Preliminary




Habitat and Stewardship Strategy

Analysis and Recommendations

2013

City of Olympia, Public Works
Water Resources
Storm & Surface Water Planning

Olympia

Executive Summary

Olympia is a wonderful place to live. One of the big reasons it is so wonderful is due to the rich and diverse natural areas that stretch across the landscape of our city. But these rich and diverse natural areas are dwindling. Based on what we know about current and anticipated population growth for Olympia this is not really a surprise. Seems like a fairly simple formula. Increased human population, means more houses, more roads, more landscaped yards which means less forests, less wetlands, less meadows, less wildlife. But just like we plan for houses and roads we can plan for our wildlife, and that is exactly what this document does...plan for our wildlife. Rather than simply assuming that wildlife habitat will be made up of whatever is left over when the rest of the city is built, this plan looks critically at the remaining habitat within Olympia and its growth boundary and proposes a suite of stewardship strategies and tools to protect and enhance the best and most critical pieces of it.

You will hear mentioned throughout this report, that this work effort was a multi-scale analysis. Simply put, we looked at the remaining habitat at a Citywide scale, which helps us understand what's left, then we looked at it on a basin scale, which tells us where it is, and finally we actually walked onto a single piece of property and figured out what we could actually do to improve it for wildlife. How many trees to plant, how many noxious weeds to remove, how many snags to create. This fine scale analysis is the one that actually makes it real. These are the things that everyone can do in their own neighborhoods to make a difference. Imagine hundreds of properties throughout Olympia with active stewardship, ranging from a small backyard to a hundred acre wetland, from a mom and her kids putting up a backyard bird feeder to an excavator installing coarse woody debris. This really is a work effort that everyone can play a role in.

You may note that this report is labeled, "preliminary". We call it that because we believe there is still work to be done. Still much to understand, which will always be true especially when working with natural systems. So...like all good natural resource managers we are recommending "adaptive management". The process of continuous improvement, learning from the past to make the future even better. This allows us to move on with this very important work, to not delay, but also not rest on our laurels.

Rather than a new work effort, this report is actually a culmination of numerous studies that have been undertaken over the past 25 years by the City of Olympia, in an attempt to understand, protect and manage the remaining natural areas in Olympia. Throughout this report you will see references to various past projects that contributed to this work effort. We commend the staff, community leaders and citizens that have championed this cause in the past, we are proud to have played a role in this current process and are immensely thankful to the members of the Utility Advisory Committee for requesting that this work be performed.

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1.0 Introduction

Historic changes in human land-use patterns have had a direct effect on habitat loss, species richness, as well as evenness of species across the urban landscape (Blair, 1996). The resulting fragmentation of habitat, loss of landcover heterogeneity and increased patch isolation has altered the availability of suitable food, cover and breeding locations, as well as affecting species population dynamics (Kucera, 1995). Meadows, forests, estuaries and wetlands are all landcover types which provide those resources needed for viable breeding populations to exist, across a broad range of species, and all are present in our community. The importance of preserving remaining corridor connections, as well as restoring degraded habitat is crucial. However, landcover heterogeneity across an urban environment will always include dense human development. In order to maximize habitat opportunities, consideration of humans, as well as wildlife, as a coexisting community within an urban matrix is needed.

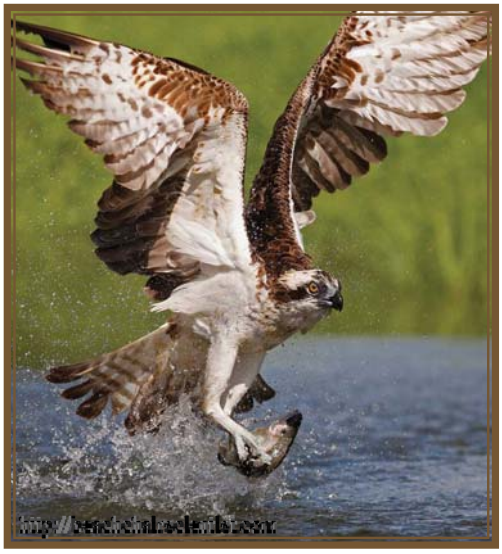
In recent years, there has been increased implementation of ecosystem services in order to minimize anthropogenic effects on ecological function within communities. These efforts, while needed and very well thought out in most cases, have done little to address habitat fragmentation. Some research has been done in an attempt to assign economic value to the environment as a provider of services through overall ecosystem health. However, landscape fragmentation has a societal dimension which is not easily quantified. The availability of landscape indices which link ecosystem health to human well being have also proven elusive. However, there are metrics which quantify human preferences for a heterogeneous and diverse landscape (Palmer, 2004). In addition, research in the field of social ecology has begun to demonstrate how environmental and community health can lead to increased individual health benefits (Stokols, 1996).

Fortunately, the citizens of Olympia haven't needed rigorous research to tell them what they are already aware of; a healthy natural environment is critical for human health and a sense of well being. For Olympians, these values are well known and exist

within and throughout the City of Olympia organizationally as evidence of our commitment to live sustainably as a part of our environment.

Not just Anytown, USA, Olympia has a rich geologic and natural history. Located on a glacial plain at the southern terminus of Puget Sound and on the shores of the twin bays comprising Budd Inlet, Olympia is in the north-central part of Thurston County. The area is topographically similar to the coastal regions and islands of the south Puget Sound, and local vegetative communities are similar as well. Native vegetation in areas with low amounts of disturbance typically form a west-side lowland mixed conifer-hardwood forest type, with Douglas-fir, western hemlock, and western redcedar likely components of the forest over story. Big leaf maple and red alder are often found as canopy or sub-canopy co-dominant cohorts. Soils in the area are primarily glacial till formed by the Vashon Glacier, which melted and receded from the area approximately 15,000 years ago, with other residual and alluvial soil types also found in the low-lying areas and wetlands within the city and its Urban Growth Area.

The Deschutes River, and associated Capitol Lake, created after the river was impounded in 1951, flows directly into the west bay of Budd Inlet. It is the Deschutes River, and other small tributaries of Budd Inlet, which provides a lacework of vegetated corridors which host a variety of resident wildlife species living within a matrix of residential and urban development. It is not uncommon to see black-tailed deer and other wildlife wandering neighborhoods during dusk or dawn. Our city streams and water bodies support fish and amphibians, as well as populations of American beaver, river otter, and a range of waterfowl, including ducks, geese, and migratory shorebirds.



Raptors such as bald eagle and osprey find roosting and nesting sites in forested areas within the city, and a variety of passerine and songbird species use available habitat to the delight of bird-watchers and naturalists alike. It is daily interactions with the environment, as well as the wildlife which co-inhabit the landscape, which gives Olympia a sense of place and binds its residents to the environment, as well as each other.

Committed to those shared community values, in 2012 the City of Olympia Utility Advisory Committee directed the Stormwater Planning & Implementation section to review potential opportunities for strategic land stewardship targeted toward protecting and improving habitat in Olympia and its growth boundaries. With that objective in mind, the purpose of this analysis is to synthesize previous research and data in order to identify focus areas for land stewardship. Based on the landscape analysis results of this report, it is the intention of staff to use a full suite of tools to develop specific, targeted strategies in order to create a more livable community for humans as well as wildlife.

2.0 Background

In an effort to minimize urban sprawl and protect rural areas, Washington State created the Growth Management Act in 1990 (GMA). In response to this, the City of Olympia designated an Urban Growth Area (UGA) in order to increase urban densities to meet those requirements. This increase in urban density hasn't been without effects to water quality, as well as habitat. Since 1990, the City of Olympia has completed multiple analyses in an effort to determine the effects of water quality and habitat degradation as a result of urbanization, as well as set policy and guidance for future mitigation efforts. Over the last two decades, the City of Olympia's goals and policies have continually evolved in response to increased ecological awareness based on the best available science, which has clearly demonstrated the effects of urbanization on the environment.

2.1 City of Olympia Wildlife Habitat Study-1994

Beginning in 1994, the City of Olympia Public Works Department commissioned Shapiro & Assoc., Inc. to perform a city wide (including associated Urban Growth Area) analysis of landcover types in an effort to identify remaining habitat. This study, using the best available science, focused on mapping and classifying landcover types in order to create rating criteria which could help managers further protect critical wildlife habitat.

2.2 Aquatic Habitat Evaluation & Management Report-1999

In 1999, City of Olympia Water Resources staff conducted an aquatic habitat evaluation which was focused on the nine major basins within the City of Olympia and its UGA. Based on research findings of the impacts of urbanization on streams and wetlands within the Puget Sound Basin, this research provided the framework to implement a management approach with basin-specific goals and objectives. The major finding of this research was the most important factors affecting aquatic habitat are changes in basin hydrology and riparian corridor vegetation. This analysis provided evaluation and rating methodology, as well as management goals and strategies at the basin scale, in order to provide managers with appropriate tools to implement effective habitat management protection measures.

2.3 City of Olympia Storm and Surface Water Plan-2003

The City of Olympia Storm and Surface Water Plan was adopted in 2003. The purpose of this plan is to establish clear priorities for the City of Olympia Storm and Surface Water Utility in order to minimize flooding, maintain or improve water quality and protect aquatic habitat. This document provides the framework for implementing these priorities, using a suite of management techniques, and is intended to provide a long term strategy capable of preserving and protecting water resources within the City of Olympia as well as the South Puget Sound region.

2.4 GIS Basin Analysis-2012

With the availability of new Geographic Information System technologies, and staff with the experience to use these tools, a basin characterization was performed in 2010, then revised in 2012. The intent of this analysis was to incorporate almost a decade of water quality and biological data, land cover—which included tree canopy, impervious surface and building coverage—as well as the stormwater control effectiveness and on-site sewage system impacts, into a comprehensive technical evaluation of all basins within the City of Olympia and its associated Urban Growth Area. Major findings of this analysis confirmed previous research regarding basin landcover —particularly loss of tree canopy—and the correlation to water quality degradation (as measured by B-IBI).

3.0 Extent of Study/Limitations

The landscape configuration and patch structure needed to maintain connectivity for wildlife isn't fragmented because of a parcel line on a map. In the natural world lines on a map have little meaning—even though the human presence those lines represent may. A great example of wildlife's response to human presence is provided in a short story entitled, "Great Possessions," *A Sand County Almanac* (Leopold, 1949):

> *Like other great landowners, I have tenants. They are negligent about rents, but very punctilious about tenures. Indeed at every daybreak from April to July they proclaim their boundaries to each other, and so acknowledge, at least by inference, their fiefdom to me. (p. 41)*

Leopold implies the fauna that co-inhabit our urban environment, not only don't acknowledge our ownership, but in fact proclaim theirs supersedes ours—at least in the early morning hours of every spring.

Suitable habitat doesn't end at political boundaries. Unfortunately, jurisdictional limits do. For the purpose of this analysis, the extent of the study area includes the City of Olympia and its associated UGA. The primary data layer which provided the framework for this analysis was the landcover classification scheme provided in the Wildlife Habitat Study conducted in 1994. This data provided some coverage outside the limits of the City of Olympia and its associated UGA. A landcover analysis—with a format compatible with existing data that ranges from a course to fine scale—is not yet available in areas of interest for habitat stewardship outside of the City of Olympia and its associated UGA. For the purposes of this study, the extent is limited primarily to service areas of the City of Olympia Stormwater Utility.

3.1 Corridor Composition and Dimension Considerations

Like all habitat needs, corridor composition and dimension requirements are species specific and has spatial as well as temporal considerations (Hilty, 2006). In the modern, fragmented, urban landscape it is unrealistic to attempt to achieve corridor composition and dimensions necessary to maintain connectivity for charismatic mega fauna such as black bears, cougars, etc. However, there are generalizations which can be made which span the needs of most species. For the most part, species are broken down into two categories: generalists and specialists. Generalists tend to have broad dietary or habitat needs, whereas specialists need specific dietary or habitat requirements (Laurance, 1995).

In a human influenced environment, such as an urban setting, narrow corridors tend to be heavily influenced by invasive species and/or frequent human disturbance. This creates a prominent edge effect generalists can adapt to. Whereas this condition affects the specific habitat needs of specialists and limits effective use of available corridors (Norton, 1995). For the purpose of this analysis, focal species with distinct habitat needs based on feeding, breeding, nesting and behavioral requirements will not be considered at the course or medium scale. Individual focal species needs and patch connectivity analysis will take place during implementation of programmatic targeted management strategies at the fine scale.

3.2 Scale and Habitat Considerations

The concept of scale—characterized by both grain and extent—is a very important discussion item prior to any analysis. Habitat—characterized by the particular type of local environment an organism needs, is another critical point needing clarification prior to data processing. Both scale and habitat are species specific, and as such are very difficult to define across the broad range of scales used to perform this analysis. For analysis of landcover and it's suitability for habitat, the project is defined by scale. When analysis is performed at a great extent, for example City -wide in our case, the finer grain—or smaller scale—details are impractical to measure and or analyze at a coarse scale. It can also be inappropriate to use coarse grain data when analyzing at a fine scale because the resolution for larger geographic areas may result in errors due to incompatibility of the data. Think of using a felt tipped pen to place a pin-head sized dot on a piece of paper. Now place your thumb over it. What can you tell me about the dot? That's the concept of matching the scale with the analysis. For the purposes of this study, a non-species specific, landscape-based approach to habitat assessment has been performed from a coarse to medium scale. A stewardship plan has been provided as an example of fine scale analysis in Appendix B. It is the intention of this study to synthesize prior research and data using a full suite of GIS tools in order to preserve habitat integrity within our community, to the benefit of all species.

3.3 Landcover and Stewardship Strategy

In 2012 the Utility Advisory Committee (UAC) asked staff to consider land acquisition as a viable strategy for meeting our aquatic habitat goals. At the December, 2012 UAC meeting, staff provided a brief assessment of the Utility's history of land acquisition. At that meeting UAC asked staff to provide a scope for developing a strategy to evaluate remaining habitat. The scope of work is defined below and provides the nexus for this report:

Scope of Work:

Task 1: Project Administration/Management:

A. Conduct, coordinate and schedule project activities and assure quality control.

Task 2: Delineate aquatic resource lands

A. Using GIS spatial analysis tools develop the initial aquatic habitat resource layer using existing water, stream and critical area coverages.

B. Ground truth to improve LIDAR stream coverage to confirm culvert/stream locations

C. Research/ground truth critical area reports to enhance critical area coverages.

D. Analyze/quantify properties with aquatic resources.

Task 3: Evaluate condition of aquatic resource lands.

A. Field assess condition of aquatic resources and associated terrestrial buffers.

B. Characterize associated terrestrial resources (buffers) via GIS land cover analysis tools.

C. Develop field data collection procedures.

Task 4. Evaluate threats to aquatic resource lands.

A. Evaluate risk of land conversion (development) by performing an evaluation of properties by land ownership (public vs. private), current and/or anticipated land use (zoning and critical areas ordinance overlays)

B. Evaluate threat of invasive species.

Task 5. Stewardship Partner Potential.

A. Evaluate potential partnerships with other property owners, agencies and organizations.

Task 6. Develop final report

A. Prioritized list of properties/property types for protection/stewardship.

B. Matrix of recommended tools for protection/stewardship by property type and ownership classification

C. Stewardship plan template.

4.0 METHODS

The primary objective of the 2013 city of Olympia land cover and stewardship strategy was to identify and classify the remaining habitat in Olympia and it's growth boundaries in order to develop a strategy for land stewardship in keeping with the storm and surface water utilities aquatic habitat goals. Staff implemented the effort of reviewing and processing existing land cover data using a three phased approach: 1) scientific literature review, 2) habitat rating,, and; 3) mapping/classifying of habitat. This analysis was performed at a coarse, (citywide) scale and a medium (basin) scale. Simultaneously a fine scale analysis of a city-owned property at Central and Marion Street was performed. This resulted in the development of a stewardship plan for the property, which will also serve as a template for future stewardship plan development for other properties. (see Appendix B).

Scientific Literature Review

Land cover typing, in theory and practice was reviewed from a national perspective in order to identify a scheme which dovetailed with our existing data, while ensuring consistency with local and regional methods. The primary scientific literature of corridor ecology and wildlife pattern process interactions was also reviewed to ensure best available science was used in developing project analysis protocols.

Habitat Rating

In order to prioritize remaining habitat for both protection and enhancement of wildlife habitat, we developed a wildlife habitat rating system that ranges from category 1 (highest quality) to category 4 (poorest quality). This system was adopted from the Olympia Wildlife Habitat Study (Shapiro, 1994). This rating system is described in greater detail later in this report.

Mapping and Classifying of Habitat

We performed a multi-scale analysis using GIS. At the coarse scale we looked at land cover from a city wide perspective. This coarse scale analysis quantified habitat by land-cover type (conifer, hardwood, etc.), allowing us to compare current habitat conditions to habitat conditions in 1994. We then classified habitat by land-use and ownership demographics. We did this by selecting parcels from the Thurston County parcel database that were coincident with the newly revised habitat layer. The medium scale or basin analysis summarized the habitat by basin, rank, land-use and risk of loss. With the information obtained in the medium scale analysis, we were able to develop comprehensive strategies and tools for protecting and enhancing habitat in each basin.

4.1 Coarse Scale Analysis (Citywide)

4.1.1 Analysis Flowchart and Data

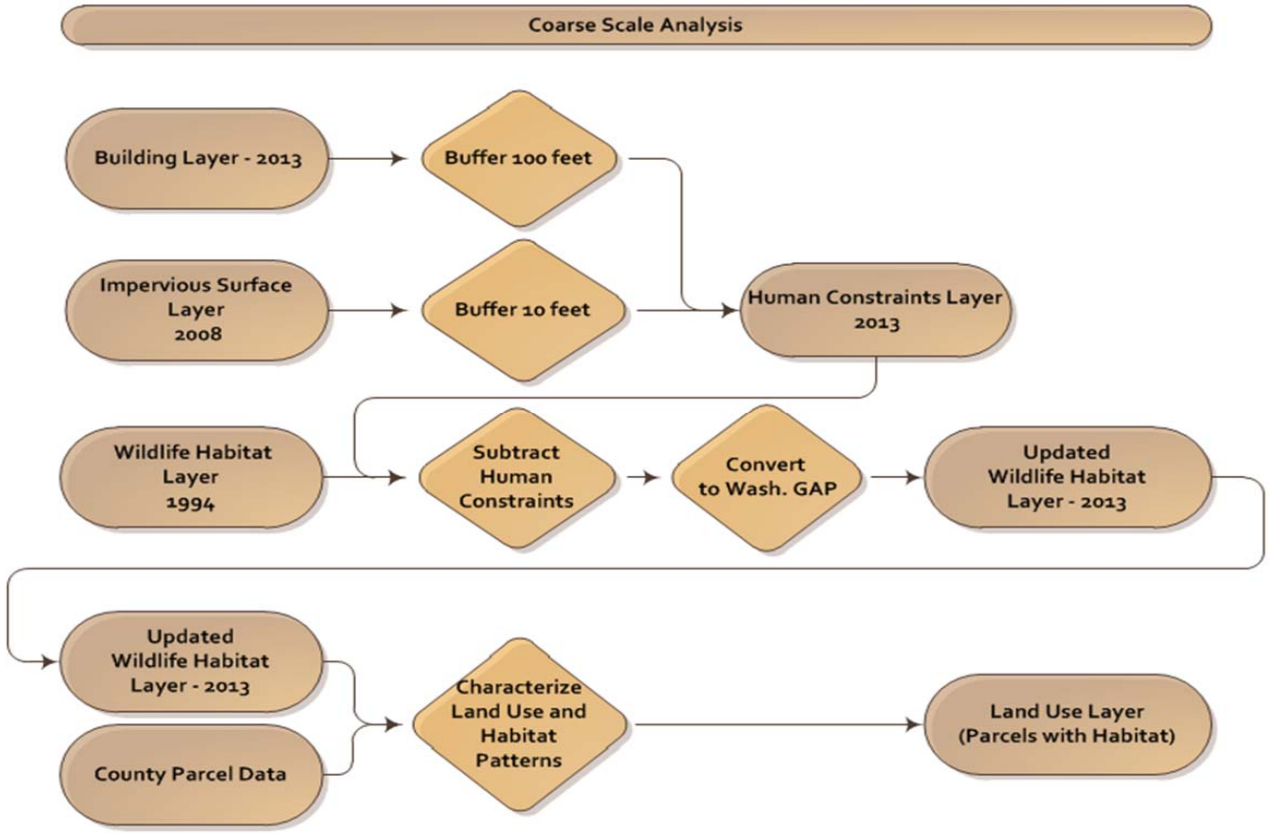


Figure 4.1.1

Building Layer-2013

Acquired from the City of Olympia basemap data source, the building layer consists of human built commercial and residential structures. We chose a 100 foot buffer on buildings based on a previous fine scale analysis staff developed for Great Blue Heron nesting tolerances to human presence in northwest Olympia.

Impervious Surface Layer-2008

Generated using the 2008 City of Olympia LIDAR data, the impervious surface data consists primarily of roads, parking lots and other landcover types categorized as impervious. A ten foot buffer was used to account for adjacent disturbance factors associated with impervious surfaces.

Human Constraints Layer-2013

The Building Layer and Impervious layer were merged to form a Human Constraints Layer. This layer served as an overlay representing human influenced landcover.

City of Olympia Wildlife Habitat Study

Staff used the base data from the City of Olympia Wildlife Habitat Study, (Shapiro, 1994) as a starting point for our land cover analysis. The 1994 study involved a comprehensive classification of natural areas within the City of Olympia and UGA.. The mapping associated for this study was developed from high resolution near infrared aerial photographs in which thousands of unique polygons were characterized by specific land cover type (i.e., young Douglas-fir, estuarine wetland, etc.), and ranked in accordance with their value for wildlife. Staff performed both field reconnaissance and digital comparisons to ensure the data was current.

4.1.2 City of Olympia Available Habitat-1994

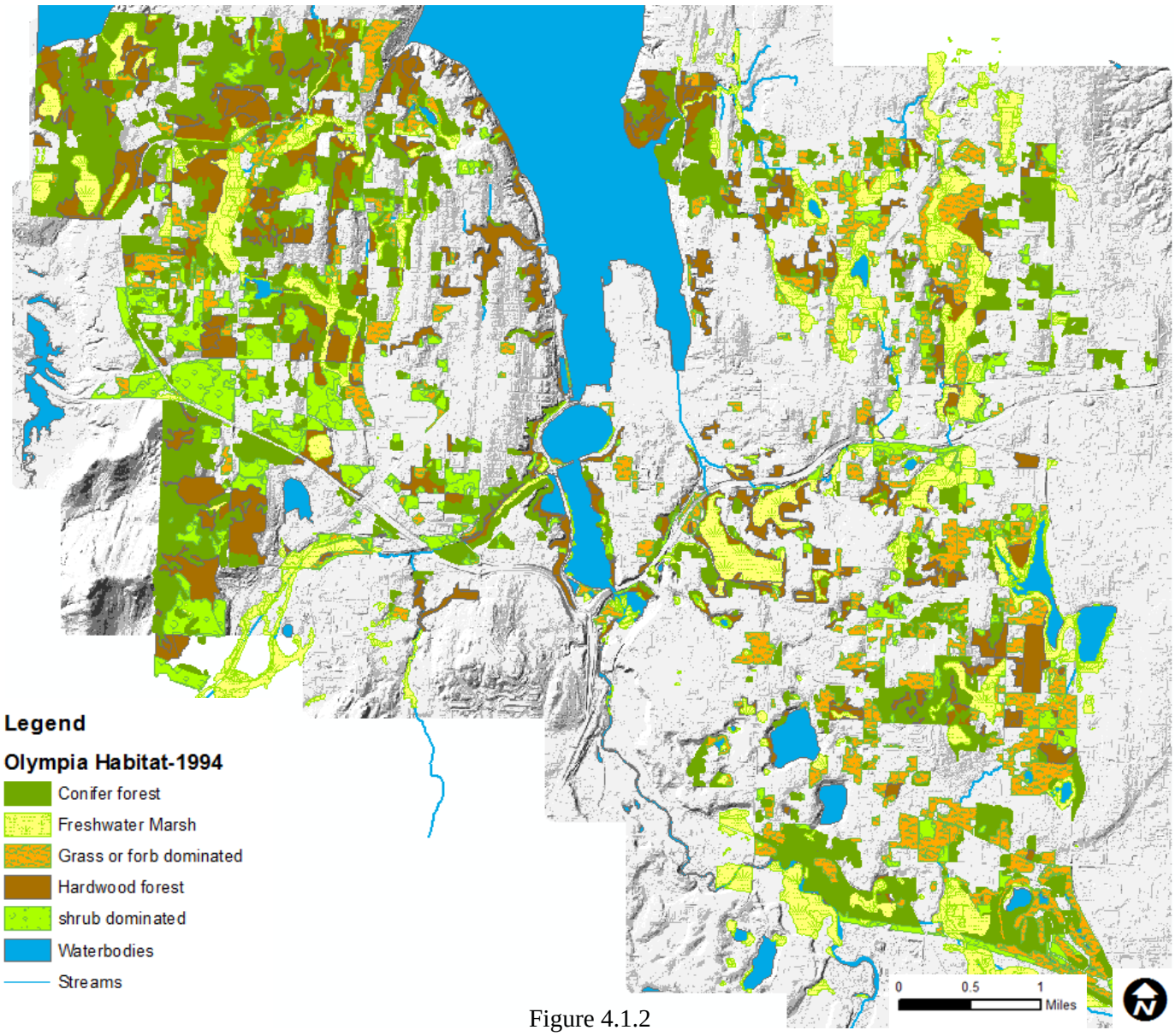


Figure 4.1.2

4.1.3 Washington GAP Analysis Program Classification System

We converted the land cover classification scheme used in the 1994 wildlife study into the Washington GAP system for our coarse and medium scale analysis. The Washington GAP system is based on the nation wide GAP analysis program developed by the United States Geological Survey. It is a coarse filter that uses land cover patterns as determinants of overall biodiversity, with an emphasis on vegetation communities. By converting the 1994 data into the GAP system our analysis will be performed consistent with land classification protocols used by most state and national conservation organizations, including the Washington State Department of Fish and Wildlife Department that uses this system for its priority habitat and species (PHS) program.

4.1.4 Updated Habitat Data – 2013

The first step in the coarse scale analysis was to update the 1994 wildlife habitat data. This was done by identifying new buildings and impervious surfaces that have been constructed since 1994 and subtracting them from the 1994 habitat layer. A follow up quality control check identified an additional 259 acres that had been recently developed (denoted as “built” in fig. 4.1.7) and 309 acres that have approval to develop (denoted as “pending” in fig. 4.1.7). The resulting chart graphically represents the wildlife habitat that existed in 1994 (9,390 acres), and the amount that is left in 2013 (5,993 acres) by land cover type.

4.1.5 City of Olympia Available Habitat-2013

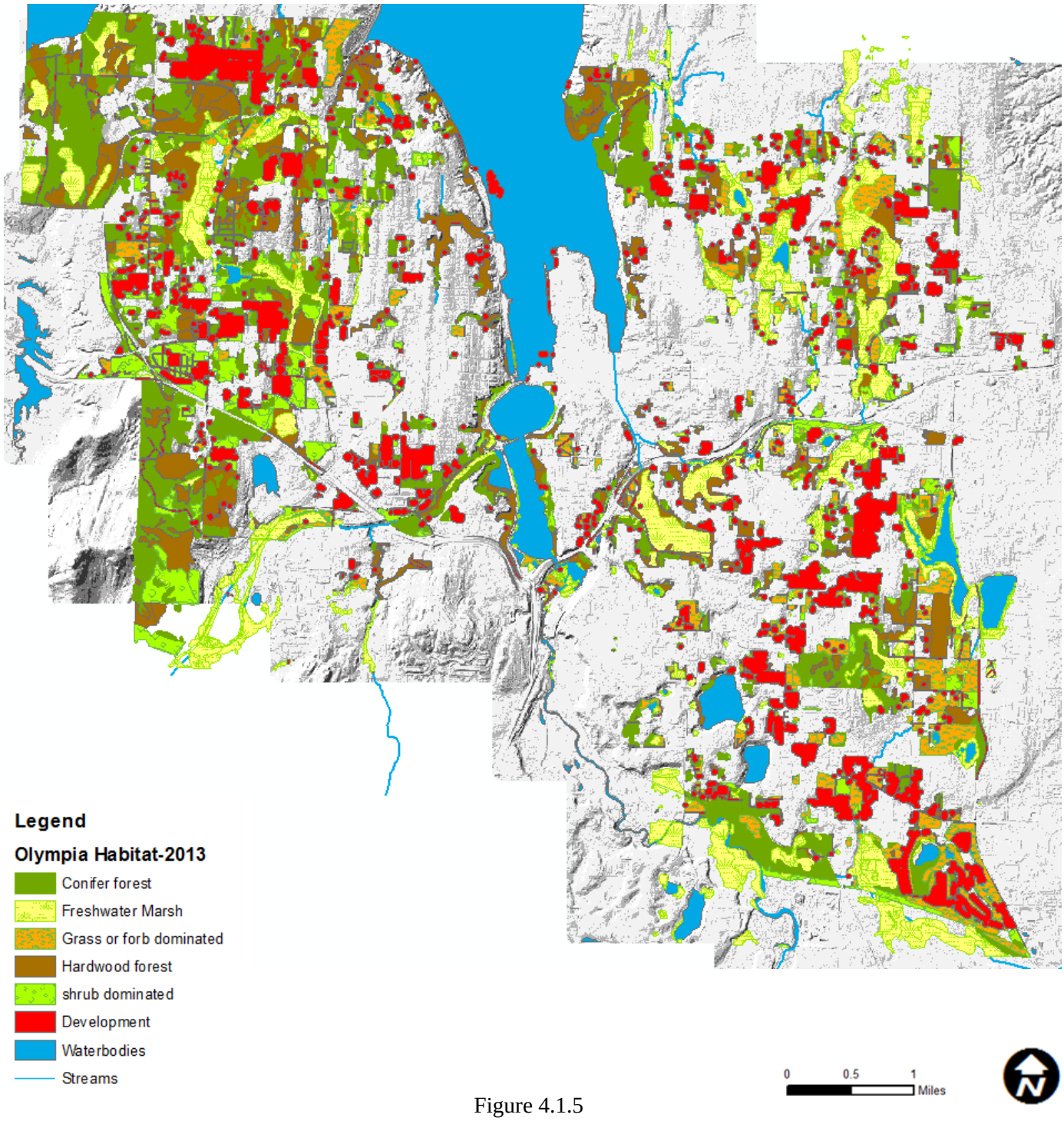


Figure 4.1.5

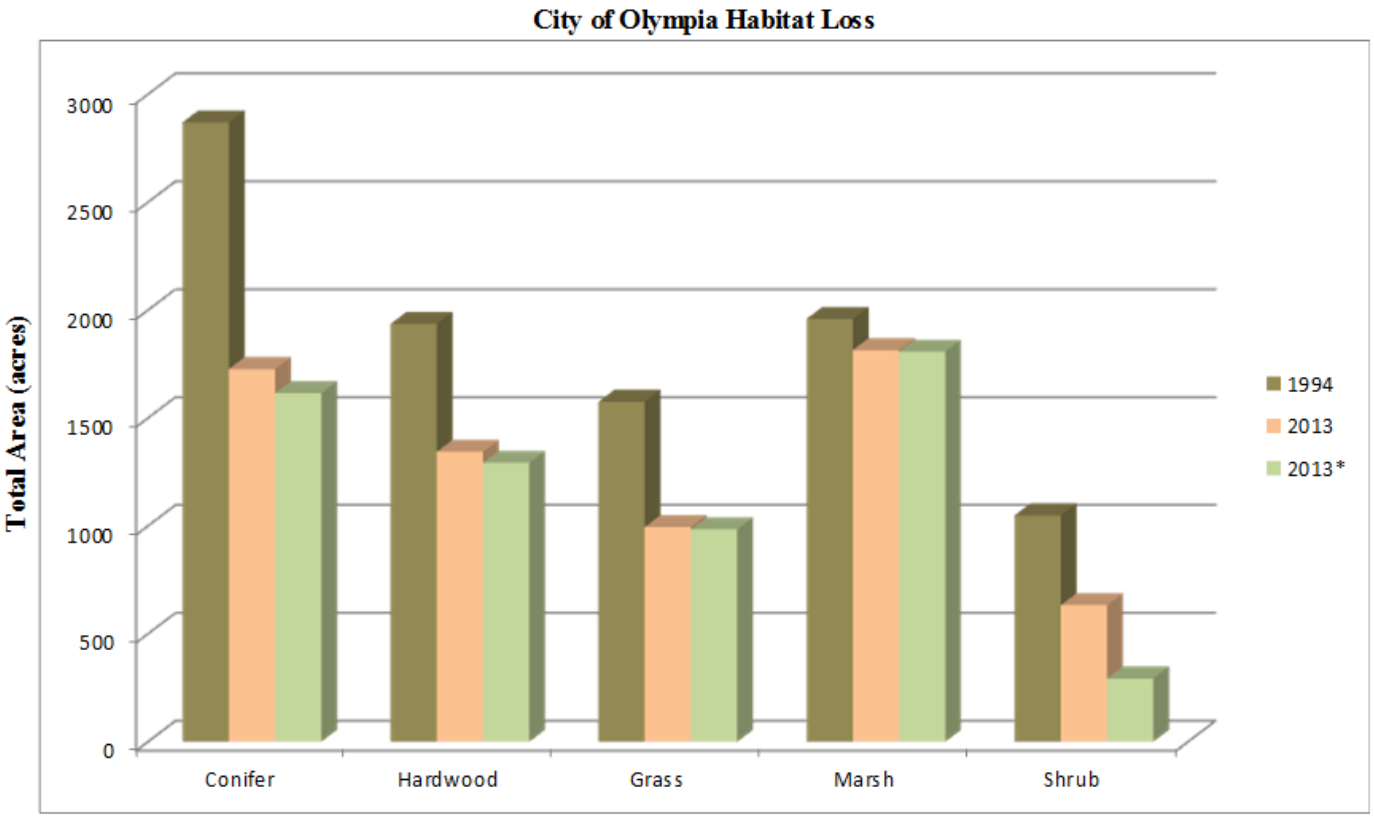


Figure 4.1.6

*Impervious surface data accurate to 2008

	1994	2013	2013 (Built)	2013 (Pending)	2013*	Difference	% Habitat Loss
Conifer	2870	1727	56	179	1615	1255	40%
Hardwood	1936	1343	25	91	1293	643	31%
Grass	1576	995	5	4	984	592	37%
Marsh	1959	1815	3	27	1808	151	7%
Shrub	1049	633	170	7	293	756	40%
Total	**9390**	**6512**	**259**	**309**	**5993**	**3397**	**31%**

*Impervious surface data accurate to 2008

City Wide Habitat (In Acres)

Figure 4.1.7

4.2 Medium Scale Analysis (Basin)

4.2.1 Analysis Flowchart and Data

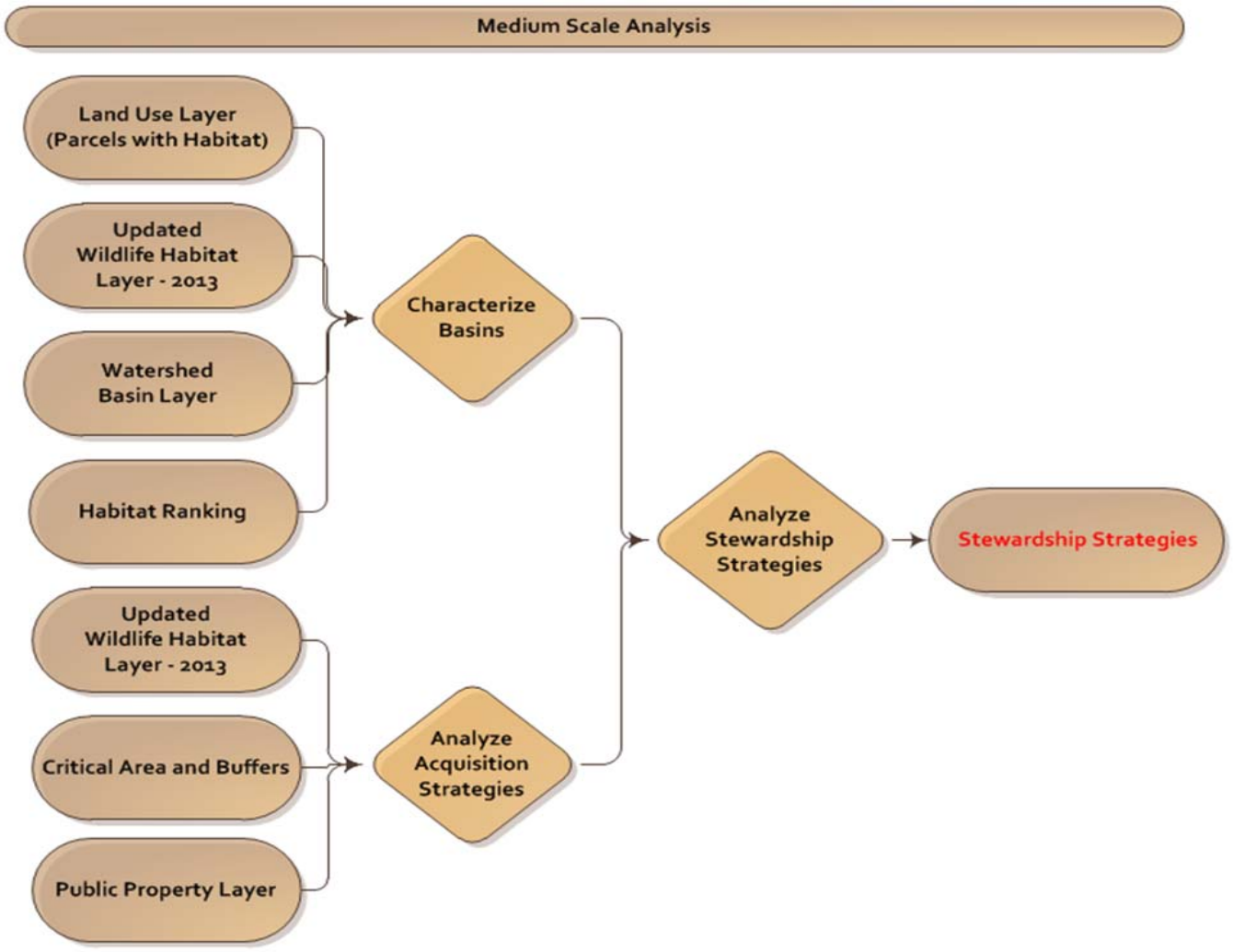


Figure 4.2.1

The next step in our multi scale analysis is to evaluate the quantity and quality of habitat on a basin scale. This provides both a geographic focus for future protection and enhancement of habitat as well as a better understanding of land-use patterns and property ownership demographics. The combination of these analyses will be the foundation for identifying specific enhancement strategies for each basin.

4.2.2 Habitat Ranking Criteria

All remaining habitat was ranked into one of four categories, this ranking structure developed by Shapiro and Associates, reflects the relative values for habitat within the City of Olympia and UGA. Category I. are those areas that offer the best available habitat; category IV are the least productive. The primary evaluation criteria are the presence of wetlands, forests, and the size of the unit. Minimum unit width, as a measure of potential core habitat, as opposed to edge habitats, was also assessed.

The table below shows the habitat ranking categories and their associated criteria.

Habitat Ranking Criteria

Category I	Category II	Category III	Category IV
State or Federal Endangered species Present	State candidate or sensitive species present	Between 5-20 acres with an average width greater than 200ft	Between 5-20 acres and less than 200ft in width
Bog or fen with > 5 acres of adjacent upland forest	Bogs or fens with <5 acres of adjacent upland forest	Between 20-75 acres with an average width of 400ft	Less than 5 acres and forested
>75 acres with a minimum width of 700ft	Between 20-75 acres with average width of 400ft	N/A	Pasture, agricultural shrubs and rural residential open space.
N/A	> 75 Acres with average widths less than 700ft	N/A	N/A

Figure 4.2.2

Applying the habitat ranking protocol above, across all available land cover types, at a basin scale is the first step in transitioning data from a course to medium scale. This process begins to tell the story of how much habitat is available by basin, and which basins have the highest quality habitat. Figures 4.2.3 & 4.2.4 provide a side-by-side basin comparison.

4.2.3 Remaining Habitat by Basin and Landcover

Landcover Type by Basin (acres)

	Conifer	Hardwood	Shrub	Grass	Marsh	Total by Basin
Chambers	321	158	94	409	374	1356
Percival	397	242	247	45	192	1123
Green Cove	385	334	61	86	210	1077
Eld Inlet	353	179	122	48	115	817
Woodard	76	80	46	151	371	725
Indian	14	54	27	48	159	301
Moxlie	35	51	3	40	109	239
West Bay	45	80	13	66	18	222
Deschutes	18	2	0	20	162	203
Ellis	34	62	0	39	58	193
Schneider	16	46	7	8	2	79
Mission	1	14	3	18	29	64
East Bay	12	24	1	2	0	39
Capitol	3	11	7	6	8	35
Ward Lake	9	6	0	3	4	22
Woodland	8	0	1	0	6	15
LOTT	0	0	0	4	0	4
Total:	**1727**	**1343**	**633**	**995**	**1815**	**6512**

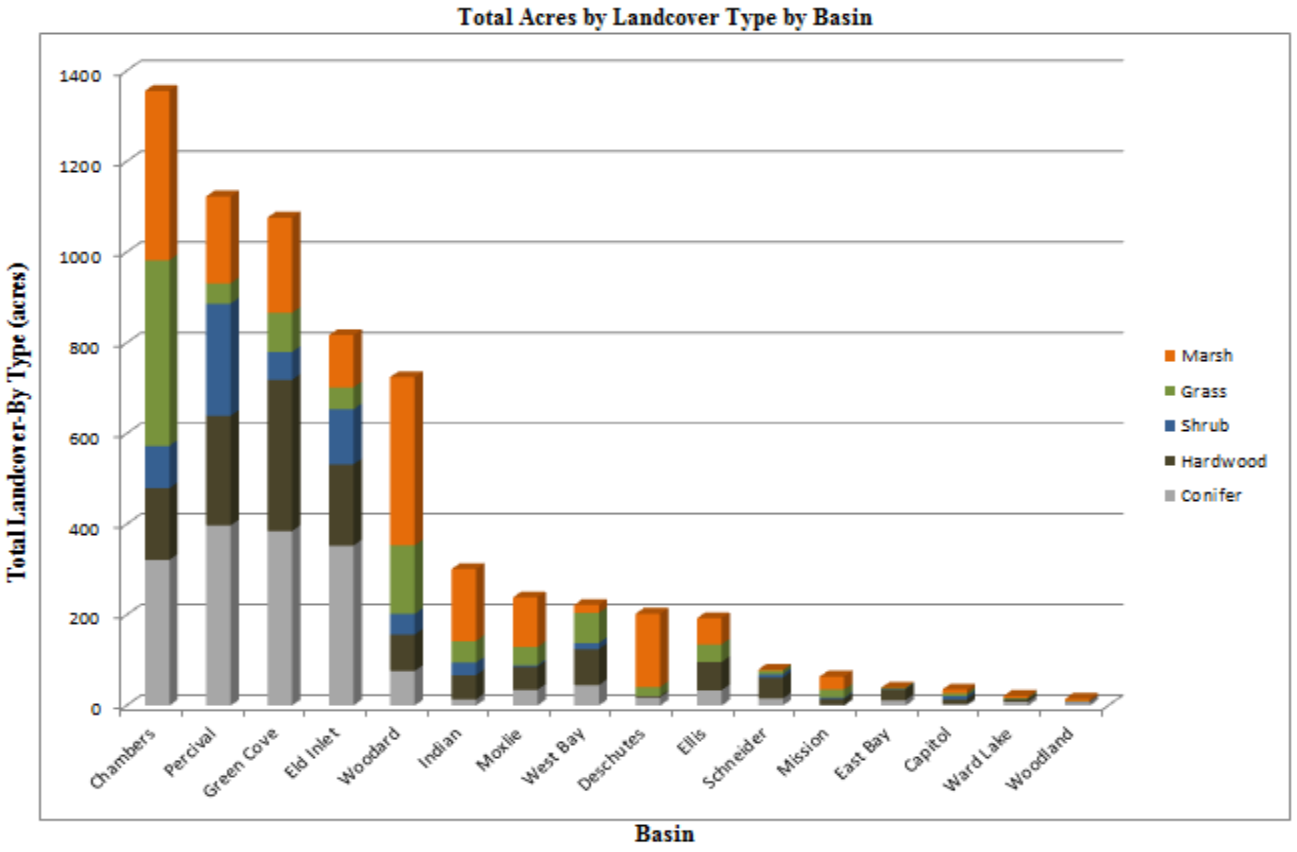


Figure 4.2.3: The table/graph above shows the quantity of remaining habitat by basin and landcover .

4.2.4 Remaining Habitat by Basin and Rank

Total Habitat by Category by Basin (acres)

Rank	I	II	III	IV	Total
Green Cove	911	119	25	50	1104
Percival	774	140	31	32	977
Eld Inlet	499	173	47	52	771
Chambers	448	248	71	385	1152
Woodard	296	100	100	146	642
Indian	178	0	90	46	314
Moxlie	106	40	45	47	239
West Bay	95	15	41	35	187
Ellis	73	49	3	51	176
East Bay	16	0	22	1	39
Mission	7	42	6	9	64
Schneider	7	42	21	9	79
Capitol	0	28	1	3	31
Deschutes	0	97	31	9	137
LOTT	0	0	0	4	4
Ward Lake	0	5	5	12	22
Woodland	0	5	10	0	15

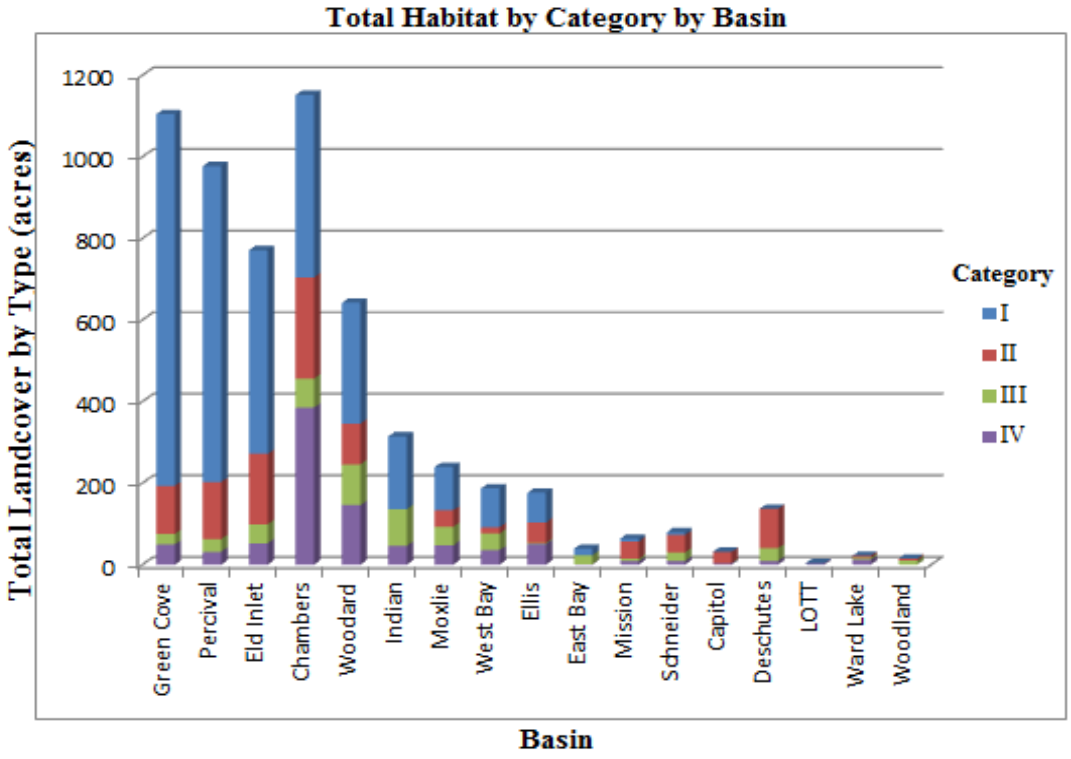


Figure 4.2.4: The table/graph above shows the quantity of remaining habitat by basin and rank.

4.2.5 Basin Evaluation Criteria

The basins were evaluated on several criteria. 1. Rank, which is the total acres of the highest quality habitat. 2. Landcover which is the total acres of habitat by land cover type., and; 3. Management category, which is the basin management category as designated in the 1999 Aquatic Habitat Study. The table below shows the relative values (1 being highest value), of the three criteria considered in prioritizing the basins.

This process was not designed to give a specific weighted value, but rather provide a side-by-side comparison of three different methods of evaluating the relative habitat values in each basin. As such, it does show some variability in how the basins were prioritized.

Basin Ranking Matrix

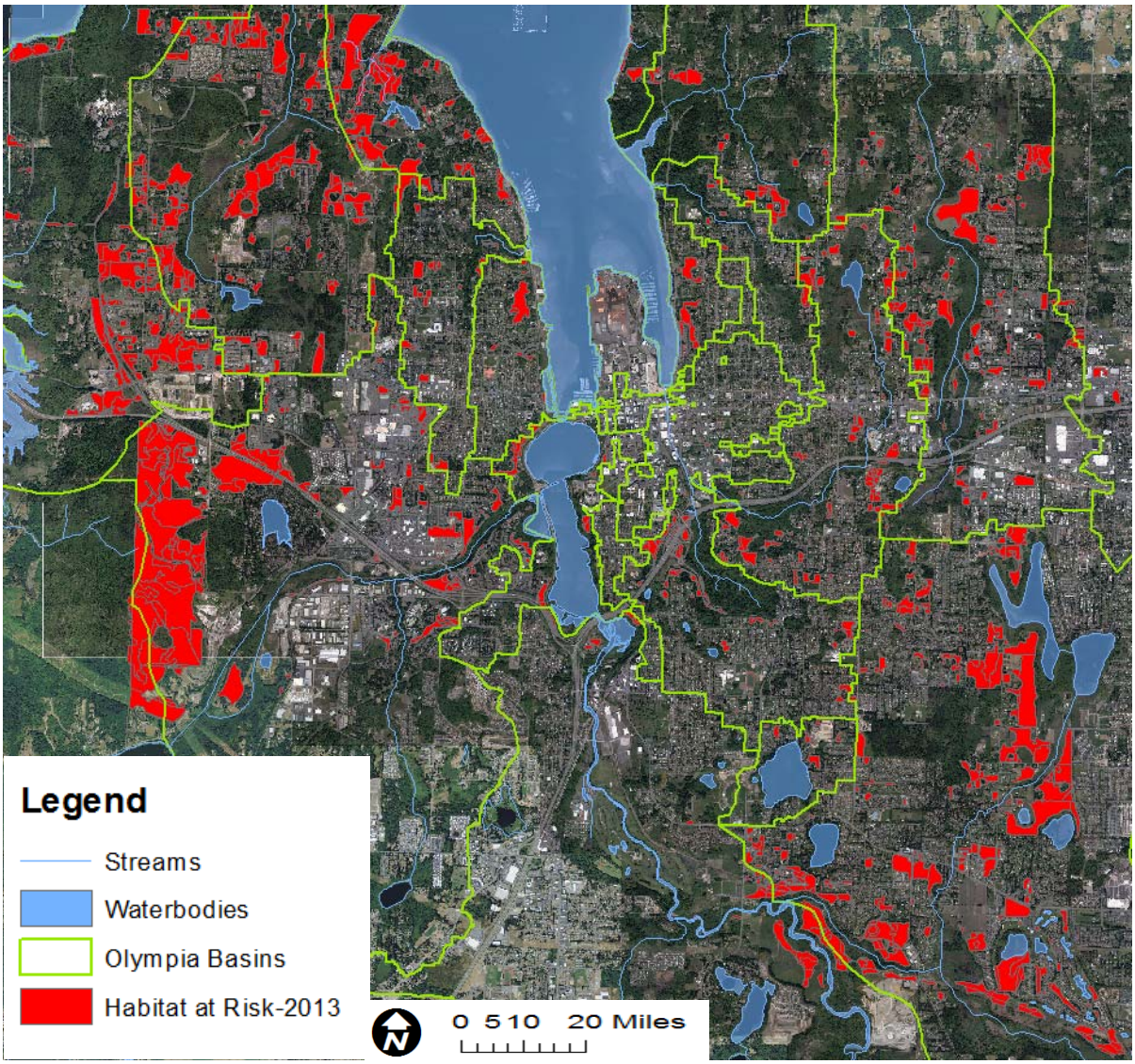
Basin	Acres by Rank	Acres by Landcover	Management Category
Green Cove	1	3	1 (Sensitive)
Percival	2	2	2 (Impacted)
Chambers	3	1	3 (Degraded)
Eld Inlet	4	4	N/A
Woodard	5	5	2 (Impacted)
Indian	6	6	3 (Degraded)
Moxlie	7	7	3 (Degraded)
Ellis	8	10	1 (Sensitive)
West Bay	9	8	N/A
Deschutes	10	9	N/A
Mission	11	12	3 (Degraded)
Schneider	12	11	3 (Degraded)
Capitol	13	14	N/A
East Bay	14	13	N/A
Woodland	15	16	N/A
Ward Lake	16	15	N/A
LOTT	17	17	N/A

Figure 4.2.5

4.2.6 Habitat at Risk (Protection Priorities)

In the urban environment, human impacts to landcover—such as development—pose the greatest threat to habitat. In the next step of our analysis, we identified and quantified those properties at greatest risk of being lost to development. Based on our coarse scale analysis, we concluded that habitat protected by the Critical Areas Ordinance (i.e., wetlands and streams) has a relatively low risk of being lost to development. Based on this assumption we subtracted wetlands, streams and their associated buffers from the remaining habitat, along with any property already in government ownership. The resultant figures 4.2.6 through 4.2.8 identify and quantify the remaining habitat by rank and basin that is at the greatest risk of being lost to development. This provides the foundation for developing and prioritizing appropriate protection strategies, which includes outright purchase, conservation easements, incentives and regulations.

Figure 4.2.6



2013 Habitat Acres (At Risk) By Basin and Rank

	Category 1	Category 2	Category 3	Category 4	Total
Percival	554	36	22	12	623
Green Cove	259	34	3	16	312
West Bay	72	15	29	26	141
Chambers	61	160	50	205	476
Woodard	53	12	57	76	197
Eld Inlet	44	79	41	48	213
Indian	32	8	22	27	89
Ellis	22	13	3	10	48
Schneider	9	2	21	2	34
Mission	4	4	0	1	9
Moxlie	3	11	16	10	40
East Bay	1	0	21	0	22
Deschutes	0	51	5	4	60
Capitol	0	18	3	0	21
Ward Lake	0	3	0	5	8
Woodland	0	0	7	0	7
LOTT	0	0	0	0	0
Total:	**1112**	**447**	**299**	**432**	

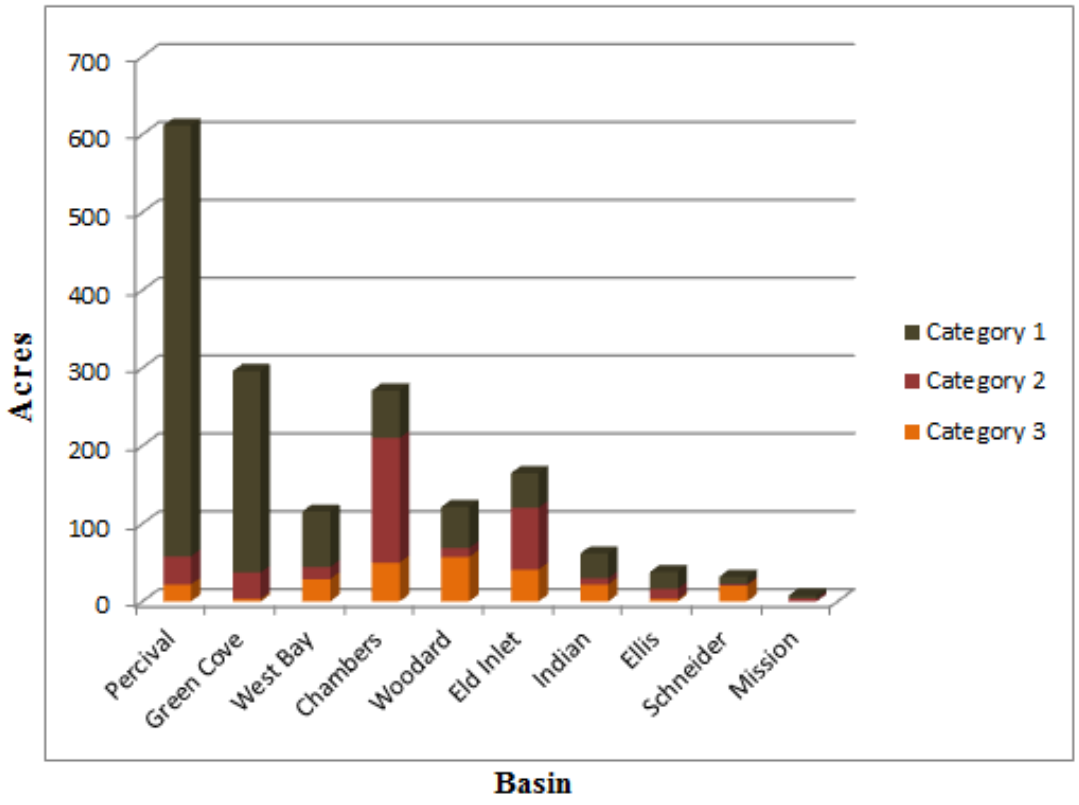


Figure 4.2.7

2013 Habitat Acres (At Risk) By Basin and Land Cover

	Conifer	Hardwood	Shrubs	Grass	Marsh	Total
Percival	331	131	157	14	3	636
Chambers	151	98	62	216	13	541
Green Cove	144	102	34	29	3	312
Eld Inlet	79	48	68	31	0	227
Woodard	50	45	24	72	8	199
West Bay	49	81	8	45	0	182
Indian	8	38	12	27	5	91
Deschutes	29	1	2	7	23	63
Ellis	10	26	0	12	0	48
Moxlie	13	14	2	11	3	42
Schneider	19	11	2	1	0	34
Capitol	5	14	1	0	1	23
East Bay	1	19	1	1	0	22
Mission	4	4	1	1	0	9
Ward Lake	5	1	0	2	0	8
Woodland	6	0	1	0	0	7
LOTT	0	0	0	0	0	0
Total:	**905**	**635**	**376**	**470**	**59**	

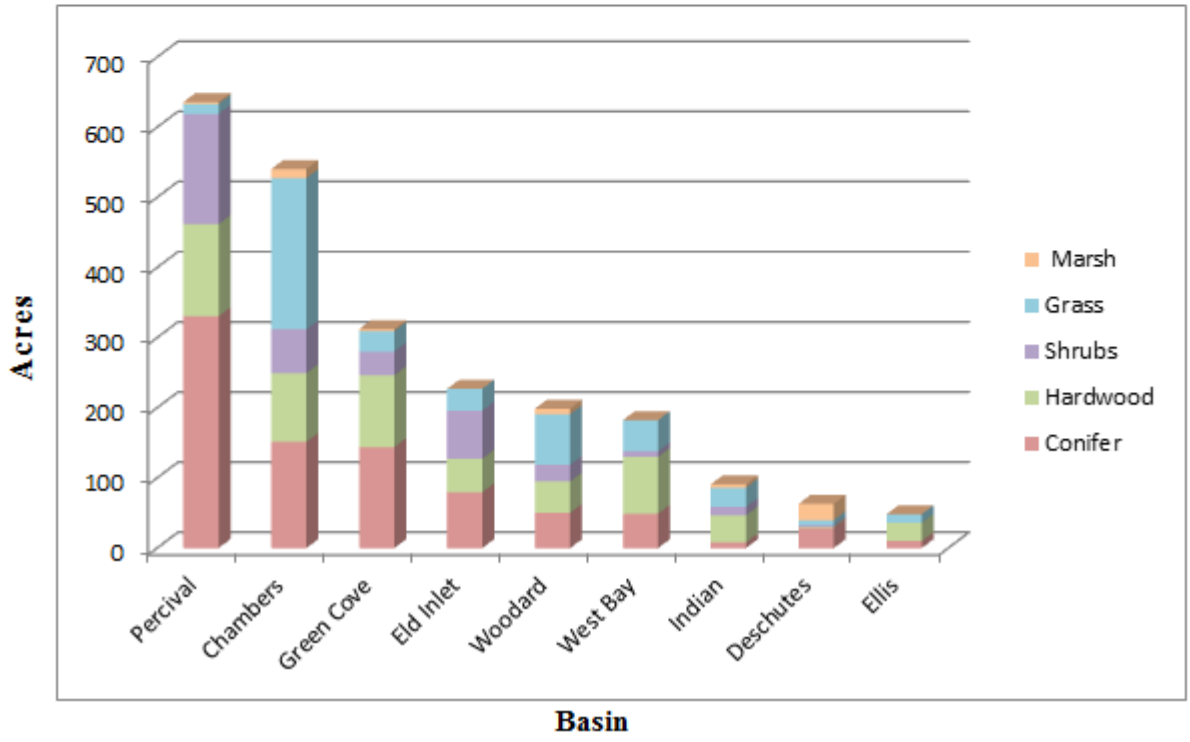


Figure 4.2.8

4.3 Stewardship

Stewardship, as we are defining it, is an umbrella term representing all aspects of land protection and enhancement (see Figure 4.3.1). There are a suite of tools that we propose to use to implement stewardship across the landscape. For critical habitat at risk of being lost to development it would include land protection such as outright purchase, conservation easements, incentives for voluntary protection and regulations. For properties already protected from development, we would propose habitat enhancement in order to optimize the habitat potential and ensure long term protection from invasive plants, illegal dumping, and other urban encroachments.

Habitat enhancement should begin with the stewardship planning process, in which staff would develop a comprehensive stewardship plan that identifies the specific habitat enhancement needs on an individual property scale. Enhancements will include such things as tree/shrub planting to improve forest structure and stream shading, invasive plant management, snag and coarse woody debris recruitment as well as ongoing maintenance and monitoring. A detailed stewardship plan for an undeveloped City owned property at Central and Marion (Appendix C) is attached as an example.

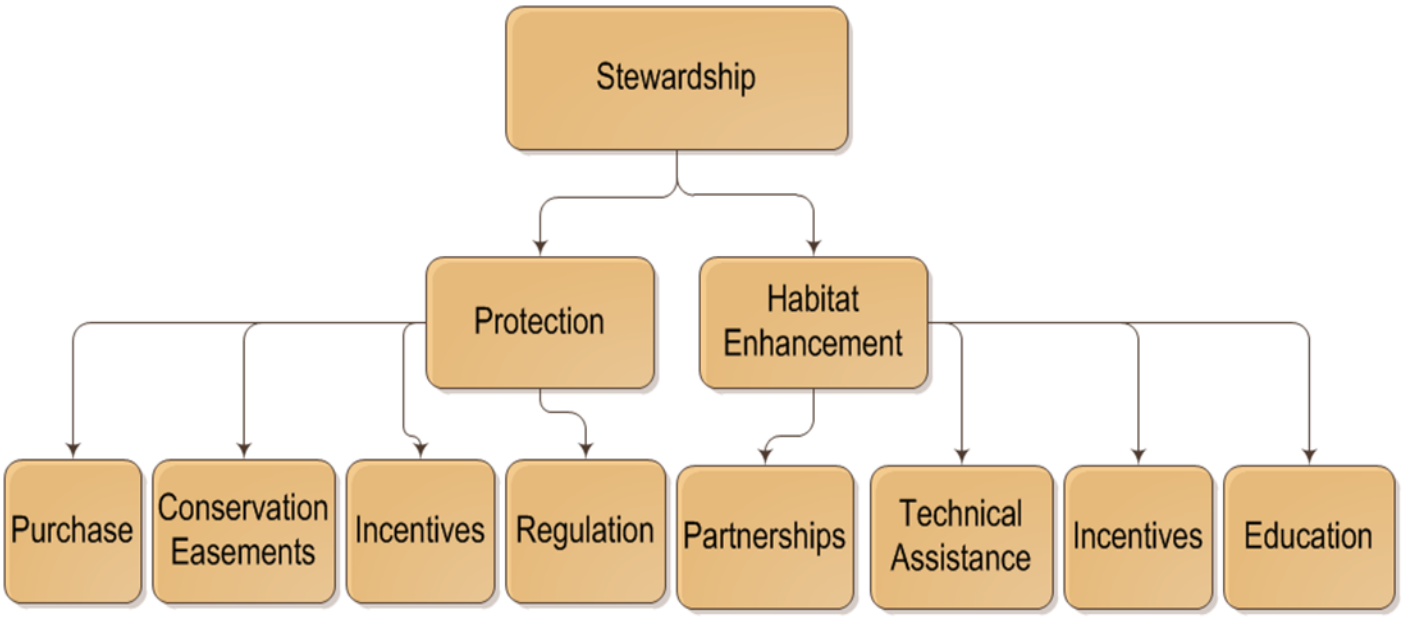


Figure 4.3.1

4.3.2 Stewardship Strategies

The analysis up to this point has: identified and quantified the remaining wildlife habitat within our study area, classified it by land cover type, assessed the risk of it being lost to development, identified associated land use, and evaluated its relative habitat value within and between basins. Following are specific enhancement strategies proposed to achieve stewardship goals (protection and enhancement) for specific land use classifications:

Land Use Class	Size Class (acres)	Description	Enhancement Strategies
Residential	< 2	2061 properties - 980 acres	For smaller residential properties we would primarily encourage voluntary stewardship similar to the backyard wildlife program developed by WDFW. Larger properties would be considered similar to undeveloped properties. If coincident with our acquisition priorities, they would be candidates for protection (purchase, conservation easements, etc.) as well as voluntary stewardship with incentives.
	2-5	302 properties - 808 acres	
	5-10	98 properties - 516 acres	
	10-50	30 properties - 333 acres	
	> 50	1 property - 60 acres	
Agriculture	< 2	1 properties - 2 acres	Depending on the intensity of the agricultural use of the property, some properties in this land use designation may be candidates for protection (purchase, conservation easements, etc.) and/or voluntary stewardship with incentives.
	2-5	3 properties -10 acres	
	5-10	3 properties - 28 acres	
	10-50	22 properties - 337 acres	
	> 50	6 properties - 437 acres	
Land	< 2	1196 properties – 556 acres	Most land in this classification is undeveloped. The smaller properties (< 2 acres) are undeveloped residential lots in developing subdivisions. Larger properties in this classification that is also coincident with our land acquisition priorities would be considered a candidate for protection (purchase, conservation easements, etc.) and/or voluntary stewardship with incentives.
	2-5	139 properties – 436 acres	
	5-10	65 properties – 437 acres	
	10-50	45 properties – 893 acres	
	> 50	5 properties – 380 acres	
Exempt	< 2	80 properties - 62 acres	The majority of the land in this classification is owned by the Government or churches. Depending on the location and the intended land use, many of these properties would be considered ideal enhancement partnership opportunities.
	2-5	41 properties -133 acres	
	5-10	23 properties - 160 acres	
	10-50	30 properties - 650 acres	
	> 50	8 properties - 1027 acres	
Recreation	< 2	105 properties – 67 acres	Most of the properties in this classification are City Parks and/ or Homeowner association open space tracts. Depending on the location and the intended land use, many of these properties would be considered ideal enhancement partnership opportunities.
	2-5	18 properties – 50 acres	
	5-10	7 properties – 45 acres	
	10-50	2 properties – 52 acres	
	> 50	1 property – 173 acres	
Golf	> 50	3 properties – 363 acres	Golf courses within our study area would be encouraged to improve their properties for wildlife. The United State Golf Assoc. has guidance available. https://www.usga.org/Content.aspx?id=26127

Figure 4.3.2

4.3.3 Stewardship Tools

Following is a full suite of stewardship tools that have been developed to address specific opportunities and limitations associated with land stewardship.

Protection

For our purposes habitat protection includes a suite of tools including: Acquisition (outright purchase, conservation easements, purchase of development rights, transfer of development rights, etc.).

Technical assistance

Primarily stewardship planning, where we would help identify the best way to optimize the wildlife habitat on an individual property and then develop a stewardship plan to help achieve those goals.

Incentives

We would provide incentives in the form of plants, tools, labor, etc. to assist in implementing stewardship activities identified in the stewardship plan.

Partnerships

We would pursue both formal and informal partnerships with other public agencies, HOA's, the Capital Land Trust, etc. to assist these partners in stewardship planning and habitat enhancement of their properties.

Education

This would include program promotion, outreach, volunteer coordination and monitoring. For smaller residential properties we will promote the optimization of habitat through programs like the Washington Department of Fish and Wildlife's backyard wildlife program. We will also coordinate significant volunteer participation, not only in active implementation of habitat enhancement (i.e., invasive removal, tree planting, etc.) but also in comprehensive monitoring of properties under stewardship, effectiveness of specific enhancement activities and specific wildlife species of interest.

4.3.4 Recommended Stewardship Strategies and Tools by Basin

The tables, maps and protection strategies that follow describes the specific opportunities, limitations and enhancement strategies that have been identified for each basin. The basins are listed in descending order of priority.

Green Cove Basin

Protection:

Green Cove Basin contains the largest quantity of the highest quality habitat remaining in our study area. It has consistently been identified as one of the highest quality basins in numerous previous studies, which eventually led to the downzoning of most of the basin to "RLI" residential low impact. RLI zoning requires 60% of a developing site to be retained in a forested condition. This coupled with the critical areas ordinance provides significant protection. Even with these protection measures there are specific high quality habitats that have been identified as candidates for acquisition because they are at risk of being developed.

Partnerships:

The greatest opportunities to improve habitat conditions in the Green Cove basin would be accomplished through partnerships with The Evergreen State College, the City of Olympia Parks Department, the Capital Land Trust, LOTT Clean Water alliance, and numerous homeowner's associations.

Technical Assistance/Education & Incentives:

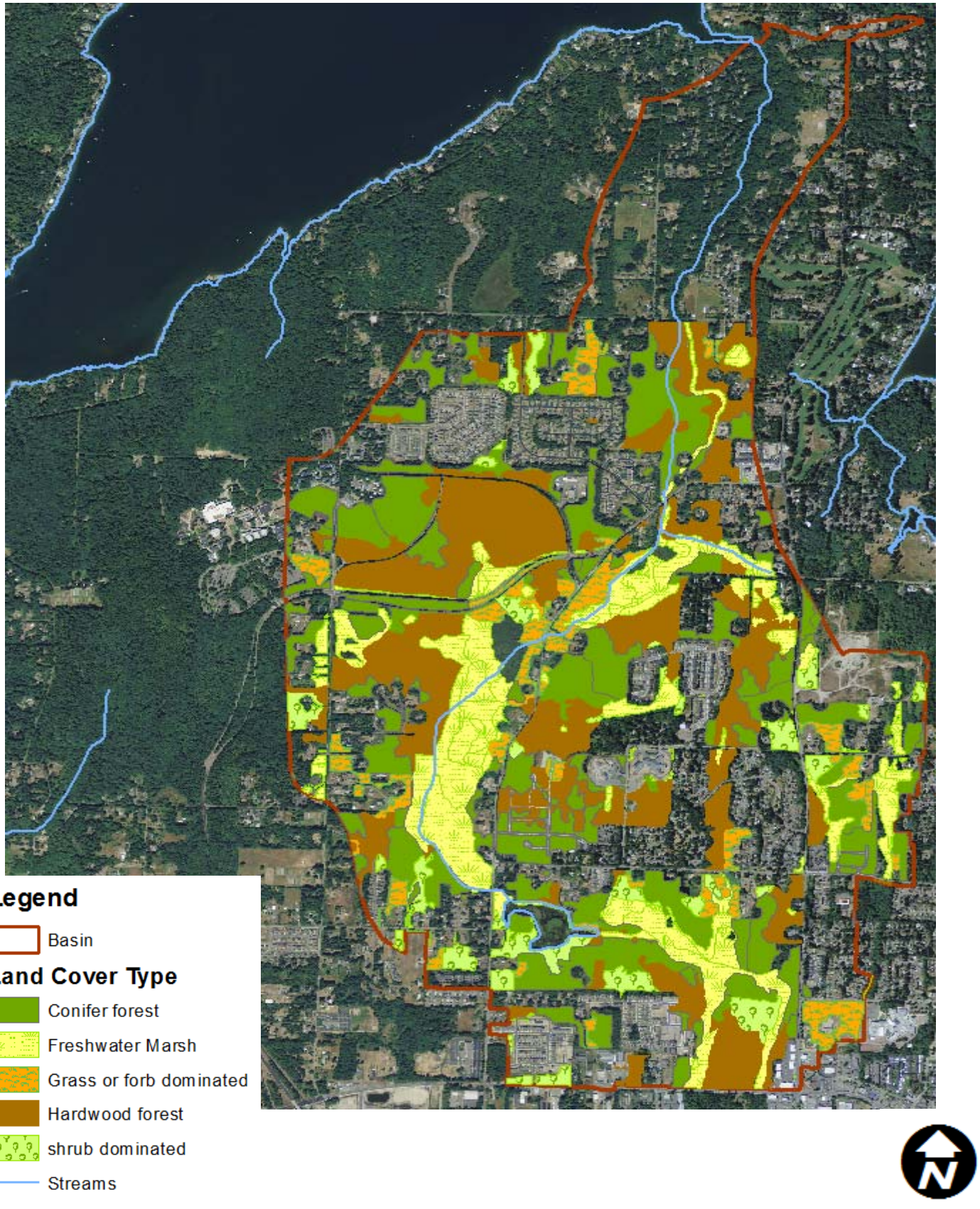
There are several hundred acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties that are protected from further development by the critical areas ordinance. There are hundreds of smaller properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

Green Cove Basin: Stewardship Strategies

Green Cove Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres to Protect	Potential Acres to Enhance
TESC	Partnering	1		235
City of Olympia	Technical Assistance	1		245
School District	Incentives	1		45
Lott Alliance	Education	1		15
Capital Land Trust		1		40
Cooper Crest HOA		1		23
Goldcreat HOA		1		25
Cyrene HOA		1		17
Evergreen Hills HOA		1		21
Cedrona HOA		1		19
Madera HOA		1		5
Green Creek Estates HOA		1		1
Grass Lake Village HOA		1		9
Bayhill HOA		1		5
	Total:	**14**		**704**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	223		110
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	32		133
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	25		181
10-50 acre residential	priorities)	4		69
	Total:	**284**		**493**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	300		25
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	12		37
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	5		25
10-50 acres undeveloped (LND)	priorities)	5		90
	Total:	**322**		**177**
Agriculture				
properties (1-37 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	10		142
	Total:	**10**		**142**
Aquistion Priority				
Category 1			259	259
Category 2			34	34
Category 3			22	22
Category 4			12	12
	Total:		**327**	**327**

Green Cove Creek Basin



Percival Creek Basin

Protection:

The Percival Basin includes the entire Percival Creek and Black Lake Ditch drainage area. There are several large tracts of privately owned forest land, south of Highway #101 and west of Ken Lake, that were identified in this analysis as an acquisition priority. These properties will be considered candidates for protection through acquisition. The City owns several tracts of land adjacent to Percival Creek from the Highway 101 bridge to Capital Lake. Our analysis identified several other properties at risk of being developed in this same area that could be valuable additions to this important corridor and will be considered candidates for acquisition.

Partnerships:

Stewardship planning and habitat enhancement for Storm and Surface Water Utility managed property along Percival Creek will be a priority.

Technical Assistance/Education & Incentives:

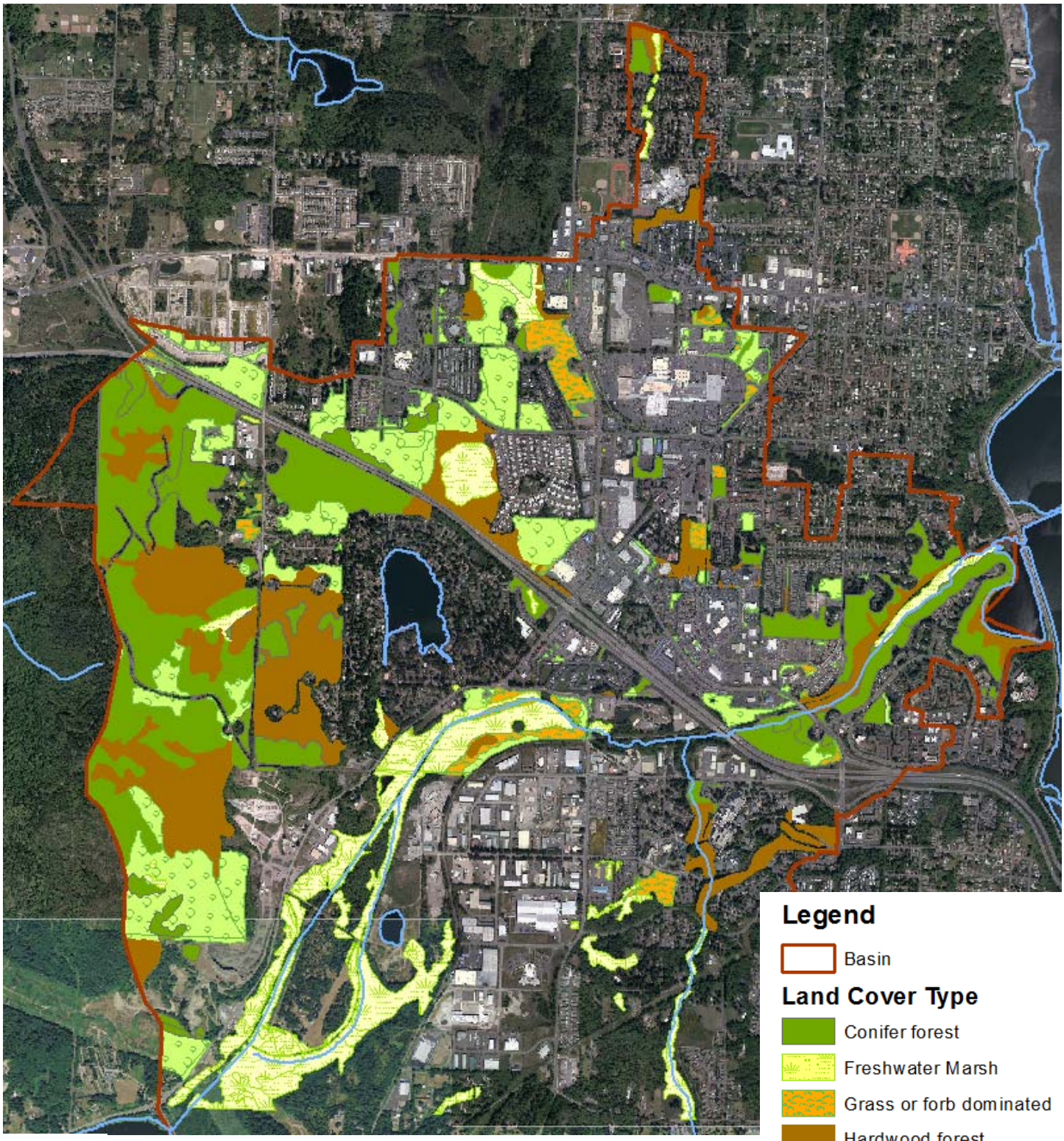
For smaller residential properties we would encourage voluntary stewardship.

Percival Creek Basin: Stewardship Strategies

Percival Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
Wellington West HOA	Partnering	1		3
City of Olympia	Technical Assistance	1		11
Walnut Park HOA	Incentives	1		2
Percival Hts HOA	Education	1		5
	Total:	**4**		**21**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	138		24
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	15		70
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	1		10
10-50 acre residential	priorities)	1		11
	Total:	**155**		**115**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	74		25
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	26		69
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	11		73
10-50 acres undeveloped (LND)	priorities)	5		101
	Total:	**116**		**268**
Agriculture				384
properties (22- 120 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	6		
	Total:	**6**		**384**
Aquistion Priority				
Category 1			554	554
Category 2			36	36
Category 3			22	22
Category 4			12	12
	Total:		**624**	**624**

Percival Creek Basin



Chambers Creek Basin

Protection:

There is approximately 450 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition.

Partnerships:

The City of Olympia, Thurston County, the Olympia School District and 27 different homeowner's associations all have property that includes habitat in this basin collectively equaling almost 250 acres. Formal and informal partnerships will be pursued with these landowners to assist with stewardship planning and habitat enhancement.

Technical Assistance/Education & Incentives:

There is at least 500 acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties that are protected from further development by the critical areas ordinance. On these properties we would encourage enhancement of habitat on by providing technical assistance, education and incentives.

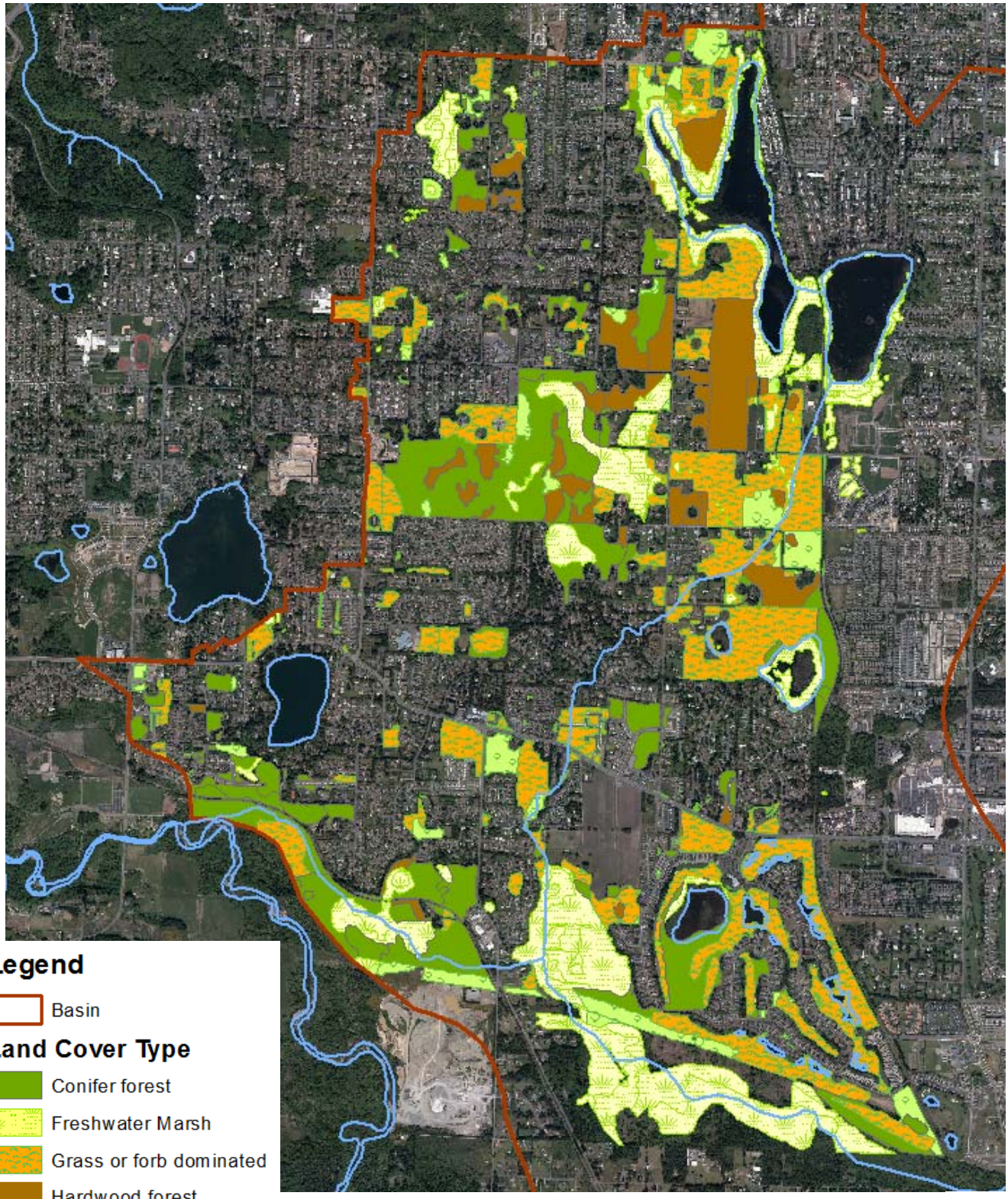
There are 600-700 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Chambers Creek Basin: Stewardship Strategies

Chambers Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
City of Olympia	Partnering	1		48
Thurston Cty	Technical Assistance	1		8
Olympia School District	Incentives	1		15
HOA's	Education	27		176
	Total:	**30**	**0**	**247**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	627		208
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	27		103
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	8		62
10-50 acre residential	priorities)	4		65
50 + acres residential		1		60
	Total:	**667**		**498**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	158		48
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	18		49
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	8		56
10-50 acres undeveloped (LND)	priorities)	12		264
50+ acres undeveloped (LND)		4		301
	Total:	**200**		**718**
Agriculture				
properties (1-46 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	14		176
	Total:	**14**		**176**
Aquistion Priority				
Category 1			61	61
Category 2			160	160
Category 3			50	50
Category 4			205	205
	Total:		**476**	**476**

Chambers Creek Basin



Eld Inlet Basin

Protection:

There is approximately 200 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition.

Partnerships:

The Eld Inlet Basin includes almost 750 acres of high quality habitat in public ownership. The greatest opportunities to improve wildlife conditions in the Eld Inlet basin would be accomplished through partnerships with The Evergreen State College and the Olympia School District, and by doing habitat enhancements on the City owned Allison Springs property.

Technical Assistance/Education & Incentives:

There is approximately 100 acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties that are protected from further development by the critical areas ordinance. On these properties we would encourage enhancement of habitat by providing Technical Assistance, Education and Incentives.

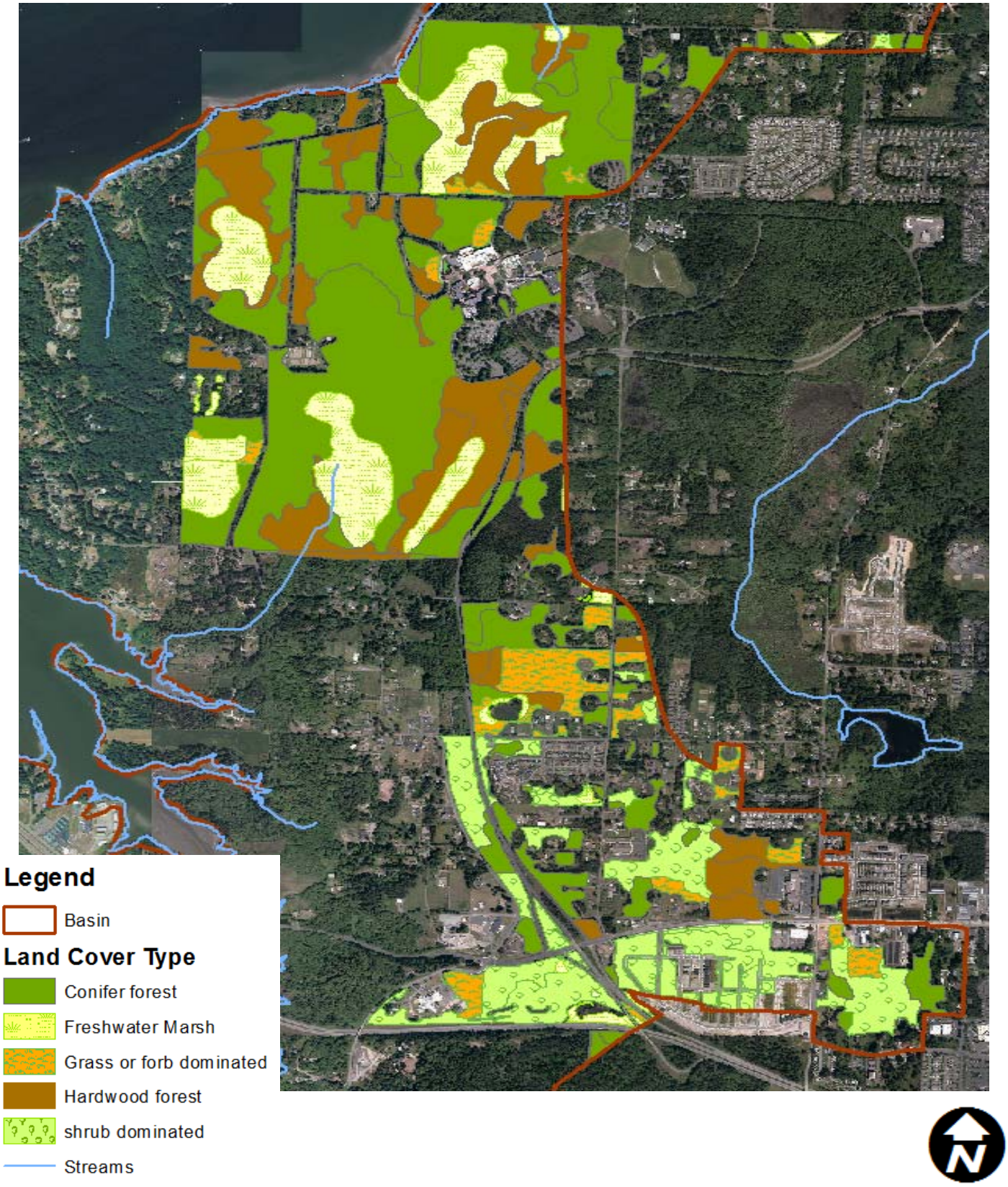
There are 86 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Eld Inlet Basin: Stewardship Strategies

Eld Inlet Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
TESC	Partnering	1		688
Westwood Baptist Church	Technical Assistance	1		23
City of Olympia (Allison Springs)	Incentives	1		37
	Education			
	Total:	**3**		**748**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	81		86
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	16		58
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	3		22
10-50 acre residential	priorities)	0		0
50 + acres residential		0		0
	Total:	**100**		**166**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	49		17
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	11		30
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	5		29
10-50 acres undeveloped (LND)	priorities)	2		36
50+ acres undeveloped (LND)		0		0
	Total:	**67**		**112**
Agriculture				
properties (10 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	2		20
	Total:	**2**		**20**
Aquistion Priority				
Category 1			44	44
Category 2			79	79
Category 3			41	41
Category 4			48	48
	Total:		**212**	**212**

Eld Inlet Basin



Woodard Creek Basin

The Storm and Surface Water Utility owned and managed 65-acre Taylor wetland is at the headwaters of Woodard Creek.. Most of the remaining habitat in this basin is protected by the Critical Area Ordinance. For these properties we would propose to provide technical assistance in stewardship planning and incentives to property owners to encourage voluntary stewardship. Properties identified as acquisition priorities would be considered candidates for acquisition.

Protection:

There is approximately 198 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition.

Partnerships:

The Woodard Basin includes the 65 acres Taylor wetland property. The Storm and Surface Water Utility manages this property. Developing a stewardship plan for this property and implementing habitat enhancement will be a priority as soon as the culvert that runs under the woodland trail is repaired and the water level can be stabilized.

Technical Assistance/Education & Incentives:

There several hundred acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties that are protected from further development by the critical areas ordinance. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

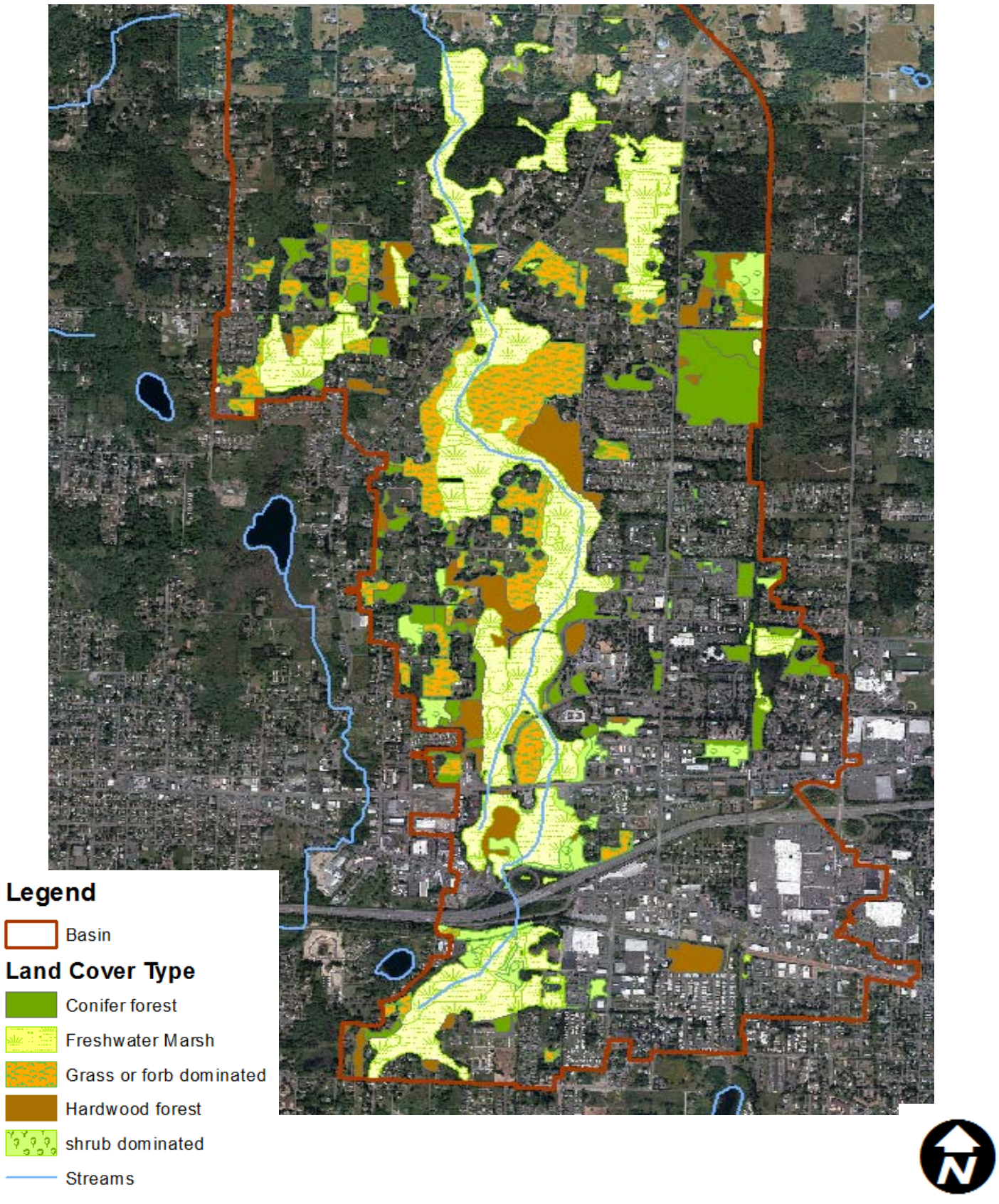
There are approximately 100 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Woodard Creek Basin: Stewardship Strategies

Woodard Basin-Stewardship Strategy

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
City of Olympia	Partnering	1		65
Peace Lutheran Church	Technical Assistance	1		5
	Incentives			
	Education			
	Total:	**2**		**70**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	193		119
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	34		146
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	5		40
10-50 acre residential	priorities)	3		42
50 + acres residential		0		0
	Total:	**235**		**347**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	64		36
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	22		56
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	7		44
10-50 acres undeveloped (LND)	priorities)	4		111
50+ acres undeveloped (LND)		0		0
	Total:	**97**		**247**
Agriculture				
properties (2-75 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	2		77
	Total:	**2**		**77**
Aquistion Priority				
Category 1			53	53
Category 2			12	12
Category 3			57	57
Category 4			76	76
	Total:		**198**	**198**

Woodard Creek Basin



Indian Creek Basin

Indian Creek extends from its headwaters at Bigelow Lake to its confluence with Moxlie creek at Plum street near the Interstate 5 interchange.

Protection:

There is approximately 89 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition.

Partnerships:

The Indian Creek Basin includes the 8 acre Indian Creek Stormwater Facility off of Wheeler Street that is managed by the Storm and Surface Water Utility. Development of a stewardship plan and habitat enhancements for the Indian Creek Stormwater Facility will be a priority. A portion of the City's Woodland Trail runs along a stretch of Indian Creek in the same vicinity. We will pursue a partnership with the Parks, Arts and Recreation Department to assist in stewardship planning and habitat enhancement.

Technical Assistance/Education & Incentives:

There several hundred acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties that are protected from further development by the critical areas ordinance. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

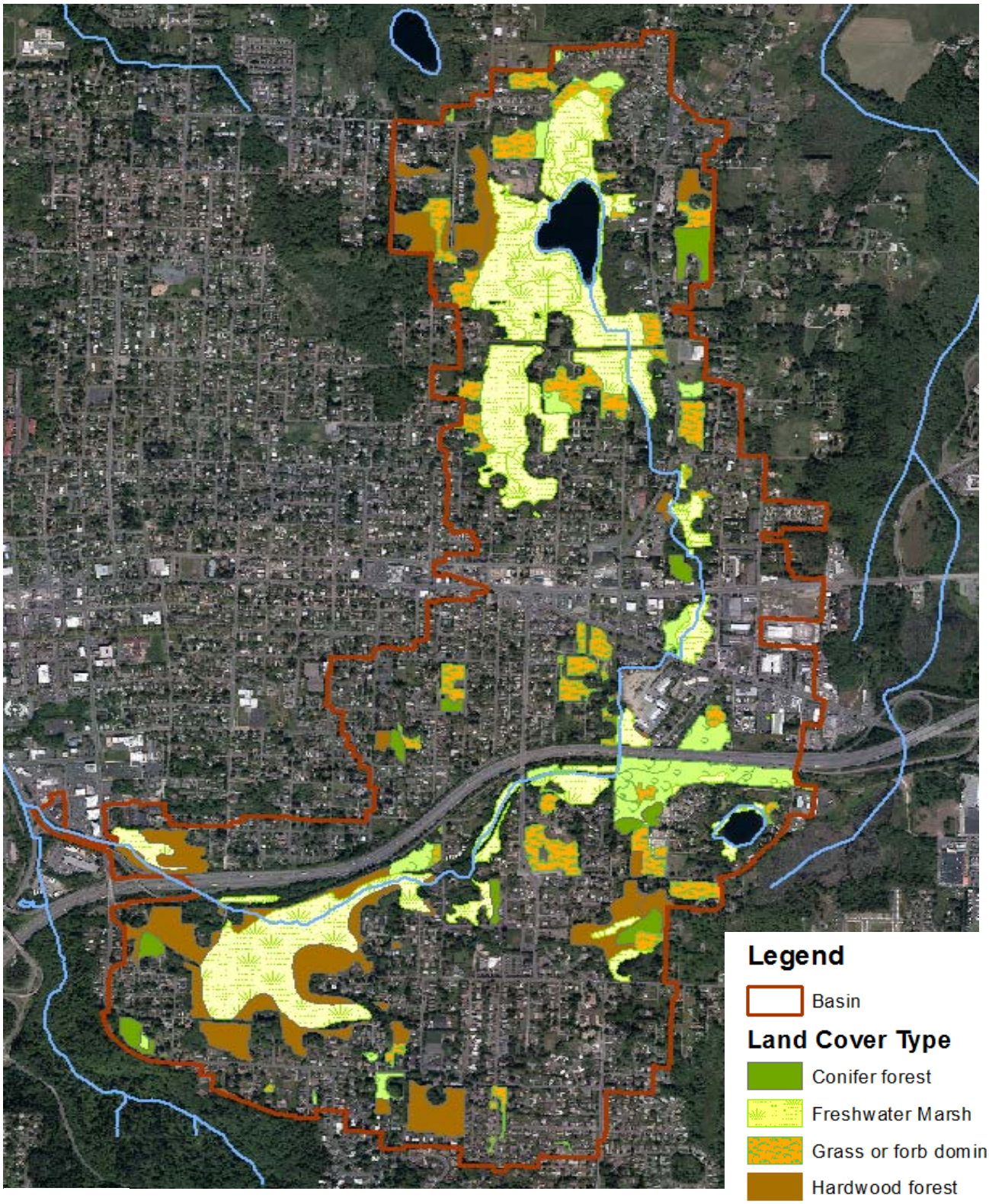
There are approximately 100 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Indian Creek Basin: Stewardship Strategies

Indian Creek Basin

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
Pentecostal Church of God	Partnering	1		2
Forest Cemetary Assoc.	Technical Assistance	1		8
Olympia School District	Incentives	1		9
City of Olympia	Education	1		8
	Total:	**4**		**27**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	67		35
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	21		83
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	2		16
10-50 acre residential	priorities)	1		17
50 + acres residential		0		0
	Total:	**91**		**151**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	216		65
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	24		65
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	3		20
10-50 acres undeveloped (LND)	priorities)	0		0
50+ acres undeveloped (LND)		0		0
	Total:	**243**		**150**
Agriculture				
properties (15 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	1		15
	Total:	**1**		**15**
Aquistion Priority				
Category 1			32	32
Category 2			8	8
Category 3			22	22
Category 4			27	27
	Total:		**89**	**89**

Indian Creek Basin



Moxlie Creek Basin

The City of Olympia owns several properties in this basin, including, Watershed Park, The Justice Center and the Maintenance Center. Watershed Park is a beautiful forested wetland that includes the headwaters of Moxlie Creek. Similar to other parks in other basins we would propose to offer our assistance in stewardship planning and habitat enhancement for this property. The Justice Center includes a wetland complex that the Storm and Surface Water Utility have been informally enhancing for a number of years.

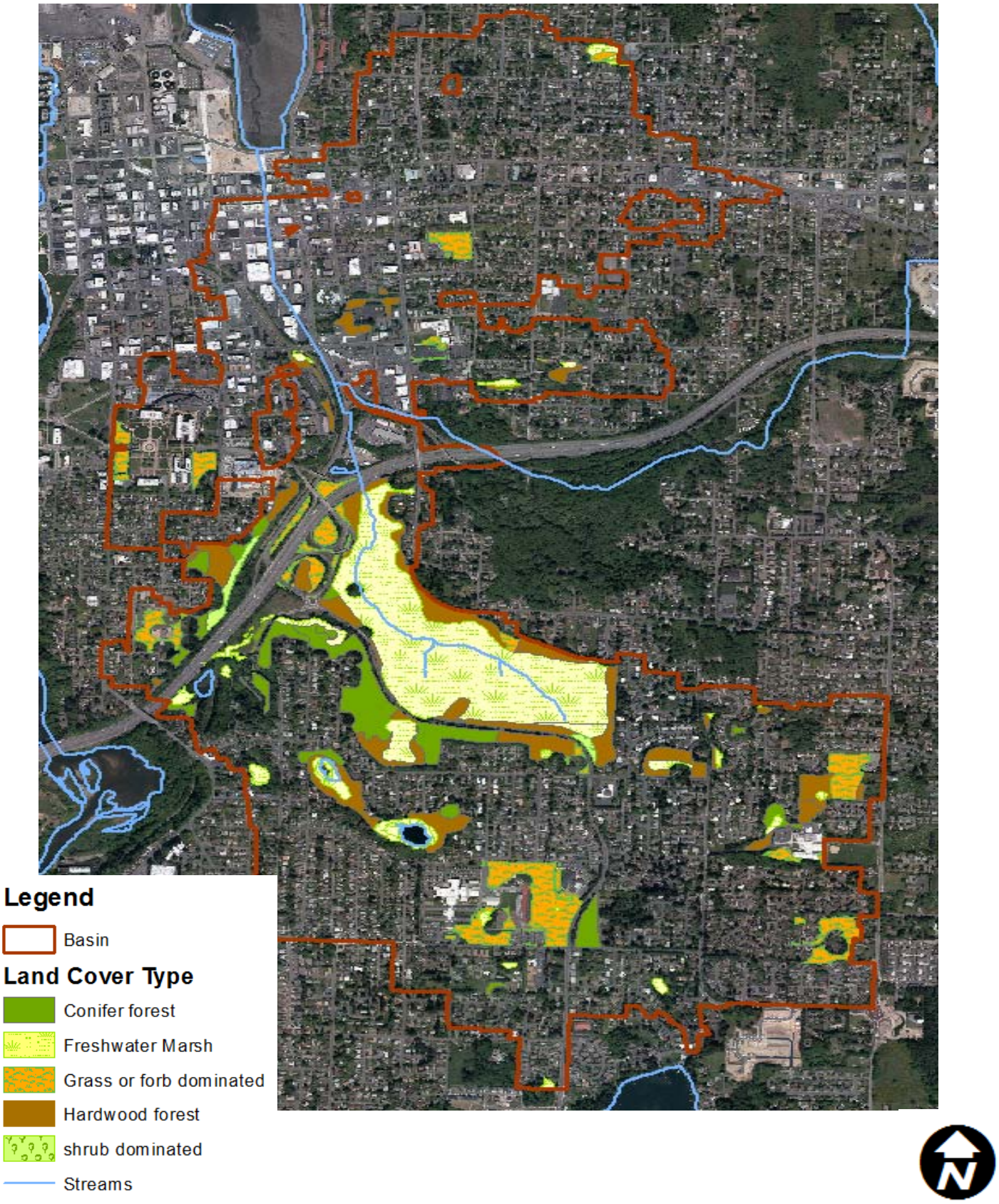
We would propose to formalize our enhancement by developing a stewardship plan for this property and continuing our habitat enhancement work. The City of Olympia Public Works Maintenance Facility is another candidate for stewardship within Moxlie Basin. There are limited stewardship opportunities in the remainder of the Moxlie Basin.

Moxlie Creek Basin: Stewardship Strategies

Moxlie Creek Basin

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
City of Olympia	Partnering Technical Assistance Incentives Education	2		200
	Total:	**2**		**200**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	178		42
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	2		8
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acre residential	priorities)	0		0
50 + acres residential		0		0
	Total:	**180**		**50**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	48		16
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	9		23
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acres undeveloped (LND)	priorities)	3		51
50+ acres undeveloped (LND)		1		79
	Total:	**61**		**169**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			3	3
Category 2			11	11
Category 3			16	16
Category 4			10	10
	Total:		**40**	**40**

Moxlie Creek Basin



Ellis Creek Basin

Although one of the smaller basins in Olympia, Ellis has some of the highest quality remaining habitat. Ellis creek has several branches, one of which starts at Setchfield Lake, travels north outside the City limits and then back down into Priest Point Park where it empties into Budd Inlet at Ellis Cove.

Protection:

There is approximately 47 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition.

Partnerships:

The Ellis Creek Basin includes almost 300 acres of Priest Point Park. Priest Point Park has very high quality habitat, but could benefit from invasive plant removal and subsequent under-planting of native plants to help manage the invasive weeds on the property. We would propose to partner with the Parks, Arts and Recreation Department by assisting with stewardship planning and habitat enhancement.

Technical Assistance/Education & Incentives:

There is less than a hundred acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties that are protected from further development by the critical areas ordinance. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

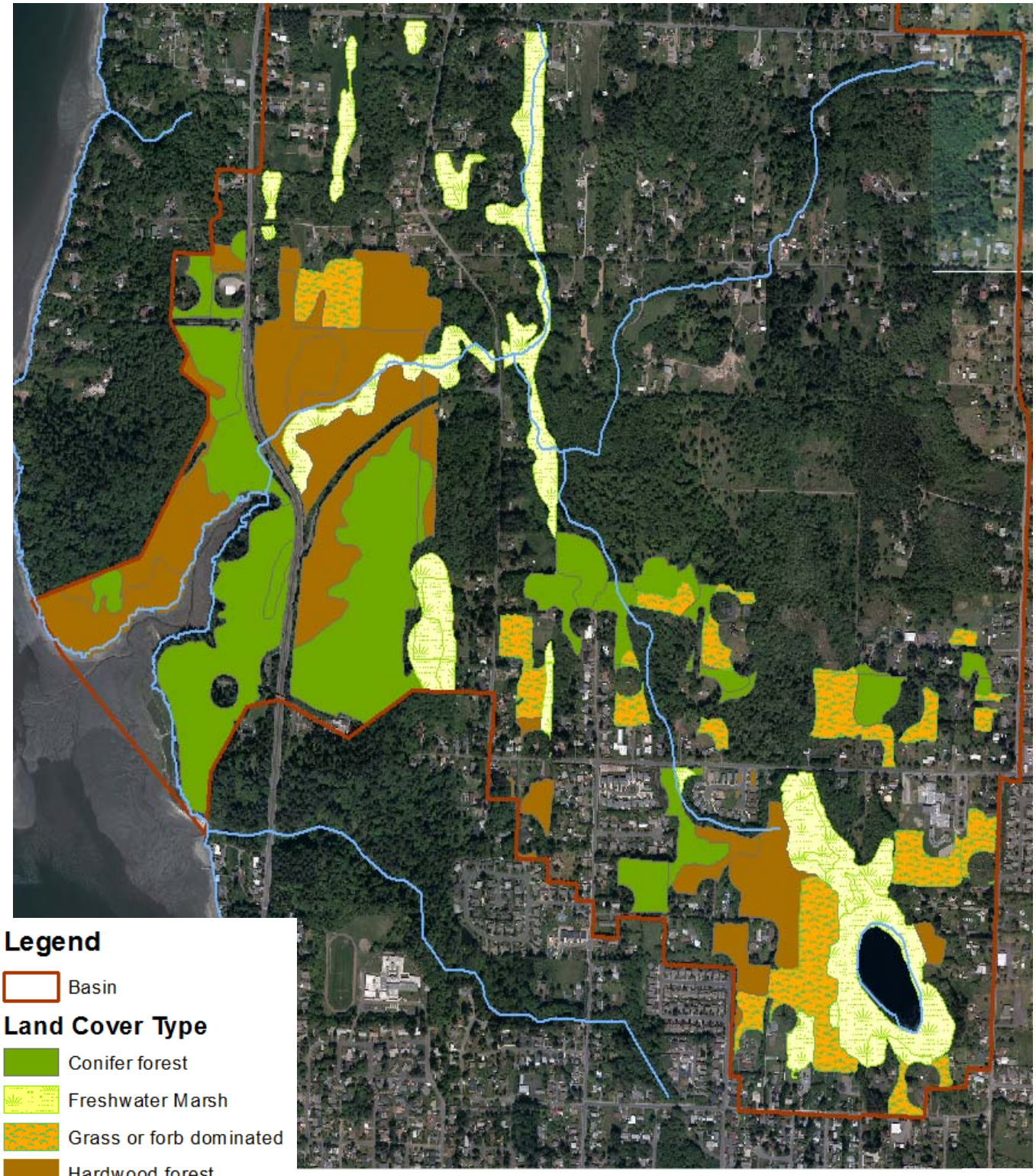
There are approximately 55 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Ellis Creek Basin: Stewardship Strategies

Ellis Creek Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
City of Olympia	Partnering	1		284
Olympia School District	Technical Assistance	2		14
S.S. Church of the Nazarene	Incentives	1		8
	Education			
	Total:	**4**		**306**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	55		42
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	15		58
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	3		19
10-50 acre residential	priorities)	1		17
50 + acres residential		0		0
	Total:	**74**		**136**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	11		8
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	5		14
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	1		6
10-50 acres undeveloped (LND)	priorities)	1		16
50+ acres undeveloped (LND)		0		0
	Total:	**18**		**44**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			22	22
Category 2			13	13
Category 3			3	2
Category 4			10	10
	Total:		**48**	**47**

Ellis Creek Basin



West Bay Basin

The West Bay Basin is split by the Schneider basin into 2 sub units. It includes Garfield Creek, as well as a number of non-descript drainages and stormwater outfalls into Budd Inlet.

Protection:

There is approximately 142 acres of privately owned habitat identified in this analysis at risk of being developed. Due to the method we used to identify properties at risk this includes the golf course at the Olympia Country Club. This property would not be considered a candidate for acquisition. We would however encourage the managers of this property to follow the wildlife habitat guidance developed by the United States Golf Association.

Partnerships:

The West Bay Basin includes limited opportunities for partnering with other public agencies. The Olympia School District has some habitat on its property at LP Brown School that would warrant assistance in stewardship planning and habitat enhancement.

Technical Assistance/Education & Incentives:

There is less than 100 acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties that are protected from further development by the critical areas ordinance. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

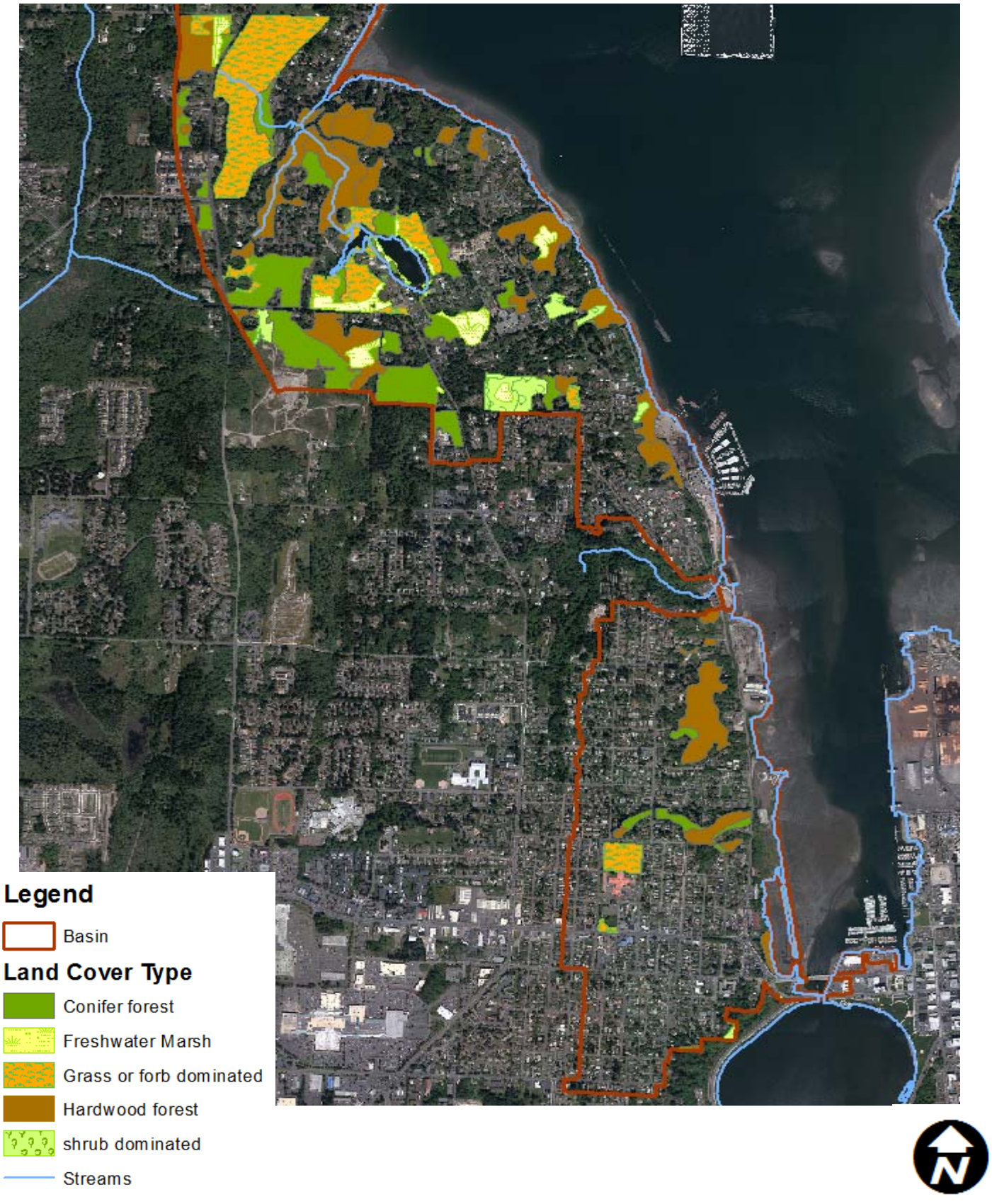
There are approximately 167 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

West Bay Basin: Stewardship Strategies

West Bay Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
City of Olympia	Partnering	2		7
Unitarian Universalist	Technical Assistance	1		2
Flood The Sound Fellowship	Incentives	1		2
Olympia School District	Education	2		15
Thurston County		1		3
	Total:	**7**		**29**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	167		99
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	15		55
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	1		9
10-50 acre residential	priorities)	1		11
50 + acres residential		0		0
	Total:	**184**		**174**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	83		39
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	14		34
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	4		28
10-50 acres undeveloped (LND)	priorities)	0		0
50+ acres undeveloped (LND)		0		0
	Total:	**101**		**101**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			72	72
Category 2			15	15
Category 3			29	29
Category 4			26	26
	Total:		**142**	**142**

West Bay Basin



Deschutes River Basin

The portion of the Deschutes Basin within our study area is limited in size and habitat.

Protection:

There is approximately 60 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition

Partnerships:

The Deschutes Basin includes limited opportunities for partnering with other public agencies.

Technical Assistance/Education & Incentives:

There is less than 50 acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

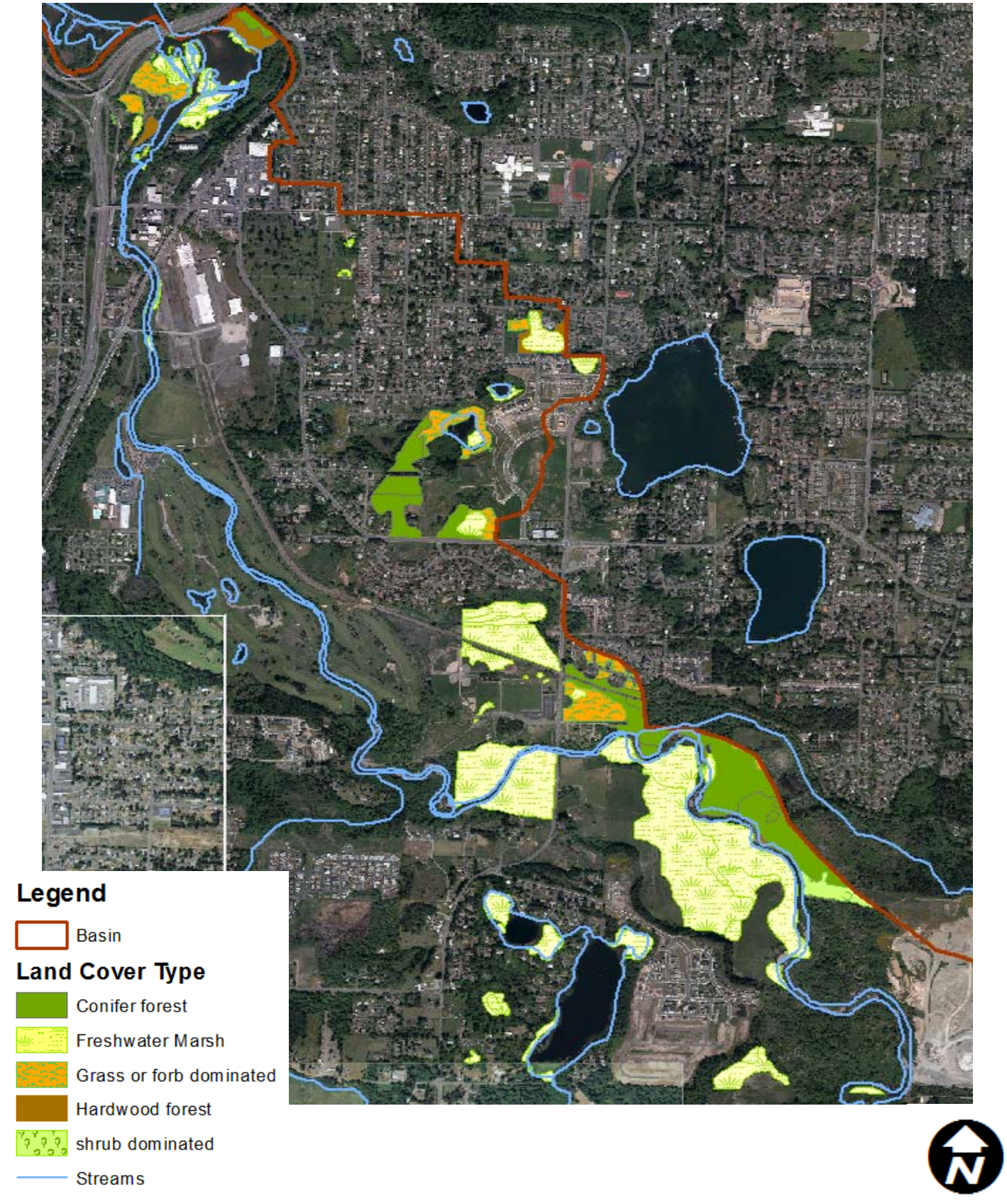
There are approximately 39 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Deschutes River Basin: Stewardship Strategies

Deschutes River Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
None	Partnering Technical Assistance Incentives Education	0		0
	Total:	**0**		**0**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	24		5
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	3		9
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acre residential	priorities)	0		0
50 + acres residential		0		0
	Total:	27		14
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	39		12
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	2		6
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	1		5
10-50 acres undeveloped (LND)	priorities)	0		0
50+ acres undeveloped (LND)		0		0
	Total:	42		23
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			0	0
Category 2			51	51
Category 3			5	5
Category 4			4	4
	Total:		**60**	**60**

Deschutes River Basin



Mission Creek Basin

Although the Mission Creek Basin is relatively small, it includes several publicly owned properties including the Mission Creek Park at the headwaters, running through Storm and Surface Water Utility managed property at Central and Marion, eventually emptying into Budd Inlet on the South side of Priest Point Park.

Protection:

There is approximately 9 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition

Partnerships:

The Mission Basin includes 3 different publicly owned properties. For the property at Central and Marion, the Storm and Surface Water Utility has developed a draft stewardship plan, which is attached to this report as an appendix. We would propose to partner with the Parks, Arts and Recreation Department by assisting with stewardship planning and habitat enhancements on both Priest Point Park and Mission Creek Park.

Technical Assistance/Education & Incentives:

There is less than 50 acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

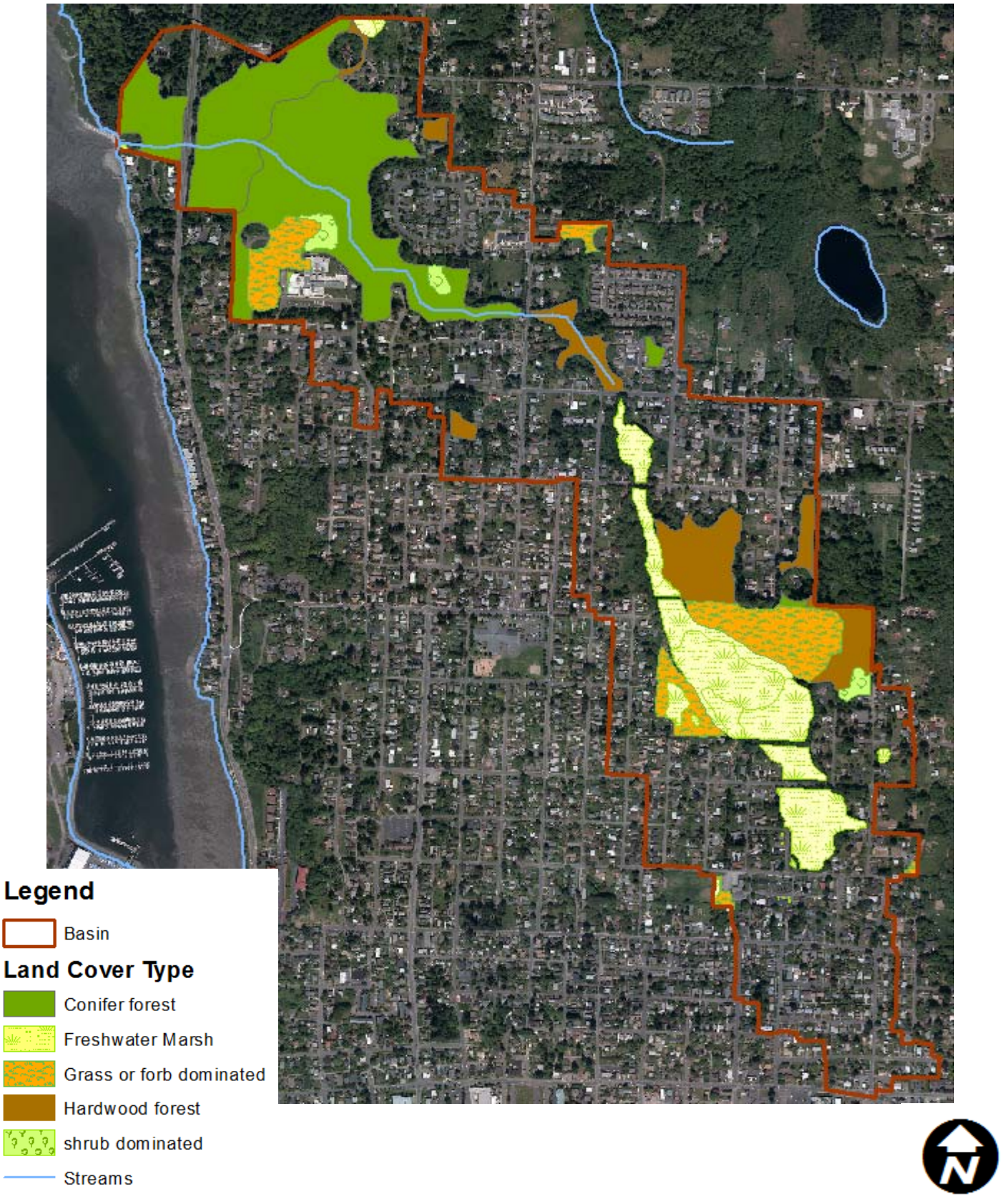
There are approximately 35 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Mission Creek Basin: Stewardship Strategies

Mission Creek Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
City of Olympia	Partnering	3		42
Devon Place HOA	Technical Assistance	1		1
Northpoint HOA	Incentives	1		1
	Education			
	Total:	**5**		**44**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	67		35
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	4		13
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acre residential	priorities)	0		0
50 + acres residential		0		0
	Total:	**71**		**48**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	26		11
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	4		10
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	1		8
10-50 acres undeveloped (LND)	priorities)	1		29
50+ acres undeveloped (LND)		0		0
	Total:	**32**		**58**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			4	4
Category 2			4	4
Category 3			0	0
Category 4			1	1
	Total:		**9**	**9**

Mission Creek Basin



Schneider Creek Basin

The Schneider Basin is also relatively small, with limited public ownership.

Protection:

There is approximately 34 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition

Partnerships:

There is limited public ownership in this basin.

Technical Assistance/Education & Incentives:

There is less than 50 acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

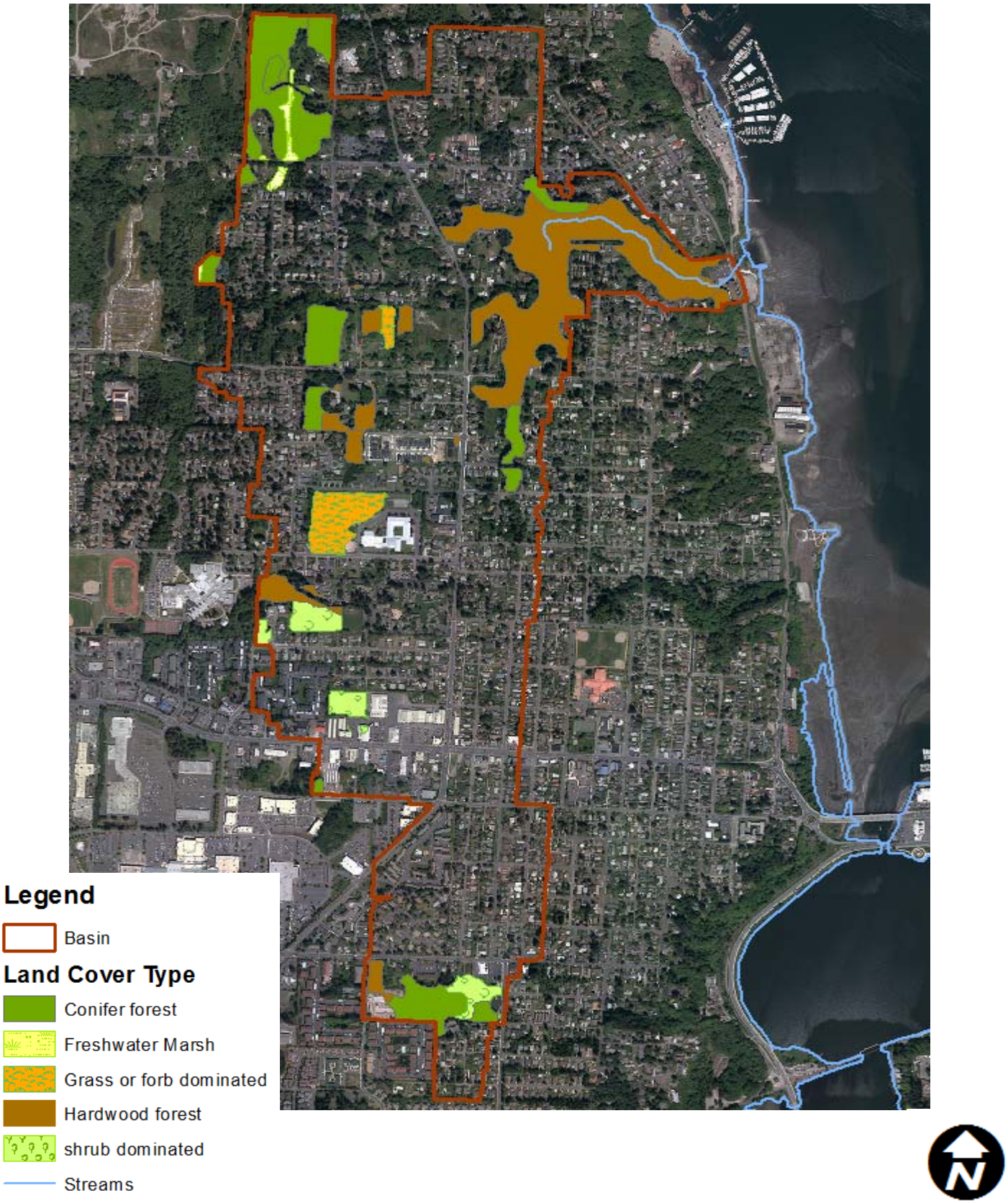
There are approximately 74 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Schneider Creek Basin: Stewardship Strategies

Schneider Creek Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
Olympia School District	Partnering	2		17
City of Olympia	Technical Assistance	1		9
Hidden Creek Comm. Church	Incentives	1		1
	Education			
	Total:	**4**		**27**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	74		34
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	5		18
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	2		12
10-50 acre residential	priorities)	1		16
50 + acres residential		0		0
	Total:	**82**		**80**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	24		9
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	3		9
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	1		6
10-50 acres undeveloped (LND)	priorities)	0		0
50+ acres undeveloped (LND)		0		0
	Total:	**28**		**24**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			9	9
Category 2			2	2
Category 3			21	21
Category 4			2	2
	Total:		**34**	**34**

Schneider Creek Basin



Capitol Basin

The Capitol Basin includes the land surrounding Capitol Lake.

Protection:

There is approximately 21 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition

Partnerships:

The Washington State Department of Enterprise Services owns/manages approximately 140 acres of habitat in this basin. We have a long history of providing technical advice and assistance on habitat related issues. We anticipate continuing this partnership in the future with stewardship planning and habitat enhancement assistance.

Technical Assistance/Education & Incentives:

There is very little undeveloped private property in this basin.

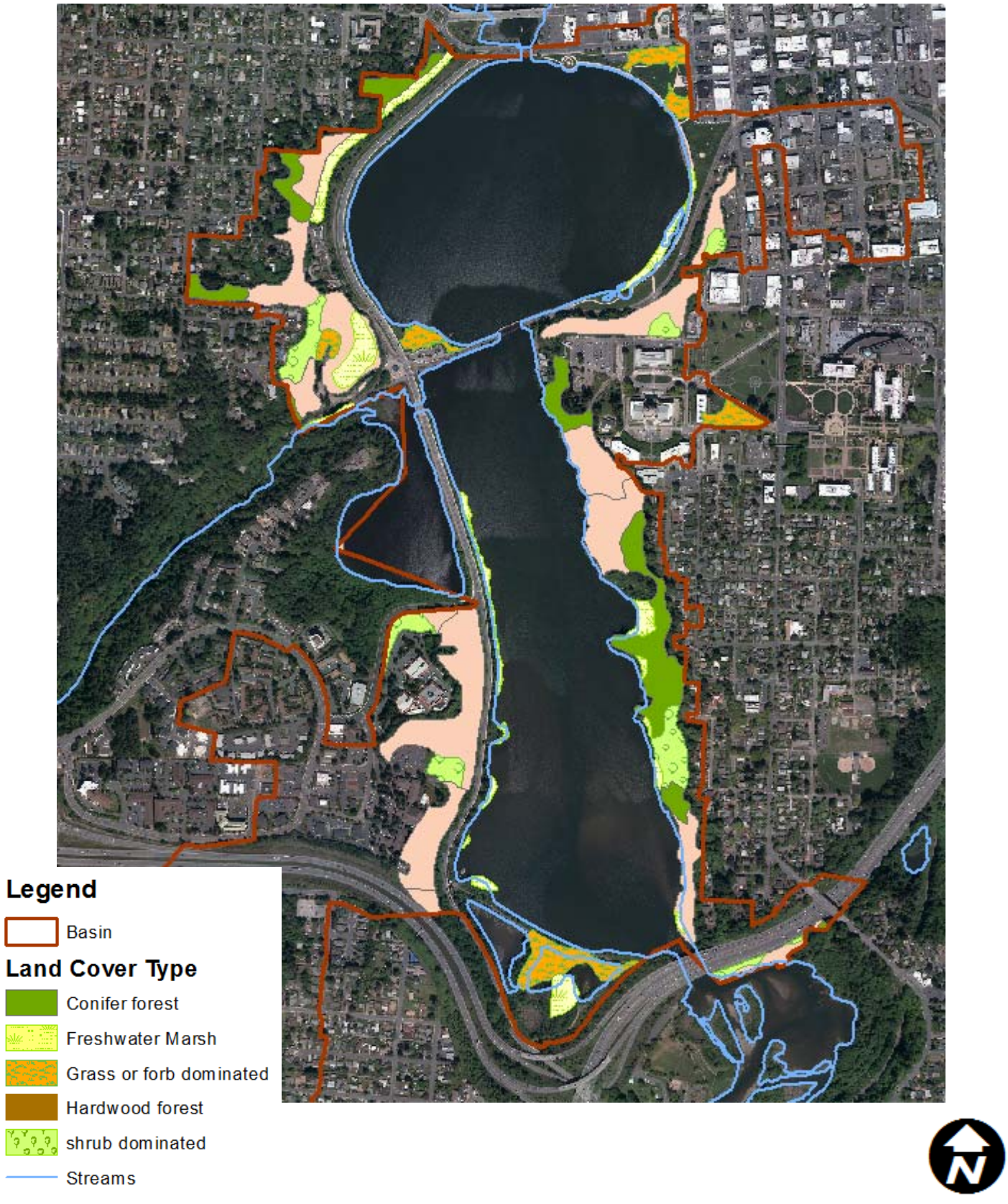
There are approximately 37 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Capitol Basin: Stewardship Strategies

Capitol Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
Washington State DES	Partnering	1		142
Thurston County	Technical Assistance	1		2
	Incentives			
	Education			
	Total:	**2**		**144**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	19		12
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	0		0
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acre residential	priorities)	0		0
50 + acres residential		0		0
	Total:	**19**		**12**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	15		10
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	3		6
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acres undeveloped (LND)	priorities)	0		0
50+ acres undeveloped (LND)		0		0
	Total:	**18**		**16**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			0	0
Category 2			18	18
Category 3			3	3
Category 4			0	0
	Total:		**21**	**21**

Capitol Basin



East Bay Basin

Habitat available for stewardship in the East Bay Basin primarily encompasses drainage areas along the east side of East Bay from the outfall of Indian/Moxlie Creek at the south to a portion of Priest Point Park to the north.

Protection:

There is approximately 21 acres of privately owned habitat identified in this analysis at risk of being developed. However, al 21 acres fall within Category 3. These properties may be considered candidates for protection through acquisition.

Partnerships:

The City of Olympia Parks, Arts and Recreation Department has approximately 19 acres of habitat in the north portion of this basin in Priest Point Park. We have a history of providing technical advice and assistance on habitat related issues and we anticipate continuing this partnership in the future with stewardship planning and habitat enhancement assistance.

Technical Assistance/Education & Incentives:

There are very few undeveloped private properties in this basin.

There are approximately 39 smaller residential properties (i.e., < 2 acres) totaling only 12 acres in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

East Bay Basin: Stewardship Strategies

East Bay Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
City of Olympia	Partnering Technical Assistance Incentives Education	1		4
	Total:	**1**		**4**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	37		14
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	1		3
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acre residential	priorities)	0		0
50 + acres residential		0		0
	Total:	**38**		**17**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	39		12
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	0		0
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acres undeveloped (LND)	priorities)	0		0
50+ acres undeveloped (LND)		0		0
	Total:	**39**		**12**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			1	1
Category 2			0	0
Category 3			21	21
Category 4			0	0
	Total:		**22**	**22**

East Bay Basin

Woodland Creek Basin

The portion of Woodland Basin within our study area is very limited.

Protection:

There are approximately 7 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition

Partnerships:

There were no partnership opportunities identified in this basin.

Technical Assistance/Education & Incentives:

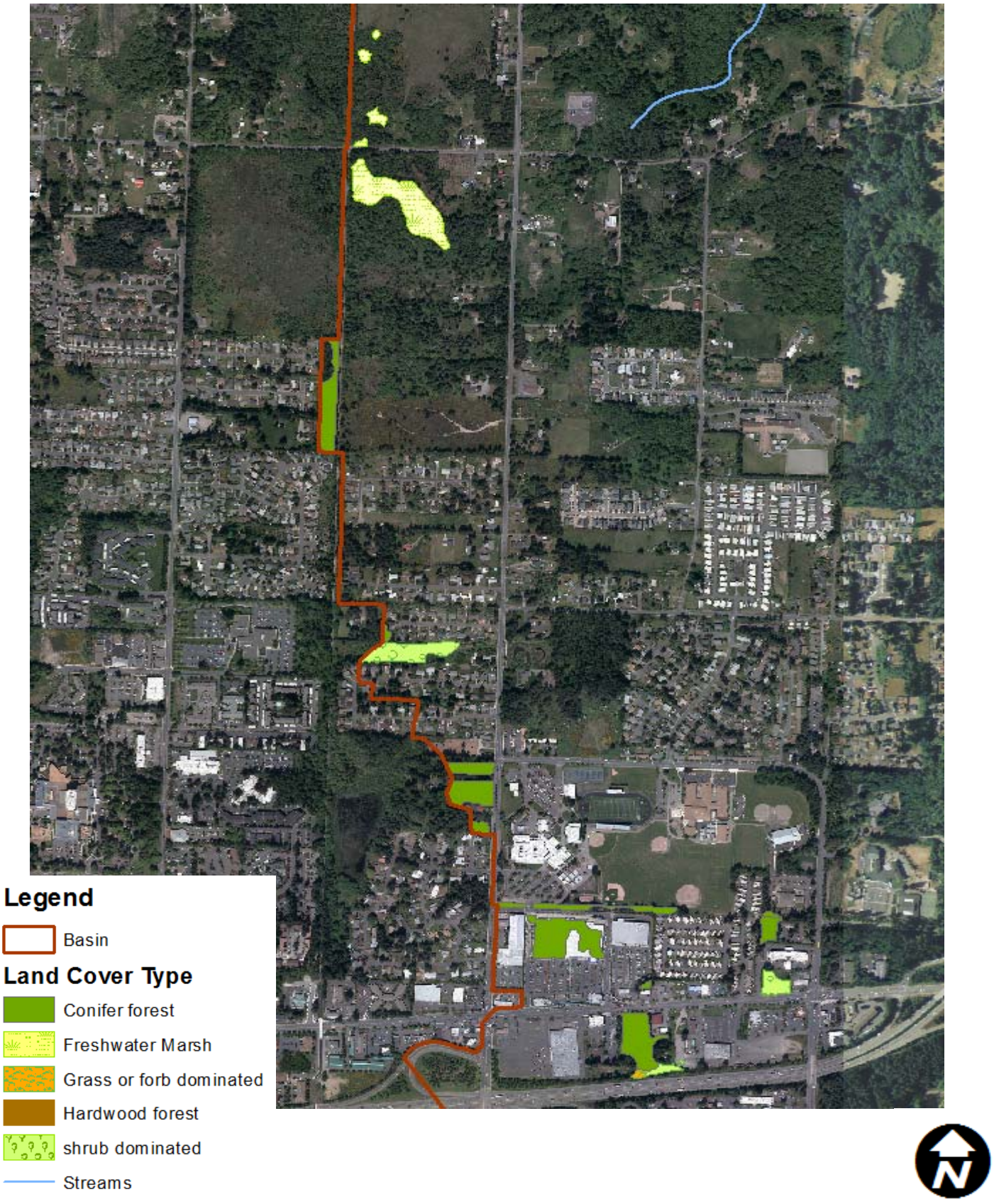
There are very few undeveloped private properties in this basin.

Woodland Creek Basin: Stewardship Strategies

Woodland Creek Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
None	Partnering Technical Assistance Incentives Education	0		0
	Total:	**0**		**0**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	0		0
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	0		0
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acre residential	priorities)	0		0
50 + acres residential		0		0
	Total:	**0**		**0**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	3		3
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	2		5
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acres undeveloped (LND)	priorities)	0		0
50+ acres undeveloped (LND)		0		0
	Total:	**5**		**8**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			0	0
Category 2			0	0
Category 3			7	7
Category 4			0	0
	Total:		**7**	**7**

Woodland Creek Basin



Ward Lake Basin

Protection:

There is approximately 8 acres of privately owned habitat identified in this analysis at risk of being developed. These properties will be considered candidates for protection through acquisition

Partnerships:

Although the Ward Lake Basin is relatively small, it includes several opportunities for partnering with Homeowner's associations surrounding the lake. We would propose to partner with these HOA's by assisting with stewardship planning and habitat enhancements on their commonly owned properties.

Technical Assistance/Education & Incentives:

There is less than 50 acres of habitat on larger (i.e., > 2 acre) developed and undeveloped private properties. On these properties we would encourage enhancement of habitat by providing technical assistance, education and incentives.

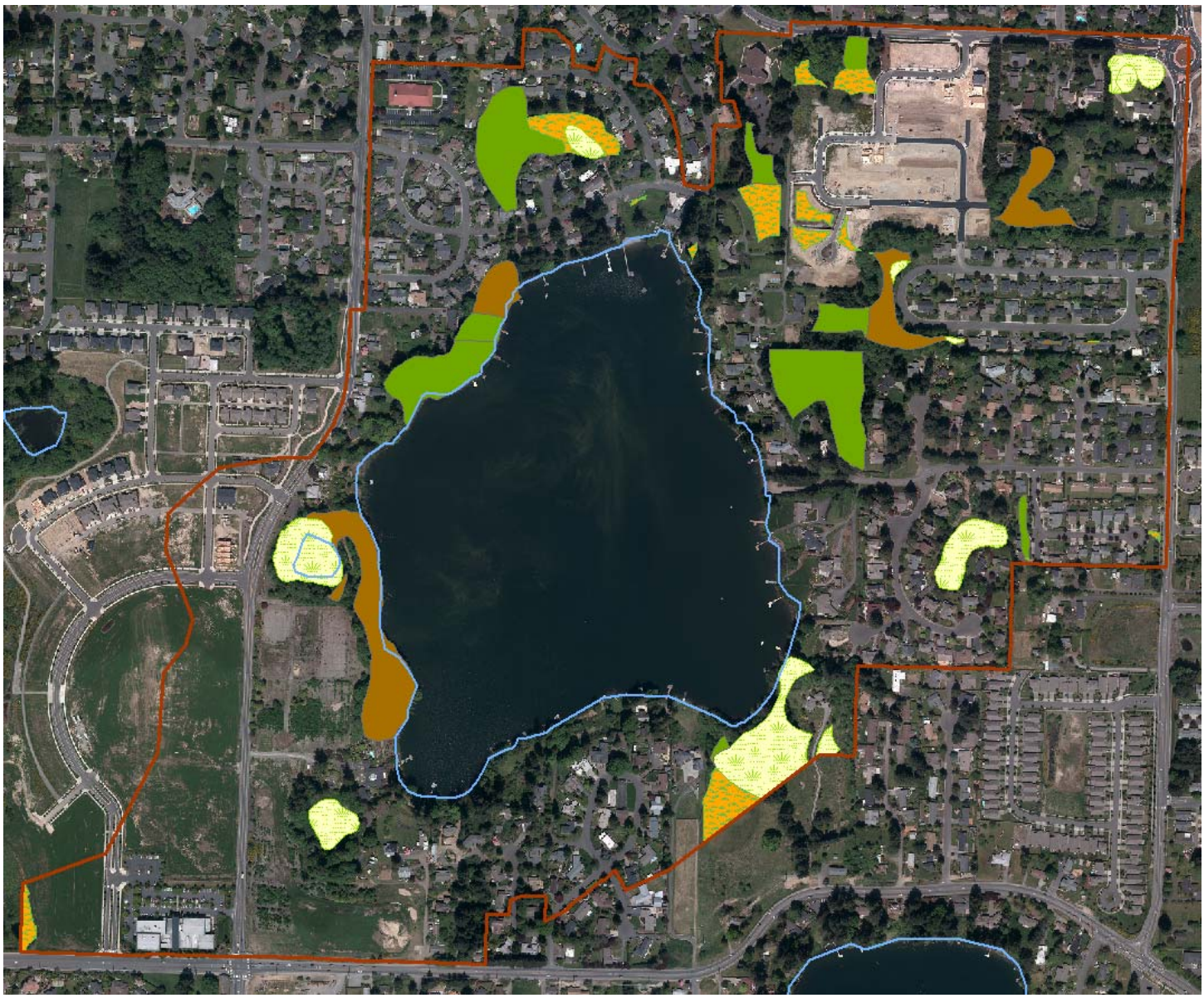
There are approximately 81 smaller residential properties (i.e., < 2 acres) in the basin that include or are adjacent to protected habitat. For these properties we would encourage voluntary stewardship.

Ward Lake Basin: Stewardship Strategies

Ward Lake Basin-Stewardship Strategies

Enhancement Partnerships	Stewardship Strategies	# of Properties	Potential Acres Protected	Potential Acres Enhanced
Ward Lake HOA	Partnering	1		10
Washington State WDFW	Technical Assistance	1		3
The Cove HOA	Incentives	1		1
Holiday Hills HOA	Education	1		3
Lakeside Heights HOA		1		1
Sten Village HOA		1		1
	Total:	**6**		**19**
Residential				
< 2 acre residential	Education (voluntary stewardship) Technical	81		42
2-5 acre residential	Assistance (Stewardship Planning) Incentives (trees,	6		23
5-10 acre residential	labor, etc.) Purchase (when coincident with Acquisition	0		0
10-50 acre residential	priorities)	0		0
50 + acres residential		0		0
	Total:	**87**		**65**
Undeveloped Land				
< 2 acre undeveloped (LND)	Education (voluntary stewardship) Technical	14		8
2-5 acre undeveloped (LND)	Assistance (Stewardship Planning) Incentives (trees,	3		6
5-10 acre undeveloped (LND)	labor, etc.) Purchase (when coincident with Acquisition	2		15
10-50 acres undeveloped (LND)	priorities)	1		17
50+ acres undeveloped (LND)		0		0
	Total:	**20**		**46**
Agriculture				
properties (0 acres) (AGR)	Education (voluntary stewardship) Technical Assistance (Stewardship Planning) Incentives (trees, labor, etc.) Purchase (when coincident with Acquisition priorities)	0		0
	Total:	**0**		**0**
Aquistion Priority				
Category 1			0	0
Category 2			3	3
Category 3			0	0
Category 4			5	5
	Total:		**8**	**8**

Ward Lake Basin



Legend

Basin

Land Cover Type

- Conifer forest
- Freshwater Marsh
- Grass or forb dominated
- Hardwood forest
- shrub dominated
- Streams

5.0 Conclusions

As stated in the introduction of this report, the purpose of this work was to identify and quantify the remaining habitat in our study area and make recommendation on a strategy to protect and enhance this habitat. Although the relationships between the wildlife habitat and an urbanizing city can be very complex, our response as stewards of this resource can be fairly straightforward.

- Acquisition as a stewardship tool can be one of our most expensive, as such:
    i. It should be used for the most important properties that are at the greatest risk of being lost to development.
    ii. We should leverage our limited resources by partnering with other agencies/organizations (Olympia Parks Department, Capitol Land Trust, etc.)
    iii. We should pursue grant funding to leverage our limited funds.
    iv. We should investigate other protection tools (regulations, conservation easements on a parcel by parcel basis before we pursue outright purchase).
- Without active management existing habitat, in an urban setting, will degrade overtime due to invasive plants and other stresses imposed by the urban areas that surround these remnant properties. Enhancement of the habitat on properties currently under our management responsibility and partnering with other public agencies and organizations that have comparable habitat goals (e.g., Capitol Land Trust) should be our highest priority.
- Technical assistance (stewardship planning) and incentives (trees, labor, etc.) for private property owners would be another cost effective way of improving wildlife habitat at the landscape scale. The development of such tools should be considered, in recognition of the public benefits provided by these improvements.

5.1 Assumptions

Land Cover as a measure of wildlife habitat – One assumption we made at the core of this analysis was that the capacity for a diverse population of wildlife to co-exist with humans in the urban environment was in direct relationship to the quantity and quality of habitat. As such we focused on the remaining habitat rather than on the management of a specific species of concern.

Aquatic Habitat vs. Wildlife Habitat – As we proceeded with our study of remaining habitat we struggled with differentiating between what might be considered aquatic habitat vs. wildlife habitat. Given that one of the goals of the Storm and Surface Water utility is to provide for the protection and enhancement of aquatic habitat we initially tried to separate the two. At one point in our analysis we attempted to specifically identify aquatic habitat by buffering all shorelines, streams and wetland by 500 feet, assuming that anything beyond 500 feet

would be non-aquatic habitat. As it turns out, there is almost no remaining habitat that is more than 500 feet from an aquatic resource. This coupled with the complex interconnectedness of all wildlife and aquatic resources we chose to not limit our study to something called aquatic habitat but instead consider all remaining habitat as equally valuable as a resource.

Stewardship vs. Acquisition - Initially staff was asked to identify property specifically for the purpose of acquiring it to preserve it for habitat and protect it from development. Recognizing that acquisition is only one limited tool, we expanded the study to include an analysis of a full suite of stewardship strategies and tools that could be used to both protect and enhance habitat across a diverse landscape of habitat types and landuse patterns. Although beyond the scope of this study, we anticipate performing a cost/benefit analysis of the various tools to provide more specific guidance for this work effort in the future.

Habitat Loss (Quantity) – Our study demonstrated a loss of 3397 acres (31%) of habitat over the past 19 years. Although not part of the original intent of our study, these results provide some insight into the effect of human population growth on the remaining habitat in our community. Other questions to consider, outside the context of this study is whether changes to our other codes (zoning, parking, etc.) could have limited this loss. Equally, a recognition of the greater impacts that could have occurred if we didn't have environmental regulations, or dense residential zoning.

Habitat and Land Use – We performed an analysis that selected parcels from the Thurston County parcel database that were coincident with remaining habitat. After identifying these properties we sorted them into various categories by property type (as defined by the assessor's office for tax purposes), and by size (i.e., <2 acres vs. 50 acres). This gave us the ability to understand ownership demographics and land use patterns of the remaining habitat. From this we were able to develop specific strategies and tools that we believe would be most effective at protecting and/or enhancing habitat. Although these parcels were coincident with the remaining habitat, they were not identical, as such the acreages reported in this section may have grossly over-estimated the amount of actual habitat that exists in these various land use classes. Another limitation of this data is the property type classification. The property type classification is the classification used by the Assessor's office for tax purposes. This approximates land use, but is not exactly the same. As such some properties in the residential classification may be a single house on a large property that could be further subdivided. Similarly there are public properties that end up in a several different property type classifications (Exempt, Land, Recreation, etc.) this may have skewed some of the analysis. Overall it was still a valuable tool for scoping the quantity of remaining habitat by land use which will help in scoping the appropriate programs that would need to be developed and implemented to protect and enhance habitat at the basin scale.

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Appendix A

Definitions (Turner, 2001)

Configuration:	Specific arrangement of spatial elements; often synonymously with spatial structure or patch structure.
Connectivity:	Spatial continuity of a habitat or cover type across a landscape.
Composition:	The number, size and quality of habitat (s) across a landscape (WDFW, 2009).
Corridor:	Relatively narrow strip of a particular type that differs from the areas adjacent on both sides.
Cover Type:	Category within a classification scheme defined by the user that distinguishes among the different habitats, ecosystems, or vegetation types on a landscape.
Edge:	Portion of a cover type near its perimeter and within which environmental conditions may differ from interior locations in the ecosystem; also used as a measure of the length of adjacency between cover types on a landscape.
Extent:	Size of the study area or the duration of time under consideration.
Fragmentation:	Breaking up of a habitat or cover type into smaller, disconnected parcels.
Grain:	Finest level of spatial resolution possible within a given data set.
Heterogeneity:	Quality or state of consisting of dissimilar elements, as with mixed habitats or cover types occurring on a landscape; opposite of homogeneity, in which elements are the same.
Landscape:	Area that is spatially heterogeneous in at least one factor of interest.
Matrix:	Background cover type in a landscape, characterized by extensive cover and high connectivity; not all landscapes have a definable matrix.
Metapoplulation:	Spatially separated populations within a geographic area that may interact through natural or human influenced dispersal patterns (Hanski, 2003).
Patch:	Surface area that differs from its surroundings in nature or appearance.
Scale:	Spatial or temporal dimension of an object or process, characterized by both grain and extent.

Appendix B

Stewardship Plan

Central and Marion

1910 NE Central St.

Olympia, WA

2013

City of Olympia, Public Works
Water Resources
Storm & Surface Water Planning

Olympia

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1.0 Introduction

The City of Olympia developed the Storm and Surface Water Utility (SSW) in 1986. The mission of SSW is "to provide services that minimize flooding, maintain or improve water quality, and protect or enhance aquatic habitat. These services reflect community values, are efficient and cost-effective, and satisfy regulatory requirements and Olympia Comprehensive Plan goals and policies" (Haub 2003). In 2012, the Utility Advisory Committee (UAC) suggested that SSW staff consider land acquisition as a strategy for achieving the SSW goal of aquatic habitat protection/enhancement. It was determined that SSW should develop a strategy to evaluate remaining habitat within the City's service area. Using GIS techniques, SSW staff has identified and rated the most valuable remaining habitat within the city, based on the following criteria, developed by SSW in 2004:

- Overall habitat value
- Association with larger area(s) of habitat
- Location within a priority basin (as identified by City of Olympia Aquatic Habitat Evaluation & Management Report 1999)
- Willingness of seller
- Complimentary to SSW and/or other City needs/goals
- Presence of ESA- protected salmon, or other threatened, endangered, or sensitive species

Other criteria developed for the Land Acquisition strategy, evaluated during the landscape-level analysis includes:

- Rating the site for its relative aquatic habitat value
- An assessment of the risk of high-value sites being lost to development
- Best management strategies to protect/enhance the habitat value of the highest valued properties

Once a property is identified as a priority site using the landscape-scale analysis, and chosen for some type of stewardship or restoration, a finer-scale analysis is performed using various forest and vegetation sampling techniques, in the field. The fine-scale analysis evaluates current site conditions based on 5 survey methods. These include:

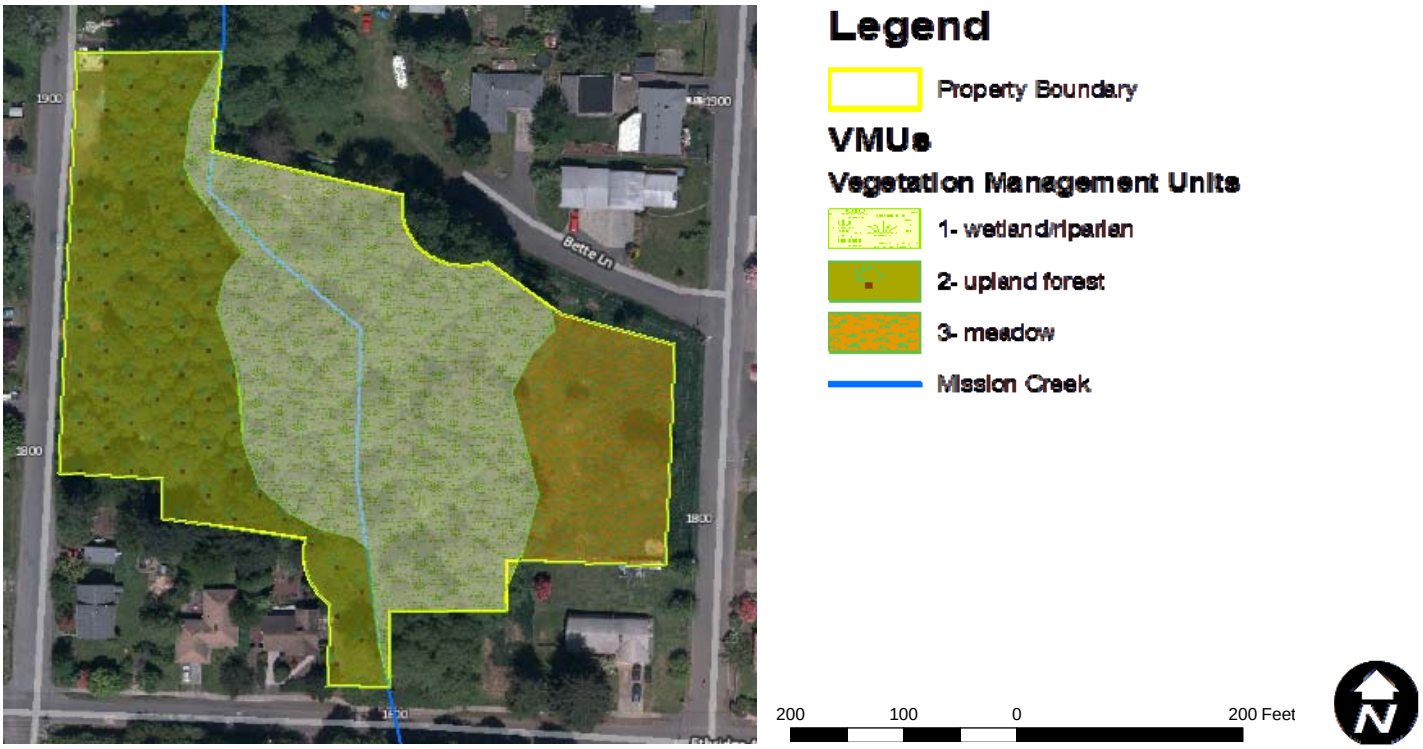
- Tree/forest canopy survey
- Regeneration/seedling survey
- Vegetation /invasive plant survey
- Snag (standing dead tree) survey
- Downed wood survey

Each sample technique, and the justification and value of each will be explained in more detail in chapter 2.

1.1 Facility Description

The property at Central and Marion is 3.68 acres located in the heart of the North East Olympia neighborhood. The property is bounded to the west by Central St. , to the east by Marion St. , to the south by Ethridge Ave. and adjacent properties, and to the north by Miller Ave. and private homes. Bette Lane also ends in a cul-de-sac, making up the northeastern border of the property. The property is owned and maintained by the City of Olympia's SSW program. The parcel number for the site is #49604400106. Mission Creek runs through the center of the property, making the area valuable habitat due to the presence of a Type F (fish-bearing) stream, as well as forested wetland of approximately 2 acres. The site is forested, with an over-story composed primarily of 45-year old *Alnus rubra*. The site can be divided into 3 separate habitat types, or Vegetation Management Units (VMU's): Wetland/riparian, forest, and meadow. Figure 1.1 shows the Central & Marion property with vegetation management units.

Figure 1.1: Central & Marion, Vegetation Management Units



1.2 Site History

This site was most likely cleared originally for agriculture and residential development. The earliest land-use records for the site include a 1947 aerial photo, flown by Pacific Aerial Surveys, Inc. This photo shows that the area was cleared some time before 1947, with the exception of the Mission Creek channel. Today, the area is zoned for single-family residential, 4-8 units per acre, and is bordered by 8 privately-owned properties. Historic forest type is unknown, but based on soils, hydrology, and vegetation communities of nearby natural areas, the site would probably support a lowland conifer-hardwood forest. Before human disturbance, the

property may have included a larger component of conifers than the current alder stand. Mission Creek probably now experiences higher amounts of peak flow due to runoff from adjacent roads, homes, and other impervious surfaces. In 2012, the portion of Mission Creek from the headwaters within Mission Creek Park to the culvert crossing at Bethel Street was identified as a Special Flood Hazard Area (SFHA) by the Federal Emergency Management Agency (FEMA). An SFHA is defined as the land area that will be inundated by the floodwaters of the 100-year (base) flood. That is, a flood having a 1% chance of being equaled or exceeded in any given year. Some restoration activities have occurred on the site, such as invasive plant removal and tree planting, though no specific management plan for the property was ever written or initiated.

1.3 Ecological Background

Thurston County is on a glacial plain extending northward from a mountainous rim. It is bordered by low-lying mountain chains to the south, west, and east, and by the Puget Sound to the north. The Central & Marion site is located in the peninsular geologic area, which includes much of the northern part of the county. The area is geologically and topographically similar to the coastal regions and islands of the south Puget Sound. The parent material is Vashon-age glacial till, and topography was formed by the advancing Vashon glacier. The site is within the Mission Creek basin, which runs along the ridge above the east bay of Budd Inlet and empties into the bay just south of Priest Point Park. Most of the Mission Creek basin is relatively flat, and at about 180 feet in elevation. Topographic features of the Central & Marion site include the Mission creek stream channel, the upland portion of the creek basin, and flat meadow to the east of the property.

Mission Creek, a Type F (fish-bearing) perennial stream, runs through the Central & Marion site. The average bank-full width for this portion of the creek is 9 feet, and the average stream gradient is around 2%. The riparian buffer for this stream segment is well-vegetated, with *A. rubra*, *Rubus spectabilis*, and *Lysichiton americanum* dominating the water's edge. The headwaters of the creek are immediately south of the property, within Mission Creek Park. Mission Creek enters Budd Inlet at the southern boundary of Priest Point Park, to the northwest of the Central & Marion site.

Along the edges of the Mission Creek channel is an untyped riverine forested wetland. This wetland is classified as a Palustrine Forested Wetland using the classification system adopted by the National Wetland Inventory (Cowardin 1979). It is part of a larger wetland complex which includes Mission Creek Park, though the two systems are separated by Ethridge Avenue. The approximate size of the wetland found on this site is 2 acres.

1.4 Basin Information

Central & Marion is located within the Mission Creek basin, one of eight urban stream basins identified in the City of Olympia's Aquatic Habitat Evaluation & Management Report (Haub 1999). Total area of the Mission creek basin is about 407 acres, with 330 acres falling within city and UGA limits. While this basin does still support intact wetlands, including the creek headwaters at Mission Creek Nature Park, hydrology is severely impacted by stormwater runoff. Reasons for this include an estimated 25% impervious surfaces within the basin, which creates increased peak flows, and inadequate storage and treatment facilities within the basin. A landcover analysis for Olympia stream basins, using GIS techniques, was conducted in 2010 and revised in 2012 (Roush 2012). This generated land cover data for all basins and sub-basins within Olympia city limits

and UGA, including the Mission Creek basin. Figure 1.4.2 summarizes the City's 2012 basin landcover analysis for Mission Creek basin, including cover types, total area, and percent of each cover type.

The 1999 report identified the overall physical condition of the stream and associated wetlands as "poor", due to insufficient flow and diversity for anadromous fish, poor substrate that will not support high-quality biological communities, and culverts which are impassible to fish. In 2013, the Mission Creek estuary, where Mission Creek enters Budd Inlet, was the site of a large restoration project. An old road, earthen berm, and concrete culvert were removed at the mouth of Mission Creek, allowing the estuary to naturally flow and evolve over time, in the manner which probably occurred before the area was developed. The property at Central & Marion is part of a vegetated corridor connecting the headwaters of Mission creek, located within Mission Creek Nature Park, and the estuary located on the southern edge of Priest Point Park. This corridor serves as a natural migration route for many species of wildlife, provides connectivity between the two larger protected areas of habitat, and provides the essential habitat functions of food, water, shelter, and cover. There are 5 roads fragmenting the Mission Creek corridor, including a large culvert under East Bay Drive which creates a partial fish barrier. Figure 1.4 .1 shows the location of the Central & Marion site , land cover types, and city-owned properties within the Mission Creek basin.

Riparian vegetation within the corridor is relatively intact, particularly from the estuary at Budd Inlet upstream to Bethel Street. Here, the channel runs through a steep, wooded ravine with little threat of human impact. From Bethel Street south to Miller Avenue, Mission Creek runs through 5 privately-owned parcels, where riparian vegetation is more degraded. South of Miller, the stream channel runs through two more private properties before reaching the Central & Marion property. The property is the northern extent of the wetland making up the headwaters of Mission Creek, along with the larger wetland to the south.

Cover Type	Area (sq. ft.)	Area (ac)	Area (%)
H			
F			
C			
D			
C			
T			

Figure 1.4.1: Mission Creek Basin

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Figure 1.4.2: Mission creek Basin Landcover Analysis

This area is composed of a 40-50 year old *A. rubra* overstory, and *R. spectabilis, L. americanum, and Athyrium filix-femina* dominated shrub layer. A variety of non-natives are also present, including bamboo spp., *Crategus monogyna, Hedera helix, Ilex aquifolium, Ranunculus repens,* and *Rubus discolor*.

VMU 2: Upland Forest

Again, 40-50 year *A. rubra* is the dominant tree species, with a small amount of *Pseudotsuga menziesii* and *Populus trichocarpa* on the southern margin. Small amounts of *Prunus* spp. and *C. monogyna* can be found interspersed throughout the site. Shrubs common in the understory include *Corylus cornuta, Oemleria cerasiformis, R. spectabilis, I. aquifolium, Sorbus aucuparia,* and *Sambucus racemosa*. The ground layer is primarily composed of *Hydrophyllum tenuipes, Polystichum munitum, H. helix,* and *Rubus ursinus*. In the eastern portion of this VMU, near the edge and along the meadow (VMU 3) is a lone *P. menziesii,* which most likely was a natural recruit that managed to out-compete the regenerating alder. This tree could not be located on the 1947 aerial photo, and must have been established after that date. This *P. menziesii* is relatively large, with a 37.7 inch diameter at breast height (DBH), and a height of 115 feet. This tree has a variety of characteristics that make it beneficial to many wildlife species. The stem forks at about 10 feet, and the tree has multiple leaders, suggesting the top was broken at some point.

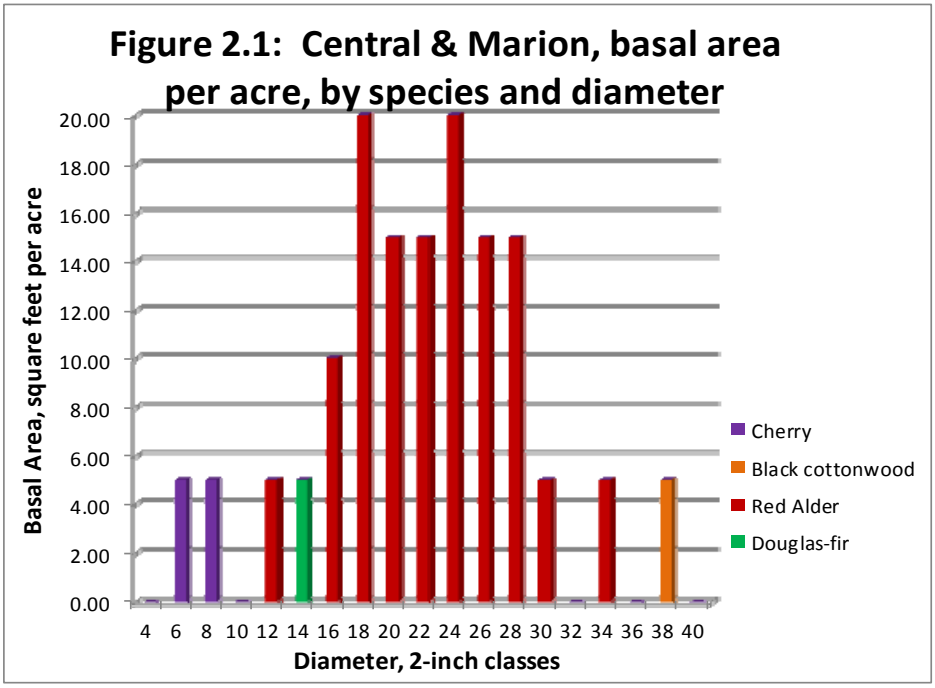
VMU 3: Meadow

This unit is dominated by grasses (family: *Poaceae*), and also includes *Symphytum officinale,* Malus spp., and *R. discolor*.

The forest on the property has a site class of 2 and a 50-year site index of 100, meaning *A. rubra* on this site should be about 100 feet tall at age 50. Height and diameter was measured on a site index tree, and age was determined using an increment borer. This shows that the 22.2 inch *A. rubra* on site was 95 feet tall at age 42 (age measured at breast height).

During the field survey, stocking density of the forest was calculated using a variety of metrics, designed to give a more complete account of the forest at Central & Marion. Basal area, a measure of the cross-sectional area each tree occupies, was determined to be 145 square feet per acre. Average number of trees per acre (TPA) for this site is 97. Quadratic mean diameter (QMD), the diameter of a tree of average basal area for the site, was calculated at 16.6 inches. Stand density index (SDI), a value providing a measure of stand density and derived from TPA, BA, and QMD, equals 327. This value is often compared to maximum SDI (a theoretical maximum density for a specific tree species), which was determined to be 722 for this site. Finally, the ratio of SDI to maximum SDI, known as relative density (RD), for Central & Marion equals 45%. This expresses the density of a site as a percentage of its theoretical maximum. Using a density management diagram for *A. rubra,* at an RD of 45% the stand at Central & Marion falls into the "mortality zone" (Puettmann 1993). This shows that competition between trees in this stand is strong, growth is restricted, and mortality is high. In a forest where the primary management goal is timber production, thinning would be recommended to lower RD and increase volume production. However, from a habitat

perspective, an "over-stocked" forest such as this can actually be beneficial to wildlife. Some trees will be suppressed and become more susceptible to disease and mortality. This will increase the amount of "wildlife trees", snags, and downed woody debris on the site. This, in turn, increases structural diversity, allowing a greater number of wildlife species to take advantage of the habitat elements on site. Tree mortality can also create gaps in the forest canopy, creating more heterogeneity in the forest structure, and increasing the potential of shrub growth and natural recruitment of seedlings. During the regeneration survey, it was determined that very little natural regeneration was occurring, and what re-seeding was occurring naturally was mainly less desirable deciduous tree species, such as *Prunus* spp. and *Acer macrophyllum*. While these tree species certainly have value to wildlife, it was determined that the forest would offer more benefits to wildlife if it was guided into a late-seral forest dominated by conifers. To this end, some planting has occurred at Central & Marion, and the majority of seedlings noted during the regeneration survey were planted *Tsuga heterophylla*, *Picea sitchensis*, and *Thuja plicata*. Figure 2.1 shows current basal area per acre, broken down by tree species and 2-inch diameter class.



2.2 Snags

In Wildlife-Habitat Relationships in Oregon and Washington (Johnson 2001), 93 wildlife species are identified as being associated with standing dead trees, or snags. This number is made up of 63 bird, 26 mammal, and 4 amphibian species. Wildlife uses of snags vary by species, and include roosting, nesting, perching, foraging, preening, drumming, courtship, and hibernation. Data regarding target densities and distribution of snags on a site such as Central & Marion was difficult to locate. One report was found that offered general recommendations for snag target densities which can be applied to Central & Marion (Bunnell 2002). This document recommends a goal of at least one 12-inch or greater DBH snag per acre, along with 4-8 snags per acre of smaller sizes. The report also suggests that in hardwood stands such as central & Marion, the number of snags per acre is less important than in conifer dominated forests. This is because rot within living trees is more common in hardwoods, and many wildlife species will create or use cavities in these living "wildlife trees". During the snag survey, it was shown that this site has an average of 10 snags per acre under 12-inch DBH, and 2 per acre at 12-inches or greater. This suggests that the current snag habitat on this site is sufficient. Future recruitment of snags, discussed in section 2.1, above, should continue to occur as the *A. rubra* overstory reaches mortality.

2.3 Coarse Woody Debris

There is a large amount of data illustrating the importance of coarse woody debris (CWD) for wildlife (Bunnell 2002, Thomas 1979, and others), though details regarding appropriate amounts and distribution of downed wood can be difficult to determine. The best science available today suggests that volumes of 1400-2800 cubic feet per acre, with a variety of log sizes, should sustain most users of downed wood (Bunnell 2002). It is worth noting that the species of wildlife dependent on the largest (20+ inch diameter) log sizes, such as marten, black bear, and fisher, are not found in an urban setting like Central & Marion, and do not need to be addressed in the management goals for this site. That said, larger diameter downed wood is still more beneficial to a wider range of species than small logs. During the CWD survey, it was determined that an average of only 765 cubic feet of downed wood per acre can be found at Central & Marion, substantially lower than the recommendation discussed above.

2.4 Fish Use & Habitat

As mentioned in section 1.4, the Mission Creek basin as a whole was rated as ”poor” regarding aquatic habitat value. While the stream is listed by WDFW as fish-bearing, insufficient flow and a lack of structural diversity in the stream channel beyond Ethridge Street make it unlikely to support populations of anadromous fish, such as chinook salmon *(Oncorhynchus tshawytscha),* steelhead *(Oncorhynchus mykiss),* or chum salmon *(Oncorhynchus keta).* With the estuary rehabilitation project undertaken in 2013, increased fish use is likely, and more rehabilitation throughout the stream channel, such as culvert widening or replacement, would greatly increase the aquatic habitat value of Mission Creek basin for anadromous fish. Other fish species which have been observed using habitat in Mission Creek include Cutthroat trout *(Oncorhynchus clarkii)* and sculpin (*Cottoidea* spp.).

2.5 Wildlife Use

A variety of wildlife species have been identified using the Central & Marion site, including Black-tailed Deer, Raccoon, Eastern grey squirrel, Virginia Opossum, Steller’s Jay, and American Crow. An extensive list of potential wildlife species using the habitat at Central & Marion, including taxonomic names, can be found in Appendix A. The site is important habitat for a variety of cavity-nesting species due to the relatively high number of snags present for an urban environment. There is also potential habitat for amphibians, such as salamanders, newts, frogs, and toads within the wetland and stream portions of the property. Table 2.5, below, demonstrates the value of each VMU to wildlife, based on the critical habitat elements of food, water, and cover, as well as nesting and rearing habitat, and travel/migration routes.

Figure 2.5: Habitat Elements at Central & Marion, by Vegetation Management Unit (VMU)

Habitat Element	VMU1(Wetland/Riparian)	VMU2 (forest)	VMU3 (Meadow)
Food	salmonberry fruit eaten by birds; young foliage eaten by deer	Leaves, twigs, & buds of alder eaten by deer. Seeds eaten by small mammals/birds. Hazelnut, elderberry, Indian plum provide fruit/seeds for a variety of wildlife spp.	Grasses, forbs provide forage for deer & small mammals. Fruit tree s provide food for many spp.
Water	Mission Creek, Type F Perennial stream		
Cover	Salmonberry and other brush provides cover	forest provides thermal/visual cover for deer & other spp.	
Nesting	Alder snags provide habitat for cavity-nesting spp.	alder provides nesting habitat for birds, squirrels, raccoons, and other spp.	Fruit trees provide nesting habitat for birds
Rearing	Downed logs provide habitat for amphibians		
Travel Routes	Mission creek channel serves as wildlife corridor		

2.6 Riparian & Wetland Habitat

Much of the habitat value at Central & Marion is due to the presence of a wetland and riparian area on site. Both wetlands and riparian zones are considered critical habitat from a terrestrial and aquatic habitat perspective. Over half of all wildlife species in Washington State use riparian areas or wetlands in some form. As these habitat types make up only 1-2% of the total landscape, the importance of protection and effective management of these areas cannot be overstated (Johnson 2001).

2.7 Soils & Slope Stability

Soil types for the area include drained Mukilteo muck in the wetland, and Yelm Fine Sandy Loam in the upland forest and meadow portions of the property. Drained Mukilteo muck is a deep, poorly draining soil found in upland depressions. Drainage has been altered in some way, by subsurface drains or open ditches. The soil is formed from organic material primarily derived from sedges. Typical vegetation for this soil type is sedges and rushes. The soil has moderate permeability, and available water capacity is high. Rooting depth is limited by the water table, usually between 18-36 inches during the growing season. Runoff is slow, and erosion due to water is not a hazard. The soil has a site index (for *A. rubra*) of 85, and is rated "severe" for equipment limitations, seedling mortality, wind-throw hazard, and plant competition. It is rated "good" for grain and seed crop potential, grasses, legumes, wild herbaceous plants, wetland plants, and shallow water areas. It is considered "poor" for conifer, hardwood, and shrub growth. This soil can create good habitat for wildlife using open areas and wetlands, though it is considered poor for woodland-using species (Pringle 1990) . Yelm fine sandy loam is a deep, moderately well-drained soil usually found on terraces. It is formed by volcanic ash and glacial outwash. Native vegetation is typically conifers and hardwoods. Permeability is moderately rapid, and available water capacity is high. Effective rooting depth is between 40-60 inches. The seasonal high water table can fluctuate between 18-36 inches from December through March. Runoff is slow, and the hazard of water erosion is slight. This soil has a site index of 130 for *P. menziesii*. There are "moderate" concerns regarding equipment limitations, and "slight" concerns about seedling mortality and wind-throw. Plant competition can be severe. It is considered a good soil for grains, seed crops, grasses, legumes, wild herbaceous plants, hardwoods, conifers, and shrubs. It is poor soil for wetland plants, and has poor potential for shallow water areas. The soil can create good habitat for both open and woodland using wildlife, but is considered "very poor" for wetland obligate wildlife species (Pringle 1990). The Thurston county Soil Survey did not identify any areas on the Central & Marion site as having the potential of mass wasting or unstable slopes.

2.8 Public Use

Currently, there are no public functions associated with this site. There have been various proposals on public use opportunities at Central & Marion; these are detailed in section 3.7.

2.9 Threats to Recovery

Due to the existence of a wetland and riparian area in the center of the property, there is little risk of this site being cleared for residential development. In fact, almost the entire 3.68 acre parcel is within the 200 foot protected stream buffer required by the City of Olympia's Critical areas Ordinance (Chapter 18.32.435).

Perhaps the greatest threat to the site is degradation by noxious and invasive plant species. An invasive plant is usually defined as a non-native plant which is highly competitive over native species. Invasive plants are usually prolific seed producers, often difficult to control or eliminate, and in many cases can create monocultures, where they blanket an area and significantly reduce native biodiversity. Some invasive plants can be beneficial to many species of wildlife, such as *R. discolor,* which produces food and cover for songbirds and other wildlife species. However, the tendency for these plants to crowd out native vegetation and reduce the diversity of habitat that our native wildlife is adapted to outweighs any potential habitat

benefits that the plant may offer. Many invasive plant species were identified during the vegetation survey portion of field analysis for the site. These include *R. discolor, H. helix, I. aquifolium, C. monogyna, S. aucuparia, R. repens,* and an unidentified species of bamboo.

Another threat identified during the field analysis is the limited species diversity of the forest at Central & Marion. The overstory is almost exclusively even-aged *A. rubra,* which may present a problem as the forest nears the end of its life cycle. *A. rubra* is a relatively fast-growing and short-lived tree species (maximum age is around 100, though many trees reach mortality before then), and is often the first tree species to become re-established on a disturbed site. *A. rubra* is a shade intolerant tree species, meaning seedling establishment in the understory is not likely to occur. Without disturbance, the *A. rubra* canopy on the site will have a difficult time regenerating. Compounding the problem is the fact that no viable seed bank exists on site for more shade tolerant tree species to replace the current overstory. This could mean that no new trees are able to out-compete the invasive plants and other shrubs and ground cover present on the site, preventing the establishment of a healthy forest canopy in the future.

3.0 Optimal Site Conditions

3.1 Plant Communities

Based solely on vegetation, the plant communities existing on the site seem to be an *A. rubra/L. americanum* community type for VMU 1; *A. rubra/ P. munitum* for VMU 2; and undesignated, non-native grassland for VMU 3. The first two plant communities represent early to mid-seral forest regimes, often caused by some type of disturbance, and are not typical for a late-successional, or climax forest. To gain some insight into what the species composition of a late-successional forest for this site should be, nearby Priest Point Park was examined, which has been free of major human disturbance since the late 1800s. While soils are different at Priest Point (primarily Skipopa series at Priest Point, Yelm series at Central & Marion), site productivity is similar, and climax forest composition should be comparable. Based on soils and plant communities at Priest Point Park, we believe that late-successional conditions at Central & Marion would most closely conform to the *T. plicata-T. heterophylla/L. americanum* community type for VMU 1, and *T. heterophylla-P. menziesii/P. munitum-Dryopteris expansa* community type for VMU 2. VMU 3, the meadow area, was too disturbed of a site to base plant community off of existing vegetation, but soils and site history suggest that it would fall under the *T. heterophylla-P. menziesii/P. munitum-D. expansa* community type as well. It is worth mentioning that in naturally disturbed areas of Priest Point Park, such as Laminated root rot (*Phellinus weirii*) pockets, existing species composition begins to resemble the disturbed plant communities found at Central & Marion.

Appropriate tree species for reforestation in the *T. heterophylla-P. menziesii/P. munitum-Dryopteris expansa* community include *T. plicata, P. menziesii, A. macrophyllum,* and *Abies grandis*. Typical shrubs are *R. spectabilis, S. racemosa, Gaultheria shallon, Acer circantium, Mahonia nervosa,* and *C. cornuta.* Ferns and forbs in this community include *P. munitum, D. expansa, Vancouveria hexandra, Trillium ovatum,* and *Trientalis borealis.*

3.2 Snags

While field data shows that current snag density is sufficient for this site (section 2.2, above), any overstory trees removed to promote the growth of planted restoration trees can either be girdled and left standing, to create new snag habitat, or felled and left on the forest floor to create CWD (see below).

3.3 Coarse Woody Debris

It is recommended that the logs from any invasive tree species removed from the property should be left on the ground to enhance the CWD component of this site, unless there is a threat of the tree re-propagating from the logs (*I. aquifolium*). Overstory trees removed to promote growth of restoration plantings can be left standing or left on the ground, as mentioned in section 3.1, above.

3.4 Fish Use & Habitat

Most restoration activities to benefit fish habitat at Central & Marion need to occur further downstream, to improve fish access to the habitat on site and further upstream within Mission Creek Nature Park. Perhaps the most beneficial action would be a modification or widening of the culvert under East Bay Drive, which was deemed a partial fish barrier by Wild Fish Conservancy (Staller 2006). Other activities which enhance aquatic habitat on site are detailed in section 3.6, below.

3.5 Wildlife Use

As mentioned in the Goals & Objectives section of Chapter 1, creating late successional forest characteristics will enhance the biodiversity of this site, making the habitat beneficial to a larger number of wildlife species. Removal of invasive vegetation will allow more desirable forage, cover, and browse to establish, and an increase of fruit or mast producing shrubs will also increase the value of the site to potential wildlife.

3.6 Riparian & Wetland Habitat

This area, primarily within VMU 1 of the Central & Marion site, can be most effectively restored by invasive removal and conifer planting, similar to the upland portions of the site. Shrub and groundcover plantings should be primarily wetland obligate or facultative wetland plant species, as identified by the US Department of Agriculture's Natural Resource Conservation Service Wetland Indicator Plant Lists.

3.7 Public Use

In early 2013, the North East Olympia Neighborhood Association (NENA) proposed an extension of the trail system in Mission Creek Nature Park into the property at Central & Marion. The proposal includes approximately ¼ mile of gravel-covered trail, along with a wooden foot bridge spanning the creek. The project did not receive funding in 2013, and city staff determined that further analysis of the ecological impacts of such a project was needed. There is also a proposed 0.8 mile wooded trail system linking Priest Point Park and Mission Creek Nature Park, using the Mission creek corridor. The Central & Marion property would be one segment of this trail system; to the north there are approximately 20 privately owned parcels that would require trail easements before installation of the trail could continue further along the Mission Creek corridor.

4.0 Site Recommendations

4.1 Invasive Management

Perhaps the greatest restoration impact could be made by removing the invasive vegetation found on site. *H. helix* and *R. discolor* are heavily encroaching on the edges of the property, with *H. helix* throughout the forested portions and *R. discolor* especially prevalent within VMU 3. Invasive trees and shrubs found throughout VMU 1 and 2 include *C. monogyna, I. aquifolium, Sorbus aucuparia,* and an unknown species of bamboo near the stream channel. Herbaceous non-natives are also present, such as *R. repens* throughout the site and *Symphytum officinale* within VMU 3. An attempt to remove all invasive species should be made prior to any restoration plantings. Reducing the amount of the more prolific invasive plants will increase the chances of successful native plant establishment, primarily by reducing competition between the two for the same area and resources.

4.2 Restoration Planting

We suggest a range of native tree species be planted in the area, specifically throughout VMU 2, to increase species and structural diversity. Underplanting within the *A. rubra* forest should occur, using shade tolerant conifer tree species such as *T. plicata, T. heterophylla, Taxus brevifolia,* or *P. sitchensis.* This will emulate the natural succession of a native forest, before any human disturbance. Shrubs and ground cover should also be considered for planting, particularly in areas where large amounts of invasives have been removed. Suggested shrubs for the site include *Rhamnus purshiana, S. racemosa, C. cornuta, Acer circantium,* and *O. cerasiformis.* Appropriate ferns and other ground cover for the site include *P. munitum, A. felix-femina, Gaultheria shallon, Mahonia nervosa,* and *Dryopteris expansa.* Along the southern and western edges of VMU 2, the upland forest portion of the property, *P. menziesii* plantings are suggested. These areas receive more sunlight than other areas of the forest, and a shade-intolerant species such as *P. menziesii would* be a likely and appropriate species for re-creating late-successional forest characteristics. VMU 3, the meadow area, should also be replanted with appropriate upland forest species, as it is largely within the riparian buffer. Appropriate conifer species for the meadow replanting, based on the potential productivity of the soil-type, include *P. menziesii*, and *T. plicata.* Hardwoods suitable for the area include *A. rubra* and A. *macrophyllum*. Shrubs and ground cover can be drawn from the above list of species suitable to VMU 2.

4.3 Other Restoration Activities

A substantial amount of garbage can be found in the stream channel, either directly dumped on the property or washed down from further upstream. Any restoration plan for the area should include clean-up of the stream channel. The culverts under Ethridge and Miller avenues should be inspected and cleaned, if necessary. Finally, some enhancement of the CWD component of this forest should occur, as discussed in section 3.3, above.

5.0 Maintenance Management Plan

5.1 Maintenance Requirements

Central & Marion has a variety of maintenance needs which are predictable or preventative in nature. The primary goal of all maintenance activities is to meet minimum life, health, and safety requirements, while secondary concerns focus on the design functions of the site. At minimum, a yearly site inspection should be conducted to identify any major issues or concerns. Natural areas such as Central & Marion are often targets for illegal dumping, camping, or other activities, and addressing these problems in a timely manner is crucial to keep them from becoming a larger issue. Ensuring that the site is actively maintained also illustrates the importance of these areas to private citizens in the neighborhoods where they are located. People see that these are not just vacant land, but natural resource areas being actively managed for habitat, water quality, and aesthetic values. This site also has some assets or improvements which require annual inspection and maintenance. A split-rail fence surrounds a portion of the site; this should be inspected for damage or vandalism. The culverts under Ethridge and Miller Avenues should be inspected as well, and any damage or blockage should be addressed immediately. During site inspection, a routine clean-up of the site should also occur, in particular the garbage that ends up in the stream channel.

5.2 Mowing

VMU 3, the meadow area, will be mowed yearly until the restoration plantings described in chapter 7 are successfully installed. This will reduce the amount of invasives, including *R. discolor*. Mowing will also reduce competition from grasses or other vegetation when restoration planting proceeds. Again, active management of this VMU helps to show the importance of this site to city staff and the North East Olympia neighborhood in general.

6.0 Invasive Management Plan

6.1 Integrated Pest Management

Currently, Olympia Public Works has not developed an Integrated Pest Management (IPM) policy specific for properties owned or managed by the Stormwater Utility. Until a policy addressing our City's needs and standards is developed, pest and vegetation management recommendations for the City will be based on the Thurston County IPM policy (Thurston County 2013). Below is a brief description of the IPM strategy adopted by the City, and several examples of common control strategies used for noxious weed management.

Integrated Pest Management (IPM) is defined by Thurston County as "an approach to pest and vegetation control that utilizes regular monitoring to determine if and when treatments are needed. This approach emphasizes physical, mechanical, cultural, and biological tactics to keep pest numbers or vegetation problems low enough to prevent intolerable damage, annoyance, or public safety hazards. When chemical controls are necessary, they will be the least toxic available and will be used only when no other control methods would be effective or practical". An IPM plan has several components, which are explained below:

1. Monitoring- The first step of any IPM program is identification of the type, location, and extent of the problem.

2. Determination of Injury and Action Levels- Injury level identifies the point in the growth of a vegetation or pest problem where it will cause an unacceptable amount of ecosystem, public health, recreational, aesthetic, or economic injury. Action level refers the point at which action must be taken to prevent a pest population or vegetation problem in a specific area from reaching injury level.
3. Timing- Treatments should be applied during the most vulnerable time in the life cycle of the pest or vegetation problem identified, with the least impact on the surrounding ecosystem.
4. Strategy Selection- Prescriptions for a specific site should be based on several factors, including:

- What is least disruptive to the natural controls present in an ecosystem
- What is least hazardous to human health
- What is least damaging to non-target species
- What is least damaging to the surrounding environment
- What best preserves the form and function of the natural ecosystem
- What is most likely to permanently remove or reduce the amount of pests or vegetation
- What is most likely to be implemented effectively
- And what is most cost-effective in the short and long term

5. Evaluation of treatment strategies to assess the efficacy of the IPM program and to develop future control strategies.

Some control strategies commonly used in IPM plans are:

- Prevention: An example would be using native vegetation to create shade and prevent establishment of some of the more shade intolerant invasives, such as *Cytisus scoparius*.
- Cultural Practices: This could include site preparation techniques, fertilization, watering or mulching to create optimal conditions for desirable plants, enabling them to better compete with non-native or invasive plants.
- Mechanical: These types of vegetation management include hand-removal of invasive plants, mowing, and pruning desirable species to boost plant health.
- Non-chemical: These include biological control techniques, such as the introduction of parasitic insects which feed on invasive plant species, or the introduction of mycorhiza to the soil to increase health and root growth of desired vegetation.
- Chemical: These include sprays and herbicides. Pesticides should only be mixed and applied by trained staff with a current Washington State Pesticide Applicator's License. All state and federal laws and regulations should be understood, and appropriate personal protective equipment should always be used. The directions on the labels of individual products should always be understood and carefully followed. Any chemical application of pesticides should only be done when suitable weather conditions exist. Signs should be posted in areas where pesticides are used, and all use should be documented on application forms.

6.2 Objectives, by VMU

VMU 1 and 2:

These management units have similar problems with invasive vegetation. During field analysis, it was determined that the understory of both VMU's have an average of around 30% *H. helix* cover, though individual plot percentages varied from 10 to 70%. *H. helix* can be a difficult species to manage, as it does well in shaded areas, forms dense mats which crowd out other plant species, and climb trees making complete removal a tedious and costly process. An IPM prescription, provided by Thurston County's Environmental Health Division, which describes several techniques for managing *H. helix* can be found in Appendix C. Several other invasive species can be found in these units to a lesser degree. *C. monogyna, I. aquifolium and S. aucuparia* can be found in both VMU's, and management techniques for all three small tree species are similar. A factsheet for *S. aucuparia,* provided by the USDA Forest Service, is also in appendix C. Specific management techniques for *C. monogyna* and *I. aquifolium* could not be found, though techniques used to manage *S. aucuparia* are applicable. *R. repens,* a common creeping non-native ground cover, is not currently on the Thurston County noxious weed list. *R. repens* can be found in both the wetland and upland portions of this site, but is not considered a management priority. Thurston County has written an IPM prescription for *R. repens,* which is included in appendix C. An unidentified, woody bamboo species is found in limited amounts within VMU 2.

VMU 3:

The major non-native and invasive vegetation concern for this unit is *R. discolor*. Currently, this unit is mowed yearly, which helps manage the *R. discolor* on site, though the prolific and rapidly growing shrub can put on another 10 feet of growth each year. Again, an IPM prescription from Thurston County is provided in appendix C, with a variety of suggested control options. Another concern for this unit is *S. officinale.* While *S. officinale* is not currently on Thurston County, state, or federal noxious weed lists, it is a prolific colonizer that can establish from root cuttings or vegetative sprouting. The root system is known to be deep and expansive, and rhizomes left in the ground can resprout, making management difficult. However, it prefers full sunlight, so the establishment of a forest canopy on this unit should effectively deal with *S. officinale* concerns.

7.0 Planting Plan

7.1 Objectives, by VMU

VMU 1:

This area was identified as an *A. rubra/L. americanum* plant community, an early seral community usually requiring some type of disturbance for establishment, such as a flood or land-clearing activity. If the site was unmanaged and left to grow freely the area would slowly progress towards the *T. plicata-T. heterophylla/L. americanum* community, a late-successional mixed conifer-hardwood community type. The objective for this VMU is to accelerate the succession of this forested wetland plant community. This will be accomplished by planting shade-tolerant and seasonal flood-tolerant conifers to supplement the established *A. rubra* canopy. This should accelerate forest succession into a mixed forest community beneficial to a

greater range of wildlife species. There will also be wetland-obligate or facultative- wetland shrubs and ground cover planted in areas where large amounts of invasive or noxious vegetation has been removed, to slow the re-establishment of these plants.

VMU 2:

Unit 2 was identified as an *A. rubra/P. munitum* plant community, again an early successional, disturbance-created community type. The vegetation in this VMU will also be guided into a late-successional, mixed-species, and structurally diverse plant community, modeled after the *T. heterophylla-P. menziesii/P. munitum-Dryopteris expansa* forest type. This plant community was identified in the Central & Marion Restoration Plan as the probable climax plant community for the area. To achieve this, shade-tolerant conifer seedlings will be planted throughout the VMU. Less shade tolerant tree species, such as *P. menziesii*, will be planted in areas with appropriate amounts of sunlight, such as any openings in the forest canopy, or along the southern and western edges of the unit. Any areas where invasive plants were removed will also be replanted with appropriate facultative or upland shrubs and ground cover.

VMU 3:

VMU 3 is currently a meadow, with grasses, a few fruit trees, and invasive shrubs. This area will be replanted with tree species to recreate the climax conditions outlined for VMU 2. However, to achieve this we will need to install a greater density of seedlings with a different selection of conifer and hardwood tree species. As there is currently no forest canopy in this area, *P. menziesii* would be an appropriate tree species to plant for reforestation. We would like to enhance the biodiversity of the area further than simply establishing a *P. menziesii* forest, so other tree species should be established in the area as well. *A. macrophyllum* would be an appropriate choice for deciduous plantings in the area, because they are fast-growing, adaptable to a variety of soils, and offer many benefits to wildlife.

7.2 Phase 1: Site Preparation

VMU 1 and 2: Previous restoration plantings have been successful at this site, with a minimal amount of site preparation. The only vegetation which required removal during earlier efforts was invasive *H. helix,* and management techniques for this and other invasive or noxious plant species is detailed in the Invasive Management Plan. The area cleared of invasive species will need to be replanted with more desirable native shrubs and ground cover. These activities are detailed in Phase 2.

VMU 3: The open meadow area of this site will require a bit more intensive site preparation, as the area is covered in grasses (*Graminoid* spp.) and invasive blackberry *(Rubus discolor).* It is recommended that the 0.5 acre area will be mowed and/or cleared of blackberry before planting. This will reduce competition between the existing ground cover and newly planted restoration trees, increasing the probability of successful tree establishment. Because this area will be planted at a higher density than the underplanting efforts within the established woodland, shrub and ground cover plantings will not be necessary. Once a dense overstory of *P. menziesii* and *A. macrophyllum* is established, the shade created by the new canopy should effectively deal with any remaining *R. discolor*.

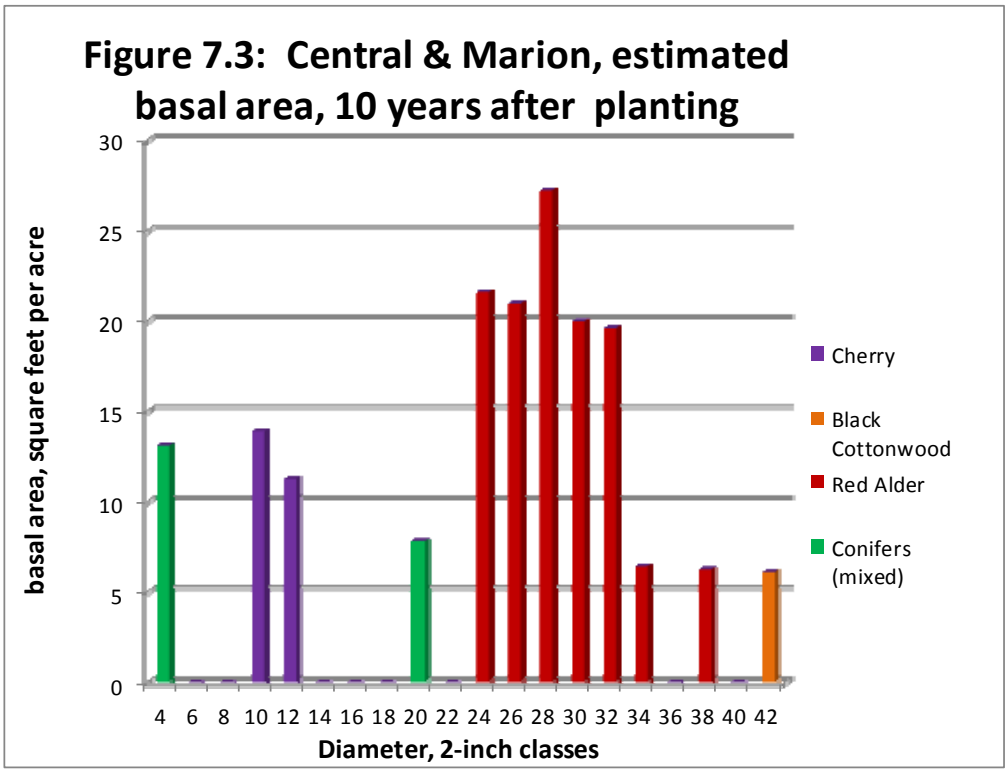
7.3 Phase 2: Tree & Shrub Planting

Tree Plantings

VMU 1 and 2: Using data collected during field surveys and making some assumptions about the mean annual diameter growth and mortality rates of *A. rubra*, a stand growth model was created to project stand density of this forest in 10 years. Hann (2011) suggested that the mean annual increase in diameter for A. rubra is 0.47 inches, or 4.7 inches over 10 years. For this site, we reduced the number to 4 inches of new diameter growth, inside bark, over 10 years, due to the increased competition created when the forest increases in volume and requires more resources to support the same amount of trees per acre. This shows a 10-year projected basal area per acre (in square feet) of 215 sq. ft. /ac, up from the current value of 145 sq. ft. /ac. To estimate tree mortality over 10 years, stand basal area was reduced by 25%, giving a final 10-year projected stand basal area of 162 sq. ft. /ac. From this data, a projected stand density index (SDI) value of 347 can be obtained. SDI and relative density (RD) are the metrics chosen to determine spacing for our restoration planting activities. The theoretical maximum SDI for an even-aged *A. rubra* stand is 450; this is relatively low for west side tree species, as alder is intolerant of shade. In contrast, the maximum SDI for a stand of *T. heterophylla*, known to be a shade tolerant tree species, is 850. Because we will be planting shade-tolerant conifers, we decided to use the maximum SDI for west side *T. plicata* of 722 to measure density on this site. Using the current SDI value of 327 for the stand at Central & Marion, and the above maximum SDI value of 722, the current relative density value was determined to be approximately 45%, which falls within the target RD range of 25%-45%. This target range is based on data suggesting that a more open forest canopy benefits wildlife by enhancing understory shrub and herb growth (Bottorff 2003). With the projected SDI value of 347 for the unmanaged stand after 10 years, RD is projected to increase to 55%. Increased density of the tree canopy will reduce survivability of understory plants, which in turn reduces the amount of forage for wildlife. Increased shade on the forest floor will also decrease the probability of successful establishment of restoration trees. Due to this increase in relative density, further reduction of stand basal area will need to occur. To accomplish this, we will remove individual *A. rubra* in direct competition with planted conifers. By removing 25-30 trees per acre of the mid-range (18-24 inch DBH) *A. rubra* on site, we can achieve a RD of 38%, within the 25%-45% target range. The final restoration planting prescription calls for an additional 150 conifers planted per acre within VMU 1 and 2, for a total of 450 seedlings within the 3 acre area. Figure 7.3 demonstrates the estimated basal area per acre at Central & Marion after restoration planting and thinning.

As discussed above, shade-tolerant conifer seedlings are the preferred tree species. The planting list includes 200 *T. plicata* and 200 *T. heterophylla*, to be underplanted throughout the unit. Another 50 *P. menziesii* will be planted along the southern and western edges of the site, where exposure to sunlight is greatest, or within any appropriate openings in the forest canopy. To achieve this planting goal, trees should be planted at a roughly 17’ by 17’ spacing throughout the unit. However, it has been shown that by attempting to plant trees in a more random fashion, with some in tighter clumps and some spaced further than the above suggestion, more structural diversity can be achieved in the forest, which correlates to more of a habitat benefit to wildlife (Johnson 2001). As deer browse of new seedlings is a significant threat to new tree establishment on this site, it is recommended that some measure of tree protection be used. Staff is currently working on a

cost and efficacy analysis of various repellent and tree protection techniques, which will be used to determine the most effective and least costly methods for preventing browse damage to planted seedlings. There could be a final recommendation of an olfactory repellent, such as Plantskydd©, plastic tree shelters, or even a welded wire "cage" around individual trees or groups of trees. As mentioned above, some thinning may be necessary by year 10 to achieve the target of RD between 25%-45%. The goals and needs of the thinning operation should be reevaluated once restoration trees have been established, using techniques similar to those used for crop tree release in eastern hardwoods (Perkey 1993). Restoration trees should be managed on an individual basis, and any *A. rubra* in direct competition with established plantings should be considered for removal. When examining the crown of each individual restoration tree, the crown will be divided into 4 separate quadrants. A determination is then made as to how many of the quadrants are free from direct competition by *A. rubra*. Wherever crowns are touching, or are within 1-2 feet of the adjacent *A. rubra* crown within a quadrant, that tree will be selected as a potential tree for removal. Once this process is done for all of the restoration trees throughout the site, 25 or 30 trees per acre with diameters ranging from 18-24 inches DBH will be selected for removal which will most benefit restoration plantings, and the stand as a whole. During field reconnaissance it was determined that this site was well below the benchmark of 1400 cubic feet per acre for coarse woody debris (CWD). For this reason, we will leave harvested trees on the ground, or scatter the logs throughout the site. This will raise the CWD component of the forest, increasing value for the reptiles, amphibians, small mammals, and birds that depend on those habitat elements.



VMU 3: This area will be replanted at a higher density than the above VMU's, to quickly establish forest characteristics in what is now essentially a meadow. 300 trees per acre, or 150 trees in the 0.5 acre site, will maximize tree growth without substantially increasing mortality due to competition (Harrington 2009). This can be accomplished by planting the trees at a 12 ft. by 12 ft. spacing. To create more structural diversity in the newly established forest, it is recommended that trees are planted in clumps, not rows, with smaller spacing intervals within each planting clump. Spacing can be greater in other areas, to leave gaps in the forest canopy and encourage shrub growth and natural tree regeneration. Tree species to

plant will be 50 *P. menziesii,* 50 *Abies grandis,* and 25 *A. macrophyllum,* in between the clumps of conifer. The final 25 trees will be a mix of species, and planting sites will be chosen individually for each. Species options for these include *Pinus monticola, Arbutus menziesii, Rhamnus purshiana, Cornus nuttallii* (on forest edge), and *T. plicata* (on forest edge).

Shrub and Groundcover Plantings

VMU 1: Groundcover and shrub planting will occur in areas where a large amount of invasive vegetation is removed. This is particularly important in areas overgrown with *H. helix,* which can grow in thick mats over large areas of land, and create a monoculture where nothing else will grow. During field surveys, it was determined that an average of around 30% of VMU 1 and 2 was infested with *H. helix*. For VMU 1, this is approximately 13,000 square feet. Once removed, this area should be replanted with a variety of obligate or facultative- wetland plants. At about 6 ft. by 6 ft. spacing, approximately 360 plants will be needed for the site. This should be a mix of shrubs, herbs, and ferns. *Cornus sericea, Athyrium filix-femina, Rubus spectabilis, Oplopanax horridus,* and *Physocarpus capitatus* are appropriate shrub and fern species for planting within this VMU, with 72 plants of each species to cover the above area.

VMU 2: Approximately 26,000 square feet of area will need to be replanted once invasive vegetation is removed. Shrub and groundcover plantings for this unit should come from more upland associated species, such as *Polystichum munitum, Symphoricarpos albus, Gaultheria shallon, Mahonia nervosa,* and C*orylus cornuta*. It is recommended that *P. munitum* make up 50% of the total to be planted, as it is relatively easy to transplant, does well in shaded conditions, and is an appropriate species to fill the niche left behind when *H. helix* is removed. 288 total *P. munitum* will be planted, along with 144 each of the other plant species listed previously.

VMU 3: As this area is currently open space with no trees, no shrub plantings are recommended until an overstory layer is established. Once a young forest exists on this unit, a survey of current understory composition will be conducted. It may be the case that enough natural regeneration of shrubs, forbs, and ferns will occur that no replanting is needed. Invasive plants may establish within the understory, requiring vegetation management and planting similar to VMU 2. Continued monitoring is required to determine the final needs of this unit.

8.0 Monitoring Plan

8.1 Adaptive Management

Adaptive management can be defined as a structured approach to addressing uncertainties by testing hypotheses, linking science to decision making, and adjusting implementation as necessary to improve the probability of a successful restoration activity. Monitoring of all restoration activities is an essential component of an adaptive management plan, to identify issues as they occur, and to make any modifications to the plan to increase chances of success. In addition to the annual site inspection detailed in Chapter 5: Maintenance Management Plan, regular monitoring will be needed to assess the success of restoration and invasive management prescriptions, and to monitor the health of the ecosystem as a whole. While monitoring will initially be conducted by city staff, there are many opportunities to include seasonal employees, members of neighborhood or non-profit groups, or volunteers from the community in monitoring efforts. Environmental

educators may also have an interest in participating in the monitoring program, as it will provide hands-on opportunities for research, data collection, and ecosystem assessment by students.

8.2 Invasive Monitoring

Thurston County's Noxious Weed Control Board lists noxious weeds under 3 classes, A, B, and C, based on criteria designated by the State of Washington. Class A weeds are often new to Washington, generally rare, and complete eradication is the goal, before the weed gains a foothold and becomes a larger problem. Other Class A weeds pose a threat to human or animal health, and eradication is required for those reasons. Class B weeds are prevalent in some parts of the state, but rare or absent in others. The goal for class B weeds it prevention of colonization into new areas, and containment or reduction of their population in areas already experiencing an infestation. Class C weeds are already widespread, and control is not required by the State. Thurston County's weed board provides advice about the most effect control methods for some Class C weeds found in the county. Most of the noxious vegetation at Central & Marion falls into Class C designation, including *H. helix* and *R. discolor*. This is because the plants are so widespread that complete eradication is infeasible, though reduction in the amounts on site is certainly a worthwhile goal. Other on-site invasives, such as *C. monogyna, I. aquifolium,* and *S. aucuparia,* are unlisted on state and county noxious weed lists. These are still prolific growers and non-native components of our plant communities, and should be removed when feasible. Following implementation of the invasive management plan discussed in chapter 6, the site should be inspected for invasive plants on an annual basis, at minimum. If any Class A or B weeds are ever found on the site, the monitoring schedule will need to be adjusted to accomplish complete eradication of those plants.

8.3 Restoration Monitoring

All restoration activities, including tree and shrub planting, will need to be monitored to assess planting success, as well as the efficacy of tree protection techniques. An annual visit is suggested as a minimum, though seasonal visits would be preferable. This will help to address any issues such as competition, shade, or browse by herbivores in a timely fashion, and improve the chances for successful restoration plant establishment.

8.4 Flora & Fauna Inventory

A full inventory of flora and fauna using habitat at Central & Marion should be conducted before any restoration activities, then repeated every 5 years to assess long-term effectiveness of restoration activities and invasive removal. While the current vegetation inventory is complete, a full inventory of wildlife use still needs to be conducted. A list of potential species using habitat at Central & Marion is included in Appendix A., though the list is based on knowledge of typical wildlife use in these types of habitat, not actual documented observations of wildlife use. Any habitat elements currently being used on site should be documented, such as inhabited nesting cavities. Any indirect wildlife sign should also be reported, such as animal tracks, antler rubs, deer bedding sites, aquatic mammal slides, or active forage sites on trees or snags.

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Appendix A: Potential Wildlife Species using habitat at Central & Marion

Taxon:	Common Name:	Scientific Name:	State Status:	Federal Status:
Amphibian	Ensatina	*Ensatina eschscholtzii*		
	Long-toed Salamander	*Ambystoma macrodactylum*		
	Northwestern Salamander	*Ambystoma gracile*		
	Rough-Skinned Newt	*Taricha granulosa*		
	Northern Pacific Treefrog	*Pseudacris regilla*		
	Northern Red-Legged frog	*Rana aurora*		
	Western Toad	*Bufo boreas*	Candidate	Species of Concern
Bird	American Crow	*Corvus brachyrhynchos*		
	American Robin	*Turdus migratorius*		
	Anna's Hummingbird	*Calypte anna*		
	Band-Tailed Pigeon	*Patagioenas fasciata*		
	Barn Owl	*Tyto alba*		
	Barn Swallow	*Hirundo rustica*		
	Barred Owl	*Strix varia*		
	Bewick's Wren	*Thryomanes bewickii*		
	Black-Capped Chickadee	*Poecile atricapillus*		
	Black-Headed Grosbeak	*Pheucticus melanocephalus*		
	Black-Throated Grey Warbler	*Dendroica nigrescens*		
	Brown Creeper	*Certhia americana*		
	Cedar Waxwing	*Bombycilla cedrorum*		
	Chestnut-Backed Chicka-dee	*Poecile rufescens*		
	Chipping sparrow	*Spizella passerina*		
	Cliff Swallow	*Petrochelidon pyrrhonata*		
	Common Yellowthroat	*Geothlypis trichas*		
	Dark-Eyed Junco	*Junco hyemalis*		
	Downy Woodpecker	*Picoides pubescens*		
	Evening Grosbeak	*Coccothraustes vespertinus*		
	Fox Sparrow	*Passerella iliaca*		
	Golden-Crowned Kinglet	*Regulus satrapa*		
	Golden-Crowned Sparrow	*Zonotrichia atricapilla*		
	Great Horned Owl	*Bubo virginianus*		
	Hairy Woodpecker	*Picoides villosus*		

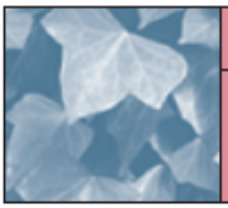
	Hermit Thrush	*Catharus guttatus*		
	Hermit Warbler	*Dendroica occidentalis*		
	House Sparrow	*Passer domesticus*		
	House Wren	*Troglodytes aedon*		
	Lincoln's Sparrow	*Melospiza lincolnii*		
	MacGillivray's Warbler	*Oporornis tolmiei*		
	Mallard	*Anas platyrhynchos*		
	Mourning Dove	*Zenaida macroura*		
	Northern Flicker	*Colaptes auratus*		
	Northern Rough-Winged Swallow	*Stelgidopteryx serripennis*		
	Orange-Crowned Warbler	*Vermivora celata*		
	Pacific-Slope Flycatcher	*Empidonax difficilis*		
	Pileated Woodpecker	*Dryocopus pileatus*	Candidate	
	Red-Breasted Nuthatch	*Sitta canadensis*		
	Red-Breasted Sapsucker	*Sphyrapicus ruber*		
	Red-Tailed Hawk	*Buteo jamaicensis*		
	Ruby-Crowned Kinglet	*Regulus calendula*		
	Rufous Hummingbird	*Selasphorus rufus*		
	Song Sparrow	*Melospiza melodia*		
	Spotted Towhee	*Pipilo maculatus*		
	Steller's Jay	*Cyanocitta stelleri*		
	Swainson's Thrush	*Catharus ustulatus*		
	Townsend's Warbler	*Dendroica townsendi*		
	Tree Swallow	*Tachycineta bicolor*		
	Varied Thrush	*Ixoreus naevius*		
	Western Bluebird	*Sialia mexicana*	Monitor	
	Western Screech-Owl	*Megascops kennicottii*		
	Western Tanager	*Piranga ludoviciana*		
	White-Crowned Sparrow	*Zonotrichia leucophrys*		
	Willow Flycatcher	*Empidonax traillii*		
	Winter Wren	*Troglodytes troglodytes*		
	Yellow Warbler	*Dendroica petechia*		
	Yellow-Rumped Warbler	*Dendroica coronata*		
Fish	Chum Salmon(historically present)	*Oncorhynchus keta*		
	Coho Salmon (historically present)	*Oncorhynchus kisutch*		
	Cutthroat Trout	*Oncorhynchus clarkii*		
	Sculpin	*Cottoidea* spp.		
Mammal	Big Brown Bat	*Eptesicus fuscus*		

	Black-tailed Deer	*Odocoileus hemionus columbianus*		
	Bushy-Tailed Woodrat	*Neotoma cinerea*		
	Common Porcupine	*Erethizon dorsatum*		
	Cottontail Rabbit	*Sylvilagus floridanus*		
	Coyote	*Canis latrans*		
	Creeping Vole	*Microtus oregoni*		
	Deer Mouse	*Peromyscus spp.*		
	Douglas' Squirrel	*Tamiasciurus douglasii*		
	Eastern Grey Squirrel	*Sciurus carolinensis*		
	Little Brown Myotis	*Myotis lucifugus*		
	Mink	*Mustela vison*		
	Mountain Beaver	*Aplodontia rufa*		
	Raccoon	*Procyon lotor*		
	Shrew Mole	*Neurotrichus gibbsii*		
	Striped Skunk	*Mephitis mephitis*		
	Townsend's Chipmunk	*Neotamias townsendii*		
	Townsend's Mole	*Scapanus townsendii*		
	Trowbridge's Shrew	*Sorex trowbridgii*		
	Vagrant Shrew	*Sorex vagrans*		
	Virginia Opossum	*Didelphis virginiana*		
	Yuma Bat	*Myotis yumanensis*		
Mollusk	Banana Slug	*Ariolimax columbianus*		
Reptiles	Common Garter Snake	*Thamnophis sirtalis*		
	Northern Alligator Lizard	*Elgaria coerulea*		
	Northwestern Garter Snake	*Thamnophis ordinoides*		
	Western Fence Lizard	*Sceloporus occidentalis*		
	Western Terrestrial Garter Snake	*Thamnophis elegans*		

Appendix B: Potential or confirmed vegetation found at Central & Marion

Scientific Name	Common Name	Type
Abies grandis	grand fir	tree
Acer circantium	vine maple	shrub
Acer macrophyllum	bigleaf maple	tree
Alnus rubra	red alder	tree
Arbutus menziesii	Pacific madrone	tree
Athyrium felix-femina	lady fern	fern
Cornus nuttallii	Pacific dogwood	tree
Cornus sericea	red osier dogwood	shrub
Corylus cornuta	beaked hazelnut	shrub
Crategus monogyna	single-seed hawthorn	tree
Dryopteris expansa	spiny wood fern	fern
Gaultheria shallon	salal	groundcover
Hedera helix	English ivy	groundcover
Hydrophyllum tenuipes	Pacific waterleaf	herbaceous
Ilex aquifolium	English holly	tree
Lysichiton americanum	skunk-cabbage	herbaceous
Mahonia nervosa	dwarf Oregon-grape	groundcover
Malus (genus name)	apple	tree
Oemleria cerasiformis	Indian-plum	shrub
Oplopanax horridus	devil's club	shrub
Picea sitchensis	Sitka spruce	tree
Pinus monticola	western white pine	tree
Poaceae(family name)	bamboo	shrub
Polystichum munitum	sword fern	fern
Populus trichocarpa	black cottonwood	tree
*Prunus (*genus name*)*	cherry	tree
Pseudotsuga menziesii	Douglas-fir	tree
Physocarpus capitatus	Pacific ninebark	shrub
Ranunculus repens	creeping buttercup	groundcover
Rhamnus purshiana	cascara	tree
Rubus discolor	Himalayan blackberry	shrub
Rubus spectibilis	salmonberry	shrub
Rubus ursinus	trailing blackberry	groundcover
Sambucus racemosa	red elderberry	shrub
Sorbus aucuparia	European mountain-ash	tree
Symphoricarpos albus	common snowberry	shrub
Symphytum officinale	common comfrey	herbaceous
Thuja plicata	western redcedar	tree
Trientalis borealis	starflower	herbaceous
Trillium ovatum	trillium	herbaceous
Tsuga heterophylla	western hemlock	tree
Vancouveria hexandra	inside-out flower	herbaceous

Appendix C: Invasive Plant Factsheets



INTEGRATED PEST MANAGEMENT PRESCRIPTION

English ivy

Description:

English ivy *(Hedera helix)* is a member of the ginseng family of plants (*Araliaceae*). It grows as a vine for up to ten years producing deeply lobed, alternating, waxy leaves with three to five points. When the plant is mature and ready to bear fruit, the leaves are only slightly lobed, if at all. Leaves are thick, waxy, shiny dark green and have distinct pale colored veins. Mature plants produce umbels (umbrella –shaped clusters) of greenish white flowers in the fall resulting in a deep purple, soft skinned, berry-like fruit in the spring. Each berry may contain up to three seeds that can be widely dispersed by birds.

Vine stems begin pale green and slender when growing along the ground and quickly become woody and stout on climbing vines. Stems produce rootlets that give the vine a hairy appearance and produce a sticky substance that allows the vine to cling to vertical surfaces. Vines can produce roots from each node, allowing it to re-establish itself from cut stems and pieces of stems left on the ground.

Impacts:

English ivy is an invasive vine in the Pacific Northwest. It grows so rapidly that it surrounds and covers many native plants so that sunlight doesn't reach them and they die. Once the vines create a thick mat across the ground, other plants have little chance to get re-established. On trees, the vines can cling to the trunk and branches and grow up and over a 90 foot tree. If left uncontrolled, the ivy will make the tree top-heavy, block out sunlight, and gradually branches will die and further weaken the tree.

Control Options:

Thurston County's integrated pest management emphasizes cultural, biological, and manual control methods to keep pests and vegetation problems low enough to prevent damage. When chemical control is considered, the least toxic product is recommended when no other control methods would be effective or practical.

Most infestations of English ivy can be effectively controlled using manual and cultural control options. Large areas covered in ivy may require the use of herbicide if time and resources are an issue.

► Cultural / Habitat

Do not intentionally plant English ivy in your landscape. This includes the varieties: *Hedera helix* 'Baltica', *Hedera helix* 'Pittsburgh, *Hedera helix* 'Star', and *Hedera hibernica* 'Hibernica'. Mulch over and replant bare areas where ivy has been removed.

► Manual / Mechanical

Hand pulling vines is very effective for controlling English ivy. The plant produces a sap that may irritate some people's skin, so wearing gloves and a long sleeved shirt is recommended. Whenever pulling or cutting vines, be careful to remove all stem fragments from the soil or they will root and start a new plant. Vines that have grown up trees or structures should be cut at an easily reached height (killing the portion above the cut) and, if possible, pulled down. Some vines may be too large to remove from trees, if so, make sure all cut sections are not in contact with soil and evaluate your tree (is it top heavy or diseased from the ivy?).

Removing large infestations along the ground will expose soil making it vulnerable to erosion, especially on steep banks. Replant areas where ground has been made bare with fast-growing native groundcover as soon as possible. Groundcover will help to keep the soil in place and will help minimize the establishment of other non-native plant species.

► Biological

There are currently no known biological controls for English ivy.

► **Chemical**

Contact herbicides kill the plant tissue it touches, and systemic herbicides are taken into the plant and transported throughout the plant to kill all the tissue. A systemic herbicide is recommended for control of English ivy because even small stem fragments left alive can root and start a new plant.

Glyphosate is an active ingredient in many systemic herbicide products that are effective in the control of English ivy. Application methods vary for the type and size of the infestation; foliar applications (spraying leaves and stems) are recommended for large ground infestations, basal bark applications (applying product to vine after removing some leaves and stems) work when upper portions of vines are inaccessible, and cut stem applications (applying directly onto cut vine stumps) are most effective when combined with manual removal of vines and plant fragments.

Timing

The best chemical control is achieved when temperatures are above 50º F for several days. However, winter may be the best time to apply an herbicide to minimize injury to surrounding plants and trees. Since ivy grows all year long, spraying an herbicide in the winter will effectively control them and will reduce the risk to other plants when they are typically dormant. Shielding or covering neighboring plants is always a good idea to protect them from herbicidal injury.

READ AND FOLLOW ALL PESTICIDE LABEL DIRECTIONS AND RESTRICTIONS. All chemical control products can cause harm if not used properly.

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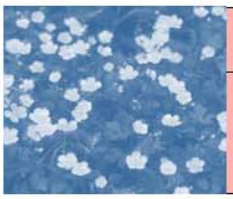

INTEGRATED PEST MANAGEMENT PRESCRIPTION

Creeping Buttercup *(Ranunculus repens)*

Description: Creeping buttercup is a short perennial plant (about 6-12 inches tall) with bright yellow flowers that shoot up to 24 inches high. The long stems grow along the ground and take root at the leaf nodes. The three-part leaves are dark green, often with pale spots, and have deeply toothed margins. Both the leaves and stems are hairy. The flowers, usually with 5 petals, are born on long erect stems spring through summer. Though creeping buttercup is capable of surviving in many soil types and exposures, it is notably problematic in wet, acidic soils with poor drainage.

John Cardina, The Ohio State University, Bugwood.org

Impacts:

Creeping buttercup spreads easily from seed and by their long stems which root and form new plants at every leaf joint. It commonly invades areas where the vegetation has been removed and wet pastures, where it displaces more desirable forage. The sap of creeping buttercup contains a toxic compound that can taint milk or cause cattle to become ill. Most often, livestock will try to avoid eating buttercup because the sap is very irritating and can cause blistering on skin and mucous membranes, but occasionally, cattle develop a taste for buttercup and consume fatal quantities.

The toxic compound in creeping buttercup (protoanemonin) is not stable, and does not retain its toxicity when dried in hay. However, hay cut from infested pastures and moved to another site can easily spread seed into new areas. Stability of the toxin in high-moisture hay and silage hasn't been determined.

Richard Old, XID Services, Inc., Bugwood.org

Difficulty in controlling creeping buttercup is compounded by several factors:

- Most livestock owners seem unaware that buttercup is an undesirable plant. It's commonly allowed to increase until livestock become ill or die.
- Most pasture management techniques such as competitive planting, close mowing, or controlled grazing aren't effective against creeping buttercup.
- Repeated tilling, though effective for controlling creeping buttercup in some areas of the country, is not an option for western Washington, since the ground moisture stays too high to allow enough repetitions, and is rarely dry enough to kill plants before they are able to establish new roots.
- Because it's a creeping perennial, it grows low enough to escape control by mowing. The continual spread and rooting of stems allows it to gradually invade even the densest pasture.
- Buttercup is so irritating that it's avoided by grazing animals; so it has an advantage over pasture plants that are closely grazed.

Control Options:

Thurston County's Integrated Pest Management emphasizes cultural, biological, and manual control methods to keep pests and vegetation problems low enough to prevent damage. The goal of Thurston County's pesticide use policy is to minimize the use of pesticides by utilizing and providing information about the most effective control options that are available and practical.

John Cardina, The Ohio State University, Bugwood.org

► Cultural / Habitat

The most important factor in creeping buttercup management is to correct the conditions that are favorable to buttercup: poor drainage, soil compaction, low fertility, and low soil ph (acidic). While these conditions are favorable to buttercup, they are very damaging to grasses; which require better drainage, aeration, fairly neutral soil ph levels, and good fertility in order to maintain a healthy, dense cover. Improved drainage through trenching or grading, soil amendments, mechanical aeration, and addition of fertilizer and lime, should be included in any buttercup control plan. Often, herbicide application is not necessary if these methods are employed. Hay harvested from infested pastures should be fed out on site, rather than transported to an uninfested area.

Bare ground can encourage buttercup seeds to germinate. Replanting desirable grass or other vegetation will help reduce the amount of weeds that germinate in those areas.

► Biological

There are currently no known biological control agents available for creeping buttercup.

► Manual / Mechanical

Manual control is only effective for small numbers of plants, and then only if care is taken to remove all the roots and plant parts. Buttercup will take root and create new plants very quickly and easily from root fragments and pieces of stems left on the ground. Because of this ability to grow from plant pieces, rototilling infested areas may actually increase the number of plants, and the long creeping stems tend to bind up around the tiller blades, making rototilling very frustrating. After manual removal, be certain to clean all equipment thoroughly, in order to prevent starting new infestations in other areas. **Be sure to wear gloves and protective clothing, as the sap from buttercups can cause irritation and blistering in some people.**

► Chemical

Control of creeping buttercup with the use of herbicides, should always include a plan for correcting the habitat conditions that allow buttercup to thrive (poor drainage, soil compaction, low fertility, and low soil ph). Spot spraying herbicides containing the active ingredient **glyphosate** (example: Roundup Pro™, Glyfos ™, etc.) is effective in controlling buttercup. A spot treatment is when you spray each plant enough so that they are wet, but not dripping, and not onto the surrounding soil or other vegetation.

Many glyphosate products have an initial glyphosate concentration of 41% and are recommended for diluting to exact percentage solutions. Herbicides labeled for spot treatment generally recommend mixing the product with water to create a specified percentage solution. For example, the Roundup Pro™ label recommends mixing a 1–2% solution for hand-held or spot applications for control of perennial weeds. Glyphosate is non-selective, and will injure any plants that it comes in contact with, including grass.

For selective control of creeping buttercup in agricultural settings (pastures, hayfields, etc.), an herbicide containing the active ingredient **aminopyralid** (example: Milestone™, Milestone VM™, etc.) may be a better choice. Aminopyralid products will not harm grass and can be used around livestock (provided all label precautions are followed). Aminopyralid is currently sold in agricultural labeled herbicides that are only to be used in areas listed on the label, and are available in farm supply stores. Aminopyralid products are considered moderate in hazard by Thurston County's review process for the potential for chemical mobility and persistence.

Aminopyralid Products: Please read the Milestone™ label for precautions. Follow all label precautions and safety measures. As a spot treatment only at a rate of 4 to 6 fluid ounces per acre (pastures section). Do not apply more than 7 fluid ounces per year. Do not enter into treated areas during the restricted entry interval of 12 hours. Keep people and pets off treated areas until spray solution has dried. Milestone should not be applied on residential or commercial lawns or ornamental plantings. Do not use plant material or hay from treated areas for mulch. Likewise, do not use manure from animals that have grazed or eaten hay from treated areas.

Herbicide/Method	Rates	Mix
RoundUp Pro® Spot/Foliar	2%	To 1 gallon of water add 2.66 oz. RoundUp Pro®, apply to foliage, covering plants thoroughly.
Milestone™ * or Milestone VM®™ * Spot/Foliar	1 tsp per 1000 ft²	**To treat a 1,000 sq. ft. area:** Using a 2 to 4 gallon backpack or tank sprayer, add half of the water needed to cover all plants with one teaspoon Milestone™, agitate, then add water to reach desired amount (0.5 - 2.5 gallons total volume, depending on quantity and size of plants). Lightly spray all buttercup plants in 1,000 sq. ft. area, then continue lightly spraying the thistle until the tank is empty and all plants have been thoroughly covered. The addition of a non-ionic surfactant (at least 80% active ingredient) is recommended to enhance herbicide activity.

Timing:

Herbicide treatments using either glyphosate or aminopyralid products can be made any time the plants are green and actively growing. Best overall control is achieved if plants are treated before flowers set seed.

READ AND FOLLOW ALL LABEL DIRECTIONS AND RESTRICTIONS. Use of brand names does not imply endorsement and is for reference only; other formulations of the same herbicides may be available under other names. Information provided is current as of the date of the fact sheet. Pesticide product registration is renewed annually and product names and formulations may vary from year to year.

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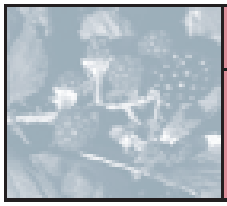


INTEGRATED PEST MANAGEMENT PRESCRIPTION

Himalayan blackberry

Description:

The Himalayan blackberry is the largest and possibly most invasive, non-native variety of blackberries in the Pacific Northwest. It was first introduced from Europe to the area as a crop plant in the 1800's. Since then, it has invaded large areas throughout the west coast.

It is a perennial plant that can reproduce from seed, root crowns, root pieces, and stem cuttings. A root crown is located at the base of a stem (cane) where nutrients are stored and numerous roots and shoots will emerge. Canes are green or green and red, stiff, angular, and have numerous large thorns. Canes have green leaves that are in groups of three or five, have jagged edges, and are round or oval shaped with a slighty pointed tip. In the second year of growth, a cane develops small white or whitish pink flower clusters that produce edible blackberries. The cane dies at the end of the second year although the plant will continue to live by producing new canes each year from root crowns.

Impacts:

Himalayan blackberry grows very rapidly and can cover and replace native habitat that is important for plant and animal diversity. Once established, it will out-compete native vegetation and cover more ground with each season. The fast growing thorny canes make removal difficult and often painful. The canes of Himalayan blackberry can grow ten feet tall and over twenty feet long in a single year.

Control Options:

Thurston County's integrated pest management emphasizes cultural, biological, and manual control methods to keep pests and vegetation problems low enough to prevent damage. When chemical control is considered, the least toxic product is recommended when no other control methods would be effective or practical.

► Cultural / Habitat

Himalayan blackberry does not grow well in areas that are well shaded. Planting an area with trees will help keep blackberry from getting established. If blackberry plants have been removed from an area it is important to remove seedlings as they appear and replant the area with native plant species.

► Manual / Mechanical

Blackberry plants can be effectively, but not easily, controlled using an approach that starts with cutting or mowing down canes and is followed by plant and root removal. Tractor mounted mowers, brush cutters, hedge trimmers, etc. can be used to cut down canes. Mowing can also provide the benefit of mulching and will make the site more accessible. A mattock (pick ax) and shovel can be effective in digging up root crowns located at the base of each cane (both ends of the cane can have roots if the cane tip touches the ground). After the site has been cleared the entire area should be monitored for blackberry seedlings. Mowing is easiest when the plant is shorter than 18 inches high and cutting of blackberry for control needs to be ongoing throughout the growing season (5 or more cuttings) and will require cutting year after year.

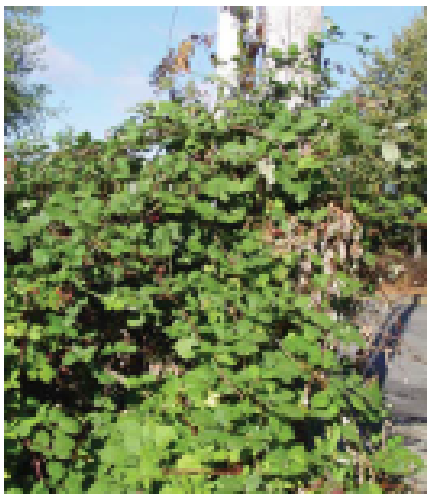
► Biological

Goats have been used to control small to modest sized infestations of blackberry and, once the mature plants have been removed, chickens have been used to help in the removal of seeds.

► Chemical

Chemical control combined with site clearing and replanting is the most effective way to remove blackberry. Canes can be cut down and removed in mid-summer to help with site access, emerging shoots and re-growth can be treated with an herbicide later in the season when it is most effective. An area that has had mature plant control will likely require follow-up control of seedlings, either by physical removal or further chemical control. Also, remember to replant the area with desirable native plants to prevent growth of another unwanted species.

Glyphosate is the active ingredient in many herbicides and is very effective in controlling blackberry. Because glyphosate is a systemic herbicide, it is absorbed and circulated to all plant parts and prevents the roots from producing new shoots. A 1% to 1.5% concentration of glyphosate is recommended for effective control. Glyphosate products are non-selective and will likely kill or cause chemical injury to any plant that is sprayed – shield or cover neighboring desirable plants to minimize the chance of unwanted injury.



Timing

Hand removal of root systems is easiest when the ground is very wet (late fall through early spring) but, removal at any time of the year will be effective. Seedling control must be done in the year they appear, prior to flower and seed production – but follow up removal must be performed each year since the seeds can sprout several years after they are in the soil.

Chemical control of mature plants is most effective late in the season (September) when the plant has produced fruit but before the first killing frost. Late summer is when blackberry plants store nutrients in the root system, so systemic herbicides used at this time will also be sent to the roots and improve control.

READ AND FOLLOW ALL LABEL DIRECTIONS AND RESTRICTIONS. Use of brand names is not an endorsement and is for reference only; other formulations of the same herbicides may be available under other names. Information provided is current as of the date of the fact sheet. Pesticide product registration is renewed annually and product names and formulations may vary from year to year.

REFERENCES:

Oregon State University. PNW Weed Management Handbook. PNW Weeds – Control of Problem Weeds; Introduction, beancaper to bursage. 2007. http://pnwpest.org/pnw/weeds

Bennett, Max. Oregon State University, Extension Service. Managing Himalayan Blackberry in Western Oregon Riparian Areas. EM 8894. Published; September 2006 and reprinted February 2007.

King County Noxious Weed Control Program. Best Management Practices: Evergreen blackberry (*Rubus laciniatus*) and Himalayan blackberry (*Rubus discolor syn. Rubus armeniacus*). March 2005.

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Weed of the Week

European Mountain Ash

Sorbus aucuparia L.

Common Names: European mountain ash, rowan

Native Origin: Originally from most of Europe, northern Africa, and western Asia

Description: A deciduous tree in the rose family (Rosaceae) that reaches heights of 25 to 30 feet and widths of 15 to 25 feet . The main trunk is often short, becoming multi-branched and the crown is initially elliptical but becomes wider with age. Bark is light grayish brown, generally smooth with numerous lenticels when young. Cracks, splits and scaly patches develop on older trunks. Leaves are alternate, pinnately compound, and 5" to 9" long. Individual leaflets are serrated on their upper halves, 1 to 1.5 inches long, dull dark green above and paler green below. In fall, leaf color is red to yellow, although sometimes leaves simply drop green. Showy clusters of small white flowers appear in late spring to early summer. Small, orange-red fruits, 3/8 inch in diameter are born in terminal clusters that ripen in fall. Fruits are usually eaten by birds and often do not persist on the tree into the winter. Seeds germinate quite readily in the landscape. Thousands of seeds are produced per plant per year. Seeds have a strong innate dormancy that lifts gradually over a few years. The seeds remain viable in the soil for five years or more. Birds consume the fruits in the fall and helped spread it.

Habitat: It favors cool to cold climates, full sun, and well-drained, loamy acidic soils. Trees can grow in urban areas where air pollution, poor drainage, compacted soil, and/or drought are common.

Distribution: This species is reported from states shaded on Plants Database map. It has been reported to be invasive in Iowa, Illinois, Maine, Minnesota, Oregon, Washington and forest communities in Wisconsin. It has naturalized in 27 northern states throughout moist cool regions of North America.

Ecological Impacts: This species has escaped ornamental plantings and is able to invade, integrate and dominate plant communities.

Control and Management:

- **Manual**- Hand pull small seedlings or dig up young trees
- **Chemical**- It can be effectively controlled using any of several readily available general use herbicides. There are many possible ways to apply such herbicides, e.g., on foliage, on cut stems, as an injection, or as a basal spray directed to the bark of uncut stems. Repeat applications may be necessary to reduce densities. Follow label and state requirements. Managers should evaluate the specific circumstances of each infestation, seek professional advice and guidance if necessary, and use the herbicide in a manner that is consistent with the product label and other state requirements.
- **Natural enemies**- This plant species is susceptible to borers, cankers, rusts, aphids, sawflies, scales and frequently develops fire blight.

References: US Forest Service Fact Sheet ST599- http://hort.ifas.ufl.edu/trees/SORAUCA.pdf, http://akweeds.uaa.alaska.edu/pdfs/species_bios_pdfs/Species_bios_SOAU.pdf. www.cnr.vt.edu/dendro/dendrology/syllabus/factsheet.cfm?ID=321, http//plants.usda.gov, www.nps.gov/plants/alien/map/soau1.htm, www.hort.uconn.edu/plants/s/sorauc/sorauc1.html, www.invasive.org/browse/genus.cfm?id=Sorbus, http://www.ag.ndsu.nodak.edu/aginfo/trees/handbook/th-3-89.pdf

Produced by the USDA Forest Service, Forest Health Staff, Newtown Square, PA. **WOW 04-10-06**
Invasive Plants website: http://www.na.fs.fed.us/fhp/invasive_plants