CWA Compensatory Mitigation
Scaling Incorporating Uncertainty

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Overview

- Scaling Compensatory Mitigation
- Incorporating Mitigation Uncertainty
- Incorporating Impact Uncertainty
Scaling Compensatory Mitigation

Example: Kilo Wharf in Apra Harbor, Guam
- Approximately 19 acres of coral habitat impacted
  - Anchor
  - Dredge
  - Fill
  - Sedimentation
- Recommended mitigation: Coral recovery through water quality improvements in Cetti Bay
  - Controlling upland sources of sediment deposition
  - Natural coral recruitment and re-establishment
Scaling Compensatory Mitigation
Scaling Compensatory Mitigation

- How much mitigation is enough?
  - New ACOE and EPA regulations for CWA § 404 permitting (2008)
    - Amount must be sufficient to replace lost aquatic resource functions
      - Method of compensatory mitigation
      - Likelihood of mitigation success (uncertainty)
      - Differences between the lost and replacement functions
      - Temporal loss of functions
      - Difficulty of restoring functions
      - Distance between the project and mitigation sites
Scaling Compensatory Mitigation

- Used an *equivalency* approach for Kilo Wharf
  - Habitat Equivalency Analysis (HEA)
  - Balances lost ecosystem services with replacement services
  - Originally developed for CWA § 404 mitigation scaling
    - King and Adler 1991
  - Subsequently used in Natural Resource Damage Assessments
  - Flexible enough to accommodate uncertainty
Scaling Compensatory Mitigation

- **Loss parameters**
  - Severity of impacts: 5 – 100 percent
  - Period of impacts: 2 – 95 years, and into perpetuity
  - Present value of loss: 102 acre-years of coral services

- **Replacement parameters**
  - Cetti Bay sedimentation control
  - Replacement rate: 3.9 – 36.8 acre-years of coral services per acre of mitigation *given complete certainty of success*
  - Range of success considered: 50 – 100 percent
Incorporating Mitigation Uncertainty

- Scaling criterion used

\[
\sum_{t=t_0}^{t_1} L_t (1 + i)^{(P-t)} = a \sum_{s=s_0}^{s_1} R_s (1 + i)^{(P-s)}
\]

- Where
  - \( L_t \) = Lost services in year \( t \)
  - \( R_s \) = Replacement services in year \( s \)
  - \( a \) = Likelihood of mitigation success
  - \( i \) = Discount rate
Incorporating Mitigation Uncertainty

- Results for Kilo Wharf
  - Present value of loss: 102 acre-years of coral services
  - Expected present value of replacement at Cetti Bay:
    - 188 – 376 acre-years of coral services
    - 50% – 100% likelihood of mitigation success
  - Cetti Bay project likely to mitigate impacts of Kilo Wharf over a wide range of mitigation success
Incorporating Mitigation Uncertainty

![Bar chart showing different categories of lost functions and their success rates with corresponding acre-years.]
Incorporating Impact Uncertainty

- Scaling criterion used

\[ a \sum_{t=t_0}^{t_1} L_t (1 + i)^{(P-t)} = \sum_{s=s_0}^{s_1} R_s (1 + i)^{(P-s)} \]

- Where
  - \( L_t = \) Lost services in year \( t \)
  - \( R_s = \) Replacement services in year \( s \)
  - \( a = \) Likelihood of impact
  - \( i = \) Discount rate
Incorporating Impact Uncertainty

Example: Garrison Diversion in North Dakota
- Bureau of Reclamation water supply study
- Study of inter-basin water transfers between Missouri River and Red River basins
  - Crosses the Continental Divide
- Concern about potential transfers of invasive biota
  - Lake Winnipeg commercial fishery
  - Hudson Bay drainage
  - Ecological Risk Assessment
  - Consequence Analysis
Incorporating Impact Uncertainty
Incorporating Impact Uncertainty

Results

- Certain mitigation now to compensate for uncertain impacts in the future
- Incorporated probability estimates from Ecological Risk Assessment
- Accounted for a variety of propagation scenarios
- Estimated a range of mitigation requirements
  - Lake Winnipeg: 2 – 27,750 acres (< 0.5%)
  - Red River: 0 – 2 river-miles (< 0.5%)
Conclusions

- Equivalency approaches such as HEA appear to satisfy the requirements of the new ACOE and EPA regulations for CWA § 404 permitting.
- HEA can accommodate mitigation uncertainty.
- HEA can accommodate impact uncertainty.
Suggested References


Suggested References
