Restoration Prioritization

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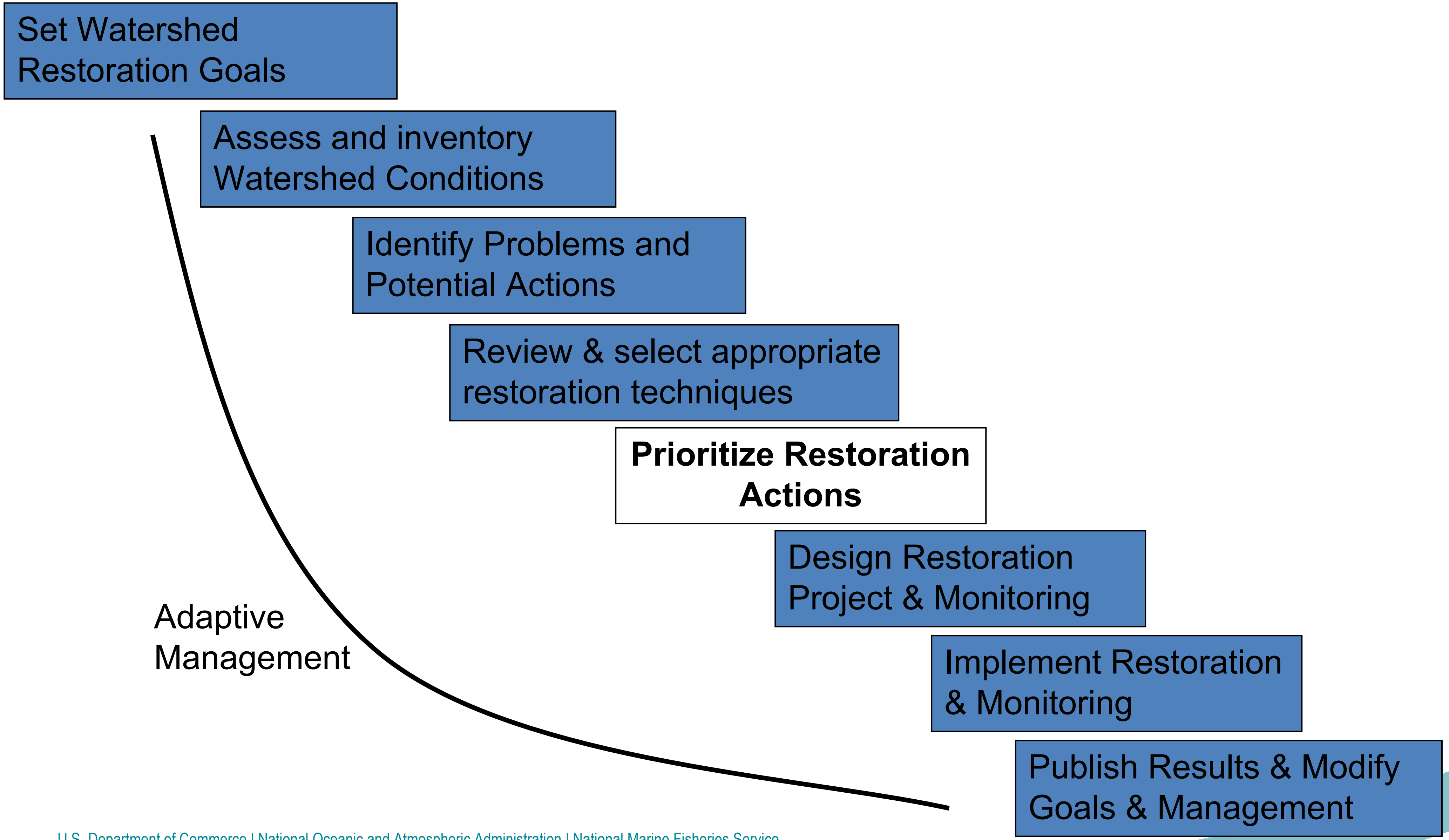
The restoration process



Roadmap for today's talk

- What is restoration prioritization?
- What are the steps to prioritize?
- What are some of the common methods used?
- What are the strengths and weaknesses of different methods?

What is restoration prioritization?

- The process of ranking projects, habitats, or watersheds to determine the sequence of restoration actions.

- Projects are ranked in accordance with a defined method or suite of methods.

- The need for ranking is typically a function of multiple goals and objectives as well as limited funding.

- The scale of ranking is a function of the scale of goals, objectives, and actions.

What are your goals and objectives?

- A well defined restoration goal includes:
  - Identified ecological or biological objectives
  - An action that ddresses the underlying causes of ecosystem degradation
  - Acknowledgement of social, economic, or land-use constraints

- A well defined set of objectives:
  - Can translate to measurable criteria to determine if success is being met.
  - Mimic well-defined goals but include quantitative criteria.
  - Have a specified timeline associated with the objectives.

What are your goals and objectives?

- Goal
  - Restore and protect watersheds to assist in the recovery of threatened and endangered diadromous fishes

- Objectives
  - Determine high-priority watersheds within a region for protection, restoration, and reintroduction of endangered fishes based upon habitat quality, historical use, current land use impacts, and susceptibility to climate change

- Criteria
  - % of watershed occupied by listed species
  - Genetic integrity
  - Watershed condition and connectivity
  - Water quality
  - % of exotic species

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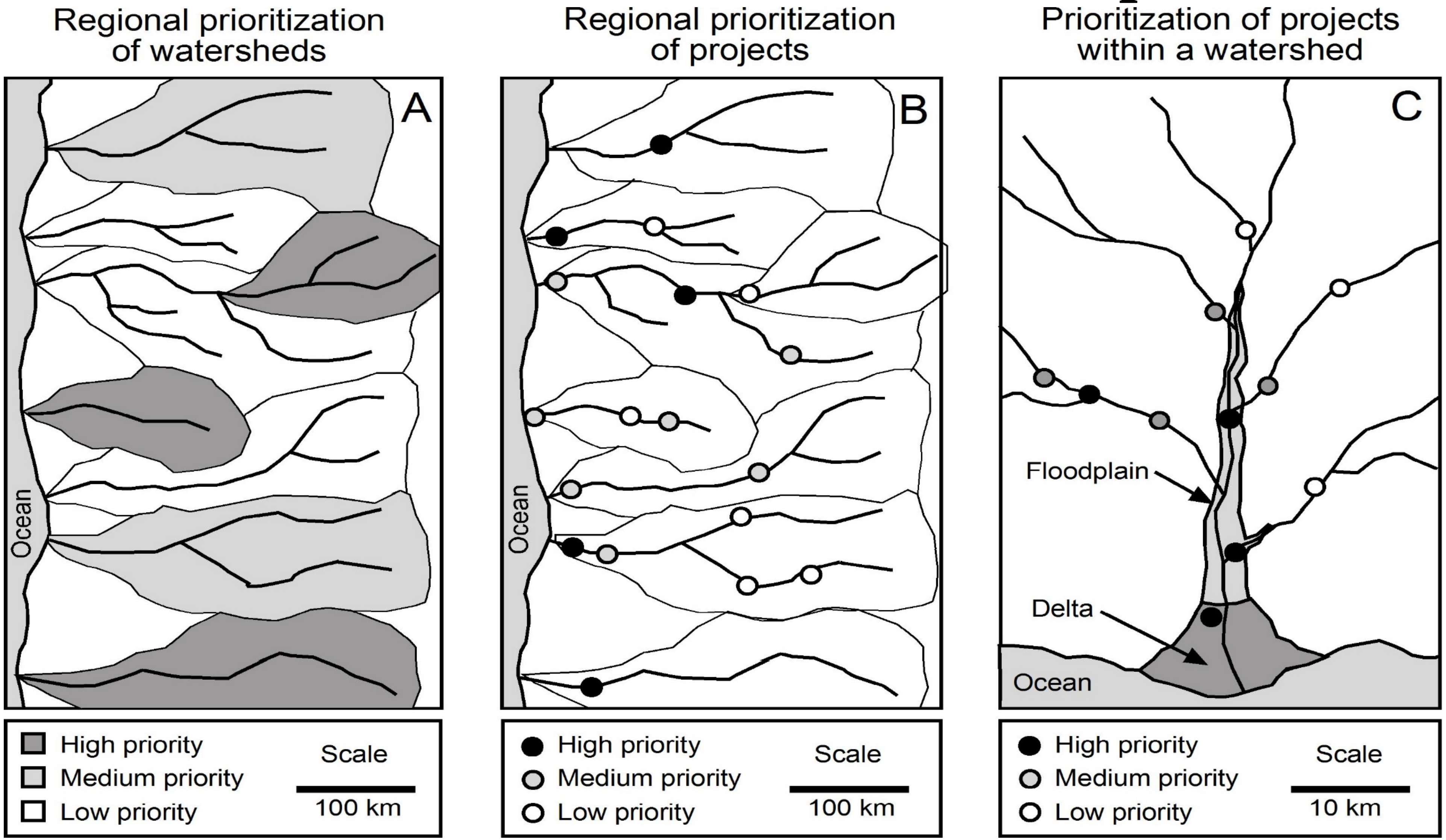
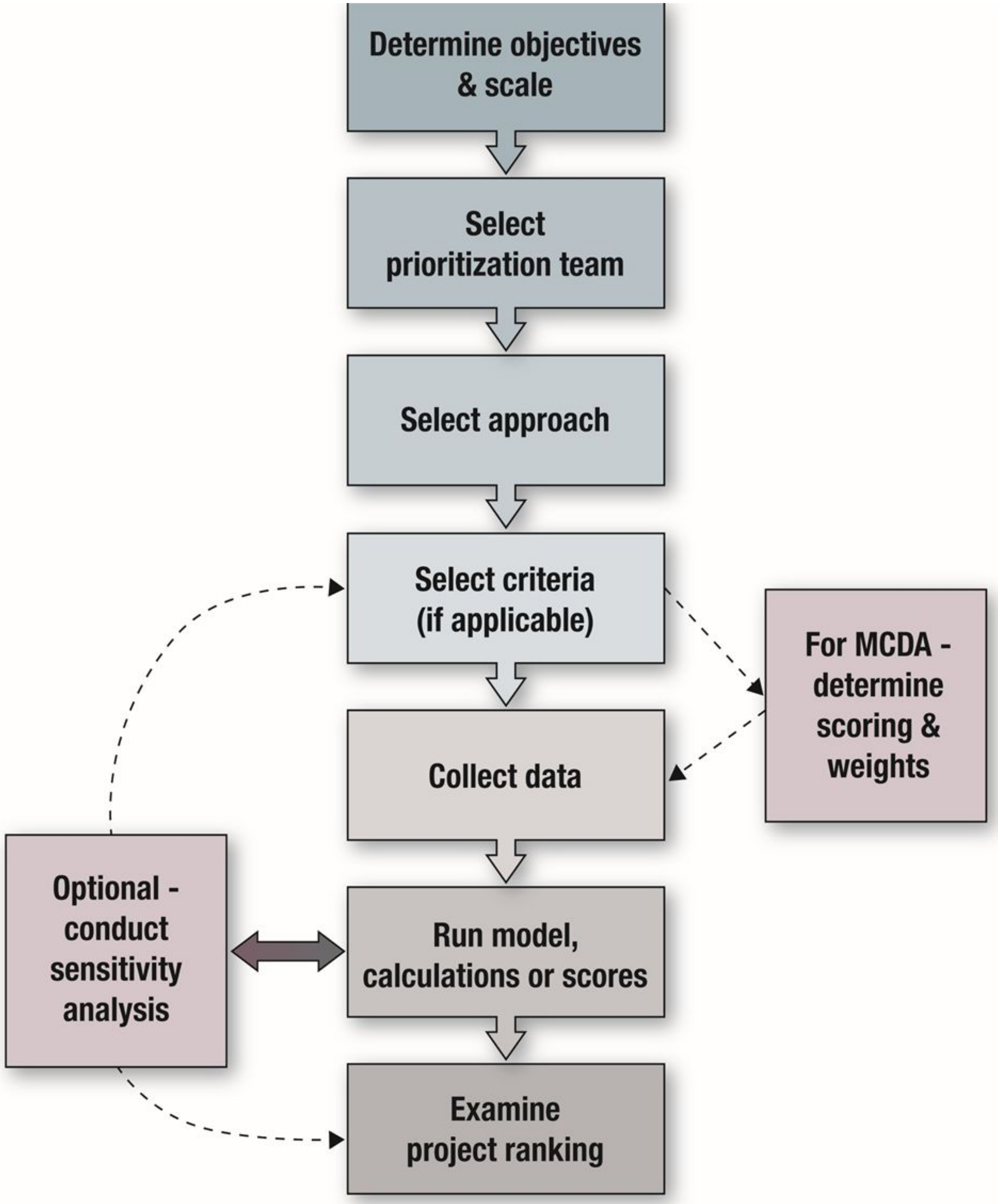
Prioritization can occur at multiple extents



Who will/should prioritize projects?

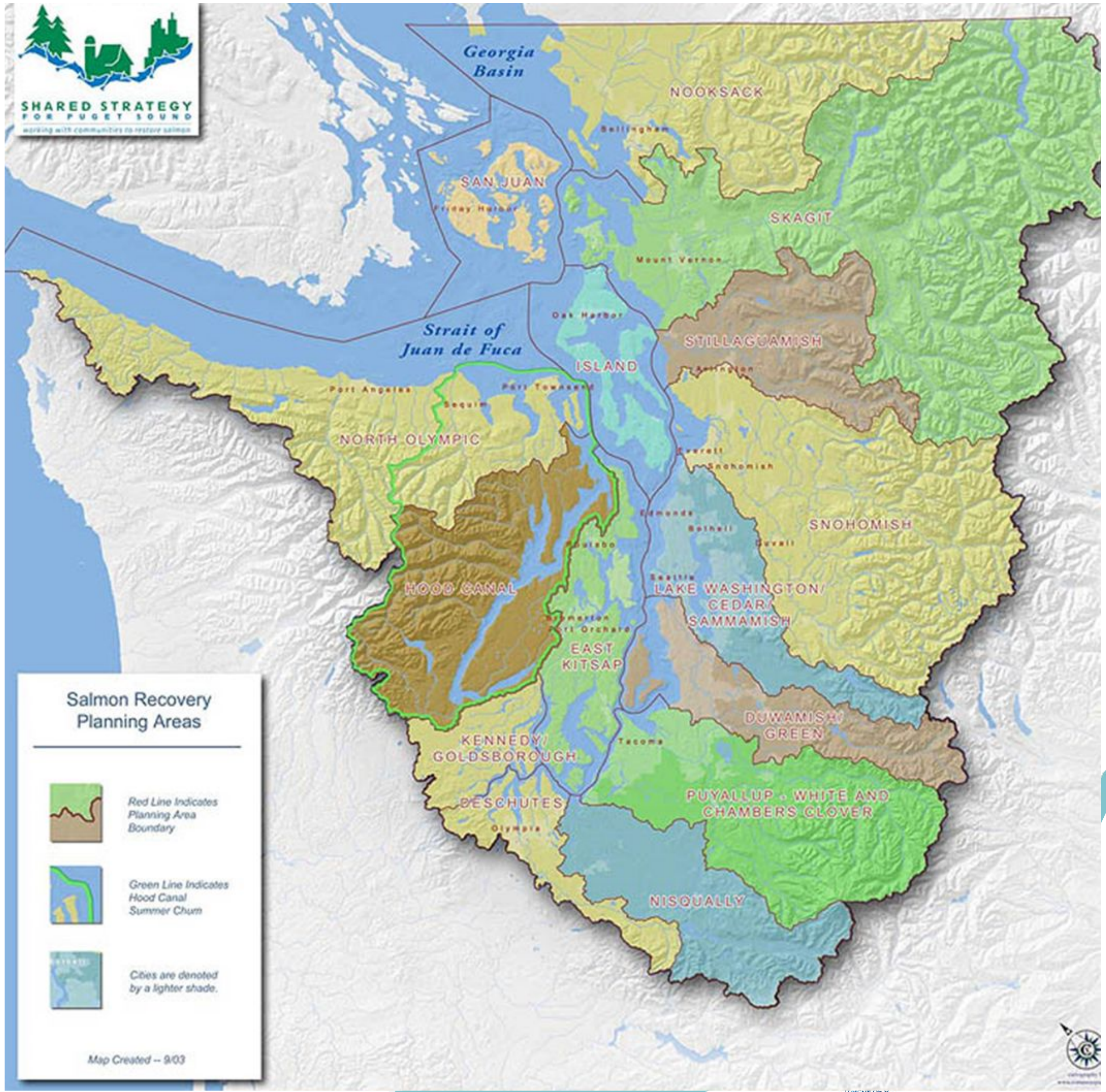
- Individuals that bring credibility and acceptance of an approach to managers, stakeholders, and the local community
- Can sometimes be legislated
- Group should include a diverse set of skills
- Most successful teams are usually 5 to 10 individuals

What are the steps to prioritize?



What approach should be used?

- Professional opinion
- Singles species
- Multiple species
- Refugia
- Project type
- Cost-effectiveness
- Life cycle model or limiting factors for a single species
- Conservation models
- Multi-criteria decision making (scoring)



Professional opinion

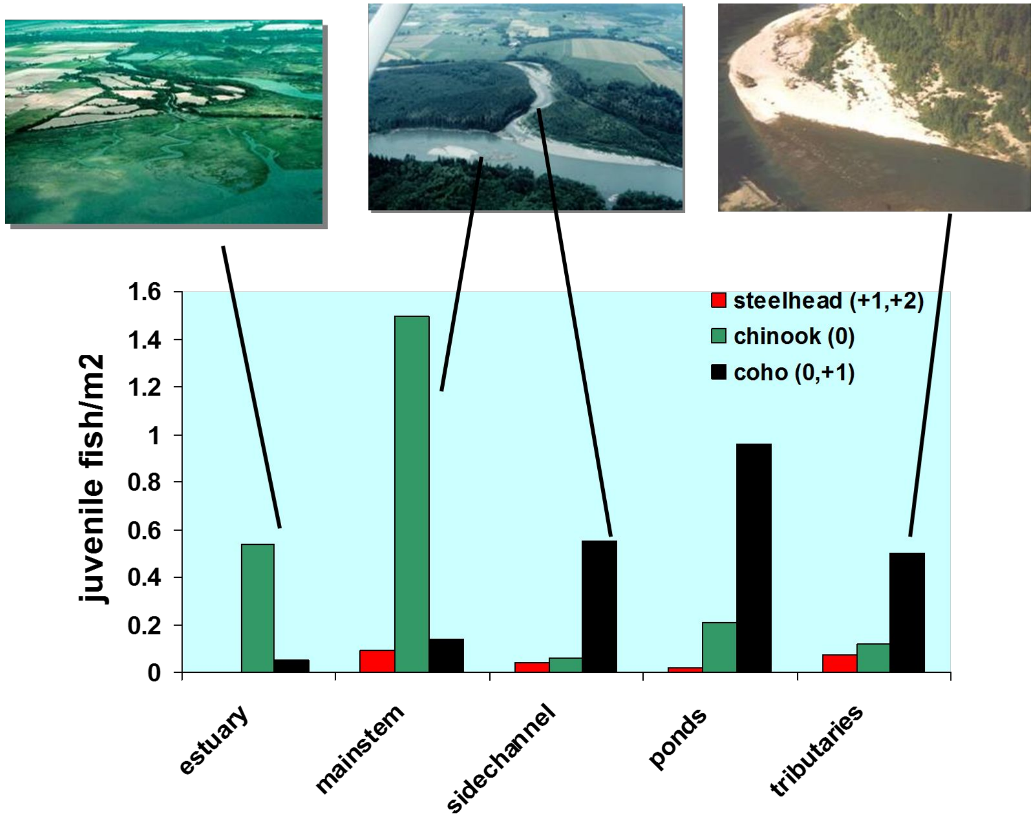
- Input from local experts
- Typically includes restoration proponents
- Can adapt to funding sources
- Is not a repeatable process
- Not scientifically defensible especially for projects that are publicly funded

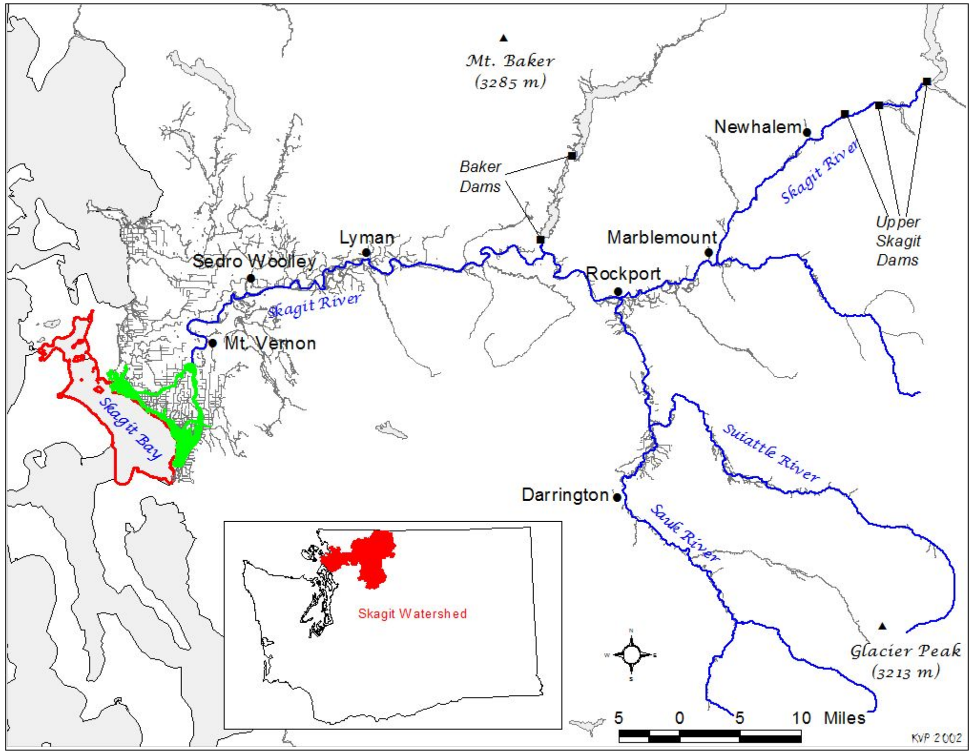
Single or multiple species

- Rank projects for a species based upon increases in;
  - Habitat area
  - Biota
- Typically based upon empirical fish & habitat data
- Straightforward
  - Number of miles of habitat
  - Increase in potential spawning or rearing numbers

- Can be difficult with estimated increases in habitat area
- Multiple species approach means different habitat requirements
- Increases in fish production for different types of restoration techniques does not exist

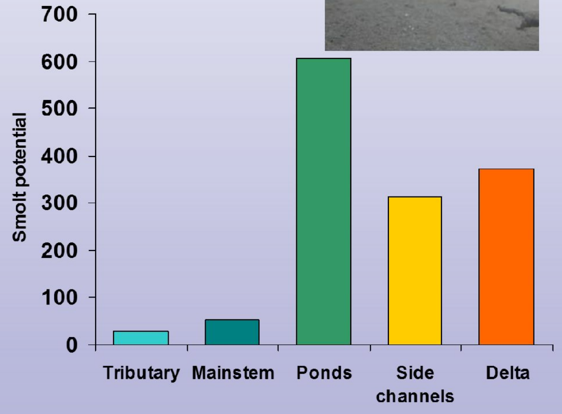
Multiple species – Skagit River, Washington State

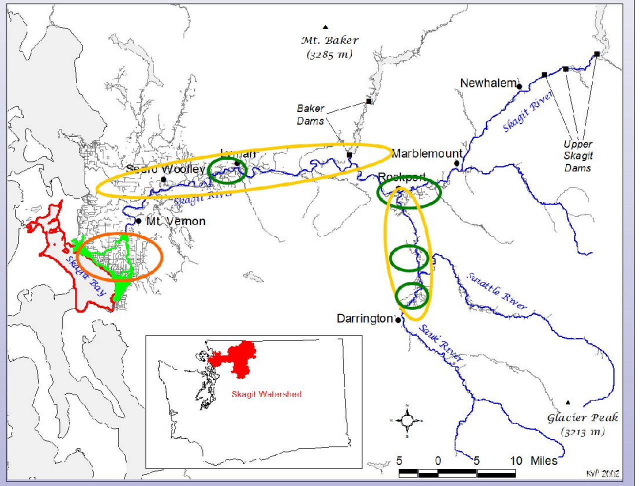




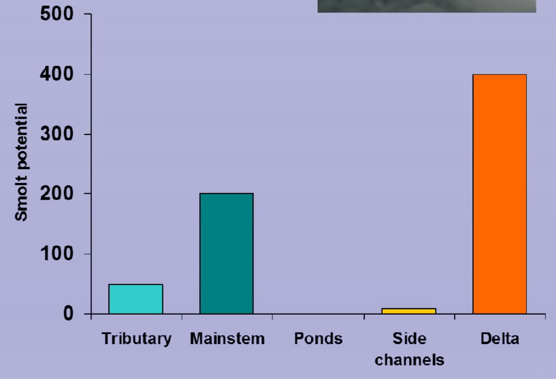
Multiple species – Skagit River, Washington State

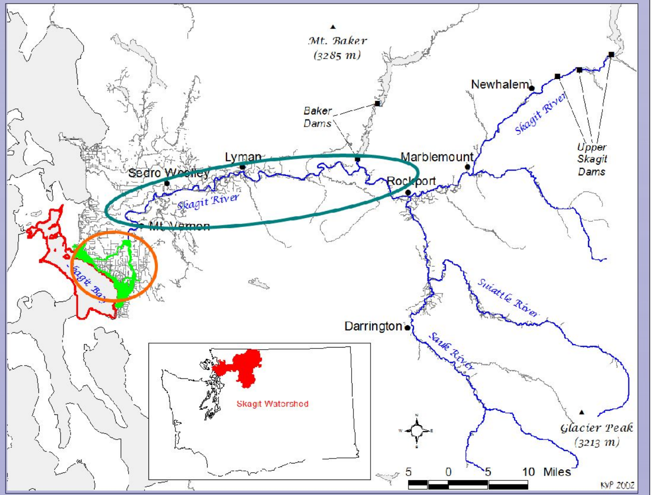
Coho
Oncorhynchus kisutch



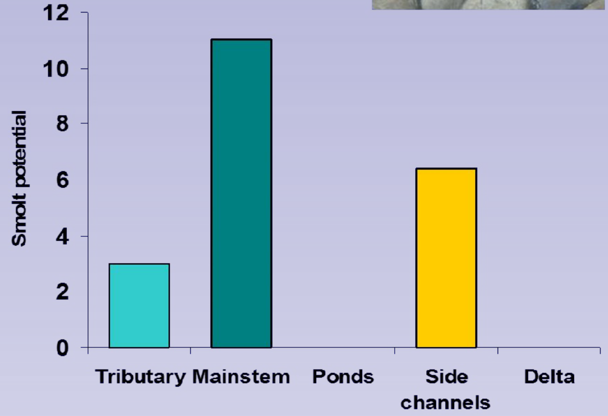


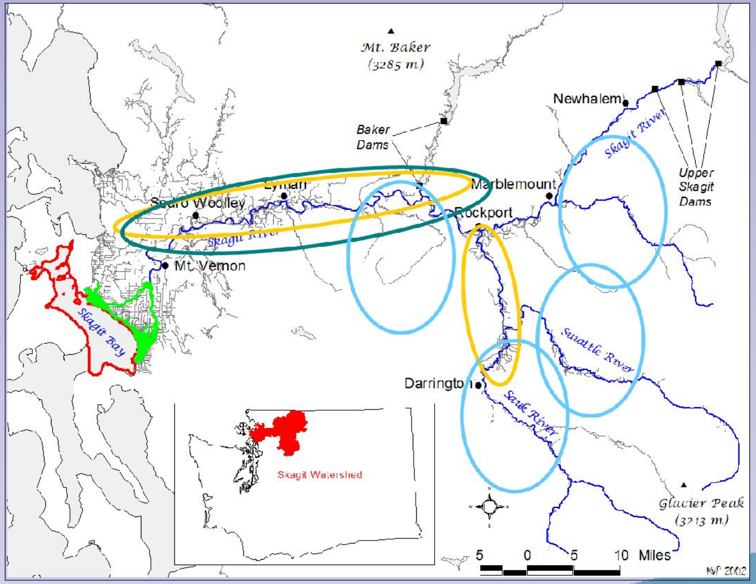
Chinook
Oncorhynchus tshawytscha





Steelhead/Rainbow
Oncorhynchus mykiss





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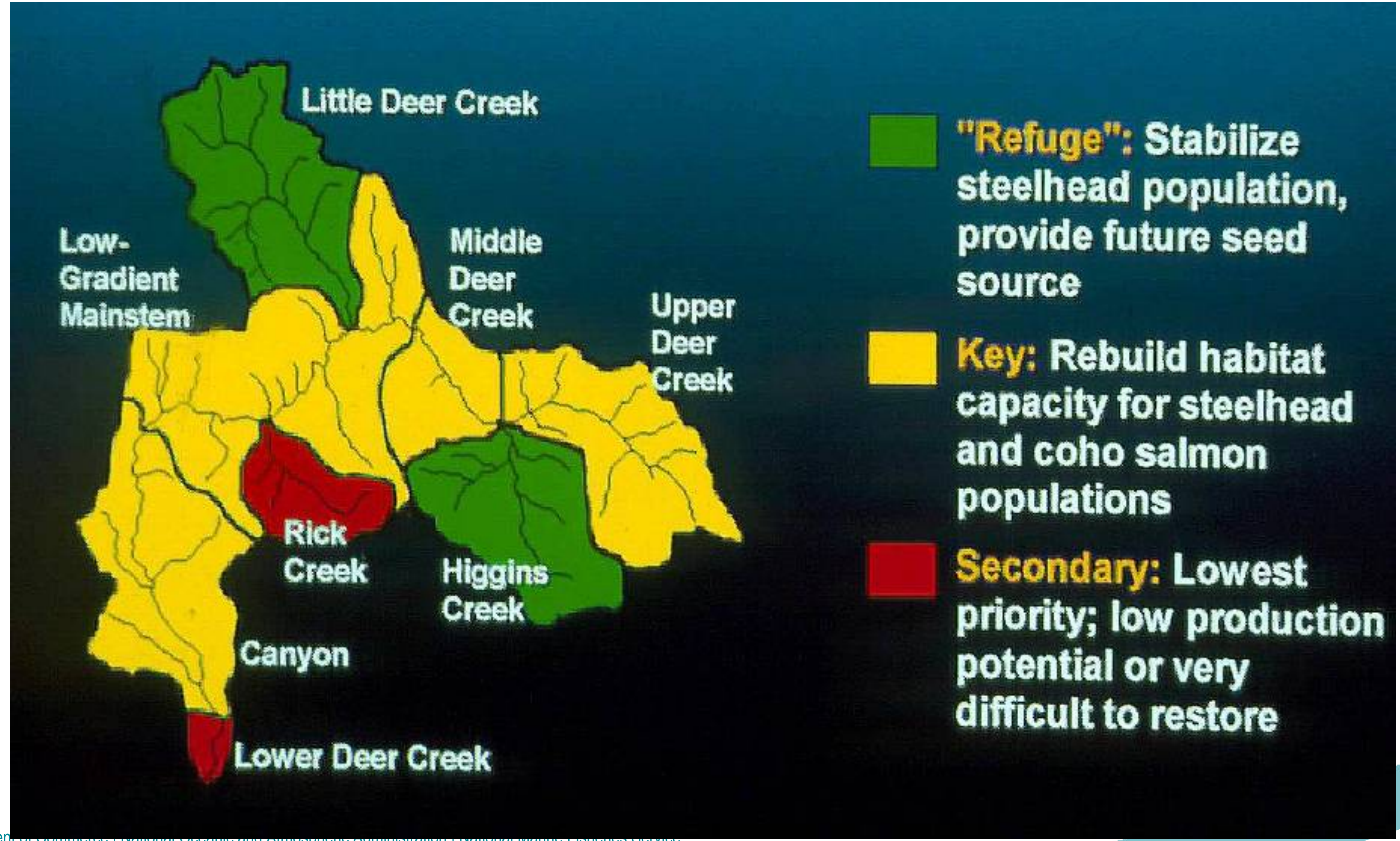
Refugia

- Identification of important regions, watersheds, or habitat for species to determine protection and restoration priorities
- Protect core areas, restore nearby areas, allowing for expansion and recovery of migratory corridors and populations
- Focuses on protecting healthy watersheds and populations which can be more cost-effective and reduces likelihood of extirpation

- Difficult to apply at the site or project levels
- If area is small then prone to disturbance/fragmentation
- Best suited for stream reach or watershed-scale

Refugia
Summer steelhead, Deer Creek, Washington State



Project type

- Rank projects based upon restoration effectiveness
- Good interim approach where data is limited
- Can be very useful for reach or site scale planning
- Can be based upon published restoration effectiveness results

- Not all projects or species have restoration effectiveness monitoring associated with them
- Not useful for ranking at larger scales such as the watershed or larger

Project type

Protect High Quality Habitats

↓

Water Quality and Quantity

↓

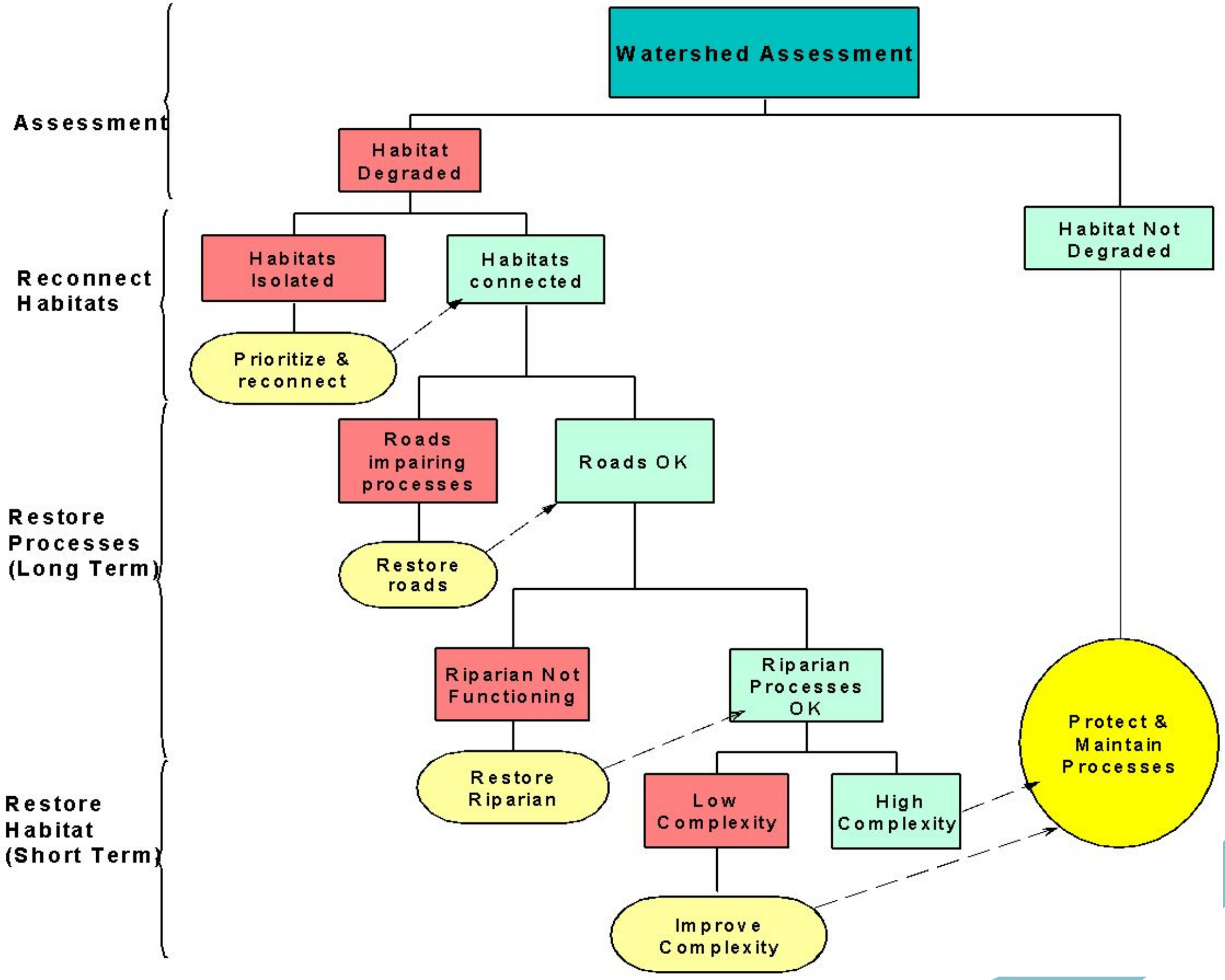
Habitat Connectivity

↓

Restoration of Processes

↓

Habitat improvement



Roni et al. 2002

Project type and climate change

Restoration action	Temperature increase	Low flow decrease	Peak flow increase	Increase resilience
Longitudinal connectivity	Y	Y	N	Y
Floodplain connectivity	Y	N	Y	Y
Restore incised channel	Y	Y	Y	Y
Restore in-stream flow	Y	Y	N	N/Y
Riparian rehabilitation	Y	N/Y	N	N
Sediment reduction	N	N	N	N
In-stream habitat	N	N	N	N
Nutrient enrichment	N	N	N	N

Beechie et al. 2013

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Cost effectiveness

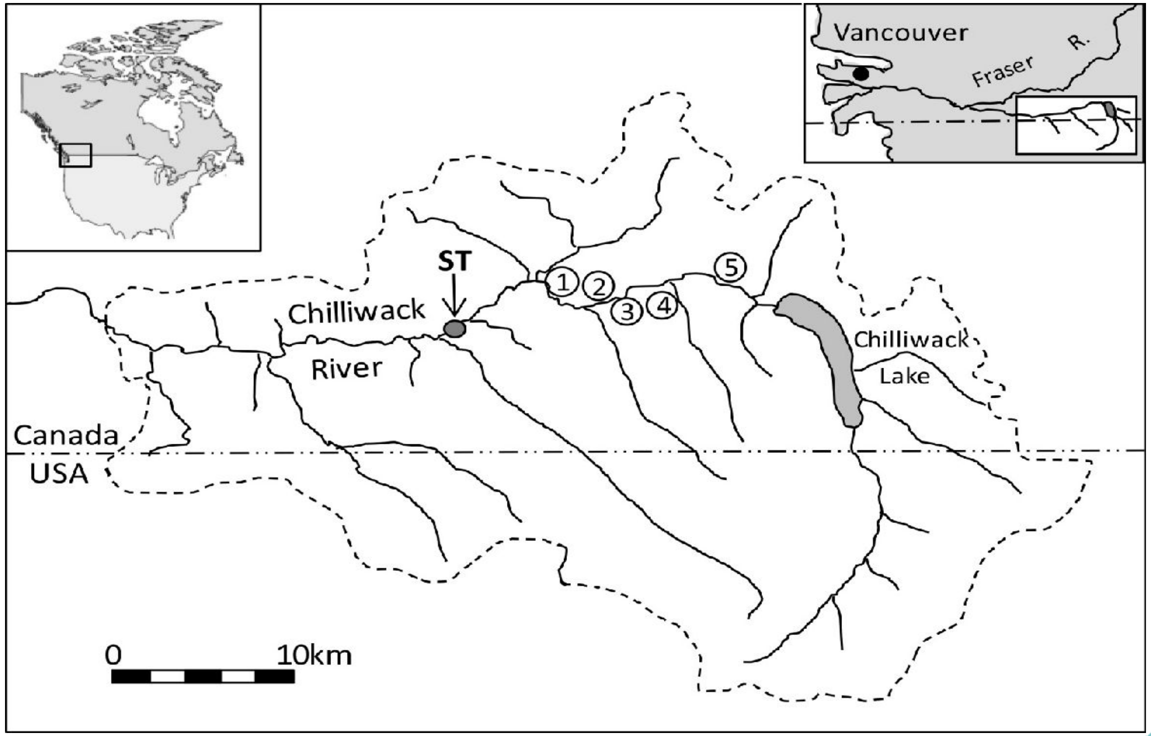
- Uses the cost, cost per unit of benefits, or economic benefit to rank & prioritize projects
- Requires data on cost, effectiveness of project type, or economic benefit
- Provides the same unit of analysis to compare projects
- Unit of analysis may not be the same
- People implicitly understand the concept of what you gain per monetary amount
- Challenges with estimating economic benefits and time value of money

Cost effectiveness

An example from British Columbia, Canada

Coho salmon populations typically are limited by overwinter floodplain habitat

Creation of 5 side channel complexes from 1996 to 2000 in Chilliwack River



Numbers correspond to side channel complexes

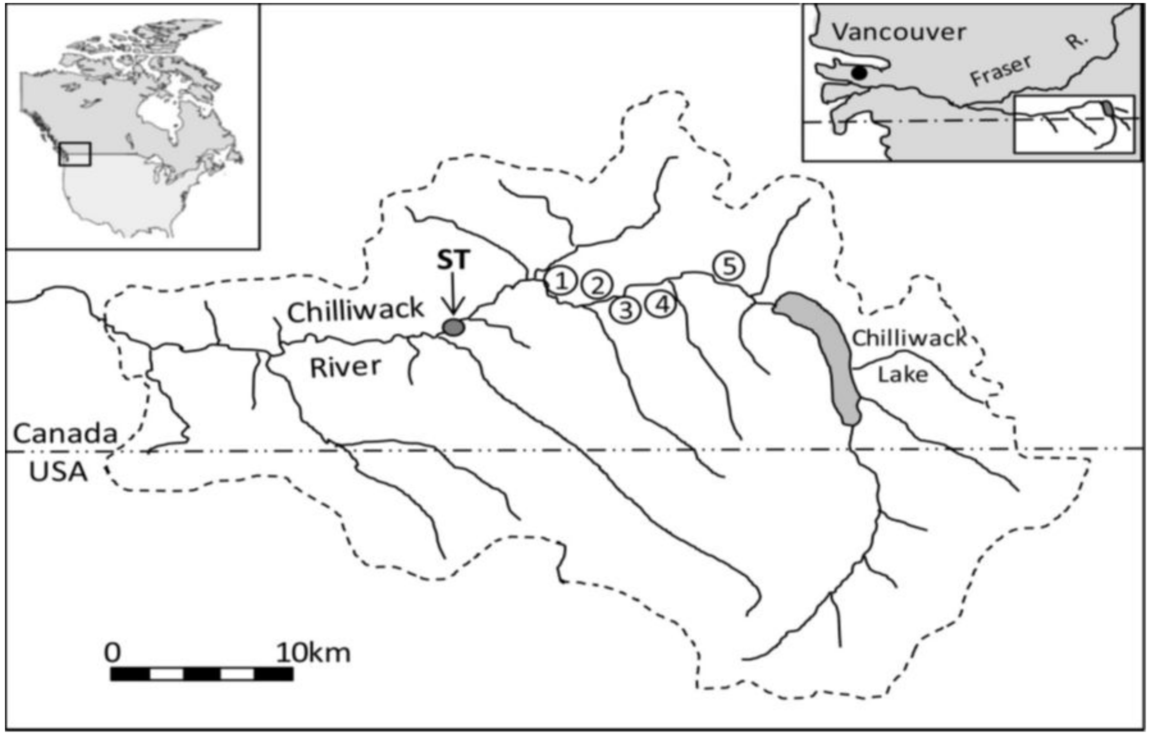
Ogston et al. 2015

Cost effectiveness

An example from British Columbia, Canada

- Between 27% & 34% of all juvenile coho salmon smolts annually produced were attributed to 157,000m^2 of new side channels

- 40% higher coho overwinter survival in deeper off channel pond habitat relative to the main stem



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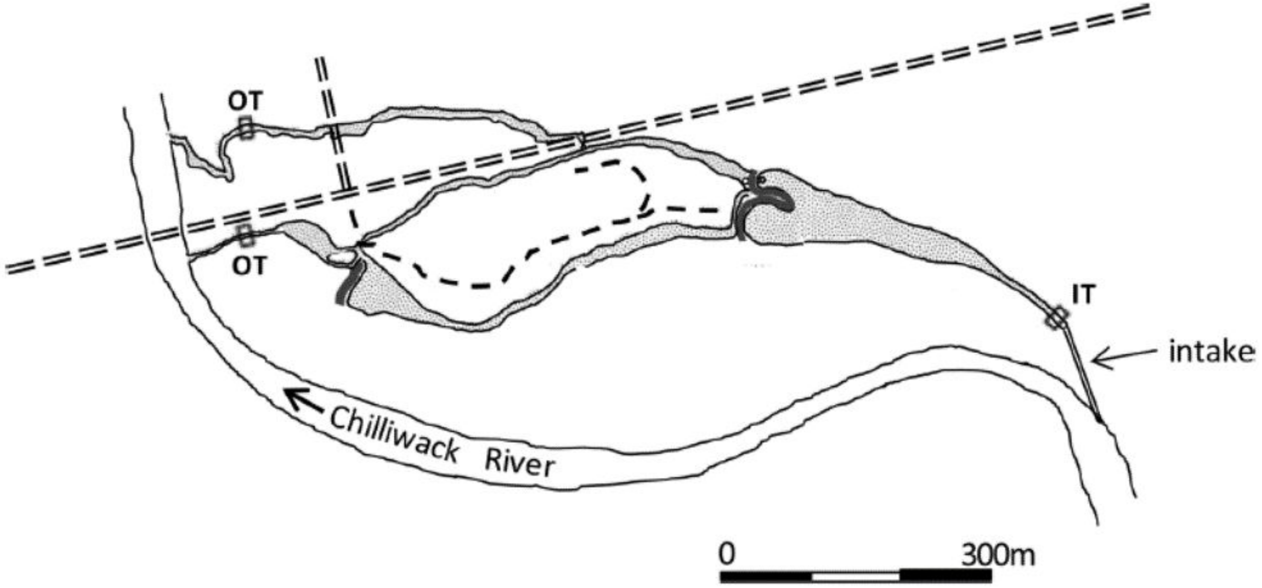


Ogston et al. 2015

Cost effectiveness

An example from British Columbia, Canada

Site	Estimation method	No. of smolts	Smolt density (smolts·m^{-2})	Smolt production over 30 years
Centennial	Count	12 210	0.41	366 300
Upper Bulbeard	Count	9 590	0.55	287 700
Lower Bulbeard	Count	32 050	0.55	961 500
Angelwing	Count	8 350	0.75	250 500
Millenium	Count	16 350	0.39	490 500
Yukalap	PPE	740±390	0.17	22 200
Centre Creek Camp	PPE	3 560±1 010	0.55	106 800
Total restored habitat		82 840±1 140		2 485 200

- Cost per smolt for side channel projects is less or near than hatchery cost per smolt ($1.00/smolt) at three of the five sites

Site	Initial cost ($·m^{-2})	Cost of 30 years maintenance ($·m^{-2})	Total cost ($·m^{-2})	Percent spawning habitat	Initial cost per smolt ($·smolt^{-1})	Cost per smolt over 30 years ($·smolt^{-1})	Cost per smolt (2009 CAN$)	Cost per smolt (2009 US$)
Centennial–Bulbeard	7.81	0.77	8.58	14	18.69	0.68	0.79	0.69
Angelwing	25.45	7.23	32.68	18	41.62	1.78	2.06	1.81
Millenium	7.65	2.76	10.41	5	16.79	0.76	0.88	0.77
Yukalap	22.73	18.41	41.14	45	164.13	9.90	11.48	10.05
Centre Creek Camp	16.92	12.46	29.38	17	37.73	2.18	2.53	2.21

Ogston et al. 2015

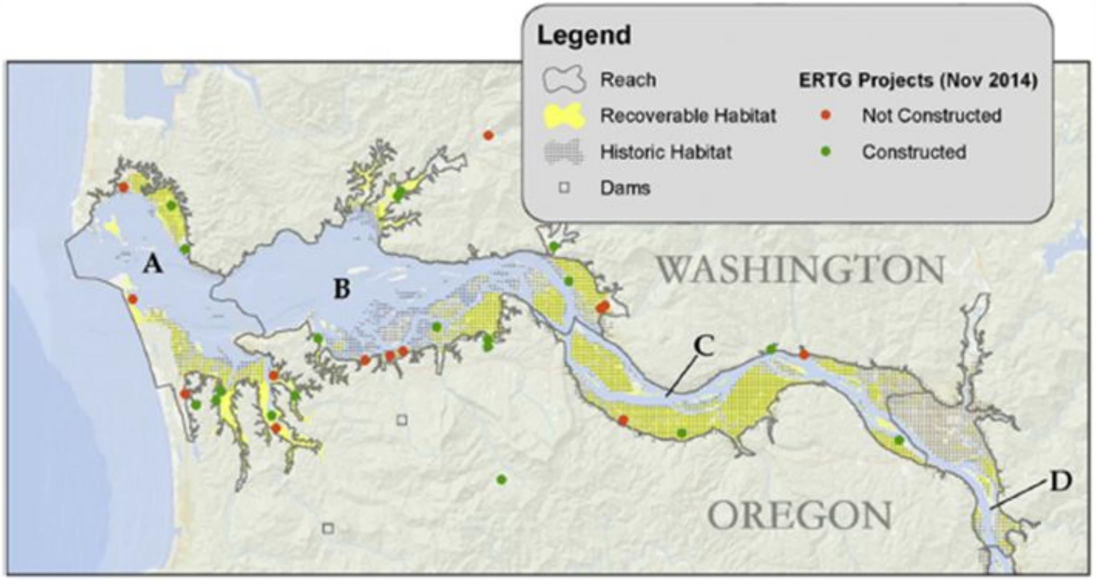
Multi-criteria decision analysis

- A scoring system that uses multiple criteria to determine project priorities
- Can be a simple, straightforward, and transparent system to incorporate multiple metrics
- Usually easily modified to incorporate new data
- Used in numerous fields including engineering and business management

- Scoring and weighting system used can dramatically effect project prioritization

Multi-criteria decision analysis

- Select criteria
  - Is it refugia?
  - Does it address limiting factors?
  - How biologically effective is the technique?
  - What is the cost?
  - Are there ownership or access constraints?

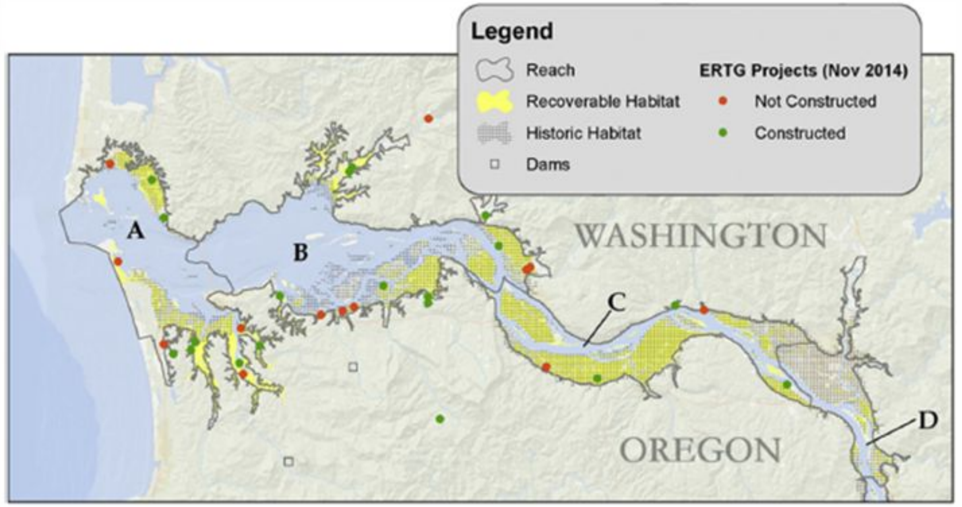


- Columbia River Estuary
  - Certainty of success
  - Certainty of benefit from habitat access
  - Certainty of benefit from habitat quality

Kreuger et al. 2017

Multi-criteria decision analysis

- Select a range of scores
  - 1 to 3, 0 to 5, 1 to 10 common
- Determine the weight system
  - None
  - Double points or percentage

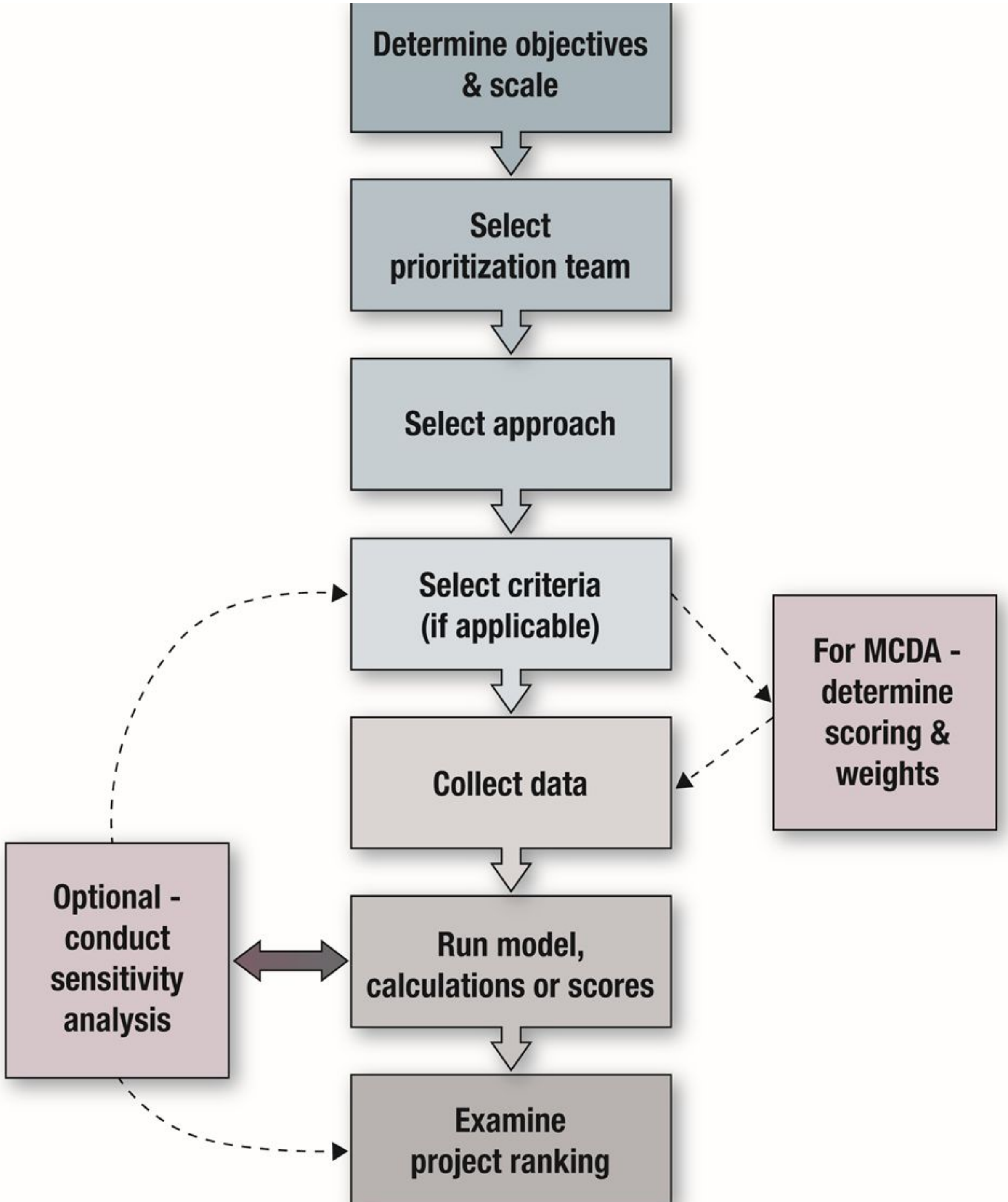


- Certainty of success
  - 5 – restore natural process, proven method
  - 3 – partially restore natural process, proven method
  - 1 - unlikely to restore nature process, unproven method
- Certainty of benefit from habitat access
  - 5 – high connectivity for multiple species
  - 3 – intermediate connectivity for some life histories
  - 1 – low connectivity for one or no species
- Certainty of benefit from habitat quality
  - 5 – Maximum natural habitat complexity
  - 3 – moderate habitat complexity
  - 1 – low habitat complexity

Kreuger et al. 2017

Conclusions

- Follow the steps to prioritization
- Make sure your prioritization method achieves your objectives, is transparent, and repeatable
- Keep it simple because it will get complicated
- Document your steps
- You will go back and reprioritize…keep that in mind



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