Avoiding irreversible loss and managing for thriving salmon populations

Dr Tara Martin - University of British Columbia, International Union for the Conservation of Nature (IUCN), 2017 Wilburforce Fellow

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MARTIN CONSERVATION DECISIONS LAB

Turning ecological data into decisions

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Home

Dr Tara Martin is a 2017 Wilburforce Fellow. Prior to this she was a Principal Research Scientist at CSIRO where she founded the Conservation Decisions Team and worked for 18 years. She is also an Adjunct Professor in the Department of Forest and Conservation Sciences at the University of British Columbia and School of Biological Sciences, University of Queensland, Australia.

"Our motivation is to solve pressing global conservation problems. We do this by connecting ecological data with decision science to determine what actions to take, when and where to get the best outcomes for biodiversity conservation, while taking into account the many other competing needs of society.

We're a multi-disciplinary group with expertise in ecology, systematic conservation planning, Bayesian statistics, applied mathematics, artificial intelligence, and decision theory. We work closely with the University of Queensland's Environmental Decisions Group with many of us holding adjunct or joint appointments. We are members of the ARC Centre of Excellence for Environmental Decisions and National Environment Research Program's Research Hub for Environmental Decisions.

We're pioneering techniques in optimal conservation resource allocation, cost-effectiveness analysis, Bayesian modelling, expert elicitation and active adaptive management. We apply our expertise to diverse conservation problems to inform the recovery of endangered species

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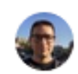
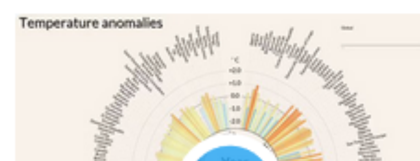


Antti Lipponen
@anttilip

Temperature anomalies arranged by country 1900 - 2016 🌡. #dataviz #climate #climatechange #globalwarming
Download 🎞: flic.kr/p/W3wPeE



1957

McClenachan et al 2009


1958
CAUGHT ON
BOAT
GREYHOUND II
"GOING FISHING?"

1968


DEEP SEA FISHING
GULFSTREAM II
9:30 to 4:30
Capt. Tommy Lones
FARE 12.00
Ph. 296-8494
GULFST

1978


GULF STREAM II
DEEP SEA FISHING
PHONE
296-8494
DAILY
9:00 AM TO
4:00 PM
FARE $10.00

1985


2007
PH. 296·5139 OR 296·5923

Shifting baselines

Ecologically something monumental has occurred

But people are still smiling…

We transform the world but we don't remember it – we adjust our baseline to a new level of normal and we don't remember what was there before

Why is this a problem?

Each generation accepts as normal 'less' than the previous generation = Generational amnesia

We don't fight for what has been lost before us and for what is possible

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]

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[4]North Australian Biodiversity Hub, Charles Darwin University, Casuarina, Northern Territory 0909, Australia
[5]Fenner School of Environment and Society, The Australian National University, Australian Capital Territory 2601, Australia
[6]The Ecology Centre, University of Queensland, St Lucia, Queensland 4072, Australia
[7]Griffith Climate Change Response Program, Griffith University, Gold Coast Campus, Queensland 4222, Australia

Priority Threat Management – questions it can answer

- Which species will be lost without management?
- What strategies are needed to save all threatened 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?

Making the business case for conservation

Priority Threat Management of Fraser River Estuary

Species at risk in the Fraser River Estuary

Threats to Fraser River salmon

Habitat loss, degradation & pollution

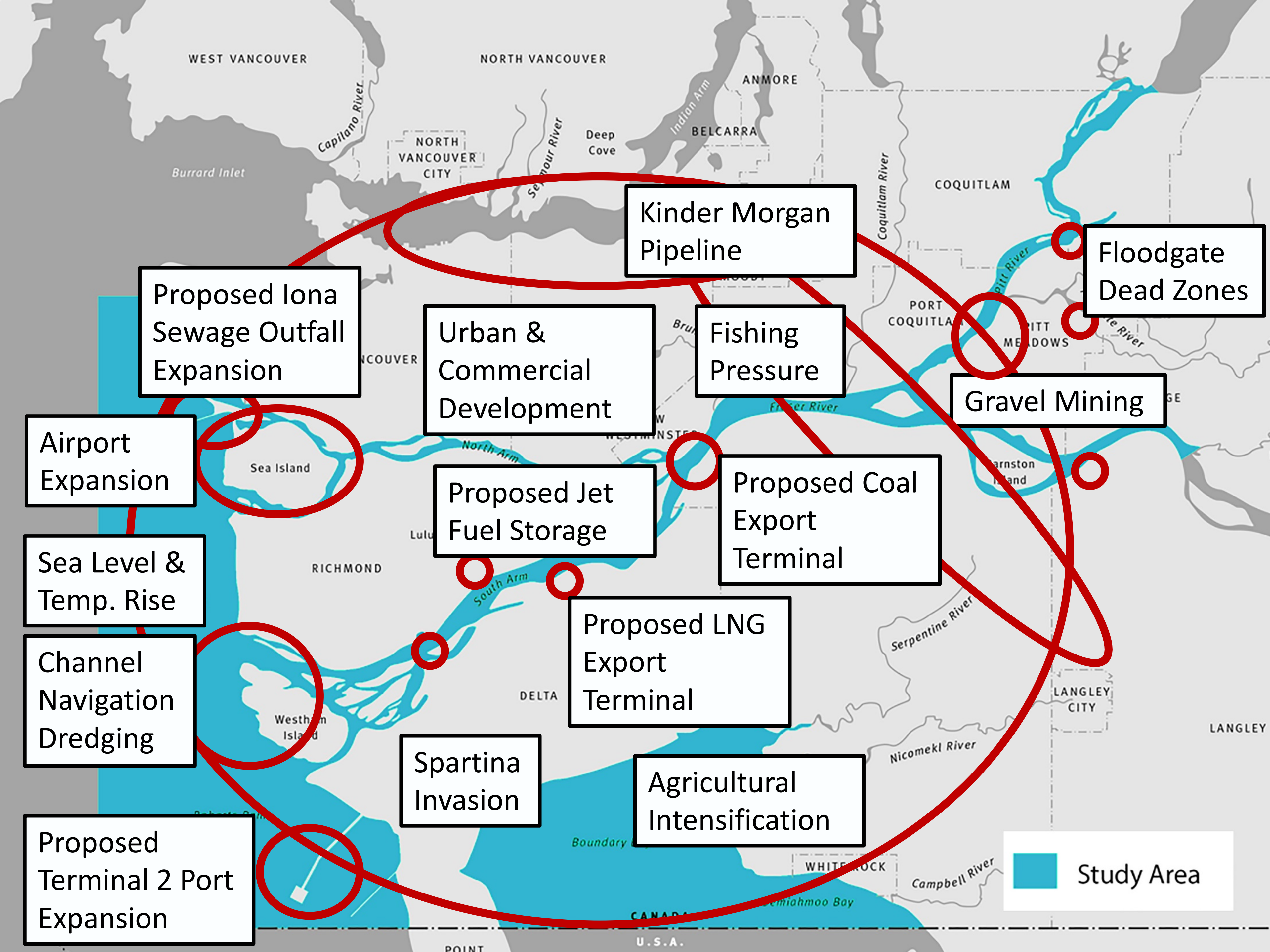
Over-exploitation

Climate change

Disease

~ Cumulative impacts

"The greatest risk to habitat for salmon and other freshwater fish in the Mat-Su Basin may be many small actions that compound over time to degrade riparian habitat, block fish passage, and impact water quality, quantity and flow." *Mat-Su SAP 2013*



Kinder Morgan Pipeline
Floodgate Dead Zones
Proposed Iona Sewage Outfall Expansion
Urban & Commercial Development
Fishing Pressure
Gravel Mining
Airport Expansion
Proposed Jet Fuel Storage
Proposed Coal Export Terminal
Sea Level & Temp. Rise
Proposed LNG Export Terminal
Channel Navigation Dredging
Spartina Invasion
Agricultural Intensification
Proposed Terminal 2 Port Expansion
Study Area
WEST VANCOUVER
NORTH VANCOUVER
NORTH VANCOUVER CITY
ANMORE
BELCARRA
Deep Cove
Burrard Inlet
Capilano River
Indian Arm
Coquitlam River
COQUITLAM
PORT COQUITLAM
Pitt River
Sea Island
North Arm
South Arm
Fraser River
RICHMOND
DELTA
Serpentine River
LANGLEY CITY
LANGLEY
Nicomekl River
Campbell River
U.S.A.

Overexploitation

Climate change

REVIEW SUMMARY

CLIMATE CHANGE

The broad footprint of climate change from genes to biomes to people

Brett R. Scheffers,* Luc De Meester, Tom C. L. Bridge, Ary A. Hoffmann, John M. Pandolfi, Richard T. Corlett, Stuart H. M. Butchart, Paul Pearce-Kelly, Kit M. Kovacs, David Dudgeon, Michela Pacifici, Carlo Rondinini, Wendy B. Foden, Tara G. Martin, Camilo Mora, David Bickford, James E. M. Watson

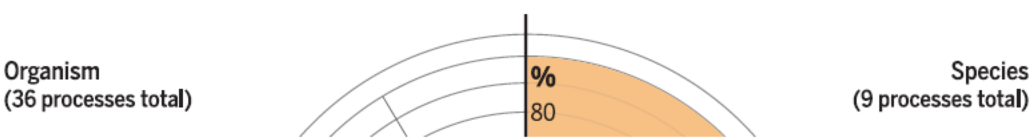
BACKGROUND: Climate change impacts have now been documented across every ecosystem on Earth, despite an average warming of only ~1°C so far. Here, we describe the full range and scale of climate change effects on global biodiversity that have been observed in natural systems. To do this, we identify a set of core ecological processes (32 in terrestrial and 31 each in marine and freshwater ecosystems) that underpin ecosystem functioning and support services to people. Of the 94 processes considered, 82% show evidence of impact from climate change in the peer-reviewed literature. Examples of observed impacts from meta-analyses and case studies go beyond well-established shifts in species ranges and changes to phenology and population dynamics to include disruptions that scale from the gene to the ecosystem.

ADVANCES: Species are undergoing evolutionary adaptation to temperature extremes, and climate change has substantial impacts on species physiology that include changes in tolerances to high temperatures, shifts in sex ratios in species with temperature-dependent sex determination, and increased metabolic costs of living in a warmer world. These physiological adjustments have observable impacts on morphology, with many species in both aquatic and terrestrial systems shrinking in body size because large surface-to-volume ratios are generally favored under warmer conditions. Other morphological changes include reductions in melanism to improve thermoregulation, and altered wing and bill length in birds.

Broader-scale responses to climate change include changes in the phenology, abundance, and distribution of species. Temperate plants are budding and flowering earlier in spring and later in autumn. Comparable adjustments have been observed in marine and freshwater fish spawning events and in the timing of seasonal migrations of animals worldwide. Changes in the abundance and age structure of populations have also been observed, with widespread evidence of range expansion in warm-adapted species and range contraction in cold-adapted species. As a by-product of species redistributions, novel community interactions have emerged. Tropical and boreal species are increasingly incorporated into temperate and polar commu-

ON OUR WEBSITE

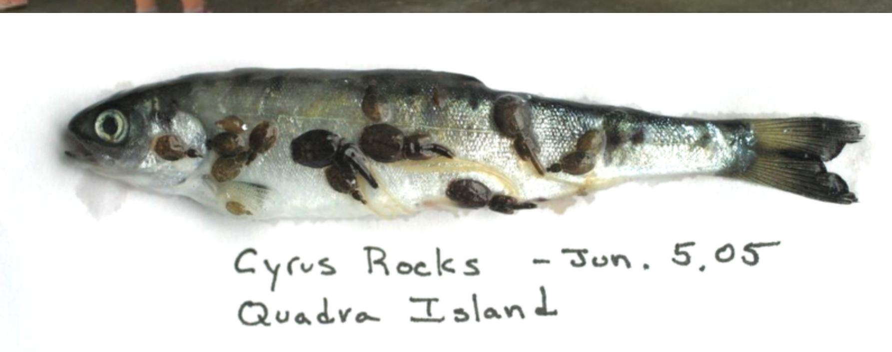
Read the full article at http://dx.doi.org/10.1126/science.aaf7671



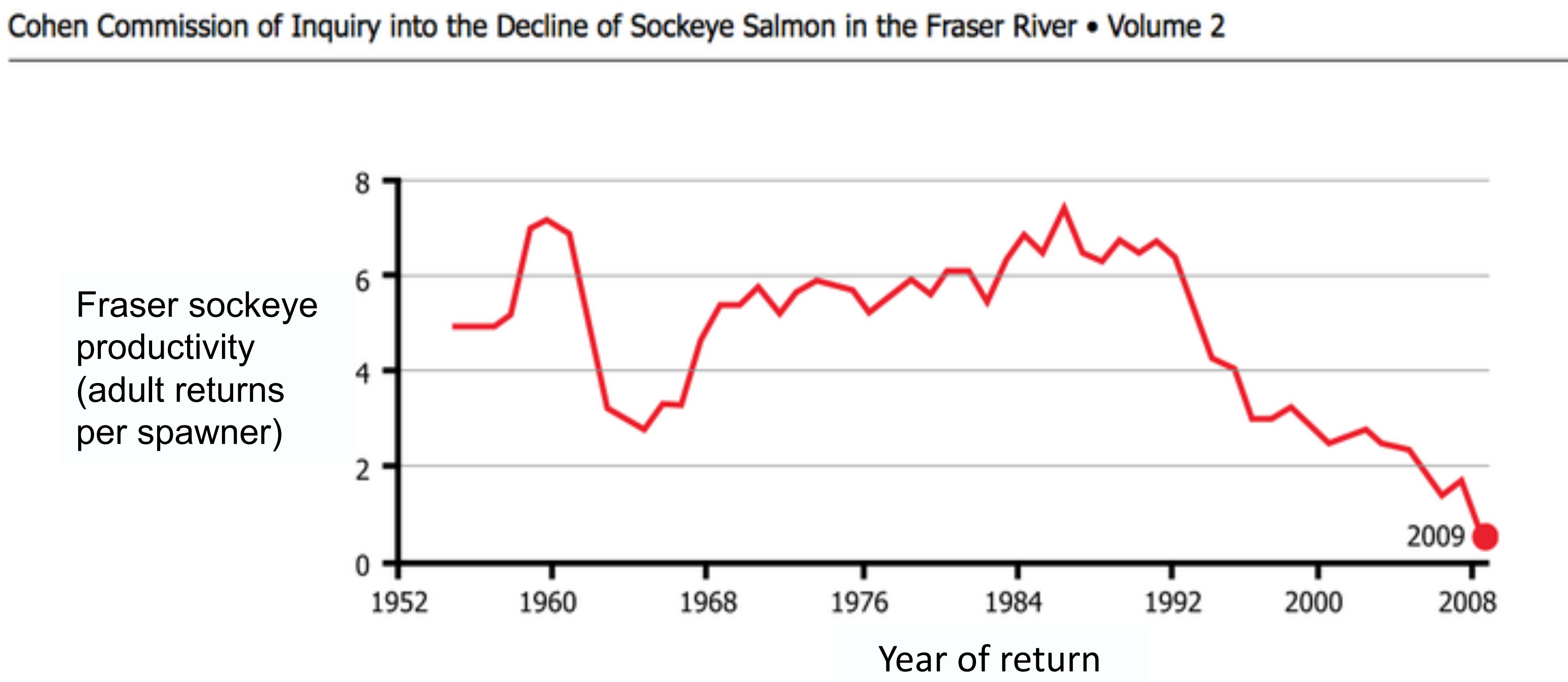
Climate change impacts on salmon

- Variability in river flows. Low flow in fall results in spawn location toward river centres ~ high risk of egg scour during peak winter flow (Ward et al. 2015)
- Elevated water temp ~ low egg survival
- Elevated water temp ~ elevated parasite loads and susceptibility
- Acidification – increasing CO_2 in freshwater results in lower pH ~ declines in fry body length, yolk conversion, & total mass (Ou et al. 2015)
- Low adaptability to elevated temp, low physiological plasticity (Muñoz et a 2015)
- Range shifts (30km/decade) (Cheung et al 2015)

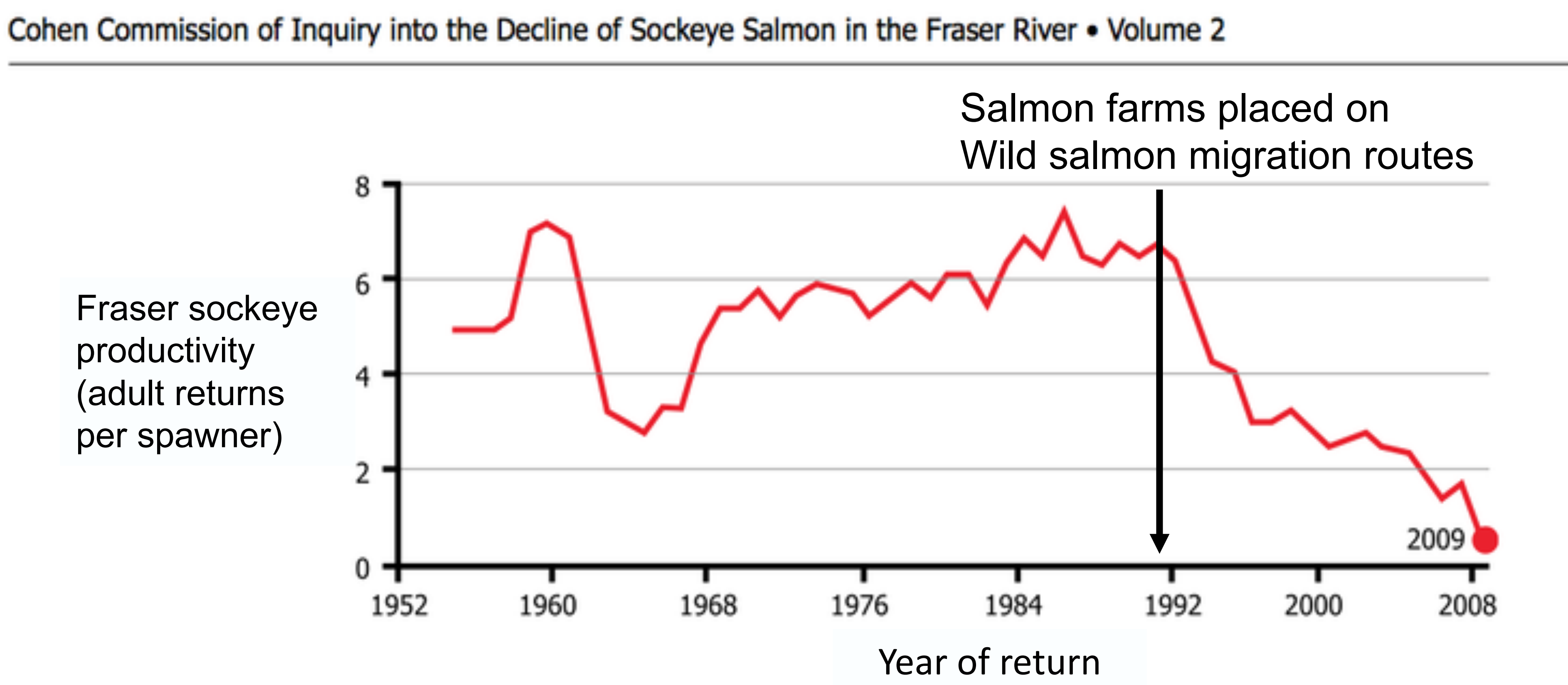
Disease and fish farms (HSMI, Piscine reo-virus)



Fraser Sockeye are crashing



Fraser Sockeye crash linked to fish farms

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Priority Threat Management & Structured Decision Making

Gregory et al. 2012

Step 1. Clarify the Decision Context

What is the spatial scope?

Fraser River Estuary

Who are the key stakeholders and decision makers?

First Nations, Provincial Government,, Industry, Conservation NGOs

What is the time-frame? - *25 years*

What species are being considered? – *150 species at risk*

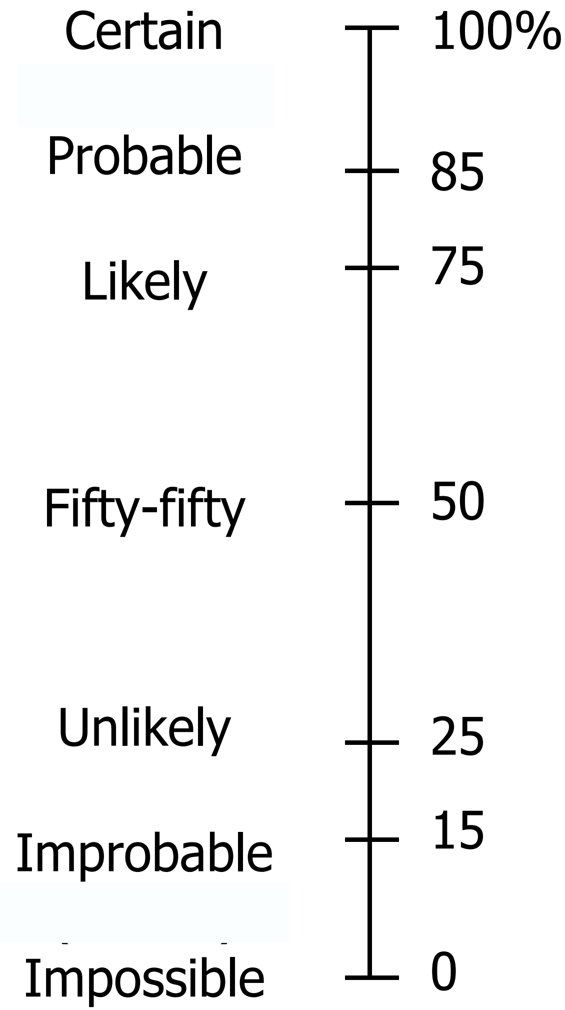
What are the key threats

Step 2. Develop clear objectives and performance measures

Over the next 25 years,

Increase the probability of persistence of 150 species at risk

Performance measure = probability of persistence (0-1)



Step 3. Define alternative strategies

Alternative Strategies
1. Terrestrial Habitat Protection
2. Private Land Stewardship
3. Flood Management/Green Infrastructure
4. Invasive Species Management/Pets
5. Transportation Regulation & Policy
6. Fisheries Regulation & Policy
7. Urban & Industrial Pollution
8. Population Management/Augmentation
9. Disease Control
10. Aquatic Habitat Restoration
11. Moratorium on Major Industrial Development
12-18. Combined strategies

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

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

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

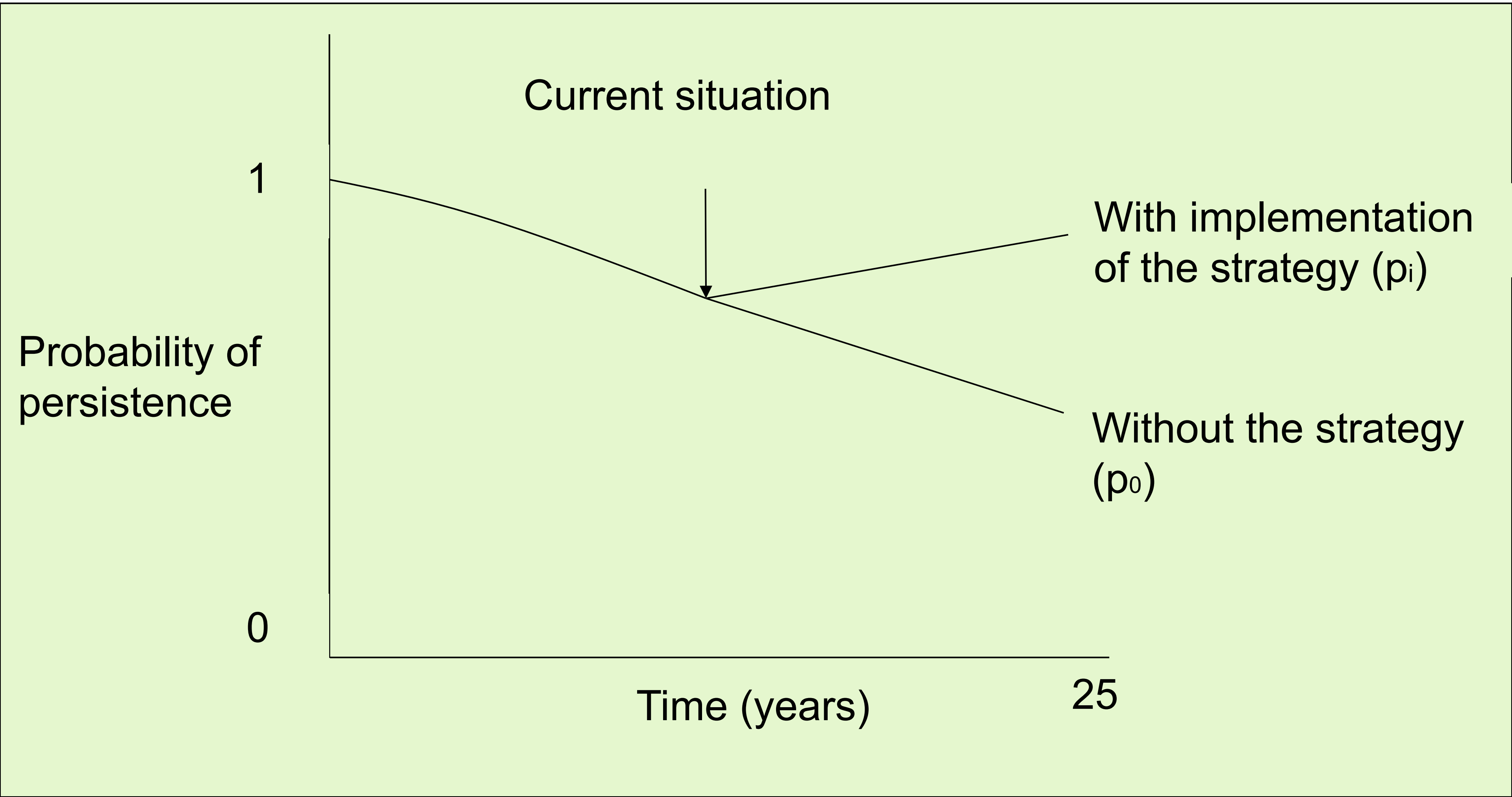
B_i = sum of improved persistence for all species under strategy i

F_i = feasibility of strategy i

C_i = total cost of strategy i

Step 4. Estimate benefit

$$B_i = p_i - p_0$$




GREAT NORTH

Eliciting expert knowledge

Conservation Biology 2012, 26: 29-38

Review

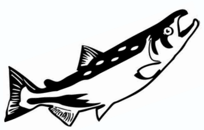
Eliciting Expert Knowledge in Conservation Science

TARA G. MARTIN,*† MARK A. BURGMAN,§ FIONA FIDLER,§ PETRA M. KUHNERT,¶
SAMANTHA LOW-CHOY,**†† MARISSA MCBRIDE,§ AND KERRIE MENGERSEN††

Step 5. Prioritize Strategies

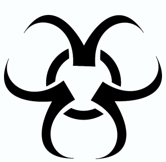
Flood Management/
Green Infrastructure

Terrestrial Habitat
Protect/Restoration



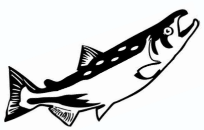
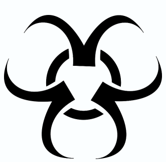
Aquatic Habitat
Restoration

Transportation
Regulation & Policy



Disease Control

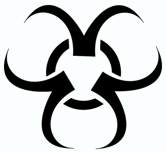
Estimate Benefits

			Benefits
1		Flood Management/ Green Infrastructure	566
2		Terrestrial Habitat Protect/Restoration	514
3		Aquatic Habitat Restoration	502
4		Transportation Regulation & Policy	441
5		Disease Control	354

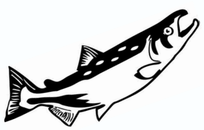
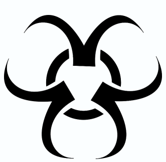
Estimate Feasibility

		Benefits * Feasibility
1	Flood Management/ Green Infrastructure	566 * 0.71
2	Terrestrial Habitat Protect/Restoration	514 * 0.71
3	Aquatic Habitat Restoration	502 * 0.50
4	Transportation Regulation & Policy	441 * 0.51
5	Disease Control	354 * 0.50

Estimate Costs

#		Category	Benefits	*	Feasibility	/	Cost
1		Flood Management/ Green Infrastructure	566	*	0.71	/	$2M
2		Terrestrial Habitat Protect/Restoration	514	*	0.71	/	$5.8M
3		Aquatic Habitat Restoration	502	*	0.50	/	$1.4M
4		Transportation Regulation & Policy	441	*	0.51	/	$0.5M
5		Disease Control	354	*	0.50	/	$1.5M

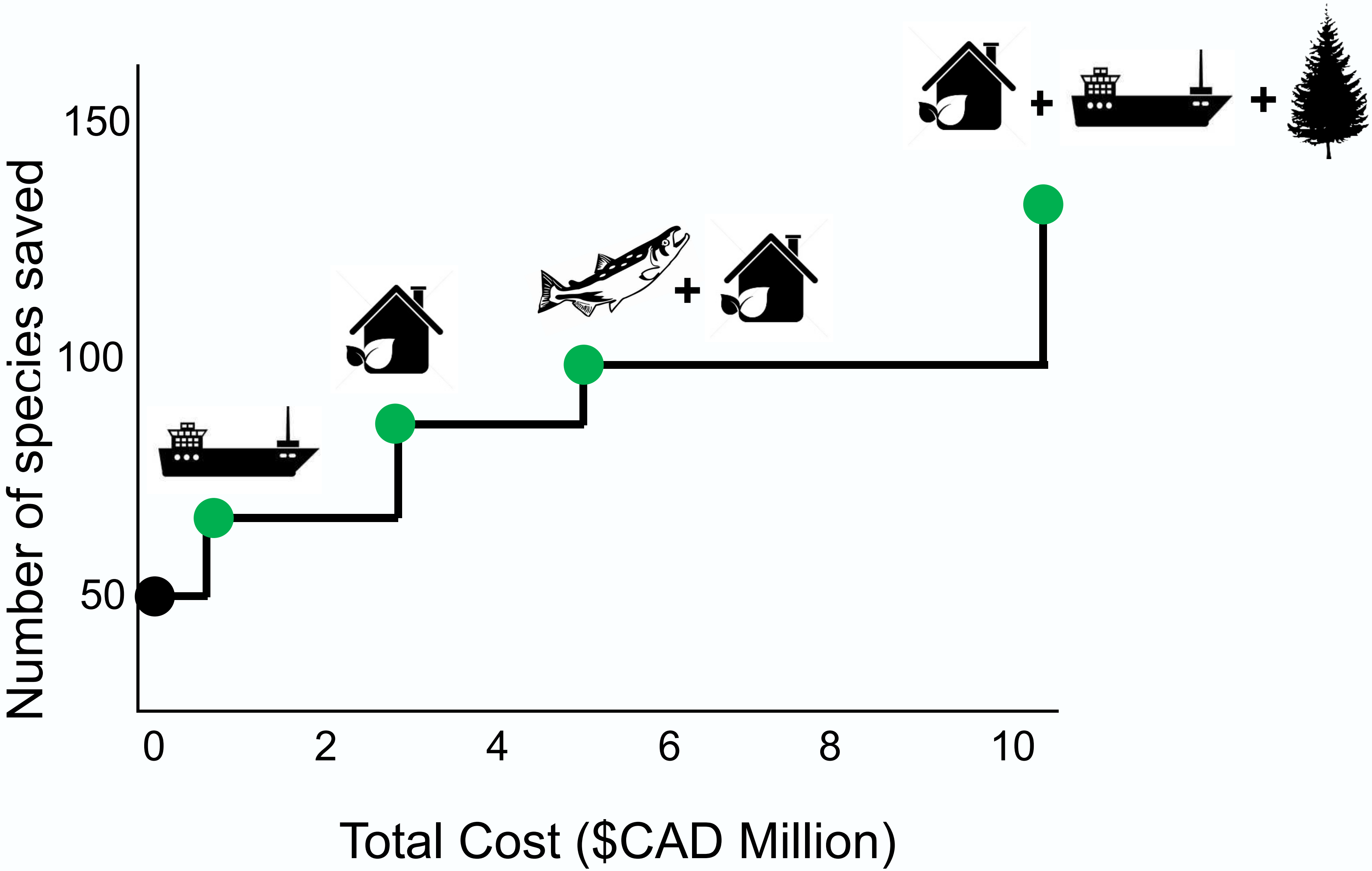
Calculate Cost-effectiveness

#		Item	Benefits	* Feasibility	/ Cost	= $*10^{-5}$
1		Flood Management/ Green Infrastructure	566	* 0.71	/ $2M	= 20
2		Terrestrial Habitat Protect/Restoration	514	* 0.71	/ $5.8M	= 6
3		Aquatic Habitat Restoration	502	* 0.50	/ $1.4M	= 18
4		Transportation Regulation & Policy	441	* 0.51	/ $0.5M	= 50
5		Disease Control	354	* 0.50	/ $1.5M	= 12

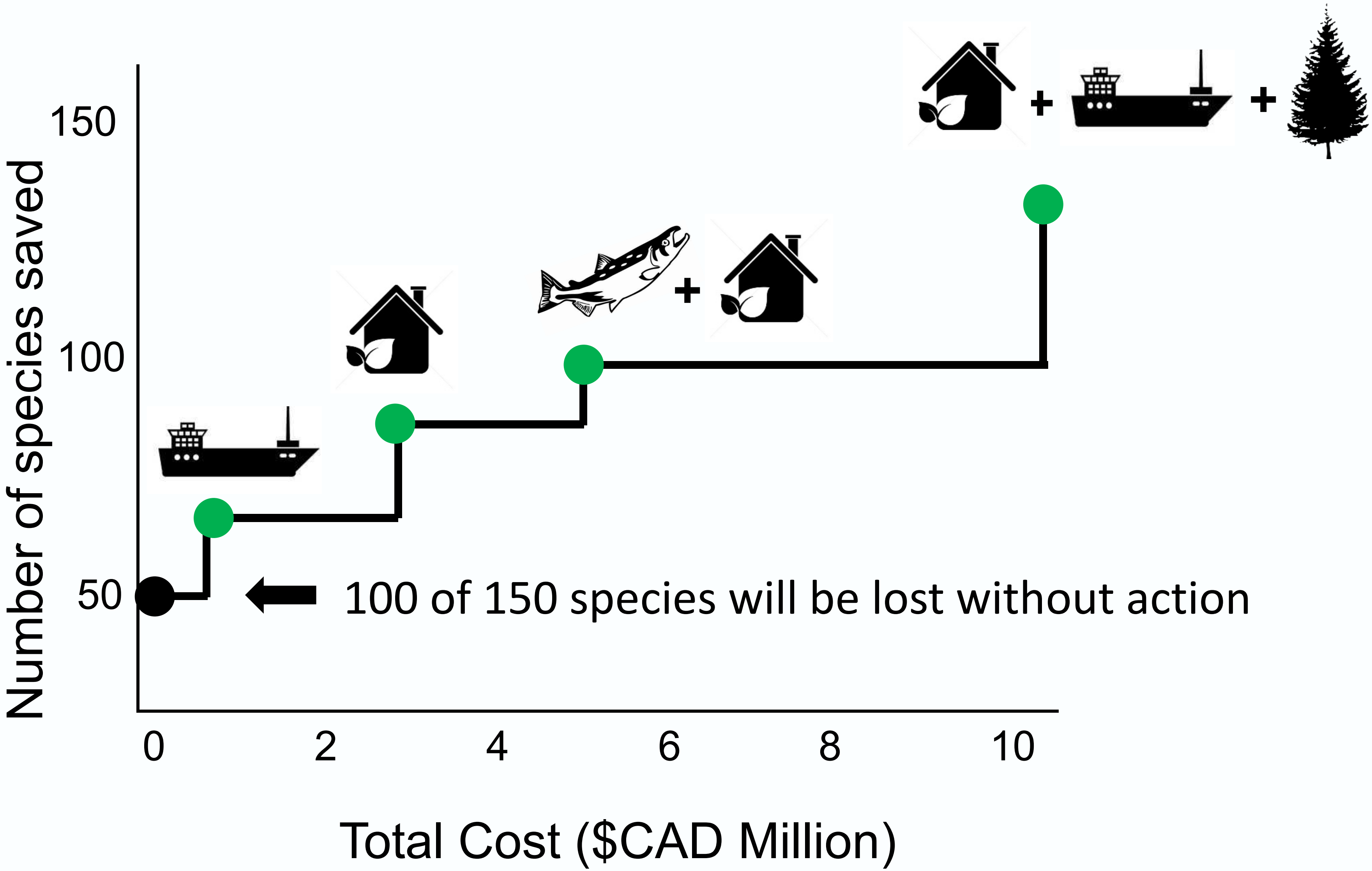
Prioritize Strategies

Rank	Strategy	Benefits	* Feasibility	/ Cost	= $*10^{-5}$
2	Flood Management/ Green Infrastructure	566	* 0.71	/ $2M	= 20
5	Terrestrial Habitat Protect/Restoration	514	* 0.71	/ $5.8M	= 6
3	Aquatic Habitat Restoration	502	* 0.50	/ $1.4M	= 18
1	Transportation Regulation & Policy	441	* 0.51	/ $0.5M	= 50
4	Disease Control	354	* 0.50	/ $1.5M	= 12

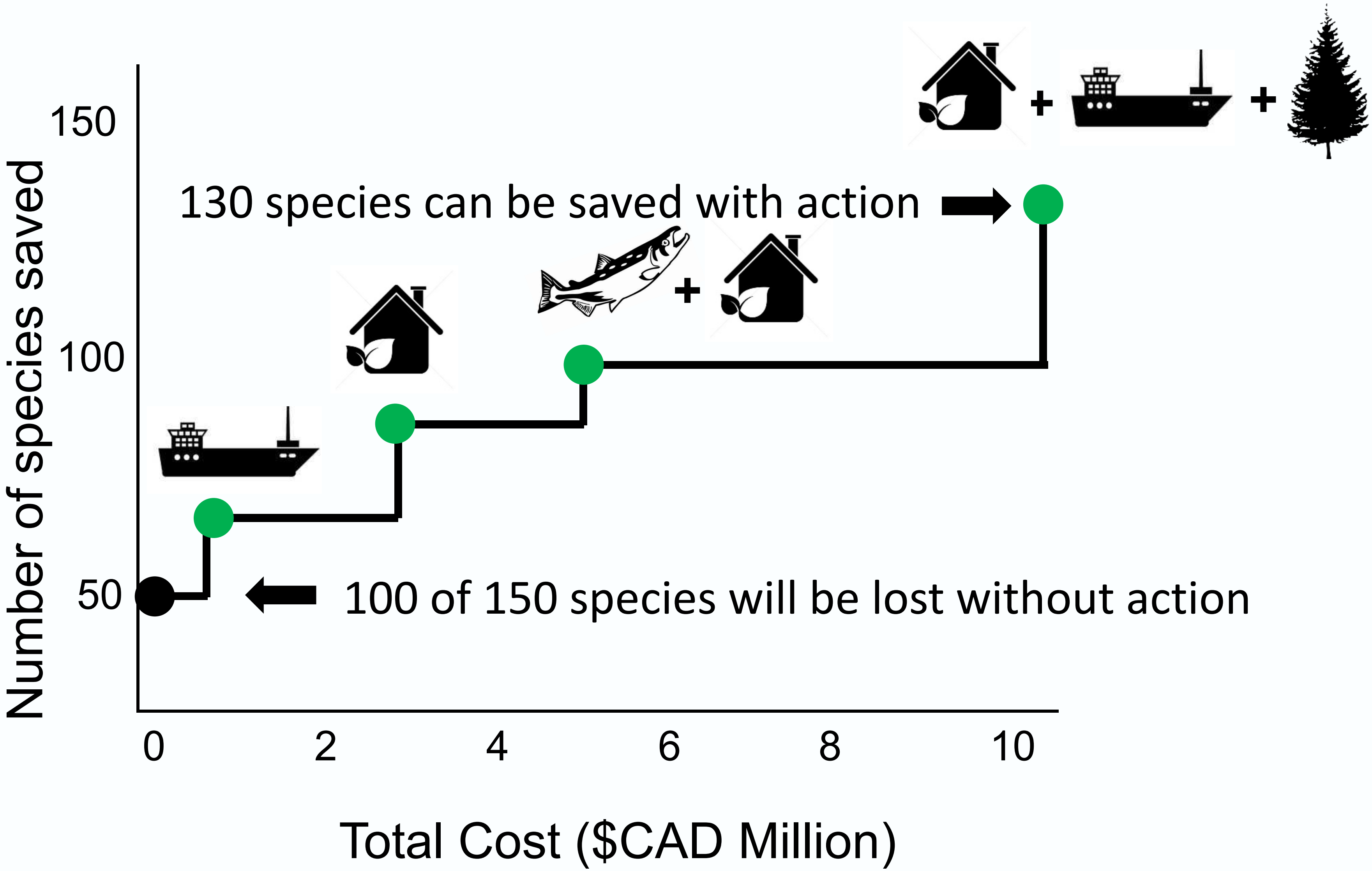
Complementary sets of strategies



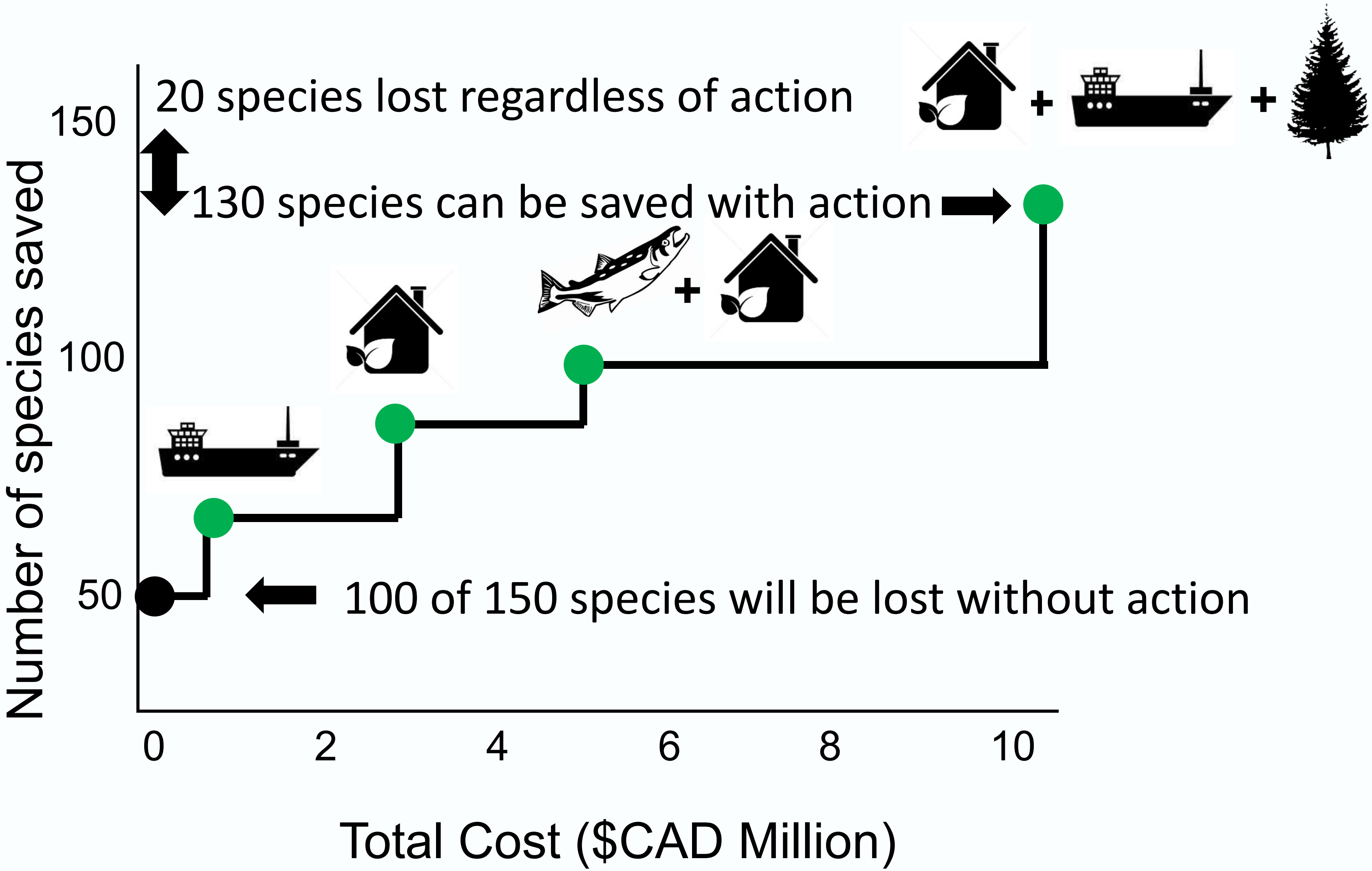
Complementary sets of strategies



Complementary sets of strategies



Complementary sets of strategies



Step 6. Implement, monitor and learn

Why this approach is working

- Realistic about the:
  - Probability of success of strategies
  - Cost of strategies
  - Feasibility of strategies
- Using best knowledge available of the day

Why this approach is working

- Clear with funding bodies about return on investment
- Clear about what can and cannot be achieved with a given budget
- Uncovering critical uncertainties
- Flexible, rational, timely and rapidly deployable

Timely action

POLICY PERSPECTIVE 2012

Acting fast helps avoid extinction

Tara G. Martin[1,8], Simon Nally[2], Andrew A. Burbidge[3], Sophie Arnall[4], Stephen T. Garnett[5], Matt W. Hayward[6], Linda F. Lumsden[7], Peter Menkhorst[7], Eve McDonald-Madden[1,8], & Hugh P. Possingham[8]

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[6] Australian Wildlife Conservancy, PO Box 432, Nichols Point, Victoria, 3501, Australia & Nelson Mandela Metropolitan University, Port Elizabeth, South Africa

Conservation Letters

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LETTER 2016

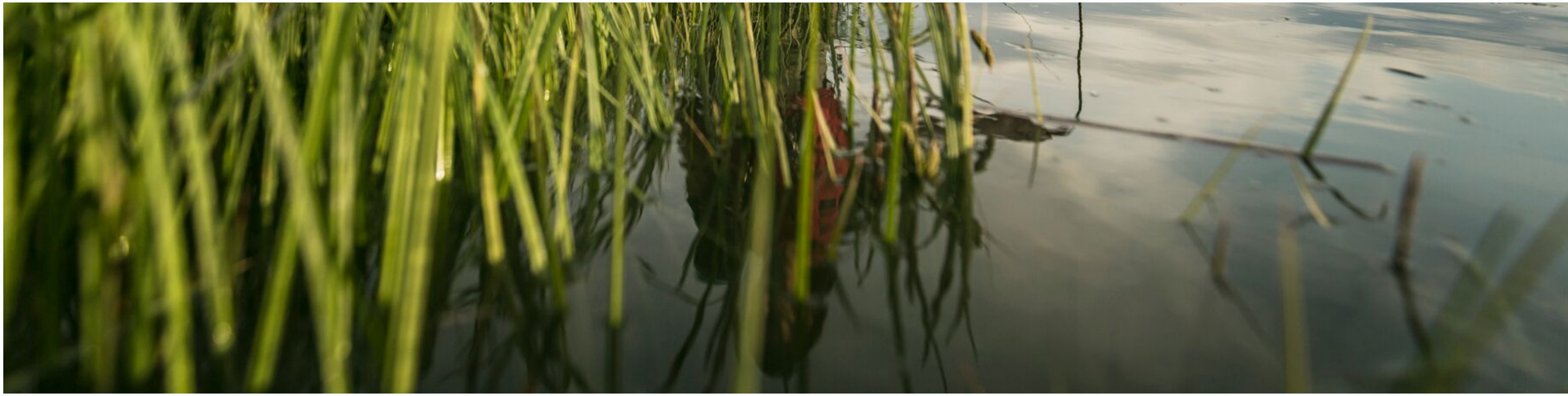
Timing of Protection of Critical Habitat Matters

Tara G. Martin[1,2,3,*], Abbey E. Camaclang[1,2], Hugh P. Possingham[2], Lynn A. Maguire[4], & Iadine Chadès[1,*]

[1] CSIRO, Brisbane, Queensland, Australia
[2] Australian Research Council Centre of Excellence for Environmental Decisions, The Australian National Environmental Research Program's Environmental Decisions Hub, Centre for Biodiversity and Conservation Science, University of Queensland, Brisbane, Australia
[3] Department of Forest & Conservation Sciences, University of British Columbia, 3041-2424 Main Mall, Vancouver, BC, Canada V6T 1Z4
[4] Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708, USA

Summary

- Resources are always limited
- Planning is about prioritisation
- Prioritization of actions, not species or places
- Avoid irreversible loss through smart legislation
- Manage for thriving populations through habitat protection & restoraton
- Climate adaptation = protecting intact ecosystems
- Thinking costs time and time is finite



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BRITISH COLUMBIA Ministry of Forests, Lands & Natural Resource Operations

RAINCOAST CONSERVATION FOUNDATION

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Centre of Excellence for Environmental Decision

National Environmental Research Program

NERP Environmental Decisions Hub





Overexploitation

1922 Sacramento, California

Managing for thriving salmon populations

- Identify baselines - how have things changed and why
- Predict how things will change in the future
- Determine the most cost-effective strategies that will achieve thriving salmon populations