

Appendix E
Prioritization of Management Options

Prioritization of Management Options

The objective of the prioritization process is to develop a science-based protocol for determining priorities and strategies for improving nearshore ecosystem functions on Bainbridge Island. The process links output from the Nearshore Characterization and Assessment with the prioritization process. The process draws from the fields of restoration ecology, landscape ecology, and conservation biology. The input to the approach is based on expert opinion founded in the best available science (BAS) for the region. A companion report developed for Bainbridge Island (Williams et al., 2003) provides a discussion of the BAS for Bainbridge Island nearshore.

Nearshore Management Strategies

Five fundamental strategies for improving ecosystem functions of nearshore systems (listed in no particular order) are included in the process and form the basis for management decisions:

- **Creation** – Creation involves bringing into being a new ecosystem that previously did not exist on the site (NRC 1992). In contrast to restoration, creation involves the conversion of one habitat type or ecosystem into another.
- **Enhancement** – Enhancement means any improvement of a structural or functional attribute (NRC 1992). As noted by Lewis (1990), enhancement and restoration are often confused. Enhancement is the intentional alteration of an existing habitat to provide conditions that previously did not exist and which by consensus increase one or more attributes. Shreffler and Thom (1993) found that, for estuarine systems, enhancement often meant *enhancement of selected attributes* of the ecosystem, such as improving the quality or size of a tidal marsh or eelgrass meadow.
- **Restoration** – As defined in the scientific literature, restoration means the return of an ecosystem to a close approximation of its previously existing condition (e.g., Lewis 1990, NRC 1992). We use the term restoration to refer to any form of human intervention with the intent of improving upon the existing condition of the ecosystem or habitat. Restoration involves doing *something* to increase the rate of recovery over the rate of natural recovery occurring without human intervention.
- **Conservation** – Conservation, as defined by Meffe et al. (1994), refers to the maintenance of biodiversity. Conservation Biology is a synthetic field that applies the principles of ecology, biogeography, population genetics, economics, sociology, anthropology, philosophy and other theoretically based disciplines to the maintenance of biological diversity. Conservation can allow development to occur as long as biodiversity and the structure and processes to maintain it are not affected.
- **Preservation** – Preservation refers to the formal exclusion of activities that may negatively affect the structure and/or functioning of habitats or ecosystems. It can also refer to preservation of a species or group of species through management actions, such as elimination of harm to a species directly or indirectly through damage of its habitat. Marine protected areas (MPAs) can fit within this strategy. Marine protected areas are receiving growing attention as a viable way to preserve fish populations threatened by over-fishing and habitat loss (e.g., Roberts et al. 2001). They are typically established in habitats known to be important for function, such as reproduction or rearing.

Influence of Disturbance on Management Actions

The prioritization process considers the level of disturbance affecting the nearshore systems of Bainbridge Island. The success of any strategy varies depending on the level of disturbance of the site and the landscape within which the site resides (NRC 1992). Using the findings of the National Research Council (NRC) and a review of the literature on estuarine habitat restoration, Shreffler and Thom (1993) concluded that the strategies of restoration, enhancement, and creation should be applied depending on the degree of disturbance of the site and the landscape (Figure E-1). It is assumed that the historical conditions represent the optimal habitat conditions for a particular site. In general, restoration to historical conditions is best accomplished where the sites and the landscape are not heavily altered (Shreffler and Thom 1993; NRC 1992). Creation of new habitat (i.e., habitat not historically present) at a site is done when the site and the landscape are heavily damaged. Because the nearshore and adjacent uplands of the Island have typically not been heavily urbanized, the goal of restoring the nearshore habitats to historical conditions is viable over much of the Island. However, in some areas of the Island, other alternative actions are more appropriate (see below). For example, sites with a high degree of disturbance on the landscape (management area) and site (reach) scales (Figure E-1), in general, have a low probability for restoration, and creation of a new habitat or ecosystem or perhaps enhancement of selected attributes would be the only viable strategies to apply in these situations. In contrast, where the site and landscape are essentially intact, restoration to historical (i.e., humans present, but insignificant disturbance) or predisturbance (i.e., before man) conditions would be viable options and the probability of success would be high.

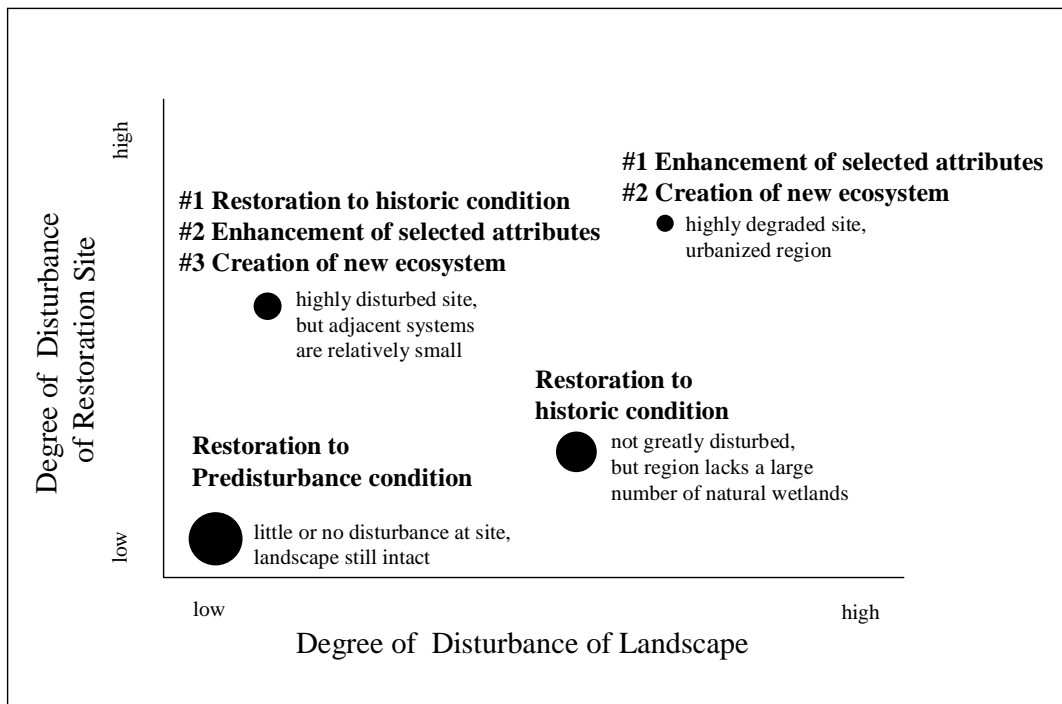


Figure E-1. The restoration strategies for nearshore systems relative to disturbance levels on the site and in the landscape (from Shreffler and Thom 1993).
(The relative chance of success increases with the size of the dot.)

Conservation strategy is related to another strategy common in the literature: *sustainable development*. *Development* here means the qualitative change in a systems complexity and configuration as opposed to (sustainable) *growth* which refers to a quantitative increase the size of the system (Meffe et al. 1994). Basically, this means that society conducts itself in a manner that preserves ecosystems for the future by

encouraging actions that conserve what exists and that restore what has been damaged or lost (Meffe et al. 1994). Hence, the fields of conservation biology and restoration ecology merge under sustainable development, and, furthermore, are interdependent upon one another.

Some of the practical steps in sustainable development include the following:

- Avoid and minimize damages from any development project through thorough review and refinement of the project—base this on sound understanding of the individual and cumulative effects of the project on the ecosystem. By knowing the sources of stress, one can better provide advice on how to avoid these stresses through engineering and project modifications.
- Devote a strong effort in the planning phase for the restoration project to maximize the assurance of success.
- Execute the restoration project effectively and comprehensively.
- Monitor and adjust the project as needed to better meet the goals.

Finally, effectively achieving the goal may require that several strategies be employed at a site and in the landscape. It is possible that preservation of landscape features, enhancement of selected nearshore attributes, and conservation in the nearshore may be highly effective in restoring the controlling factors that affect historical structure, functions, and processes to the system.

Background to Prioritization Process

There is no universally accepted method for prioritizing nearshore sites for restoration or for determining what strategies are best applied to each site. At a national level, the U.S. Army Corps of Engineers (2000) has the most developed planning process for projects under their civil works mission (i.e., navigation, flood control), and they are adapting this process to ecosystem restoration projects (Thom et al., in press). Once the site is selected, the Corps process evaluates alternative plans relative to environmental planning objectives and cost. Through what is termed incremental analysis, they arrive at a point where there is a rapidly diminishing return on investment in the project. The process therefore highlights the action that provides the most benefit per unit of investment. The Corps utilizes environmental indices (e.g., habitat suitability indices; hydrogeomorphic indices; Shafer and Yozzo 1998; Thom et al., in press) as metrics to evaluate environmental outcomes from alternative restoration plans.

In the northwest, several approaches have been applied to prioritizing restoration projects. The approaches have several aspects in common: a goal statement, a site assessment to ascertain changes in conditions from the historical condition, a set of selection criteria, and a qualitative or semi-quantitative scoring protocol. The overall driver for these programs is to determine where and what needs to be done to result in improved conditions relative to the goal. Improvement in the landscape (management area) (e.g., limiting factor analysis), or simply the opportunity for restoration (e.g., sites made easily available, Bloch et al., 2002) at least partially drives the process of site prioritization. In highly urbanized and developed areas such as ports, site selection and prioritization is strongly driven by the cost for the site and its restoration relative the chance for restoration to be successful (Shreffler and Thom 1993). The chief drawback with all approaches has been the need to rely heavily on subjective (i.e., expert opinion) information in the face of a lack of critical data on key relationships. For example, it would be ideal to develop a metric that indicates the increase in fitness of juvenile salmon relative to various manipulations of the nearshore ecosystem. Because this is not possible with our present understanding, surrogates are utilized, such as area of selected habitats, juvenile salmon prey densities produced by habitats, area covered by exotic plants, and area of intact riparian zone.

Multi-criteria methods use data on the physical and chemical requirements (i.e., the *controlling factors* as used in this study) of a selected nearshore habitat (e.g., eelgrass), along with data on past restoration experience for that habitat to parameterize a model or index that evaluates the restoration potential for sites in a region (e.g., Store and Kangas 2001; Short 2003). Recent work with multi-criteria methods link results directly to a Geographic Information System (GIS), where the results of the analysis can be displayed on maps of the region (Store and Kangas 2001). The advantage of these habitat suitability models (HSM) is that quantitative data on habitat requirements are used along with information on existing conditions at sites. If data on habitat requirements are available and used, this type of analysis is generally more objective than other methods relying on expert opinion. However, expert opinion can also be incorporated when quantitative data are not available, which increases susceptibility to bias and decreases repeatability.

For analysis of sites, the method not only requires information on the needs of a particular habitat type, but also on the historic and present conditions of sites in the region. For example, a site with appropriate conditions prior to development may not presently be suitable for a particular habitat. Therefore, careful examination of the potential site needs to incorporate past (historical undisturbed) and present conditions, and the degree of change that needs to take place to reestablish the habitat. This method deals only with habitats where there is a large amount of information on their requirements as well as on their restoration potential. A separate model would be required for each habitat within a system.

The Index of Biological Integrity (IBI) is a multi-metric index of habitat quality and condition that composite several environmental or biotic variables to evaluate aquatic resources and to assess the effects of anthropogenic degradation (Karr 1993; Hughes et al. 2002). A biotic index is calculated based on a set of measurable biotic variables that are known to be indicative of habitat quality. For example, the following set of variables was used by Hughes et al. (2000) for evaluating estuarine quality on the east coast:

- Fish abundance or biomass
- Total fish species per trawl
- Species dominance
- Number of resident species
- Number of estuarine nursery species
- Number of in-estuary spawning species entering the estuary as adults to spawn
- Proportion of benthic-associated, or demersal, species
- Proportion of diseased fish.

The eight variables are compared with critical values indicating low habitat quality, and assigned a score. Often an independent set of data on water quality or other environmental variables are collected, computed as an index similar to the IBI, and compared with the IBI scores. If the IBI is a valid indicator of habitat conditions, the IBI score will correlate with the index based on environmental variables. Through analysis, the environmental factors most responsible for site-to-site variation in the IBI can be identified, and these can guide actions at the site that would lead to an improved IBI. For the IBI analysis to be most informative and defensible, critical values for the biotic and environmental variables need to be known.

In developing ecological assessment criteria for restoring anadromous salmon habitat, Simenstad and Cordell (2000) advocated the use of measures directly relatable to the ecological and physiological responses of juvenile salmonids to restored habitats. They proposed the use of three categories: *capacity*, *opportunity*, and *realized functions* (Table E-1). Capacity metrics include habitat attributes that promote juvenile salmon production through promotion of foraging, growth, and growth efficiency, and/or decreased mortality. The capacity category is an extension of the ecological concept of carrying capacity.

Examples of capacity metrics include the productivity and density of prey, physical and chemical conditions that promote high assimilation efficiencies, and structural conditions that provide protection from predation. Opportunity metrics appraise the ability of salmon to access and benefit from the habitat's capacity (Simenstad and Cordell 2000). Opportunity incorporates the principles of landscape ecology (Forman and Godron 1986). Examples of metrics include tidal elevation of feeding habitats, extent of morphometric features such as habitat edge length, as well as refugia (such as low-tide, deep-water refuges) from predation. Finally, realized function metrics include any direct measures of physiological or behavioral responses that can be attributable to fish occupation of the habitat and that promote fitness and survival (Simenstad and Cordell 2000). Survival is the ultimate metric, but related metrics include habitat-specific residence time, foraging success, and growth.

Table E-1. Capacity, Opportunity, and Realized Functions as Measures of Ecological and Physiological Responses of Juvenile Salmonids to Restored Habitats (Simenstad and Cordell 2000)

Category	Potential Armoring Impact	Potential Impact to Salmon
Capacity	Altered habitat type Altered habitat forming processes Altered habitat production	Change in prey species Change in prey production Change in prey abundance Change in prey distribution Change in predator abundance
Opportunity	Altered access Altered migration route Altered habitat size Altered habitat location Altered refugia from predators	Change in ability to find prey Change in rate of migration Change in predation rate
Realized Function	Altered residence time Altered foraging success	Change in growth rate and survival

Relevance to Bainbridge Island Nearshore

On Bainbridge Island, a numerical multi-criteria assessment of habitat suitability could be developed for eelgrass and tidal marshes. Quantitative information on physical and chemical requirements for these habitats would drive assessments of the appropriateness of sites for restoring these habitats. Other potential habitats include tidal flats and cobble and rocky shores, although these have not been evaluated rigorously. To accomplish this evaluation, the classification system developed by Dethier (1990) would be an important source for the physical “setting” for the various nearshore habitats found on Bainbridge Island. Dethier’s classification is descriptive, however, and linking physical conditions to habitat types is qualitative. The IBI multi-metric analysis, as described for other estuarine systems, may be appropriate for evaluating the functionality of restoration projects carried out on the Island. An IBI approach could also be employed to compare conditions before and after site restoration.

The process developed here relies as much as possible on solid ecological principles, coupled with the best available scientific understanding of the nearshore ecosystems of Puget Sound (Williams et al., 2003), and the best information available on the biophysical conditions of the nearshore on Bainbridge Island (this report). Specifically, the process developed here relies on *restoration of controlling factors as the key to successful and long-term sustainability*. We have not done an analysis of historical conditions on the Island. Historical information on reaches on the Island should be examined to fully evaluate the

appropriate strategy and potential for a strategy to work for those reaches. In the present analysis, we assumed that the “historical” conditions are present within other similar geomorphic settings in Puget Sound or relatively undisturbed sites on Bainbridge Island.

The Prioritization Method for Bainbridge Island Nearshore

The prioritization for Bainbridge Island nearshore involves an initial assessment of which strategies would have the highest priority of working within each reach, followed by a site (reach) specific assessment to refine the strategy and priority. This approach uses landscape ecology and conservation biology principles, and national recommendations on the most applicable restoration strategies as the fundamental underpinnings for prioritization (see above and NRC 1992; Shreffler and Thom 1993). These principles are well established in the ecological literature, and are highly useful in providing comprehensive, larger-scale guidance.

Analysis of the Most Applicable Management Strategies

A national assessment showed that the degree of impact on the landscape and site scales affected the probability of restoration success, and that the most appropriate restoration strategies varied according to disturbance on these two scales (Figure E-1). Restoration of natural aquatic systems can be uncertain (NRC 1992; Thom 2000). Prioritization of sites and management action strategies for these sites are presented here using information designed to reduce this uncertainty as much as possible. For Bainbridge Island, reach is equated to site-scale, and management area is equated to landscape scale. Actual sites on Bainbridge Island may be smaller than a reach, and should be evaluated at the actual scale when developing strategies for that site. Because the shoreline management area is based on drift cells, a major contributor to habitat-forming processes in reaches, shoreline management areas encompass appropriate landscape-scale processes. Because some sites may be located at the convergence or divergence between two drift cells, these sites should be evaluated relative to their unique position.

The matrix in Figure E-2 identifies the strategies most appropriate under the different states of combined reach and management area impact. Figure E-2 integrates the restoration strategies in Figure E-1 and the two additional strategies of conservation and preservation discussed above. The strategies most likely to work are indicated, as well as where each strategy might also be applied with a somewhat lower probability of working.

As seen in the matrix (Figure E-2), multiple strategies are potentially viable under any one of the states. This matrix provides general guidance as a first approximation of specific management actions that could be evaluated within a reach or management area. In developing the matrix in Figure E-2, the following logic was used:

- The lower the disturbance on both scales, the greater reliance on preservation, conservation, and restoration
- The greater the disturbance on both scales, the greater reliance on enhancement
- Under the greatest levels of disturbance, greater is the reliance on creation.

Low Reach Impact	Restore Enhance	Preserve Conserve Restore Enhance	Preserve Conserve Restore
	Restore Enhance Create	Conserve Restore Enhance Create	Conserve Restore Enhance
High Reach Impact	Restore Enhance Create	Restore Enhance Create	Restore Enhance
	High Management Area Impact		Low Management Area Impact

Figure E-2. Matrix of management action strategies most appropriate for a reach based on the degree of disturbance of the management area and the reach (not listed in any particular order).

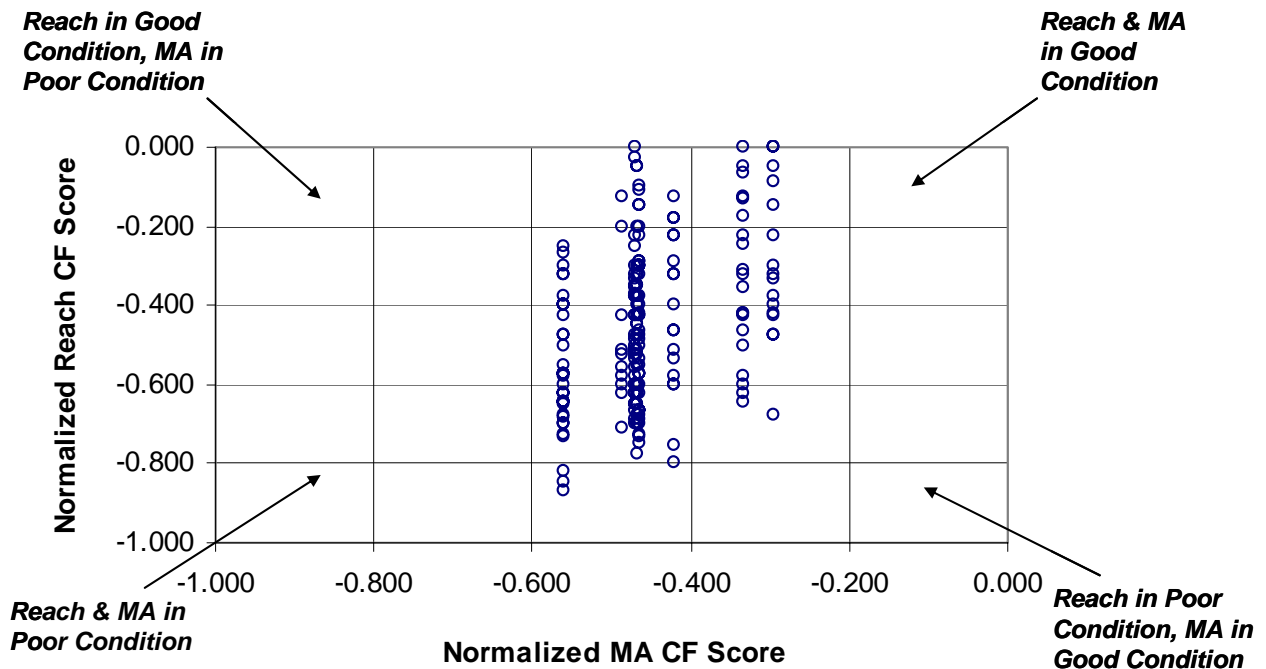


Figure E-3. Shoreline Management Area average normalized controlling factor disturbance score versus reach normalized controlling factor disturbance score.

To develop this prioritization specifically for the Bainbridge Island nearshore, the average controlling factor score (based on normalized reach scores) for each shoreline management area is plotted against the normalized controlling factor score for reaches (Figure E-3). Each point in Figure E-3 represents a reach. The rationale for using average controlling factor scores within each management area is that the average score indicates the relative degree of disturbances of the management area, which corresponds to the

degree of disturbance of the landscape in Figure E-1. The degree of disturbance on the site scale is represented by the reach scale controlling factor score.

Figure E-3 corresponds to the matrix of management action strategies in Figure E-2 above, and can be used to *prioritize appropriate management action strategies for those reaches*. For example, for reaches with low controlling-factor disturbance scores on both axes, the most appropriate management action strategies would be to conserve, preserve, and restore (to pre-disturbance or pre-historical conditions). Whereas, reaches where controlling-factor disturbance scores are high on both axes, management action strategies of enhancement of selected habitat attributes or creation of new ecosystems are most appropriate. Areas where shoreline management area controlling factor scores are low (good), but reach scores are high (poor), the reach is in relatively good condition; however, any strategy for restoration needs to be considered relative to the ability of processes afforded by a relatively disturbed landscape to maintain the restored reach in the long term. Because the points are continuously distributed (at least on the reach scale) and there is a high degree of variability, the management action strategy most appropriate for a particular reach needs further reach-specific analysis. This degree of variation in the application of strategies is reflected in the general zones illustrated in Figure E-4. The scores and categories for each reach and management area are provided in Table E-2.

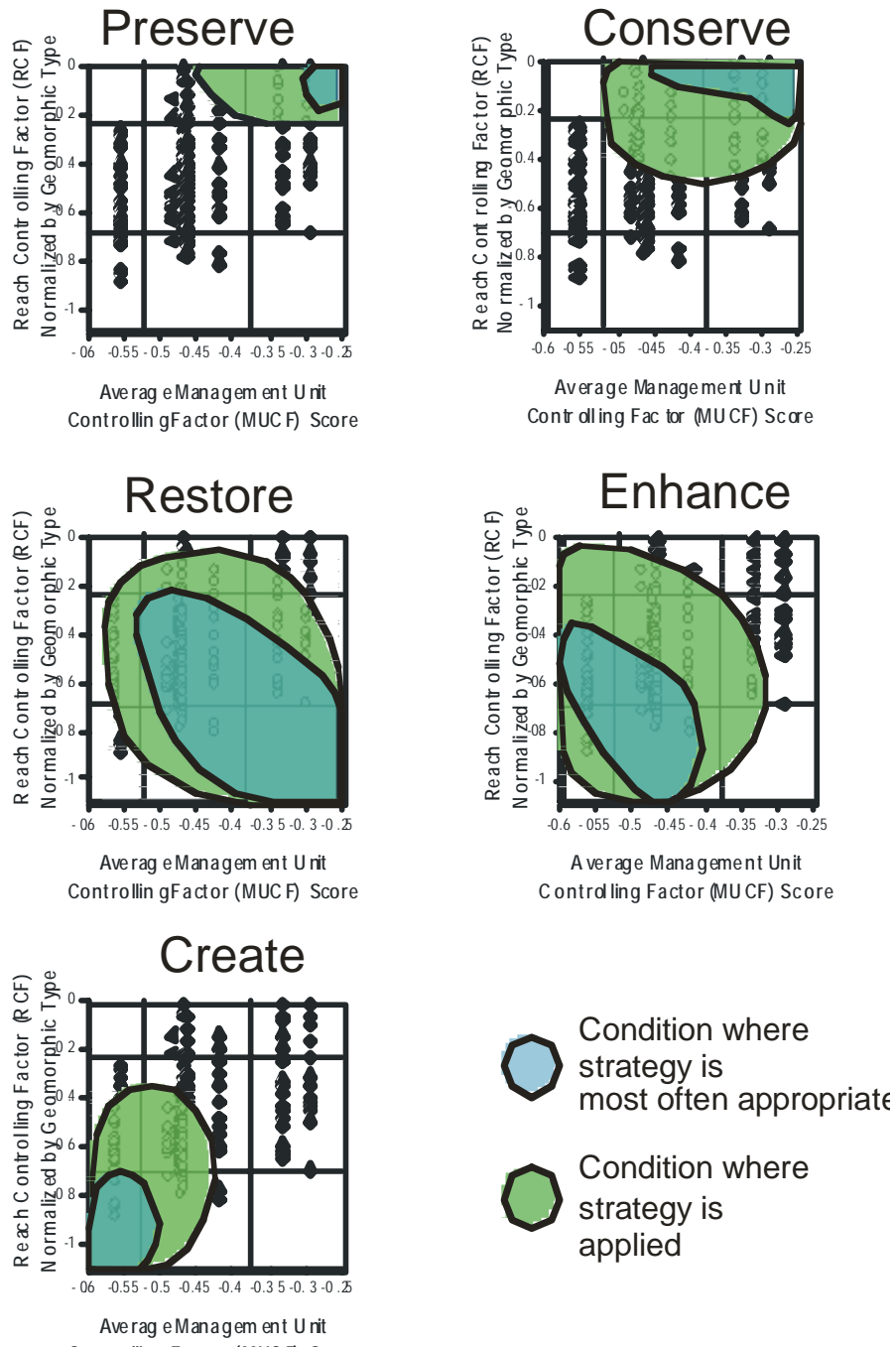


Figure E-4. Generalized zones of application of management strategies relative to management area and reach disturbance.

Table E-2. Controlling factors scores for reaches and management areas, along with their relative qualitative ranking.

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
1	3217	-0.689	Mod/High	-0.470	Mod	32
1	3218	-0.622	Mod/High	-0.470	Mod	32
1	3219	-0.578	Mod	-0.470	Mod	30
1	3220	-0.556	Mod	-0.470	Mod	30
1	3221	-0.600	Mod	-0.470	Mod	26
1	3222	-0.378	Low/Mod	-0.470	Mod	30
1	3223	-0.333	Low/Mod	-0.470	Mod	26
1	3487	-0.622	Mod/High	-0.470	Mod	22
1	3488	0.000	No	-0.470	Mod	28
1	3489	-0.222	Low/Mod	-0.470	Mod	28
1	3490	-0.511	Mod	-0.470	Mod	28
1	3491	-0.533	Mod	-0.470	Mod	27
2	3193	-0.622	Mod/High	-0.471	Mod	22
2	3194	-0.025	Low	-0.471	Mod	32
2	3195	-0.371	Low/Mod	-0.471	Mod	27
2	3196	-0.486	Mod	-0.471	Mod	30
2	3197	-0.600	Mod	-0.471	Mod	21
2	3198	-0.375	Low/Mod	-0.471	Mod	22
2	3199	-0.625	Mod/High	-0.471	Mod	19
2	3200	-0.600	Mod	-0.471	Mod	18
2	3201	-0.425	Mod	-0.471	Mod	19
2	3202	-0.325	Low/Mod	-0.471	Mod	16
2	3203	-0.300	Low/Mod	-0.471	Mod	16
2	3204	-0.475	Mod	-0.471	Mod	18
2	3205	-0.650	Mod/High	-0.471	Mod	16
2	3206	-0.650	Mod/High	-0.471	Mod	16
2	3207	-0.500	Mod	-0.471	Mod	20
2	3208	-0.250	Low/Mod	-0.471	Mod	20
2	3209	-0.425	Mod	-0.471	Mod	18
2	3210	-0.700	Mod/High	-0.471	Mod	18
2	3211	-0.375	Low/Mod	-0.471	Mod	20
2	3212	-0.525	Mod	-0.471	Mod	30
2	3213	-0.356	Low/Mod	-0.471	Mod	36
2	3214	-0.350	Low/Mod	-0.471	Mod	32
2	3215	-0.622	Mod/High	-0.471	Mod	34
2	3216	-0.667	Mod/High	-0.471	Mod	32
3	3176	-0.467	Mod	-0.421	Mod	20
3	3177	-0.800	Mod/High	-0.421	Mod	18
3	3178	-0.756	Mod/High	-0.421	Mod	20
3	3179	-0.178	Low	-0.421	Mod	25
3	3180	-0.400	Low/Mod	-0.421	Mod	22

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
3	3181	-0.578	Mod	-0.421	Mod	23
3	3182	-0.325	Low/Mod	-0.421	Mod	22
3	3183	-0.533	Mod	-0.421	Mod	21
3	3184	-0.511	Mod	-0.421	Mod	24
3	3185	-0.178	Low	-0.421	Mod	25
3	3186	-0.125	Low	-0.421	Mod	24
3	3187	-0.225	Low/Mod	-0.421	Mod	20
3	3188	-0.600	Mod	-0.421	Mod	26
3	3189	-0.325	Low/Mod	-0.421	Mod	24
3	3190	-0.600	Mod	-0.421	Mod	22
3	3191	-0.467	Mod	-0.421	Mod	24
3	3192	-0.289	Low/Mod	-0.421	Mod	26
3	6002	-0.225	Low/Mod	-0.421	Mod	26
4	3156	-0.622	Mod/High	-0.334	Low/Mod	18
4	3157	-0.422	Mod	-0.334	Low/Mod	18
4	3158	-0.311	Low/Mod	-0.334	Low/Mod	26
4	3159	-0.133	Low	-0.334	Low/Mod	24
4	3160	-0.600	Mod	-0.334	Low/Mod	26
4	3161	-0.325	Low/Mod	-0.334	Low/Mod	20
4	3162	-0.244	Low/Mod	-0.334	Low/Mod	24
4	3163	-0.578	Mod	-0.334	Low/Mod	22
4	3164	-0.356	Low/Mod	-0.334	Low/Mod	26
4	3165	-0.067	Low	-0.334	Low/Mod	22
4	3166	-0.467	Mod	-0.334	Low/Mod	22
4	3167	-0.644	Mod/High	-0.334	Low/Mod	14
4	3168	-0.425	Mod	-0.334	Low/Mod	13
4	3169	-0.125	Low	-0.334	Low/Mod	16
4	3170	-0.050	Low	-0.334	Low/Mod	19
4	3171	0.000	No	-0.334	Low/Mod	24
4	3172	-0.222	Low/Mod	-0.334	Low/Mod	17
4	3173	-0.175	Low	-0.334	Low/Mod	16
4	3174	-0.500	Mod	-0.334	Low/Mod	17
4	3175	-0.422	Mod	-0.334	Low/Mod	18
5	3121	-0.267	Low/Mod	-0.559	Mod	19
5	3122	-0.475	Mod	-0.559	Mod	20
5	3123	-0.575	Mod	-0.559	Mod	18
5	3124	-0.578	Mod	-0.559	Mod	24
5	3125	-0.700	Mod/High	-0.559	Mod	20
5	3126	-0.700	Mod/High	-0.559	Mod	14
5	3127	-0.575	Mod	-0.559	Mod	12
5	3128	-0.425	Mod	-0.559	Mod	12
5	3129	-0.325	Low/Mod	-0.559	Mod	16
5	3130	-0.625	Mod/High	-0.559	Mod	14
5	3131	-0.844	High	-0.559	Mod	14

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
5	3132	-0.644	Mod/High	-0.559	Mod	22
5	3133	-0.550	Mod	-0.559	Mod	18
5	3134	-0.686	Mod/High	-0.559	Mod	18
5	3135	-0.400	Low/Mod	-0.559	Mod	19
5	3136	-0.325	Low/Mod	-0.559	Mod	16
5	3137	-0.500	Mod	-0.559	Mod	19
5	3138	-0.375	Low/Mod	-0.559	Mod	18
5	3139	-0.250	Low/Mod	-0.559	Mod	20
5	3140	-0.300	Low/Mod	-0.559	Mod	19
5	3141	-0.725	Mod/High	-0.559	Mod	22
5	3142	-0.571	Mod	-0.559	Mod	19
5	3143	-0.867	High	-0.559	Mod	14
5	3144	-0.822	High	-0.559	Mod	13
5	3145	-0.675	Mod/High	-0.559	Mod	16
5	3146	-0.733	Mod/High	-0.559	Mod	17
5	3147	-0.650	Mod/High	-0.559	Mod	18
5	3148	-0.600	Mod	-0.559	Mod	13
5	3149	-0.622	Mod/High	-0.559	Mod	18
5	3150	-0.475	Mod	-0.559	Mod	21
5	3151	-0.622	Mod/High	-0.559	Mod	20
5	3152	-0.400	Low/Mod	-0.559	Mod	16
5	3153	-0.400	Low/Mod	-0.559	Mod	20
5	3154	-0.644	Mod/High	-0.559	Mod	20
5	3155	-0.644	Mod/High	-0.559	Mod	20
6	3105	-0.150	Low	-0.295	Low/Mod	14
6	3106	-0.400	Low/Mod	-0.295	Low/Mod	10
6	3107	-0.222	Low/Mod	-0.295	Low/Mod	18
6	3108	-0.333	Low/Mod	-0.295	Low/Mod	16
6	3109	-0.422	Mod	-0.295	Low/Mod	14
6	3110	-0.675	Mod/High	-0.295	Low/Mod	16
6	3111	-0.325	Low/Mod	-0.295	Low/Mod	14
6	3112	0.000	No	-0.295	Low/Mod	19
6	3113	0.000	No	-0.295	Low/Mod	22
6	3114	-0.089	Low	-0.295	Low/Mod	27
6	3115	-0.300	Low/Mod	-0.295	Low/Mod	20
6	3116	-0.375	Low/Mod	-0.295	Low/Mod	17
6	3117	-0.475	Mod	-0.295	Low/Mod	17
6	3118	-0.425	Mod	-0.295	Low/Mod	16
6	3119	-0.475	Mod	-0.295	Low/Mod	17
6	3120	-0.050	Low	-0.295	Low/Mod	24
7	3080	-0.600	Mod	-0.468	Mod	15
7	3081	-0.475	Mod	-0.468	Mod	16
7	3082	-0.350	Low/Mod	-0.468	Mod	15
7	3083	-0.650	Mod/High	-0.468	Mod	21

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
7	3084	-0.600	Mod	-0.468	Mod	17
7	3085	-0.525	Mod	-0.468	Mod	18
7	3086	-0.450	Mod	-0.468	Mod	15
7	3087	-0.300	Low/Mod	-0.468	Mod	14
7	3088	-0.700	Mod/High	-0.468	Mod	12
7	3089	-0.675	Mod/High	-0.468	Mod	14
7	3090	-0.375	Low/Mod	-0.468	Mod	16
7	3091	-0.050	Low	-0.468	Mod	18
7	3092	-0.050	Low	-0.468	Mod	16
7	3093	-0.700	Mod/High	-0.468	Mod	18
7	3094	-0.650	Mod/High	-0.468	Mod	14
7	3095	-0.425	Mod	-0.468	Mod	14
7	3096	-0.625	Mod/High	-0.468	Mod	14
7	3097	-0.600	Mod	-0.468	Mod	20
7	3098	-0.511	Mod	-0.468	Mod	18
7	3099	-0.450	Mod	-0.468	Mod	16
7	3100	-0.550	Mod	-0.468	Mod	14
7	3101	-0.375	Low/Mod	-0.468	Mod	16
7	3102	-0.350	Low/Mod	-0.468	Mod	14
7	3103	-0.400	Low/Mod	-0.468	Mod	14
7	3104	-0.200	Low	-0.468	Mod	14
7	3540	-0.778	Mod/High	-0.468	Mod	14
7	6000	-0.325	Low/Mod	-0.468	Mod	21
7	6001	-0.375	Low/Mod	-0.468	Mod	22
8	3502	-0.667	Mod/High	-0.466	Mod	24
8	3503	-0.289	Low/Mod	-0.466	Mod	24
8	3504	-0.489	Mod	-0.466	Mod	22
8	3505	-0.725	Mod/High	-0.466	Mod	20
8	3506	-0.467	Mod	-0.466	Mod	24
8	3507	-0.150	Low	-0.466	Mod	26
8	3508	-0.200	Low	-0.466	Mod	24
8	3509	-0.150	Low	-0.466	Mod	16
8	3510	-0.100	Low	-0.466	Mod	24
8	3511	-0.533	Mod	-0.466	Mod	30
8	3512	-0.550	Mod	-0.466	Mod	24
8	3513	-0.325	Low/Mod	-0.466	Mod	18
8	3514	-0.375	Low/Mod	-0.466	Mod	20
8	3515	-0.400	Low/Mod	-0.466	Mod	22
8	3516	-0.422	Mod	-0.466	Mod	24
8	3517	-0.667	Mod/High	-0.466	Mod	18
8	3518	-0.700	Mod/High	-0.466	Mod	15
8	3519	-0.575	Mod	-0.466	Mod	16
8	3520	-0.600	Mod	-0.466	Mod	13
8	3521	-0.300	Low/Mod	-0.466	Mod	20

Management Area (MA)	Reach	Normalized Reach Controlling Factor Score	Qualitative Reach Rating	Average Normalized MA Controlling Factors Score	Qualitative MA Rating	Ecological Function Score
8	3522	-0.675	Mod/High	-0.466	Mod	21
8	3523	-0.429	Mod	-0.466	Mod	18
8	3524	-0.425	Mod	-0.466	Mod	19
8	3525	-0.733	Mod/High	-0.466	Mod	16
8	3526	-0.222	Low/Mod	-0.466	Mod	24
8	3527	-0.289	Low/Mod	-0.466	Mod	22
8	3528	-0.111	Low	-0.466	Mod	22
8	3529	-0.300	Low/Mod	-0.466	Mod	16
8	3530	-0.689	Mod/High	-0.466	Mod	18
8	3531	-0.667	Mod/High	-0.466	Mod	16
8	3532	-0.475	Mod	-0.466	Mod	16
8	3533	-0.750	Mod/High	-0.466	Mod	18
8	3534	-0.575	Mod	-0.466	Mod	18
8	3535	-0.575	Mod	-0.466	Mod	18
8	3536	-0.300	Low/Mod	-0.466	Mod	18
8	3537	-0.500	Mod	-0.466	Mod	16
8	3538	-0.625	Mod/High	-0.466	Mod	14
8	3539	-0.667	Mod/High	-0.466	Mod	14
9	3492	-0.525	Mod	-0.486	Mod	22
9	3493	-0.425	Mod	-0.486	Mod	23
9	3494	-0.125	Low	-0.486	Mod	26
9	3495	-0.622	Mod/High	-0.486	Mod	33
9	3496	-0.556	Mod	-0.486	Mod	30
9	3497	-0.200	Low	-0.486	Mod	21
9	3498	-0.711	Mod/High	-0.486	Mod	20
9	3499	-0.600	Mod	-0.486	Mod	20
9	3500	-0.514	Mod	-0.486	Mod	22
9	3501	-0.578	Mod	-0.486	Mod	20

Refining Management Actions

A further analysis may be needed to refine the best management action for each site (i.e., reach or a portion of a reach where a management decision is required). Eight criteria guide the development of management actions. The first four are based on landscape ecology and conservation biology principles, and indicate the *existing environmental quality of the site*. The latter four are based on restoration ecology and reflect the *potential environmental quality of the site* following implementation of a management action strategy. The primary emphasis in these latter criteria is on potential for controlling factors to be reestablished or enhanced at the site to eventually result in a structurally and functionally enhanced and sustainable ecosystem. These criteria can help in development of a site design plan.

1. *Size* – Size refers to reach length and the size of the potential management action within a site. In general, larger size enhances habitat stability, increases the number of species that can potentially use the site, is easier to identify by migratory species, and increases within-habitat complexity. On Bainbridge Island, specific sites located with a single reach would be

considered small because they potentially contain only a subset of the habitats naturally occurring over a larger area. A site that covers most or all of a reach would be considered large, since it contains all habitats that naturally occur within the reach. A site that covers more than one reach would be considered very large, because it covers areas where two or more suites of habitat types are naturally found, and the animals using them benefit from being adjacent to one another.

2. *Complexity* – This criterion refers to the numbers of different types of habitats within a reach. As the number of habitat types increases, so does the number of different species that can occupy an area, and the number of functions supported by the area. Higher complexity results in greater biodiversity. For Bainbridge Island, sites and reaches that have more natural habitats will generally have more associated species. Adjacent reaches that differ in their habitat types would cumulatively contain greater complexity.
3. *Accessibility* – Accessibility refers to unencumbered access by nearshore-dependent aquatic, avian, and terrestrial species. Projects that would allow or enhance access of these species to important nearshore habitats would potentially enhance the feeding, rearing, and refuge functions of the site. For example, opening a system to fish access appears to have resulted in utilization of the system by fish.
4. *Connectance* – This criterion refers to the degree of natural connection and pathways between adjacent habitats or migratory corridors. Connectance means that an animal can move between adjacent habitats to derive the benefits of each habitat. It also refers to the flow of material such as organic matter between areas of production (e.g., a salt marsh) and areas of deposition (e.g., tidal channels and creek bottom) where the materials are utilized by the ecosystem. On Bainbridge Island, connectance can be interrupted by overwater structures, armoring, boat activity, and other features.
5. *Potential to conform to natural habitat structure, processes, and functions* – This criterion expresses the relative probability that a site can return some or all of the natural habitat structure, function and processes found on the site historically. As mentioned above, the level of impact to the site (reach) and landscape (management area) is important.
6. *Potential for self-maintenance* – Self-maintenance addresses the desire for a site to be able to persist and evolve toward a natural (historical) habitat condition without significant human intervention. As a pre-requisite for this to occur, conditions for controlling factors in the reach and in the management area must be appropriately developed and maintained. Self-maintenance means that the habitat can persist and develop under natural climatic variation, and that the system has a natural degree of resilience to natural perturbations. This criterion also takes into account the need to know the probable historical conditions, and the factors that produced the present conditions.
7. *Potential benefit to nearshore-dependent threatened and endangered species* – This criterion is specifically directed at those species whose populations are at precariously low numbers, and who might benefit from improved nearshore habitat conditions. At present, wild Chinook salmon would be one of the major species driving the decision process.
8. *Potential to substantially improve ecosystem functions* – This criterion acknowledges that some actions can result in greater enhancement of ecosystem functions than others, and that these projects may not be the largest or most complex systems. For example, the location may be more important than the size of a project. A medium-sized project done in a location

where an endangered species can directly benefit because of the proximity to its normal migratory pathway would be more important than a project done far outside of the pathway.

The eight criteria are for the most part, qualitative. They can be applied directly to evaluate the benefit of management action alternatives for a particular site. A simple application of these criteria would be a checklist. For example, with the exception of size (which can be stated as aerial extent of habitat types within a reach or site), each of the remaining seven criteria can simply be assessed as being present or absent, with a qualifying statement as to degree. This evaluation can be done with existing data as well as with a site visit. In cases where aspects (e.g., the number of habitat types) may be uncertain, new data may be required.

Criteria 5 and 6 can be assessed relative to the level or degree of disturbance on the management area scale. An appropriate question would be, "Are the natural habitat forming processes healthy enough to allow for the development and maintenance of natural habitat structure and functions, and will the site be maintained through time?" Multi-criteria methods available but still untested in Puget Sound could also be used for specific habitat recommendations addressing Criteria 5 and 6. The method developed by Short et al. (2002) provides an excellent example of a multi-criteria protocol to assess the potential for a site to support eelgrass.

To address Criterion 7 relative to salmon, the criteria of Simenstad and Cordell (2000) can be applied (Table E-1). Will the management action potentially provide enhanced capacity, opportunity, and realized function in support of juvenile salmon? In the example cited in Table E-1, armoring of a shoreline can affect all three of these criteria, and removal of armoring may result in improvement to one or more of the criteria. Criterion 8 can be evaluated by examining the present reach ecological function (Table E-2), and whether this ecological function can be enhanced. In some cases, the ecological function is high for reaches with a moderate controlling factor score, and improvement in ecological function may not be expected even with improved conditions in the reach controlling factors. Specific elements contributing to the summed controlling factor level for a site need to be examined to make this assessment. For example, planting riparian vegetation may improve a reach controlling factor score, and also substantially improve the ecological function.

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