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APPENDIX 5

WILLAMETTE NATURAL RESOURCE INVENTORY TECHNICAL REVIEW - JANUARY 2008

The following paper addresses a number of key methodological issues raised in public comments on the draft Willamette Natural Resource Inventory for the North Reach. Most of these issues were discussed at a meeting of technical experts on January 10, 2008. Meeting participants included staff from the Port of Portland and SWCA Environmental Consultants, Ellis Ecological Services, Windward Environmental, Oregon Department of Fish and Wildlife, US Fish and Wildlife Service, Metro, NOAA Fisheries, Audubon Society of Portland, and the Portland Bureau of Environmental Services.

This paper provides a summary of the comments provided and staff responses which take into consideration input from the technical expert meeting and information gleaned from additional staff analysis.

Following the narrative discussion of the issues, comments, discussion and staff recommendations is a table summarizing this information and the anticipated changes in functional scores, aggregated riparian corridor and wildlife habitat ranks, and combined ranks.

Topic – Assigning riparian corridor functions and value to rivers and streams

Introduction to the Issue

Metro and Oregon Land Use Planning Goal 5 rules include rivers and streams as part of a riparian corridor. Metro's GIS inventory model did not assign scores directly to rivers and streams for the six riparian functions inventoried. According to Metro staff this was primarily due to mapping limitations (availability of stream centerline data only). The Bureau of Planning decided to explicitly recognize the important contribution of rivers and streams to each of the riparian functions addressed in the inventory. Rivers and streams store and convey flows and flood waters; contribute significantly to nutrient cycling and food web; provide hyporheic interactions and influence microclimate; contribute to channel dynamics; and are significant movement corridors for aquatic, terrestrial and avian species. As such, the GIS model assigns primary riparian functional scores directly to the rivers and streams in the draft WNRI.

Comments and Technical Discussion

Some commenters disagreed with the assignment of primary scores to Willamette River for the six riparian functions inventoried. They suggested that this approach obscures the variability of river conditions, including the considerable alteration and degradation of function in the lower river.

During the January 10th meeting, several of the technical experts attending supported the assignment of primary score to the Willamette River for the riparian corridor functions inventoried. It was noted that the river is the primary feature of the riparian corridor in the North Reach, and that it contributes significantly to all of the functions associated with the adjacent riparian zone. For example, the river provides the hydraulic forces that shape the channel and transports large wood from upstream that is then deposited onto North Reach beaches. Others disagreed, stating that that the riparian functions addressed in the inventory model are not the most appropriate metrics to use in assessing the quality or condition of the river.

There was general agreement that additional metrics should be incorporated into the inventory, whether or not the model is applied to the river. Recommended metrics include depth, width, geomorphology,

substrate, and water quality. Some of the meeting participants said that inventory needs to better reflect the degradation of the river conditions (e.g., water quality). Others said that despite the degradation, the inventory should reflect the unique and important ecological role and value of the lower river in the City, the region, and the basin as a whole.

All agreed that the inventory should address the variability in the North Reach character and conditions, such as shallow water areas. Participants encouraged staff to incorporate additional summary information from other reports, but cautioned staff not to duplicate the information provided in more detailed reports. They encouraged staff to cross-reference and provide links to other relevant studies.

Staff Recommendations and Results

Staff agrees the additional metrics should be incorporated into the draft WNRI to help characterize the condition of the river and contamination of sediment and riparian sites. The North Reach description will be revised to include more information on river geomorphology, water quality, and contamination. The revised inventory site descriptions will include more information (e.g. shallow water areas) to highlight variability in relative condition of the river where it exists.

Staff also proposes that the inventory continue to reflect the role of the river as a Special Habitat Area and the important contribution of the river to the riparian corridor functions addressed in the inventory.

Staff recommends that the river continue to receive primary scores for the following riparian corridor functions:

- Microclimate and shade
- Stream flow moderation and flood storage
- Organic inputs, food web and nutrient cycling
- Riparian wildlife movement corridor
- Large wood and channel dynamics (Note: Beaches will be incorporated into the Willamette River channel, and will also be assigned a primary score for channel dynamics)

To better reflect existing channel alterations, bank hardening, flow control, sediment contamination and water quality issues, staff recommends that the model be revised to assign a secondary score to the Willamette River in the North Reach for Bank Function, and Sediment, Pollution and Nutrient control. Changes to the model criteria will shift the scores assigned to the river for this function, however the aggregate relative rank assigned to the river for riparian functions will remain "high."

Staff will refine the methodology section of the report to more clearly describe the relationships between the river and adjacent riparian areas.

Topic – Functional value of flood areas in the North Reach

Introduction to the Issue

The draft WNRI attributes riparian functional value to the flood areas within the Willamette River North Reach. Flood areas represent the combined FEMA 100-year floodplain and the areas inundated during the 1996 flood. The WNRI GIS riparian corridor model assigns primary scores to vegetated flood areas for five of the six riparian corridor functions. Developed flood areas are assigned a secondary score based solely on their contribution to flood storage. Therefore, the developed flood area receives a low relative rank for both aggregated riparian function and combined riparian/wildlife habitat function in the draft WNRI. This approach is consistent with the approach Metro used to evaluate riparian corridor function for the adopted regional Nature in Neighborhoods inventory.

Comments and Technical Discussion

Some commenters on the draft WNRI disputed the functional value attributed to the developed flood area along the Willamette in Portland. They suggested that:

1) The developed flood area does not provide significant ecological value;
2) More frequently flooded areas provide more value than the 100-year floodplains;
3) The storage capacity of the flood area in the Lower Willamette is insignificant relative to the flow volumes generated in such a large basin; and
4) The impact of flood storage is reduced given the management of flows by the Willamette Basin reservoir system.

A range of opinions on this topic were expressed during the January 10th meeting of technical experts. Some continued to dispute the value attributed to the 100-year floodplain, noting that it is primarily a tool developed by FEMA to insure property, rather than as an indicator of ecological value. They noted that this is a social, not an ecological function. Others asserted that the 100-year floodplain does provide significant ecological values (e.g. water storage, flow attenuation) and that the social values, such as property protection, are intertwined with the ecological values.

There was also disagreement as to whether the storage provided by flood area is important enough to be attributed value in the inventory. One participant pointed out that during a flood, the flood areas along the North Reach will fill with water within a very short period of time. It was also noted that some of the North Reach flood areas were inundated for several days during the 1996 flood. Others suggested that the role and value of these areas is cumulative and should be valued in the context of the basin as a whole. It was noted that no single site can "hold the river."

Everyone agreed that frequently flooded areas provide important ecological functions as well, and that developing data for these areas would enrich future inventories.

Staff Recommendations and Results

Staff agrees with the perspective that flood storage along the North Reach must be considered in the basin-wide context and valued from a cumulative perspective. Staff recommends that vegetated flood areas within the North Reach continue to be assigned primary score consistent with the adopted regional inventory, and developed (non-vegetated) flood areas continue to receive secondary score for flood storage. Staff also recommends that developed flood areas continue to receive a low relative rank for aggregated riparian functions and combined riparian/wildlife habitat function.

Topic – Functional Value of areas within 50 feet of the River

Introduction to the Issue

The draft WNRI attributes riparian corridor functional values to land within 50 feet of rivers, streams and wetlands for two of the six riparian corridor functions (*bank stabilization and control of sediments, nutrients and pollutants;* and *large wood and channel dynamics*). Primary scores are assigned to this area for these two functions regardless of bank condition. Therefore, the area within 50 feet of rivers and streams receive a high or medium relative rank for riparian corridor function and for combined riparian/wildlife habitat function.

This is consistent with the approach Metro used to develop the regional Nature in Neighborhoods inventory of riparian corridors and wildlife habitat. This approach was the subject of much discussion during the development of the regional inventory. Metro established these "default criteria" to recognize the critical role of river and stream banks and lands closest to the waterway in maintaining riparian functions. This approach was intended, in part, to reflect policies established to protect water quality through the adoption of Title 3 of the Urban Growth Management Functional Plan. Metro noted that these criteria should apply specifically to low and moderate gradient channel types (Metro, Table 4, Inventory report, August 2005).

Comments and Technical Discussion

Some commenters on the WRNI disputed this approach. They suggested that in the North Reach much of the riverbank and lands within 50 feet of the river is hardened or developed and do not provide functional values reflected by the relative ranks assigned in the inventory. They also suggest that the draft rankings do not draft reflect the variability of bank conditions and functions.

During the January 10th meeting of technical experts, most participants agreed that in the North Reach the extensive bank hardening and development within the first 50 feet of the river significantly affects the overall contribution of large wood and channel dynamics throughout the reach. Meeting participants seemed to agree with staff's proposal to assign non-vegetated banks and areas within 50 feet of the river a secondary instead of a primary score for *large wood/channel dynamics* functions.

Technical experts expressed more diverse opinions as to how the North Reach riverbank and first 50 feet should be valued in terms of *bank stabilization and sediments, pollution and nutrients control*.

Most agreed that vegetated banks, in a more natural condition, typically provide a superior range of functions compared to hardened banks. Several meeting participants pointed out that vegetation captures and filters sediments and contaminants and tempers erosion. However, there was also agreement that in areas like the North Reach, hardened banks provide important functions that should not be ignored or dismissed. For example, rip rap and seawalls are designed to stabilize banks and prevent erosion. In addition, it was noted that hardened banks can, in some instances, help prevent contaminants from entering the river.

A couple of experts suggested that the Willamette River banks are tied to the river and its ecological functions at all times and under all conditions. They noted that the banks provide important habitat and should be assigned a high relative rank regardless of condition. As the discussion progressed, experts pointed out that while structures like seawalls and pilings stabilize the riverbank, a truly functioning riverbank should not be static and isolated from the river. It was noted that stream and river channels

operate in state of dynamic equilibrium and that the function of hardened banks is significantly reduced compared to more natural banks.

After reflecting on the January 10th discussion, the Bureau of Environmental Services (BES) has recommended that the title for this function be changed. BES suggests that replacing the phrase "bank stability" with "bank function" or "bank dynamics" would more accurately reflect the functions the inventory is attempting to capture, and would help prevent the type of confusion and disparate views expressed during the meeting.

Staff Recommendations, and Results

Large wood and channel dynamics

Staff agrees with technical experts that the extensive bank hardening and development significantly reduces the overall channel dynamics functions along the North Reach. Almost seven miles of riverbank in the North Reach are mostly devoid of vegetation and are hardened, developed, and/or highly disturbed.

Staff conducted additional analysis of the available landcover data, and has determined that forest vegetation along the North Reach is generally associated with non-hardened banks. Other vegetation types are associated with a mix of bank types. As such, the forested , non-hardened river bank areas can provide a rare opportunity for localized channel dynamics and habitat structure in the North Reach by large wood and trapping sediments.

Based on the January 10th discussion and this additional analysis, staff recommends that only forested areas within 50 feet of the river continue to be assigned a primary score for its contribution to large wood and channel dynamic functions in the North Reach. Staff recommends that the score for non-forested areas, including non-vegetated banks, within 50 feet of the river shift from primary to secondary for these functions.

Bank stabilization, erosion and control of sediments, nutrients and pollutants

As pointed out at the January 10th technical expert meeting, seawalls, pilings and riprap help stabilize riverbanks and prevent sediments from entering the river. Nevertheless, staff believes that it is inappropriate to attribute a similar or greater functional value to structures that immobilize and isolate the river or stream bank from a water body, as is attributed to non-hardened or vegetated banks that can interact with the water body and change over time. Staff questions how effective riverbank structures are at containing contaminants (particularly water soluble pollutants) unless they are designed specifically to do so. Riparian vegetation also provides sediment, nutrient and pollution filtration and uptake benefits. .

Staff agrees with technical experts who have suggested that more complex natural or semi-natural vegetation assemblages provide these functions more effectively than highly manicured landscapes or lawn. Semi-natural landscapes generally provide more structural diversity and stronger root systems that help trap sediments, stabilize the soil and steep slopes, and help capture nutrients and pollutants. Cultivated landscapes in the North Reach generally contain a predominance of actively managed lawn, ornamental shrubs and trees. Further, the soils may be more compacted, and this type of landscape can contribute herbicides, fertilizers and pesticides to nearby water bodies.

Staff recommends that functional value continue to be attributed to the riverbank and first 50 feet for all conditions, however the inventory model criteria will be modified as follows to better reflect the variability in existing conditions and relative functionality:

- Vegetation with 50 feet of the river will continue to receive a primary score.

- Only forest or natural/semi-natural woodland and shrubland vegetation within the flood area or between 50 and 100 feet of the river will continue to receive a primary score for bank stabilization, erosion and control of sediments, nutrients and pollutants. Scores assigned to cultivated woodland and shrubland vegetation in these areas would shift from primary to secondary.

- The functional score assigned to seawalls, pilings and non-vegetated riprap, and adjacent land within 50 feet of the river, will shift from primary to secondary to reflect the diminished functions associated with hardened banks and areas largely devoid of vegetation.

Also, staff recommends that a portion of the title for this riparian function be changed from "bank stabilization" to "bank function" as recommended by the Bureau of Environmental Services.

As a result of the proposed changes to the WNRI GIS riparian corridor model:

- Cultivated woodland and shrubland vegetation within 100 feet of the river or within the flood area will shift to a medium or low relative rank for both aggregated riparian function and combined riparian/wildlife habitat function.

- The relative ranks assigned to seawalls, pilings and non-vegetated riprap, and land within 50 feet of the river will shift to low for aggregated riparian function and combined riparian/wildlife habitat function.

- Forested areas and natural/semi-natural woodland and shrubland vegetation within 100 feet of the river or within the flood area will continue to receive a medium or high relative rank for both aggregated riparian function and combined riparian/wildlife habitat function.

Staff believes that the resulting relative ranks more accurately reflect the variability in conditions along the river and will better inform future management decisions, including setting priorities for protection and restoration.

Topic – Contribution of large wood to channel dynamics along the North Reach

Introduction to the Issue

The draft WNRI attributes functional value to forest vegetation in the riparian corridor for its contribution to channel dynamics. Primary scores are assigned to forest vegetation within the flood area or 150 feet from river, stream or wetland. Secondary score is assigned to forest vegetation between 150 and 260 feet from the water body. These criteria are consistent with those Metro developed to assign scores for this function in the regional Nature in Neighborhoods inventory. The draft WNRI also assigns primary scores to wetlands within 150 feet of a stream or river for this function. Metro assigned scores for this function to any wetland within ¼ mile of a river or stream.

Comments and Technical Discussion

Some commenters on the draft WNRI disagree with the value attributed to riparian forest vegetation for its contribution to channel dynamics in the North Reach. They argue that 1) large wood is not an important factor in shaping the channel in the lower reaches of a large river system; and 2) alterations to the channel (dredging, straightening, and narrowing), filling and armoring of the river banks, further reduce the relative functional value of woody riparian vegetation along the North Reach. It was also suggested that the riparian forest vegetation will have a greater potential benefit where the vegetation on steep slopes that extend to the river. (Note: This situation occurs in the North Reach only where the east side bluffs are close to the river, below the University of Portland.)

At the January 10th meeting, technical experts agreed that the primary channel forming feature in the lower reaches of large rivers like the Lower Willamette, is the river itself. It was noted, however, that large wood does influence local channel conditions in the North Reach, helping to trap sediment and provide important habitat structure for salmonids and other species. Meeting participants agreed that large wood is conveyed from upstream areas to beaches and deposition areas in the North Reach. Trees along North Reach riparian corridor can contribute large wood to the system, particularly in more natural areas and where there are steep slopes. It was noted that the City is installing large wood as part of restoration projects along the Willamette River.

Staff Recommendations and Results

Taking into consideration the January 10th discussion, staff recommends that forest vegetation located within the flood area or within 150 feet of the river continue to receive a primary score for its locally significant contribution to channel conditions. Forest vegetation is associated with non-hardened riverbank conditions in the North Reach, which, along with the beach areas, may provide the only real opportunity for channel dynamism in this study area,

Staff also recommends that forest vegetation between 150 and 260 feet from a river or stream continue to be assigned a secondary score only where the vegetation is contiguous to primary vegetation and located on slopes greater than 25 percent. This modification to the riparian corridor criteria may lower the relative rank assigned to contiguous riparian forest vegetation located 150 – 260 feet from the river for both for aggregated riparian functions and combined riparian/wildlife habitat function.

Topic – Microclimate, shade and the role of riparian vegetation along the North Reach

Introduction to the Issue

The draft WNRI attributes functional value to trees and woody vegetation along rivers and streams, including the North Reach of the Willamette River. A primary score is assigned to trees and woody vegetation within a flood area or within 100 feet of a river, stream, or wetland. Secondary scores are assigned to contiguous trees and woody vegetation extending from 100 feet to a maximum of 780 feet from a river stream or wetland. These criteria are consistent with those Metro developed to assign scores for this function in the regional Nature in Neighborhoods inventory. The draft WNRI also assigns scores for these functions to shrubland vegetation within 50 feet from a river, stream or wetland.

Comments and Technical Discussion

Some commenters on the draft WNRI disputed the value attributed to woody riparian vegetation for microclimate and shade along the Lower Willamette River generally and the North Reach in particular. One assertion was that the shade provided by woody riparian vegetation cannot reduce the temperature of flows in the Willamette given the channel width and volume of flow. One commenter pointed out that the maximum functional distance prescribed in the secondary scoring criterion for microclimate (i.e., 780 feet) is based on scientific studies of how forest management practices affect microclimate, and that these studies should not be used as a basis for evaluating microclimate along the Willamette. Commenters have also questioned whether highly manicured landscapes provide equivalent microclimate value as more complex natural or semi-natural riparian vegetation.

At the January 10th meeting, the technical experts agreed that shade provided by riparian vegetation will not affect the overall temperature of flows in the river. However, several pointed out that shade provided by riparian vegetation can be important for aquatic species where the vegetation is adjacent to nearshore shallow water areas. It was noted that shading is also dependant on aspect, slope and river width.

In terms of microclimate, the discussion focused on the relationship between the river and the riparian area, and the influence the river and the hyporheic zone have on riparian microclimate. The concern regarding the 780-foot secondary functional distance was reiterated. It was noted that this number is based on research done to examine the effect of forest clear-cuts and has limited transferability to riparian vegetation on a large, low-gradient river. However, there seemed to be general agreement that the interaction between a large river like the Willamette, associated groundwater, hyporheic and soil conditions, and woody riparian vegetation would create a microclimate effect. No alternative functional distances or topographic criteria were suggested.

Staff Recommendations and Results

The January 10th discussion seemed to confirm that the shade from riparian vegetation along the North Reach is important primarily in conjunction with shallow water areas. Staff will provide additional descriptive information in the revised WNRI report linking the value of shade along the Willamette River to areas of shallow water.

Staff has also conducted additional research to determine whether the secondary functional distance of 780 feet should be modified. Staff did not find any studies suggesting alternate functional distances for microclimate effects within the riparian corridor of a large, low-gradient river. Looking specifically at the North Reach, there are only a few areas that receive a secondary score for microclimate; where woody vegetation is contiguous to the river and extends beyond 100 feet from the river. These areas include

forest and woodland vegetation at Kelley Point Park, T-5, Harborton Wetlands, Willamette Cove, Doane Lake, and the bluff below the University of Portland.

Considering the January 10th discussion and additional analysis, staff recommends the following modifications to the draft WNRI riparian corridor model criteria.

- Forest vegetation within a flood area or within 100 feet of the river will continue to receive a primary score for microclimate and shade functions, but only if the vegetation is contiguous to the river, stream or wetland.

- The score assigned to natural/semi-natural woodland vegetation within the flood area or 100 feet of the river should shift from primary to secondary, to reflect the open tree canopy associated with this vegetation type. Cultivated woodland vegetation will not be assigned values for this function.

- The criterion assigning shrubland vegetation a secondary score for microclimate should be eliminated. Shrubland vegetation may contribute significantly to microclimate along small streams, but it would not contribute significantly to microclimate along the Lower Willamette River.

Staff does not recommend changes to the 780 foot secondary functional distance for microclimate.

These criteria modifications will lower the scores assigned to some of the riparian vegetation for this function, particularly for some woodland vegetation, or forest vegetation that is within 100 feet but not contiguous to the river. The revisions may result in changes to the aggregate riparian ranks or combined ranks assigned to this vegetation depending on the values assigned by other criteria. Forest vegetation between 300 and 780 feet, outside of the flood area, would continue to receive a low rank.

Topic – Organic inputs/food web functions along the North Reach

Introduction to the Issue

The draft WNRI attributes functional value to riparian vegetation for its contribution of organic inputs along the North Reach of the Willamette River. Organics and nutrients enter the river through transport by stormwater runoff, wind and wildlife. A primary score is assigned to forest, woodland or shrubland vegetation in a flood area or within 100 feet of a river, stream or wetland. A secondary score is assigned to contiguous forest, woodland or shrubland vegetation extending from 100 feet to 170 feet from the water body. These criteria are consistent with those Metro developed to assign scores for this function in the regional Nature in Neighborhoods inventory.

Comments and Technical Discussion

Some commenters on the WNRI questioned the value attributed to vegetation located outside the flood area, noting that the organic inputs to the food web in Lower Willamette River are based primarily on inputs from upstream and in-stream phytoplankton production. Questions were also raised about the secondary functional distance of 170 feet from the water body, noting that vegetation that far from the river is not a likely source of organic inputs.

The technical experts attending the January 10th meeting seemed to agree that organic inputs, nutrient cycling and food web functions in the lower reaches of a large river are predominantly internal to the river itself. Much of the food web and productivity is associated with phytoplankton production in the river. However, it was also noted that the interactions and lateral exchanges between the banks and river provide locally important inputs of organic material and nutrients, especially where the water is relatively shallow. Some pointed out that riparian vegetation can provide important food sources for fish, and also for birds and other terrestrial species. Analysis of fish stomach contents indicate that some of their food comes from terrestrial sources along the Lower Willamette.

Staff Recommendations and Results

The January 10th discussion confirmed that riparian vegetation can be a locally important source of organic matter and nutrients to the river, especially where the river is shallow. This vegetation also contributes to terrestrial food webs in riparian corridors which are important to most wildlife species in the region.

Staff suggests that natural or semi-natural vegetation will be of greater value in terms of organic inputs aquatic and riparian ecosystem than cultivated landscaped areas comprised of lawn and ornamental shrubs or trees. Therefore, staff recommends modifying the WNRI GIS riparian corridor model criteria for this function to assign primary scores only to natural and semi-natural vegetation. Natural and semi-natural forest, woodland and shrubland vegetation within 100 feet of a river, stream or wetland, or with the flood area, will continue to receive a primary score. Scores assigned to cultivated woodland and shrubland within 100 feet of a river, stream or wetland should shift from primary to secondary.

Staff also recommends that only natural/semi-natural forest, woodland and shrubland vegetation continue to receive a secondary score for this function. Cultivated vegetated areas between 100 – 170 feet from a river, stream, or wetland will not be assigned values for this function.

These criteria modifications will change the scores shown on the resource maps for this function only. The modifications are not expected to result in changes to the relative ranks for aggregated riparian corridor function or combined riparian/wildlife habitat.

Topic – Willamette Beaches as Special Habitat Areas (SHA)

Introduction to the Issue

The draft WNRI identifies Special Habitat Areas (SHAs), which are resource features consisting of rare, unique or declining habitat types and/or features that would be expected to support special status species during portions of their life cycle. The designation of SHAs is largely consistent with areas that Metro designated as Habitats of Concern in the regional Nature in Neighborhoods inventory. Examples of Special Habitat Areas include oaks, bottomland hardwood forests, wetlands, connectivity corridors, mudflats, grasslands, etc. The Bureau of Planning designated beaches along the Willamette River as SHAs, recognizing the habitat they provide habitat for ESA-listed salmonids and for waterfowl and other species that use the river. The Bureau based this designation largely on the Oregon Department of Fish and Wildlife (ODFW) study *Biology, Behavior, and Resources of Resident and Anadromous Fish in the Lower Willamette River* (Friesen 2005), which found a correlation between observations of salmonids species and beaches along the river.

Comments and Technical Discussion

Some commenters on the WNRI expressed strong support for the designation of beaches as SHAs, noting that beaches provide important habitat for salmonids, and also for bald eagles, great blue herons, and shorebirds. Others disputed the designation, expressing concern that the ODFW study did not conclusively find that salmonids show a preference for beach habitats.

During the January 10th technical experts meeting, Tom Friesen, author of the ODFW study, clarified that the observations of salmonids were correlated primarily with water depth rather than substrate or bank type. Salmonids were found in shallow water areas generally. Coho observations were correlated with beach habitats. Macroinvertebrate communities along the Willamette were found to be more diverse at beaches, but greater numbers at riprap areas. Several technical experts noted that salmonids use a mix of bank types including rip rap. Some experts reiterated that beaches are rare and declining along the Lower Willamette, and should recognized as important for fish and other species such as shorebirds.

Staff Recommendations and Results

Taking the January 10th discussion into consideration, staff feels that the inventory should continue to recognize the Willamette beaches as providing important habitat function. However, staff has since decided that it would be simpler and more appropriate to incorporate and map the beaches as part of the river channel. Beaches are dynamic features in the Lower Willamette River. Depending on tidal influences and seasonal water flows, beaches are inundated daily and seasonally, which influences their shape and size. Because of this direct relationship with the river, it is appropriate to consider beaches as part of the river channel itself. Since the City does not have maps showing the top-of-bank, this change will provide an incremental improvement in the accuracy of the river channel maps.

The draft WNRI already designates the Willamette River as a SHA to reflect NOAA's designation of the river as Critical Habitat for listed salmonids, and the role of the river as a migratory corridor. So as part of the channel, the Willamette River beaches will become part of the Willamette River SHA. The revised inventory report will include information about the role of beaches and shallow water areas, and the inventory site descriptions will note where beaches and shallow water areas exist. New or modified feature maps depicting different bank conditions will be provided in the revised report.

This change will not result in changes to the relative ranks for riparian, wildlife habitat, or combined riparian/wildlife habitat function. However, mapping beaches as part of the Willamette River channel will result in minor changes to the riparian function and rank maps. This is because the riparian functions will be mapped from the landward edge of the beach instead of from mapped edge of the water surface.

Topic – Fragmentation of the riparian wildlife movement corridor along the North Reach

Introduction to the Issue

The draft WNRI attributes functional value to vegetation along the North Reach for riparian wildlife movement. A primary score is assigned to vegetation that is contiguous to and within 100 feet from the river. A secondary score is assigned to vegetation that is contiguous to, and between 100 – 300 feet of river, stream or wetland. This criterion was added to the riparian corridor model to recognize that vegetation patches smaller than 2 acres aide in wildlife movement along the river (2 acres is the minimum size for a patch to be scored by the GIS wildlife habitat model). The riparian wildlife movement criterion is not species-specific and is intended to recognize potential use by multiple species. This criterion does not consider fragmentation of vegetation along the river, although the GIS wildlife habitat model does evaluate connectivity and fragmentation between habitat patches.

Comments and Technical Discussion

Comments on the draft WNRI raised questions about the value of vegetation along the Willamette North Reach as a wildlife movement corridor. It was suggested that fragmentation and isolation of the habitat areas along the riparian corridor in the North Reach significantly reduces the value of these area as a wildlife movement corridor.

At the January 10th meeting it was again suggested that the relative value of riparian vegetation on the North Reach as a wildlife movement corridor was lower than if the vegetation were better connected. Some of the technical experts attending the January 10th meeting responded by pointing out that the Willamette River itself is a significant fish and wildlife movement corridor and that the river connects and elevates the value of vegetation patches along the riparian corridor. They noted that signs of river using wildlife such as beaver and river otter are often observed in these areas, and that the movement birds, deer and coyotes is less hindered by development than some other types of wildlife (e.g., amphibians).

Staff Recommendations and Results

Staff has determined that approximately 50% of the area within 100 feet of the river in the North Reach consists of vegetated areas at least ½ acre in size. Nearly 20% of the area within 100 feet of the river is impervious surface and the remaining area (30%) contains sparse vegetation, dirt/fill, rocks, etc. This information will be added to the revised WNRI report as well as the inventory site descriptions.

Taking the January 10th discussion into consideration, staff proposes that the value of habitat areas along the Willamette River be considered as part of the wildlife movement corridor formed by the river itself, and recommend no change to the WNRI GIS riparian corridor model for this function. Vegetation contiguous to and within 100 feet of the river will continue to receive a primary score for riparian wildlife movement. Contiguous vegetation that is between 100 and 300 feet of the river will continue to receive a secondary score for riparian wildlife movement.

Topic – Contamination

Introduction to the Issue

The Willamette River North Reach inventory area contains the 10.2-mile Portland Harbor Superfund site, and is associated with extensive areas of contaminated soil, groundwater, and in-river sediment. In September 2001 an agreement was established between the Oregon Department of Environmental Quality (DEQ) and a coalition of businesses and public agencies, including the City of Portland, to participate in investigation and cleanup of the sites. DEQ is working on the cleanup of approximately 70 sites along the banks of the Willamette River, most of which are in the North Reach.

The current draft WNRI provides descriptive information on contamination in the North Reach generally, and for individual inventory sites. The information comes from DEQ's Environmental Clean-up Site Information (ECSI) database.

Comments and Technical Discussion

Comments on the draft WNRI question how areas can rank relatively "high" for riparian corridor functions and wildlife habitat and also be heavily contaminated. Some have raised concerns that assigning contaminated areas a "high" relative rank may lead to restrictions on how remediation can be completed. (This topic was not discussed at the January 10th meeting.)

Staff Recommendations and Results

Staff agrees that the revised inventory should provide more information about contamination in the North reach. The inventory should make it clear that many of the scarce remaining natural resource features in the North Reach provide valuable riparian corridor and wildlife habitat functions and are also affected by at least some level of contamination. Having this information will better inform current planning efforts, and priority-setting for restoration and enhancement.

Staff is currently compiling additional information to include in the North Reach and inventory descriptions. The revised inventory report will include a summary of hazardous substances and waste types as well as environmental and health threats. A link to the DEQ ECSI database will be included. The revised inventory will also include maps showing the presence and status of contamination investigation and remediation on inventory site maps.

Topic –WNRI Resource Scoring and Ranking Systems

Introduction of the Issue

The draft WNRI includes an evaluation of the relative functional value of natural resources in the North Reach. Resource features are assigned scores for six riparian corridor functions and four wildlife habitat attributes. These scores are aggregated to generate riparian corridor and wildlife habitat ranks of "high," "medium" or "low." All Special Habitat Areas are assigned a high aggregated rank for wildlife habitat. The aggregated ranks for riparian corridors and wildlife habitat areas are then combined to produce a single riparian corridor/wildlife habitat relative rank of "high," "medium," or "low." Where inventoried riparian corridor and wildlife habitat areas overlap, and where their relative ranks differ, the higher of the two ranks becomes the combined relative rank for that resource feature.

This scoring and ranking approach is consistent with the approach Metro developed for the regional Nature in Neighborhoods Inventory. In addition, Oregon Laud Use Planning Goal 5 requires local natural resource inventories to assess the relative quality, quantity and significance of inventoried natural resources compared to similar features within the city or region.

Comments and Technical Discussion

Comments on the draft WNRI raised two general issues regarding the resource ranking approach. Some commenters suggested that relative ranking approach implies that some resources are "better" than others, which, in their view represents an application of policy that goes beyond the role of a scientifically based inventory. Concerns were raised that the ranking formulae are arbitrary and do not reflect science. Some also suggested that the aggregated and combined ranks mask the variability in existing conditions.

During the January 10th meeting, concerns were raised about the how the high, medium and low riparian corridor ranks are generated; specifically, that high and medium ranks are reflect only the number of primary functional scores assigned and not the number of secondary scores assigned to the resource feature. It was also suggested that combining the riparian corridor and wildlife habitat ranks and assigning the higher of the two ranks can be ambiguous and hard to interpret. For example features receiving a high riparian rank and low wildlife rank, receive a high combined rank, while features receiving a high riparian rank and medium wildlife rank also receive a high combined rank.

The technical experts discussed the utility of developing a more detailed ranking system for riparian corridors and combined ranks. Some suggested that more detailed ranks would be more informative than the current system. Others noted that Metro tried to provide more detailed rankings, but that the maps were too complex to be useful. Technical experts acknowledged the difficulty in producing maps that are sufficiently detailed without making them unduly complicated. One participant suggested that the revised inventory include tabular data showing the modeling results. Some felt that it might be most helpful for the revised inventory to include the individual function maps rather than creating a more complex ranking system.

Staff Recommendations and Results

First, staff believes that assessing the relative functional value or quality of existing natural resources is an appropriate component of an inventory, and is consistent historical and legal precedent pertaining to such inventories. The scoring criteria for individual riparian corridor function and wildlife habitat attributes are based on information gleaned from a comprehensive review of scientific literature. The scores are summed and broken down into aggregated ranks using an approach similar to the approach Metro developed for the regional inventory.

Willamette/North Reach Natural Resource Inventory – Methodological issues discussed by technical experts on January 10, 2008	**Staff Recommendations**	**Effect of Recommendations on Riparian Function Score**	**Effect of Recommendations on *Aggregated Riparian Relative Rank***	**Effect of Recommendations on *Combined Riparian/Wildlife Habitat Relative Rank***
Riparian Function of the Willamette River Should the Willamette River be assigned primary value for the 6 riparian functions addressed in the inventory?	▪ Continue to assign functional value to the Willamette for the 6 riparian functions. ▪ Shift from primary to secondary score to reflect extent of bank hardening and sediment pollution. ▪ Incorporate beaches into the river channel, map functional distances from landward edge of beach, and assign beaches a primary value for Large Wood/Channel Dynamics function. ▪ Include additional river-specific metrics in the revised inventory report.	**Changes:** The Willamette in the North Reach will shift from a primary to secondary score *Bank Dynamics and Control of Sediments, Nutrients and Pollutants* functions. Change the name of this function	**No change:** North Reach will continue to rank high given primary scores for 5 riparian corridor functions.	**No change:** North Reach will continue to receive a high relative combined rank.
Functional value of vegetation Should the inventory distinguish between functional of natural/semi-natural vegetation and highly cultivated landscapes?	Use refined woodland, shrubland, and herbaceous vegetation data to differentiate between the functional value of natural/semi-natural vegetation and highly cultivated landscapes in the North Reach. (Note: All forest vegetation is classified as natural/semi-natural.)	**Changes:** Cultivated woodland and shrubland vegetation scores shift from primary to secondary for: ▪ *Bank Stability/Control of Sediment, Nutrients and Pollutants* ▪ *Organic inputs/food web* Cultivated woodland shrubland vegetation no longer assigned value for *Microclimate/Shade* as relates to the Willamette river.	**Changes:** The Aggregated Riparian Rank for cultivated vegetation will likely shift from high to medium, or from medium to low.	**Changes:** The Combined Rank for cultivated vegetation will likely shift from high to medium, or medium to low.
Flood Areas Is the flood storage provided by the flood areas in the Lower Willamette/North Reach important given size of basin, flow volumes and flood levels? Should the inventory focus on more frequently flooded areas?	Recognize the importance of incremental flood storage by continuing to assign primary scores to vegetated flood areas along the North Reach. Continue assigning a secondary score to the developed flood area for flood storage only. Update the inventory to include information on frequently flooded areas if/when made available.	**No change**	**No change**: Vegetated flood areas will continue to receive a medium or high Aggregated Riparian Rank; developed flood area will continue to rank low.	**No change:** Vegetated flood areas will continue to receive a medium or high Combined Rank; developed flood area will continue to receive a low Combined Rank.
Land within 50 feet of the river Should the functional value assigned to land within 50 feet of the North Reach be downgraded where riverbanks areas within 50 feet are developed/hardened and primarily devoid of vegetation?	Continue to assigning primary value to vegetated land within 50 feet of the river. Shift functional scores assigned to non-vegetated land w/in 50 feet of the river (North Reach only) from primary to secondary for 2 functions.	**Changes:** Non-vegetated area w/in 50 feet of the river will receive secondary scores for *Large Wood / Channel Dynamics* and *Bank Stabilization and Control of Sediments, Nutrients and Pollutants.*	**Changes:** The Aggregated Riparian rank for non-vegetated area w/in 50 feet of the river will shift to low rank. The Aggregated Riparian Rank for herbaceous vegetation w/in 50 feet of the river will shift from high to medium	**Changes:** The Combined Rank for non-vegetated areas w/in 50 feet will shift to a low rank. The Aggregated Riparian Rank for herbaceous vegetation w/in 50 feet of the river will shift from high to medium

Willamette/North Reach Natural Resource Inventory – Methodological issues discussed by technical experts on January 10, 2008	**Staff Recommendations**	**Effect of Recommendations on Riparian Function Score**	**Effect of Recommendations on *Aggregated Riparian Relative Rank***	**Effect of Recommendations on *Combined Riparian/Wildlife Habitat Relative Rank***
Role of large wood in the Lower Willamette Does riparian forest vegetation contribute significantly to channel dynamics in the Lower Willamette River and North Reach? Does functional value of riparian forest vegetation for channel dynamics correlate with slopes? Should beaches be assigned functional value for channel dynamics?	Recognize localized effects of large wood contribution by assigning primary scores to contiguous forest vegetation within 150 feet of the river. Assign secondary scores to forest vegetation between 150 and 260 feet *only if* vegetation is located on slopes exceeding 25% Assign beaches a primary score for channel dynamics.	**Changes:** In the revised inventory forest vegetation between 150 and 260 feet from the river will receive a secondary value score only on slopes exceeding 25% Beaches will now be assigned primary value for this function.	**No change**	**No change**
Microclimate/shade Is the functional value of the shade provided by riparian forest vegetation significant in the Lower Willamette/North Reach? Is it appropriate to use functional distances (<=780') to assign secondary microclimate score to forest vegetation based on studies pertaining to forest practices in tributary drainages?	Primary scores should be assigned to forest vegetation within 100 feet of river, stream, and wetland *only if* vegetation is contiguous to the water. Do not continue to assign functional value to shrubland or cultivated woodland for this function (North Reach only) No change to secondary functional distances is recommended.	**Changes:** Some forest vegetation within 100 feet of a river, stream, and wetland may shift from a primary to secondary score if it is not contiguous to the water/wetland feature. Shrubland and cultivated woodland along the Willamette mainstem in the North Reach will no longer score for this function.	**Changes :** The Aggregated Riparian rank assigned to cultivated woodland vegetation along the Willamette mainstem in the North Reach will likely shift from high to medium or low.	**Changes:** The Aggregated Riparian rank assigned to cultivated woodland vegetation along the Willamette mainstem will likely shift from high to medium or low combined rank if not associated with a high ranking wildlife habitat patch or Special Habitat Area.
Organic Inputs/Food Web Does riparian vegetation along the Willamette mainstem in the North Reach provide a significant contribution of organic inputs to the aquatic ecosystem/food web? Terrestrial ecosystem/food web?	Continue to assign primary and secondary values to forest vegetation and natural/semi-natural woodland and shrubland vegetation within 100 feet of a river, stream or wetland to reflect important effect of localized inputs. Lower the score assigned to cultivated vegetation within 100 feet from primary to secondary. Do not assign value to cultivated vegetation further than 100 feet from a river, stream or wetland.	Cultivated woodland and shrubland vegetation will receive a secondary score for this function. Cultivated woodland and shrubland vegetation further than 100 feet from a river, stream or wetland will no longer be assigned value for this function.	Cultivated woodland and shrubland vegetation within 100 feet of a river, stream or wetland in the North Reach will shift from a high to a medium or low Aggregated Riparian Rank.	Cultivated woodland and vegetation within 100 feet of a river, stream or wetland in the North Reach will shift from a high or medium, to a medium or low Combined Rank if not associated with a high ranking wildlife habitat patch or Special Habitat Area.
Riparian Movement Corridor Does the vegetation along the Willamette River mainstem in the North Reach provide a significant wildlife movement corridor function given existing fragmentation due to development?	Continue to assign primary and secondary value to vegetation contiguous to and no further than 300 feet from the Willamette to reflect the use of these areas by wildlife traveling in and along the river.	**No change**	**No change**	**No change**
Willamette Beaches Is it appropriate to designate Willamette beaches as SHA based on the ODFW Willamette Fish Study?	Continue to highlight the role of beaches and also shallow water areas as special habitats for fish and wildlife. Show and describe in the context of the Willamette River SHA.	**No change**	**No change**	**No change**

Willamette/North Reach Natural Resource Inventory – Methodological issues discussed by technical experts on January 10, 2008	**Staff Recommendations**	**Effect of Recommendations on Riparian Function Score**	**Effect of Recommendations on *Aggregated Riparian Relative Rank***	**Effect of Recommendations on *Combined Riparian/Wildlife Habitat Relative Rank***
Ranking system Should the WNRI ranking system be modified to provide more detailed information about the variability in relative resource condition and quality?	Retain current system for assigning "high," "medium," and "low" aggregate riparian corridor and wildlife habitat ranks, and combined riparian /wildlife habitat ranks. Include maps showing scores for individual riparian corridor and wildlife habitat functions with the revised inventory.			

APPENDIX 6

MAPPING PROTOCOLS

Natural Resource Inventory Update

stream and drainageway mapping project

City of Portland Bureau of

Planning and Sustainability

Sam Adams, Mayor | Susan Anderson, Director

Natural Resource Inventory Update

stream and drainageway mapping project

project description

The stream and drainageway mapping project originated in 2003 as the Bureau of Planning, (now called and referred to in this report as the Bureau of Planning and Sustainability) was developing a new automated GIS model to map and rank landscape features that contribute to riparian resource values and functions. This map is used to update Portland's significant natural resource inventories.

Initially the model was developed and tested using Metro's regional stream map layer. However, during the model testing phase it became apparent that the Metro map was not accurate enough to support Portland's inventory update and resource protection program. A more detailed, precise map of streams and drainageways was necessary for analysis at the local scale.

The key goals of the re-mapping project were defined as:

- to refine the location of streams and drainageways previously mapped by Metro;
- to verify the existence and location of a number of stream and drainageway segments that were not previously mapped by Metro or included in the City's significant natural resource inventories;
- to refine the maps to address the location of piped stream and drainageway segments and their connections to open channels, as there had never been a complete review of stream and drainageway location and surface water piping within the City.

For the purposes of this project streams and drainageways are defined as follows:

stream – An area where enough surface water flows to produce a channel, such as a river or creek, that carries flowing surface water during some portion of the year. Surface water flows may include stormwater runoff or groundwater discharge. Streams include:

- the water itself, including any vegetation, aquatic life or habitat;
- beds and banks below the ordinary high water level[1] which may contain water, whether or not water is actually present;
- the floodplain between the ordinary high water level of connected side channels;
- beaver ponds, oxbows, and side channels if they are connected by surface flow to the stream during a portion of the year;
- stream-associated wetlands;
- perennial stream (stream that flows throughout the year; permanent stream);

[1] *Ordinary high water* is the line on the bank established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

- intermittent stream (stream that flows only at certain times of the year, as when receiving water from springs or from surface sources; stream that does not flow continuously, as when water losses from evaporation or seepage exceed the available stream flow);
- ephemeral stream (stream or portion of stream that flows briefly in direct response to precipitation in the immediate vicinity, and with channels at all times above water table).

drainageway - An open linear depression, whether constructed or natural, which functions for the collection and drainage of surface water, subsurface flow or groundwater. It may be permanently or temporarily inundated. Drainageways may include sloughs[2]. Road-side ditches and similar facilities generally do not meet the definition of a drainageway unless the channel is a segment of an existing stream or redirected or relocated existing stream or stream segment.

The stream and drainageway mapping project focused on streams and drainageways flowing through the City of Portland, as well as those located within unincorporated parts of Multnomah County where land use permitting is administered by the City of Portland.

There are areas of the city where streams and drainageways have been relocated or reconfigured as part of or to accommodate development. In some situations, streams and drainageways have been created to supplement or even replace the natural hydrologic system. Relocated, reconfigured and some created streams and drainageways provide the critical watershed functions of the hydrologic system and were mapped as part of this project.

Beginning in April of 2003 the Bureau of Planning and Sustainability began revising stream and drainageway geometry based on information from reference data sources including 2' contours, aerial photos, and GPS surveys. New streams and drainageways were also added where previously unmapped surface flow was identified. All revised and newly mapped surface streams and drainageways were connected to the stormwater and combined sewer/stormwater pipes as mapped by the Bureau of Environmental Services.

In addition, the Bureau of Planning and Sustainability conducted an extensive field effort to confirm the existence and location of stream and drainageway channels and piped segments. Field crews employed global positioning system (GPS) technology to verify the presence and location of streams and drainageways where this information could not be derived from available sources of information. The field effort included streams and drainageways on public and privately-owned land (with permission from property owners).

[2] *Sloughs* are slow-moving, canal-like channels that are primarily formed by tidal influences, backwater from a larger river system, or groundwater. They may be permanently or temporarily inundated.

The stream and drainageway mapping project has been a collaborative effort involving Portland's Bureaus of Planning, Parks and Recreation, Environmental Services, and Corporate GIS. Metro and Clean Water Services also participated in the project. GIS staff from each of these agencies met at the beginning of the project to share the stream and drainageway centerline information used by each agency at that time. This information was combined into a single, regional stream and drainageway centerline dataset that served as a starting point for the mapping. The revised stream and drainageway centerlines are provided to all City bureaus for their use, and to Metro for regional distribution along with the Regional Land Information System (RLIS) "Natural Resource" GIS data.

The following report provides a brief description of the project status, the stream and drainageway mapping methodology, and the data sources used as reference for re-mapping and adding streams and drainageways. For a detailed description of the stream and drainageway centerline GIS data, please refer to the online metadata at:

http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52071&Db_type=sde&City_Only=False.

project status

The initial mapping and classification of all known stream and drainageway centerlines within the City of Portland is complete. The data is updated regularly as new information becomes available. The following chart is a summary of stream and drainageway miles mapped at the completion of the initial mapping exercise (January, 2006). Ongoing modifications to the map since that time are not reflected in these numbers.

Stream and Drainageway Mapping Project Summary
Miles of streams and drainageways currently mapped in Portland and the Multnomah County pockets (as of January, 2006)

Re-mapping progress to date:	miles	%
Total miles of stream and drainageways previously-mapped by Metro:	180	
Miles of previously-mapped stream and drainageways revised:	180	100.0%
Miles of stream and drainageways added:	131	
Total stream and drainageway miles revised or added:	*311*	
Total number of surface stream and drainageway miles revised or added:	*260*	83.6%
Total number of piped stream and drainageway miles revised or added:	*51*	16.4%
Stream and drainageway verification to date:		
Stream and drainageway miles verified using existing sources:	250	80.4%
Stream and drainageway miles verified in the field:	24	7.7%
Total stream and drainageway miles verified to date:	*274*	*88.1%*
Remaining stream and drainageway miles to verify:	*37*	*11.9%*
Field work summary to date:		
Total number of property owners contacted:	670	
Number of property owners granting access:	304	45.4%
Number of properties visited:	163	24.3%

methodology

The starting point for the mapping project was the 2003 regional stream and drainageway centerlines developed by Metro. More accurate stream and drainageway centerline maps available for select areas around the City were also used as reference – including Columbia Slough centerlines created by the Bureau of Environmental Services and Powell Butte centerlines mapped by the Bureau of Parks and Recreation. All editing of stream and drainageway data was done in ESRI's ArcGIS GIS software.

1) Stream and Drainageway Mapping Protocol

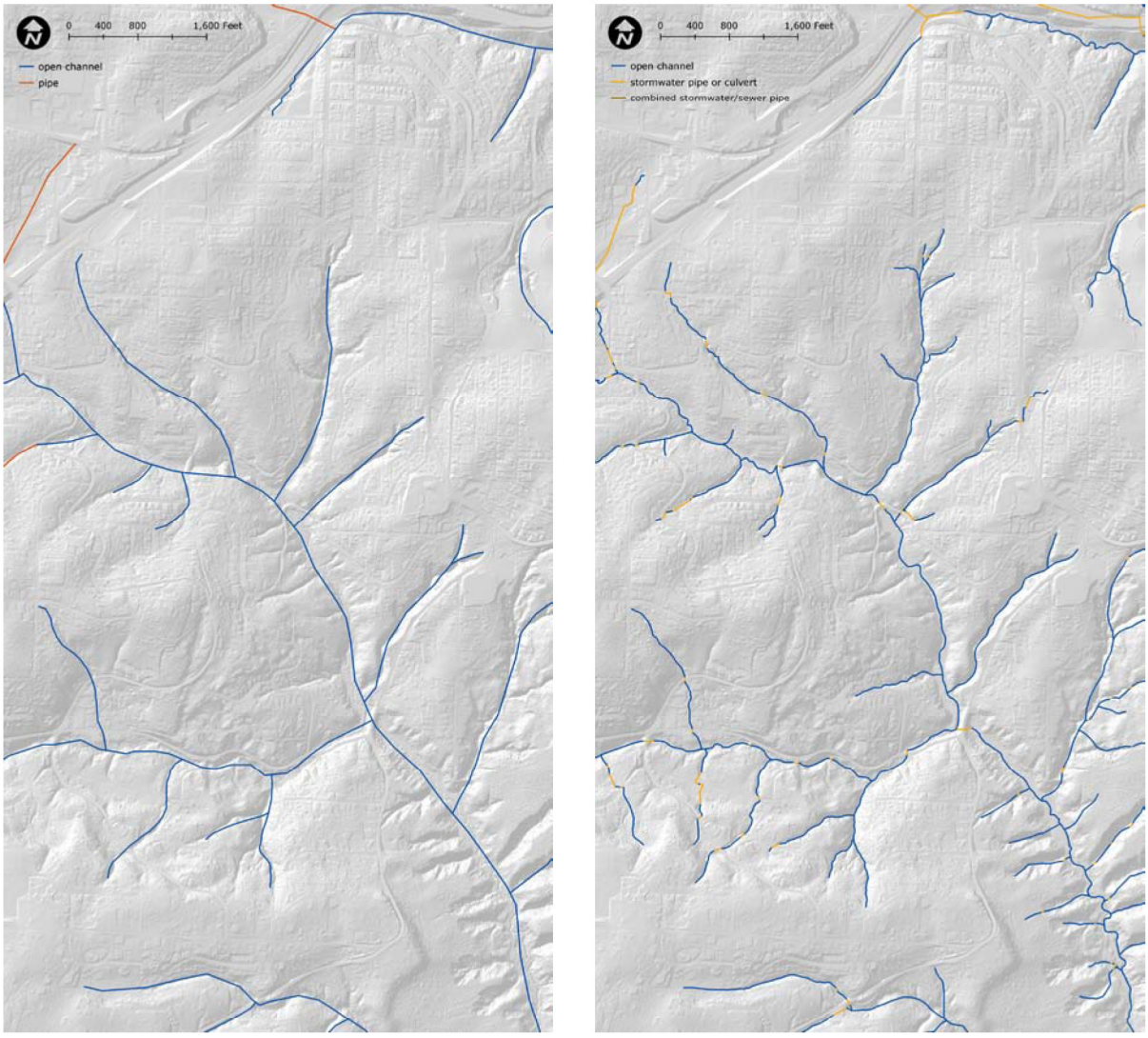
BES collection line GIS data, LiDAR-derived elevation models, photogrammetric data (2' contours), and aerial photos were among the data sources referenced by the Bureau of Planning and Sustainability when mapping the stream and drainageway centerlines.

Streams and drainageways that were previously-mapped by Metro[3] were checked against all reference sources and re-mapped starting at the lowest confluence and moving up to the headwaters. Virtually all of the previously-mapped streams and drainageways were re-mapped to correspond with the new and more detailed reference data. Any new tributaries apparent in the reference data were added to the map as they were encountered during the revision process (Figure 1).

New streams and drainageways were required to satisfy the following criteria in order to be added to the map:

- a channel exists and appears to be formed, at least in part, by water flowing through it - flow may be comprised of water from streams, surface flow, subsurface flow, groundwater, or stormwater discharge. Channels that emerge downstream of a pipe were mapped as beginning at the pipe outlet;
- the topographic information, aerial photo, BES collection line information or Multnomah County Drainage District information indicates that water on or upstream of the site drains to the channel;
- the length of the stream or drainageway was greater than 50' (stream, drainageways and springs under 50' in total length were not mapped.)

[3] Metro's 2003 stream and drainageway data was originally based upon 1:24000 USGS quad topography. Stream and drainageway centerlines and banks were adjusted or digitized at approximately 1:10000 using the 1998 Spencer Gross 2'-resolution aerial photography.



Original Metro Centerlines

Remapped Centerlines

Figure 1. Comparison of previously-mapped Metro streams and drainageways and remapped stream and drainageway centerlines .

Any stream or drainageway segments satisfying the mapping criteria above were further evaluated based on the following:

- If two or more reference sources affirmed the existence of a stream or drainageway channel (e.g., topography indicates a channel and BES has mapped the channel), project staff deemed the stream or drainageway "substantiated" and required no further verification. The stream or drainageway was mapped based on the reference data.

- If a stream or drainageway channel was supported by only one reference source (e.g., topography suggests a channel), project staff "flagged" the channel for field verification.

The Bureau of Planning and Sustainability compiled a list of all property owners whose tax lot contained a channel flagged for field verification. Property owners were sent a letter requesting permission for City staff to enter their property for on site stream/drainageway verification. The request included a self-addressed stamped return envelope for property owners to reply. Approximately 46% of property owners contacted granted access.

Database attributes from the old stream or drainageway centerlines were transferred to the new stream and drainageway centerlines. Additional information about the new and revised streams and drainageways was also captured, including the channel type, source of the geometry, and the date of the modification.

2) Field Verification Methodology

Project staff visited properties owned by the public and privately-owned properties where the owner had given written permission allowing access.

Because of time and staff constraints, staff was not able to visit every property that was accessible. Priority for visitation was given to stream or drainageway segments flowing through properties where a larger percentage of property owners had given staff permission to enter and survey the stream or drainageway. Staff also focused on visiting streams and drainageways that were relatively easy to access given topography (e.g., not steep vs. steep) and vegetation (e.g., penetrable vs. overgrown).

Once the decision to visit a particular stream or drainageway segment was made, a field crew visited the site and verified the presence and location of the stream or drainageway channel. Field crews used both visual assessment and, when GPS-satellite coverage was available, differentially-corrected GPS data collection. Field crews also took written notes on the location and description of the stream or drainageway segment.

Stream and drainageway characteristics used to verify whether the channel met the stream/drainageway criteria, include one or more of the following:

- water flowing through the channel or evidence of periodic inundation
- riparian-associated plants; including both native and non-native species
- presence of amphibians, aquatic reptiles (e.g. turtles) or fish; including both native and non-native species
- evidence of wildlife use (e.g. beaver chews)

Field crews carried copies of a standard field visit form for notes and sketches, a map showing local topography, stream, drainageways, etc., and a map with 6"-resolution aerial photographs of the property and surrounding area. All notes and maps for a particular field visit were scanned and stored in Acrobat PDF format. Digital photos of the stream or drainageway were also taken in most cases. All digital documentation and photos are available from the Bureau of Planning and Sustainability.

Two survey-grade GPS receivers were used during the project – a Trimble Pathfinder Pro backpack system and a Trimble GeoXT handheld receiver. Both systems collected points and lines with an average horizontal error after differential correction of between 1 and 3 feet.[4] Two types of GPS data were collected – point features and line features.

Point features represented a minimum of 10 GPS points collected at 1-second intervals at multiple locations along a stream or drainageway channel. GPS points at each location on the stream/drainageway were differentially-corrected, averaged, and exported to GIS shapefile format. Stream and drainageway centerline segments were then digitized by manually "connecting" the field collected points in ArcInfo workstation. Digitized lines were "smoothed" to more realistically portray stream and drainageway geometry. Most GPS data was collected as point features.

Line features were created by collecting a series of points at 1-second intervals while physically walking the centerline of a stream or drainageway. The collected points were each differentially-corrected and exported to GIS shapefile format as the vertices of a line feature. The advantage of this method was that it produced an actual centerline that could be directly incorporated into the stream/drainageway dataset, rather than a series of points that had to be manually connected. However, because the points were not averaged at a single location over time, this method was slightly less accurate then the point feature collection method. In addition, it was only practical when the stream and drainageway channel was open enough to allow relatively long – 50' or more – sections to be walked without obstruction.

[4] Differential correction is the process of correcting GPS data collected on a field unit with data collected simultaneously at a fixed base station. Because the base station it is at a known, surveyed location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the field collected data.

A summary of the specific GPS data collection parameters follows:

- Collection interval: 1 second
- Minimum number of points[5]: 10
- Maximum PDOP[6]: 6
- Minimum number of satellites: 4
- Elevation mask: 15º above the horizon

Points were differentially-corrected using the base station located at the U.S. Forest Service/Bureau of Land Management building in downtown Portland[7]. All GPS data was exported into the U.S. Stateplane coordinate system, in international feet, based on the NAD HARN/HPGN datum.[8] All GPS point and line features collected for the stream and drainageway re-mapping project are available in ESRI Shapefile format from the City of Portland, Bureau of Planning.

Stream and drainageways flagged for further verification and visited in the field were remapped to correspond with the visual assessment and/or GPS information collected for that segment. Stream and drainageways located in this matter were assigned a "field date" in the stream and drainageway centerline GIS database. Not all stream and drainageways flagged for field verification were visited by project staff. To date, approximately 40% of flagged stream and drainageways have been visited. Any flagged stream and drainageways not visited are identified in the stream and drainageway centerline GIS database.

[5] Though a minimum of 10 GPS points were required, field crews attempted to collect a minimum of 60 points (1 minute of data collection) whenever possible.
[6] The Position Dilution of Precision (PDOP) is a numerical value representing the quality of the satellite geometry and its impact on data collection accuracy.
[7] refer to http://www.fs.fed.us/database/gps/portland.htm for more information about the U.S. Forest Service base station.
[8] High Accuracy Reference Network (HARN) datum, a.k.a. High Precision GPS Network (HPGN), is a statewide upgrade to the NAD83 datum using Global Positioning System (GPS) observations.

reference data sources

The following sources were used as reference for determining the presence and/or location of stream and drainageway centerlines:

Source:	**BES Collection Lines**
Created By:	City of Portland, Bureau of Environmental Services
Data Format:	GIS Shapefile
Date of Last Update:	11/26/2003
Description:	City of Portland regional sewer and drainage infrastructure. Includes sewer lines, stormwater pipes, combined sewer/stormwater pipes, culverts, and drainage ditches.
Notes:	Data is viewable for specific properties via www.portlandmaps.com
Metadata Reference:	http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52073&Db_type=sde&City_Only=False

Source:	**LiDAR Data**
Created By:	Puget Sound LiDAR Consortium for Metro
Data Format:	ERDAS Imagine-format elevation models
Date of Acquisition:	March/April 2007, March 2005, & March 2004
Description:	3-foot resolution digital elevation model (DEM) of all Portland area bare-earth LiDAR point returns collected and processed to date (2004 through 2007). The DEM was used to generate hillshades and 2'/5'/ 10' contours that were used to map stream and drainageways.
Notes:	Data is the property of the Portland LiDAR Consortium.
Metadata Reference:	http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52888&Db_type=sde&City_Only=False

Source:	**Photogrammetric Data (2' Contours)**
Created By:	City of Portland, Bureau of Environmental Services.
Data Format:	GIS Shapefile
Date of Acquisition:	1988 to 1994 (depending on location)
Description:	City of Portland 2' elevation contours. Contour lines derived from stereo analysis of aerial photos flown between 1987 and 1994. Created for the Bureau of Environmental Services.
Notes:	Data is viewable for specific properties via www.portlandmaps.com

Metadata Reference:	http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52452&Db_type=sde&City_Only=False
Source:	**2008 Aerial Photos**
Created By:	Sanborn Map Company for Metro
Data Format:	Geo-referenced GEOTIFF images
Date of Acquisition:	June 19-29, 2008
Description:	Natural color (RGB) and color infrared (CIR) ortho-rectified digital imagery. Images are at six-inch resolution.
Notes:	Data is viewable for specific properties via www.portlandmaps.com. Other image years (1996 through 2007) were also used as reference.
Metadata Reference:	http://rlismetadata.oregonmetro.gov/display.cfm?Meta_layer_id=2302&Db_type=rlis
Source:	**5' Elevation Contours**
Created By:	Metro
Data Format:	GIS shapefile
Date of Acquisition:	July 2001
Description:	Five-foot elevation contours for urban areas of Multnomah, Clackamas, and Washington counties. Covers Portland metropolitan area.
Notes:	Copyright 2001 by Metro.
Metadata Reference:	http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52453&Db_type=sde&City_Only=False
Source:	**BES Columbia Slough Centerlines**
Created By:	City of Portland, Bureau of Environmental Services
Data Format:	GIS Shapefile
Date of Last Update:	11/26/2003
Description:	Stream and drainageway centerlines mapped by the Bureau of Environmental Services Columbia Slough watershed team. Stream and drainageway locations not field verified.
Notes:	Shapefile data for the entire Columbia Slough watershed is available from BES.
Metadata Reference:	None currently available – contact Kevin Ramey in the City of Portland, Bureau of Environmental Services for more information.

project contacts

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Natural Resource Inventory Update

vegetation mapping project

City of Portland Bureau of
Planning & Sustainability
Sam Adams, Mayor | Susan Anderson, Director

vegetation mapping project

project description

The vegetation mapping project originated in 2004 as the Bureau of Planning & Sustainability was developing a new automated GIS model to inventory landscape features that contribute to riparian and upland natural resource values and functions. The inventory will update Portland's existing significant natural resource inventories and their related programs (e.g., environmental overlay zoning, Willamette Greenway, etc.)

Initially the GIS model was developed and tested using the regional vegetation map layer digitized by Metro from 2000 aerial photos. During the model testing phase it became apparent that this regional data was not sufficient to support Portland's inventory. A more detailed, precise, and comprehensive map of vegetation was necessary for analysis at the local scale.

The key goals of the vegetation mapping project include:

- refine the location of vegetation "patches" — the patch *geometry* — of areas previously mapped by Metro;
- incorporate vegetation maps generated by other agencies — such as Portland Parks and Recreation and the Portland Bureau of Environmental Services — and refine and improve that information where necessary;
- map vegetation patches meeting Portland's criteria for inclusion in the natural resource inventory — a ½ acre minimum patch size versus the 1 to 2 acre patch size used by Metro for the regional dataset;
- map all vegetation within a ¼ mile of a surface stream, wetland, or regionally significant habitat resources included in Metro's inventory;[1]
- classify the vegetation into four NVCS[2] classes — forest, woodland, shrubland, and herbaceous;
- further classify vegetation as either "natural/semi-natural" or "cultivated";
- update, refine and improve vegetation map annually as new aerial images become available.

In June of 2004 the Bureau of Planning & Sustainability began mapping vegetation based on information from reference data sources including 2003 aerial photos and 2002 multi-spectral

[1] Significant regional resources mapped by Metro as part of their Goal 5 mapping process. Adopted by the Metro Council in September of 2001. Upland resources included resource classes A, B, and C. For more information, contact Metro's Long Range Planning Office.
[2] "National Vegetation Classification System" developed by the Nature Conservancy for classifying terrestrial vegetation (Grossman *et al.*, 1998).

imagery. The map has been updated in subsequent years, using new aerials, to incorporate changes in vegetation since the original mapping. The mapping area includes all land within the City of Portland and the unincorporated parts of Multnomah County that are administered by the City of Portland.

The Bureau of Planning & Sustainability is also conducting limited field surveys to confirm the existence, location, and correct classification of vegetation patches. Field crews employed global positioning system (GPS) technology and digital photography to document the presence and/or location of different classes of vegetation where this information could not be confidently derived from available GIS reference sources (such as aerial photos).

The vegetation mapping project has been a collaborative effort involving Portland's Bureaus of Planning, Parks and Recreation, Environmental Services, and Corporate GIS. Metro also participated in the project by supplying data and advice on mapping protocols. An effort was made at the beginning of the project to acquire all mapped vegetation information developed by each agency for internal use. This information was combined into a single, regional vegetation dataset that served as a starting point for the mapping project. The vegetation dataset has been made available to all City bureaus and to Metro for their use. We are hoping to regularly update the dataset and keep the vegetation information accurate and current.

The following report provides a brief description of the project status, the vegetation mapping methodology, and the data sources used as reference. For a detailed description of the vegetation GIS data, please refer to the online metadata at http://www.portlandonline.com/cgis/metadata/viewer/display.cfm?Meta_layer_id=52135&Db_type=sde&City_Only=False.

project status

The initial mapping and classification of vegetation patches has been completed. The data will be updated each year as new aerial photos are made available. The following chart shows how much vegetation has been mapped as of **January 21st, 2009**:

Bureau of Planning Vegetation Mapping Project
Acres of vegetation in Portland and the County pockets

	previously mapped[1]		***currently mapped[2]***		***change in acres***	
	natural	cultural	natural	cultural	natural	cultural
forest	16,573	0	15,137	0	(1,436)	0
woodland	375	0	1,230	2,666	855	2,666
shrubland	406	0	896	53	490	53
herbaceous	2,962	0	1,970	5,316	(993)	5,316
total by category	*20,317*	*0*	*19,233*	*8,036*	*(1,084)*	*8,036*
totals		*20,317*		*27,269*		*6,952*

Notes:
[1] *previously mapped* vegetation refers to Metro's regional vegetation map layer digitized from 2000 and 2002 aerial photos.
[2] *currently mapped* vegetation refers to the Bureau of Planning & Sustainability vegetation map as of the date above.

methodology

The starting point for the vegetation mapping project was the 2000 regional vegetation map developed by Metro. More accurate vegetation information available for select areas around the City was incorporated into the regional dataset, superseding Metro data for these locations. This information includes vegetation maps created by the Bureau of Parks and Recreation for all of the natural area parks and habitat maps created by the Bureau of Planning & Sustainability for areas along the Willamette River and Columbia Rivers. All editing is performed in ESRI's ArcGIS 9 using custom tools developed by the Bureau of Planning & Sustainability.

The following is a summary of the vegetation mapping and classification methodology.

1) Mapping Area

All areas within a ¼ mile of a surface stream, wetland, or regionally significant habitat resource included in Metro's inventory were reviewed and remapped as necessary (Figure 1). The mapping effort is focused on areas that meet the following criteria:

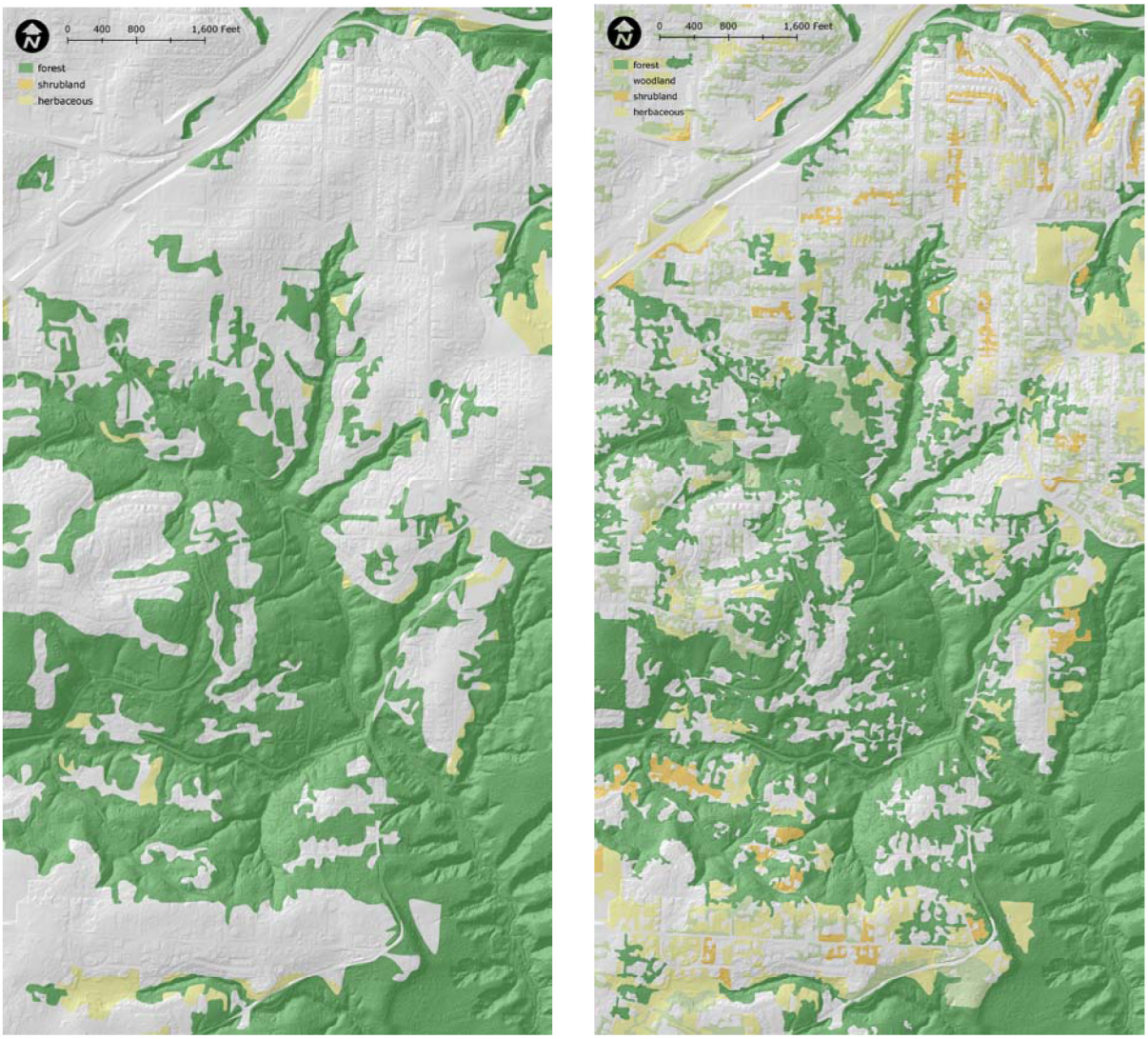
- Located with 300 feet of a river, stream/drainageway or wetland. Contiguous vegetation that begins within and extends beyond 300 feet from a river, stream/drainageway or wetland is mapped to its full extent;
- Comprised of forest vegetation and/or wetlands, at least 2 acres in size, plus any additional, adjacent woodland vegetation;
- Located within a current environmental overlay zone (e.g. c, p);
- Identified by Metro as regionally significant riparian corridor or wildlife habitat.

2) Vegetation Patches

City of Portland 6" resolution aerial photos are the primary reference sources for identifying vegetation patches. Other reference sources include Metro vegetation maps, LiDAR data, Portland Parks natural area assessments, and river habitat maps (refer to "Reference Data Sources" for more information).

For the purposes of this project, a vegetation patch is defined as:

> **Vegetation Patch**: *an area of contiguous vegetation greater than ½ acre in size containing a distinct pattern, distribution, and composition of vegetation relative to surrounding vegetated and non-vegetated areas (Figure 2).*



Original Vegetation Map

Revised Vegetation Map

Figure 1. Comparison of original and revised vegetation map.

Figure 2. Example of a vegetation patch.

2) Vegetation Patch Classification

a) Vegetation Class

The National Vegetation Classification System (NVCS) was derived by The Nature Conservancy (TNC) for the purpose of classifying properties for conservation purposes. The broadest level of the NVCS contains seven classifications: forest, woodland, shrubland, dwarf-shrubland, herbaceous, nonvascular and sparse vegetation.

For the purposes of this project, aerial photos were the primary reference for classifying vegetation patches into the following four NVCS classes (Grossman *et al.*, 1998) [3,4]:

Forest: *Trees with their crowns overlapping, generally forming 60-100% of cover.*

Woodland: *Open stands of trees with crowns not usually touching, generally forming 25-60% of cover. Tree cover may be less than 25% in cases where it exceeds shrubland and herbaceous vegetation.*

Shrubland: *Shrubs generally greater than 0.5 m tall with individuals or clumps overlapping to not touching, generally forming more than 25% of cover with trees generally less than 25% of cover. Shrub cover may be less than 25% where it exceeds forest, woodland, and herbaceous vegetation. Vegetation dominated by woody vines (i.e., blackberry) is generally included in this class.*

Herbaceous: *Herbs (graminoids, forbs, ferns and shrubs less than 0.5m tall) dominant, generally forming at least 25% of cover. Herbaceous cover may be less than 25% where it exceeds forest, woodland and shrubland vegetation. This includes shrubs less than 0.5 m tall.*

Figure 3 shows examples of each class. For more examples, refer to "appendix 1 | image supplement" at the end of this document. Note that the 0.5 m height as a determination of class is difficult to apply consistently when using aerial photos as the primary reference source. Calculating the exact height of shrubs and low-structure vegetation in a patch is not possible without field verification, Vegetation heights were therefore estimated by comparing the shadows cast with those of nearby features such as trees and houses. This is not possible in all areas. Therefore, the shrubland class tends to be applied to areas with larger, woody shrubs more easily visible on the current aerial photos.

[3] For the purpose of this project, the dwarf-shrubland class described by the NVCS is classified as herbaceous given there is no accurate way to distinguish small shrubs from grass and other low-structure vegetation on the aerial photos.
[4] Nonvascular (e.g. moss and algae) and sparse vegetation were not mapped. The NVCS defines sparse vegetation as areas with a predominance of boulders, gravel, cobble, talus, consolidated rock and/or unconsolidated material.

b) Vegetation Subgroup

Each vegetation patch was further classified into either "natural/semi-natural" or "cultivated" NVCS subgroups based on the following definitions (adapted from Grossman *et al.*, 1998):

> **Natural/Semi-Natural Vegetation**: *Natural vegetation is that which appears to be unmodified by human activities, occurring spontaneously without regular management, maintenance or planting. Semi-natural vegetation has a composition or structure that has been sufficiently altered by anthropogenic disturbances such that it no longer has the characteristics of natural vegetation assemblages found in comparable conditions the watershed. However, semi-natural vegetation is self-maintaining without significant human maintenance or management. This type of vegetation may be dominated by either native or non-native species.*
>
> **Cultivated Vegetation**: *Vegetation that is consistent with traditional landscaping and is highly manicured and regularly (annually, semi-annually or more frequently) managed and maintained. Cultivated vegetation is often dominated by turf grasses and ornamental shrubs and trees. Cultivated vegetation typically has low species and structural diversity. It is assumed that cultivated areas are managed using a combination of mowing, pruning, fertilizers and pesticides. Residential yards, common areas, golf courses, parks and rights-of-way are included in this management class. In areas where agricultural land uses occur, cultivated fields and orchards are also included.*

Figure 4 shows examples of the two NVCS subgroups. For more examples, refer to "appendix 1 | image supplement" at the end of this document. Most vegetation, particularly within an urban setting, has been subjected to human disturbance. Even where these impacts are apparent, if the patch appears to be self-sufficient and displays patterns consistent with uninhibited and un-maintained growth, the patch is identified as natural/semi-natural.

It is important to note that though natural/semi-natural areas may be dominated by native species, they need not be. An example of this would be a patch of Himalayan blackberry. Though these plants are not naturally-occurring in the Portland area, they are not generally planted or maintained and they distribute naturally, so they are mapped as a natural/semi-natural vegetation patch. The subgroup distinction is based on the pattern of plant distribution within the patch and the patch's proximity to human features (such as houses and park infrastructure) rather than the type of vegetation present in the patch (which is often unknown).

Vegetation that has been planted as part of a restoration or enhancement project, includes a predominance of native vegetation, and is managed as a natural area, is classified as "natural/semi-natural." While this type of vegetation is often routinely managed for multiple years, it is managed to create a more naturalistic vegetation assemblage that supports an array of ecologic functions.

Also note that forest vegetation is always designated as semi-natural/natural. This is appropriate because forested areas are dominated by trees which provide significant ecologic functions, such as

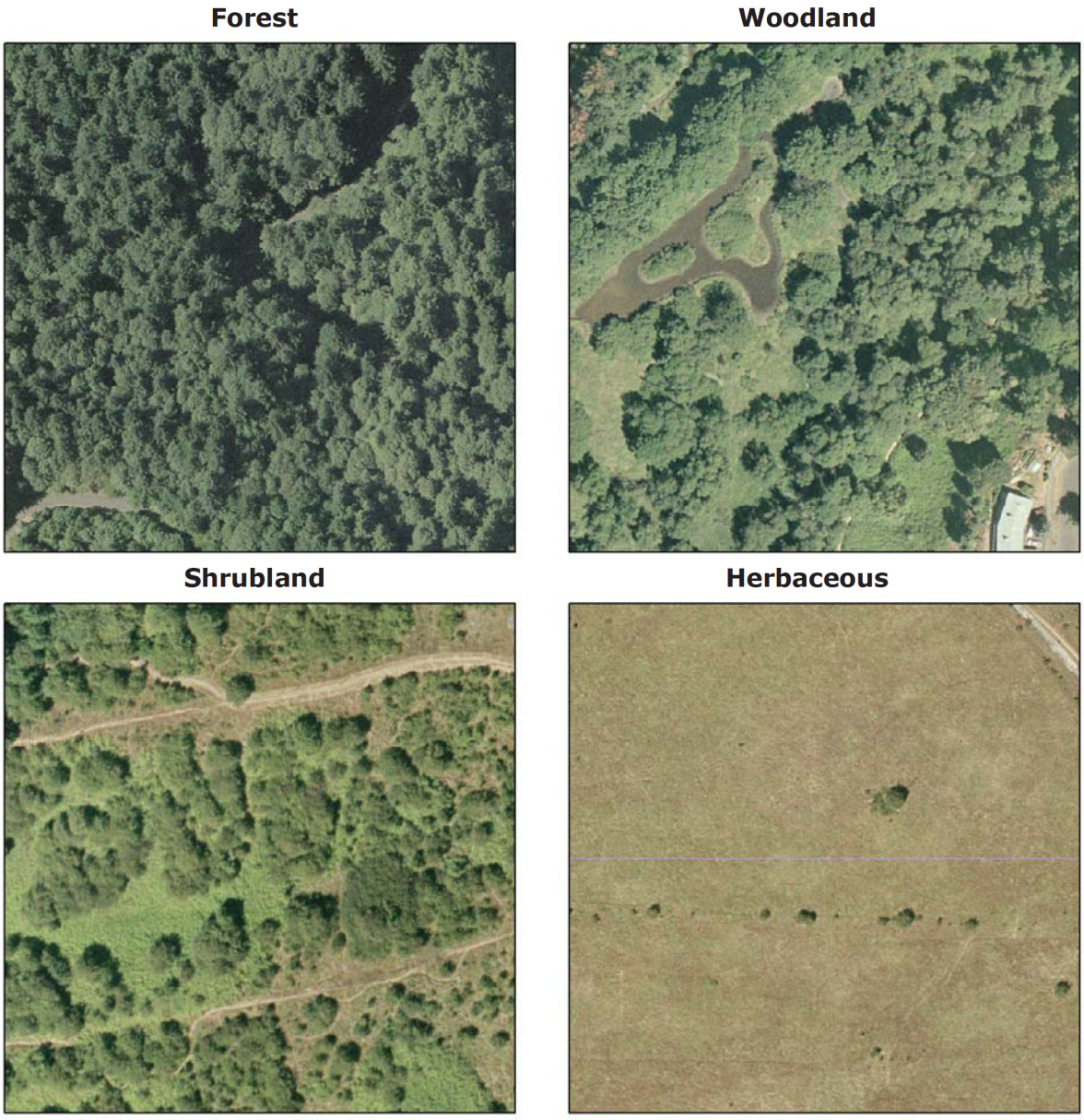


Figure 3. Examples of each of the four NVCS vegetation classes.

Figure 4. Examples of the two NVCS subgroups.

rainwater capture, nutrient uptake, organic inputs, wildlife cover, etc. In addition, the forest canopy itself is not regularly maintained.

Figure 5 summarizes the vegetation classification process.

4) General Mapping Protocol

Vegetation patches are mapped using the following protocol:

1. *Understand the landscape and general character of the vegetation*. At a scale of 1:8,000, which is approximately a quarter section, the general distribution and character of vegetation is observed. Other land use (e.g. residential, commercial) patterns are noted.

2. *Look at previously mapped vegetation patches*. Still at a scale of ~1:8,000, the previously mapped patches are reviewed to determine where refinements may be necessary. The patch should be refined if:

    - There are different patterns, distributions or character of vegetation included within the patch boundary;
    - Vegetation of the same character and patterns as adjacent vegetation is not included in the patch;
    - Patches that are not mapped to the smallest appropriate unit. For example, if a 4-acre area is mapped as woodland, but there are distinguishable ½-acre areas of herbaceous vegetation, then the herbaceous vegetation should be mapped as a separate patch;
    - In some cases, the boundary of a patch may be accurate but the vegetation type has changed. For example, a woodland patch may have developed into a forest patch.

3. *Refining and creating patches*. At a scale of approximately 1:3,000, distinct patches are mapped. This process includes both creating new patches and refined previously mapped patches.

    Below are the steps for refining and creating patches:

    i. First, vegetation that meets the forest or herbaceous NVCS classification is mapped. The guidelines to map forest vegetation patches are as follows:

        - A 4-lane road or highway splits a forest patch. Roads with less than 4 lanes split a patch where the road is clearly visible (i.e., no overhanging canopy). Where large vegetated areas located on two sides of a street are connected via a single tree overhanging the street, the two patches should be mapped separately;

- A narrow section of a forested area, which is one or two trees wide, can create a break between patches, provided that the two resulting vegetated areas are large enough to meet the ½ acre threshold;
- A significant change in character, even when the vegetation type and distribution is similar, can create a natural break between two forest patches. For example, a break between areas would likely occur where there is a significant shift from closed forest canopy with very few buildings or impervious area, to a primarily developed area with thin strips of trees between structures and yards. In this situation the closed forest canopy with few building/impervious would be a separate patch from the thin strip of trees that extends away from it.

The guidelines to map herbaceous patches are:

- When an area of predominantly herbaceous vegetation contains a narrow area of trees or shrubs located along its perimeter, and the trees do not meet the ½ acre criterion, the trees or shrubs should be included within the boundary of the herbaceous patch;
- When an area of predominantly forest, woodland or shrubland vegetation has a narrow area of herbaceous vegetation located along its perimeter, and the herbaceous vegetation does not meet the ½ acre criterion, the herbaceous vegetation should not be included within the boundary of the patch;
- Within developed areas, highly managed herbaceous vegetation that is fragmented or separated from larger vegetated areas by buildings, driveways, parking areas, etc. is generally excluded. The intent is to include larger structure vegetation when appropriate.

ii. Second, woodland and shrubland vegetation is mapped. There is a range of vegetation that meets woodland and shrubland vegetation classifications and often the differentiation is not clear. The following guidelines are used to differentiate between woodland and shrubland vegetation:

- Trees within a woodland patch generally make up about half the land cover but do not create significant closed canopy. The understory could be shrubs or herbs or sparsely vegetated; native or non-native;
- The trees should be distributed across the patch;
- When a vegetation contains relatively minimal canopy coverage (e.g. 25-30%) and the character of the vegetation doesn't appear to be woodland (e.g. intensely managed turf grass understory with very few, non-consolidated trees and shrubs), the patch should be classified as herbaceous vegetation;

- Shrubland vegetation should have a predominance of shrubs throughout the patch. Trees and grass may be present, but should occur throughout less than half the patch.

iii. Third, the vegetation management classification of semi-natural/natural or cultivated, is determined as follows:

- Forest is always classified as natural/semi-natural;
- Cultivated areas typically include yards, landscaped areas around buildings, golf-courses, ball parks and soccer fields, and rights-of-way. These areas are intensely managed and typically include turf grass and ornamental shrubs and trees. These areas generally lack structural diversity (e.g. sparse trees interspersed across lawn);
- Irrigated areas are usually, but not always, classified as cultivated. Other indicators, such as structural diversity, are used to determine if irrigated areas should be classified as semi-natural/natural;
- Semi-natural/natural vegetation is typically, but not always, found around rivers, streams and wetlands and in parks and natural areas. However, semi-natural/natural vegetation can be found in yards, around buildings, and adjacent to ball parks and soccer fields. These areas typically include a mix of trees, shrubs and grasses that do not appear to be mowed, pruned or otherwise treated. The vegetation may be dormant in the summer due to lack of irrigation;
- Areas maintained to restore a more natural vegetation pattern are considered semi-natural. These areas may be managed to remove invasive plant species and irrigation may occur;
- Topography is used to help differentiate between areas that are cultivated and areas that are not. Very steep areas are not typically cultivated.
- In cases where a patch meets one vegetation type, but two management types are present, the patch is split to differentiate between the management types.

iv. Finally, visible, non-vegetated areas (e.g. buildings, bare soil) are excluded or removed from vegetation patches as necessary using the following guidelines:

- Visible buildings, driveways, parking areas are removed from vegetation patches;
- Vegetation that overhangs a non-vegetated area (e.g. a driveway) is included within the vegetation patch;
- Areas of bare soil, gravel, rocks are removed from a vegetation patch when the area is greater than ¼ acre in size;
- Large trails (5′ wide or more) visible on the aerial photos are not included in the vegetation patch.

4. *Reassess the general pattern and distribution of vegetation*. Returning to a scale of 1:8,000, the general pattern, distribution and character of vegetation is assessed based on the refined vegetation patches.

4) Field Survey Methodology

Project staff visited properties owned by the public and privately-owned properties where vegetation patch was visible from public right-of-way. Field crews used visual assessment and, when GPS-satellite coverage was available, GPS data collection.

Field crews carried copies of a standard field visit form for notes and sketches, and a map with 6"-resolution aerial photographs of the vegetation patch and the surrounding area. All notes and maps for a particular field visit were scanned and stored in Acrobat PDF format. Digital photos of the patch were also taken in some cases. All digital documentation and photos are available from the Bureau of Planning & Sustainability.