Prioritizing threat management to save Mat-Su salmon

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Priority threat management

LETTER CONSERVATION LETTERS 2012 5:196-204

Prioritizing threat management for biodiversity conservation

Josie Carwardine[1,6], Trudy O'Connor[2,5], Sarah Legge[3,4], Brendan Mackey[5,7], Hugh P. Possingham[6], & Tara G. Martin[1]

Global Change Biology

Global Change Biology (2015) 21, 3917–3930, doi: 10.1111/gcb.13034

Priority threat management of invasive animals to protect biodiversity under climate change

JE
BE
JE

Conservation Biology

Contributed Paper

Benefits of integrating complementarity into priority threat management

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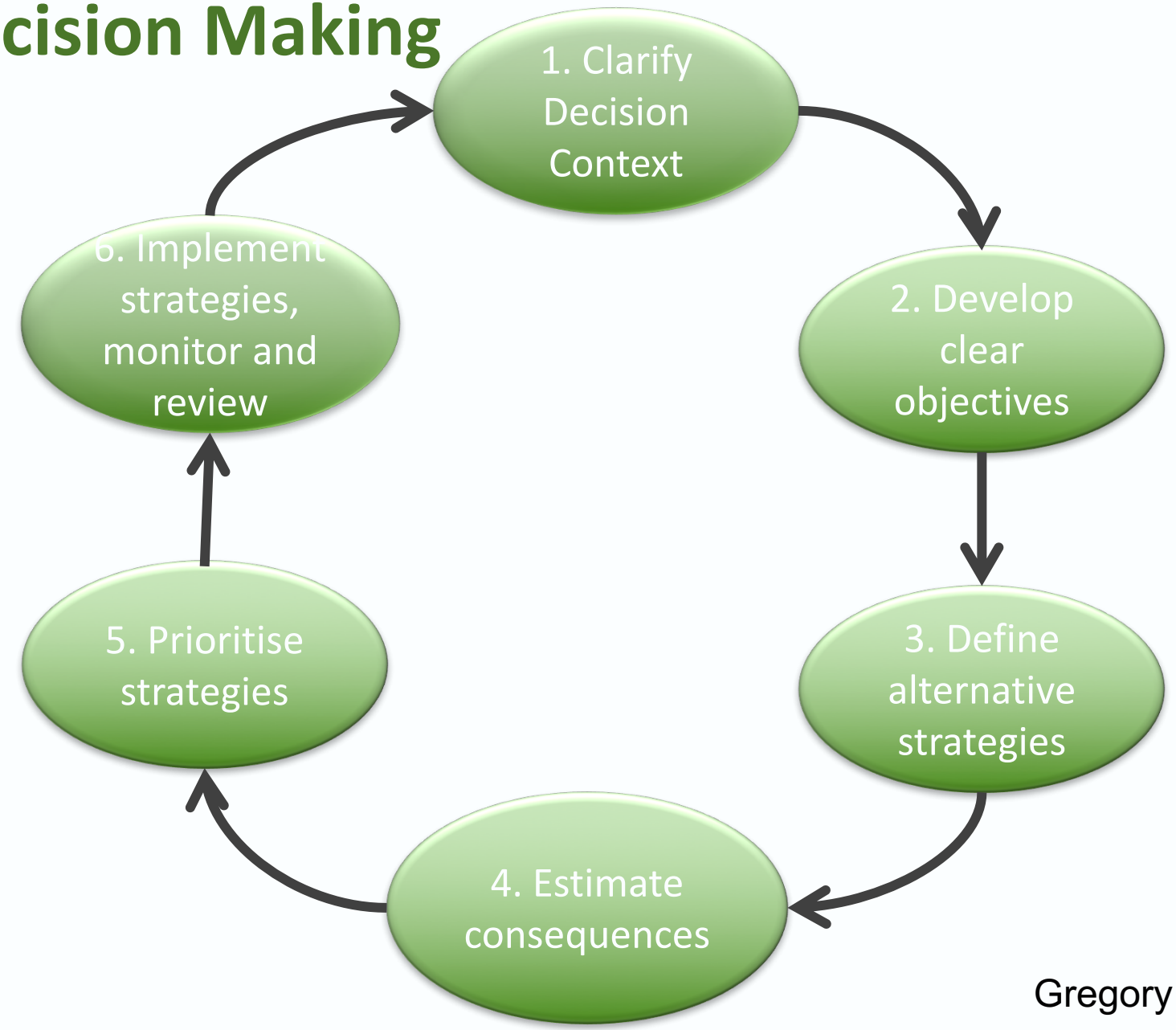
Priority Threat Management – questions it can answer

- Which salmon species will be lost without management?
- What strategies are needed to save all species and how much will it cost?
- Which strategies are most cost-effective (save most species per $ spent)?
- How many species can be saved for a given budget?
- Which species are unable to be saved, irrespective of management?

Priority Threat Management & Structured Decision Making



Gregory et al. 2012

Step 1. Clarify the Decision Context

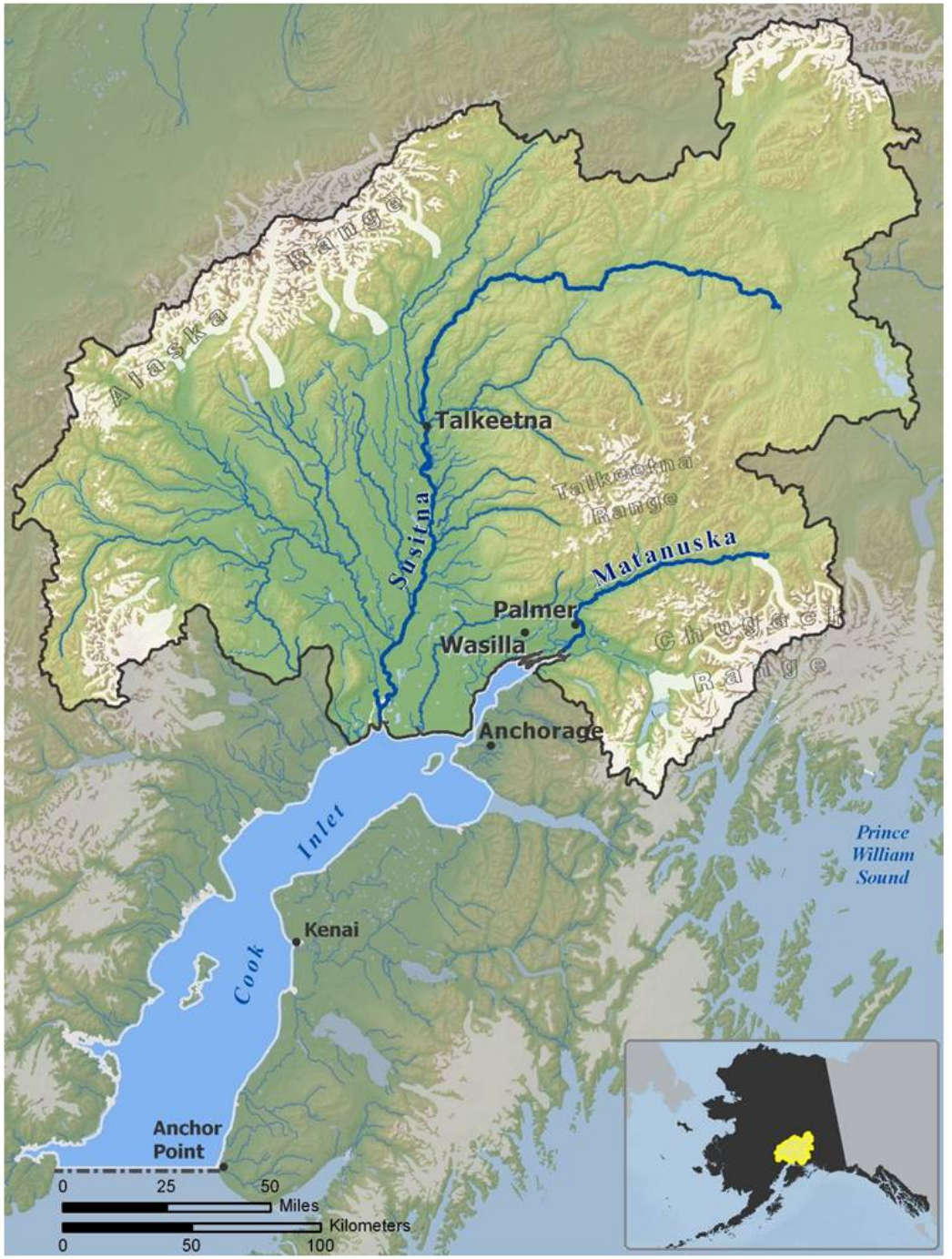
What is the spatial scope?

Who are the key stakeholders and decision makers?

What is the time-frame?

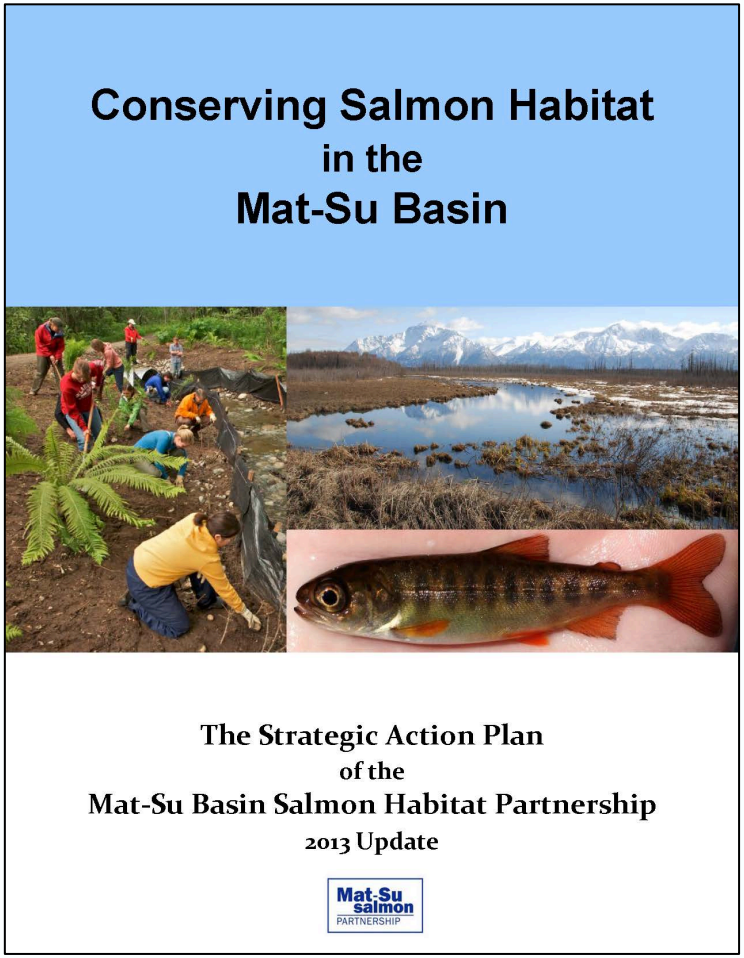
What species of concern?

What are the key threats?



Threats to Mat-Su Basin Salmon

- Aquatic Invasive Species
- Climate Change
- Development in Estuaries and Nearshore Habitats
- Ground & Surface Water Withdrawals
- Household On-site Septic Systems & Wastewater
- Large-scale Resource Development
- Motorized Off-road Recreation
- Residential, Commercial, & Industrial Development
- Roads & Railroads
- Stormwater Runoff

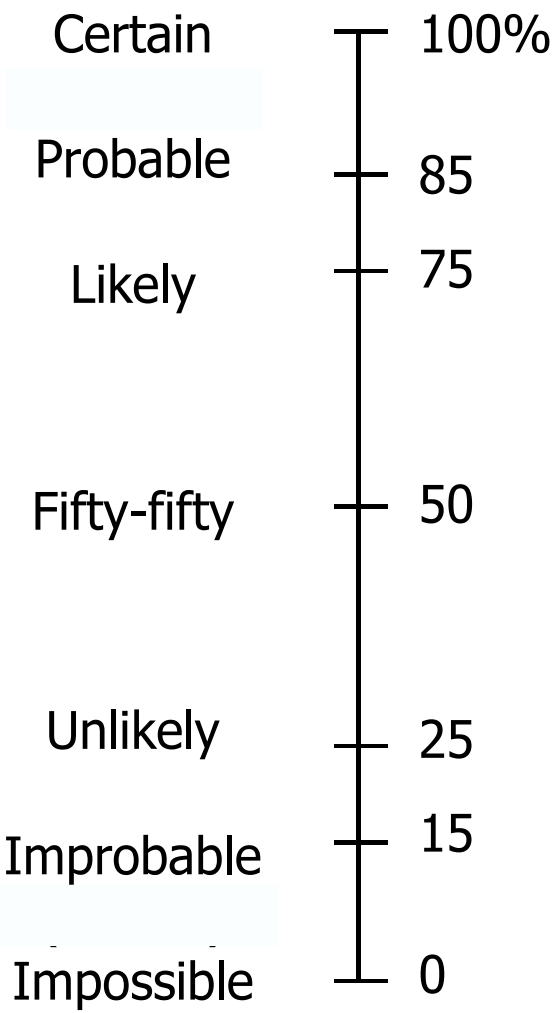


Step 2. Develop clear objectives and performance measures

Over the next 20 years,

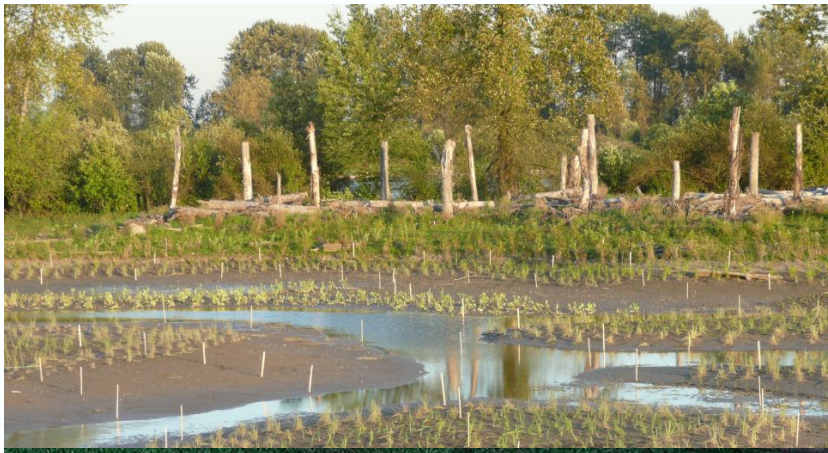
- Meet escapement goals for pink, chum, chinook, coho and sockeye

- Performance measure = probability of achieving above goals



Step 3. Define alternative strategies

Alternative Strategies
1. Overarching Science Strategies
2. Alteration of Riparian Areas
3. Climate Change
4. Culverts that Block Fish Passage
5. Filling of Wetlands
6. Impervious Surfaces & Stormwater Pollution
7. Aquatic Invasive Species
8. Large-scale Resource Development
9. Loss or Alteration of Water Flow or Volume
10. Loss of Estuaries & Nearshore Habitats
11. Motorized Off-road Recreation
12. Wastewater Management



Step 4. Estimate the consequences (costs, benefits, feasibility of strategies)

The cost-effectiveness (CE) of strategy *i*

$$CE_i = \frac{B_i \times F_i}{C_i}$$

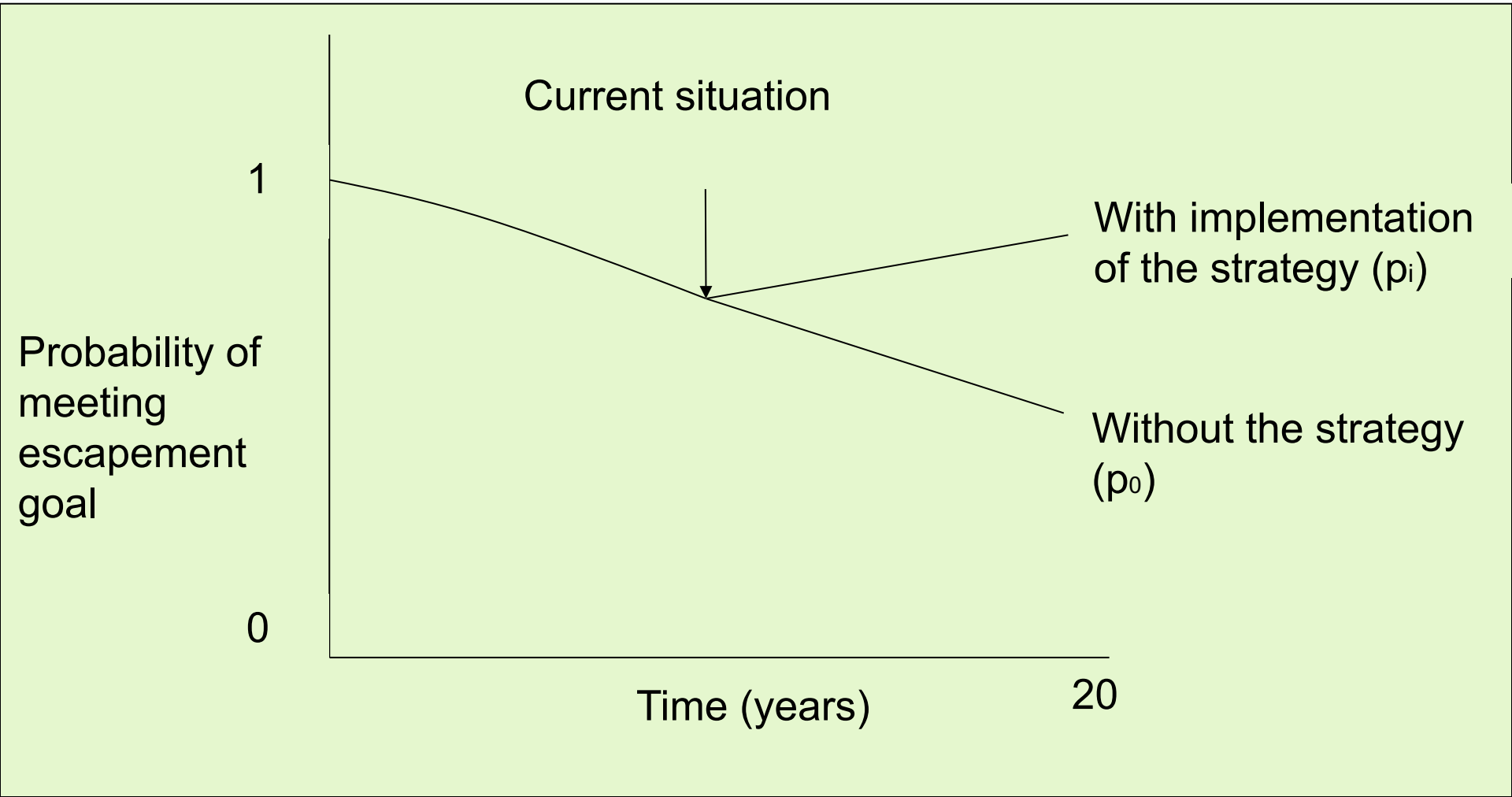
B_i = sum of improved persistence for all species under strategy i

F_i = feasibility of strategy i

C_i = total cost of strategy i

Step 4. Estimate benefit

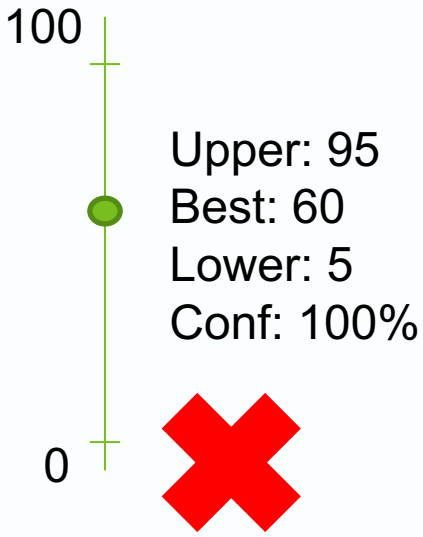
$$B_i = p_i - p_0$$

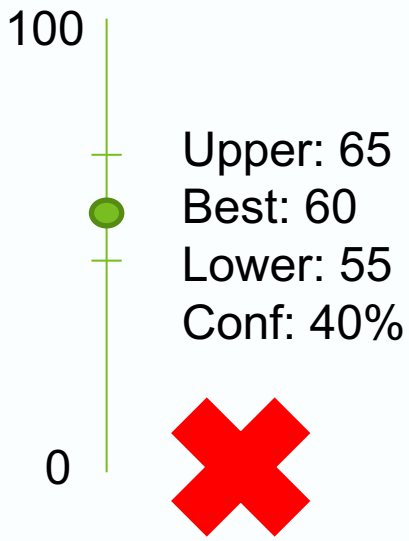


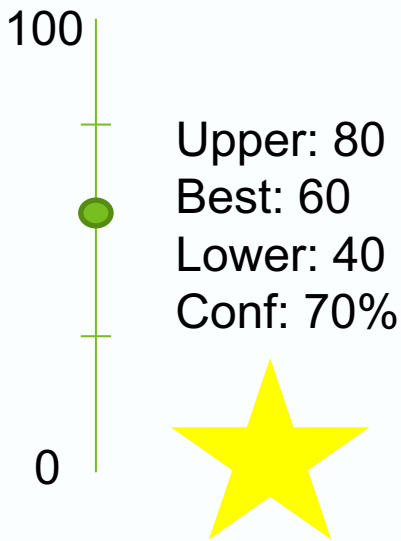
Estimating benefits

Best guess and bounds for worst-case and best-case scenarios + a level of confidence that the real outcome will be between these bounds

Should be at least > 50%, but < 100% sure that the real outcome will be between your bounds.







Estimating Cost

Strategy: Culverts that block fish passage

Action:Develop and Implement Fish Passage Restoration

Costs of:	Unit	Extent	Cost/ Yr	Total No. Yrs	Start Yr	Annual or Alternate Yrs
Materials, fuel, transport and equipment	Fuel and materials	4 per yr across Basin	$141,000	20	1	1
Labour and/or number of FTEs, even if these people are already employed	0.25FTE FishBio 0.25 Contract.		$20,000 $30,000	20	1	1
Accommodation, travel etc	$1500 *2 months		$3,000	20	1	1
Monitoring	0.1FTE FishBio		$6000	20	2	2

Estimate Feasibility (uptake and likelihood of success)

- ***% uptake*** is the proportion of situations where the action will be accepted by the decision maker, assuming funds are available
  - e.g. 80% of jurisdictions will be amenable to removing barriers
- ***Likelihood of success*** is the proportion of times that the action will achieve its stated goals assuming it is implemented
  - e.g. how often will replacing culvert improve fish passage for salmon?

Step 5. Prioritize Strategies

Impervious Surfaces Stormwater Poll.

Alteration of Riparian Areas

Fish Passage

Motorized Off Road Recreation

Aquatic Invasive species

Estimate Benefits

		Benefits
1	 Impervious Surfaces Stormwater Poll.	605
2	 Alteration of Riparian Areas	575
3	 Fish Passage	566
4	 Motorized Off Road Recreation	441
5	 Aquatic Invasive species	354

Estimate Feasibility

		Benefits	*	Feasibility
1	Impervious Surfaces Stormwater Poll.	605	*	0.61
2	Alteration of Riparian Areas	575	*	0.71
3	Fish Passage	566	*	0.80
4	Motorized Off Road Recreation	441	*	0.51
5	Aquatic Invasive species	354	*	0.50

Estimate Cost

		Benefits	*	Feasibility	/	Cost	
1	Impervious Surfaces Stormwater Poll.	605	*	0.61	/	$2M	=
2	Alteration of Riparian Areas	575	*	0.71	/	$5.8M	=
3	Fish Passage	566	*	0.80	/	$0.5M	=
4	Motorized Off Road Recreation	441	*	0.51	/	$0.5M	=
5	Aquatic Invasive species	354	*	0.50	/	$1.5M	=

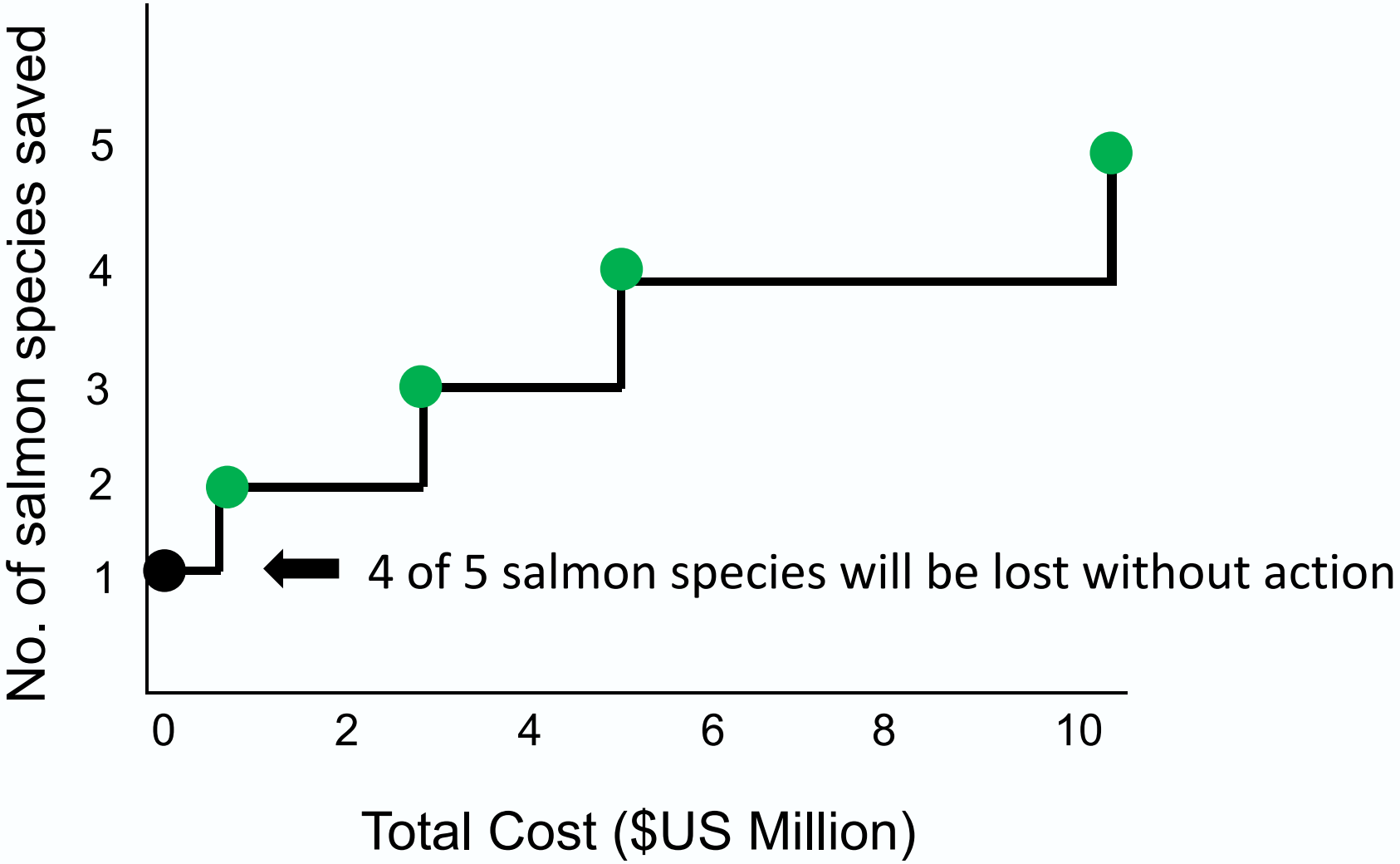
Calculate cost-effectiveness

		Benefits	*	Feasibility	/	Cost	=	*10^{-5}
1	 Impervious Surfaces Stormwater Poll.	605	*	0.61	/	$2M	=	184
2	 Alteration of Riparian Areas	575	*	0.71	/	$5.8M	=	70
3	 Fish Passage	566	*	0.80	/	$0.5M	=	905
4	 Motorized Off Road Recreation	441	*	0.51	/	$0.5M	=	449
5	 Aquatic Invasive species	354	*	0.50	/	$1.5M	=	118

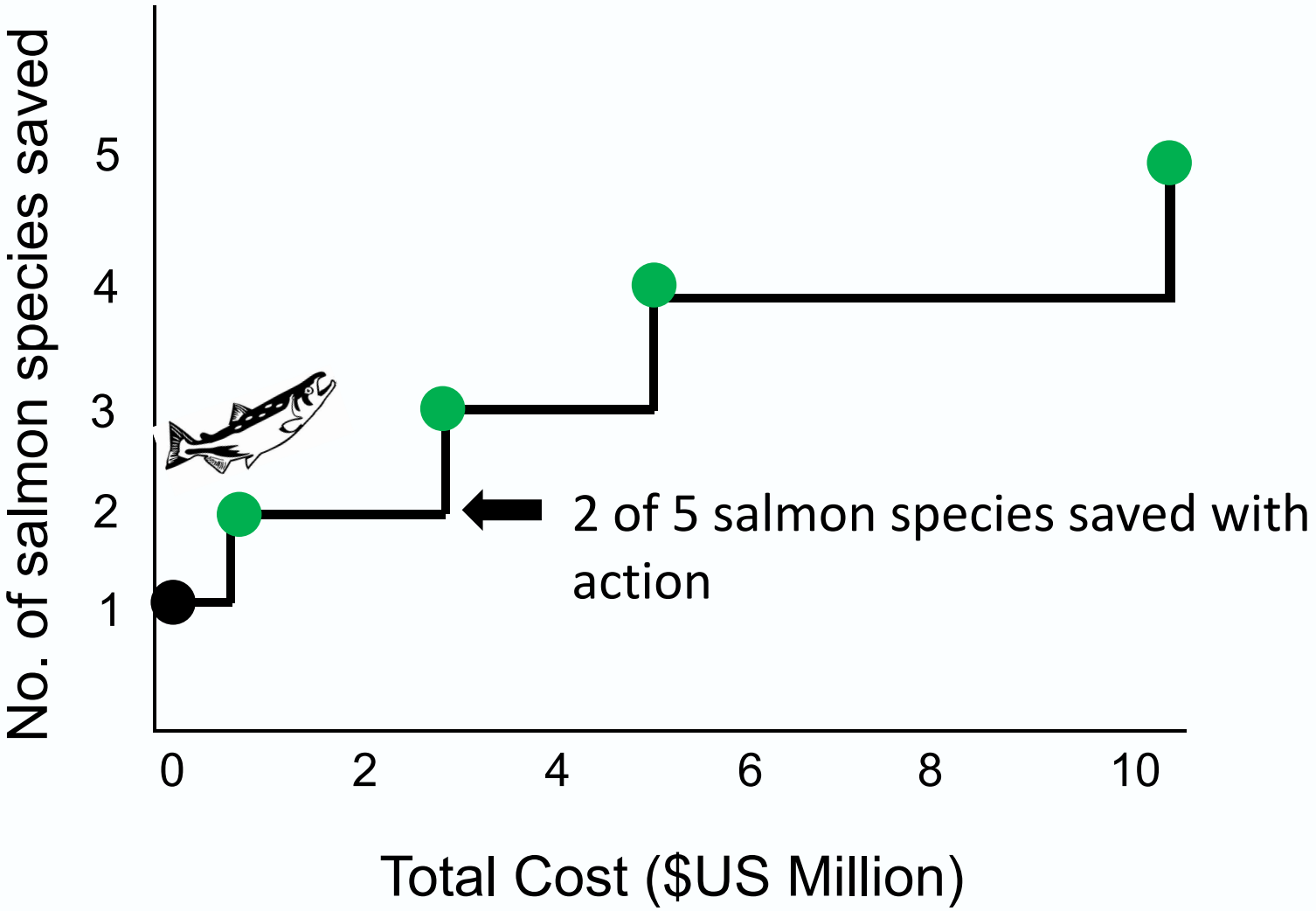
Prioritize Strategies

		Benefits * Feasibility / Cost = *10^{-5}
3	Impervious Surfaces Stormwater Poll.	605 * 0.61 / $2M = 184
5	Alteration of Riparian Areas	575 * 0.71 / $5.8M = 70
1	Fish Passage	566 * 0.80 / $0.5M = 905
2	Motorized Off Road Recreation	441 * 0.51 / $0.5M = 449
4	Aquatic Invasive species	354 * 0.50 / $1.5M = 118

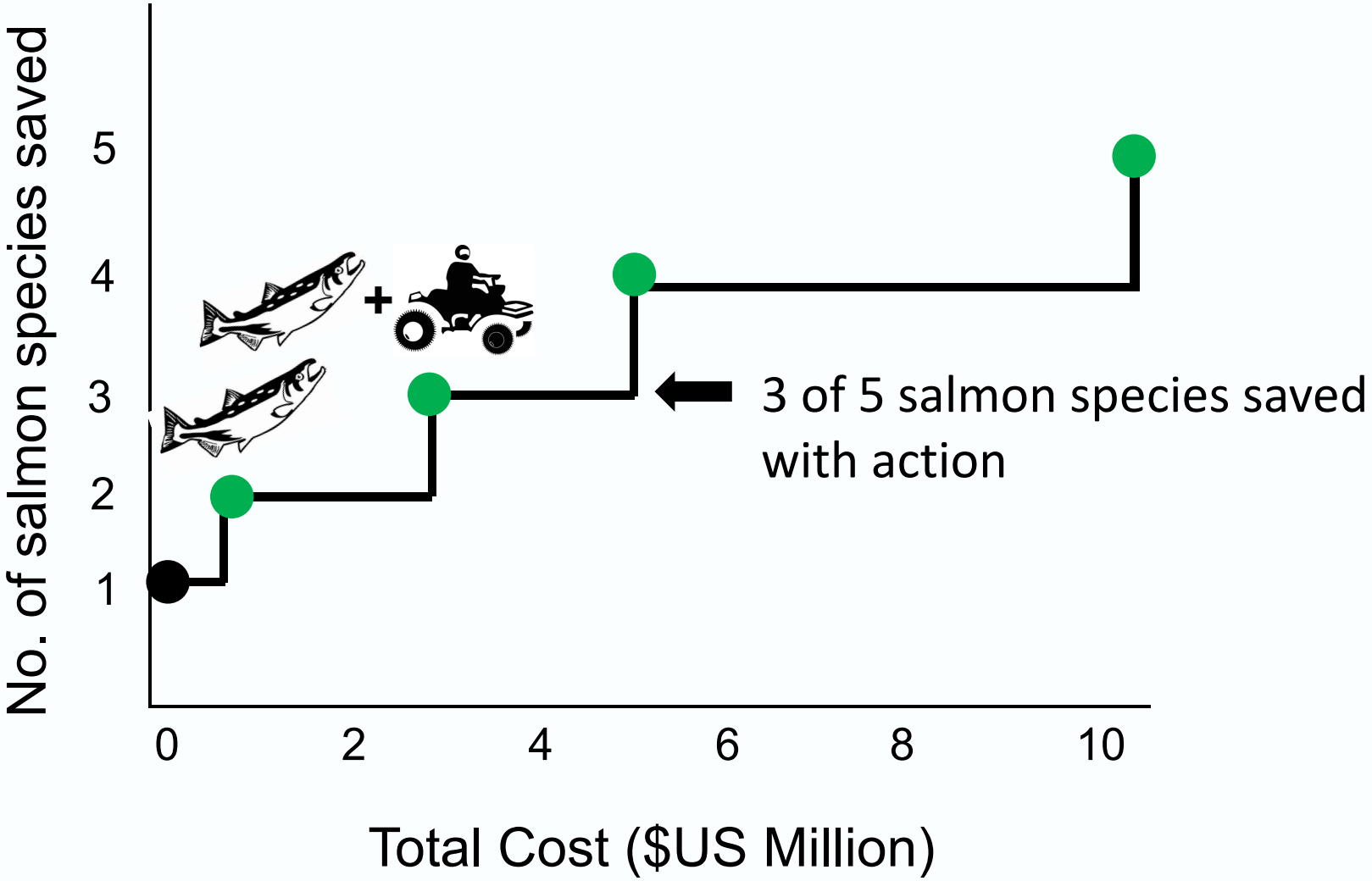
Complementary sets of strategies



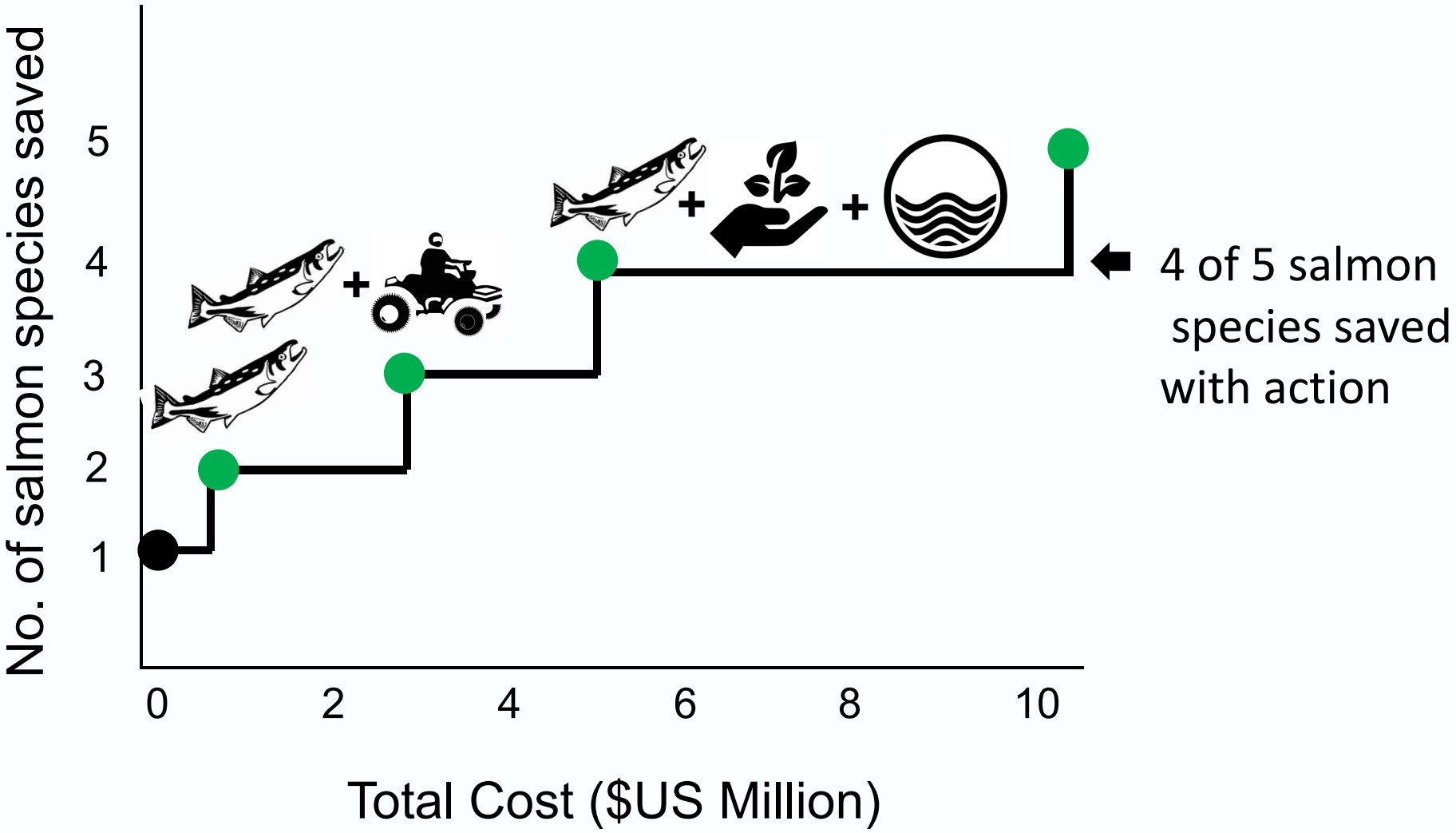
Complementary sets of strategies



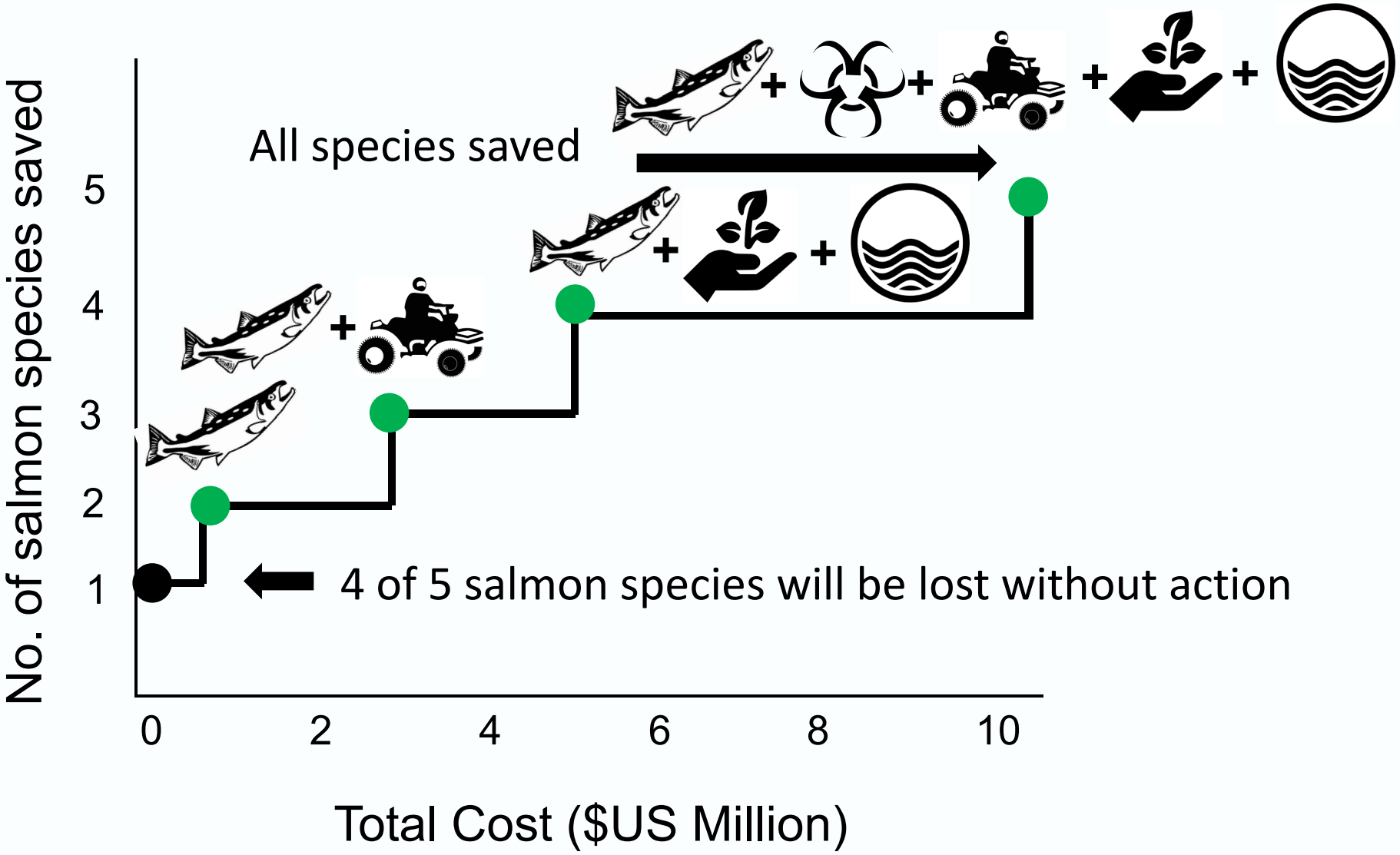
Complementary sets of strategies



Complementary sets of strategies



Complementary sets of strategies



Why this approach could work for Salmon conservation in the Mat-Su

- Making best use of limited resources
- Using best knowledge available of the day
- Clear about what can and cannot be achieved with a given budget
- Not trying to put a $ value on nature

Why this approach could work for Salmon conservation in the Mat-Su

- Ability to leverage additional funding
- Clear with funders on Return on Investment
- Uncovering critical uncertainties
- Ability to test state of knowledge

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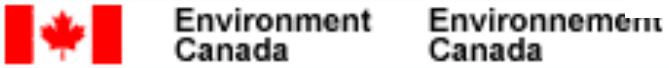

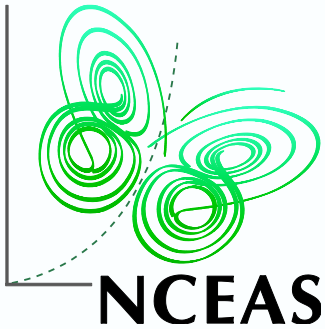

Prioritize strategies

Strategy	Benefit (B)
1. Overarching Science Strategies	90
2. Alteration of Riparian Areas	85
3. Climate Change	50
4. Culverts that Block Fish Passage	90
5. Filling of Wetlands	79
6. Impervious Surfaces & Storm Poll.	68
7. Aquatic Invasive Species	56
8. Large-scale Resource Development	20
9. Loss or Alteration of Water Flow/Vol	78
10. Loss of Estuaries & Nearshore Hab	75
11. Motorized Off-road Recreation	60
12. Wastewater Management	50

Prioritize strategies

Strategy	Benefit (B)	Cost (C) (NPV 10 Yr)
1. Overarching Science Strategies	90	$1,286,318
2. Alteration of Riparian Areas	85	$965,790
3. Climate Change	50	$760,601
4. Culverts that Block Fish Passage	90	$1,418,346
5. Filling of Wetlands	79	$951,419
6. Impervious Surfaces & Storm Poll.	68	$612,604
7. Aquatic Invasive Species	56	$729,056
8. Large-scale Resource Development	20	$38,994
9. Loss or Alteration of Water Flow/Vol	78	$405,145
10. Loss of Estuaries & Nearshore Hab	75	$873,411
11. Motorized Off-road Recreation	60	$81,084
12. Wastewater Management	50	$112,810

Prioritize strategies

Strategy	Benefit (B)	Cost (C) (NPV 10 Yr)	Feas. (F)
1. Overarching Science Strategies	90	$1,286,318	0.57
2. Alteration of Riparian Areas	85	$965,790	0.66
3. Climate Change	50	$760,601	0.62
4. Culverts that Block Fish Passage	90	$1,418,346	0.67
5. Filling of Wetlands	79	$951,419	0.67
6. Impervious Surfaces & Storm Poll.	68	$612,604	0.71
7. Aquatic Invasive Species	56	$729,056	0.56
8. Large-scale Resource Development	20	$38,994	0.81
9. Loss or Alteration of Water Flow/Vol	78	$405,145	0.59
10. Loss of Estuaries & Nearshore Hab	75	$873,411	0.60
11. Motorized Off-road Recreation	60	$81,084	0.53
12. Wastewater Management	50	$112,810	0.62

Prioritize strategies

Strategy	Benefit (B)	Cost (C) (NPV 10 Yr)	Feas. (F)	CE (B*F/C)
1. Overarching Science Strategies	90	$1,286,318	0.57	3.99
2. Alteration of Riparian Areas	85	$965,790	0.66	5.81
3. Climate Change	50	$760,601	0.62	4.08
4. Culverts that Block Fish Passage	90	$1,418,346	0.67	4.25
5. Filling of Wetlands	79	$951,419	0.67	5.56
6. Impervious Surfaces & Storm Poll.	68	$612,604	0.71	7.88
7. Aquatic Invasive Species	56	$729,056	0.56	4.30
8. Large-scale Resource Development	20	$38,994	0.81	41.54
9. Loss or Alteration of Water Flow/Vol	78	$405,145	0.59	11.36
10. Loss of Estuaries & Nearshore Hab	75	$873,411	0.60	5.15
11. Motorized Off-road Recreation	60	$81,084	0.53	39.22
12. Wastewater Management	50	$112,810	0.62	27.48

Prioritize strategies

Strategy	Benefit (B)	Cost (C) (NPV 10 Yr)	Feas. (F)	CE (B*F/C)	Priority
1. Overarching Science Strategies	90	$1,286,318	0.57	3.99	**1**
2. Alteration of Riparian Areas	85	$965,790	0.66	5.81	7
3. Climate Change	50	$760,601	0.62	4.08	2
4. Culverts that Block Fish Passage	90	$1,418,346	0.67	4.25	3
5. Filling of Wetlands	79	$951,419	0.67	5.56	6
6. Impervious Surfaces & Storm Poll.	68	$612,604	0.71	7.88	8
7. Aquatic Invasive Species	56	$729,056	0.56	4.30	4
8. Large-scale Resource Development	20	$38,994	0.81	41.54	12
9. Loss or Alteration of Water Flow/Vol	78	$405,145	0.59	11.36	9
10. Loss of Estuaries & Nearshore Hab	75	$873,411	0.60	5.15	5
11. Motorized Off-road Recreation	60	$81,084	0.53	39.22	11
12. Wastewater Management	50	$112,810	0.62	27.48	10