
				✓	100%	40%	40%	40%

Cost data

	$
	$$
	$$$$$
	$0

Big improvement in persistence for small investment?

Project data

Recovery projects

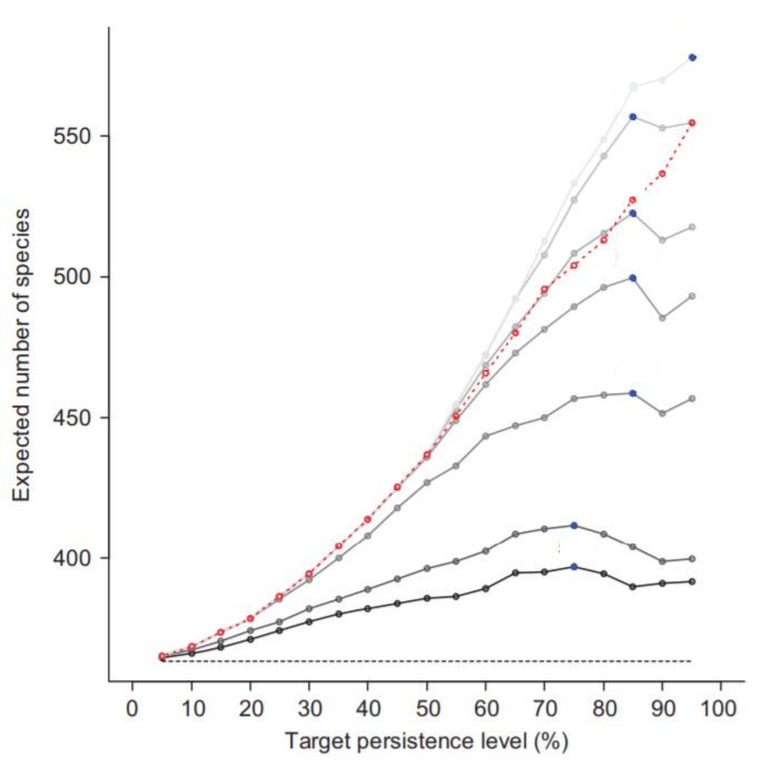
	Actions				Success	Persistence (%)		
1	✓	✓			50%	95%		
2	✓				90%		85%	
3		✓			56%			45%
				✓	100%	40%	40%	40%

Cost data

$
$$
$$$$$
$0

Trade-offs between persistence and expected number of species conserved

- X-axis: the (target) minimum probability of persistence we want for species
- Y-axis: overall number of species expected to persist given optimized project funding based on budget and target
- Lines: Different budgets for funding projects (0.5, 1, 5, 10, 15, 30, and 40 M NZD per year; from darkest to lightest)

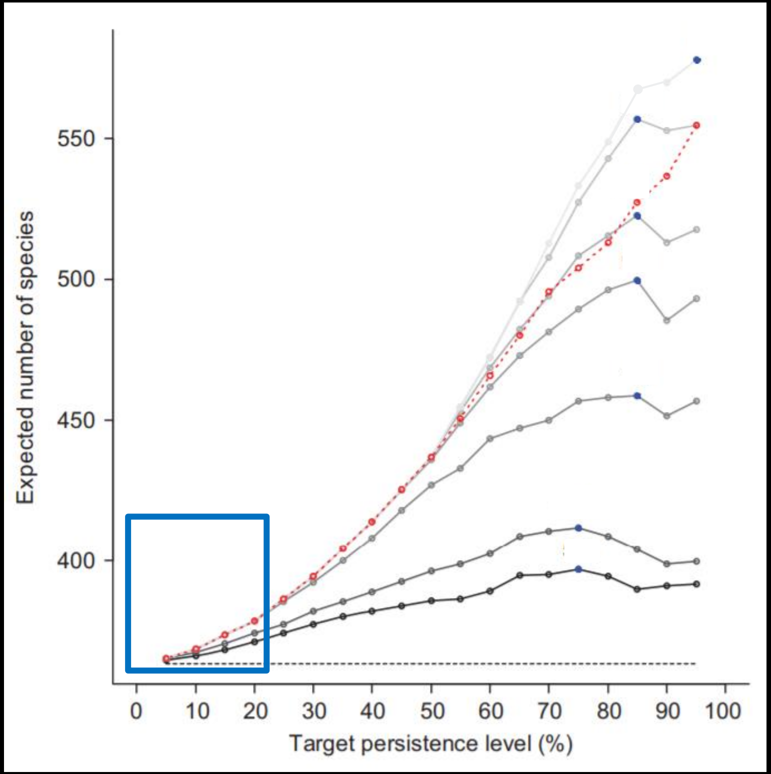


Di Fonzo et al. (2015) Cons Lett, DOI:10.1111/conl.12179

Trade-offs between persistence and expected number of species conserved

- If target level of persistence is too low, then very few species are actually likely to persist overall

- This is because funding is spread too thinly across lots of species

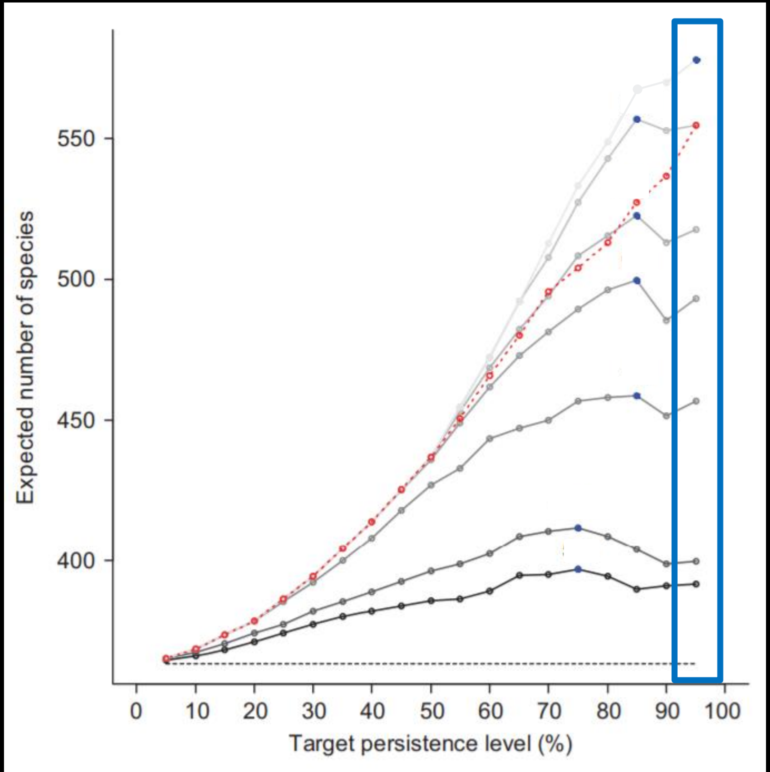


Di Fonzo et al. (2015) Cons Lett, DOI:10.1111/conl.12179

Trade-offs between persistence and expected number of species conserved

- If target level of persistence is too high, then sub-optimal number of species are actually likely to persist overall

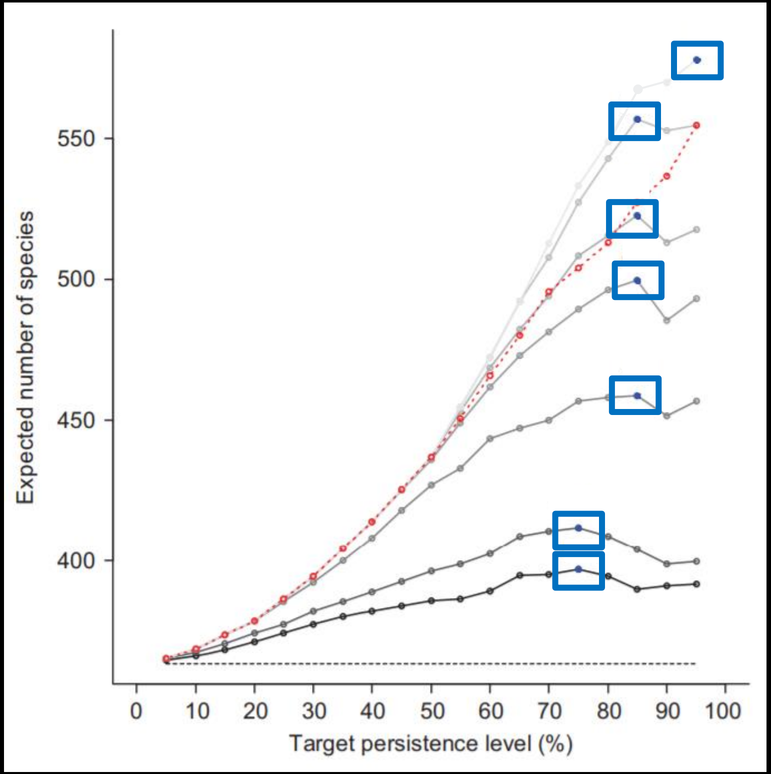
- This is because funding is concentrated among just a few species



Di Fonzo et al. (2015) Cons Lett, DOI:10.1111/conl.12179

Trade-offs between persistence and expected number of species conserved

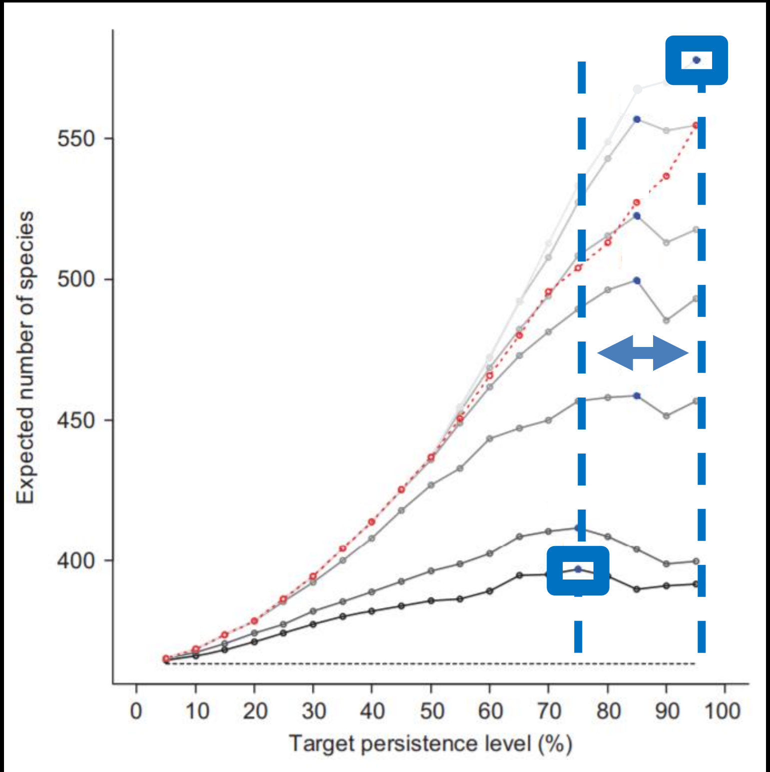
- If target level of persistence is optimized, then we can maximize the overall expected number of species that are likely to persist



Di Fonzo et al. (2015) Cons Lett, DOI:10.1111/conl.12179

Trade-offs between persistence and expected number of species conserved

- The target level of persistence that results in the greatest overall number of species persisting into the future depends on available funding

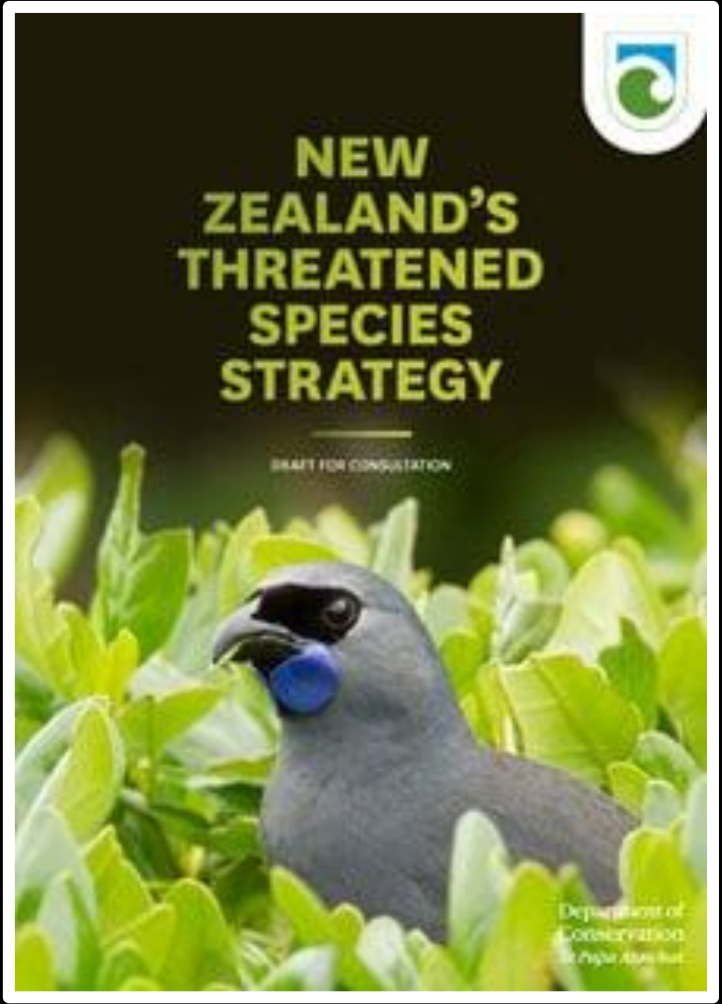


Di Fonzo et al. (2015) Cons Lett, DOI:10.1111/conl.12179

How has project prioritization has been used for real world decision making?

Threatened Species Strategy

- “Manage 500 species for protection by 2025 – a 40% increase on today – and 600 species for protection by 2030.”
- **<u>“Enhance the populations of 150 prioritised threatened and at risk species by 2025.”</u>**
- “Integrate Te Ao Māori (the Māori world view) and mātauranga Māori (Māori knowledge) into species recovery programmes by 2025.”
- “Support research, particularly through the National Science Challenges, that helps us to better understand data deficient species.”



https://www.doc.govt.nz/get-involved/have-your-say/all-consultations/2017/draft-threatened-species-strategy-consultation/draft-threatened-species-strategy/

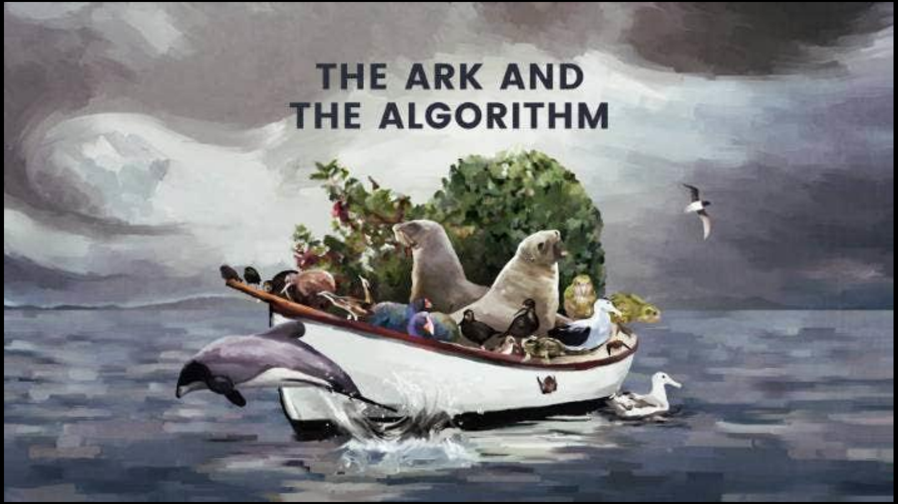
Threatened Species Strategy

“We start by assuming that all candidate threatened species are included in the list and are therefore ‘secure’. We then deselect each species in turn, testing the effect against genera, families, and orders. Each taxon is then assigned a representative score (R) weighted by conservation status and rate of decline. The taxon with the lowest score is assigned the lowest rank and removed from the list. The process is repeated until all taxa are removed in an order that optimises taxonomic security. Socially important taxa are assigned a high weighting to ensure that they are removed last.”

https://www.doc.govt.nz/get-involved/have-your-say/all-consultations/2017/draft-threatened-species-strategy-consultation/threatened-species-strategy-algorithm/

“Noah’s Ark” framing is misleading and melodramatic

- <u>Prioritizing projects</u> is about <u>allocating funds</u> to implement <u>actions</u> to achieve <u>objectives</u>.
- Prioritizations change depending on these factors
- If available funding was high enough, then the prioritization would select all projects



“[….] New Zealand is on the forefront of making choices around a tough question that has echoes of Noah's Ark: Which species most deserve to survive?”

https://www.stuff.co.nz/environment/103568532/the-ark-the-algorithm-and-our-conservation-conundrum
https://www.stuff.co.nz/environment/105385528/how-do-we-decide-which-endangered-species-to-save

Ranking is methodologically flawed and distracts from important considerations

- The overall set of projects selected by the prioritization is what is important (akin to principle of complementarity)

- The rank of projects for individual species distracts from looking at the overall prioritization (unless they directly relate to the conservation objectives)

"How did a stinky, ugly plant become a higher priority for protection than the iconic Kauri tree?"

"Which one is most worthy of our protection? Someone has to decide."

https://www.stuff.co.nz/environment/103568532/the-ark-the-algorithm-and-our-conservation-conundrum
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https://www.stuff.co.nz/environment/105385528/how-do-we-decide-which-endangered-species-to-save

How did **flour** become a higher priority for **baking** than **chocolate**?

THE CAKE AND THE RECIPE

Baking requires tough choices.

An algorithm developed by the Department of Conservation was used to make a list of 150 'priority' ingredients, based on a range of criteria.

Some of the following tasty ingredients **made it, and others didn't.**

Can you guess which ones were chosen?

"Which one is most worthy of our shopping list? Someone has to decide."

https://www.stuff.co.nz/environment/103568532/the-ark-the-algorithm-and-our-conservation-conundrum
https://www.stuff.co.nz/environment/105385528/how-do-we-decide-which-endangered-species-to-save

So, focussing on species' recovery projects can make it difficult to reach consensus – what's the alternative?

Remember this?

Project data

Recovery projects

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

Cost data

	$
	$$
	$$$$$
	$0

Priority threat management

Project data

Projects for managing threats	Actions				Success	Persistence (%)		
	✓				90%	95%		
			✓		20%		10%	
	✓	✓			50%			70%
				✓	100%	40%	9%	65%

Cost data

	$
	$$
	$$$$$
	$0

Priority threat management

Project data

Projects for managing threats	Actions				Success	Persistence (%)		
	✓				90%	95%		68%
			✓		20%	60%	10%	
	✓	✓			50%	50%		70%
				✓	100%	40%	9%	65%

Cost data

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	$$$$$
	$0

Case study

TABLE 1 Pacific salmon species and the biological status of their conservation units (CUs) on British Columbia's Central Coast (Figure 1), which were grouped into nine CU groups for the analysis. Sockeye CUs were divided into CU groups based on their ecotype, distribution and biological status (Connors et al., 2018). Status presented here is based on historic spawner abundance benchmarks

CU groups	Green	Amber	Red	Data deficient (DD)	Total CUs/ group
Chinook salmon		5	1		6
Chum salmon		5	2	2	9
Coho salmon	1	5			6
Pink salmon	3	2			5
Coastal and inland lake-type sockeye salmon—green status	8				8
Coastal lake-type sockeye—amber, red or DD status		4		31	35
Inland lake-type sockeye salmon—amber, red or DD status		1		5	6
South Atnarko lake-type sockeye salmon CU			1		1
River-type sockeye salmon				3	3
All	12	22	4	41	79

Walsh et al. (2020) J Appl Ecol, DOI:10.1111/1365-2664.13646

Case study

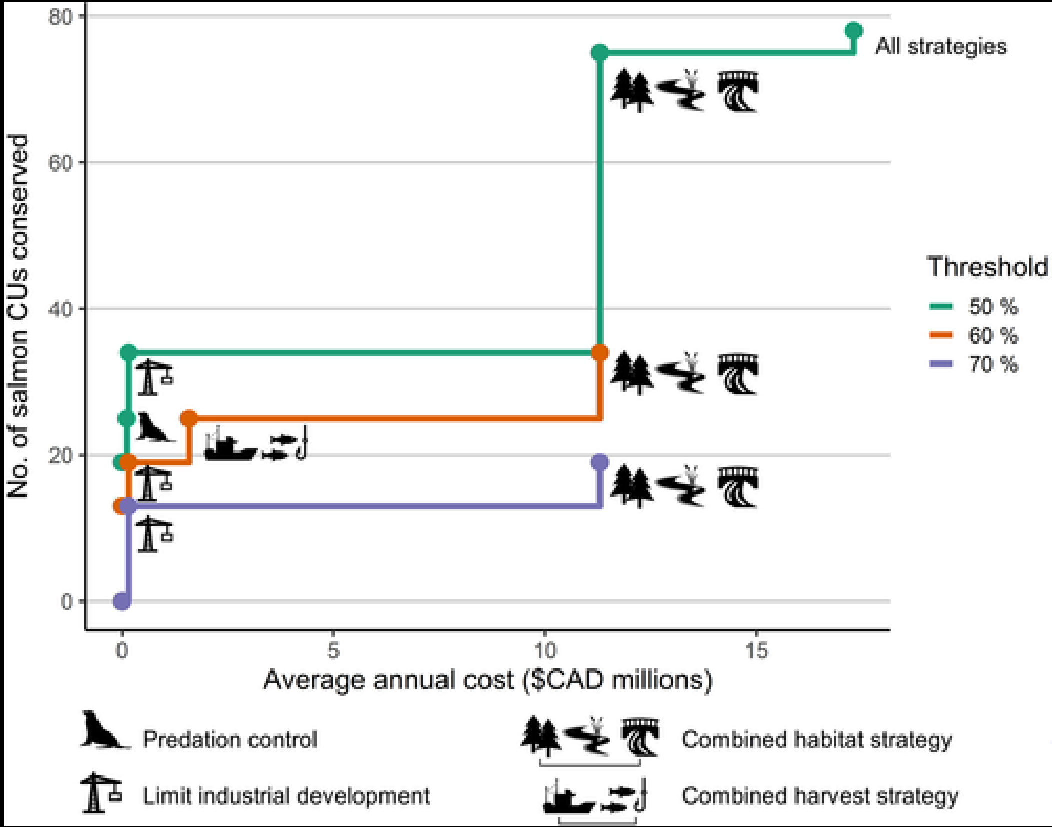
- Lots of different strategies
- Each strategy could benefit one or more salmon groups

Conservation strategy	Summary of underlying actions	Benefit	Cost (CAD millions)	Feasibility	E	E rank
Limit future industrial development	Restrict future industrial developments in salmon habitat, manage water pollution; assess risks of shipping traffic to salmon	1,490	0.15	0.74	362	1
Predation control	Conduct experimental culls (or traditional First Nation harvest) of pinnipeds; reduce juvenile predation by trout & sculpin	1,241	0.11	0.46	253	2
Remove barriers to fish passage	Remove significant barriers (e.g. culverts) to upstream adult migration and juvenile dispersal	1,395	0.21	0.72	239	3
Salmon aquaculture management	Implement salmon aquaculture best practices; develop siting guidelines for aquaculture licenses; incentivize land-based aquaculture	772	0.09	0.34	147	4
Watershed protection	Improve forestry practices; restore watershed vegetation to pre-logging conditions	1,407	0.54	0.7	92	5
Marine and estuary habitat restoration	Restore and protect eelgrass and other important salmon rearing estuary habitats	1,293	0.79	0.56	46	6
Sustainable commercial harvest	Reduce mixed-stock catches; improve enforcement of regulations; reduce bycatch of non-target salmon species	1,406	0.59	0.38	45	7
Sustainable recreational harvest	Limit expansion of tourism and sport fishing operations; regulate size and daily catch limits; improve monitoring	707	0.99	0.73	26	9
Supplement small populations with hatcheries	Set up hatcheries as a last resort for CUs in the red zone; monitor and improve effectiveness of hatcheries supplementing target CUs; fish ladders over natural barriers where appropriate	1,102	3.27	0.72	12	11
Stream restoration	Fine-scale habitat monitoring; maintain and restore riparian habitat characteristics and processes	1,421	10.55	0.76	5	13
Combined harvest strategy	Overarching harvest strategy; Sustainable commercial harvest strategy; Sustainable recreational harvest strategy	1,818	1.59	0.59	34	8
Combined supplementation and predation strategy	Supplement small populations; Predator control	1,911	3.39	0.57	16	10
Combined habitat strategy	Watershed protection and water management; Stream restoration; Remove barriers to fish passage	2,366	11.30	0.73	8	12
All strategies combined		2,896	17.30	0.59	5	14
Enabling strategy: Monitoring and assessment	Integrated status assessments for CUs; adult escapement and smolt abundance monitoring for CU indicator streams; monitor data-deficient CUs	NA	0.699	0.71	NA	NA

Walsh et al. (2020) J Appl Ecol, DOI:10.1111/1365-2664.13646

Prioritization

- Best strategy at low budgets is *generally* limit industrial development
- Best strategies at low budget depend on desired threshold probability of persistence
- Best strategy at high budgets is always combined habitat strategy



Walsh et al. (2020) J Appl Ecol, DOI:10.1111/1365-2664.13646

Thanks for listening!

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2. convert to a Web Address:

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3. copy and paste into web browser address bar