0094600

Natural Resource Damage Assessment Concepts & Approaches, Part Two

Prepared for:
Hanford Natural Resources Trustee Council

David Chapman and Jamie Holmes
Stratus Consulting Inc.
Boulder, CO
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Outline

- Review of previous training
  - NRDA overview
  - NRDA process
  - Injury determination & quantification
- Damage determination methods
- Equivalency examples

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Goals

- Provide Trustee Council with increasing level of knowledge of NRDA frameworks and methods
- Allow Trustee Council to begin discussion of possible framework for Hanford NRDA

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Review: NRDA Overview

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NRDA Overview

- Process of determining and quantifying the adverse effects of releases of hazardous chemicals/oil on natural resources
  - Use data to quantify damages
  - Damages used for "restoration"

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Purpose

- Make the public whole for harm to natural resources resulting from releases of hazardous substances or oil
  - Damages recovered must be used for restoration
  - Restoration complements, but is distinct from, response and remedy

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Statutory Authority

- Clean Water Act (1972)
- CERCLA (1980)
  - Site cleanup (response, remediation)
  - Damages for losses to public (restoration)
- OPA (1990)
  - Damages for oil releases to navigable waters
- Other federal statutes
- Various state laws

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NRDA Compensation

- Public is compensated for harms that may accrue over time
  - Past, present, future
- Compensation is for "primary restoration" and "interim loss"

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Natural Resources "Services"

- Physical and biological functions performed by the resource
  - Including human uses
- Services are the result of the physical, chemical, or biological quality of the resource

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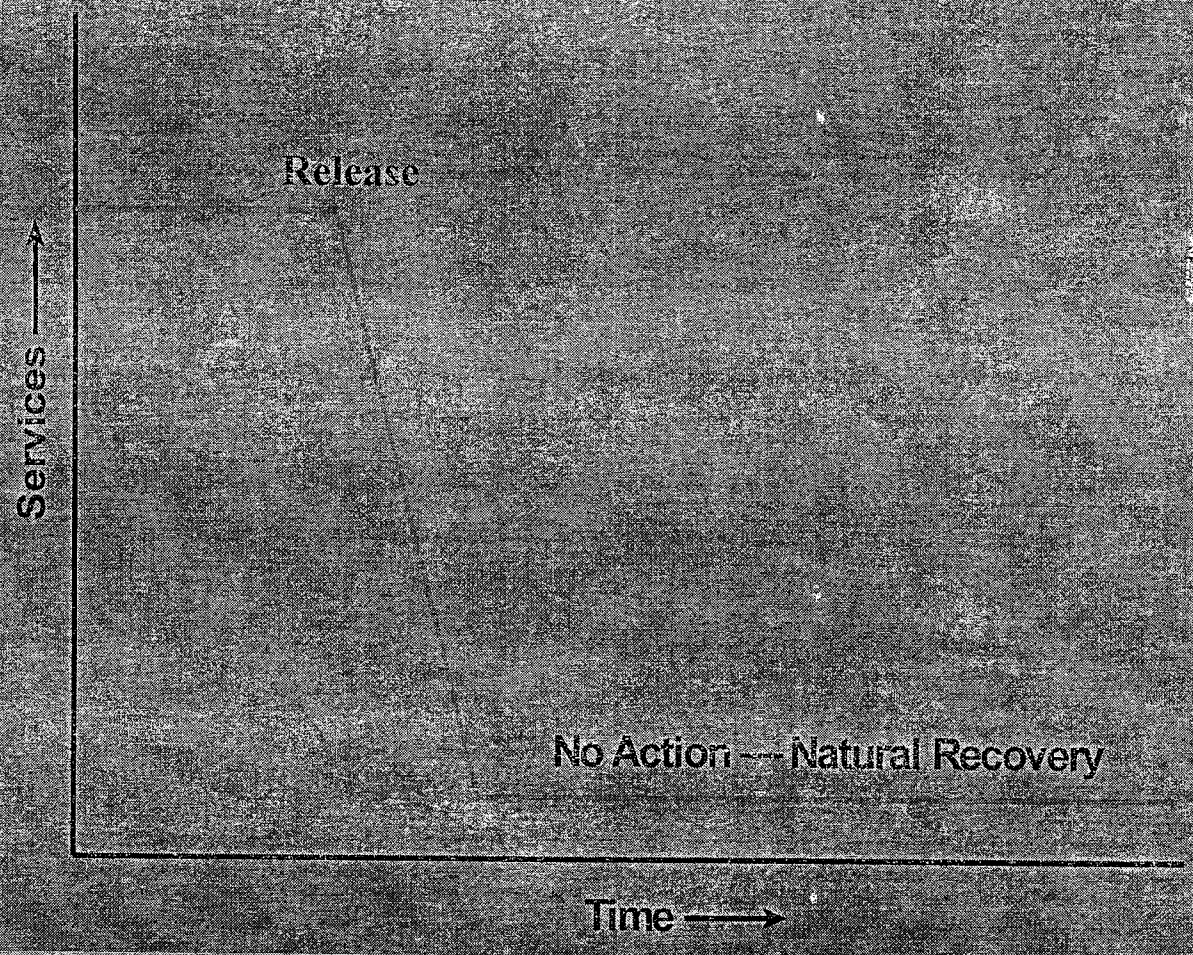
Service Loss



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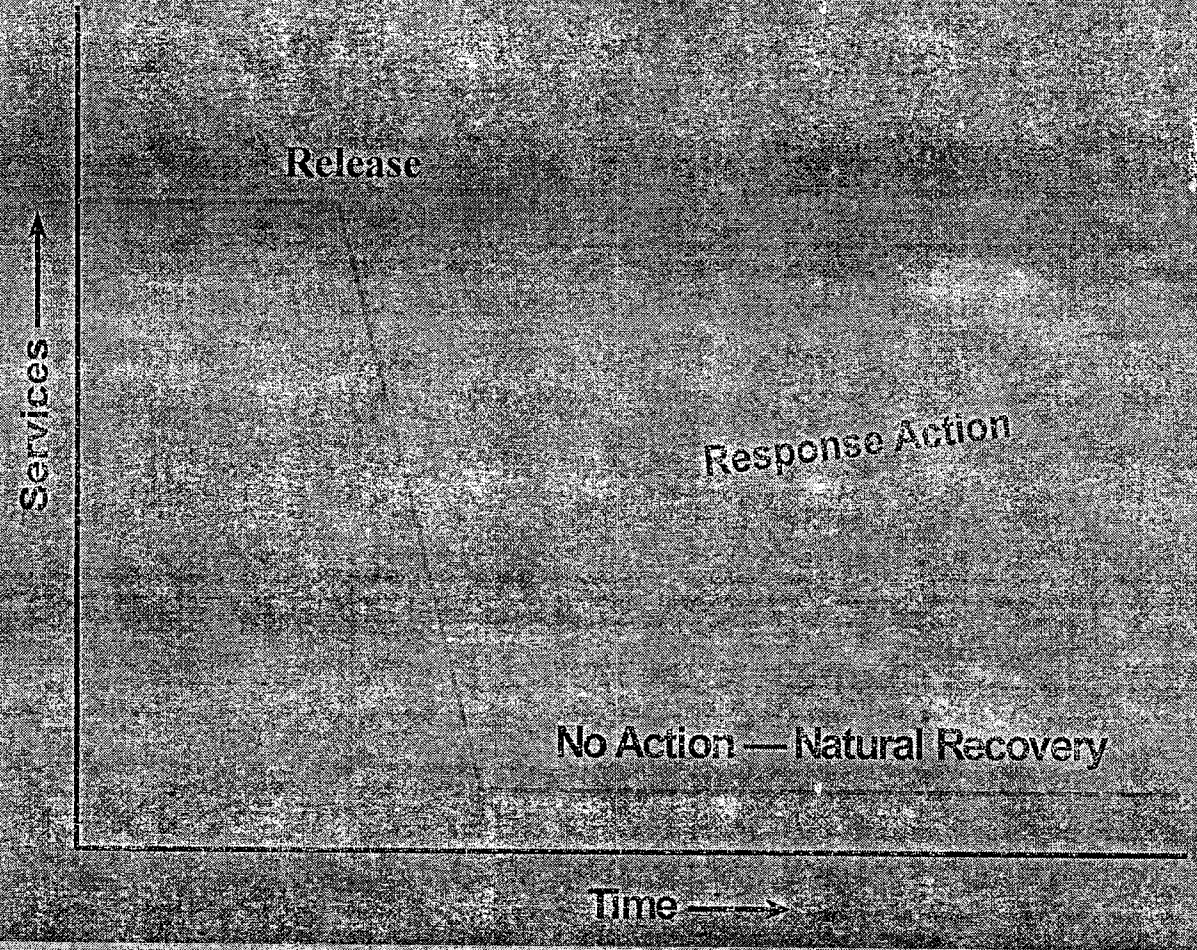
Service Loss (cont.)



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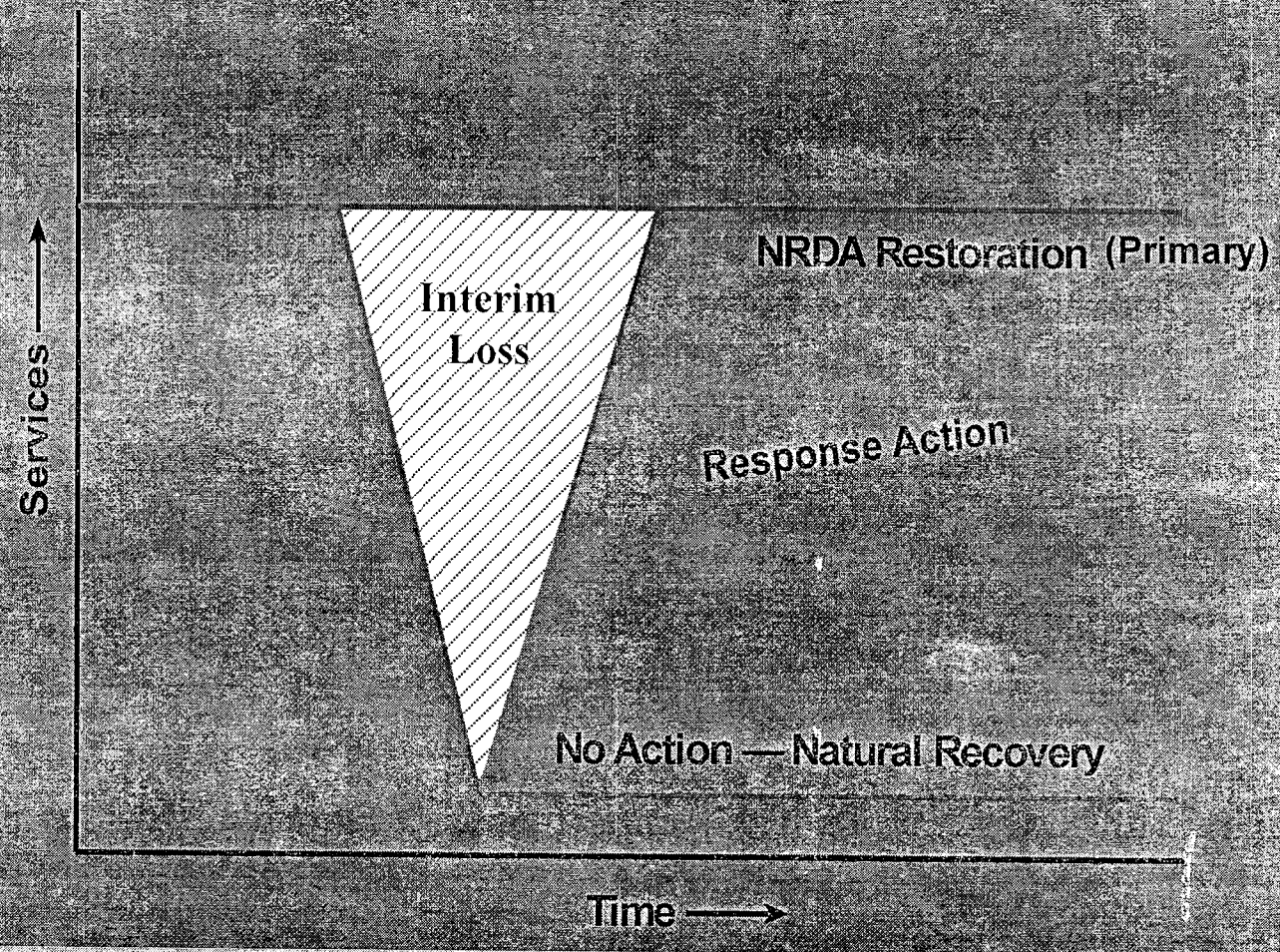
Service Loss (cont.)



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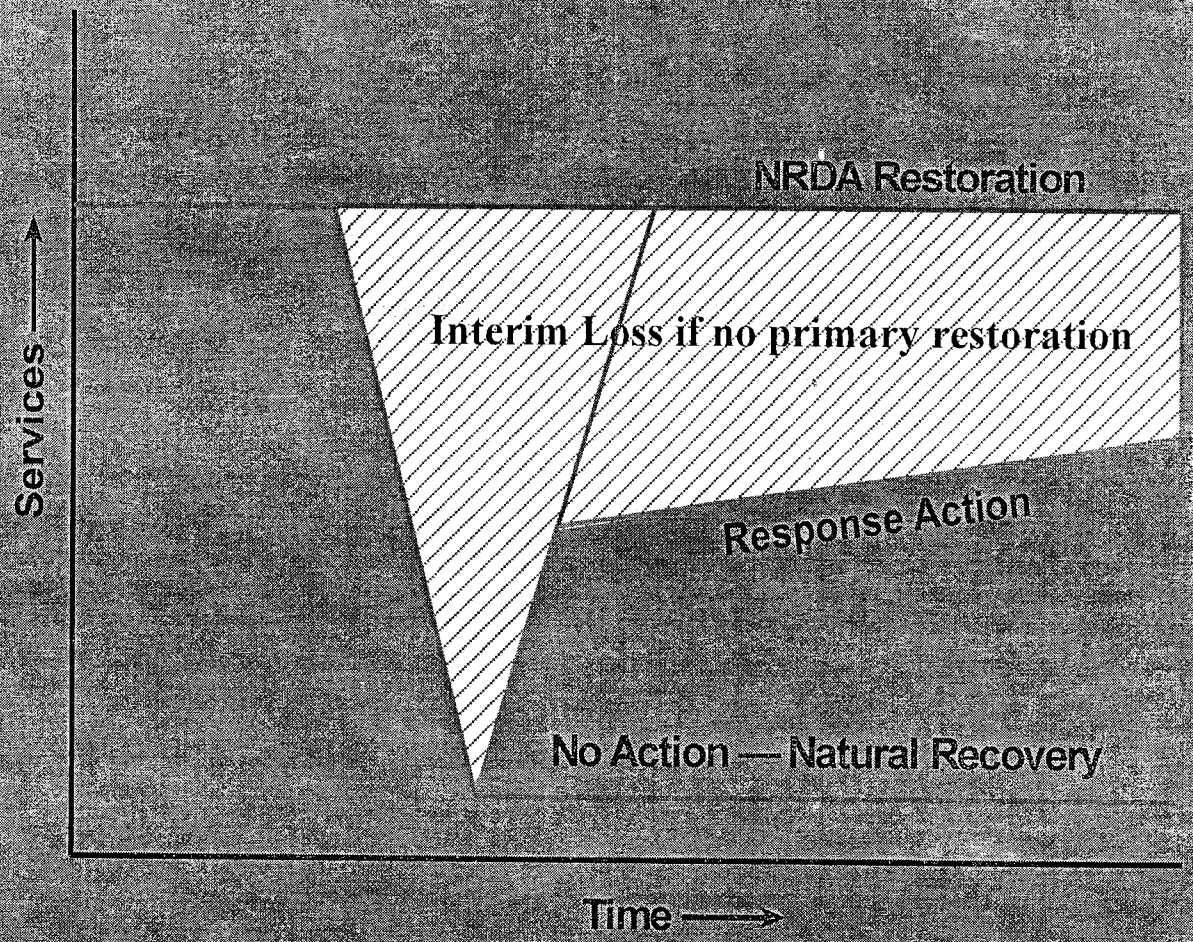
Service Loss (cont.)



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NRDA Process

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NRDA Elements

- Characterize:
  - Sources of hazardous substances
  - Pathways to Trustee natural resources
  - Injuries to Trustee natural resources
- Quantify
  - Spatial and temporal extent of injuries
    - Service losses
  - Damages

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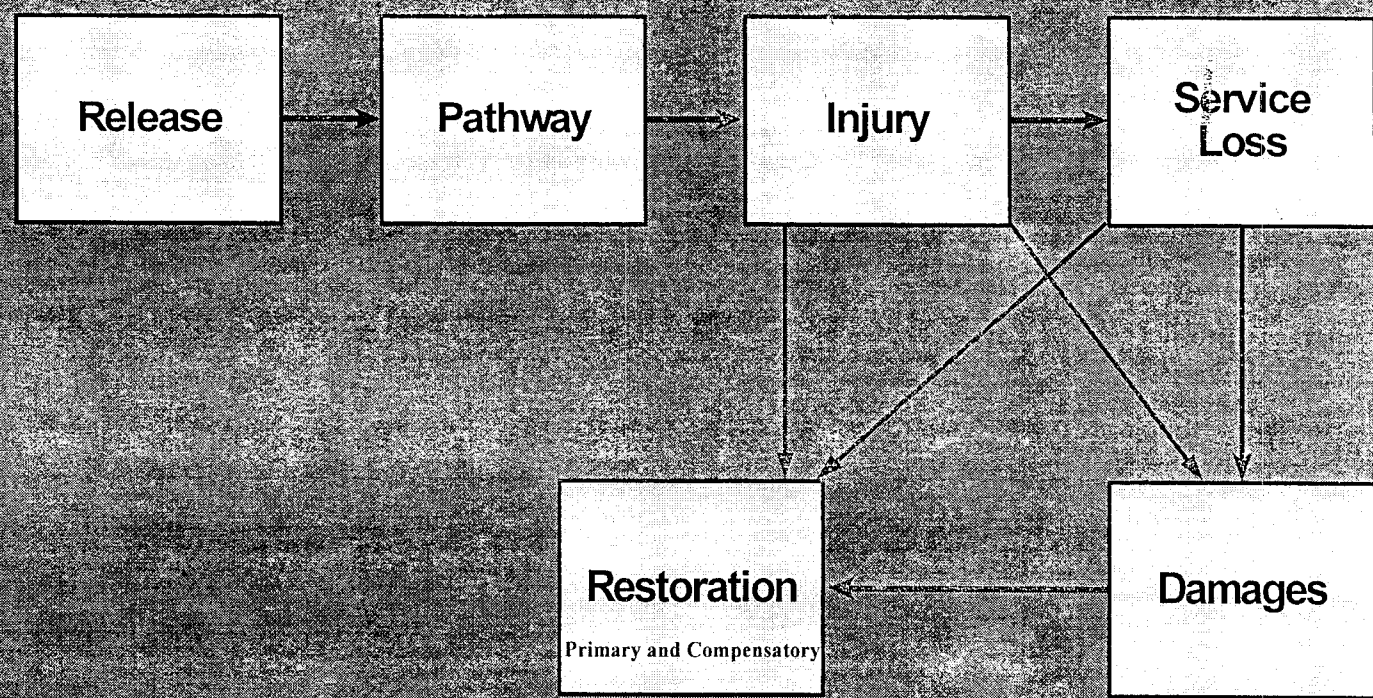
Sequence of Events



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Administrative Process [43 CFR Part 11]

- Preassessment Screen (PAS) and Determination
  - Rapid review of available information
  - Ensure reasonable probability of successful claim

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Administrative Process (cont.)

- Assessment Plan
  - Propose assessment methods
    - Can use phased assessment approach
  - Show reasonable cost of assessment
  - Allow for public/RP review & comment
  - Preliminary Evaluation of Damages (PED)
    - Does assessment make sense?

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Administrative Process (cont.)

- Assessment
  - Injury determination
  - Injury quantification
  - Damage determination
  - Restoration planning
    - Restoration and Compensation Determination Plan (RCDP)

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Administrative Process (cont.)

- Report of Assessment
  - Summarize data from all phases
  - Present claim for damages
- Post-Assessment Phase
  - Restoration Plan
  - Implementation of restoration

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Changes to DOI Regulations

- DOI issued final rules on Oct 2, 2008
  - 53 FR 57259 *et seq.*
- Revised language
  - Puts restoration scaling on equal footing with economic damages
  - Allows RCDP to be after Assessment Plan
    - RCDP before assessment does not make sense

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Changes to DOI Regulations (cont.)

- Compliance with *Ohio v. Interior* (1989)
  - Original language:
    - nonuse values only to be used if no use values could be determined
  - DC Circuit invalidated this clause
  - Clause now removed

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Changes to DOI Regulations (cont.)

- Compliance w/ *Kennecott v. Interior* (1996)
  - DC Circuit found dichotomy:
    - Restoration of natural resources

      vs.
    - Restoration of lost services
  - New rule attempts to clarify
    - Restoration of natural resources until they provide baseline services

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Injury Assessment

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Injury Assessment - Purpose

- Evaluate injuries to trust resources
  - Identify injured natural resources
- Determine:
  - Causes of injuries
  - Spatial extent of injuries
  - Temporal extent of injuries

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Definitions

- Injury
  - Measurable adverse change in quality or viability of a natural resource resulting from exposure to a release of a hazardous substance or discharge of oil
- Definitions in DOI regulations
  - *per se* (e.g., exceed threshold)
  - Interpretive (e.g., physiological changes)

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Definitions (cont.)

- Pathway
  - The route or medium through which a hazardous substance or oil is transported from the source of the release to the injured resource

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Definitions (cont.)

- Baseline
  - Conditions expected to exist in the impacted areas absent the release of hazardous substances
    - Not pre-release conditions
    - Not absent human development
    - May vary over time

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Injury Determination

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Injury Determination: Sources

- Characterize hazardous substance releases
  - Which hazardous substance(s)?
  - Timing/frequency/duration?
  - Location?
  - Quantity?
  - Method?
  - Responsible party?

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Pathway Determination

- Sampling approach
  - Use environmental data to demonstrate presence of hazardous substances in pathway components
- Modeling approach
  - Use model to demonstrate environmental mobility/transformation

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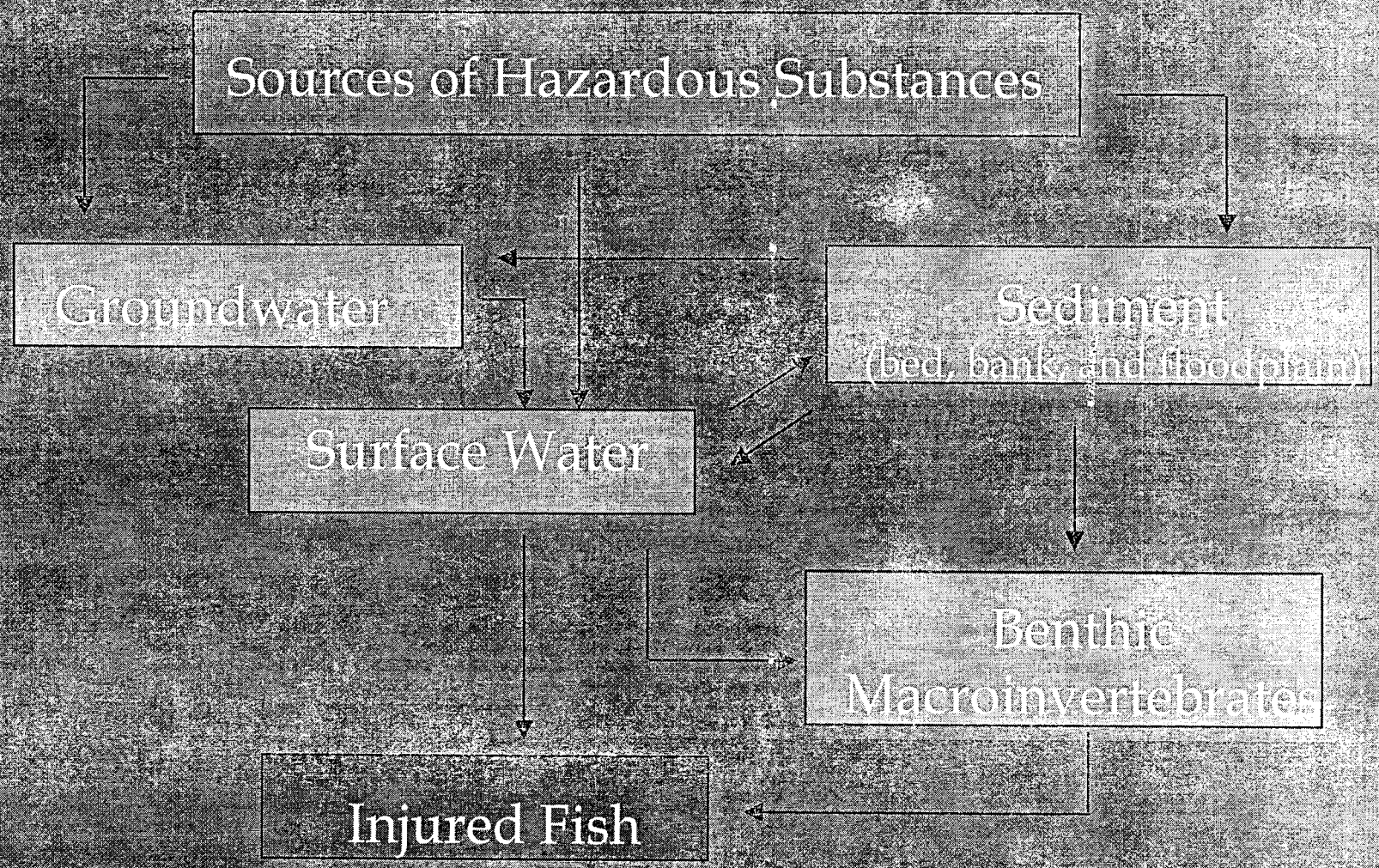
Pathway Determination (cont.)



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Injury Determination: Examples

- Surface water and groundwater
  - Conditions sufficient to adversely affect biological resources or human users
  - Contaminant concentrations that exceed regulatory limits
  - Reduced assimilative capacity

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Injury Determination: Examples (cont.)

- Soils ("geologic resources")
  - Chemical concentrations toxic to microorganisms, invertebrates, plants, wildlife
  - Reduced water holding capacity, nutrient cycling
  - pH<4

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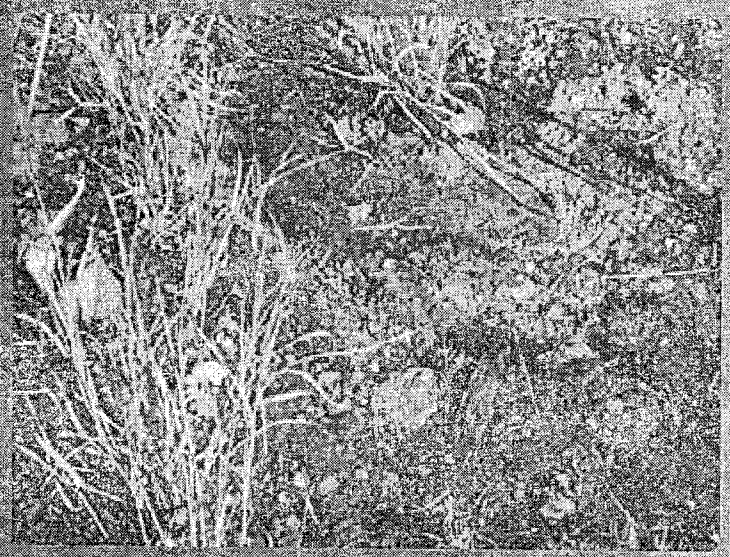
Injury Determination: Examples (cont.)

- Vegetation
  - Reduced cover, diversity, health, vigor, reproductive capacity, stability
  - Reduced habitat value



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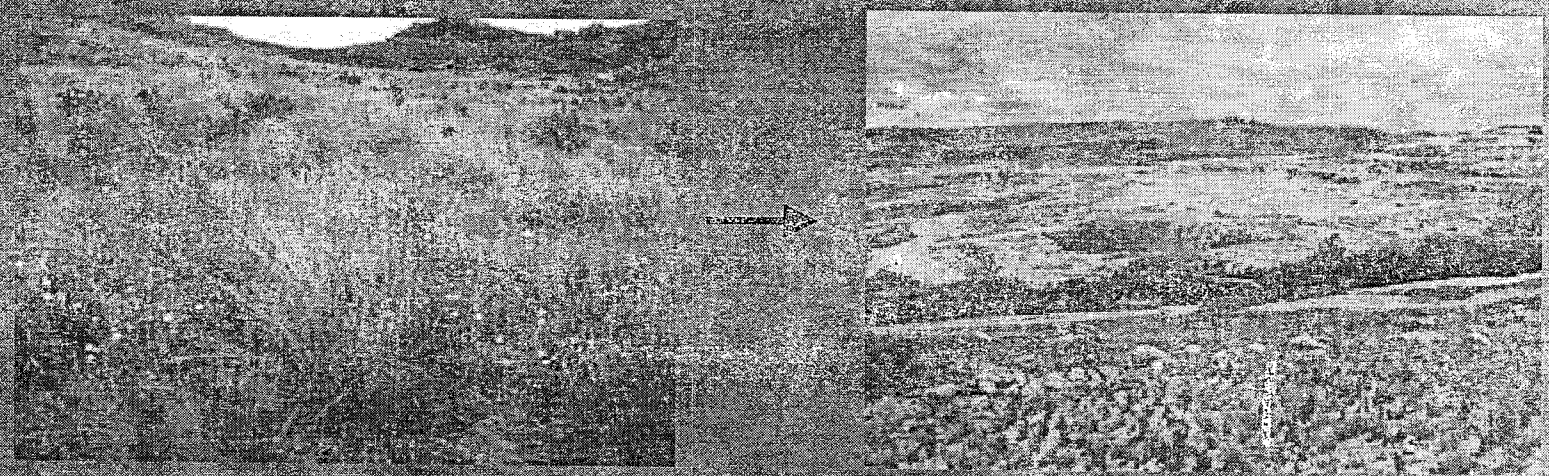
Injury Determination: Examples (cont)

- Habitats
  - Alterations in habitat structure, function, resistance, resilience, stability, etc.



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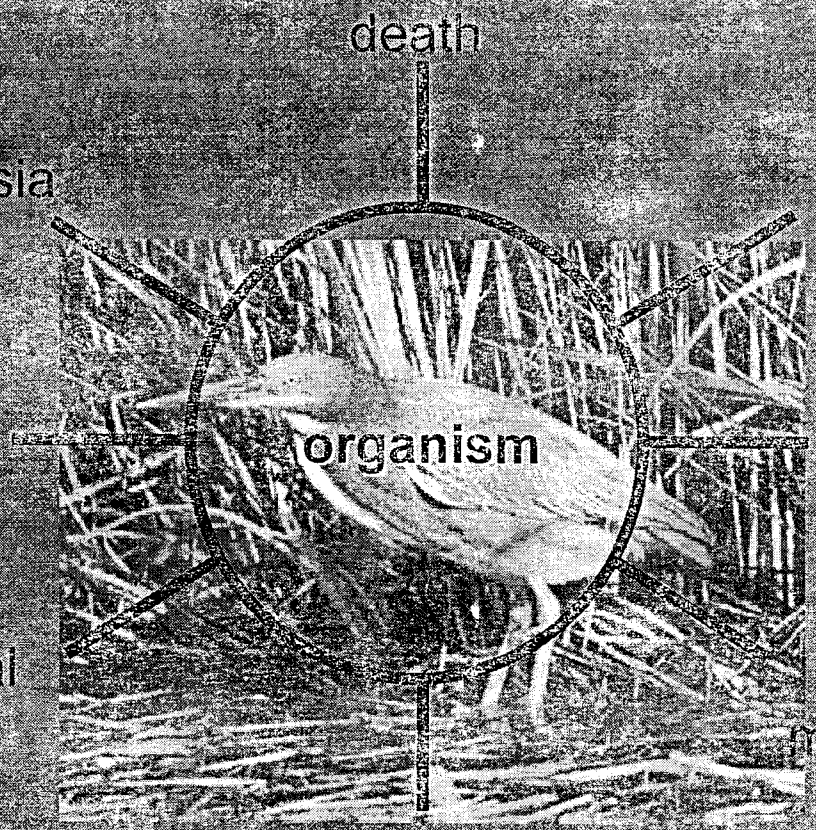
Injury Determination: Biota



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Injury Quantification

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Injury Quantification

- Quantify changes relative to baseline
  - Extent or degree of injury
  - % occurrence in individual, population, community
  - Magnitude of effects
- Temporal extent
- Spatial extent

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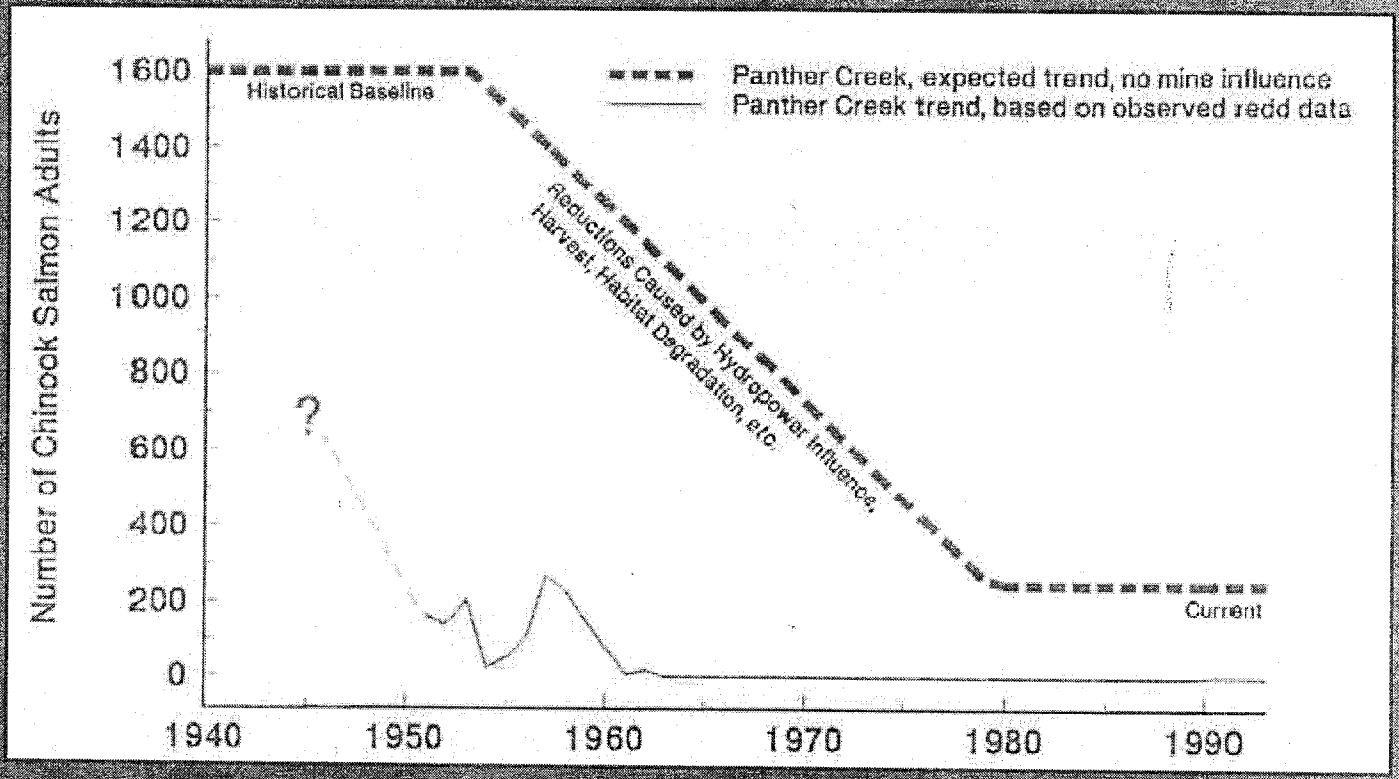
Baseline Example

- Absent release, conditions getting worse



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Injury Quantification Example: GW

- Spatial extent of injury
  - Surface area:
    - Combined plume of multiple contaminants
  - Saturated thickness
    - 3-D MODFLOW model

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Injury Quantification Example: GW

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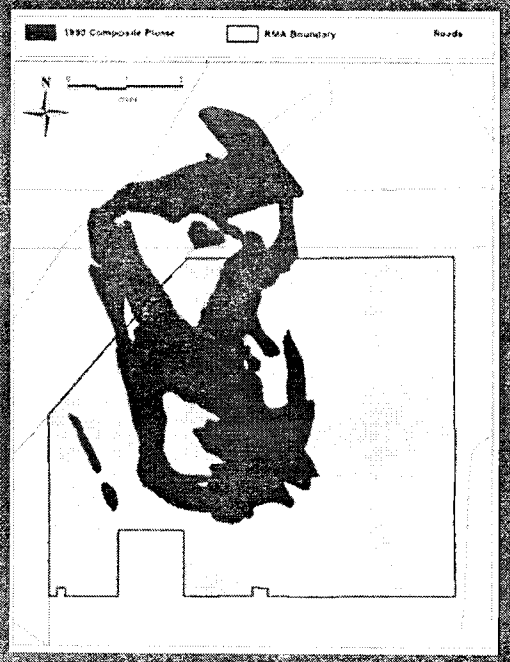
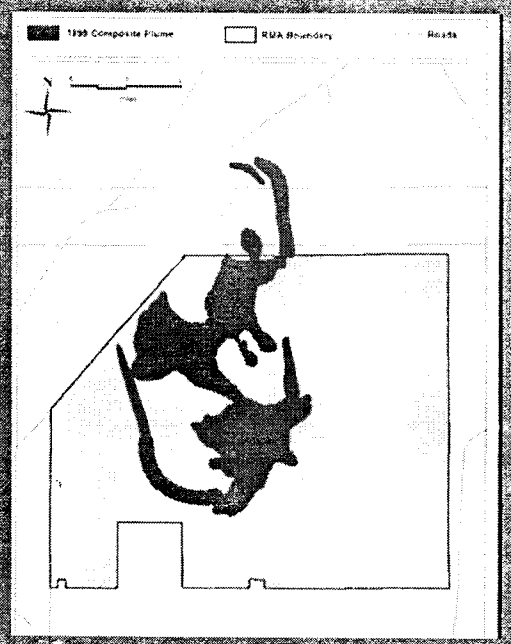
Injury Quantification Example: GW

- Temporal extent of injury
  - Calculate plume volume for multiple years





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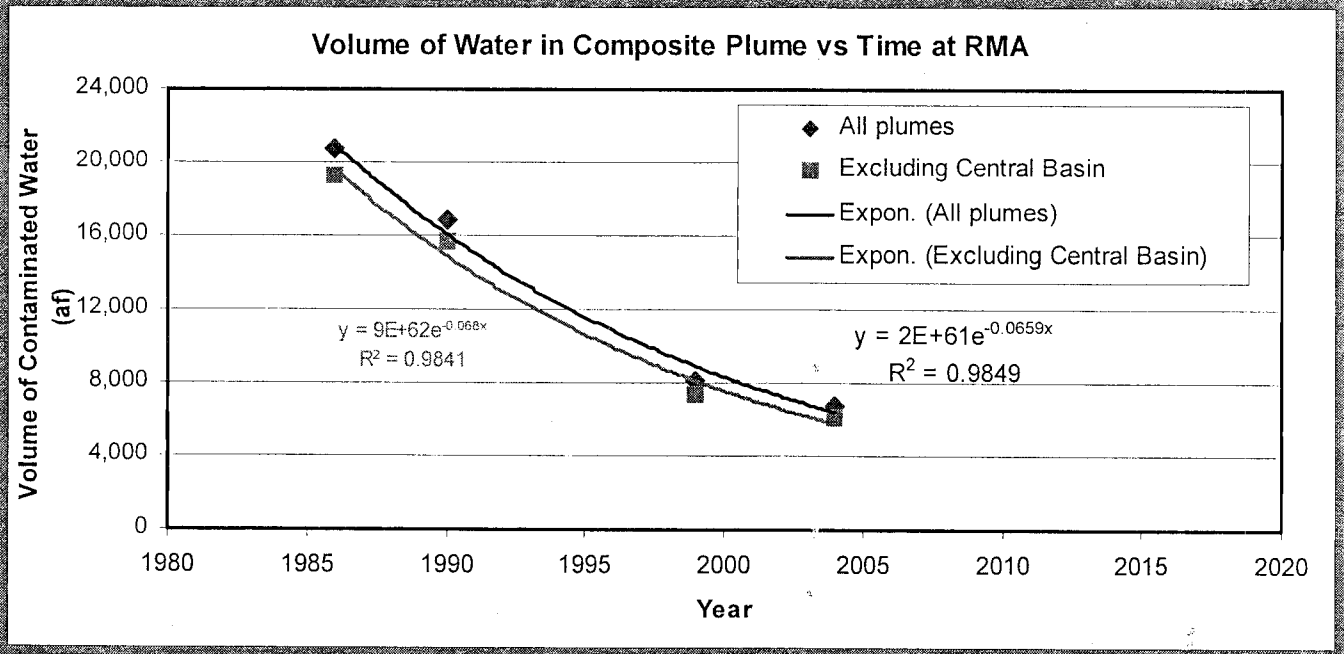
Injury Quantification Example: GW

- Temporal extent of injury (cont.)
  - Fit a plume decay curve



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Damage Determination

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Damages Definition - 43 CFR § 11.80(b)

- The cost of
  - (i) Restoration to baseline services

    or
  - (ii) The replacement and/or acquisition of equivalent resources capable of providing such services.

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Compensable Value – 43 CFR 11.83(c)

- The amount of money required to compensate the public for the interim loss
  - Until resources returned to baseline, or
  - Until the resources are replaced and/or equivalent natural resources are acquired

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Compensable Value – 43 CFR 11.83(c)

- Can include
  - The economic value of lost services provided by the injured resources

    or

    the cost of restoring lost services
  - Public use and nonuse values
    - Existence
    - Bequest

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Damage Determination - Total

- The cost of restoring natural resources sufficient to return services to baseline

&

- The cost (or value) of compensating for interim losses until baseline is reached

&

- The cost of reasonable (i.e., value justifies cost) assessment costs

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Valuation

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Value: Definition

- The rate at which individuals are willing to trade off one resource or service for another

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Value Determination

- Determine value of resource/service by:
  - How much money an individual is willing to give up to get a resource or service

    -OR-
  - How much of other resources or services an individual is willing to forego

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Types of Values

- Active use
  - Recreation, hunting, boating, commercial (market value)
- Option
  - Not using now, may use later
- Passive/Nonuse (independent of use)
  - Existence/bequest
  - Public or ecological value of resource

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Approaches

- Resource-to-resource/Service-to-service:
  - Restoration action provides services of same type, quality, and comparable value
- Value-to-value
  - Restoration action provides services of comparable value
  - Does not meet criteria for service-to-service – e.g., out of kind

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Approaches (cont.)

- Value-to-cost
  - Does not meet criteria for service-to-service
  - Valuation of replacement services cannot be done within reasonable timeframe and/or at reasonable cost

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Scaling Methods

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Methods for Scaling

Service-to-service
Resource-to-resource

- Habitat/resource equivalency
- Conjoint

Value-to-value
Value-to-cost

- Travel cost
- Conjoint
- Hedonic price models
- Contingent valuation
- Market valuation
- Factor income
- Benefits transfer

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Habitat/Resource Equivalency

- Calculates compensation for interim lost services
  - Resources/services created provide the same type and level of services over time as were lost due to the injury
  - Claim = cost of implementation
- Provides integrated framework for injury quantification and restoration scaling

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Habitat/Resource Equivalency (cont.)

- Four basic steps
  - Document and quantify the injury
  - Evaluate replacement project options
  - Scale replacement project
  - Determine appropriate compensation
    - Cost of selected restoration options
      - Include performance standards

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Habitat/Resource Equivalency (cont.)

- Issue
  - How to compare injury and restoration services?

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Value Equivalency

- Monetary value of service losses = monetary value of service gains from compensatory restoration project
  - When service-to-service is not appropriate
- Directly analogous to HEA scaling
  - Value (rather than measured resources or services) is the basis of equivalency

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Value-to-Cost

- Monetary value of service losses = cost of restoration
  - Traditional NRDA models
  - OPA: least preferable alternative

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Valuation Scaling Tools

- Conjoint analysis
  - Survey to determine the values of goods or services based on stated and revealed preference
- Contingent valuation
  - Estimate total value using questionnaire to determine respondents' willingness to pay to prevent a loss of a good or service

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Valuation Scaling Tools (cont.)

- Travel cost model
  - Model recreation demand based on observed behavior (e.g., site choice and trip cost)
- Market valuation
  - Determine market value or price of goods/services (e.g., surface water)
- Hedonic analysis
  - Measure environmental value through market prices (e.g., housing prices)

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Selecting Appropriate Approach

- Classifying restoration actions
  - Do restoration actions match injuries?
- Are injured and replacement resources/services of:
  - The same type?
  - The same quality?
  - Comparable value?

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Equivalency

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Equivalency Approaches

- HEA/REA
  - Restoration provides equivalent resources/services to what was lost
    - Acre of habitat lost = acre gained
- VEA (Conjoint)
  - Restoration provides similar (but not equivalent) resources/services
    - Acre of habitat lost = Improved fish populations

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Equivalency: Factors to Consider

- Can use different approaches for different resources
- Reasonable cost
  - Complex method must be justifiable
    - Provide information not available otherwise
- Reliability
  - Use best technical practices

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Evaluation of Services

STRATUS CONSULTING

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Habitat Services Evaluation

- Need to quantify:
  - Service loss from releases
  - Service gain from restoration
- Questions
  - What are baseline services?
  - How have releases affected services?
  - How will restoration change services?

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Habitat Services Evaluation (cont.)

- No specific guidance or publications for service evaluation
- Published habitat evaluation methods
  - Habitat evaluation procedure (HEP)
  - Habitat appraisal and barter (HAB)

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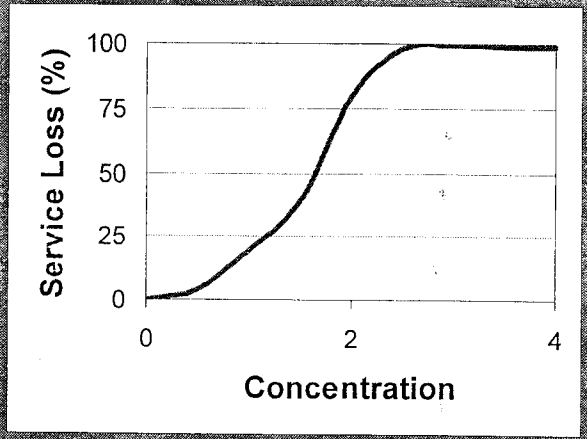
Habitat Services Evaluation (cont.)

- Contaminant concentration effects model
  - 0% loss: Concentration < baseline
  - 100% loss: Everything is dead
  - In between: Dose-response relationship



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Habitat Equivalency Analysis (HEA)

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Practical Restoration-Based Approach

- Restoration opportunities frequently dominated by habitat considerations
- Describe injuries terms of habitat losses
  - Calculate quantity of habitat restoration is needed (offset; replacement)

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Typical Use of HEA

- Known quantity of habitat destroyed
- Restoration of the same habitat is possible
  - Trustees can calculate unit cost
- Restore equivalent habitat
  - Or seek $ damages to cover the cost

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Incorporation of Time

- Concept: lose an acre, restore an acre
  - How to account for passage of time?
- Sum losses and gains over time
  - Acre-years, not acres

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Incorporation of Time (cont.)

- Habitat lost over time
  - If an acre is lost, and nothing brings it back, an acre-year is lost every year
- Habitat restored over time
  - If an acre is restored and maintained, an acre-year is gained every year
- Balance sheet
  - Acre-years of restoration must offset acre-years lost

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Discounting

- Method for equating past, present, and future benefits and costs
  - Typically 3% discount rate in NRDA
- Consumer rate of time preference
  - More is lost if an acre is harmed in 1981 rather than 2008
  - More is gained if an acre is restored in 2010 rather than in 2050

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Discounting Injured Habitat

- The longer the public has suffered the loss, the greater the amount of compensation
- Present value of 1 acre of destroyed habitat lost in:
  - 1981: 2.22 acres
  - 1995: 1.47 acres
  - 2008: 1.00 acres

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Discounting Restored Habitat

- The sooner the public is compensated, the less the amount of compensation
- Present value of 1 acre of habitat restored in:
  - 2009: 0.97 acres
  - 2050: 0.29 acres
  - 2100: 0.07 acres

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HEA Without Discounting

- Per-acre debit
  - One acre-year lost each year until baseline conditions are reach
- Per-acre credit
  - One acre-year gained each year in perpetuity
    - "In perpetuity" = infinite credit

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Simple Accounting

- Total interim loss ("debit")
  - For each year of loss
    - # acres x % service loss x 3% discount
  - Sum all years until baseline reached
    - Debit in discounted service acre-years (DSAYs)

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Simple Accounting (cont.)

- Total amount of restoration ("credit")
  - For each year of gain
    - # acres x % service loss x 3% discount
  - Sum all years that habitat is restored
    - Credit in DSAYs
- Compare
  - DSAYs debit = DSAYs credit

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Example HEA

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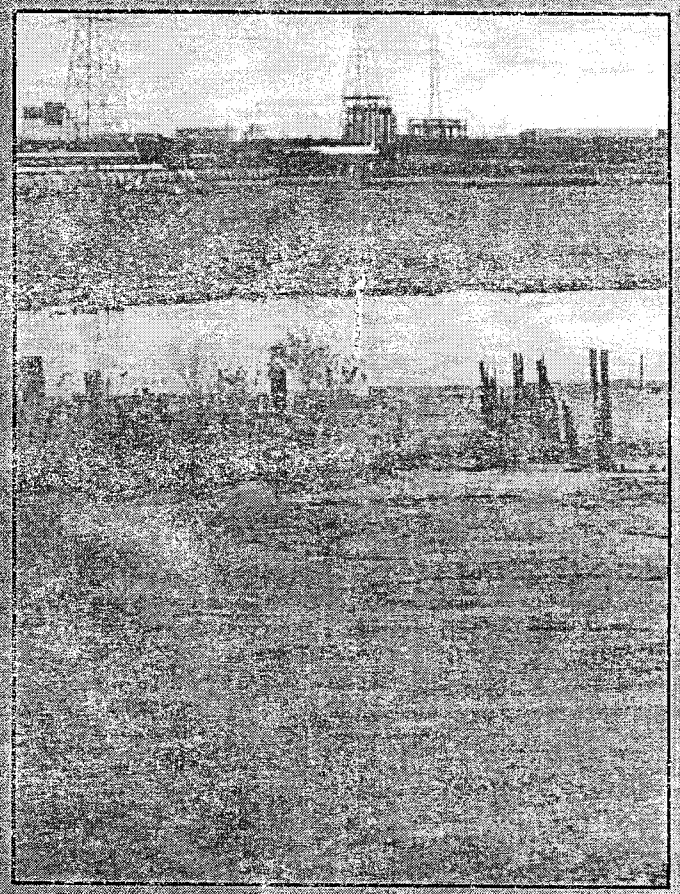
Simple HEA Example – Wetland

- Debit:
  - Acres of injury x % Service Loss
  - Multiply by # years
  - Incorporate discount rate
- Credit:
  - How much restoration provides equivalent ecological services?



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Wetland Example – HEA Debit

- Lost wetland services
  - Biodiversity, habitat, protected species…
- Metric for calculating service loss
  - % vegetative cover
- Current level of services
  - Zero. No vegetative cover.
  - 100% service loss (relative to a baseline wetland in this area).

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Wetland Example – the Debit

- Area: 10 acres
- Service loss: 100%
- Temporal extent: 30 years
  - Jan 1981 to Dec 2010
- Linear recovery starting in 2005
  - 0% service loss by end of 2010
- Discount rate: 3%

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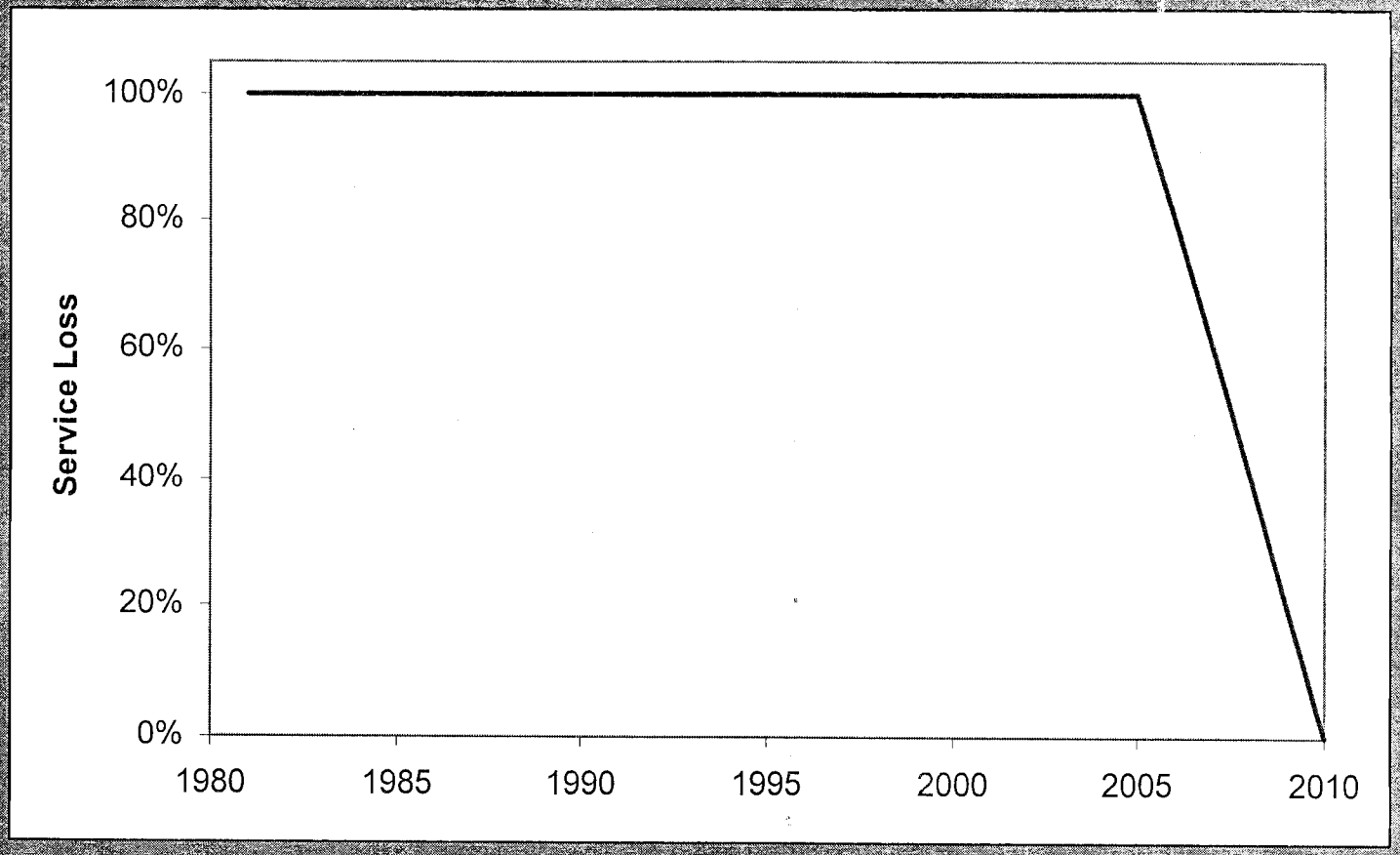
Wetland Example – the Debit (cont.)



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Wetland Example – the Debit (cont.)

Year	Discount factor	Service Loss	Discounted debit per acre
1981	2.22	100%	2.221
1982	2.16	100%	2.157
1983	2.09	100%	2.094
1984	2.03	100%	2.033
1985	1.97	100%	1.974
1986	1.92	100%	1.916
1987	1.86	100%	1.860
1988	1.81	100%	1.806
1989	1.75	100%	1.754
1990	1.70	100%	1.702
2005	1.09	100%	1.093
2006	1.06	80%	0.849
2007	1.03	60%	0.618
2008	1.00	40%	0.400
2009	0.97	20%	0.194
2010	0.94	0%	0.000

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Wetland Example – the Debit (cont.)

<u>With discounting</u>:

- Sum of PV debit = 41.9 DSAYs per acre
- Total area = 10 acres
- Total debit = 419 DSAYs

<u>With no discounting</u>:

- Sum of debit: 27 SAYs per acre
- Total area = 10 acres
- Total debit = 270 SAYs

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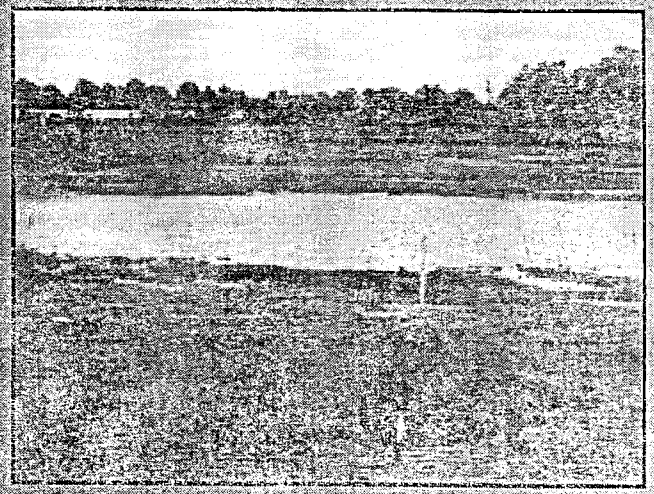
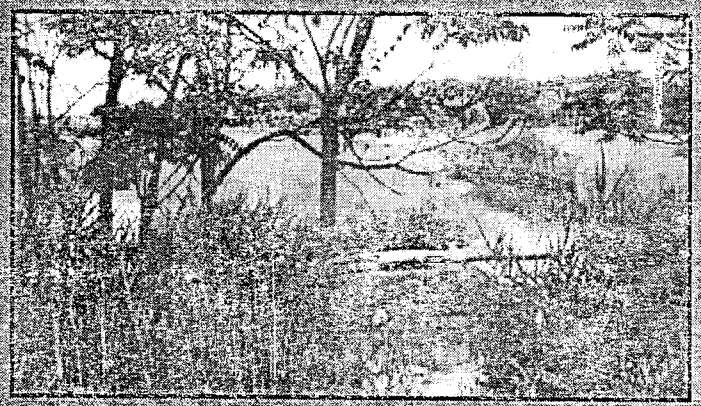
Wetland Example – the Credit

- Wetland restoration
  - Equivalent services
  - Nearby location
  - Feasible
  - Desirable
  - Available





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Wetland Example – the Credit (cont.)

- Per-acre credit for wetland creation
  - Must use same metric!
    - Wetland vegetation cover
  - Assume +50% service gain
  - Linear recovery over 10 yrs
  - Services continue long into the future

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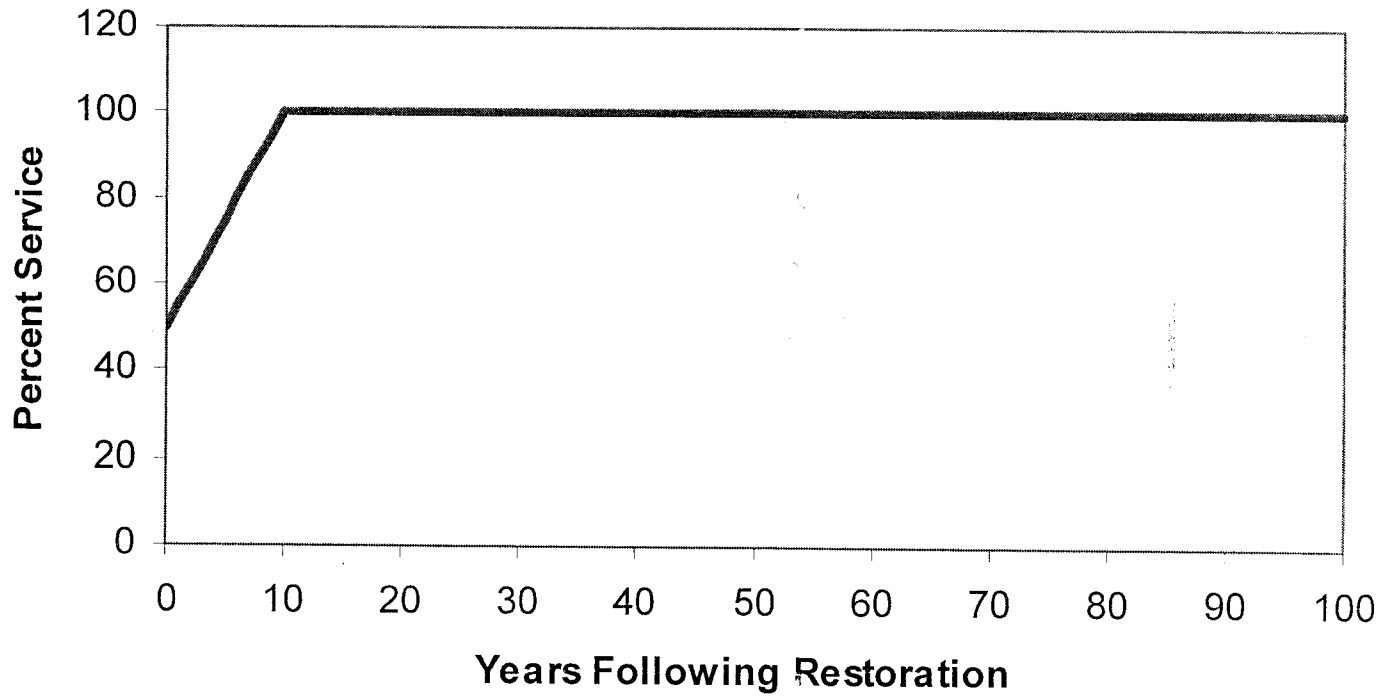
Wetland Example – the Credit (cont.)



- Baseline = 100% services

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Wetland Example – the Credit (cont.)

Year	Discount factor	Net service increase	PV credit per acre
2010	0.94	5.0%	0.047
2011	0.92	10.0%	0.092
2012	0.89	15.0%	0.133
2013	0.86	20.0%	0.173
2014	0.84	25.0%	0.209
2015	0.81	30.0%	0.244
2016	0.79	35.0%	0.276
2017	0.77	40.0%	0.307
2018	0.74	45.0%	0.335
2019	0.72	50.0%	0.361
2020	0.70	50.0%	0.351
2106	0.06	50.0%	0.028
2107	0.05	50.0%	0.027
2108	0.05	50.0%	0.026
2109	0.05	50.0%	0.025
2110	0.05	50.0%	0.025

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Wetland Example – the Credit (cont.)

<u>Per-acre credit, with discounting</u>:

- 100 yrs: 13.4 DSAYs
- 200 yrs: 14.2 DSAYs
- >200 yrs: 14.2 DSAYs

<u>Per-acre credit, with no discounting</u>:

- 100 yrs: 48.3 DSAYs
- 200 yrs: 98.3 DSAYs
- 1,000 yrs: 498.3 DSAYs

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Scaling Restoration

<u>Required restoration, with discounting:</u>

- Debit: 419 DSAYs
- Credit: 14.2 DSAYs (200 years)
- Total: 419/14.2 = 29.5 acres

<u>Required restoration, without discounting:</u>

- Debit: 270 DSAYs
- Credit: 98.3 DSAYs (200 years)
- Total: 270/98.3 = 2.7 acres

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Wetland Example – Total Damages

- Calculate restoration cost
  - planning and design, permitting, implementation, oversight, O&M, monitoring, contingency, etc.
- Hypothetical unit cost = $100,000/ac
- Total damages for hypothetical scenarios
  - 29.5 ac x $100,000/ac = $2,950,000
  - 2.7 ac x $100,000/ac = $270,000

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Tribal/Human Use Issues

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Tribal/Human Use Valuation

- "Restoration" issues for lost tribal use
  - Likely more than ecological restoration
  - But, issues identifying and quantifying compensable restoration
- Restoration projects
  - Do they address similar types of uses?
  - How do they benefit tribal members?

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Example: Tribal Loss in NRDA

- Loss: Identification/use of specific resources
  - Traditional plant harvest for basket making
  - Traditional food sources and uses
- Restoration: Resource and Education Center
  - Focus on important resource
    - Seed bank, husbandry education
  - Teach identification and use of resources
    - Education in native language

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Example: Tribal Loss in NRDA (cont.)

- Data: Interviewed knowledgeable tribal members
  - In conjunction with human health risk assessment
- Estimated number of days of lost uses
  - 1981 through recovery to baseline (estimated - remedy not yet final)

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Example: Tribal Loss in NRDA (cont.)

- Calculated benefits of Center
  - Number of tribal members,
  - Estimated number of days of use
- Calculated the cost of Center
  - Buildings, staff, materials, land

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Restoration

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Restoration Planning

- Often the most public aspect of the project
  - Public solicitation of potential restoration actions
  - Need to control the public's expectations
- Engage interested stakeholders
  - Start planning process early
- Document selection criteria
- Ensure nexus with injured resources
- Can be started at any time in the process

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Restoration Implementation

- Restoration plan
  - Describe details of restoration
  - Engineer-level design

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Restoration Monitoring

- Credit assumes successful restoration
- For engineered restoration projects
  - Must include regular monitoring
  - Warranty if restoration fails

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