



Use of Ecosystem Service Values for More Sustainable Remedial Decision Making

NICOLE

Madrid, October 2008

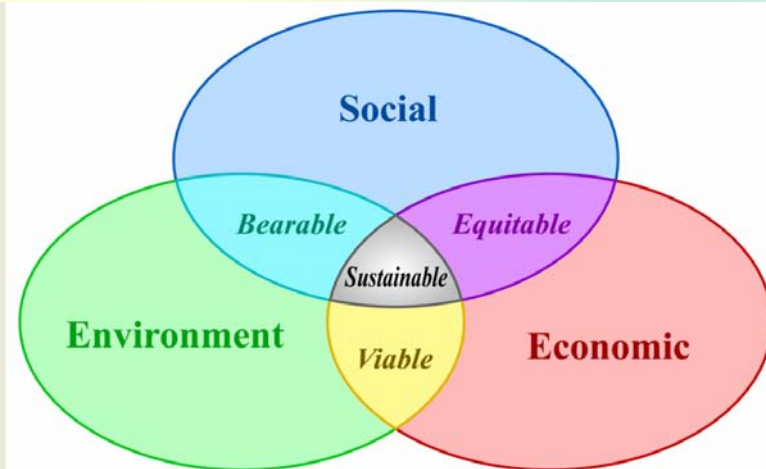
John Lovenburg

Agenda

- Sustainable Remediation
- Natural Resource Valuation
- Net Environmental Benefit Analysis
- Case Studies
- Discussion

Sustainable Remediation

- Future benefits outweigh remediation costs
- Environmental impact of implementation less than impact of leaving land untreated
- Minimize or eliminate energy consumption, or consumption of other natural resources
- Biomimicry, using natural technologies and processes
- Decision-making process includes proper engagement of stakeholders
- Reduce or eliminate releases to environment, especially air (e.g., GHG)
- Renewable energy (e.g., solar)
- Recyclable materials



From SuRF Meeting Minutes

Natural Resource Land Values

- Traditional Commercial Services
 - Timber, groundwater supply, minerals, real estate development
- Human Use Services
 - Recreational, aesthetics
- Ecological Services
 - Nutrient recycling, photosynthesis, flood control, preserving biodiversity, wildlife habitat

Ecosystem Services

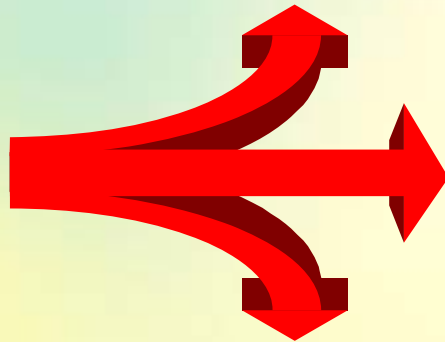
“The functions a natural resource provide for other resources and for humans”.

Ecological



Nesting Area for Birds
Breeding Area for Fish
Sediment Stabilization
Water Quality Enhancement
Many Others

Land/Habitat



Direct Human Uses (e.g., Recreational, Commercial)



Bird watching
Fishing
Swimming
Hunting
Commercial Fishing

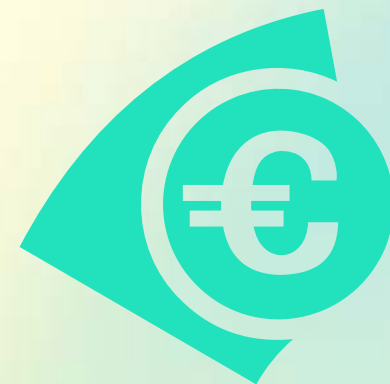
Passive Use



Existence value
Aesthetic value
Preservation of diversity
T&E species

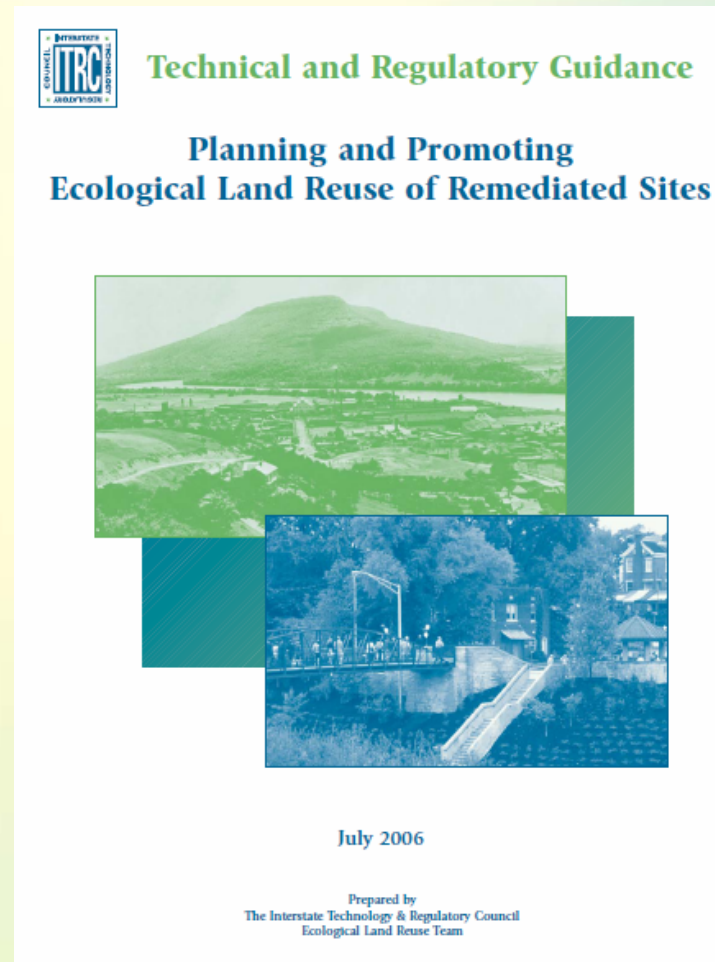
Quantifying Natural Resource Values

- Market Values
 - Fair market value
 - Eco asset markets - e.g., mitigation banks, timber, carbon sequestration
- Public Interest Values
 - Human recreational use value
 - Ecological service value



Net Environmental Benefit Analysis

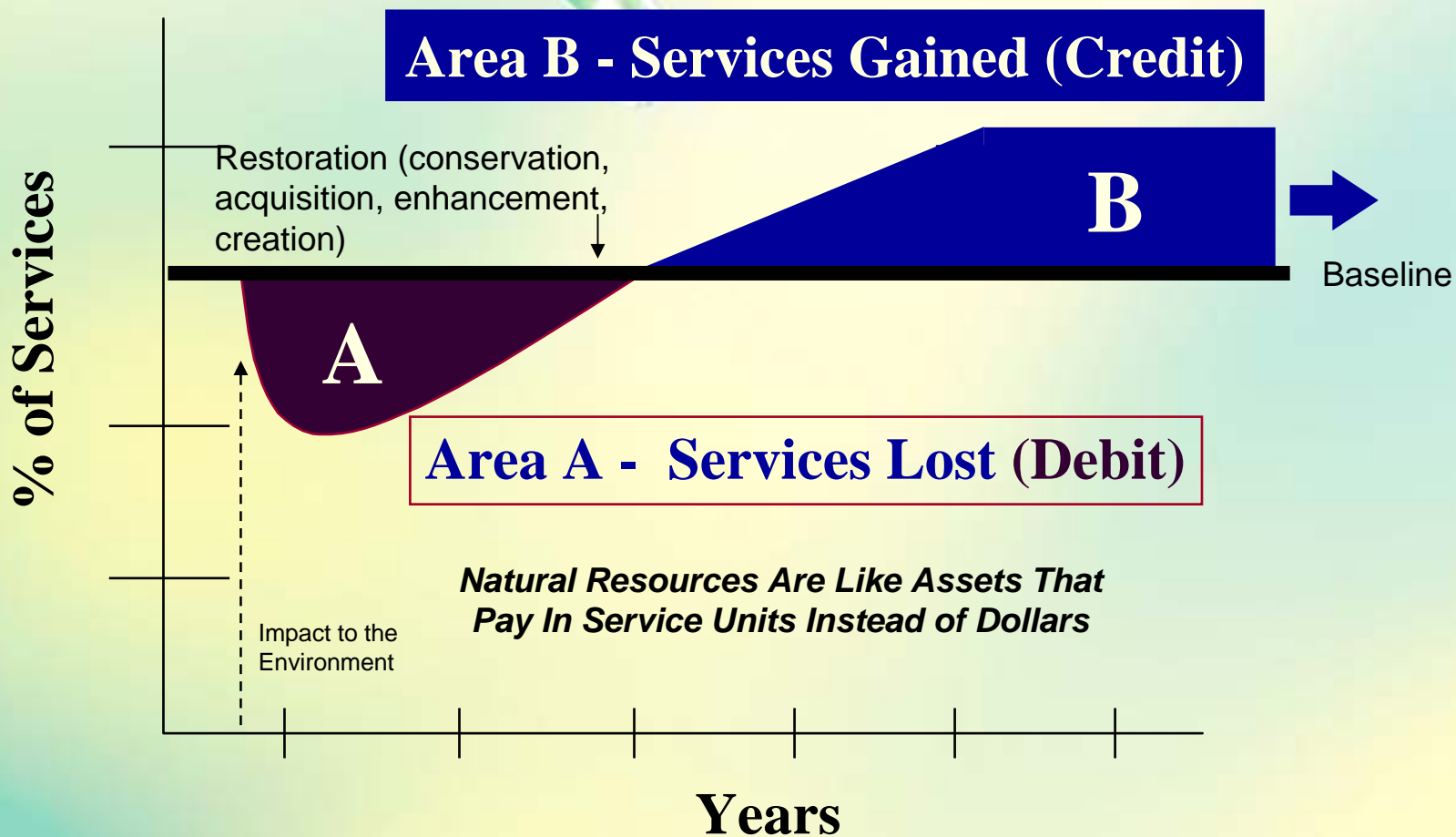
- Risk-Benefit Analysis Applied to Environmental Decision Making
 - Documentation of ecosystem value of property
 - Comparison of ecosystem benefits/costs between actions; and
 - Selection of actions that maximize ecosystem benefits
- Allows
 - Demonstration of environmental sustainability
 - Assist land management decisions to optimize ecosystem service values
 - Manage existing and potential long-term risks
 - Generate a revenue stream



Ecosystem Service Metrics

- Ecological Service Metric
 - Measured in Services per Unit Area Per Year (e.g., *Services Acre Year [SAY]*)
 - Discounting applied for common base year (e.g., dSAYs)
 - Surrogate Parameters Used
 - e.g., changes in biodiversity, invertebrate abundance reduction, or vegetation biomass lost
- Human Use Service Metric
 - Measured in User-Days, Visitor-Days, and \$
 - Economics benefit transfer and willingness to pay approaches
 - Discounting applied for common base year (e.g., dSAYs)

Quantifying Natural Resource Value Changes




Case Studies

- Groundwater Case Study - Edwards Air Force Base, California
- Sediment Dredging Case Study – Confidential Chemical Company, Connecticut, U.S.

Draft Report

**Demonstrating the Net Benefit of Site Cleanup:
An Evaluation of Ecological and
Economic Metrics at Two Superfund Sites**



Prepared for
**United States Environmental Protection Agency
Office of Solid Waste and Emergency Response
Policy Analysis and Regulatory Management Staff**

ES-11-200703-147L

November 2007

Edwards Air Force Base Groundwater Restoration

- NASA testing and research since 1946
- Past practices led to TCE & benzene plumes
- Negligible risks given lack of receptors
- Regulatory requirement to restore groundwater to background

Alternatives

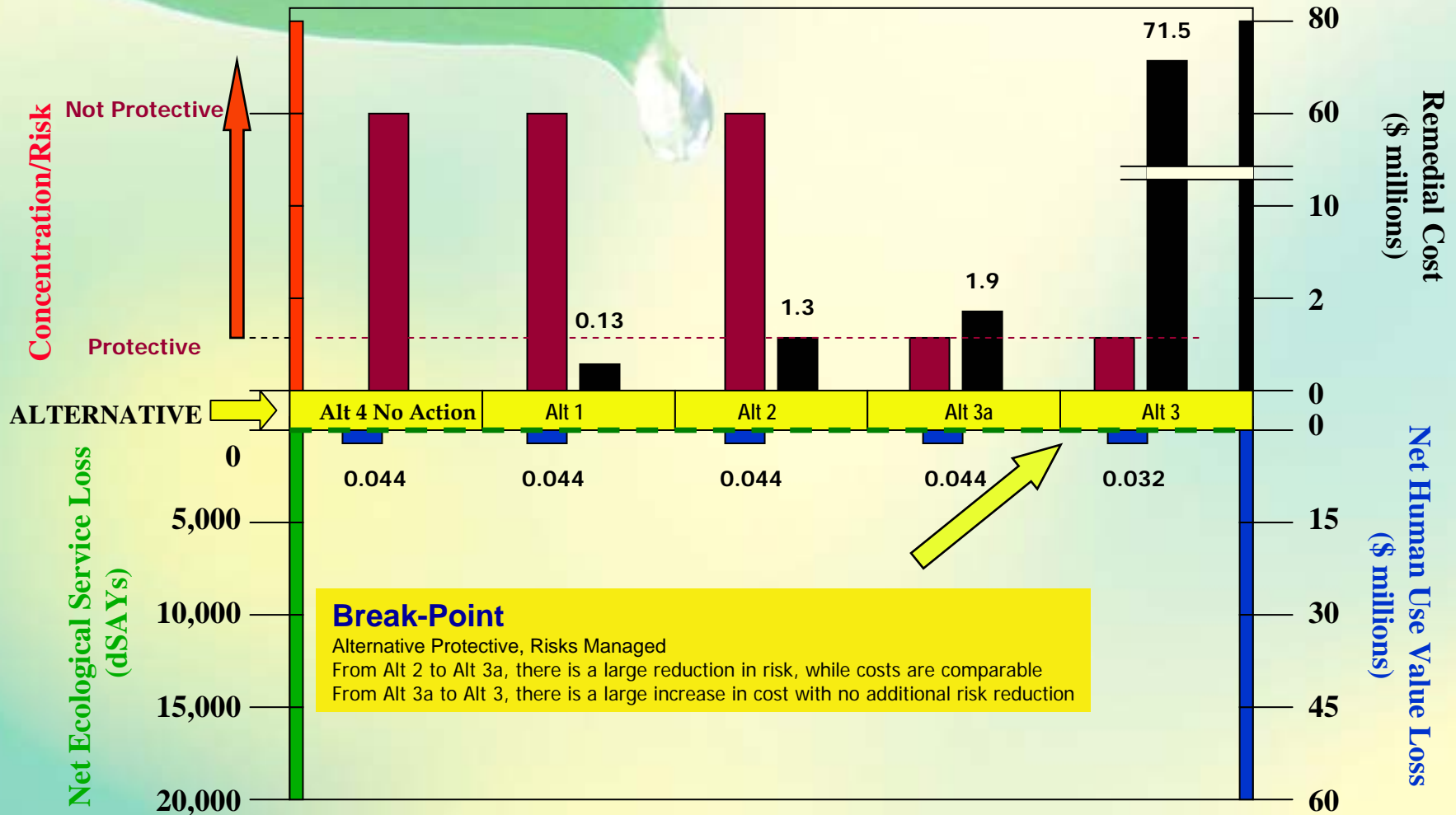
- **Alternative 1:** Land Use Controls
- **Alternative 2:** Groundwater Monitoring/Hydrologic Control
- **Alternative 3:** *In Situ* Chemical Oxidation of the Entire Plume
- **Alternative 3a:** *In Situ* Chemical Oxidation of TCE Plume, Enhanced Natural Attenuation of Benzene Plume, Plume Containment, and Groundwater Monitoring
- **Alternative 4:** No Action

Basis of Net Env. Benefit Analysis

Human-Use Services

- Based on value of groundwater as a drinking water source
- Calculated by fair-market value
 - Maximum aquifer yield
 - 158 million gallons (696 million liters) per year
 - Delivered potable water
 - \$274 acre-foot (1 acre = roughly 0.4 hectares)

NEBA Results: Comparison of remedial costs to risk profile, ecological/human use service changes for each remedial alternative evaluated over a 30-year timeframe.



Regulators Agreed to Alternative 3a – Remedial Costs More Proportionate to Service Loss

	Human Use Services (NPV)	Human Risk Profile	Ecological Risk Profile	Cost of Remedial Alternative (NPV)
Alternative 4 No Action	\$0.007 million	Not Protective	No Risk	\$0
Alternative 1	\$0.007 million	Not Protective	No Risk	\$0.13 million
Alternative 2	\$0.007 million	Not Protective	No Risk	\$1.3 million
Alternative 3a	\$0.007 million	Protective	No Risk	\$1.9 million
Alternative 3	\$0.032 million	Protective	No Risk	\$71.5 million

Case Study: Confidential Chemical Company Sediment Dredging

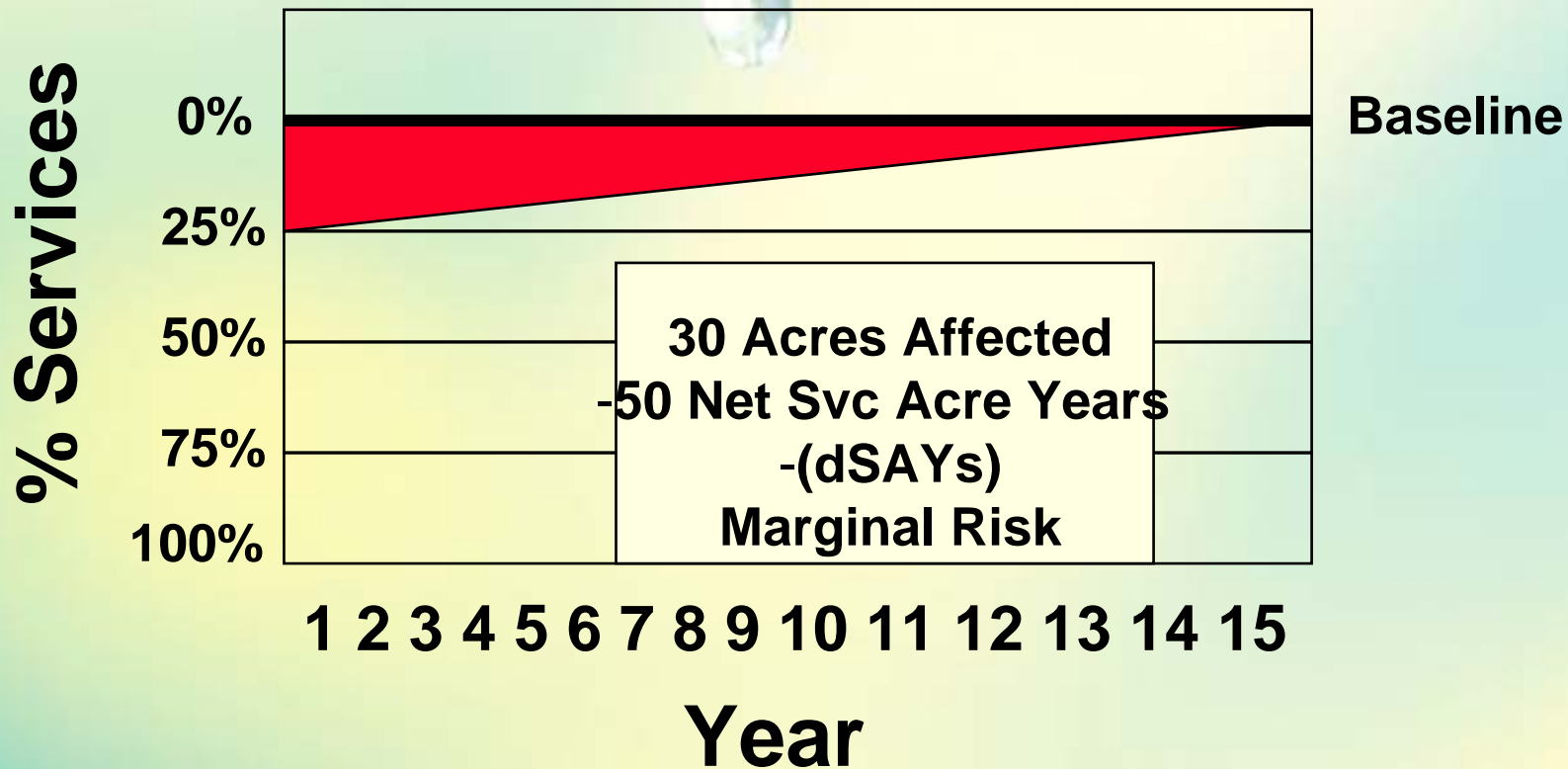
- Estuarine System
- Metals Contamination
- Regulatory order stipulates dredging
- Evidence of limited risk
- Evidence of attenuation

Alternatives

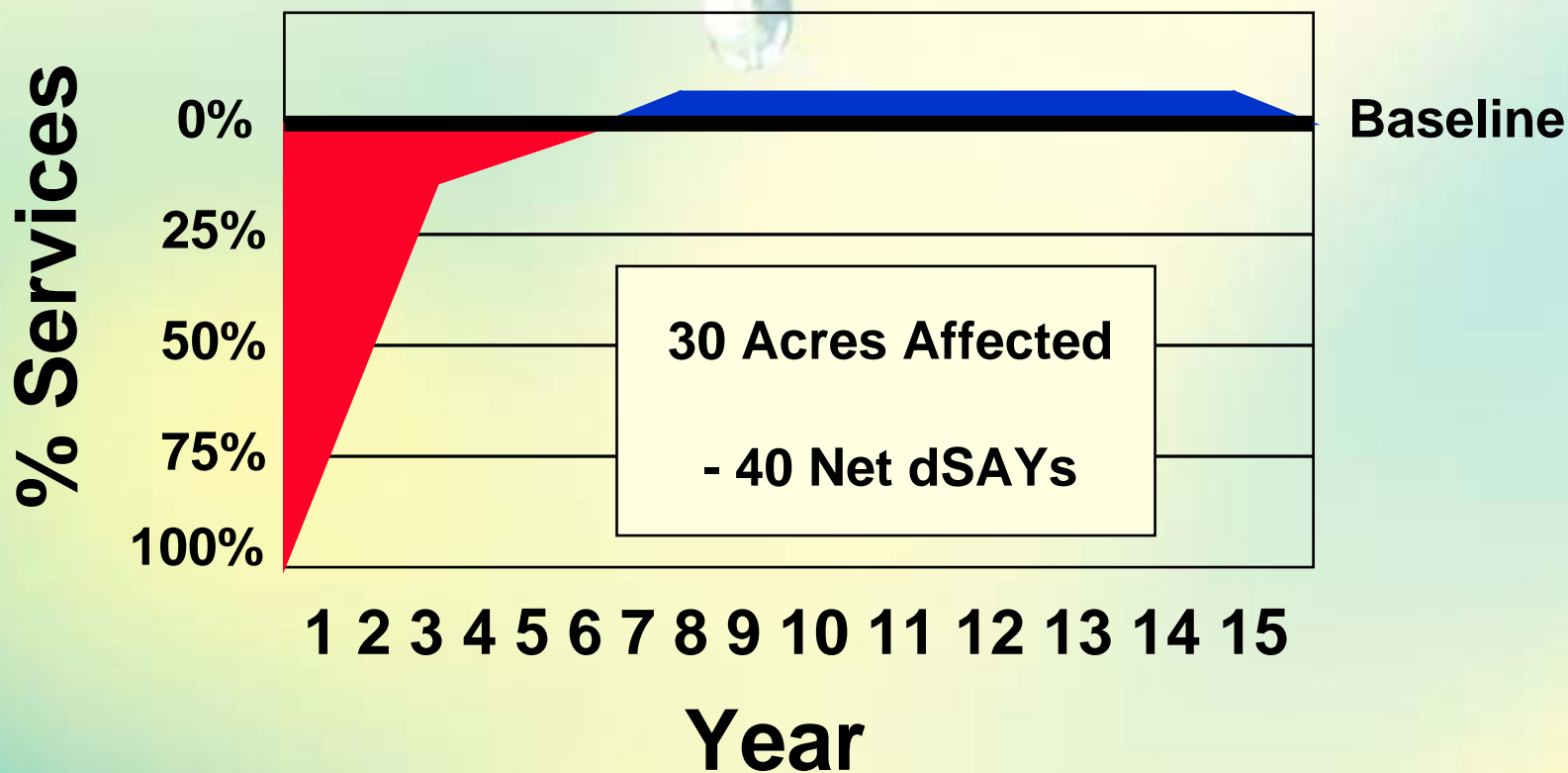
- Dredging
 - 30 acre site (12 hectares)
 - Disturb Habitat
 - U.S. \$16 million
- Natural Attenuation
- Natural Attenuation with Restoration

Natural Attenuation: No Action

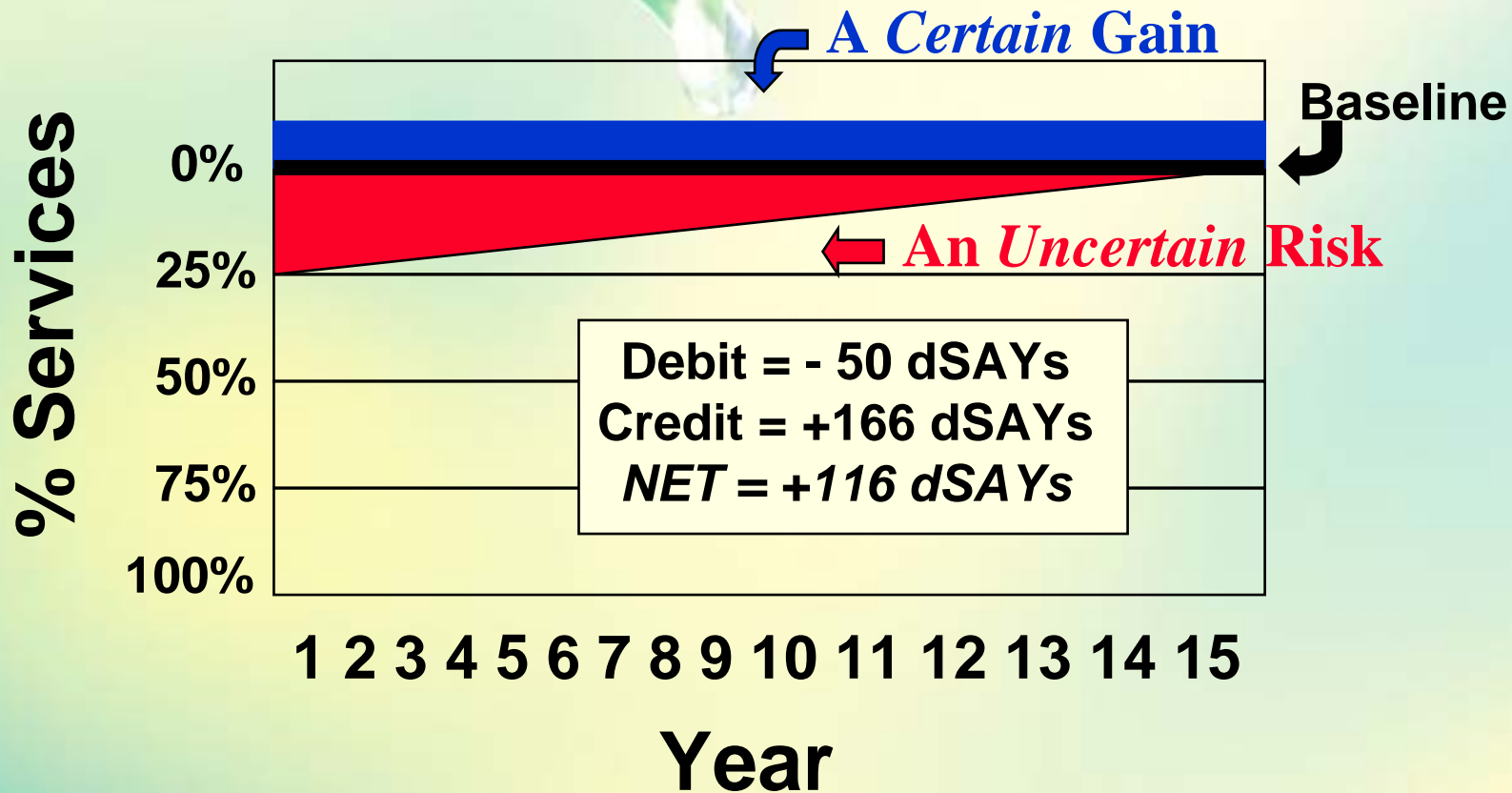
The **red** area represents marginal risks (“potential” injury) associated with the no-action alternative



Dredging Impacts



Natural Attenuation With Restoration (Balance Risks)



Net Environmental Benefit Analysis

Remedial Action Cost (\$) Net Envir. Benefit

Dredging	16 M \$	-50 dSAYs <u>+10 dSAYs</u> Net -40 dSAYs
Natural Attenuation	0.5 M \$	-50 dSAYs
Natural Attenuation With Restoration	1.0 M \$	-50 dSAYs <u>+166 dSAYs</u> Net +116 dSAYs

Summary

- Use of natural resource service values can provide the basis for more sustainable remedial decisions
- Improve decision making by assessing the net environmental benefit of each remedial alternative

Discussion

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