Using HEA to Evaluate and Select Options for Restoring Ecosystem Services

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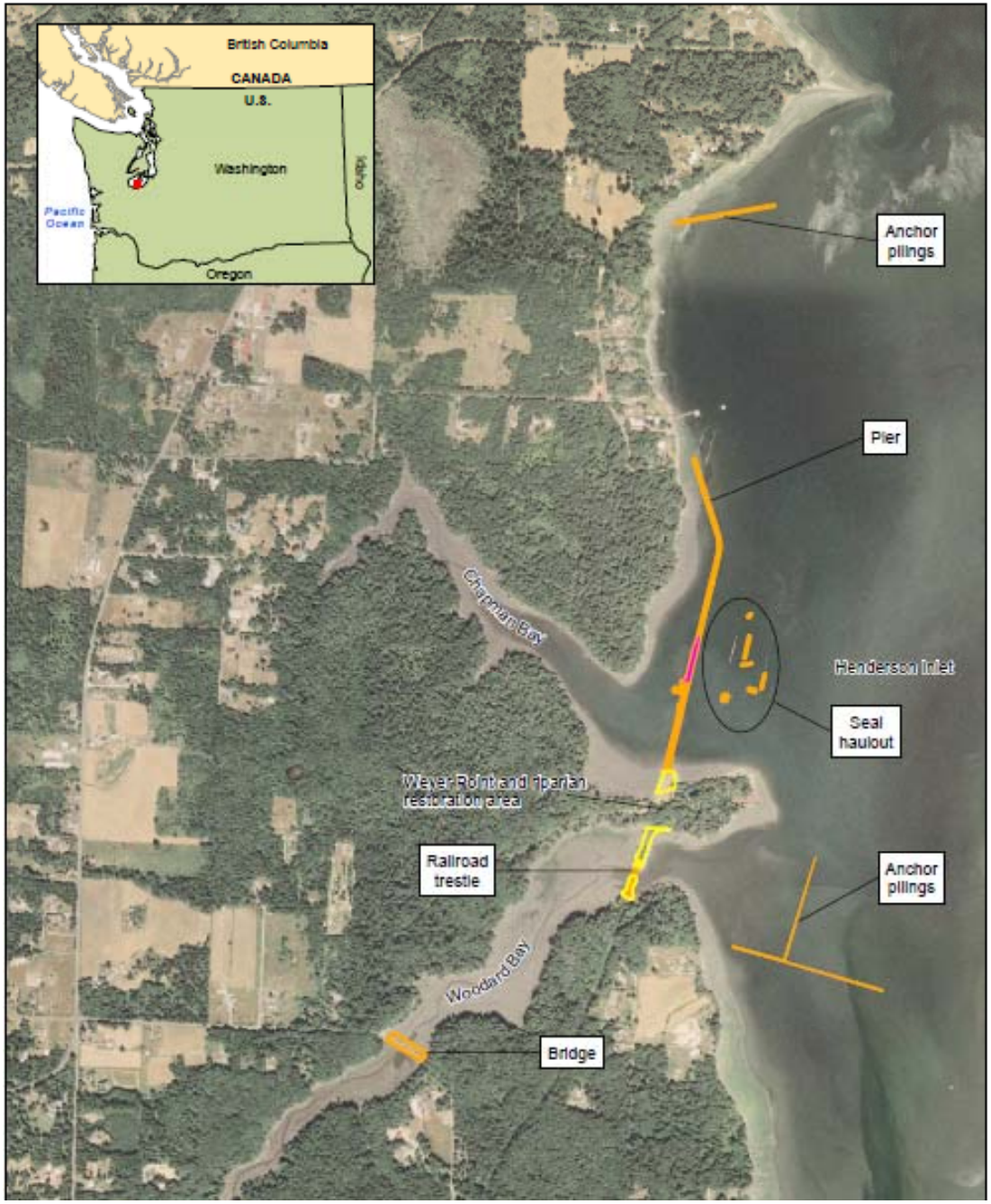
Woodard Bay Project

- Habitat Equivalency Analysis (HEA) used to evaluate ecological functions and services at the Woodard Bay Natural Resources Conservation Area (NRCA) to develop restorations options for an estuarine ecosystem impacted by 50 years of use as a log dump

Participants

- Windward's team
  - Windward Environmental LLC
  - Dalton, Olmsted & Fuglevand, Inc.
  - Sitts & Hill, Inc.
  - Historical Research Associates
- DNR's partners
  - US Army Corps of Engineers
  - US Environmental Protection Agency
  - Washington State Department of Ecology
  - The Nature Conservancy

Site Location and Features



Chapman Bay Pier

Chapman Bay Piling Field

Woodard Bay Bridge

Woodard Bay Trestle

Upper Woodard Bay

Pier/Piling Impact on Nearshore Processes

HEA

- Accounting technique used to compare restoration actions and alternatives
- Semi-quantitative model that looks at changes in ecosystem functions or services
- Results in numeric score that represents the overall function of the ecosystem following an action or alternative

HEA Model Assumptions

- Ecosystem functions and services tied to size, distribution, and quality of habitat
- Habitat values derived from both ecological characteristics and management priorities
- Ecosystem service flows following an action or perturbation vary by restoration target

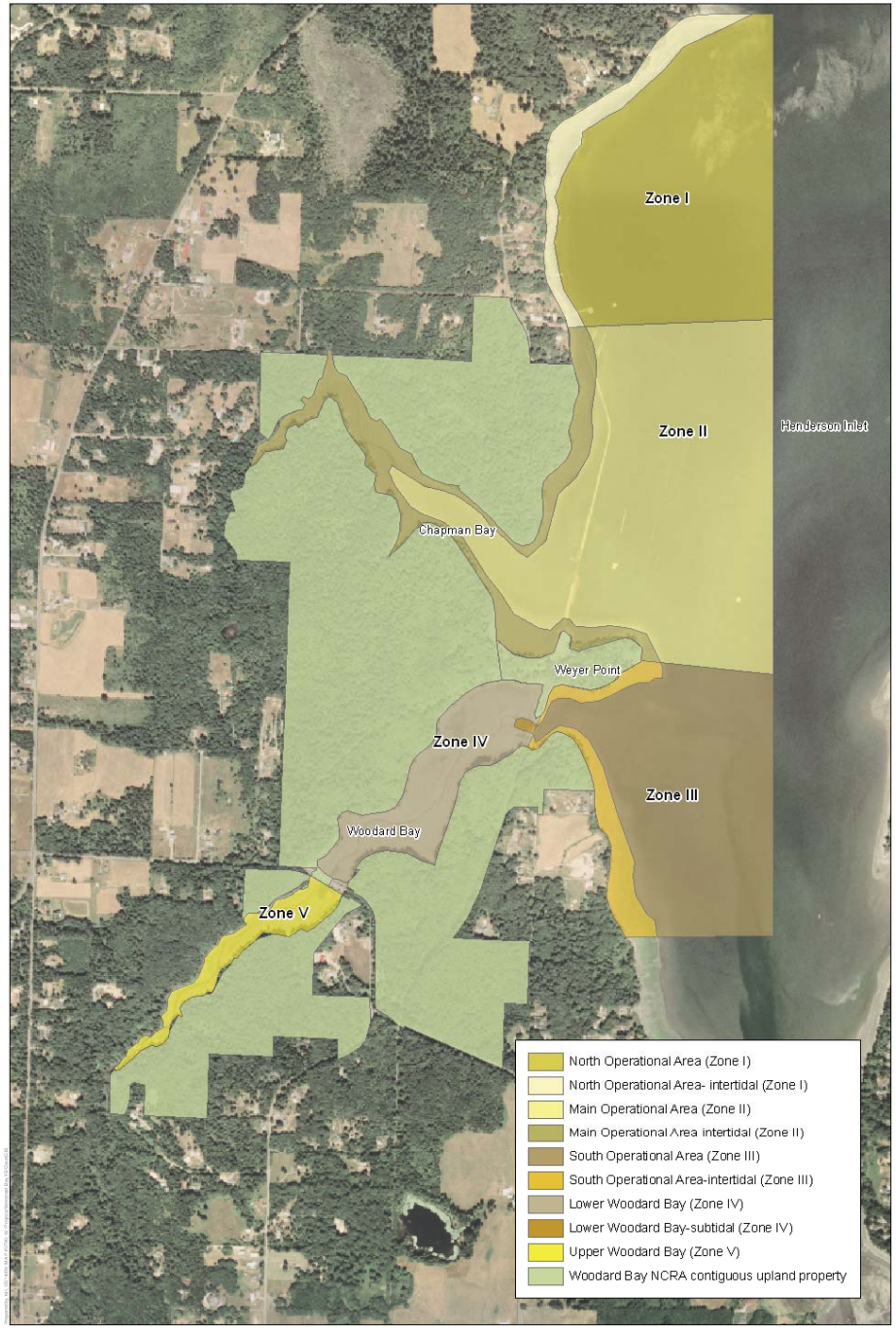
Approach

- Determine restoration targets and goals
- Assign an area and value to each service for each restoration target
- Identify potential individual restoration actions
- Evaluate spatial and temporal changes in services for each action
- Aggregate actions into larger alternatives
- Analyze alternatives based on benefits/risks and costs

Restoration Targets

- Restoration targets identified from Woodard Bay NRCA management plan and input from agency partners and the public
- Primary target was nearshore processes, followed by the restoration affected biota
  - Bats
  - Salmon and forage fish
  - Harbor seals
  - Olympia oysters and other invertebrates
  - Birds and waterfowl
  - Riparian/shoreline plant communities

Areal Distribution of Habitat Types



Potential Restoration Actions

- Focused on structures and site modifications from historical activities that potentially affect nearshore processes
  - Removal of in-water structures
    - All or part of pier
    - All or part of trestle
    - All or part of pilings/dolphins
  - Removal of shoreline fill
  - Reconfiguration of county bridge
  - Removal of invasive riparian species

HEA Results for Individual Actions

Restoration Action	Restoration Targets																		
	Bald eagle	Forage fish-foraging	Forage fish-spawners	Heron	Juvenile salmonids	Oyster	Purple martin	Shorebirds	Seal-foraging	Seal-haulout	Bat foraging	Bat roosting	Waterfowl foraging	Waterfowl nesting	Benthic	Riparian	Sediment Quality	Water Quality	Sediment Transport	Grand Total
Chapman fill removal	4.4	0.7	9.8	18.0	21.6	21.9	0.0	14.8	0.4	0.0	0.0	0.0	7.4	0.0	7.0	-0.1	0.0	-0.2	4.6	**110.1**
Chapman fill removal - no action	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Pier removal - no action[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.8	0.0	0.0	-0.5	0.0	-0.1	-1.2	-2.7	**-5.3**
Pier removal 1 - 76%[b]	11.1	0.0	4.8	8.1	4.1	0.0	0.0	2.4	0.1	0.0	-2.1	-1.3	-1.7	0.0	6.3	-0.3	1.3	-0.4	44.0	**76.5**
Pier removal 2 - 49% [b]	7.2	0.0	2.4	5.2	2.6	0.0	0.0	1.5	0.1	0.0	-2.1	-1.3	-1.4	0.0	3.8	-0.2	0.8	-0.1	38.0	**56.5**
Pier removal 3 - 38% [b]	5.6	0.0	1.8	4.1	2.0	0.0	0.0	1.2	0.1	0.0	-1.1	-1.3	-1.2	0.0	2.8	-0.2	0.6	-0.1	9.0	**23.2**
Piling removal (Zone 1) - 100%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	0.0	0.0	0.0	0.0	-0.2	0.5	**-0.1**
Piling removal (Zone 1) - no action	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	-0.1	**-0.6**
Piling removal (Zone 2) - 80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	0.0	-0.1	0.0	0.4	-0.4	3.5	**2.8**
Piling removal (Zone 2) - no action	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	-0.7	**-2.0**
Piling removal (Zone 3) - 100%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	0.0	0.0	0.0	0.1	-0.3	0.6	**-0.1**
Piling removal (Zone 3) - no action	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.4	-0.1	**-1.5**
Riparian restoration – no action	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.9	0.0	0.0	0.0	**-3.9**
Riparian restoration – Weyer Point (all)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.7	0.0	0.0	0.0	**9.7**
Riparian restoration – Weyer (partial)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	**5.2**
Seal haulout – no action[c]	0.0	4.0	13.0	0.0	6.3	0.0	0.0	0.0	-7.9	-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**-6.9**
Seal haulout – *status quo*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Seal haulout - *status quo* with enhancement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Trestle and fill removal - no action	0.0	0.0	0.0	0.0	-13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	**-13.3**
Trestle and fill removal (south side only)	0.0	0.8	11.1	0.0	54.9	-37.2	0.0	14.3	1.1	0.0	0.0	0.0	17.1	0.0	5.7	-0.3	0.0	0.0	1.7	**69.1**
Trestle and fill removal (south side only)	0.0	0.4	5.5	0.0	27.5	-18.6	0.0	10.3	0.6	0.0	0.0	0.0	15.1	0.0	2.8	-0.3	0.0	0.0	0.9	**44.2**

Alternatives

- Alternatives configured to represent a range of benefits and costs
  - Alt 1 – No action
  - Alt 2 – Minimal removal of structures/fill
  - Alt 3 – Moderate removal of structures/fill
  - Alt 4a – Maximum removal of structures/fill
  - Alt 4b – Same as 4a without county bridge element

Comparison of Alternatives

Restoration Action	Alternative 1 No Action	Alternative 2 minimal action	Alternative 3 moderate action	Alternative 4a Max Action w/out bridge replacement	Alternative 4b Max Action w/ bridge modification	Alternative 4c Max Action w/bridge replacement
Chapman fill removal			110.1	110.1	110.1	110.1
Chapman fill removal – no action						
Pier removal 1 – 76%				74.4	74.4	74.4
Pier removal 2 – 49%			54.4			
Pier removal 3 – 38%		22.1				
Pier removal – no action	-5.3					
Piling removal (Zone 1) – 100%[a]			-0.1	-0.1	-0.1	-0.1
Piling removal (Zone 1) – no action	-0.6					
Piling removal (Zone 2) – 90%		2.8	2.8	2.8	2.8	2.8
Piling removal (Zone 2) – no action	-2.0					
Piling removal (Zone 3) – 100%[a]			-0.1	-0.1	-0.1	-0.1
Piling removal (Zone 3) – no action	-1.5					
Riparian restoration – Weyer Point (all)			9.7	9.7	9.7	9.7
Riparian restoration – Weyer Point (partial)		5.2				
Riparian restoration – no action	-3.9					
Seal haulout – maintain		1.0	1.0	1.0	1.0	1.0
Seal haulout – no action	-6.9					
Trestle and fill removal (south and north sides)				68.9	68.9	68.9
Trestle and fill removal (south side only)			44.0			
Trestle (only) removal		28.5				
Trestle and fill removal – no action	-13.3					
Woodard bridge-modification					-1.4	
Woodard bridge-reconstruction						2.4
Woodard bridge – no action	-26.3	-26.3	-26.3	-26.3		
Grand Total	**-60**	**33**	**195**	**240**	**265**	**270**

Cost Assumptions

- Costs developed only for comparison of alternatives
- Based on typical Puget Sound in-water work
- Assumed limited in-water work windows for protection of sensitive species/life stages
- Added 30% to total to address uncertainty
- Did not include design, permitting, construction, or oversight

Estimated Costs

Alternative	Description	Cost Estimate ($ millions)
1	No action: 30 years maintenance[a]	$1.1
2	Minimal removal of structures	$4.6
3	Moderate removal of structures	$7.1
4a	Maximum removal of structures	$10.2
4b	Alternative 4a + bridge modification	$10.6
4c	Alternative 4a + bridge replacement	$18.4

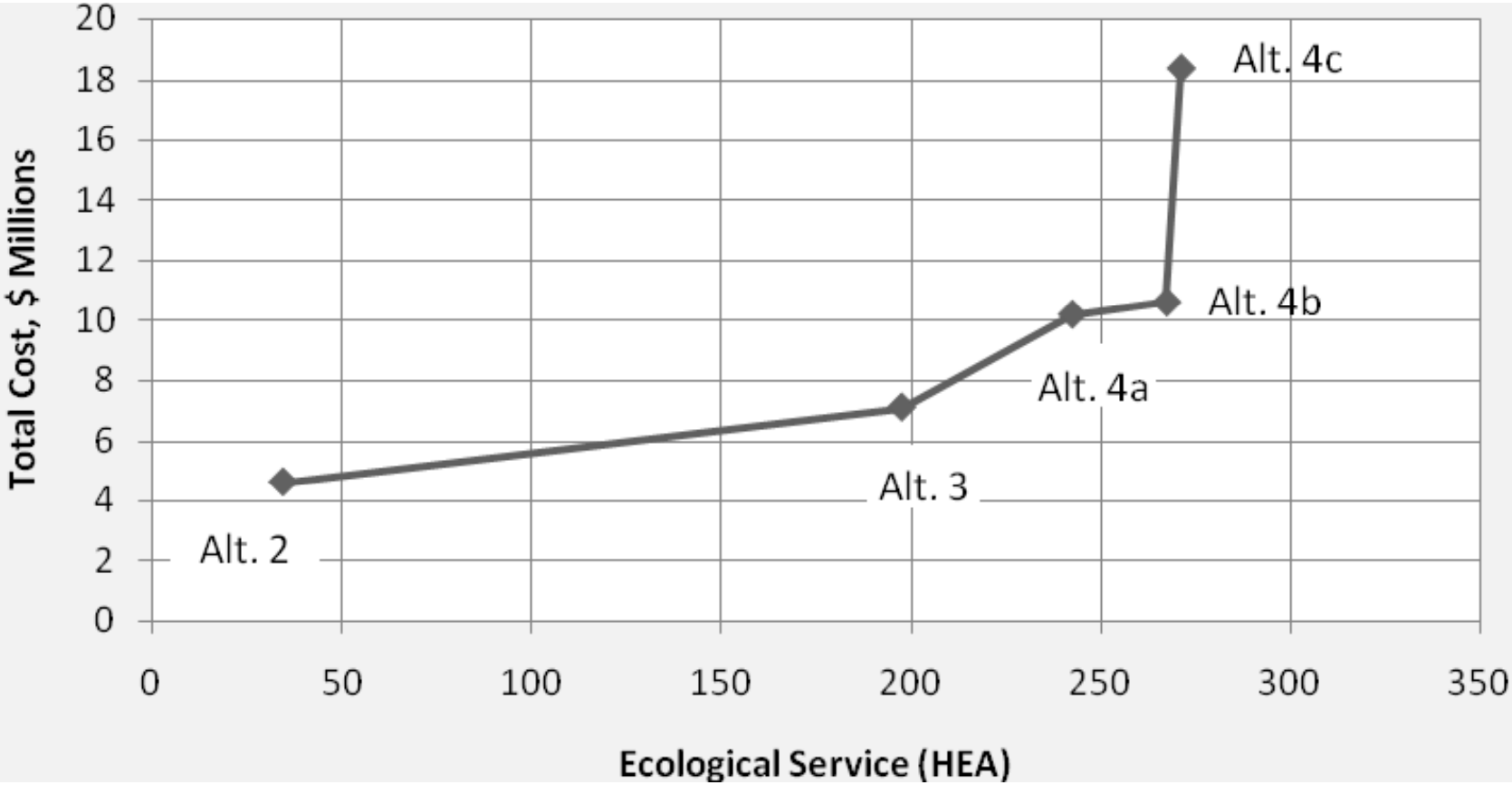
Cost-Benefit Analysis

- Used a non-standard approach
  - Evaluated post-restoration ecological services vs. restoration costs
  - Used aggregated HEA scores to represent ecological services
  - Costs based on engineers' planning-level estimate

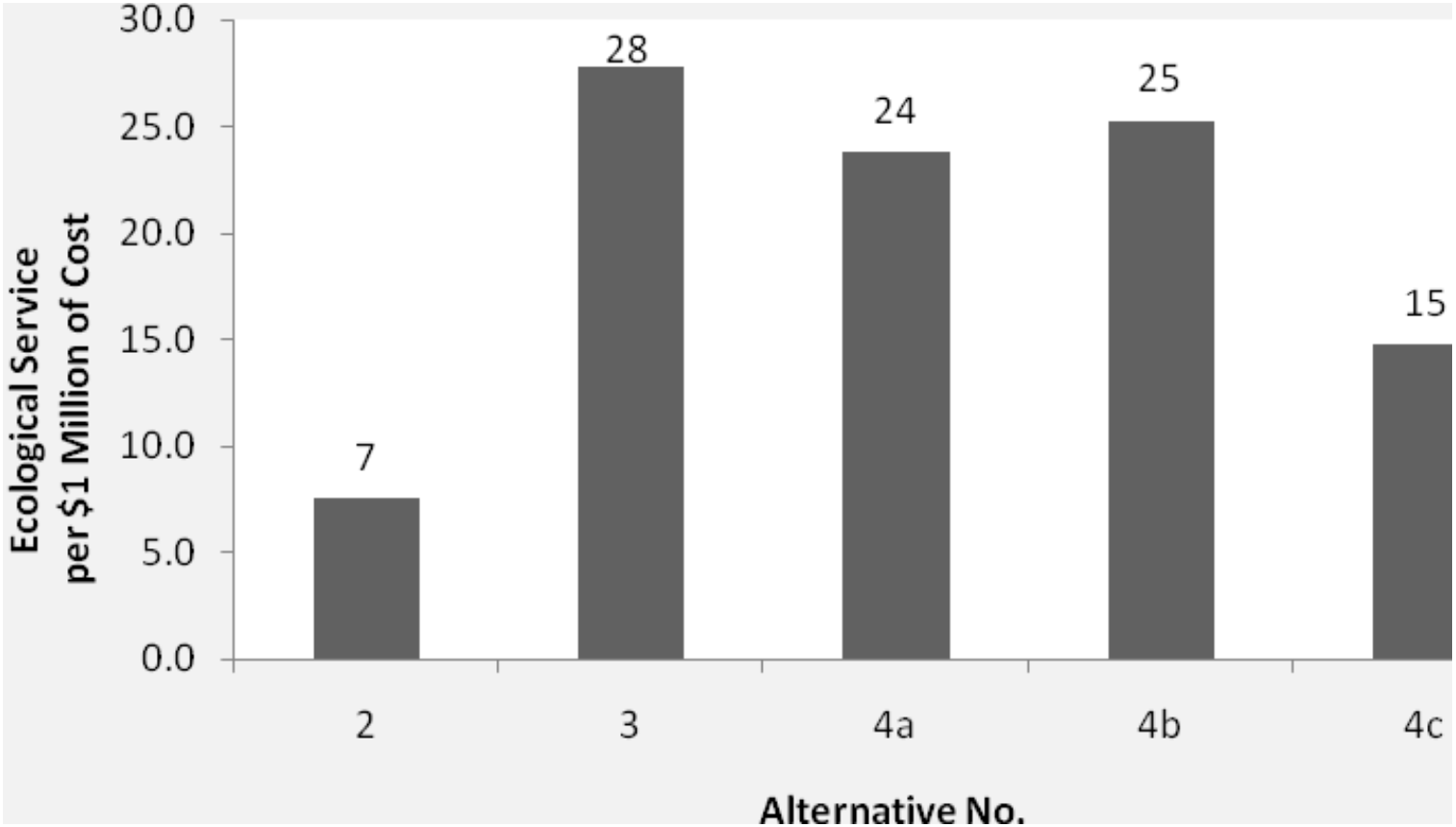
Ecological Service and Cost by Alternative

Alternative	Ecological Service (HEA)	Cost ($million)	Service/ $1 Million
2 – Minimal action	33	$4.6	7
3 – Moderate action	195	$7.1	28
4a – Max action w/out bridge replacement	240	$10.2	24
4b – Maximum action w/ bridge modification	265	$10.6	25
4c – Maximum action w/ bridge replacement	270	$18.4	15

Cost vs. Ecological Service



Cost/Ecological Benefit Ratios



Selection Criteria

- Ability to meet restoration goals
- Cost effectiveness
- Public acceptance
- Impact on historical and cultural resources
- Likelihood of funding

Preferred Alternative

Alternative 3 – balances overall goals for site

- Highest ecological services in relationship to cost
- Accomplishes many of the objectives expressed by public and agency stakeholders
- Preserves some elements of the historical landscape that triggered its listing on the National Register of Historic Places
- Reasonable probability that it can be implemented with likely funding mechanisms