



Net Ecosystem Service Analysis for the Selection of Best Remedial Alternatives: The Lake Maggiore Case Study

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Convegno sul tema:

SURF Italy Day – La Sostenibilità delle Bonifiche

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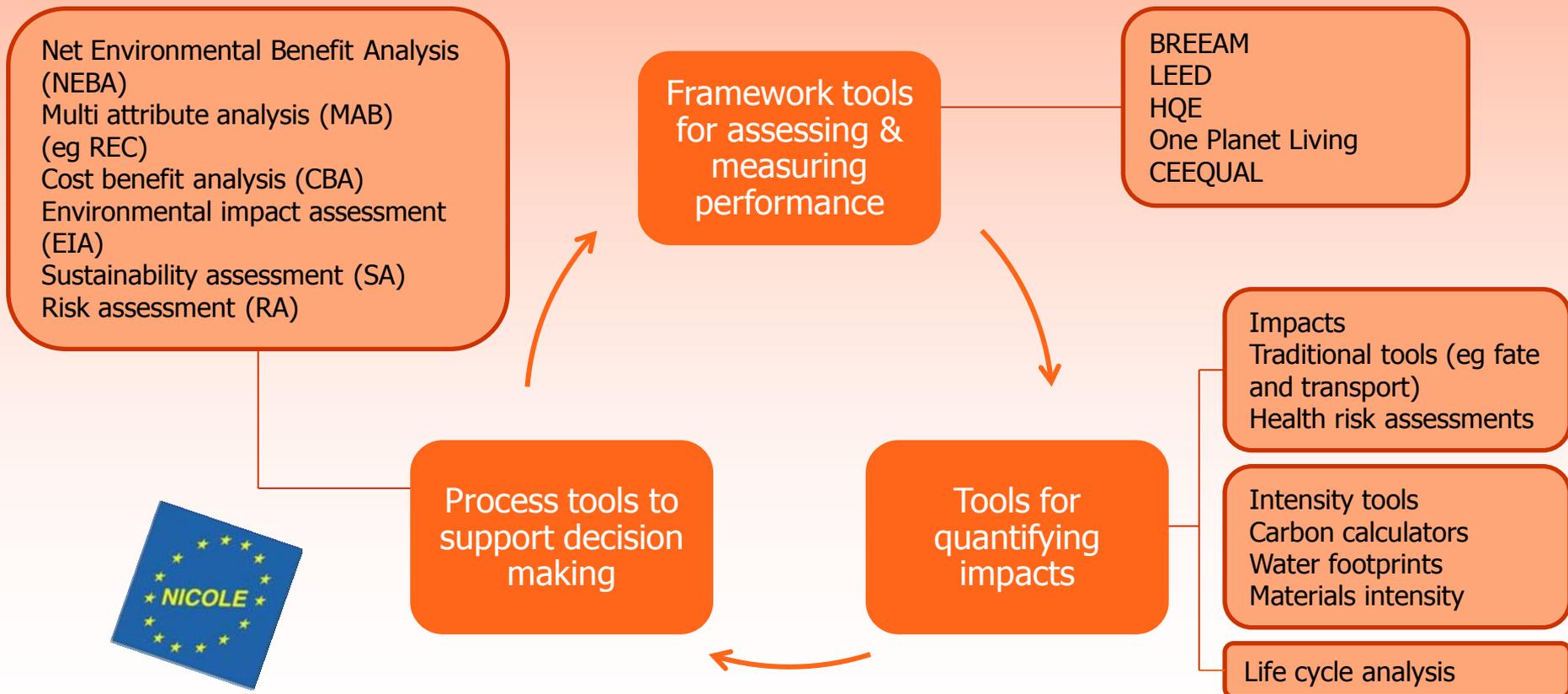
A sustainable remediation project is one that represents the best solution when considering *environmental, social and economic factors* – as agreed by the stakeholders

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NICOLE Road Map for Sustainable Remediation

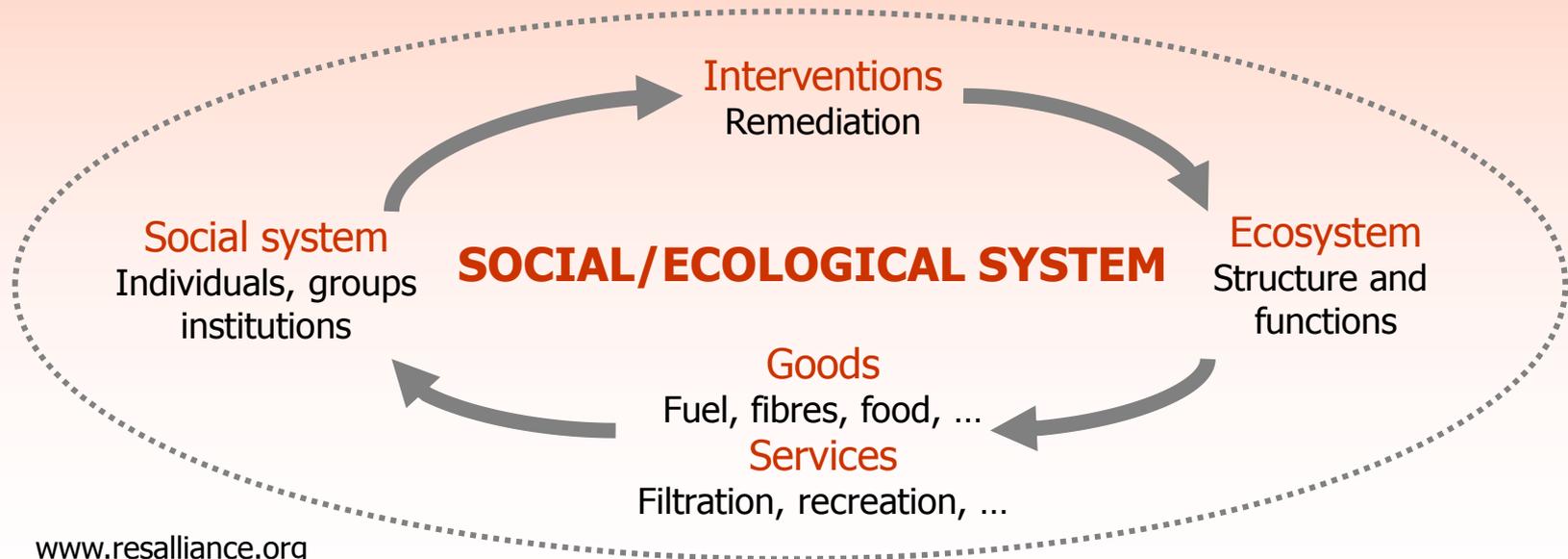
Tools to Support Sustainability Assessment

Remedial actions can significantly influence not only polluted matrices such as soil and groundwater but also quality and quantity of other natural resources and services offered by surrounding landscape and ecosystems



Net Environmental Benefit Analysis

- **NEBA**, also known as Net Ecosystem Services Analysis (NESA) (Nicolette et al, 2011) is a useful approach to compare management options
- Formal quantification of the change in assets provided by the environment to people (ecosystem services), considering the implementation of different remedial scenarios and comparing those changes to cost and predicted risks

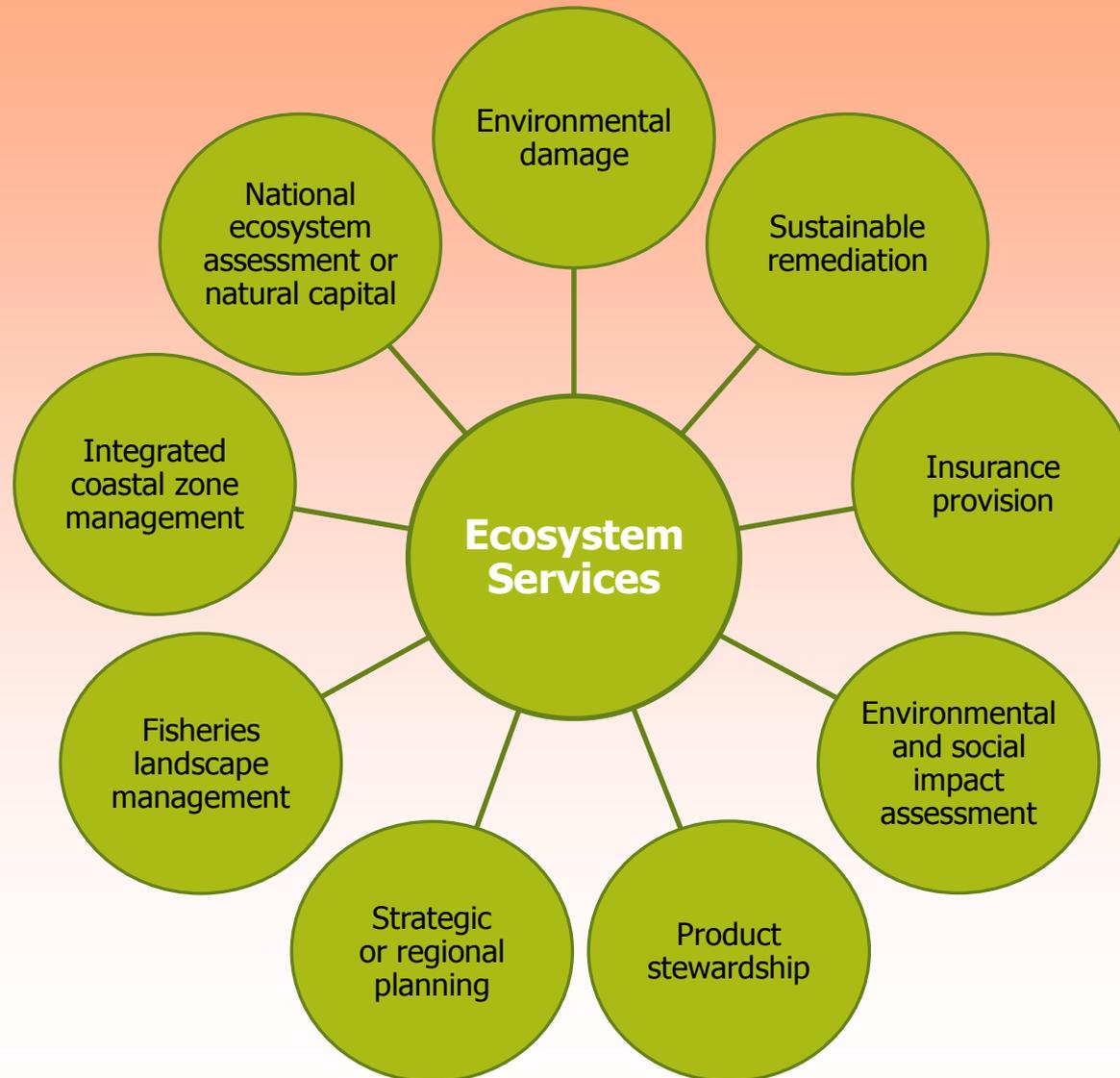


What are Ecosystem Services?

Ecosystem services contribute to economic welfare both through contributions to the generation of income and wellbeing and the prevention of damages that impose costs on society



Ecosystem Services in Practice

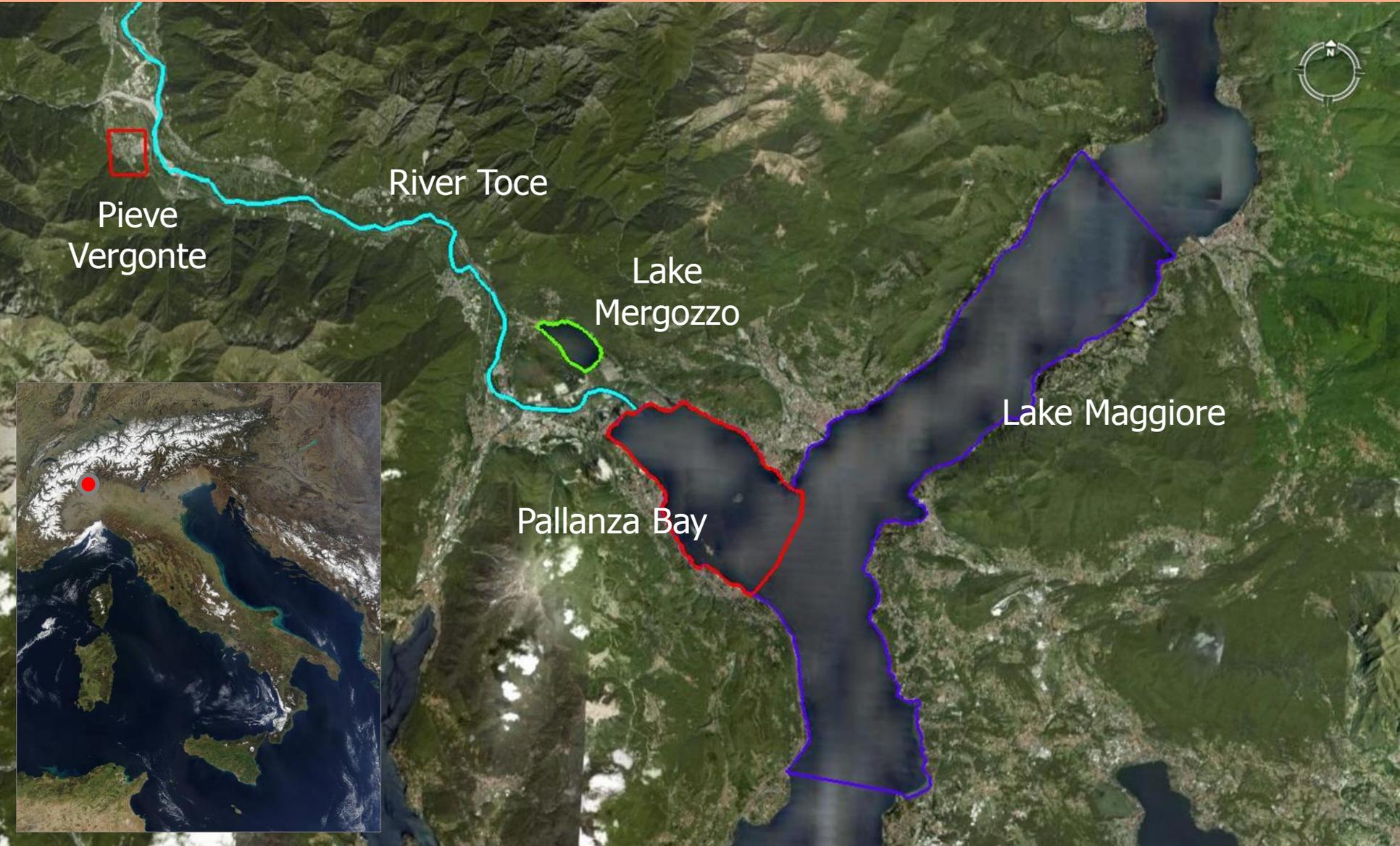


NEBA can add clarity if:

- The contaminated site may have a potentially significant ecological value or may be surrounded by areas of naturalistic interest
- The proposed remedial actions can be environmentally damaging
- The benefit of remediation appears to be disproportionate to costs of remediation
- Remediation actions appear to provide a marginal benefit or no net increase in ecosystem service value for the effort expended (eg marginal contamination)

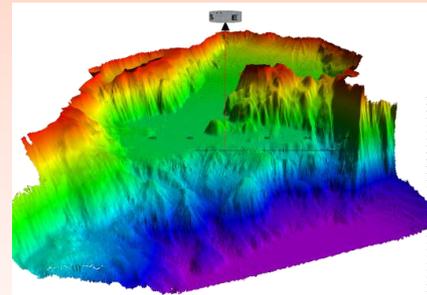


Lake Maggiore Watershed



Field Activities

- Sediment sampling for chemical characterisation
- Sediment profile imaging (SPI) survey
- Bathymetric and topographic surveys
- Sediment transport modelling
- Geochronology analysis
- Site-specific toxicity testing
- Fish and benthos sampling for chemical characterisation
- Benthos community analysis
- Ecological risk assessment
- Baseline characterisation
- Net ecosystem service analysis



Ecological Risk Assessment

Benthos

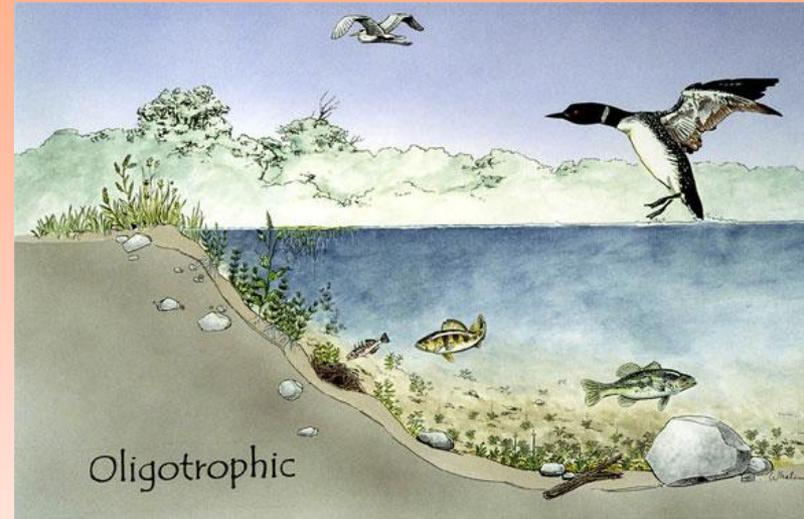
- Site specific toxicity testing
- Chemical concentration (biota and sediment) vs benchmark
- SPI camera and benthos survey

Fish

- Fish tissue analysis vs toxicity benchmark
- Water analysis vs water quality benchmark
- Evaluation of fish fitness (weight/length)

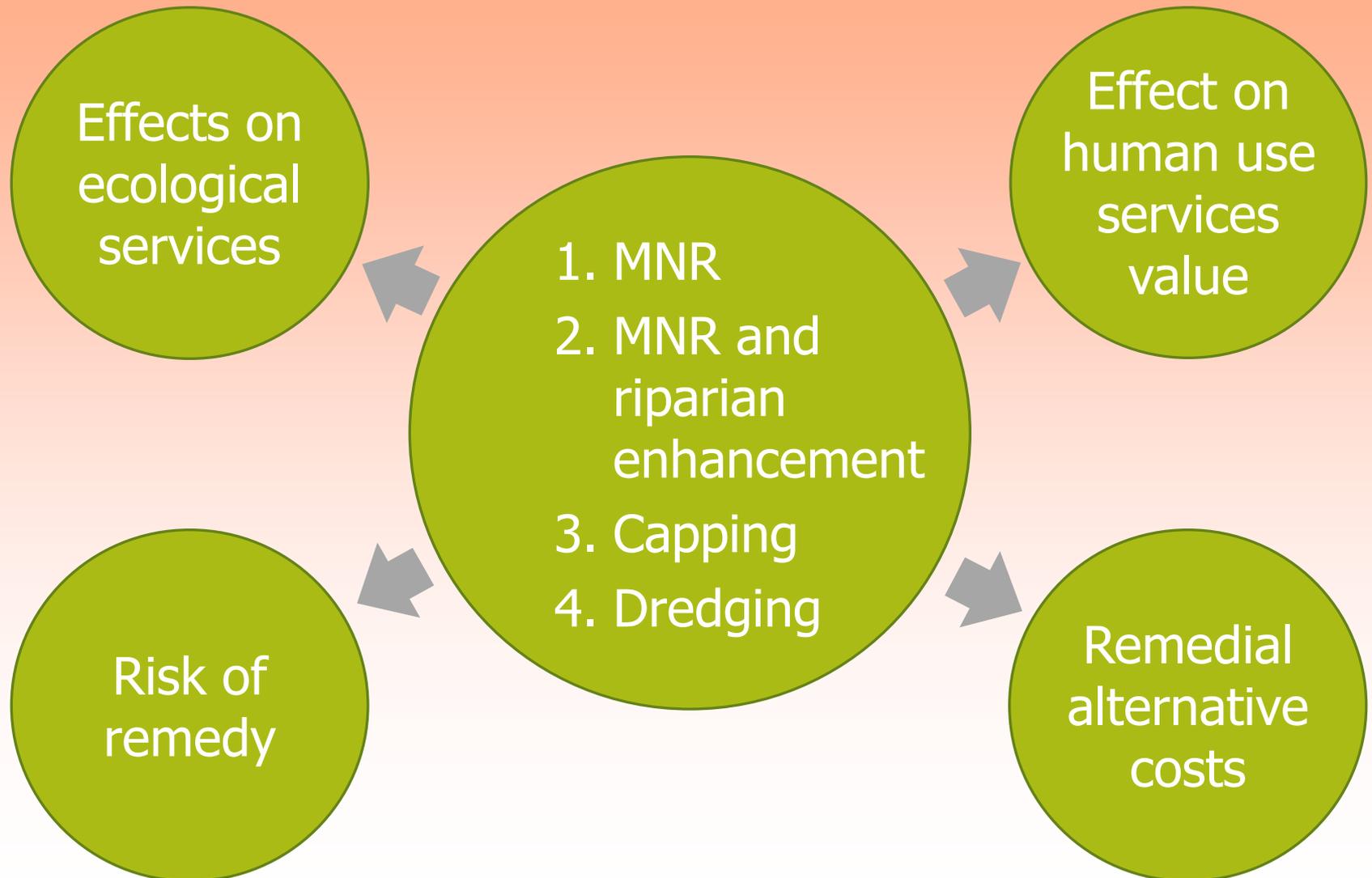
Wildlife

- Diet exposure estimates vs literature derived benchmark
- Evaluation of site specific studies



At current conditions (baseline), ERA results define that no ecological service loss is associated with the current conditions in Pallanza Bay

Evaluation of Remedial Alternatives



Effects on Ecological Services

MNR

- No variation compared to the baseline

MNR and riparian enhancement

- Enhancements positively affect riverbank erosion, flood potential and habitat

Capping

- Physical impacts to the benthic community

Dredging

- Physical habitat disturbance
- Re-suspension of contaminants
- Re-exposure of sediment contaminants previously buried and creation of direct exposure pathway for biota

Example: Ecological Service Gain for MNR and Riparian Enhancement

Projects were identified for their value in providing ecological and human use services gains:

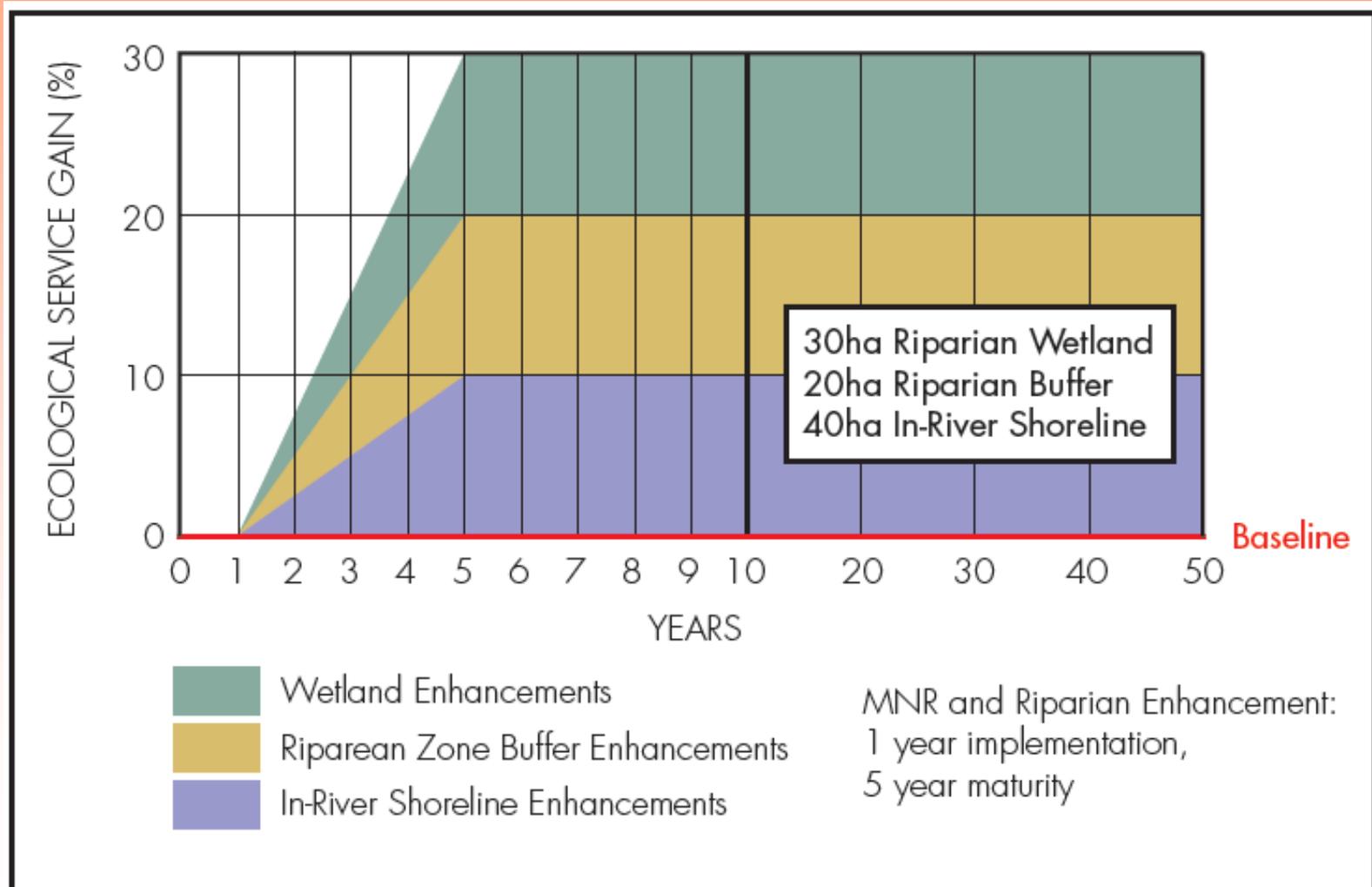
- Wetland enhancement
- Riparian buffer and corridor enhancement
- Riverbank erosion and flow management enhancements

Positive effects on:

- Generation of habitat along the river
- Shoreline soils stabilisation and erosion decrease
- Flood control and water storage

Based on US experience, the enhancement of the ecological services were estimated for all three riparian habitat projects

Example: Ecological Service Gain for MNR and Riparian Enhancement

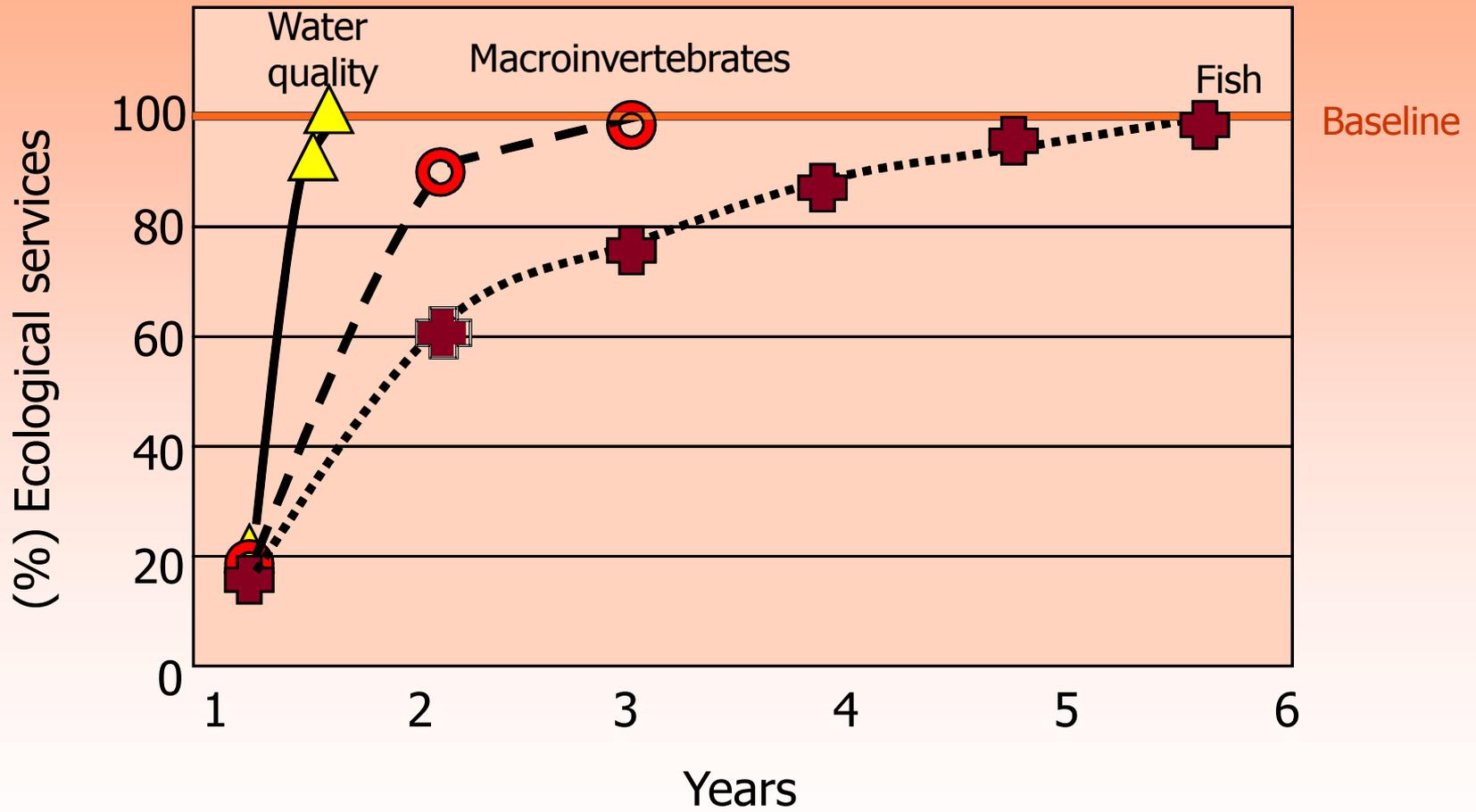


Example: Ecological Service Loss for Dredging

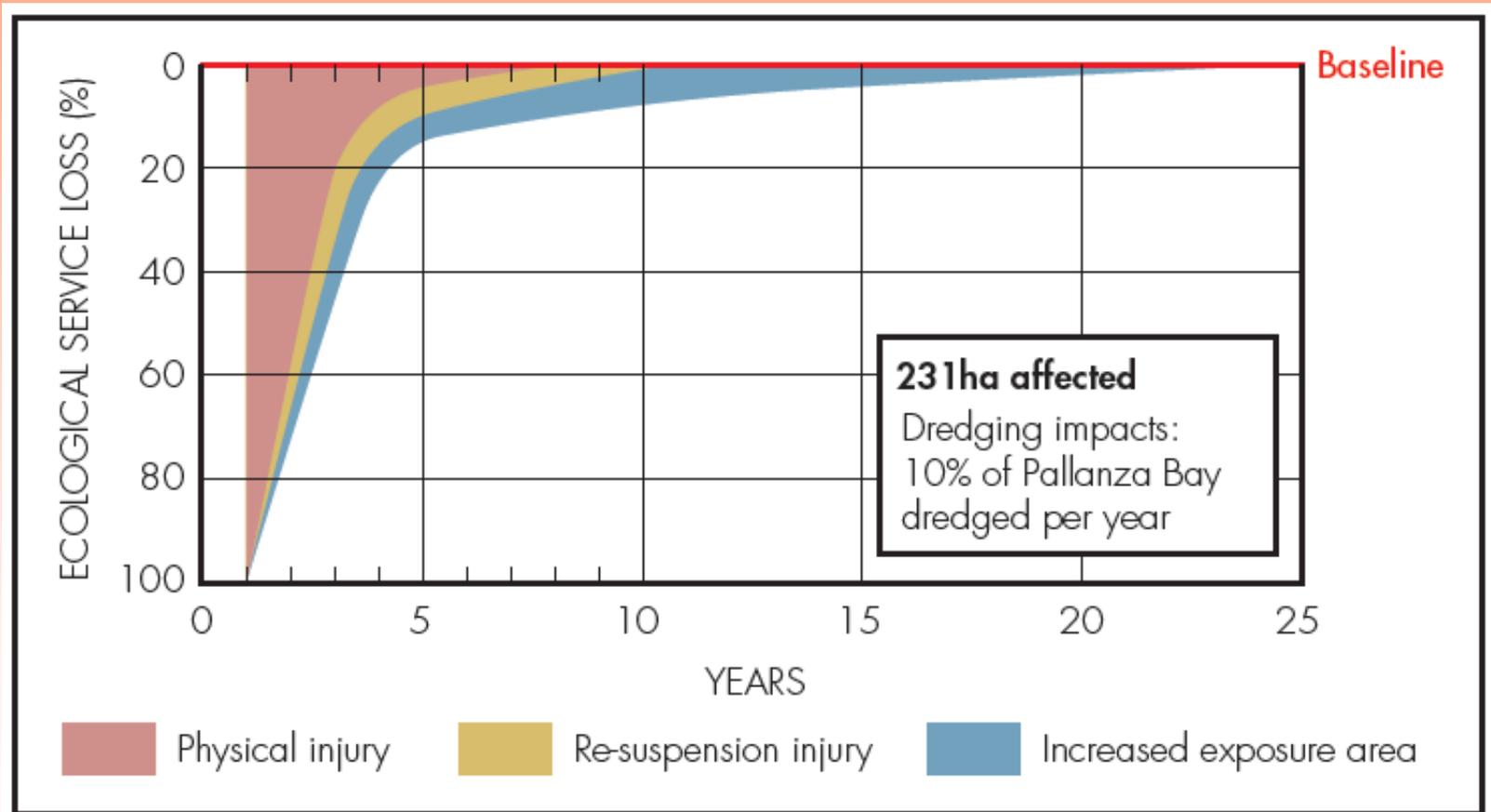
Benthic invertebrate community served as a surrogate to represent the overall service flows associated with the bay. Impacts to the benthic community were assumed to translate to impacts to upper trophic level organisms

- **Physical injury:** recovery to baseline conditions were assumed on the basis of studies on benthic community recovery after disturbance; the recovery curve was extended to encompass injury that would be reflected in longer lived species such as fish
- **Re-suspension injury:** effects would extend system recovery times for benthos and fish; it was assumed that overall recovery to baseline would be delayed for a 25-year period
- **Re-exposure injury:** considering site specific data, surface sediment concentrations were estimated considering different dredging scenarios and potential ecological risk for benthos was evaluated (% area of elevated risk)

Example: Recovery to Baseline After Dredging



Example: Ecological Service Loss for Dredging



Changes in ecological service were translated in discounted service hectare/year (dSHY) using habitat equivalency analysis methods

Effects on Human Use Service

MNR

- No variation compared to the baseline

MNR and riparian enhancement

- Reduced risks associated with high flood events
- A higher ecological quality will provide additional value to local residents as well as tourists

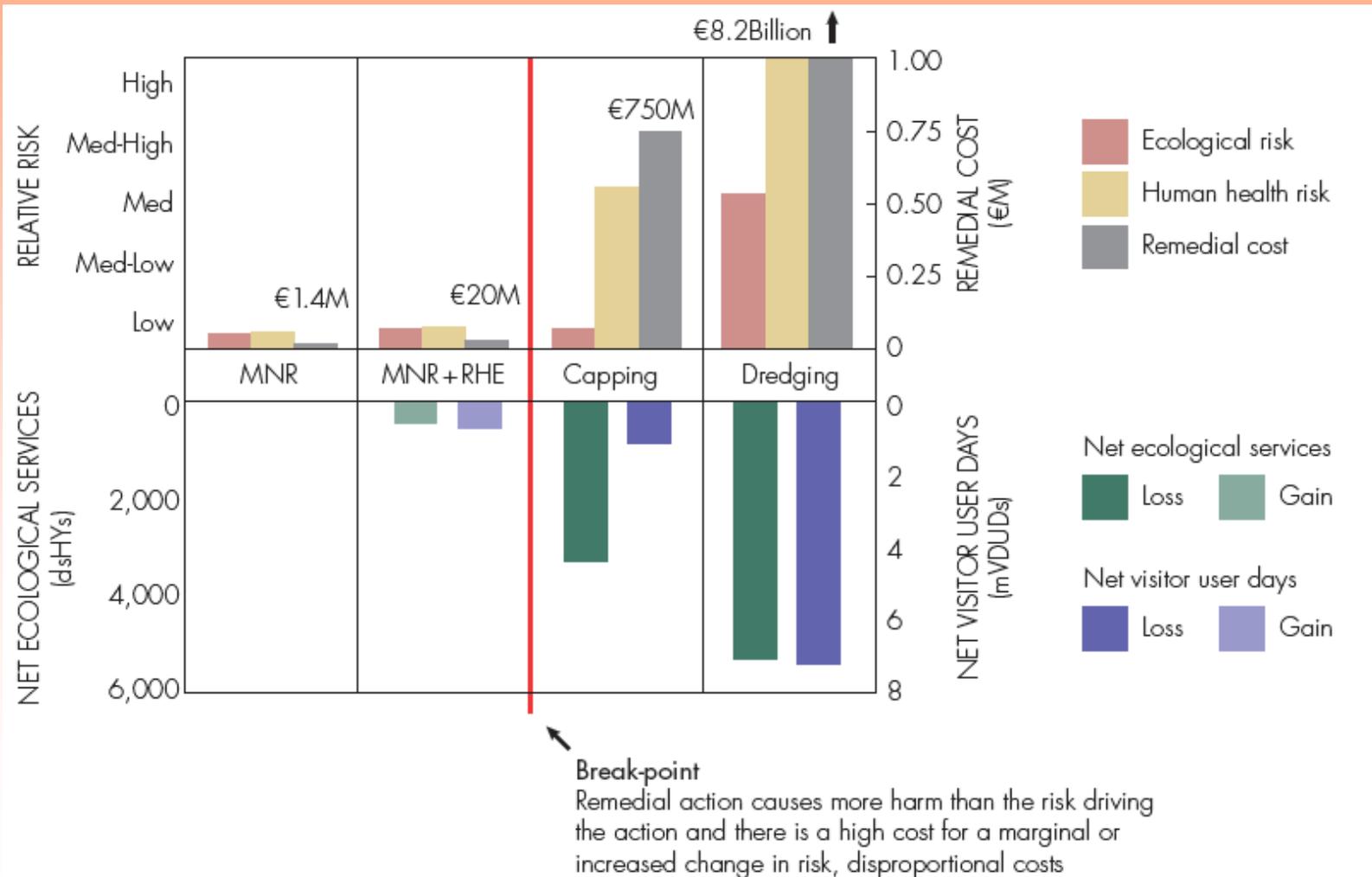
Capping

- Heavy construction equipment on the waters of the bay, with effects on the quality of trips to the area
- Reduced fishing success due to potential impacts to benthos (fish prey)

Dredging

- Heavy construction equipment on the waters, with effects on the quality of trips to the area
- Reduced fishing due to voluntary or regulated fishing restrictions and impacts on benthos

Comparative Analysis Results



Conclusion

Based on the results of the comparative analysis it is recommended that capping and dredging not be considered as viable options for Pallanza Bay

Lake Maggiore NEBA

- Provided framework for discussion with regulators
- Improved communication and decision making

NEBA more generally

- Defensible basis for sustainable environmental management
- Integrates environmental, social and economic concerns
- Framework for stakeholder communication

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Grazie dell'attenzione!