> *"We abuse the land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we begin to use it with love and respect."*

ALDO LEOPOLD, 1956

REFUGIA IDENTIFICATION

Viewed from the perspective of native salmon or trout, the environment of the PNW is a mosaic of complex habitats. In this "fish landscape" there are salmon-friendly areas, where diversity and productivity is high, and there are other areas where just the opposite is true and salmon survival is low. These areas are constantly changing in quantity and quality on both a temporal and spatial scale. Such is the nature of ecosystems. As was discussed earlier, a large body of research indicates that protection and restoration of these salmon-friendly areas or *refugia* is one of the keys to regional salmon recovery (Sedell et al., 1990; Niemi et al., 1990; Doppelt et al., 1993; Schlosser, 1995; Spence et al., 1996; NRC, 1996; Frissell, 1998; Lichatowich, 1999; Lichatowich, 2000; Levin and Schiewe, 2001;Dewberry, 2001; IMST, 2002).

Salmonid refugia, in general, represent habitat patches that currently or historically function to provide a disproportionately large share of native salmonid productivity and diversity within the overall salmon landscape. These refugia areas can be critical for the persistence of native salmonid populations during major disturbances, both natural (flooding, drought, or fire) and human-induced (timber harvest, agriculture, or development). Refugia also function as sources of recolonization when adjacent or nearby watersheds experience a loss of native populations for whatever reason.

There is a degree of uncertainty in the refugia evaluation and selection process. As such, all watersheds in the study area (see Figure 27) that support populations of native salmonids were considered for refugia status. It was decided not to distinguish between each of the proposed refugia during the early phases of the evaluation process, but to wait until the entire process was

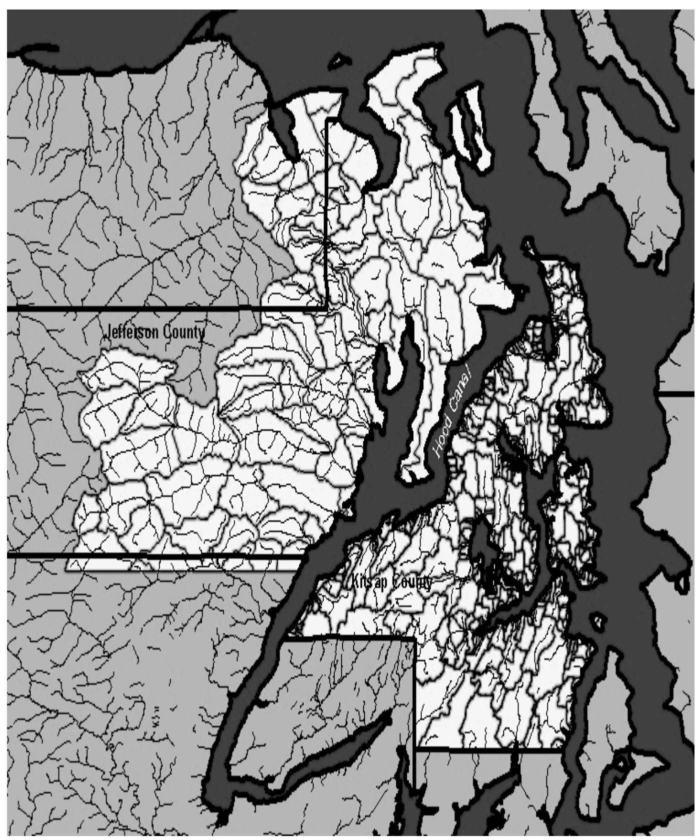


Figure 27: Study Area Watersheds.

complete before prioritizing. This included the *fish-centered approach* described in the previous section and the *landscape-centered approach* described in this section.

It is also important to recognize that the evaluation and selection criteria are not all-inclusive. Based on the findings of this report, areas not proposed for refugia status should not be considered unimportant with respect to regional salmon recovery efforts. Every watershed, stream, and nearshore area deserves protection and stewardship to some degree. Even the smallest watershed or nearshore area has some salmonid habitat value, which may be critical to the survival of a population or populations of fish. By the same token, degraded watersheds, streams, or nearshore areas may also still retain some measure of habitat value and therefore should be managed appropriately. It should also be reiterated that this study does not imply that protection of the designated refugia areas alone is ecologically sufficient to support salmon recovery or even to maintain current conditions within the region. This action is considered a necessary, but not sufficient, first step in a comprehensive, long-term ecosystem conservation program.

REFUGIA DELINEATION

Natural hydro-geographic features were generally used to delineate refugia boundaries. Watershed boundaries derived from the GIS digital elevation model (DEM) were used where appropriate based on hydrologic and ecological considerations. Ecologically significant, natural boundaries, such as ravines or floodplains, were also used to delineate refugia boundaries for stream-riparian corridors. For nearshore and estuarine refugia areas, natural shoreline features and drift-cells were the primary determinants of refugia boundaries. In delineating refugia areas, the size of the refugia was also a major consideration. Every effort was made to include sufficient area to encompass the migratory, spawning, and rearing needs of all salmonid species under consideration for refugia status. It is a basic principle of landscape ecology and conservation biology that larger refuge areas are preferable to smaller, fragmented reserves whenever possible (Sedell et al., 1990; Noss and Cooperrider, 1994; Foreman, 1997; Dewberry, 2001). This principle applies for a number of reasons, including the scale of ecological processes and the structure of the ecosystem being protected.

The following categories were utilized for delineating salmonid refugia areas in this report (modified based on Frissell, 1998 and 1999):

- Focal Sub-Watersheds (FSW)
- Nodal -Riparian Corridors (NRC)
- Nearshore and Estuarine Refugia (NSE)
- Critical-Contributing Areas (CCA)

The delineation of refugia areas is based primarily on hydro-geographic features and ecological considerations. Because natural features were primarily used to delineate refugia, the different categories of refugia are less critical. Therefore, a focal sub-watershed (FSW) refugia area is not necessarily "better" than a nodal-riparian corridor (NRC) refugia area. It is more a matter of which type of refugia fits the specific conditions in the field and which type will be most effective for conservation or restoration of salmonid habitat. For instance, consider a refugia area located within the lower, mainstem stream flowing through a ravine or narrow valley. That refugia area is likely more suited to NRC status whereas the headwater tributary area of the same watershed may be more suited to being delineated as a FSW. Both may be equally important in the overall scheme of protecting salmonid resources within the larger watershed that both are part of, but each is more suited to different types of refugia. An area designated as a critical contributing area (CCA) is not in itself a refugia area, but is an area that can significantly influence water flows and water quality of downstream refugia. The refugia categories utilized in this report are described below in detail.

FOCAL SUB-WATERSHEDS

The term "focal watershed" was developed by Frissell (1998) to describe key or critical catchment areas (whole watersheds or "nested" sub-basins) that contain relatively unimpaired ecological structure and function in support of a significant number of salmonid species and life-stages. The refugia designation of *focal sub-watershed* (FSW) is used in this study to identify stream-ecosystem, whole watershed, or tributary sub-watershed-level refugia. The scale of these refugia is typically on the order of 10-100 square kilometers. These areas are analogous to the "key watersheds" designated under the FEMAT (1993) process, but at a local rather than regional scale. The typical FSW refugia include anadromous migration corridors, as well as spawning and rearing habitat for a number of species and populations of salmonids.

In most cases, watersheds in the study area have experienced a variety of human impacts, which have resulted in some degree of degradation. There are few watersheds that can be considered "pristine" or completely natural, therefore it will be important to maintain, enhance, or restore natural watershed processes within designated FSW refugia to create a complex, diverse landscape pattern of habitats favorable to the native salmonid community. Maintaining connectivity between high-quality *habitat patches* within each FSW is also critical to the success of the refugia. Although an entire watershed could be designated as a FSW refugia, the FSW designation is typically used to identify refugia within the broader watershed level. An example of this would be the designation of a tributary sub-basin within a larger stream watershed. In general, a FSW is disproportionately important within the larger watershed for providing critical salmonid spawning and rearing habitat.

In general, the FSW classification of refugia is also used to designate those areas that still have a low level of human impact (i.e. timber harvest, mining, agriculture, and development) and retain a significant amount of natural forest cover, wetland area, and intact riparian corridor. Most designated FSW refugia have maintained a relatively natural hydrologic regime and have very few, if any, water-quality problems. Most importantly, however, to be designated as a FSW, a watershed must also retain a significant degree of natural salmonid productivity and species diversity. At the very least, a FSW should support at least one wild spawning population of salmonid. A FSW should also be resilient to disturbance and be able to function as a recolonization source for local or regional salmonid population recovery. In summary, the key characteristics of FSW include:

- Support relatively unimpaired biological and physical processes.
- Support a significant diversity of salmonid species and are relatively productive.
- Function as "zones of convergence" (Frissell, 1998) for multiple life-history stages of salmonids.
- Retain natural water quality and a natural hydrologic regime.
- May serve as migratory corridors.
- Have relatively low levels of human land-use activities.
- Have relatively intact, natural riparian corridors.

Most FSW refugia are typically not "pristine", but still have a significant proportion of natural landscape (forest and wetlands), intact segments of high quality riparian corridor, and functional instream habitat. FSW designation is concentrated on those watersheds that have the greatest potential for full recovery to a natural condition. Clearly, as was discussed earlier, the preponderance of research indicates that an ecosystem or watershed focus is the optimum approach to aquatic resource protection (Noss and Cooperrider, 1994; Spence et al., 1996; Stouder et al., 1997; Naiman and Bilby, 1998). Designation of FSW refugia recognizes this and will rely heavily on innovative, "fish-friendly" land-use management to conserve the remaining aquatic resources. In addition, rehabilitation and restoration efforts will also be required as part of the overall watershed-based conservation strategy.

NODAL-RIPARIAN CORRIDORS

According to current refugia theory, nodal-riparian corridors (NRC) are those stream segments where refugia occur in the form of complex mosaics of instream habitat, off-channel wetlands, floodplain complexes, and natural riparian forests (Sedell et al., 1990; Stanford et al., 1996; Naiman and Bilby, 1998). These areas have also been referred to as "riparian reserves" in some scientific literature (Noss and Cooperrider, 1994) and were originally called nodal corridors by Frissell (1998). As with FSW refugia areas, NRC refugia also tend to sustain a disproportionately heavy use by numerous salmonid species and typically support several life-stages of salmonids.

The NRC refugia designation is used in this report in situations where a portion of a stream system or stream segment is designated as a refugia area, as opposed to the entire watershed or tributary sub-watershed. In many cases, rivers and streams within the study area flow through a steep ravine or narrow valley, with few tributaries. These are natural delineations for NRC refugia areas. NRC refugia also include riverine reaches, valley-bottoms, or floodplain segments where salmonid refuges occur in the form of complex stream channel and off-channel wetland mosaics (Frissell, 1998). NRC Refugia almost always include the entire floodplain area, or channel migration zone (CMZ), and any associated wetlands critical to their structure and function (Sedell et al., 1990; Stanford et al., 1996; Frissell, 1998). Many NRC refugia have high groundwater levels, unconfined near-surface aquifers, or extensive hyporheic zones that interact with surface waters in complex paths that help control stream temperatures, hydrologic flows, and nutrient flux (Sedell et al., 1990; Stanford et al., 1996; Knutson and Naef, 1997; Frissell, 1998). The availability of groundwater and frequent inundation of floodplain areas also encourages natural riparian succession and recovery of native vegetation (Gregory et al. 1991).

These NRC refugia can also include small "patches" of intact salmonid habitat that provide critical ecological functions, also known as "hot-spots" (Doppelt et al., 1993). In general, NRC refugia are areas where instream habitat complexity is high, off-channel habitat is accessible and functional, riparian corridor integrity is high, and/or important tributary connections are present. NRC can also provide linkage or access to other refugia areas and have a degree of local resistance to external disturbances and a level of natural resilience. The key characteristics of NRC refugia include (Frissell, 1998):

- Used by a significant diversity of salmonid species.
- Serve as "nodes" for multiple salmonid life histories.
- Serve as salmonid migratory corridors.
- Provide significant "patches" of juvenile salmonid habitat.

- Consist of complex channel and wetland mosaics with off-channel and floodplain habitats.
- Are dominated by the riparian corridor and its physical and biological processes.
- May be impacted by human land-use.

In addition to the above description of a typical NRC, this refugia designation is also used in areas where development already exists and watershed-level cumulative impacts have already occurred, but some degree of natural ecosystem structure and function still remains. In this situation, it is assumed that full protection on a watershed scale is not currently feasible in these areas due to present and future human land-use activities. The basic hypothesis is that, although not as holistically effective as the watershed approach, a riparian reserve or NRC refugia strategy will be effective for the long-term conservation of salmonid resources in areas of continued watershed development and future human activity. For this report, NRC refugia may be designated as either a short segment ("patches") of exceptional stream-riparian habitat or as a continuous riparian corridor within a developing watershed, which is still in relatively good condition. These NRC typically are disproportionately important within the developed or developing watershed as a whole for supporting native salmonids (May and Horner, 2000).

The NRC refugia approach assumes that protecting a high quality instream and riparian habitats along the stream-riparian corridor is a critical step in "buffering" the stream from the effects of land-use and human activities in the watershed. Research in the Puget Sound region indicates that protecting a nearly continuous forested corridor around the stream ecosystem can be effective in maintaining ecological integrity under some watershed conditions (May et al., 1997; May and Horner, 2000; Booth et al., 2001). Based on current research, it is likely that human activities in the watershed will also need to be managed so as to reduce the cumulative impacts on hydrology, water quality, instream habitat conditions, and other environmental factors.

In general, "riparian reserves" or NRC refugia tend to have a degree of local resistance to external disturbances and maintain a level of natural resilience. The inclusion of the entire floodplain area, channel migration zone (CMZ), and any associated off-channel wetland areas is critical to the structure and function of these riparian reserves (Sedell et al., 1990; Stanford et al., 1996; Frissell, 1998). Many riparian corridors have high groundwater levels, unconfined near-surface aquifers, or extensive hyporheic zones that interact with surface waters in complex paths that help control stream temperatures, hydrologic flows, and nutrient flux (Sedell et al., 1990; Stanford et al., 1996; Knutson and Naef, 1997; Frissell, 1998). The accessibility of off-channel wetlands and frequent inundation of floodplain areas also encourages natural riparian succession and recovery of native vegetation (Gregory et al., 1991). A detailed discussion of the benefits of protecting stream-riparian ecosystems is included in Appendix E to this report.

NEARSHORE AND ESTUARINE REFUGIA

Designated *nearshore-estuarine refugia* (NSE) include stream estuaries, nearshore migration corridors, and marine shoreline areas that provide refuge habitat for migrating and rearing salmonids. The typical NSE refugia will encompass the entire nearshore zone, which is usually defined as that area between the lower limit of the "photic" zone (i.e. the zone of sunlight penetration to the bottom) and the upland–aquatic interface (i.e. the shoreline riparian ecotone). This category of refugia was not part of the original refugia methodology (Frissell, 1998), but was added due to the recognized importance of the nearshore area to salmonid recovery in particular (Williams and Thom,

2001) and to the conservation of marine resources in general (Beck, 2001). The NSE refugia designation is the marine equivalent of the FSW and NRC refugia in the freshwater environment.

The NSE refugia concept was developed to address the ecologically important marine environment that is critical to the survival of several salmonid species, including the Puget Sound chinook (PSC) and Hood Canal summer chum (HCSC), both ESA listed species. Although most salmonids spend a significant portion of their life history spawning and rearing in freshwater, all the anadromous species utilize saltwater areas for the majority of their existence. An important period in the typical salmonid life history (see Figure 1) is spent in the transitional area of the nearshore environment (Groot and Margolis, 1991). This is a critical rearing area for juvenile salmonids of all species, but it is especially important to sea-run cutthroat trout, as well as chinook, chum, and pink salmon (Stouder et al., 1997).

Nearshore and estuarine areas provide protection from waves, winds, and storms to salmonids and other species that use the habitat. Although most salmonids spend a significant portion of their life history spawning and rearing in freshwater, all of the anadromous species utilize saltwater areas for the majority of their existence. These areas also provide foraging habitat, critical refuge habitat for adult and juvenile salmonids from predators, a physiological transition zone for smolts moving from the freshwater to the marine environment, and a migration corridor to and from the ocean environment (Simenstad *et al*. 1982). Juvenile salmonids remain in nearshore habitats for varying residence periods depending on the species, their size at smolt migration from freshwater, the time of year of transition to the marine environment, and the habitat conditions in the nearshore/estuary areas. A detailed discussion of the utilization of the nearshore environment by salmonids is included in Appendix F to this report.

The delineation of NSE refugia areas is based on the "drift-cell" concept. Littoral *drift cells* in nearshore areas are analogous to watersheds in the freshwater environment. A drift cell typically includes a source of sediment, such as a "feeder bluff" or other naturally erosive area. The prevailing long-shore currents then transport this sediment through the nearshore environment to a depositional area. Within a drift cell there may be a variety of nearshore habitats that support salmonids (Williams and Thom, 2001). In general, NSE refugia were delineated based primarily on drift-cells and significant geographic or ecological features. River and stream estuaries are among the most important transitional habitat areas for salmonids and therefore are prominent among the designated NSE refugia. NSE refugia can also have associated CAA. The upland shoreline, low-order streams, seasonal/intermittent channels, and areas directly upslope should be considered as CCA. The condition of the CCA adjacent to NSE refugia can directly affect salmonid habitat. Key characteristics of NSE refugia include:

- Provide juvenile and adult salmonid migratory habitat and access to estuarine wetlands and tributaries.
- Provide refuge from predators to juvenile and adult salmonids.
- Provide juvenile and adult salmonid foraging habitat.
- Provide juvenile rearing habitat.
- Can be adversely affected by human modifications such as tide-gates, dikes, levees, docks, seawalls, bulkheads, marinas, and boat ramps.
- Can be adversely affected by point and non-point source pollution.

Based on understanding of the importance of nearshore ecotones to almost all salmonid species and our less than complete knowledge of these critical marine habitat areas, our protection efforts should be very conservative. A protective strategy similar to that established for riparian areas on streams should also be established for nearshore refugia. Native vegetation should be preserved as much as possible in critical nearshore areas, estuaries, and sensitive (steep banks and landslide-prone) shorelines. The impacts of development within the nearshore "riparian zone", including structures, septic systems, docks, bulkheads, and roads should also be reduced to negligible levels in all NSE refugia areas.

For this report, the designation of NSE refugia areas, although based on the current best available information, is considered as "interim" to acknowledge the rudimentary and evolving level of knowledge with regard to these important ecosystems. Until such time as our understanding of these critical habitat areas improves, a conservative resource protection strategy should be established for NSE refugia areas. In summary, our modification of the "nearshore landscape" has diminished the ability of salmonid species to effectively utilize one of their critical rearing and migration habitats (Broadhurst, 1998). Recovery of sustainable salmonid populations will require extensive protection, enhancement, and restoration efforts in our designated nearshore refugia (NRC, 1996; Broadhurst, 1998; Williams and Thom, 2001).

CRITICAL-CONTRIBUTING AREAS

A *critical contributing area* (CCA) is not in itself a refugia area, but has important hydrologic and/or water-quality influences on refugia (FSW, NRC, and NSE) that are located downstream. For various reasons (e.g. natural barriers, ephemeral flows, etc.), these areas typically do not contain viable salmon populations, but are of recognized importance to maintaining the ecological integrity of downstream areas that do contain salmon habitat and populations. There are usually one or more critical contributing areas associated with each focal sub-watershed (FSW) or nodal-riparian corridor (NRC) refugia. In addition, the adjacent shoreline, any low-order streams or seasonal/intermittent channels, and areas directly up-slope from nearshore-estuarine refugia (NSE) should also be considered as critical contributing areas (CCA). These areas typically consist of the shorelines and small streams that drain directly into the nearshore areas. Management of these areas will be one of the keys to restoring and preserving our nearshore salmonid habitat.

Although critical contributing areas are not by themselves refugia and typically do not directly provide habitat for anadromous salmonids, they do contribute indirectly to downstream habitat. These areas, including seasonal and intermittent streams or wetlands, are hydrologically connected to associated riparian corridors. Also included in the CCA category are steep slope areas, which are prone to mass-wasting events and can be significant sources of sediment to downstream refugia. In addition to protecting downstream refugia from hydrologic and erosional impacts, there are also chemical water quality concerns that justify the designation of an area as a critical contributing area. Furthermore, gravel and/or LWD recruitment from a CCA may also be significant as a habitat-forming process.

Critical Contributing Areas protect downstream refugia from hydrologic, erosional, and water quality impacts; thus they are critical to maintaining the ecological integrity of downstream habitat and have the following key characteristics:

- Linked by topography and hydrology to FSW or NRC refugia.
- Can include tributary and upland habitats including wetlands, lakes, and beaver ponds.

- May include areas prone to mass wasting due to steep slopes.
- May include seasonal and intermittent streams.

In summary, the purpose of the CCA designation is to call attention to upland and tributary areas that may be of critical importance in maintaining ecological integrity of downstream refugia habitat. Restoration efforts, such as improved stormwater treatment or rehabilitation of roads within the CCA may be especially important to protecting or enhancing downstream refugia habitat (Frissell, 1998).

REFUGIA CLASSIFICATION

In addition to the actual refugia scores produced by the model, those areas identified for refugia status were also placed into one of the following categories based on their combined refugia model score, as well as their unique salmonid habitat characteristics. Because of the inherent uncertainty in determining a single numerical score that encompasses all natural ecosystem attributes, refugia were placed into classification categories with watersheds of similar quality. This classification scheme serves to group refugia based on their overall condition to further aid in conservation or restoration prioritization, as well as management focus. The rationale in doing this is two-fold. First, there may be specific characteristics of a refugia area that make it a better "fit" in another management classification than its model score alone would indicate. Second, the difference between two refugia model scores may or may not be significant from an ecological perspective. For example, a refugia scored as 7.50 (83% of maximum) by the model is likely not significantly "better" than one scored as 7.00 (78% of maximum). This reasoning is based on sensitivity analysis conducted during this study. However, the difference between refugia scored as 5.40 (60% of maximum) and one scored as 6.75 (75% of maximum) is ecologically significant and measurable.

CATEGORY A

Priority Refugia with Natural Ecological Integrity. Category "A" designated refugia contain the most abundant natural salmonid populations and most nearly intact native assemblages of salmon relative to their historic conditions. In most of these areas, while not pristine, natural conditions have been relatively undisturbed by major environmental alterations. In most cases these areas are not completely undisturbed, but ecological recovery from historic disturbances has advanced significantly. Salmonid habitat conditions are generally properly functioning.

Basically, category "A" areas are those that: (1) support nearly natural levels salmonid productivity and diversity; (2) have a relatively undisturbed, forested watershed and an intact riparian corridor or natural estuarine-nearshore environment; and (3) have a high level of ecological integrity and salmonid habitat quality. Unfortunately, due to the cumulative effects of human activities (both historical and current), very few refugia of this category were identified within the study area.

CATEGORY B

Primary Refugia with Altered Ecological Integrity. Those areas with somewhat disturbed watershed conditions and those areas that have less than natural riparian, instream, or nearshore habitat, but still support natural assemblages of native salmonids, were rated as category "B" refugia. Although the salmonid populations and habitat quality (riparian, instream, and nearshore) in these areas are not at historic levels or conditions, they have shown some resistance to degradation. Some also tend to be in an early stage of recovery due to some level of natural resilience. These refugia are not pristine, but frequently constitute the "next-best" remaining salmonid habitat and generally support the largest remaining salmonid populations in their geographic sub-region. In addition to land conservation and aquatic resource protection, rehabilitation measures will likely be required to maintain or enhance the ecological integrity of these category "B" refugia areas.

In summary, category "B" designated refugia have been altered from natural conditions, but at least some salmonid populations appear to be self-sustaining and resilient. These areas are not pristine, but frequently constitute the best of what salmon habitat remains within moderate to highly developed watersheds and generally contain adequate functional habitat.

CATEGORY C

Secondary Refugia with Altered Ecological Integrity. Category "C" designated areas are where there is an indication, based on salmonid population and instream habitat information that the refugia might belong in Category "A" or "B". However, because of limited quantitative habitat data, lack of information on salmonid utilization, diversity, or abundance, and/or lack of information altogether, the higher category classification is not fully justified. These areas should be a high priority for field surveys, stock assessments, and further investigation. In all likelihood, these areas could be reclassified as category "A" or "B" refugia after further analysis based on quantitative habitat assessments and with a concerted rehabilitation effort. In addition, some "C" refugia areas are geographically positioned such that they may be only salmonid refugia within a critical sub-region, thus further emphasizing the need for further evaluation and conservation efforts. These areas are sometimes called "possible" refugia.

Also included in category "C" refugia are those streams with relatively good habitat conditions, but due to significant downstream fish-passage barriers (i.e. dams or culverts that are partial migration barriers) and/or hatchery operations (e.g. weirs, fish-racks, and fish releases) that may negatively impact wild salmonid populations, do not fully support native salmonid populations. The future ability of these areas to fully support wild salmonid populations may be speculative, but they warrant recognition because of their historic productivity, functional habitat conditions, and/or their potential for higher ecological integrity. If migration barriers were removed and/or hatchery operations modified to support wild salmonids, these areas could be reclassified.

In summary, most category "C" refugia areas may contain functional habitat but have limited native, anadromous fish due to artificial downstream barriers such as dams, impassable culverts, or hatchery facilities. In all likelihood, the removal of barriers should restore access to upstream habitat for future, newly colonizing salmon populations.

CATEGORY D

Potential Refugia with Altered Ecological Integrity. Category "D" refugia are simply those areas that can best be described as "potential" or future refugia, either because the area was historically important habitat, but has been degraded over time, or because the refugia is completely blocked to fish access by an impassable, man-made barrier. The first type includes areas of watersheds that historically contained the most productive and diverse salmonid habitats, but habitat has been degraded by land-use activities. This type of refugia is most often associated with low gradient valley floodplains that historically contained a diversity of side-channels and complex wetland habitats critical to the life history of many salmonid species. Most of these floodplain systems have been highly modified by drainage modifications, channelization, and conversion for agricultural or residential purposes. These once productive areas are potential refugia that are usually good restoration candidates, but do not generally qualify for outright protective status.

In most cases, category "D" refugia areas were likely historically important salmonid resource areas, but typically have significantly degraded watershed and instream habitat conditions that do not currently support natural levels of ecological integrity or abundant, diverse salmonid populations. Also included in this category are NSE refugia areas that have been significantly modified or degraded by human activities, such that they no longer function naturally or support historic levels of native salmonid populations.

> *"A river, with its waterfalls and meadows, a lake, a hill, a cliff, or individual rocks, a forest, and ancient trees standing singly…If the inhabitants of a community were wise, they would seek to preserve these things, though at a considerable expense; for such things educate far more than any hired teachers or preachers, or any present recognized system of school education. I do not think him fit to be the founder of a state or a town who does not foresee the use of these things…."*

HENRY DAVID THOREAU, 1861

REFUGIA DESIGNATION

The designation of Kitsap County salmonid refugia was a multi-step process. Initially, all potential refugia areas (watersheds, sub-watersheds, and stream-segments) were scored using the combined fish and landscape GIS model. See Tables 16 and 17 for a summary of scores for all potential refugia for Kitsap County. Figures 28-42 show the overall refugia model results for each geographic sub-region within Kitsap County. Tables 18, 19, and 20 summarize the refugia areas by type for the entire study area.

The refugia classification categories were assigned to specific "bins" based on the refugia scores developed in the combined Kitsap-Jefferson GIS model. The values assigned to these bins were determined using statistical considerations and based on ecologically significant "breaks" in the model results. In other words, some professional judgment was used to assign the bin-values after statistical analysis was used to determine the most logical data bins. The following model result bins were assigned to each refugia category:

- Category A = >75%
- Category B = 60-75%
- Category C = N/A
- Category D = <60%

Table 16 shows the categories assigned to each category C refugia area based solely on the GIS model scores, and explains why the final classification differs. A map of Kitsap's refugia by category is in the Executive Summary; see Figure ES-4 page ES-6.

Next, each potential refugia area was reviewed individually to determine if the "scored" refugia classification category should be changed based on specific information compiled about that river, stream, or stream segment. This included a review of salmonid diversity and productivity data as well as the salmonid habitat data available. This is also where any unique biological features or ecological characteristics that were identified during field surveys and interviews were incorporated into the refugia evaluation. Based on this information the classification of some potential refugia areas was "adjusted" to reflect this information. The most common adjustment was to shift refugia from a category "B" refugia to a category "C" because of a lack of quantitative data or even good "local knowledge" on salmonid utilization, instream habitat, species diversity, and/or productivity (see the discussion of category "C" refugia in the previous section). In addition, some potential refugia areas were shifted from category "B" to a category "C" or "D" based on artificial barriers that significantly restrict salmonid utilization. Some potential refugia areas were also "adjusted" from category "B" to category "A" (or "D" to "B") based on unique and/or important salmonid-supporting characteristics. See the "Reason not Category A/B/D" column in Table 16 for a summary of these changes.

As was discussed in detail earlier, category "A" areas are those that: (1) support nearly natural levels salmonid productivity and diversity; (2) have a relatively undisturbed, forested watershed and an intact riparian corridor or natural estuarine-nearshore environment; and (3) have a high level of ecological integrity. Unfortunately, due to the cumulative effects of human activities (both historical and current), very few refugia of this category were identified within the study area. The category "B" designated refugia have been altered from natural conditions, but at least some salmonid populations appear to be self-sustaining and resilient. These areas are not pristine, but frequently constitute the best of what salmon habitat remains within moderate to highly developed watersheds. This refugia category of refugia comprised the bulk of all areas identified.

Category "C" designated areas are where there is a good indication, based on salmonid population and instream habitat information that the refugia might belong in Category "B". However, because of limited quantitative habitat data, lack of information on salmonid utilization, diversity, or abundance, and/or lack of information altogether, a category "B" classification is not fully justified. These areas should be a high priority for field surveys, stock assessments, and further investigation. Also included in category "C" refugia are those streams with relatively good habitat conditions, but due to significant downstream fish-passage barriers (dams or culverts that are partial migration barriers) or hatchery operations (weirs, fish-racks, etc.) that negatively impact wild salmonid populations, do not fully support native salmonid populations.

In most cases, category "D" refugia areas were likely historically important salmonid resource areas, but typically have significantly degraded watershed and instream habitat conditions that do not currently support natural levels of ecological integrity or abundant, diverse salmonid populations. Category "D" refugia are simply those areas that can best be described as "potential" or future refugia, either because the area was historically important habitat, but has been degraded over time, or because the refugia is completely blocked to fish access by an impassable, man-made barrier. The first type includes areas of watersheds that historically contained the most productive and diverse salmonid habitats, but have been degraded by land-use activities. This type of refugia is most often associated with low gradient valley floodplains that historically contained a diversity of side-channels and complex wetland habitats critical to the life history of many salmonid species. Most of these floodplain systems have been highly modified by drainage modifications, channelization, and conversion for agricultural or residential purposes. These once highly productive and diverse areas of the watershed are potential refugia that should be given high priority for restoration efforts, but do not generally qualify for conservation/protection.

Finally, refugia areas were designated and the "refugia type" (FSW or NRC) was assigned to each designated refugia area based on the criteria discussed in the previous section of this report (see Table 16 for refugia type assignments). The delineation of refugia areas is based primarily on hydro-geographic features and ecological considerations. In this respect, a FSW refugia is not necessarily "better" than a NRC refugia, but it is more a matter of which type of refugia fits the specific conditions in the field. For instance, consider a watershed with the lower, mainstem stream flowing through a ravine or narrow valley. That refugia area is likely more suited to NRC status whereas a headwater tributary of the same watershed may be more suited to being delineated as a FSW. Both may be equally important in the overall scheme of protecting salmonid resources with the larger watershed that both are part of, but each is more suited to different types of refugia. In addition, a CCA is not in itself a refugia area, but is an area that can significantly influence water flows and water quality of downstream refugia. Therefore, it should not be implied that a FSW designation is somehow "better" than a NRC. The designation of a refugia area as a NRC or FSW is based on which configuration is judged to be most effective for protection. The conservation priority of the refugia area should be judged based primarily on the refugia classification and on the overall refugia model score.

Refugia Area	Description
Category A Focal Sub-Watershed Refugia (FSW)	
Chico Creek	Lost and Wildcat tributaries
Dewatto River	
Stavis Creek	
Tahuya River	
Category A Nearshore-Estuary Refugia (NSE)	
Holly Nearshore	w/CCA
Point-No-Point	w/CCA
Category B Focal Sub-Watershed Refugia (FSW)	
Big Anderson Creek	
Blackjack Creek	Headwaters, Square tributary
Boyce Creek	
Harding Creek	
Little Anderson Creek	
Martha John Creek	
Nellita Creek	
Seabeck Creek	Headwaters
Union River	
Category B Nodal Riparian Corridor Refugia (NRC)	
Anderson Creek	
Barker Creek	w/CCAs
Blackjack Creek	Mainstem
Chico Creek	Mainstem, Dickerson tributary (w/CCA) & Kitsap tributary
Gamble Creek	
Kinman Creek	w/CCA
Seabeck Creek	Mainstem w/CCA
Steele Creek	w/CCAs
Category B Nearshore-Estuary (NSE) Refugia	
Bangor Nearshore	w/CCA
Foul-Weather Bluff	w/CCA
Lone Rock Nearshore	w/CCA
Murden Cove	w/CCA
Port Gamble Bay	w/CCA
Rolling Bay	w/CCA
Stavis Bay Estuary	w/CCA
Union Estuary	w/CCA

Category C	**Refugia Type and Reason not Category A**
Big Beef Creek	**FSW**: Headwaters. NRC. Mainstem. Hatchery Influences
Big Mission Creek	**FSW**. Need Habitat Data
Caldervin Creek	NRC. Need Habitat Data
Coulter Creek	**FSW**. Hatchery Influences
Little Mission Creek	**FSW**. Need Habitat Data
Rendsland Creek	NRC. Need Habitat Data
Rocky Creek	**FSW**. Need Habitat Data
Category C	**Refugia Type and Reason not Category B**
Beaver Creek	NRC. Need Habitat Data
Big Cedar Creek	NRC. Need Habitat Data
Blakely Harbor Creek	NRC. Need Habitat Data
Brown Creek	NRC. Need Habitat Data
Cady Creek	NRC. Need Habitat Data
Carpenter Creek	NRC w/CCA. Need Habitat Data
Cattail Creek	NRC. Migration Barriers
Curley Creek	NRC. Need Habitat Data
Devils Hole Creek	NRC. Migration Barriers
Fletcher Creek	NRC. Need Habitat Data
Gazzam Creek	NRC. Need Habitat Data
Gorst Creek	NRC: Mainstem. FSW: Headwaters, Jarstad & Heins tribs. CCA. Hatchery Influences
Grovers Creek	**FSW**: Hatchery Influences
Hall Creek	NRC. Need Habitat Data
Hawks Hole Creek	**FSW**. Need Habitat Data
Illahee Creek	NRC w/CCAs. Need Habitat Data
Indianola Creek	NRC. Need Habitat Data & Culvert
Jukes Creek	NRC. Need Habitat Data
Kitsap (North) Creek	NRC. Need Habitat Data & Culvert
Little Beef Creek	**FSW**. Need Habitat Data
Little Boston Creek	**FSW**. Need Habitat Data & Barrier
Middle Creek	NRC. Need Habitat Data & Barrier
Little Shoofly Creek	NRC. Need Habitat Data.
Minter Creek	NRC. Hatchery Influences & Habitat
Olalla Creek	NRC. Need Habitat Data
Reservation Creek	NRC. Need Habitat Data & Barrier
Salmonberry Creek	NRC. Need Habitat Data
Schoolhouse Creek	NRC. Need Habitat Data
Shipbuilder Creek	NRC. Need Habitat Data
Shoofly Creek	NRC. Need Habitat Data
Silver Creek	NRC. Need Habitat Data
Stimson Creek	NRC. Need Habitat Data
Sundstrom Creek	NRC. Need Habitat Data

Category C	Refugia Type and Reason not Category D
Blackjack Creek	**FSW**. Ruby Creek. Significant Spawning & Rearing Habitat.
Gamble Creek	NRC. Mainstem. Significant Migration Corridor with Degraded Habitat.
Gorst Creek	NRC. Mainstem. Significant Migration Corridor with Degraded Habitat.
Steele Creek	NRC. South Fork. Significant Spawning & Rearing Habitat.
Seabeck Bay Estuary	NSE: Significant Migration Corridor with Degraded Habitat.

Category C: NSE Refugia With Insufficient Data to Classify "A" or "B"	
Burley Lagoon	Dewatto Nearshore
Case Inlet	Tahuya Nearshore

Category D ("Potential Refugia") Nodal-Riparian Corridors	Reason Category D
Bjorgen	Degraded Habitat
Blackjack (middle reaches)	Degraded Habitat
Burley (Mainstem)	Degraded Habitat
Clear (mouth; East Fork, West Fork, Mountainview, and Bangor tribs) w/CCA	Degraded Habitat
Cougar	Migration Barrier(s)
Cowling	Degraded Habitat
Dogfish (mainstem, East Fork, South Fork)	Degraded Habitat
Fern	Migration Barrier(s)
Hudson	Migration Barrier(s)
Laudine DeCouteau	Migration Barrier(s)
Lemolo	Migration Barrier(s)
Machias	Migration Barrier(s)
Manzanita	Degraded Habitat
Murden Cove	Degraded Habitat
Sam Snyder	Migration Barrier(s)
Schel-Chelb	Degraded Habitat
Spring	Migration Barrier(s)
Todhunter	Migration Barrier(s)
Wright	Degraded Habitat
Category D ("Potential Refugia") Nearshore-Estuary (NSE) (all have an associated CCA)	
Agate Passage Nearshore	Indianola Nearshore
Brownsville Nearshore	Liberty Bay
Colvos Passage	Lynwood Nearshore
Dyes Inlet East	Manzanita Bay
Dyes Inlet West	Miller Bay
Eagle Harbor	Port Blakely Harbor
Fletcher Bay	Port Madison Bay
Illahee Estuary	Sinclair Inlet

Table 16: Kitsap County Refugia Designations

Refugia Area	Type	Score	% Max
Stavis Creek	**FSW**	7.45	83%
Little Mission Creek	**FSW**	7.44	83%
Dewatto River	**FSW**	7.37	82%
Big Beef Creek RM 6.5-HW	**FSW**	7.38	82%
Chico Creek Lost Tributary	**FSW**	7.25	81%
Big Mission Creek	**FSW**	7.19	80%
Big Beef Creek RM 6.0-6.5	**FSW**	7.21	80%
Chico Creek Wildcat Tributary RM 2.5-4.5	**FSW**	7.19	80%
Rocky Creek	**FSW**	7.13	79%
Big Beef Creek RM 0.0-1.0	NRC	7.09	79%
Big Beef Creek RM 1.0 -5.5	NRC	7.09	79%
Tahuya River	**FSW**	7.03	78%
Coulter Creek	**FSW**	6.98	78%
Chico Creek Wildcat Tributary RM 4.5-HW	**FSW**	6.86	76%
Rendsland Creek	NRC	6.74	75%
Caldervin Creek	NRC	6.74	75%
Harding Creek	**FSW**	6.70	74%
Big Anderson Creek	**FSW**	6.68	74%
Big Cedar Creek	NRC	6.68	74%
Gorst Creek Jarstad Tributary	**FSW**	6.58	73%
Nellita Creek	**FSW**	6.58	73%
Chico Creek Dickerson Tributary	NRC	6.57	73%
Union River	**FSW**	6.52	72%
Anderson Creek East Fork	NRC	6.51	72%
Anderson Creek West Fork	NRC	6.51	72%
Boyce Creek	**FSW**	6.45	72%
Gorst Creek RM 1.0-HW	**FSW**	6.44	72%
Curley Creek	NRC	6.39	71%
Seabeck Creek RM 1.0-HW	**FSW**	6.32	70%
Seabeck Creek RM 0.0-0.5	NRC	6.32	70%
Chico Creek Kitsap Tributary	NRC	6.31	70%
Gorst Creek Heins Tributary	**FSW**	6.26	70%
Martha John Creek	**FSW**	6.25	69%
Kitsap Creek	NRC	6.22	69%
Olalla Creek RM 0.0-1.5	NRC	6.19	69%
Blackjack Creek Square Tributary	**FSW**	6.17	69%
Seabeck Creek RM 0.5-1.0	NRC	6.15	68%
Little Beef Creek	**FSW**	6.12	68%
Gorst Creek RM 0.75-1.0	NRC	6.10	68%
Gamble Creek RM 1.5-HW	NRC	6.09	68%
Indianola Creek	NRC	6.04	67%
Grovers Creek	**FSW**	5.95	66%
Barker Creek RM 0.0-0.5	NRC	5.90	66%
Barker Creek RM 0.5-1.0	NRC	5.90	66%

Refugia Area	Type	Score	% Max
Minter Creek Huge Tributary	NRC	5.89	65%
Minter Creek RM 0.0-1.5	NRC	5.89	65%
Blackjack Creek RM 0.0-1.5	NRC	5.86	65%
Anderson Creek RM 0.0-0.5	NRC	5.85	65%
Carpenter Creek RM 0.0-1.0	NRC	5.79	64%
Chico Creek RM 1.25-2.5	NRC	5.78	64%
Little Anderson Creek	**FSW**	5.77	64%
Big Beef Creek Lake Symington RM 5.5-6.0	NRC	5.76	64%
Kinman Creek RM 0.0-0.5	NRC	5.74	64%
Kinman Creek RM 0.5-HW	NRC	5.74	64%
Minter Creek RM 1.5-HW	NRC	5.73	64%
Steele Creek RM 0.0-0.5	NRC	5.67	63%
Blackjack Creek RM 5.5-HW	**FSW**	5.62	62%
Carpenter Creek RM 1.0-1.5	NRC	5.62	62%
Olalla Creek RM 1.5-HW	NRC	5.52	61%
Chico Creek RM 0.75-1.25	NRC	5.44	60%
Kinman Creek South-Lofall Tributary	NRC	5.41	60%
Illahee Creek North Fork RM 1.0-1.5	NRC	5.40	60%
Illahee Creek RM 0.0-1.0	NRC	5.40	60%
Salmonberry Creek	NRC	5.38	60%
Clear Creek West Fork RM 1.0-2.0	NRC	5.32	59%
Chico Creek RM 0.0-0.75	NRC	5.28	59%
Steele Creek South Fork RM 0.5-1.0	NRC	5.18	58%
Clear Creek Mountainview Tributary	NRC	5.14	57%
Carpenter Creek RM 1.5-HW	NRC	5.12	57%
Dogfish Creek East Fork RM 0.0-1.0	NRC	5.12	57%
Dogfish Creek East Fork RM 1.0-HW	NRC	5.12	57%
Blackjack Creek Ruby Tributary	**FSW**	5.09	57%
Barker Creek RM 1.0-1.5	NRC	5.06	56%
Burley Creek RM 0.0-0.5	NRC	5.05	56%
Burley Creek RM 0.5-1.5	NRC	5.05	56%
Blackjack Creek RM 1.5-3.0	NRC	5.03	56%
Gorst Creek RM 0.5-0.75	NRC	5.02	56%
Gamble Creek RM 0.0-1.0	NRC	4.93	55%
Dogfish Creek RM 1.0-3.0	NRC	4.86	54%
Dogfish Creek RM 3.0-HW	NRC	4.86	54%
Steele Creek Crouch Tributary	NRC	4.83	54%
Steele Creek North Fork RM 0.5-HW	NRC	4.83	54%
Clear Creek West Fork RM 0.0-0.5	NRC	4.82	54%
Clear Creek West Fork RM 0.5-1.0	NRC	4.82	54%
Burley Creek RM 1.5-HW	NRC	4.72	52%
Gorst Creek RM 0.0-0.25	NRC	4.69	52%
Gorst Creek RM 0.25-0.5	NRC	4.69	52%
Clear Creek East Fork RM 1.0-2.0	NRC	4.64	52%
Clear Creek East Fork RM 2.0-HW	NRC	4.64	52%

Refugia Area	Type	Score	% Max
Dogfish Creek RM 0.0-0.5	NRC	4.62	51%
Dogfish Creek RM 0.5-1.0	NRC	4.62	51%
Barker Creek RM 1.5-HW	NRC	4.56	51%
Clear Creek West Fork RM 2.0-HW	NRC	4.32	48%
Blackjack Creek RM 3.0-5.5	NRC	4.28	48%
Clear Creek RM 0.0-1.0	NRC	4.16	46%

Table 17: Kitsap County Refugia Model Results

Focal Sub-Watershed (FSW) Refugia	Score	% Max
Stavis Creek	**7.45**	**83%**
Little Mission Creek	**7.44**	**83%**
Big Beef Creek Headwaters (Upper)	**7.38**	**82%**
Dewatto River	**7.37**	**82%**
Chico Creek Lost Tributary	**7.25**	**81%**
Big Beef Creek Headwaters (Lower)	**7.21**	**80%**
Big Mission Creek	**7.19**	**80%**
Chico Creek Wildcat Tributary (Upper)	**7.19**	**80%**
Rocky Creek	**7.13**	**79%**
Tahuya River	**7.03**	**78%**
Coulter Creek	**6.98**	**78%**
Chico Creek Wildcat Tributary (Lower)	**6.86**	**76%**
Harding Creek	**6.70**	**74%**
Big Anderson Creek	**6.68**	**74%**
Gorst Creek Jarstad Tributary	**6.58**	**73%**
Nellita Creek	**6.58**	**73%**
Union River	**6.52**	**72%**
Boyce Creek	**6.45**	**72%**
Gorst Creek Headwaters	**6.44**	**72%**
Shine Creek Headwaters	*6.38*	*71%*
Seabeck Creek Headwaters	**6.32**	**70%**
Gorst Creek Heins Tributary	**6.26**	**70%**
Martha John Creek	**6.25**	**69%**
Thorndyke Creek Headwaters	*6.24*	*69%*
Blackjack Creek Square Tributary	**6.17**	**69%**
Big Quilcene River Penny Tributary	*6.13*	*68%*
Little Beef Creek	**6.12**	**68%**
Ludlow Creek Headwaters	*6.02*	*67%*
Grovers Creek	**5.95**	**66%**
Little Anderson Creek	**5.77**	**64%**
Chimicum Creek East Fork Headwaters	*5.72*	*64%*
Tarboo Creek Coyle Tributary	*5.71*	*63%*
Blackjack Creek Headwaters	**5.62**	**62%**
Tarboo Creek Headwaters	*5.54*	*62%*
Chimicum Creek West Fork Headwaters	*5.40*	*60%*
Blackjack Creek Ruby Tributary	**5.09**	**57%**

Table 18: Focal Sub-Watershed (FSW) Refugia Scores

Note: East Jefferson County watersheds in *italics* and Kitsap County watersheds in **bold**.

Nodal Riparian Corridor (NRC) Refugia	Score	% Max
Dosewallips River RM 2.5-5.5	*7.81*	*87%*
Dosewallips River RM 5.5-11.5	*7.64*	*85%*
Duckabush River RM 2.5-4.5	*7.43*	*83%*
Duckabush River RM 4.5-7.5	*7.36*	*82%*
Fulton Creek	*7.30*	*81%*
Big Beef Creek RM 0.0-1.0	**7.09**	**79%**
Big Beef Creek RM 1.0 -5.5	**7.09**	**79%**
Dosewallips River RM 0.0-2.5	*7.05*	*78%*
Duckabush River RM 0.0-2.5	*6.76*	*75%*
Rocky Brook Creek	*6.75*	*75%*
Thorndyke Creek RM 0.0-1.0	*6.74*	*75%*
Rendsland Creek	**6.74**	**75%**
Caldervin Creek	**6.74**	**75%**
Tarboo Creek RM 0.0-1.0	*6.71*	*75%*
Shine Creek RM 0.0-1.0	*6.71*	*75%*
Big Cedar Creek	**6.68**	**74%**
Camp Discovery Creek	*6.60*	*73%*
Chico Creek Dickerson Tributary	**6.57**	**73%**
Little Quilcene River RM 0.8-3.0	*6.55*	*73%*
Anderson Creek East Fork	**6.51**	**72%**
Anderson Creek West Fork	**6.51**	**72%**
Big Quilcene River RM 2.8-7.8	*6.39*	*71%*
Curley Creek	**6.39**	**71%**
Nordstrom Creek	*6.38*	*71%*
Devils Lake Creek	*6.36*	*71%*
Ludlow Creek RM 0.0-0.5	*6.35*	*71%*
Seabeck Creek RM 0.0-0.5	**6.32**	**70%**
Chico Creek Kitsap Tributary	**6.31**	**70%**
Howe Creek	*6.29*	*70%*
Big Quilcene River RM 0.7-2.5	*6.26*	*70%*
Little Quilcene River RM 0.0-0.8	*6.22*	*69%*
Little Quilcene River RM 3.0-6.0	*6.22*	*69%*
Kitsap Creek	**6.22**	**69%**
Olalla Creek RM 0.0-1.5	**6.19**	**69%**
Seabeck Creek RM 0.5-1.0	**6.15**	**68%**
Snow Creek RM 0.0-1.0	*6.13*	*68%*
Snow Creek RM 3.5-6.5	*6.13*	*68%*
Gorst Creek RM 0.75-1.0	**6.10**	**68%**
Gamble Creek RM 1.5-HW	**6.09**	**68%**
Snow Creek Andrews Tributary	*6.06*	*67%*
Fisherman's Harbor	*6.05*	*67%*
Little Thorndyke Creek	*6.05*	*67%*
Indianola Creek	**6.04**	**67%**
Indian George Creek	*6.02*	*67%*
Chimicum Creek RM 0.0-1.0	*5.96*	*66%*
Snow Creek RM 1.0-3.5	*5.96*	*66%*

Nodal Riparian Corridor (NRC) Refugia	Score	% Max
Salmon Creek RM 0.8-2.0	*5.95*	*66%*
Barker Creek RM 0.0-0.5	**5.90**	**66%**
Barker Creek RM 0.5-1.0	**5.90**	**66%**
Ripley Creek	*5.89*	*65%*
Minter Creek Huge Tributary	**5.89**	**65%**
Minter Creek RM 0.0-1.5	**5.89**	**65%**
Blackjack Creek RM 0.0-1.5	**5.86**	**65%**
Ludlow Creek RM 0.5-1.0	*5.85*	*65%*
Anderson Creek RM 0.0-0.5	**5.85**	**65%**
Carpenter Creek RM 0.0-1.0	**5.79**	**64%**
Chico Creek RM 1.25-2.5	**5.78**	**64%**
Lindsay Creek	*5.77*	*64%*
Big Quilcene River RM 0.0-0.7	*5.76*	*64%*
Big Beef Creek Lake Symington RM 5.5-6.0	**5.76**	**64%**
Kinman Creek RM 0.0-0.5	**5.74**	**64%**
Kinman Creek RM 0.5-HW	**5.74**	**64%**
Minter Creek RM 1.5-HW	**5.73**	**64%**
Bones-Hubbard Creek	*5.71*	*63%*
Steele Creek RM 0.0-0.5	**5.67**	**63%**
Beaver Creek RM 0.0-0.5	**5.65**	**63%**
Beaver Creek RM 0.5-HW	**5.65**	**63%**
Chimicum Creek RM 1.0-2.0	*5.62*	*62%*
Carpenter Creek RM 1.0-1.5	**5.62**	**62%**
Salmon Creek RM 0.0-0.8	*5.61*	*62%*
Donovan Creek	*5.55*	*62%*
Tarboo Creek RM 2.5-4.0	*5.54*	*62%*
Spencer Creek	*5.53*	*61%*
Olalla Creek RM 1.5-HW	**5.52**	**61%**
Chico Creek RM 0.75-1.25	**5.44**	**60%**
Kinman Creek South-Lofall Tributary	**5.41**	**60%**
Chimicum Creek Naylors Tributary	*5.40*	*60%*
Illahee Creek North Fork RM 1.0-1.5	**5.40**	**60%**
Illahee Creek RM 0.0-1.0	**5.40**	**60%**
Salmonberry Creek	**5.38**	**60%**
Mats Mats Creek	*5.37*	*60%*
Little Goose Creek	*5.37*	*60%*
Leland Creek	*5.37*	*60%*
Tarboo Creek RM 1.0-2.5	*5.37*	*60%*
Clear Creek West Fork RM 1.0-2.0	**5.32**	**59%**
Chico Creek RM 0.0-0.75	**5.28**	**59%**
Chimicum Creek East Fork Mainstem	*5.22*	*58%*
Steele Creek South Fork RM 0.5-1.0	**5.18**	**58%**
Clear Creek Mountainview Tributary	**5.14**	**57%**
Carpenter Creek RM 1.5-HW	**5.12**	**57%**
Dogfish Creek East Fork RM 0.0-1.0	**5.12**	**57%**
Dogfish Creek East Fork RM 1.0-HW	**5.12**	**57%**
Barker Creek RM 1.0-1.5	**5.06**	**56%**

Nodal Riparian Corridor (NRC) Refugia	Score	% Max
Burley Creek RM 0.0-0.5	**5.05**	**56%**
Burley Creek RM 0.5-1.5	**5.05**	**56%**
Blackjack Creek RM 1.5-3.0	**5.03**	**56%**
Gorst Creek RM 0.5-0.75	**5.02**	**56%**
Gamble Creek RM 0.0-1.0	**4.93**	**55%**
Chimicum Creek RM 2.8-9.0	*4.90*	*54%*
Dogfish Creek RM 1.0-3.0	**4.86**	**54%**
Dogfish Creek RM 3.0-HW	**4.86**	**54%**
Steele Creek Crouch Tributary	**4.83**	**54%**
Steele Creek North Fork RM 0.5-HW	**4.83**	**54%**
Clear Creek West Fork RM 0.0-0.5	**4.82**	**54%**
Clear Creek West Fork RM 0.5-1.0	**4.82**	**54%**
Chimicum Creek RM 2.0-2.8	*4.79*	*53%*
Burley Creek RM 1.5-HW	**4.72**	**52%**
Gorst Creek RM 0.0-0.25	**4.69**	**52%**
Gorst Creek RM 0.25-0.5	**4.69**	**52%**
Clear Creek East Fork RM 1.0-2.0	**4.64**	**52%**
Clear Creek East Fork RM 2.0-HW	**4.64**	**52%**
Dogfish Creek RM 0.0-0.5	**4.62**	**51%**
Dogfish Creek RM 0.5-1.0	**4.62**	**51%**
Barker Creek RM 1.5-HW	**4.56**	**51%**
Clear Creek West Fork RM 2.0-HW	**4.32**	**48%**
Blackjack Creek RM 3.0-5.5	**4.28**	**48%**
Clear Creek RM 0.0-1.0	**4.16**	**46%**

Table 19: Nodal Riparian Corridor (NRC) Refugia Scores

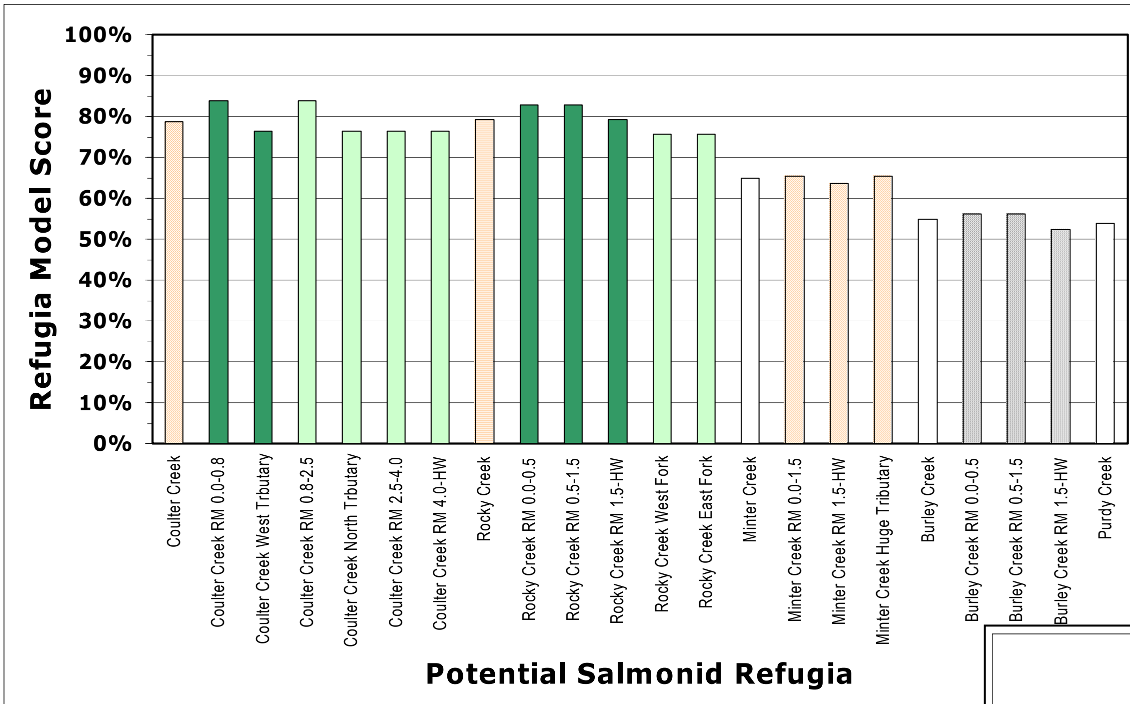
Note: East Jefferson County streams in *italics* and Kitsap County streams in **bold.**

Nearshore-Estuary Refugia	Score	% Max
Kala Point South	*8.82*	*98*
Quilcene Bay	*8.27*	*92*
Chimacum North	*8.18*	*91*
Dabob Bay East	*8.09*	*90*
Duckabush North	*8.00*	*89*
Dabob Bay West	*7.82*	*87*
Shine South	*7.82*	*87*
Nordstrom Estuary	*7.55*	*84*
Thorndyke South	*7.55*	*84*
Thorndyke North	*7.55*	*84*
Chimacum South	*7.45*	*83*
Point-No-Point	**7.45**	**83**
McDonald North	*7.27*	*81*
Duckabush South	*7.27*	*81*
Dosewallips North	*7.27*	*81*
Ludlow East	*7.27*	*81*
Holly Nearshore	**7.09**	**79**
Shine North	*7.00*	*78*
Kala Point North	*6.91*	*77*
Thorndyke Estuary	*6.82*	*76*
Shine Estuary	*6.82*	*76*
Chimacum Estuary	*6.82*	*76*
Kala Point Lagoon	*6.82*	*76*
Quilcene Bay Head	*6.73*	*75*
Murden Cove	**6.73**	**75**
Devil's Lake Estuary	*6.64*	*74*
Jackson Cove North	*6.55*	*73*
Dabob Bay Head	*6.45*	*72*
Bangor Nearshore	**6.27**	**70**
Foul-Weather Bluff	**6.18**	**69**
Stavis Bay	**6.18**	**69**
Jackson Cove South	*6.09*	*68*
McDonald South	*6.00*	*67*
Lone Rock Nearshore	**6.00**	**67**
Rolling Bay	**5.91**	**66**
Port Gamble Bay	**5.73**	**64**
Union Estuary	**5.64**	**63**
Discovery Bay	*5.55*	*62*
Fulton Estuary	*5.36*	*60*
Port Blakely Harbor	**5.27**	**59**
Seabeck Bay	**5.27**	**59**
Dewatto Nearshore	**5.09**	**57**
Indianola Nearshore	**5.00**	**56**
Fletcher Bay	**4.82**	**54**
Dosewallips South	*4.73*	*53*
Colvos Passage	**4.73**	**53**
Lynwood Nearshore	**4.73**	**53**
Agate Passage Nearshore	**4.64**	**52**
Port Ludlow Bay	*4.45*	*49*

Nearshore-Estuary Refugia	Score	% Max
Brownsville Nearshore	4.36	48
Miller Bay	4.18	46
Burley Lagoon	4.09	45
Illahee Estuary	4.09	45
Dyes Inlet East	4.00	44
Port Madison Bay	3.91	43
Dyes Inlet West	3.64	40
Manzanita Bay	3.64	40
Tahuya Nearshore	3.45	38
Case Inlet	3.36	37
Eagle Harbor	3.27	36
Liberty Bay	2.91	32
Sinclair Inlet	1.73	19

Table 20: Nearshore-Estuarine (NSE) Refugia Scores

Note: East Jefferson County nearshore areas in *italics* and Kitsap County nearshore areas in **bold**.



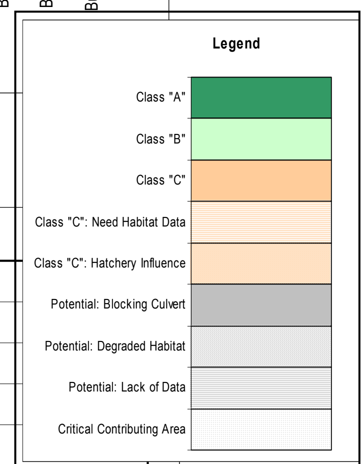


Figure 28: Overall Refugia Model Scores for the Key Peninsula Sub-Region of Kitsap County.

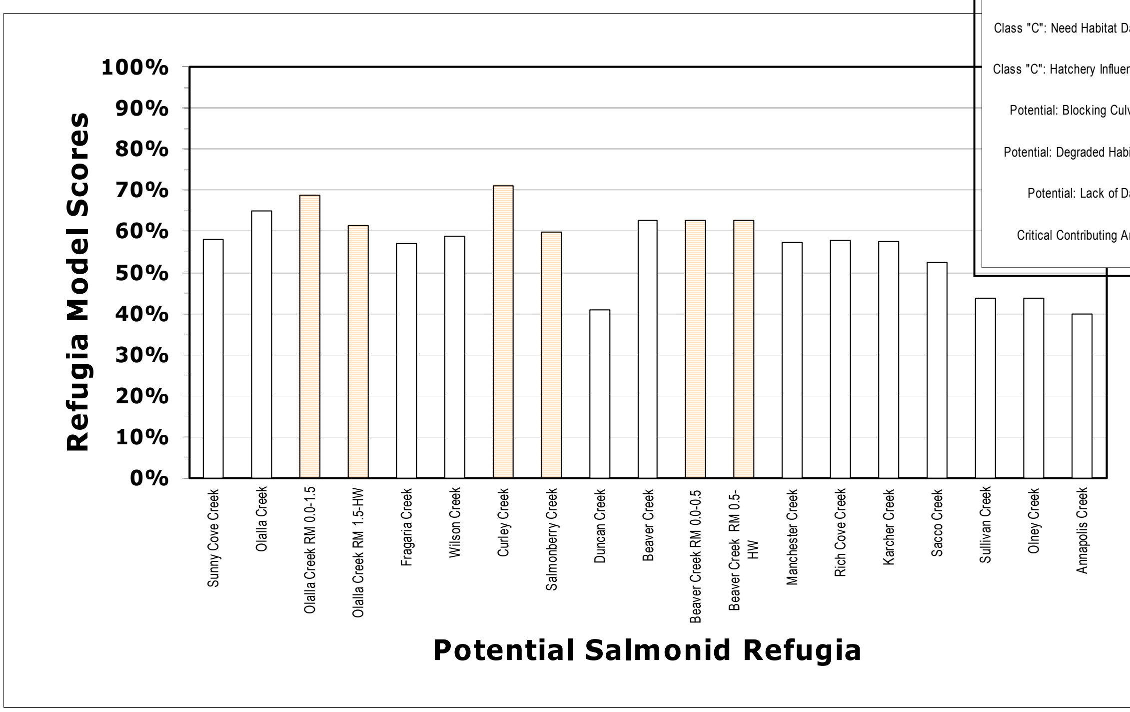
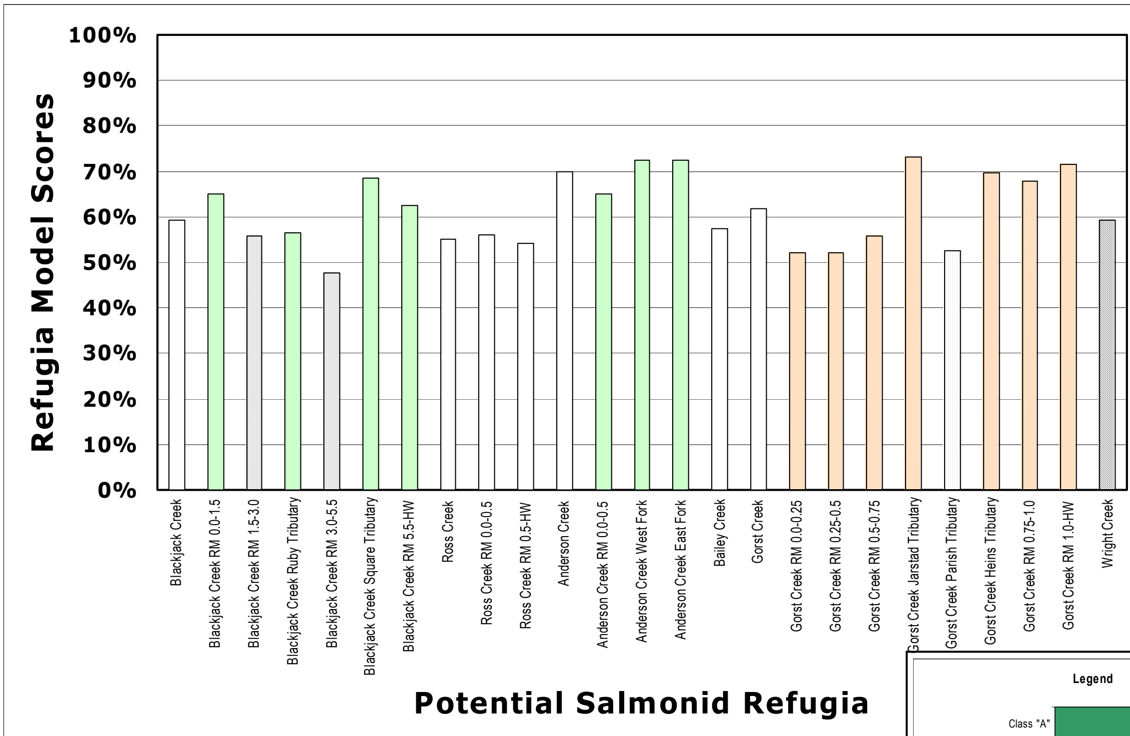


Figure 29: Overall Refugia Model Scores for the South Kitsap Sub-Region of Kitsap County



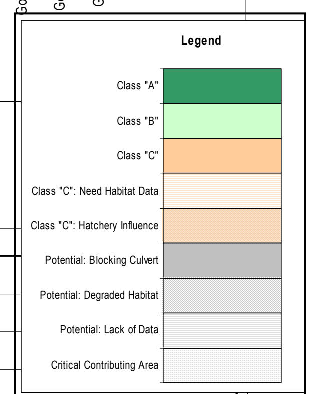


Figure 30: Overall Refugia Model Scores for the Sinclair Inlet Sub-Region of Kitsap County.

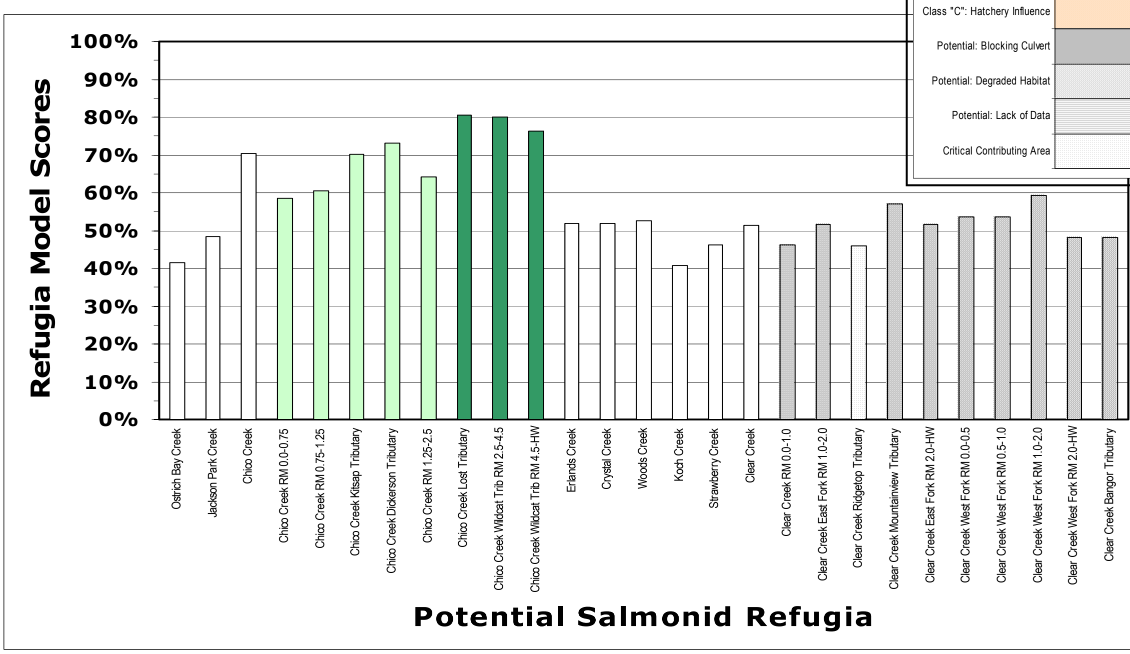


Figure 31: Overall Refugia Model Scores for the Western Dyes Inlet Sub-Region of Kitsap County.

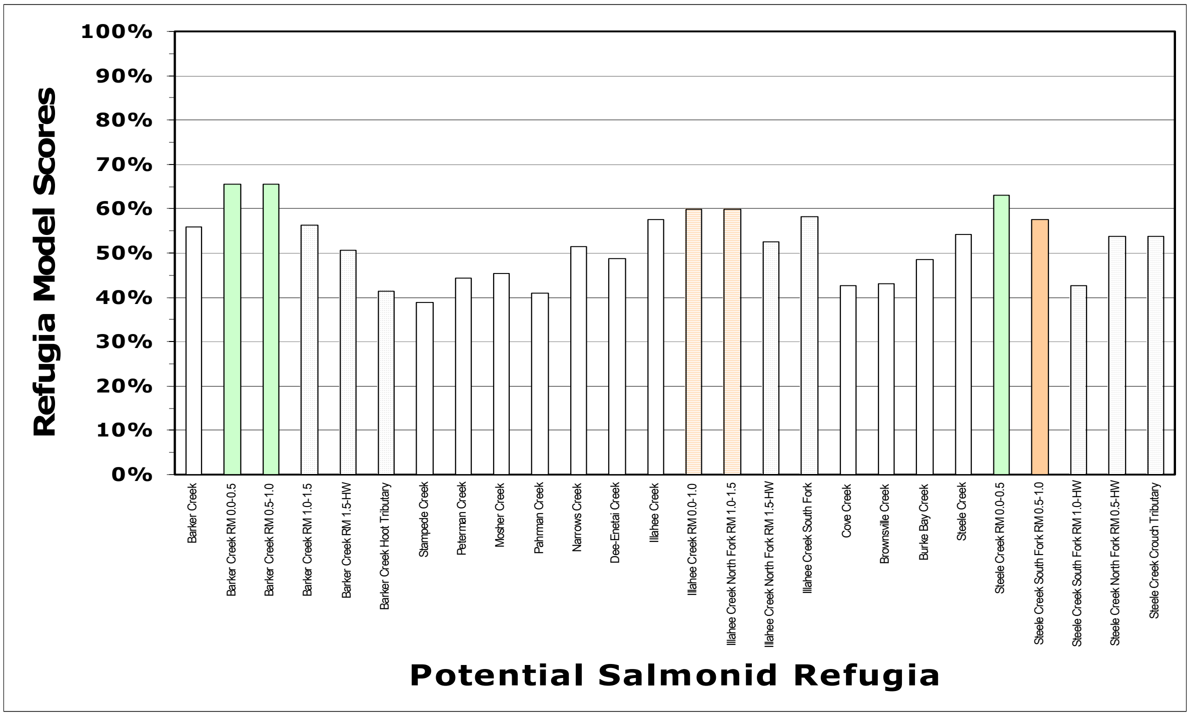


Figure 32: Overall Refugia Model Scores for the Eastern Dyes Inlet Sub-Region of Kitsap County.

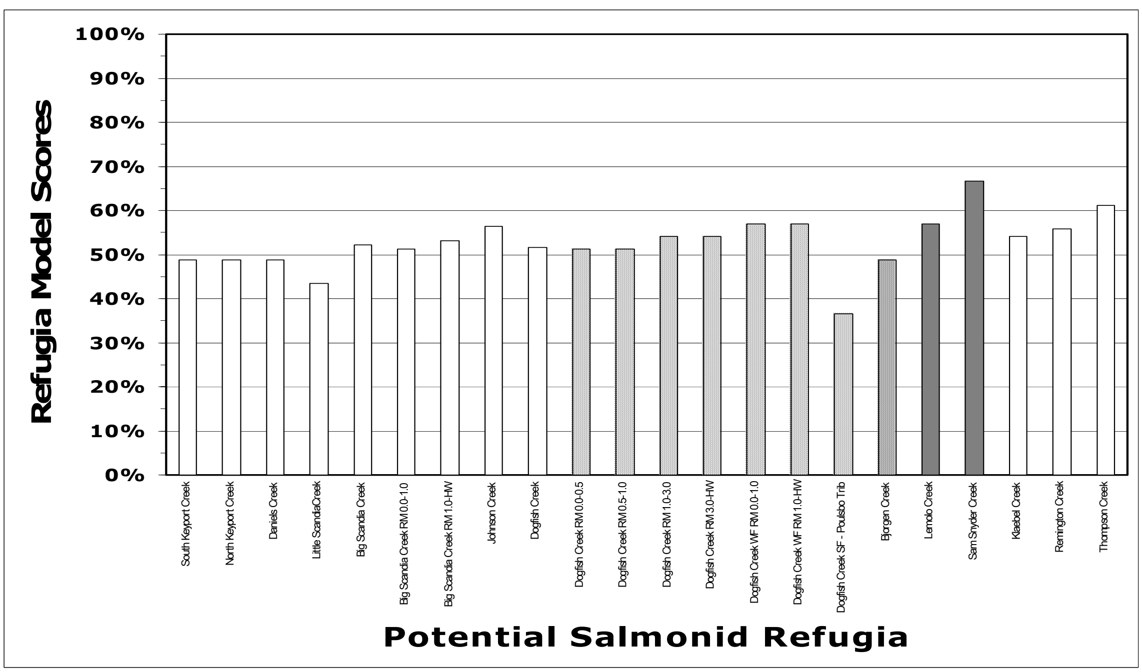
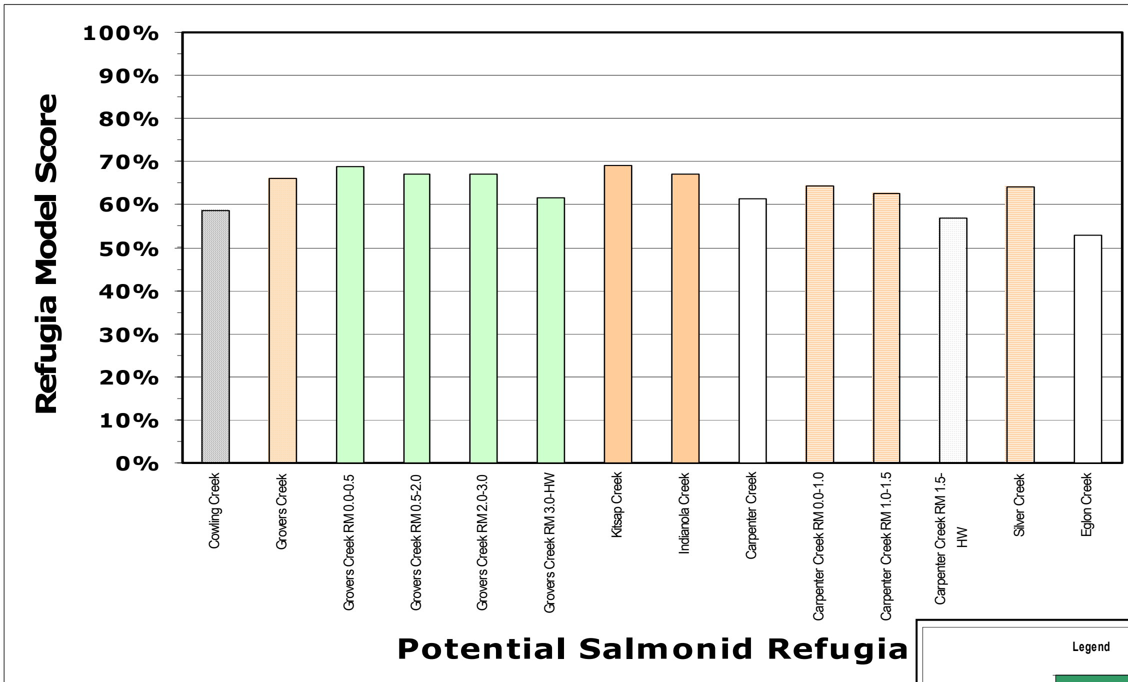


Figure 33: Overall Refugia Model Scores for the Liberty Bay Sub-Region of Kitsap County.



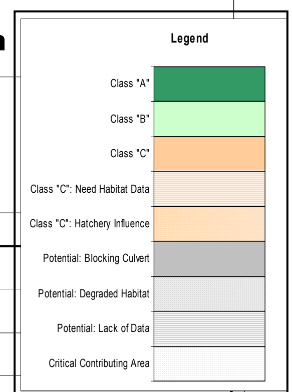


Figure 34: Overall Refugia Model Scores for the Kingston Sub-Region of Kitsap County.

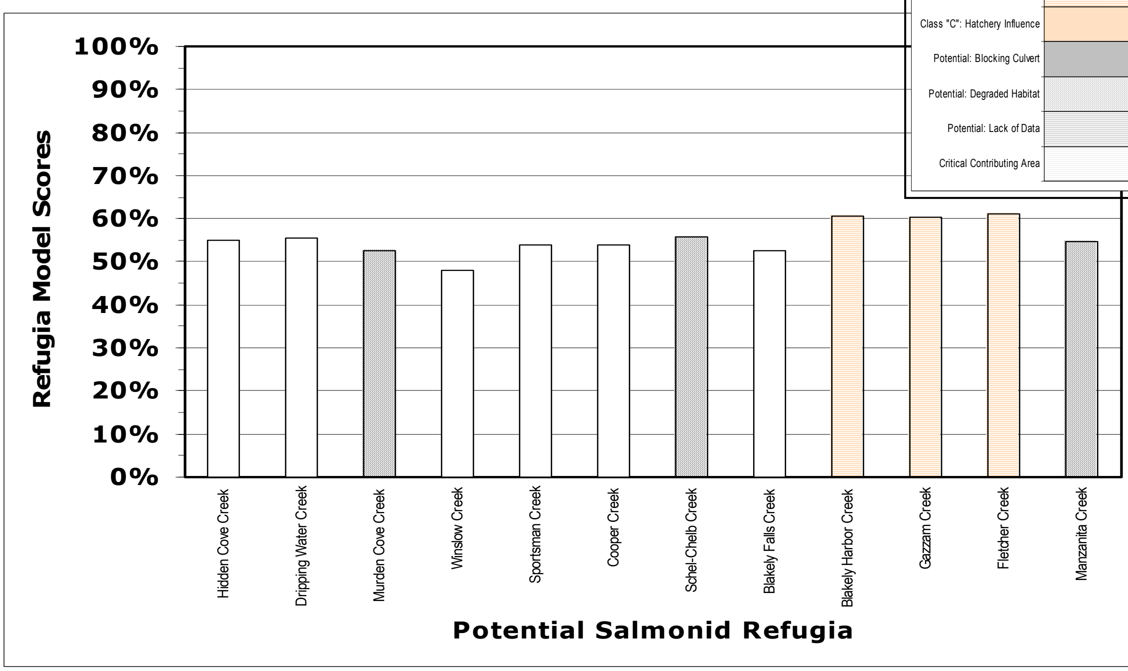


Figure 35: Overall Refugia Model Scores for the Bainbridge Island Sub-Region of Kitsap County.

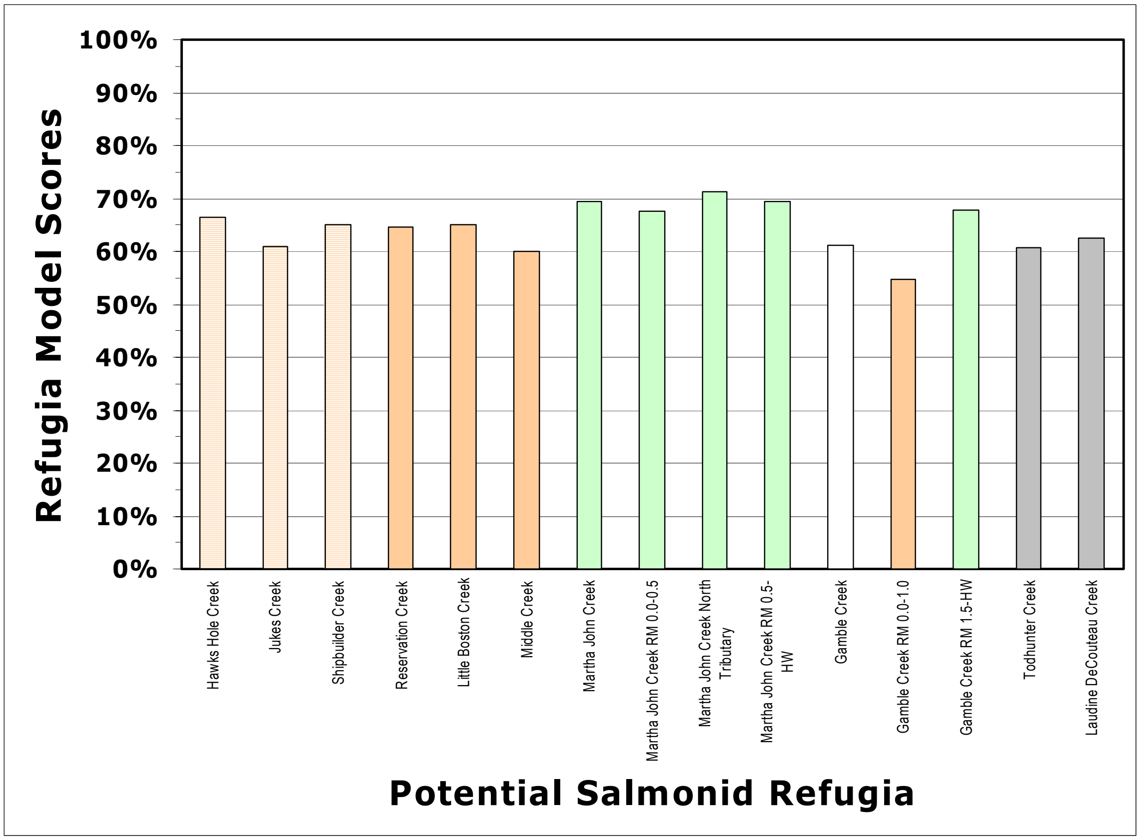


Figure 36: Overall Refugia Model Scores for the Gamble Bay Sub-Region of Kitsap County.

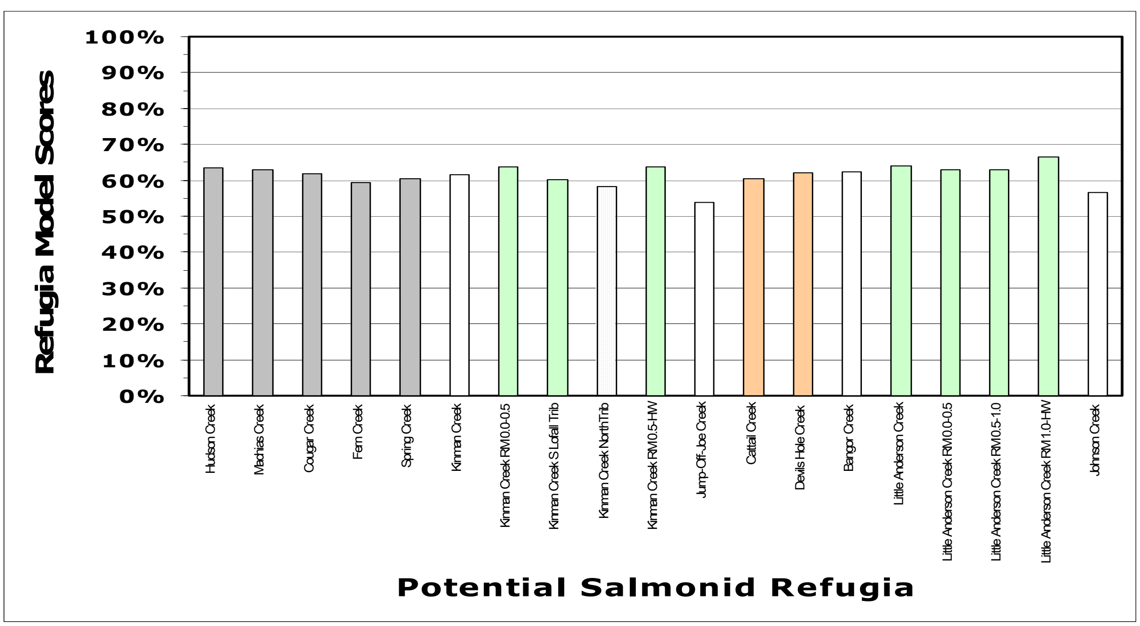
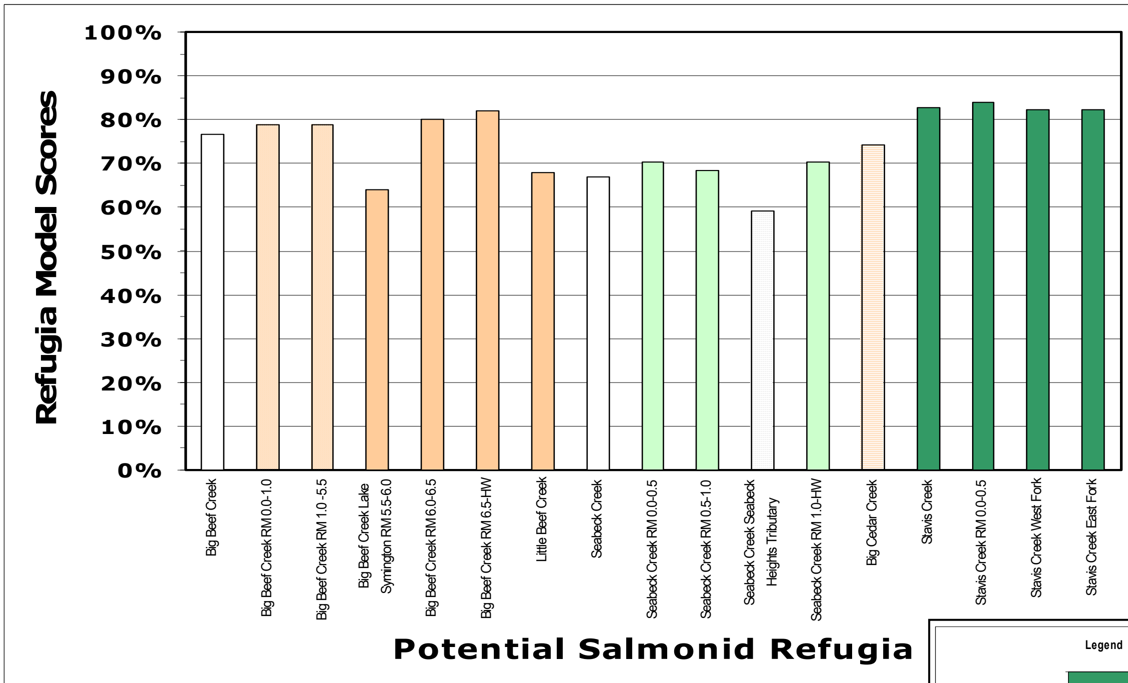


Figure 37: Overall Refugia Model Scores for the North Hood Canal Sub-Region of Kitsap County.



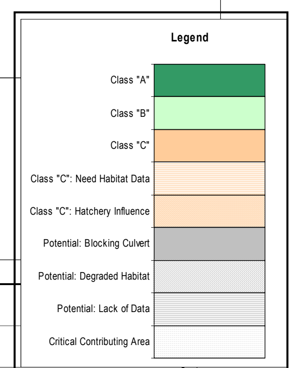


Figure 38: Overall Refugia Model Scores for the Seabeck Sub-Region of Kitsap County.

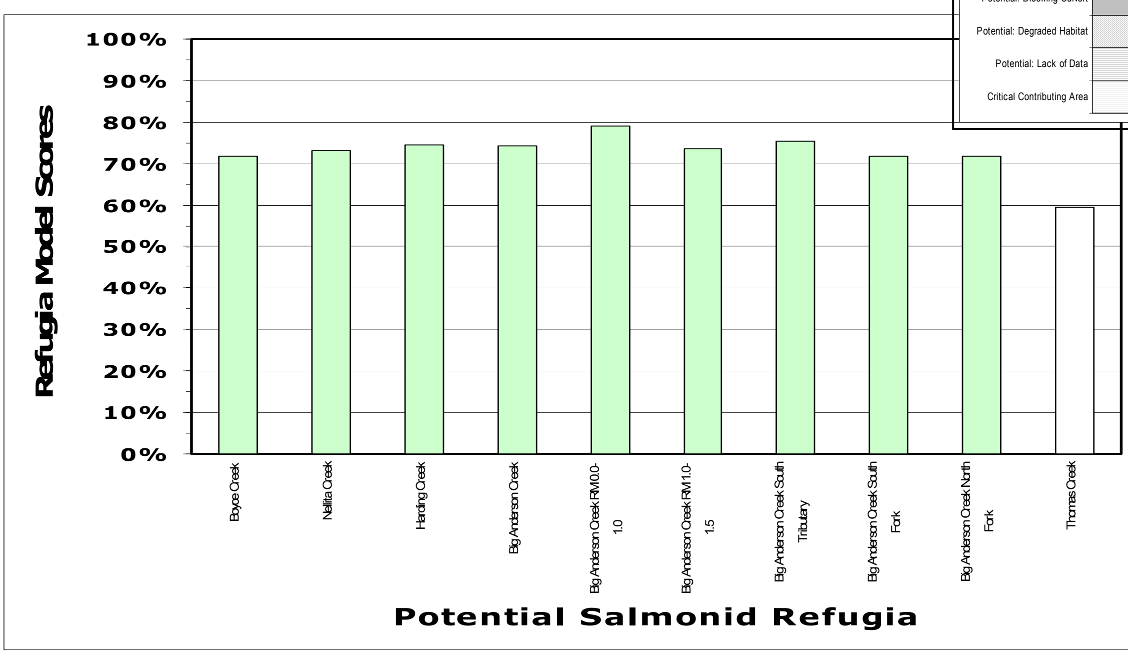


Figure 39: Overall Refugia Model Scores for the Holly Sub-Region of Kitsap County.

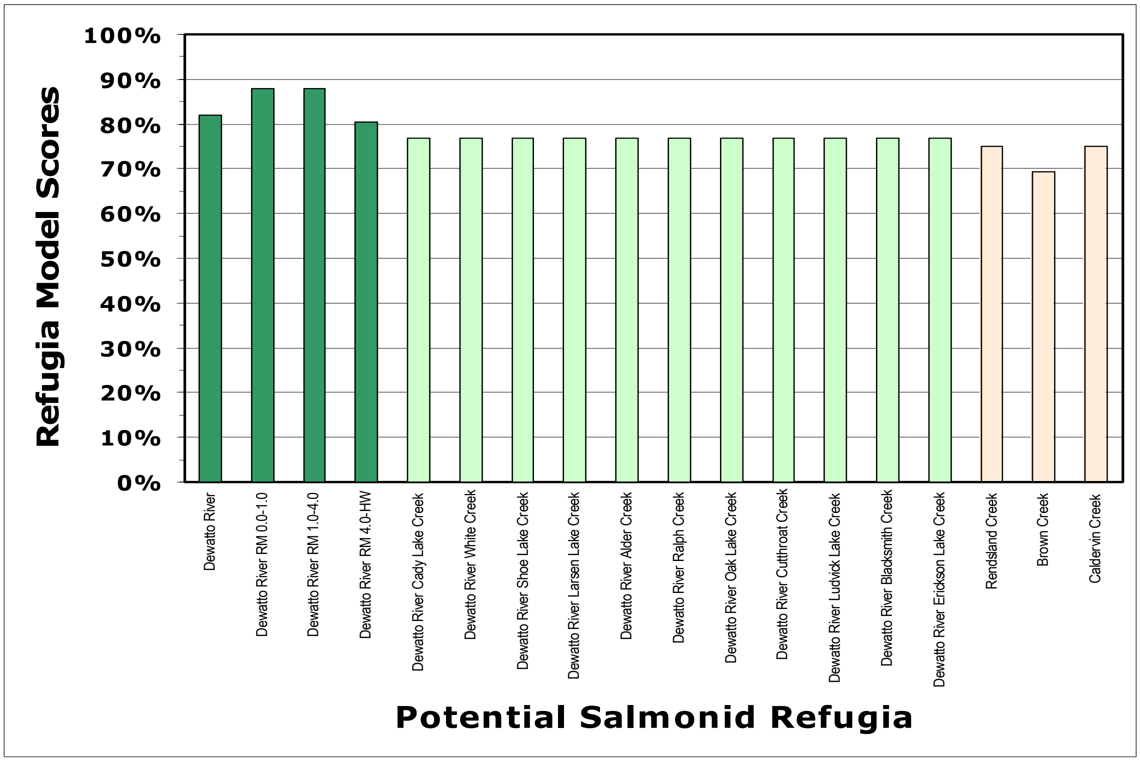


Figure 40: Overall Refugia Model Scores for the Dewatto Sub-Region of Kitsap County.

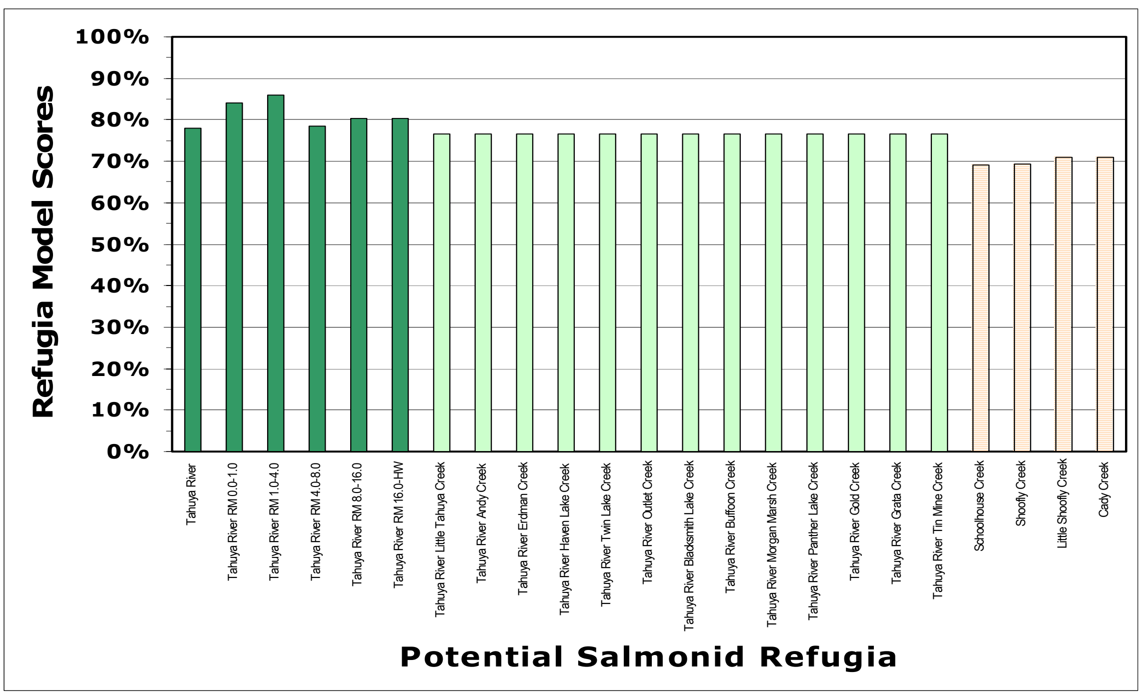


Figure 41: Overall Refugia Model Scores for the Tahuya Sub-Region of Kitsap County.

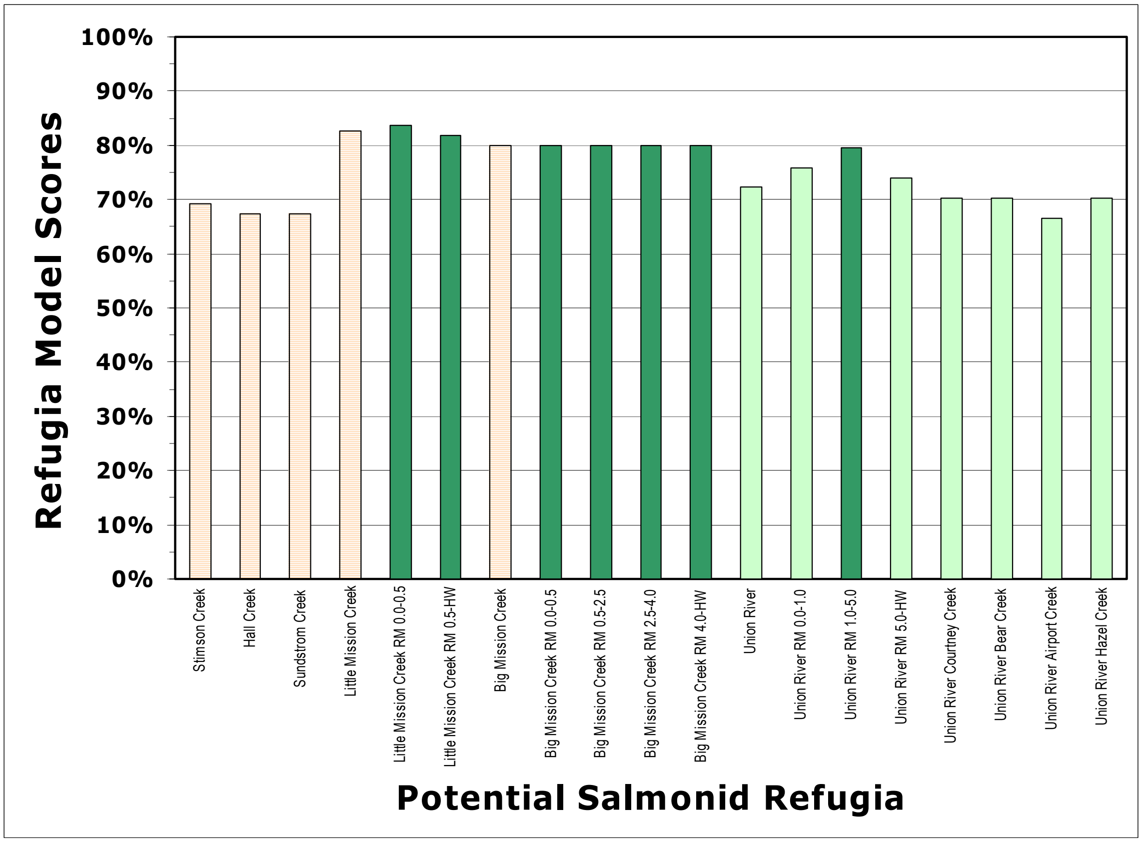


Figure 42: Overall Refugia Model Scores for the Union Sub-Region of Kitsap County.